NORTHERN ONTARIO PRECIPITATION COMPARISONS

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INTRODUCTION

During the period 1967 to 1978 the Atmospheric Environment Service operated a network of 18 automatic recording precipitation gauges in Northern Ontario. The purpose of this network was to supply precipitation data to a federal/provincial study on the quantity and quality of water flowing into Hudson and James Bays in Northern Ontario (Inland Waters Directorate, 1973).

The precipitation gauge used in the project was the Fischer and Porter digital recording gauge which is capable of measuring all forms of precipitation. Frozen and freezing precipitation - normally snow - was converted to water-equivalent by melting these types into an antifreeze solution within the gauge.

STUDY AREA AND CLIMATE

The study areas covered approximately 200,000 km^2 in Northern Ontario, bounded by the coast of Hudson and James Bays to the north, and approximately 50^{o} latitude to the south, the Manitoba provincial boundary to the west and the Moose River to the east. The topography is generally quite flat, rising upward from Hudson Bay to 300-400 m at the edge of the Canadian Shield. The area is covered by many lakes in the western and southern sections and has vast wetlands in the northern and eastern portions.

The climate of Northern Ontario may be classified as modified continental, with the modification mainly provided by the Great Lakes to the south and Hudson and James Bays to the north (Chapman and Thomas, 1968). Precipitation averages 650 mm annually, 200 mm of which normally falls as snow. Major storms produce most of the winter precipitation and generally sweep in from the southwest, picking up moisture from the Great Lakes. These storms move quickly and usually persist for one or two days, thus producing a relatively even precipitation pattern across the area.

GAUGE SITE EXPOSURE AND DATA

The majority of the precipitation gauge sites were in isolated locations which were selected because of their proximity to major rivers or stream gauging stations. As a result, many sites lacked ideal meteorological instrument exposure and were sheltered by trees 5 to 10 meters in height on one or more sides. This selection of gauge exposures allowed the 18 sites to be divided into three classes:

1) exposed - no obstructions* within 50 m of gauge
2) partially sheltered - some obstructions* within 50 m of gauge
3) sheltered - obstructions* within 50 m of gauge

*obstructions - generally, trees 5 to 10 m high

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In order to compare winter precipitation (snowfall) from gauges in the three classes of exposure, precipitation for the months of October through March was considered.

Means of monthly and seasonal precipitation totals were calculated for all stations. Comparisons of winter precipitation between exposed sites and sheltered sites are shown in Figure 1 and Table 1.

Point measurement of snowfall by recording gauges will most often differ from site to site, even over short distances. It was assumed that the relatively even precipitation pattern across Northern Ontario and the use of ten year monthly means, would minimize these spatial differences when comparing precipitation from gauge sites with different exposures.

The mean winter precipitation from exposed and partially exposed sites was calculated as a percentage of the mean precipitation from the nearest sheltered sites(s). These percentages are shown for all sites in Table 2 as the "estimated exposure undercatch" and were calculated by:

EX1 - mean winter precipitation from exposed site
S1,S2 - mean winter precipitation from sheltered site #1, #2 ....

GROUP MEAN UNDERCATCH

Each classification group was made up of six stations. The mean of the precipitation undercatch percentages of each group, became the "Group Mean Undercatch." Winter precipitation means for each station were adjusted according to the station's site classification or exposure, as shown in Table 2.

Data from the exposed sites averaged 15.3 per cent less than the mean precipitation from the sheltered sites. The partially exposed sites averaged 11.7 per cent less precipitation than sheltered sites.

Mean winter precipitation and adjusted mean precipitation values are plotted on maps and shown in Figure 2. An average adjustment of 20 millimetres or 10 per cent, appears to be general across Northwestern Ontario with respect to the 1967-1978 mean winter precipitation.

CONCLUSION

McKay (1968) noted that any instrument has limitations in its ability to measure point snowfall accurately. Site selection (e.g. exposure) is one of these limitations. The differences in mean winter precipitation between the three classes of site exposures in the NOWRS network support this observation.

Precipitation caught in a weighing type precipitation gauge used in Northern Ontario was approximately 20 per cent more in a sheltered site than that in an exposed site. Also, the upward adjustment of precipitation data from the automatic gauge network, matches the data from the climatological station network very well when snowfall water equivalent representative of the region is considered (e.g. snow depth x .08 = W.E.).

Automatic gauges, capable of measuring all forms of precipitation are increasing in use and the knowledge of what they are measuring or not measuring should be improved. Comparing gauge site exposures is only one way of learning about the inconsistencies often found in the data. Whether or not adjustments for the undercatch can be made to some data sets of snowfall measurements is still questionable, however, the results from the Northern Ontario study are at the very least promising, but further studies into the problems of gauge undercatch of snowfall are necessary.

REFERENCES

Chapman, L.J. and Thomas, M.K., 1968: The Climate of Northern Ontario. Climatological Studies No. 6, Dept. of Transport, Meteorological Branch, Toronto, Ontario, Canada.

Inland Waters Directorate, 1973: Northern Ontario Water Resources Studies. Water Resources Branch, Ottawa, Canada.

McKay, G.A., 1968: Problems of Measuring and Evaluating Snow Cover. Proceedings, Workshop Seminar on Snow Hydrology; Canadian National Committee, IHD, Dept. of Supply and Services; Ottawa, Ontario, pp. 49-62.

Table 1

Comparisons of Mean Winter Precipitation (Oct - Mar)

Exposed Sites (A) vs Sheltered Sites (B)

Site A	Site Exposure Class	Winter Pcpn	Site B	Site Exposure Class	Winter Pcpn	Percentage A/B x 100
Lansdowne House	1	167.4	Karl Lake	3	197.7	84.7%
Lansdowne House	1	167.4	Shred Lake	3	211.5	79.2%
Ghost River	1	204.4	Mammamattawa	3	263.9	77.5%
Dog Hole Bay	1	155.2	Shed Lake	3	211.5	73.4%
Sandy Lake	1	153.9	Muskrat Dam Lake	3	186.3	82.6%
Ogoki Post	2	218.3	Mammamattawa	3	263.9	82.7%
Ogoki Post	2	218.3	Fort Hope	3	218.7	99.8%

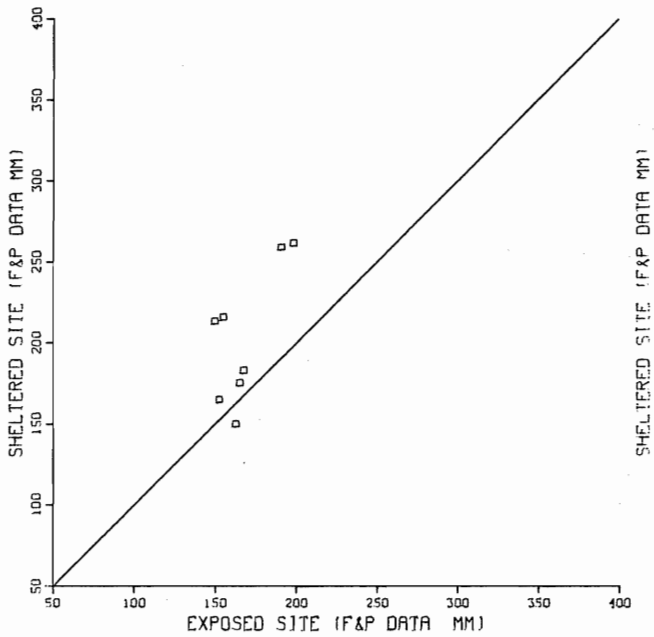
Table 2

Estimated Exposure Undercatch

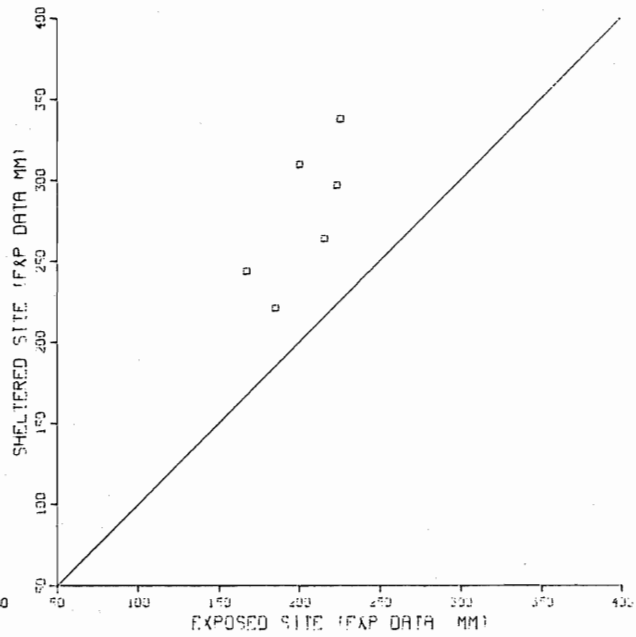
Station Number	Station Name	Site Exposure Class	Mean Precip (mm) Oct - Mar	Undercatch %
1	Agusk Lake	2	161.5	10%
2	Dog Hole Bay	1	155.2	20%
3	Fort Hope	3	218.7	0
4	Ghost River	1	204.4	15%
5	Karl Lake	3	197.7	0
6	Lansdowne House	2	170.4	19%
7	Mammamattawa	3	263.9	0
8	Mattice	1	224.3	12%
9	Melchett Lake	2	213.0	9%
10	Muskrat Dam Lake	3	186.3	0
11	Ogoki Post	2	218.3	9%
12	Onakawana	1	187.9	14%
13	Ranger Lake	2	172.8	10%
14	Root Portage	1	176.7	11%
15	Sandy Lake	1	153.9	20%
16	Sachigo Lake	2	151.4	13%
17	Shred Lake	3	211.5	0
18	Webequie	3	196.6	0

FIGURE 1

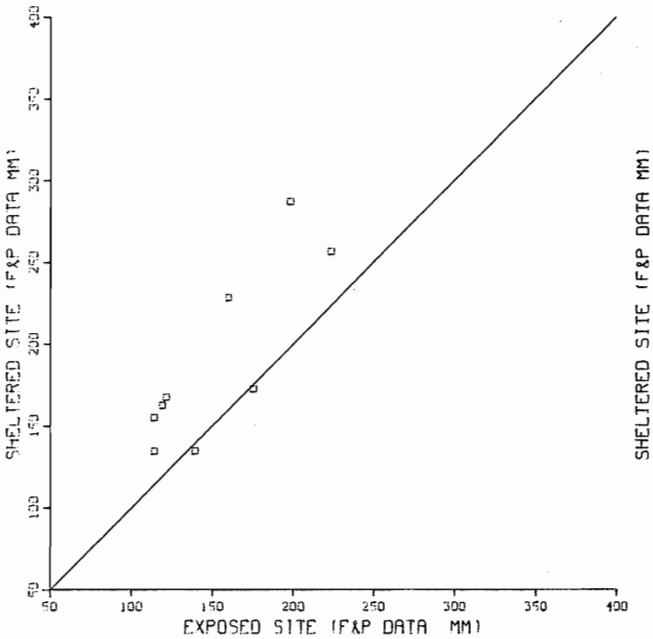
SITE EXPOSURE COMPARISONS
1967-1978 MEAN WINTER PRECIPITATION
(MONTHS: 1, 2, 3, 10, 11, 12)



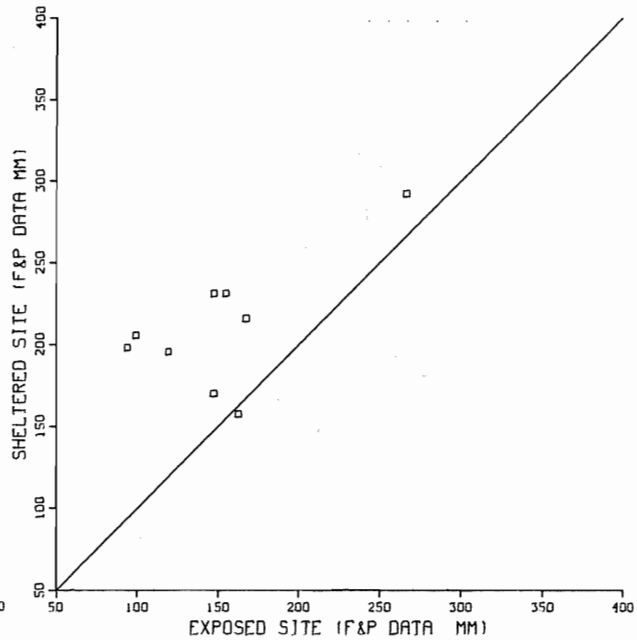
EXPOSED SITE - LANSDOWNE HOUSE
SHELTERED SITE - KARL LAKE



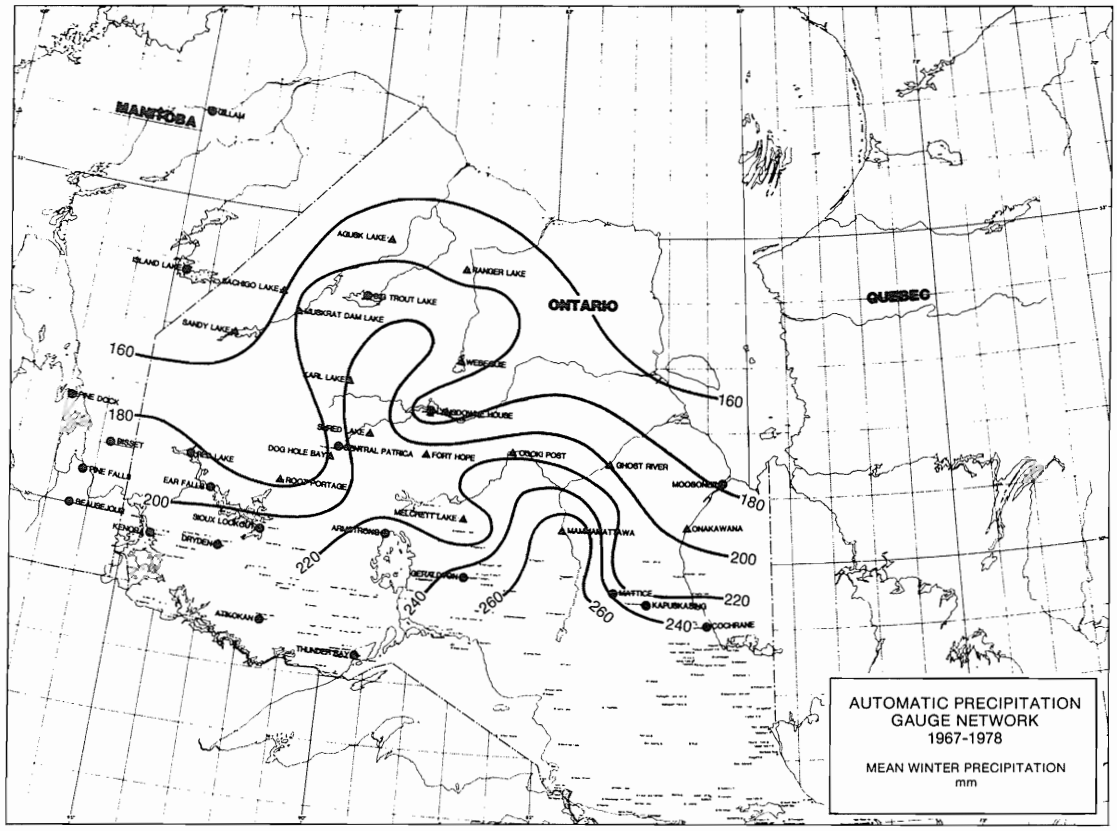
EXPOSED SITE - GHOST RIVER
SHELTERED SITE - MAMMAMATTAWA



EXPOSED SITE - SANDY LAKE
SHELTERED SITE - MUSKRAT DAM LAKE



EXPOSED SITE - DOG HOLE BAY
SHELTERED SITE - SHRED LAKE


MANITOBA
ONTARIO
QUEBEC
160
180
200
220
240
260
AUTOMATIC PRECIPITATION
GAUGE NETWORK
1967-1978
MEAN WINTER PRECIPITATION
mm

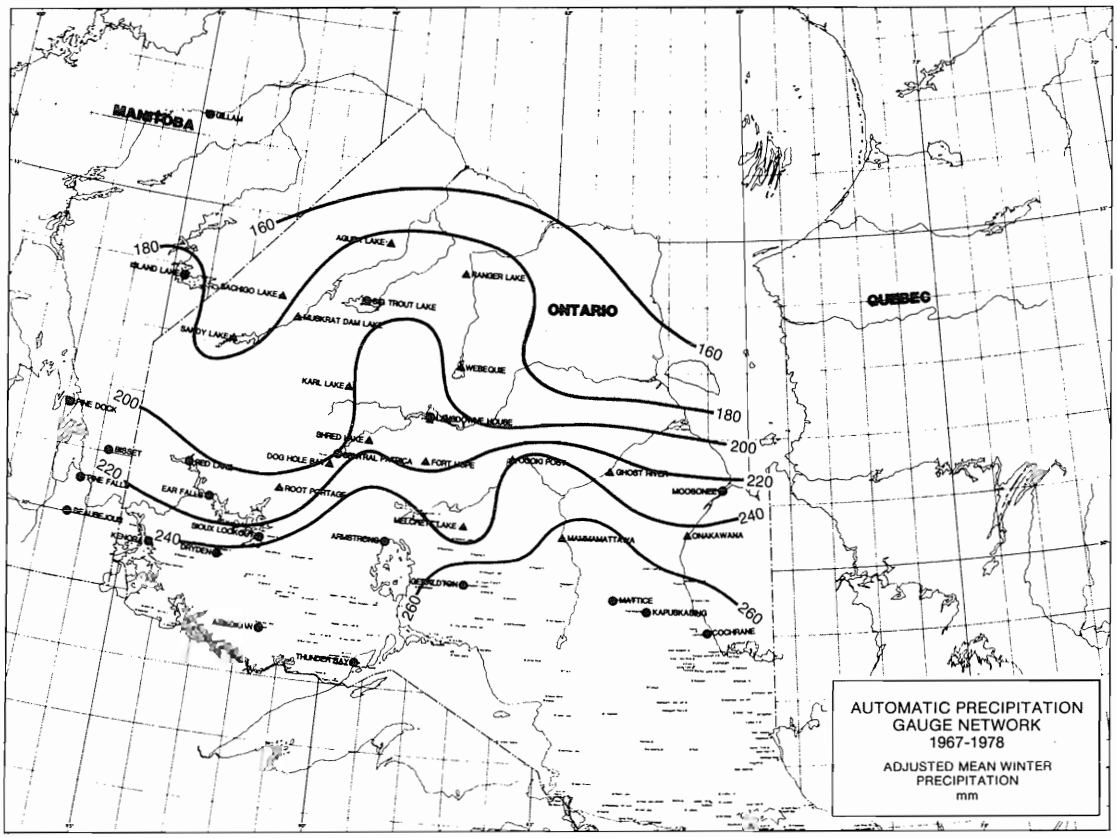

MANITOBA
ONTARIO
QUEBEC
160
180
200
220
240
260
AUTOMATIC PRECIPITATION
GAUGE NETWORK
1967-1978
ADJUSTED MEAN WINTER
PRECIPITATION
mm

FIGURE 2