Frontline

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Getting into the Zone – what does Canada's new plant hardiness zones map really mean?

by

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INTRODUCTION

Confusion and Controversy?

Canada's new Plant Hardiness zones map http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/intro.html seems to have generated some confusion and controversy. Zones have stayed the same in many areas, changed slightly in a few areas and seemingly changed significantly more in a couple of key noticeable locations – parts of southern Vancouver Island and a few spots in deep southern Ontario. Why is this, what does it mean for growers and where do we go from here?

METHODS AND DISCUSSION

To understand the changes and implications it is important to explain how the new and original maps were created (see Ouellet and Sherk 1967 or McKenney et al. 2001).

1) The map is the result of a mathematical formula that adds together several long-term climate factors; mean minimum temperature of the coldest month, frost free period in days, rainfall June through November, mean maximum temperature of the warmest month, rainfall in January, mean maximum snow depth and maximum wind gust in 30 years.

2) The formula was established in the early-to-mid 1960s and came about by statistical analysis of the survival of 174 ornamental trees and shrubs at just 108 locations across the country.

3) The formula gives a hardiness index (usually a number between 0 and about 100). A 42.2 would be in zone 4a, 68.3 would be in zone 6b and so on.

4) In the original work the index was calculated at just 640 location weather stations across the whole country and the map was produced by hand drawing the general zones between these stations.

The new zone map was produced by creating new climate maps of all the variables needed for the formula. These maps are actually computer models that were "gridded". Values for each climate variable were estimated across the country at a spacing of approximately every 2 km. We actually did this for two time periods – 1930-1960 and 1961-1990. The first time period roughly matched the period of the original work and matched the original map surprisingly well even though they were developed with different methods. This is an important point because everyone's point of comparison is the original map. However, we also included the effects of elevation on our climate maps. This inclusion significantly improves the quality of the maps because elevation has such a big influence on climate.

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Elevation influences are very noticable in mountainous areas; although they are subtle in other areas, they still have an effect. The journal article goes into much more detail about the methods (McKenney et al. 2001). Table 1 attempts to put the index into perspective and focus attention on the data that went into making the new map. Several weather station locations are listed from British Columbia and Ontario. These are stations from parts of the country where the new map seems to have generated some controversy or confusion. Also

Table 1: Some plant hardiness zone estimates for selected locations in British Columbia and Ontario

Station Name	Longitude	Latitude	Elevation	Index station data point	Zone	Index nearest grid	Zone	Index from climate model	Zone
Victoria Gonzales Hts, BC	-123.317	48.4167	70	88.1	8b	69.2	6b	79.9	7b
Patricia Bay A, BC	-123.433	48.65	20	70.2	7a	67.2	6b	72.7	7a
Abbotsford A, BC	-122.367	49.0333	54	75.1	7b	79.7	7b	80.3	8a
Agassiz, BC	-121.767	49.25	15	83.9	8a	81.2	8a	81.9	8a
Langley Lochiel, BC	-122.583	49.05	101	64.7	6a	80.3	8a	79.9	7b
N Vanc Gr. Mtn Resort, BC	-123.083	49.3833	1128	64.5	6a	63.5	6a	60.4	6a
Burnaby Mtn Terminal, BC	-122.933	49.2667	137	88.9	8b	81.1	8a	80.1	8a
Burnaby Simon Fr. U, BC	-122.917	49.2833	366	80.4	8a	77.3	7b	80.8	8a
Vancouver A, BC	-123.167	49.1833	3	79.5	7b	65.3	6b	63.6	6a
Delhi, ONT	-80.55	42.8667	232	59.8	5b	58.2	5b	60.1	6a
Harrow, ONT	-82.9	42.0333	191	66.6	6b	65.5	6b	67.1	6b
Niagara Falls, ONT	-79.0833	43.1333	183	67.6	6b	63.6	6a	63.9	6a
Woodstock, ONT	-80.7667	43.1333	282	57.5	5b	57.8	5b	58.7	5b
Niagara Falls Ont Hydro	-79.0833	43.0833	198	55.7	5b	63.7	6a	63.7	6a
Niagara on the Lake, ONT	-79.1333	43.25	81	62.9	6a	64.4	6a	64.7	6a

included in the table are the latitude, longitide and elevation of the stations. This information is important because these locations are sometimes incorrectly recorded, which can influence the climate models (and maps) because they require quite precise station locations. In the table, the plant hardiness index was calculated in three ways. The first approach uses the exact station data. The second approach uses the nearest grid point value on the new map. The third approach uses the mathematical climate models that generated the maps, with values calculated at at exact longitude, latitude and elevation coordinates.

Errors in Station Data

The first point to notice is that each approach gives a slightly different answer. While the first approach, which uses station data, is probably as close to the "truth" as possible, the fact is, there are sometimes errors in the station data. Also, several of these stations do not record all the data needed to calculate the plant hardiness index. In these cases it is usually values for wind and snow cover that have to be estimated. In the old map these values were often estimated from existing maps. In fact it is very difficult to measure rain, snow depths and even wind speeds. Relatively small changes in these numbers can change the index value by 1 or 2 zones, especially in southern B.C.. Even temperature readings can have errors. Plus or minus half a degree celcius is usually considered as the measurement error for temperature readings. Despite the best efforts on quality control, errors are still possible. They can range from misplaced decimal points, to wrong locations or even missing records. The bottom line is that one should not expect the results to be exactly the same from using the climate model results to using the exact station data.

Estimates Between Weather Stations

The second point is that for climate mapping the biggest challenge is accurate estimation away from weather stations – exact estimation at weather station locations is actually quite trivial and assumes there are no errors in station data. Some arguments can be made that a good model may better represent the climate of an area (sometimes, not always) because it uses all the data in a region and "smooths" out anomolies that might in fact be errors.

The main advantages of new climate mapping method are as follows:

- Provides quite accurate estimates of climate away from the weather stations
- Uses more station data that went into the original map
- Repeatable.

The original plant hardiness zone map would be very hard to replicate even if the climate had not changed over the last 30-40 years. The new climate maps are probably among the best available climate maps for Canada and they use methods that are repeatable. So when errors are corrected or new data are available in the future the map can be updated again.

Except for a couple of cases, most of the index values in the table are quite close to each other but when the index is rounded off into a zone more confusion can occur. For example, the Niagara on-the-Lake station data gives an index of 62.9 (zone 6a), the climate model is 64.7 (round to 65 which is 6b). There are a couple of more noticeable stations out west.

The Victoria Gonzales Heights station data gives an index of 88.1, the nearest grid value is 69.2 (which is what is on the Internet map) and the model approach gives 79.9. These are zones from 8b to the very edge of 6b. The snow depth variable is the likely cause of the differences here when you compare the results to the old map. For example, if the snow depth value is changed to 15cm from the 3.7cm in the station data, then the index changes to 94, a zone 9a, almost 9b. This perhaps suggests that a little bit of protection, for example, mulching, can make a big difference in plant survival in this area.

The Map is Only a Guide

The third point to consider is that small changes in some factors can make a big difference, but not in all locations. The results are not so sensitive in Ontario. However, this re-emphasizes the point that the zones are only a general guide. Sometimes plus or minus two zones may be reasonable, especially where there are big gradients in snow or wind in small areas. Consider too, that the zones were not originally designed to support the movement of perennial flowers, which is what many gardeners want to use the zones for. Year-to- year weather changes, combined with the effects of micro-climate and gardening practices, have impacts on plant survival. Gardeners appreciate that the vagaries of weather in any given year can have a huge impact on plant survival.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The original Plant Hardiness Zones map calculated a hardiness index based on just 640 locations across Canada, and hand-drawing general zones between stations. The new map is produced using climate models that incorporate long-term climate factors, that affect plant survival, over a 2km gridded surface across the country.

These models also take elevation into account. The new map was developed for the time period of the original map (1930-1960) and a later period of recorded data (1961-1990).

Despite its improvements, the new map like the old map should be used as a guide only, and not a substitute for expertise and experience. Errors remain in station data and in estimates in between stations. Weather is unpredictable and subject to local variation. Gardening practices including soil preperation, management of micro-climate and the use of specialty plant varieties, have an impact on plant survival and growth. Ultimately, it is the skill and judegment of the grower that determines success; the map is but one tool at his or her disposal.

Interest has been expressed in enhancing the map to include climatic profiles for hundreds of plant species. With the help of the Internet this work is underway bringing people, data and modelling together in a project called "Going beyond the Zones" see Frontline Technote No. 104.

References

McKenney, D.W.; Hutchinson, M.F.; Kesteven, J.L.; Venier, L.A. 2001. Canada's plant hardiness zones revisited using modern climate interpolation techniques. Canadian Journal of Plant Science 81: 129-143.

Oullet, C.E.; Sherk, L.C. 1967. Woody ornamental plant zonation. III. Suitablity map of the probable winter survival of ornamental trees and shrubs. Canadian Journal of Plant Science 47: 351-358.

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