PACIFIC CLIMATE IMPACTS CONSORTIUM

PCIC SCIENCE BRIEF 6: PROJECTED IMPLICATIONS OF CLIMATE CHANGE FOR ROAD SAFETY IN GREATER VANCOUVER, CANADA

PCIC Science Briefs are a series of brief reports on recent climate science literature relevant to stakeholders in the Pacific and Yukon Region of Canada. Science Briefs contextualize and explain the results and implications of important scientific findings.

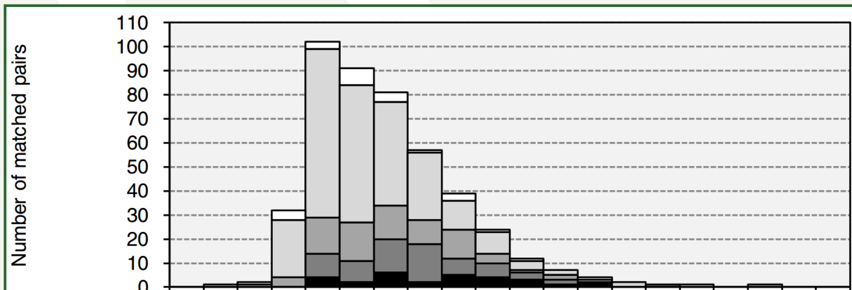
Recent research published in the journal *Climatic Change*, by Hambly et al. (2013) suggests that projected increases in heavy rainfall events in the Greater Vancouver area could lead to higher automobile collision counts by the 2050s.

Climate change could bring with it a variety of challenges for transportation systems, from increasing road deterioration due to freezing and thawing, to rail-line deformation due to increased summer heat. An important weather hazard in the current climate relates to precipitation; there is a documented increase in automobile collisions rates of between 50% and 100% on days when there is precipitation. This is due to reduced traction and visibility. Given this weather hazard, Hambly and colleagues explored what potential impacts a changing climate could have on road safety in Vancouver, BC.

Vancouver has a maritime, temperate climate with mild winters and warm summers. It experiences precipitation on about 46% of all days, on average, with fall-winter seasons that are relatively wet compared to the summer. Only about 4% of Vancouver precipitation[1] falls as snow. Vancouver also has fewer collisions involving fatalities or injuries than the national average (358 per 100,000 people versus 459 per 100,000 people).

Hambly et al. first analyzed collision data from Transport Canada and weather data from Environment Canada to determine the historic crash risk from precipitation events. The authors then used model output from two regional climate models that participated in the North American Regional Climate Change Assessment Program[2] in order to conduct a climate change impact assessment.

The authors found that, over the 2001-2007 period, there were more collisions on days with precipitation. They also found that the risk of collision increases as the amount and intensity of precipitation increases. This is illustrated in the figure below. The figure shows matched pairs of days in which a given weekday with



	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
Winter	0	0	1	4	3	7	4	1	3	1	1	0	1	0	0	1	0	0	0	0
Very light rain	0	1	1	24	70	57	43	28	12	9	4	2	1	2	0	0	0	1	0	0
Light rain	0	0	0	4	15	16	14	10	12	4	1	2	0	0	0	0	0	0	0	0
Moderate rain	0	0	0	0	10	9	14	16	7	6	3	2	0	0	1	0	0	0	0	0
Heavy rain	0	0	0	0	4	2	6	2	5	4	3	1	2	0	0	0	0	0	0	0

Frequency distribution of relative risk estimates by precipitation category from Hambly et al. (2013).
The horizontal axis displays the estimated relative risk estimate. (A value of 1 would suggest no difference between days with and without precipitation, values greater than one indicate more risk on days with precipitation of that category and vice-versa; e.g. a value of two would indicate twice the risk.) The vertical axis shows the number of matched pairs of days, one of the pair being a given day of the week (e.g. Tuesday) when there was precipitation and one being the same day of the week chosen from a week or two earlier, when there was no precipitation (for more information, see the methods section on next page).

1. As measured at the Vancouver Airport.

2. For more information on the North America Regional Climate Change Assessment Program, see: http://narccap.ucar.edu.

precipitation is compared with the same weekday on which there was no precipitation, from a week or two earlier. Although there are relatively fewer days with heavy precipitation, more of those days are associated with an increased risk of collision. The results show that as precipitation increases, crashes that only involve property damage increase more rapidly than crashes involving casualties. This suggests that people reduce their speeds as weather conditions worsen. Hambly et al. also found that 'winter precipitation' events posed the same risk as very light (0.2 mm to 4.9 mm) or light (5.0 mm to 9.9 mm) rainfall. The authors did not find a link between daily minimum temperature and the number of crashes.

Model projections for the 2041-2070 period were found to increase in rainfall frequency for all intensities. Days with rainfall are projected to become 19 to 25 % more frequent. The distribution of precipitation amounts is also projected to change, such that moderate and heavy rainfall days become a larger portion of total annual rainfall days and winter precipitation days (days with a minimum of 0.2 mm of precipitation and temperature below 1 °C) decrease. Collision risk is projected to increase with these changes in rainfall distribution. The authors project that the number of casualty collisions will increase by 1.4 to 2.3 % and the number of crashes attributable to precipitation will increase by 17 to 28 %.

Hambly et al. note that their research is only a first step and a variety of factors not included in their study could affect road safety in the coming years. Some of these factors include changes to: infrastructure, vehicle technology, travel choices (automobiles versus public transit), traffic density, driving norms and driver age demographics.

Methodology

In the first part of their paper, the authors used Transport Canada data for the number of collisions in Vancouver from 2003-2007. They then used weather data to divide the number of crashes per day into days in which there was precipitation and days in which there was not. They then further divided these up into 'rain' days (minimum 0.2 mm of precipitation and temperature at least 1 °C) and 'winter precipitation' days. In their analysis they further divided the 'winter precipitation' days by selecting only those days that had minimum temperatures as low as -3 °C and dividing these up by the type of precipitation that fell that day, into 'rain,' 'mixed/frozen' and 'snow' categories. The days were analyzed in matching pairs, such that a day with precipitation would be compared with a dry day, the same day of the week, a week or two earlier. This was done to estimate differences in collision risk on days when there was precipitation, relative to days without precipitation and to control for such things as traffic volume and travel patterns. The authors then examined the relative frequency of collisions on each of these pairs of days, in order to determine the frequency of collisions on days with and without precipitation and the relative risk of collision for each type of weather condition. Hambly et al. also calculated the risk for crashes in which only property damage occurs and crashes in which there were casualties.

In the second part of the paper, the authors used output from two regional climate models, each being driven by output from a different global climate model. The global and regional climate models used the A2 emissions scenario, from the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios3. The authors looked at projections for the 2041-2070 period relative to a 1971-2000 baseline period. Hambly et al. examined the projections to determine how the number of days with precipitation and the severity of precipitation could change as the climate changes. The authors then looked at the precipitation changes and combined this with the findings for the 2003-2007 period, in order to determine what this would mean for collision risk and the number and severity of collisions.

Using these methods, Hambly et al. arrived at the conclusions above.

Hambly, D., J. Andrey, B. Mills and C. Fletcher, 2013: Projected implications of climate change for road safety in Greater Vancouver, Canada. *Climatic Change*, 116, 613–629.

3. For more information on these emissions scenarios, see: http://www.ipcc.ch/publications_and_data/ar4/syr/en/mains3.html.

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