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IMPACT DES CHANGEMENTS CLIMATIQUES SUR LE SKI ET LE GOLF AU QUÉBEC

**(Impacts of and adaptation to GHG climate change on the ski and golf recreational activities
and the tourism industry: A case study in Quebec)**

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Submitted to

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Executive Summary

Several scientific studies, all with varying levels of certainty, show that climate changes and their variability due to the increasing atmospheric concentrations of greenhouse gases will manifest themselves in the future. Such climate changes will, in all likelihood, affect a number of climatic variables at the global scale. However, the magnitude and extent of regional and local climate changes will be more difficult to predict.

These climate changes, including their variability, will most likely have significant impacts on several economic sectors, including those of the tourism and recreation industries. In Southern Québec, Canada, the ski and golf industries, according to most studies, will be affected in some manner by these climate changes. In the context of such climate changes, the different spheres of economic activity, that are likely to be directly or indirectly affected by climate changes, may suffer serious disruptions which would call for the implementation of a variety of adaptation measures. However, these measures would require an understanding of the issues surrounding the likely future impacts of climate change.

The ski and golf operations form two of the major sectors of the tourism industry of Québec. These recreational activities are fragile and very sensitive to the vagaries of climate. For instance, the ski industry can be severely affected by mild winters, which can have major economic impacts. On the other hand, although the golf industry may be favored by slightly longer seasons, it may be negatively impacted by such climate changes as an increase in rainy days and an increase in extremely hot days. These impacts, amongst others, attributable to future climate change and variability can seriously influence the profitability and viability of these two key tourism activities in Southern Québec.

In order to undertake the impacts and adaptation studies on the ski and golf industries in southern Québec, we selected certain representative sites for three key regions, namely: Montréal and the Laurentians, Québec City and Charlevoix and the Eastern Townships. These stations were selected based on certain criteria such as the availability of climate and activity data and elevation. For the ski sector the following stations were retained: Montréal and La Macaza for the Montréal-

Laurentians region; Québec City and Grands Fonds for the Québec City-Charlevoix region and Sherbrooke and Lennoxville for the Eastern Townships region. Similarly, for the golf sector the following stations were retained: Montréal and Saint Hippolyte for the Montréal-Laurentians region; Québec City and Grands Fonds for the Québec City-Charlevoix region and Sherbrooke and Sutton for the Eastern Townships region.

For the detailed studies and analyses on the impacts of climate change on the ski and golf industries in Southern Québec, we used the diagnostic outputs of two coupled atmosphere-ocean general circulation models (AO-GCMs), namely the Canadian (CGCM1) and the British (HadCM3: A and B) models, for three time slices: a control/observed period (1961-1990); a short-term future period (2010-2039) and a long-term future period (2040-2069). The climate variables chosen for the impacts and adaptation studies included: maximum and minimum air temperature, precipitation (snow and rain), atmospheric humidity and wind speeds. Furthermore, other climate parameter and indicators were calculated from these data sets for both the ski and golf sectors. For the control (1961-1990) period, observed data was obtained from Environment Canada. However, for all stations except Montréal, statistical procedures involving mainly regression analyses between neighboring stations were used to fill the gaps for missing data.

We then used the outputs of the two A-O GCMs, namely the CGCM1 and HadCM3 (A and B) to derive the changes in the selected climate variables for the two future time periods (2010-2039 and 2040-2069). Given, the inadequacies of the outputs of the AO-GCMs at the global scale, in order to derive the pertinent climate data at the local and regional scale, we used downscaling procedures using the Statistical Downscaling Model (SDSM). For the control (1961-1990) period observed data is first compared to AO-GCM simulated data. Then, the climate changes for the two future time periods (2010-2039 and 2040-2069) are derived by adjusting the observed (1961-1990) accordingly.

For the golf sector, a further number of agroclimatic indices, in-season and off-season, are calculated for each of the stations within the three study regions, for the observed (1961-1990) and for the two future time periods (2010-2039 and 2040-2069). Furthermore, irrigation requirements

during the golfing season are calculated for each of the stations within the three study regions, for the observed (1961-1990) and for the two future time periods (2010-2039 and 2040-2069).

The results of our research on the impacts of and adaptations to climate change of the ski and golf industries in Southern Québec show that future climate change and variability will have significant impacts on these two key sectors in Southern Québec. According to the three climate scenarios used (CGCM1 and HadCM3 A and B), for the two future time periods (2010-2039 and 2040-2069), for the three study regions, namely, the Montréal-Laurentians region, the Québec City-Charlevoix region and the Eastern Townships region, there will very likely be important changes in variety of key climate variables and parameters, mainly temperature and precipitation, which will cause negative impacts, more so for the ski as opposed to the golf sector.

Based on the results of our study the following conclusions have been arrived at in relation to the impacts of and adaptation to climate change and variability for the ski sector:

- The impacts of climate change on the length of the ski season and on snow conditions during the ski season will vary according to the region in question, the future time period involved and the climate scenario used.
- There will be a drastic reduction in the length of the ski season in the future, more so for the regions situated more to the South, namely, the Montréal and Eastern Townships regions.
- In Southern Québec, as a measure of adaptation already in place, the vast majority of ski stations operate with artificially fabricated snow, so much so that in today's context, the amount of accumulation of natural snow is less of a determining factor insofar as the viability of a ski centre is concerned.
- The ski season, even by making snow at -2°C or at -5°C , faces the risk of being severely compromised, for stations in the Eastern Townships (Sutton), where the season be shortened to periods ranging from 67 days (at -5°C) to 90 days (at -2°C) (2010-2039) and to 36 days (at -5°C) to 68 days (at -2°C) (2040-2069).
- In the ski sector there are a number of windows of opportunity for gaining revenues, more so insofar as tourists coming from outside of Québec (United States, Ontario, Europe) are

concerned. These windows are: thanksgiving weekend at the end of November in the United States, the Xmas break at the end of December-beginning of January, the March break, and for certain more northerly and higher centers, the Easter weekend at the beginning of April. In fact, most ski stations plan their season and their profitability by hoping to achieve at least two-thirds of their revenues during these critical periods.

- For some ski stations in the future, for instance the Easter Townships, certain critical periods, as the Xmas break and the March break and the Easter weekend may be completely lost on account of poor or non-existent snow conditions, with significant losses of revenues.
- Snow-making may be the only possibility for certain ski centers to continue to operate. But for stations in the more Southerly locations of Québec (Montréal, Eastern townships), even this will be limited by the shortened season and mild and rainy conditions.
- On the other hand, climate warming (less intense cold, especially when combined with windiness) may favour the number of skiable days for certain stations.
- The ability to have access to water for snow-making is already a problem in certain cases and this problem will become a more important issue with climate change. Currently water for snow-making is accessed from drainage basins within or adjacent and these water withdrawals must be authorized by the provincial Ministry of The Environment, which exercises restrictions to the amount of water withdrawn for snow-making. Furthermore, several studies point to a reduction in water levels in water courses (streams, rivers and lakes) in southern Québec in the future, which in all likelihood would increase the competition for water for snow-making.
- Insofar as adaptation to climate change is concerned, ski hill operators recognize the importance and the potential impacts of future climate change and they are beginning to anticipate the impacts that these future changes may have on their profits and investments.
- Furthermore, investments in snow-making infrastructure and efforts at diversification by moving to all-season operations (snow-boarding, water parks and mountain-biking in summer), are some of the further adaptation measures being anticipated or already being undertaken by certain ski centers in Southern Québec. However, even these efforts are already being frustrated by increasing costs for snow-making deriving from, increasing amortization costs, energy costs and taxes.

- The competition for ski clientele is already a problem and this situation may worsen in the future.
- Currently, there are approximately 84 ski centers in Southern Québec. Of these 15 stations represent 70 % of the market. About another 12 centers have focussed on clients mainly from outside of Québec, mainly middle USA, but they face stiff competition from ski centers from other ski hill operators both on the East and west coasts of North America.
- Climate warming may however benefit ski hill operators in Southern Québec, since they may be able to draw on clients from the Eastern USA, where climate change may have a more profound impact on the ski sector. Weather forecasts, especially regarding mild or rainy conditions in the home towns/states of these visitors are however perceived as a major constraint.
- In general, a good number of ski hill operators, especially those located in more northerly and higher regions (Grands Fonds, Le Massif, Laurentians) in spite of projected climate changes seem optimistic about the ski industry and this is reflected by major investments in snow-making and ski-lift infrastructure.
- In spite of the increasing tendency towards snow-making, certain ski centers located at more northerly and higher locations (Québec-Charlevoix), that can operate with natural snow use this as a measure of promotion to build a solid client base, and this separates them from other competing centers who do not have this advantage.
- In fact, certain ski centers located at more northerly and higher locations (Québec-Charlevoix), where the winters are currently very cold and where snowfalls are abundant, perceive climate warming as an advantage in that it will create more favourable and comfortable conditions for skiing in the future.
- Apart from climate, several economic and cultural factors influence, to varying degrees, the attraction of certain ski centers to their client base/profile, so much so that economic and social preoccupations take precedent over climatic preoccupations although the latter are not completely ignored.
- For several years now, the ski industry in Southern Québec has had to adapt to changing consumer habits that are becoming more oriented to less costly recreational activities and that have access to other outdoor activities that take up less time (a concern for people with families) such as hiking on snow trails.

- Recently, a number of ski centers in Southern Québec, in order to separate themselves from their competitors and to satisfy a more demanding clientele, have taken steps towards diversification of their operations in an attempt to attract new clientele and increase profits. Amongst these new activities are snow-boarding, snow sliding, mini-ski and snow parks.
- In order to make skiing more affordable and attractive to a larger client base, several ski centers, in collaboration with the Association des Stations de Ski du Québec (ASSQ) have turned to a variety of marketing promotional efforts such as pricing incentives (Passe Partout booklets...).
- Looking to the future, several ski centers, in collaboration with the Association des Stations de Ski du Québec (ASSQ) have undertaken efforts aimed at attracting young skiers, including the immigrant population of Québec through school outings and lessons programs, and also by introducing a variety of activities of interest to the younger population such as snow parks and snow boarding.
- In view of the unfavourable weather conditions for skiing in recent years, several ski centers (Laurentians), in collaboration with the Association des Stations de Ski du Québec (ASSQ) have undertaken further diversification efforts of tourist-oriented leisure activities such as snow-mobiling and use of all-terrain vehicles.
- Risk management of climate change is not a high priority issue for public institutions. As a matter of fact, certain managers see climate change as an opportunity for conditions more favourable to outdoor skiing in the future.
- Finally, it is recognized that future climate changes may not only impact on certain economic sectors, such as the ski industry, but also on the environment. It is also recognized that the ski industry should be mindful of new research and data and new technologies to deal with climate change.

Based on the results of our study the following conclusions have been arrived at in relation to the impacts of and adaptation to climate change and variability for the golf sector:

- In general, for the selected regions and stations, it would appear that the duration of the golfing season will increase significantly for the future time periods (2010-2039 and 2040-2069), by about 2 to 3 weeks depending upon the climate scenario and the region.

- However, the benefits of a longer golfing season will depend on the type of club membership: clubs with fixed annual memberships and whose main clientele is made up of members will see little benefit of operating longer unless members are willing to absorb the increases costs of maintenance. For most golf courses, members represent 70 to 80 % of the clientele both during the week and weekends.
- Golf courses also try to stabilize their revenue streams by encouraging and promoting company and other tournaments.
- Also, the benefits of a longer golfing season will be more beneficial at the beginning of the season than at the end (November), when people have other preoccupations (children at school, upcoming Xmas holidays...).
- The golf season, for most golf course in Southern Québec ends around November 1 st, on account of limiting daylight, cooler temperatures and time required to winter-proof the greens and fairways.
- As an adaptation measure, some golf clubs in Southern Québec (eg., International 2000), are already using snow blowers to clear the fairways and greens so as to get an earlier start to the season.
- It is very likely that there may a greater loss of golfing days in the future on account of unfavorable weather conditions, mainly raininess and extremely hot days.
- The lengthening of the golf season will have a minimal impact on a good number of golf courses: the busiest period (75 % of the clientele) is from July to September, with a peak in July.
- The greater variability of precipitation in the future may also have a negative impact, especially in regards to irrigation water requirements and use. For southern Québec climate models project more or less stable or a slight increase in precipitation. This combined with much higher evapotranspiration rates will very likely require greater irrigation applications.
- New and changing environmental norms and regulations regarding water use and the use of chemicals (herbicides, pesticides and fertilizers) may also pose challenges and problems for golf course operators in the future. Already the Québec Ministry of The environment has banned the use of certain pesticides and herbicides, although, in the interim, golf courses are exempt.

- Golf course operators may also have to look to substituting currently used grass species (*Poa annua* and Creeping Bent Grass) by newer varieties that may tolerate rain and thaw and freeze in the winter and drought in the summer.
- Golf course grasses on greens and fairways may very likely be exposed to damaging weather conditions in the future. In the fall, milder temperatures and raininess may cause of loss of cold hardiness and thus an increased susceptibility to cold winter conditions. In the winter milder temperatures, combined with rain and freeze and thaw cycles and a thinner snow pack will very likely lead to damage to the roots and crowns of grasses.
- Similarly in summer, with increasing air temperature and humidity, grasses on golf course greens and fairways may be more susceptible to bacteria and diseases.
- The golf industry is very sensitive to global and national economic cycles.
- Weather forecasts are of crucial importance to golf course operators. An inaccurate forecast, especially with respect to rain, and for a particular locality, can cause significant revenue losses.
- Golfers are generally very demanding and discerning when it comes to the quality of the fairways and greens and already large investments are made to acquire irrigation systems and the use of chemical agents for fertilization and weed control are widespread. Climate change and variability in the future may very likely lead to an increase in these practices. However, government regulations may pose further challenges.
- In Southern Québec, there has been a significant increase in the number of golf courses in recent years. This has led to increased competition amongst golf courses with the result being lower green fees and profitability.
- Certain golf course operators seem to feel the necessity to redefine their product and find a niche market, since the competition for the clientele is becoming stiffer. Some even foresee the closing of certain golf courses, which may help regularize the market.
- It would seem that in recent years there has been an increase the number of people playing golf and that the sport is becoming increasingly popular. It seems that since 1997, the sport has taken on added interest amongst the younger clientele, a phenomenon very likely due to the impact of Tiger Woods.
- Golf courses must try to strategically place themselves and try to stay ahead of the competition in order to stay in business. They must adjust and adapt to climate and non-

climate stressors by vigorously involving themselves in promotional campaigns, especially amongst the younger clients by encouraging and promoting, golf schools, maintaining contacts with schools and by offering attractive prices and discounts.

- Insofar as adaptation to climate change is concerned, a large number of golf course operators expressed the need to be more vigilant of climate changes and shifting economic conditions both during the golfing season and the off-season. It is also recognized that golfers are becoming more demanding with respect to the condition of the fairways and greens and this requires greater effort especially at the beginning of the season when the demand is great.
- If in truth and in fact the golfing season is getting longer on account of climate change, this is perceived, in general, as beneficial for the golfing industry. But these benefits would have to be weighed against the added costs of management and maintenance, especially towards the end of the season.
- There is also the perception amongst the clientele, driven by the media, that climate change will be very beneficial to golfing and this may be viewed as a positive advantage.
- On account of recent research efforts especially by the Royal Canadian Golf Association (RCGA), there are specialized covers to protect the greens and to accelerate grass growth in the spring and this has allowed golf courses to provide good fairways and greens at the beginning of the season.
- Similarly, problems related to frost heaving on the fairways and greens are being addressed by research efforts. But this problem may become more prevalent with climate change.
- Good drainage is another problem that golf course operators must face. For some courses, where soil and topography conditions dictate, added costs of drainage equipment is required, especially at the beginning of the season. However, if climate change were to cause a shallower snow pack in the future this problem may be alleviated.
- The cost of operations of golf courses are largely driven by labor and products used to maintain the greens and fairways in top condition.
- There is the perception that changes may be more related to advances in research than to eventual climate changes.

Finally, the deliverables of this research project, apart from this report are: the training of three Masters Level students (M. Savoie, V. Tapes and I. Pécheux), one postdoctoral fellow (D. Granjon) and one Bachelor's thesis (N. Davey). Furthermore, a series of articles emanating from this research will be forwarded to scientific journals (Climatic Change, Mitigation and Adaptation Strategies to Global Changes...).