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Building new homes for the wind and water to come

By Jason Thistlethwaite, PhD
Research Associate, ICLR

Extreme weather damage was a common experience for many Canadians in 2012. Hurricane Sandy, overland flooding in British Columbia, and urban flooding in Thunder Bay, Montreal and Hamilton are all examples of these damaging events. For most Canadians, their home represents the first line of defense against extreme weather. Information on the ways homes can be built to withstand extreme weather, however, remains scarce. This is unfortunate because property damage linked with extreme weather has now replaced fire as the most expensive source of insurance claims in Canada.

New family homes are designed to last the next 50 years.

Climate change is predicted to increase the likelihood of extreme weather. This means that homes built today must be designed to withstand a future climate where extreme weather is more probable and frequent. The problem, according to the Canadian Mortgage and Housing Corporation is that "no other consumer product has changed so little in appearance, structure and functional performance over the past several decades as the single-family house." In other words, new homes are built based on historical experience, not the weather these homes are likely to experience throughout their life cycle.

Fortunately, building scientists at the Institute for ►



Catastrophic Loss Reduction (ICLR) have been working to develop a range of cost-effective building practices that can help a home withstand extreme weather now and in the future. For example, the installation of a backwater valve between the municipal sewer and a home's basement drain represents the most effective approach to limiting damage from sewer backup – a common experience during heavy rain events. Sump pumps that pump water through a discharge pipe at the surface of the lot that drains at least 1.8 metres away from the foundation is also a critically important technology. Downspouts should also drain onto a permeable surface (not cement or asphalt), so that it is absorbed into the ground, rather than channeled into overburdened storm sewers.


Below-grade openings or entrance ways, such as sunken basement doors, exterior stairwells, below-grade windows and reverse-sloped driveways act as channels that direct water into basements and should be avoided. A variety of backfill and overland drainage strategies are

also useful for preventing water damage. The installation of a swale between houses, ensuring foundation walls are at least 200mm above grade, and a 7-10% slope away from the house are all identified as important water damage mitigation measures.

Researchers at ICLR have also tested a number of building practices at Western University's Boundary Layer Wind Tunnel that builders can use in the design and construction of new homes to mitigate wind damage. A one story house, for example, is much more resilient to extreme wind than a two story house. 'Hip', rather than 'gable' roofs, with no dormers also ensure a high level of protection from damage. Builders should also be aware of technologies such as hurricane straps that connect a roof to the wall. Roof sheathing is another vulnerability that can be strengthened by using 5/8" sheathing that is fastened using 'twist-shank' nails at a spacing of 6" apart rather than 12".

Building code officials should also pay close attention to

the impact of extreme weather on residential housing. The building code provides the minimum standards for the design and construction of new homes in Canada. Many of the building design practices mentioned above should be included in the building code to ensure new homes are constructed to withstand extreme weather now and in the future. Mandatory hurricane straps, for example, would help ensure that any new house built in Canada could withstand extreme winds, even those experienced during an EF-2 tornado.

ICLR is partnering with home builders from across the country willing to test out these practices on new home construction. ICLR will be documenting the process to demonstrate that a small investment in resilient homebuilding today, can prevent the significant costs generated by storms like Sandy in the future. 

Swiss Re: Preliminary estimates put insured damage for natural catastrophes at USD 60 billion for 2012


According to preliminary estimates from Swiss Re, natural catastrophes will lead to over 11,000 lives lost and roughly USD 60 billion in insured damage for 2012.

After a benign first half of the year, Hurricane Sandy and drought in the U.S. in the second half of 2012 will lead to total economic losses from disasters of at least USD 140 billion. The tally, says Swiss Re, is moderate compared to 2011, which saw historic insured losses of over USD 120 billion, largely due to record earthquakes and flooding. It is still, however, above the average for the last 10 years.

After two years of historic losses arising from record earthquakes and floods in Asia Pacific and South America, 2012 was dominated by large, weather-related losses in the U.S. The top five insured loss events of the year were all in the U.S. Hurricane Sandy was the largest Atlantic hurricane on record in terms of width. Estimates for the insured cost of the devastation are between USD 20 and 25 billion, which is relatively high despite the fact that Sandy was weak in comparison to other North Atlantic hurricanes. The total insured loss for Sandy is, however, still subject to a high

degree of uncertainty, as it is still too soon to gauge the final overall damage.

In addition, extremely dry weather conditions and limited snowfall in the U.S. led to one of the worst droughts in recent decades, affecting more than half of the country.

Drought-related agricultural losses are likely to reach approximately USD 11 billion, including pay-outs from federal assistance programs. 

Superstorm Sandy: An Ontario perspective

By Geoff Coulson, Warning Preparedness Meteorologist, Environment Canada

Superstorm Sandy began its life as a tropical storm approximately 600 kilometres south of Jamaica on October 22, 2012. During the course of the following days it would transition into a hurricane, striking Jamaica, Cuba and the Bahamas. As it moved northwards from the Bahamas, it would begin to exhibit the characteristics of both a hurricane and a mid-latitude fall storm. By the time it made landfall in New Jersey on the evening of Monday, October 29, it had completely transitioned into a mid-latitude fall storm – albeit a massive one, with a diameter in excess of 1,600 kilometres. The combination of Sandy’s winds, rain, storm surge and snow would leave 135 people dead and loss estimates in the United States ranging from \$50-\$65 billion dollars. The impacts in Canada, while not on the same scale as those on the U.S. Eastern Seaboard, were still noteworthy: the loss of two lives in Ontario, 150,000-plus homes without power in Ontario at one point, and approximately \$100 million in insured losses in Ontario, Quebec and Atlantic Canada. A good portion of those losses occurred in the Sarnia and Lambton County areas; the winds from Sandy came howling from the north right off Lake Huron.

Much has already been written about the rare “hybrid” nature of Sandy, and over the coming years the data gathered during Sandy’s life will be analyzed and reanalyzed. Many experts have referred to this event as a “once-in-a-lifetime” storm which combined the elements of a hurricane with those of a massive fall storm. The storm renewed debates about the best ways to protect cities near oceans and what role climate change may have played in its creation. While the answers to these questions are not readily available, Sandy has opened the

discussion on how best to adapt to the potential for more storms of this nature in the coming years. One of the best ways to describe Sandy’s lasting legacy will be the fact that this could be the storm that “launches a thousand dissertations.” Many Ph.D. theses in the coming years in Atmospheric Science, Climate Science and Emergency Management will be drawn from how Sandy formed, evolved and impacted the U.S. Eastern Seaboard.

Sandy also provided an opportunity to demonstrate just how much weather modelling has improved over the last couple of decades. The ECMWF (European Centre for Medium-Range Weather Forecasts) prediction model uses a very powerful computer and has been designed to forecast the weather in the 3-to-10-day timeframe. Even as Sandy was in its formative stages on October 23, the ECMWF model was predicting a rare westward turn in Sandy’s track into the northeastern seaboard of the U.S. six days into the future. At this point, the ECMWF model

was somewhat unique, with models from Canada, the U.S. and the U.K. indicating a more traditional track for the storm keeping it out over the Atlantic.

Given the skill shown by the ECMWF model in the past, and the fact that its forecast track could potentially impact portions of Ontario, Quebec and Atlantic Canada with strong winds and rain, a preliminary e-mail was sent to key provincial and municipal contacts within Ontario on October 23 mentioning the possibility of significant weather a full six days into the future. This e-mail represented an example of the type of “early notification” to key clients that Environment Canada would like to develop more fully in the coming years. The form that this early notification may take could change in the coming years, but the main issue is to try to inform key stakeholders about potentially significant weather in the 3-to-7-day timeframe – when forecaster confidence may not be high, but the event is growing in probability. Once forecaster confidence about the event has grown, then formal ►

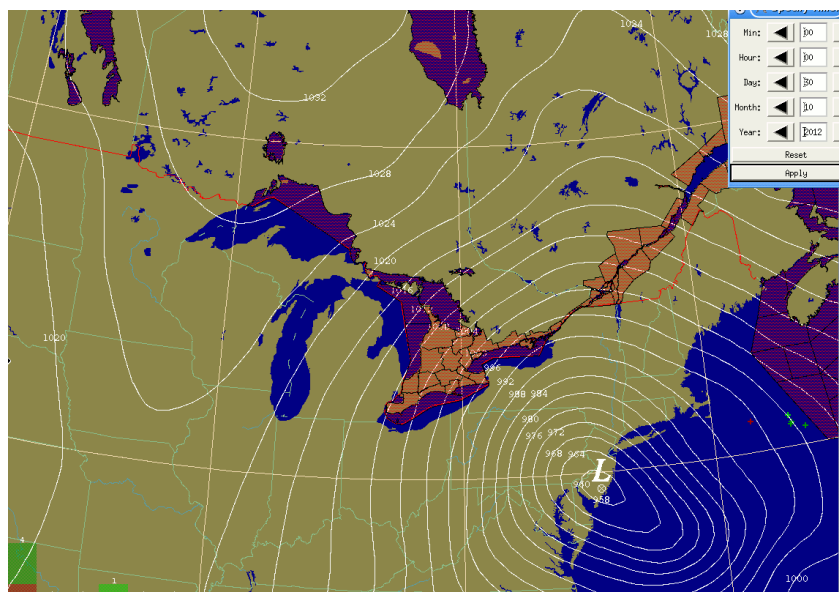


Image 1: This image shows Sandy making landfall at around 8 PM on October 29 (0000 GMT Oct. 30). The number of isobars around the low indicate just how low its central pressure was; the purple areas denote marine warnings over Canadian waters; and the red shows where wind warnings were in effect.

messaging to the media and general public (i.e., Special Weather Statements, Watches and Warnings) would follow.

As the days went by and other forecast models began to follow the track originally forecast by the ECMWF, and forecaster confidence grew, a Special Weather Statement was issued by the Ontario Storm Prediction Centre on Friday, October 26, for much of Southern Ontario. The statement mentioned the potential of damaging winds and heavy rain from Sandy as it made its anticipated landfall in the northeastern U.S. on Monday, October 29. By Friday, October 26, the Weather Centres in all affected regions (Toronto, Montreal, Dartmouth and Gander) were closely co-ordinating to ensure common messaging for this event. This co-ordination included internal technical briefings, briefings for key provincial government clients and media briefings.

As Sandy neared the U.S. coast during the early morning hours of Monday, October 29, the forecasters in Toronto realized that wind would be the main concern in Southern Ontario. So, a Wind Warning was issued for this area, mentioning gusts to 90 km/h or more. With the winds forecast to come from the north, the region that was expected to receive the highest gusts was the Lambton County area (as the winds blew in from Lake Huron).

Sandy made landfall at about 8 p.m. on Monday, October 29, bringing with it the various

types of damaging weather that had been mentioned in the National Weather Service warnings. Because Sandy hit around the time of high tide, the damage from its storm surge was even more severe. The storm surge was accompanied by damaging winds, significant rain and, in portions of Ohio and West Virginia, significant amounts of snow as cold air was drawn into the system from the north. In Ontario, winds began to pick up on the evening of the 29th with many locations reporting wind gusts of 80 km/h or more into the early morning hours of Tuesday the 30th. As anticipated, Lambton County received the highest wind gusts and most significant damage, with gusts as high as 100 km/h. Another impact over the south end of Lake Huron was the creation of 7 metre waves from the strong and persistent winds from the north. This led to direct impacts on Great Lakes shipping as many large lakers had to hold up on the west end of Lake Erie unable to transition up through Lake St Clair and into Lake Huron with waves of this height. A witness along the shores of western Lake Erie during that Monday evening remarked that it looked like a floating city of lights given the number of lakers waiting for the winds to die down. The strongest gusts diminished over most of Southern Ontario by mid-morning on the 30th except in Lambton County and over southern Lake Huron, where strong gusts continued for much of the day.

Extensive media

coverage accompanied the days leading up to, during, and in the aftermath of Sandy's landfall. In Ontario, more than 200 media requests were handled from Saturday, October 27, through Tuesday, October 30. One of the issues faced by Environment Canada spokespersons concerning this event was attempting to separate the American impacts of Sandy from the Canadian ones. Some Ontario media outlets had assumed there would be greater impacts in Ontario, based on the reports about Sandy coming out of the U.S., and so some time was spent to explain the differences and to provide more context concerning the Ontario impacts.

In summary, Sandy was a very rare storm that combined the ocean-driven energy of a hurricane with those of a massive fall storm system. No storm quite like Sandy had been documented before, but its method of birth and evolution will be a source of research for a number of years to come. It dramatically demonstrated the vulnerabilities of large cities along the U.S. Eastern Seaboard, where approximately 20% of the American population is found. While the worst impacts from Sandy were along the U.S. northeast coast, the storm was so immense that its impacts were felt well into Ontario, Quebec and Atlantic Canada. The storm also provided evidence of the increased ability for weather models to provide useful guidance a full seven days before an event. This has important ramifications for the ability of weather services like Environment Canada to provide some form of "early notification" well in advance of large-scale events of this nature. Now that the ability to provide advance notice in this kind of timeframe has been demonstrated, more work needs to be done in the coming years to determine the best avenues to share this type of information with key clients and the general public, and how best to express the uncertainties involved in the forecasting of these events. 🐾

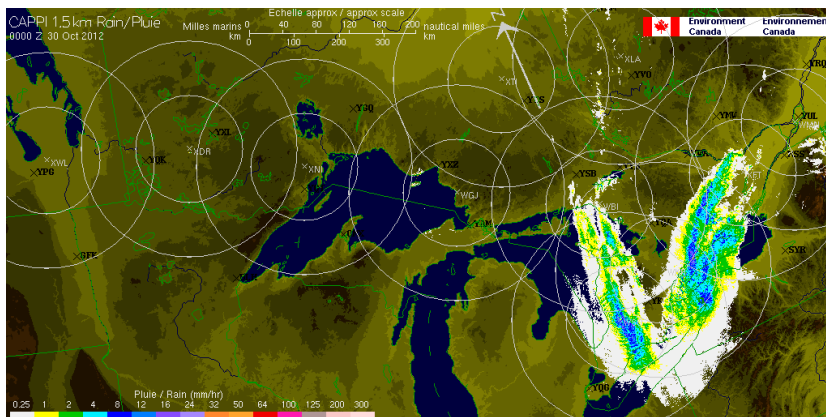


Image 2: This is a composite of radars showing two bands of rain wrapping over Southern Ontario from Sandy at the time the first image on page 3 was captured. (i.e. 0000 GMT on October 30).

Reducing urban flooding through ‘Green Streets’

By Credit Valley Conservation Authority

On a walk through two unique streets in the Lakeview neighbourhood of Mississauga, visitors might notice meadow flowers and grasses blowing along the boulevards while at one end of the street, a large patch of black-eyed susans beckons. The only hint that there is something truly unique here is a large sign near the black-eyed susans proudly proclaiming, “This is a Green Street”.

The Lakeview Road Revitalization project (on portions of First and Third Streets) is the first-of-its-kind project in Canada that is serving as a model for communities province-wide. On these streets, bioretention cells (or “rain gardens”) and permeable driveways replace a traditional curb-and-gutter streetscape to treat rainfall and urban runoff where it falls. Such “green streets” prevent stormwater from overwhelming storm sewers during extreme weather events and filter out pollutants before entering streams and rivers which flow to Lake Ontario, the source of drinking water for 8 million people.

Growth in urban flooding

Urban flooding has become one of the most substantial threats to property and health safety in many Ontario cities. Events of the past ten years have exemplified its severity and costs.

In southern Ontario alone in the past eight years, there have been three 100-year storms (storms expected to occur once every 100 years) and five 50-year storms (storms expected to occur once every 50 years) Flooding events in Peterborough, Mississauga and Toronto have caused over \$500 million in damages to public and private property.

One of the southern Ontario 100-year storms occurred in the Cooksville Creek watershed in Mississauga on August 4, 2009. In two hours, the storm dropped 68 mm of rain that rushed through urban streets and parks overwhelming the stormwater management system, flooding hundreds of residential and business basements. Since that date, 21 other rain events have occurred in the Credit River watershed including remnants of Hurricane Sandy. These extreme events ranged from dropping 50 to 121 mm of rain over a 24-hour period. The remnants of Hurricane Sandy event produced 95 mm of rain over two days.

Costs to clean-up and repair devastation caused by severe storms continue to mount. Insured damages for one southern Ontario storm in 2005 were estimated at \$500 million. In Mississauga, the estimated cost of repairing damages from the Cooksville 2009 storm is \$90 million.

According to the Insurance Bureau of Canada

(IBC), water damage insurance claims have soared to \$1.7 billion annually in Canada, overtaking fire as the leading cause of damage to homes. IBC further indicates that the majority of claim payouts are now related to severe weather and water damage. Compounding this is frustration by homeowners who cannot get insurance against overland flooding or damages caused by rising water tables.

The climate picture continues to darken. The Toronto Environment Office released its *Toronto's Future Weather & Climate Driver Study* in October 2012 projecting that by 2049, the maximum amount of rainfall expected in any single day and in any single hour will more than double.

In the midst of escalating insurance and infrastructure costs, innovative water technologies such as low impact development (LID) practices offer environmentally sound and economically viable alternatives to traditional stormwater management practices. ►



A “green street” in the Lakeview neighborhood of Mississauga incorporates permeable paver driveways, curb cuts and bioretention or “rain” gardens to treat rainfall and urban runoff where it falls.

Sites such as the Lakeview project prove why.

Lakeview Project

The project in Mississauga's Lakeview neighborhood began with extensive neighborhood consultation. Through door-to-door conversations and newsletters to an on-site open house, all homeowners actively participated in the process. The result? Twenty-one of twenty-six homeowners chose flowering gardens to top the bioretention cells that replaced their original ditches, while the remaining five selected various grasses. This vegetation allows rainfall to infiltrate slowly into the ground rather than rushing directly into municipal storm sewers.

Performance monitoring at the site began in August 2012 from equipment located at the two green street sites and at a control site close to the same neighborhood. This monitoring is one factor in understanding impacts from specific LID practices on both the quality and quantity of water flowing from the site. A key objective of the monitoring will be to evaluate the performance of LID practices to effectively reduce infiltration/inflow (I&I) of stormwater into municipal sanitary sewer systems, ease stress on aging stormwater infrastructure by decreasing runoff volume, peak flows, pollutants and erosion as well as to restore natural water balance.

Based on observations to date, the Lakeview site is capturing 80 to 95 percent of typical rainfall events in the GTA. The water quantity benefits of these practices were evident following the watershed's Hurricane Sandy event. During this event, the curb and gutter control site representing conventional stormwater practices produced significantly

more runoff than those of the LID sites. Furthermore, the response time for the LID sites was delayed and spread out over a longer period of time, thus mimicking pre-development or natural conditions.

Though this is very encouraging in these early days, many questions remain: Are these results because of one particular LID practice or all? What will happen during more significant rainfall events? How is water quality affected?

Performance monitoring will continue throughout 2013 at this and various LID sites. Lessons learned from design, construction, operation and maintenance as well as monitoring at LID sites throughout southern Ontario will

Current systems and infrastructure, however, are not designed or operated with a dramatically changing climate in mind, and more frequent extreme weather events forecast to continue into the foreseeable future.

Innovative water technologies such as those currently operating in the Lakeview neighborhood of Mississauga are showing real and significant opportunities to reduce water quantity and improve water quality entering municipal storm sewers for protection of human health and the natural environment. 🐾



form the basis of guidance documentation that Credit Valley Conservation and partners will publish beginning in 2014.

Municipal stormwater management systems protect health and safety of the public and the natural environment by controlling the quality and quantity of rainfall and urban runoff reaching streams and rivers that eventually flow to Lake Ontario, the source of drinking water for millions of people.

ICLR announces new book on pioneering wind engineer

By Glenn McGillivray
Managing Director, ICLR

The Institute for Catastrophic Loss Reduction has announced the launch of *Wind Wizard: Alan G. Davenport and the Art of Wind Engineering*, a book commissioned by the Institute in honour of Dr. Alan Davenport, pioneering wind engineering professor at Western University and former Chairman of Research at ICLR.

With *Wind Wizard*, author Siobhan Roberts tells the story of Alan Davenport (1932-2009), the father of modern wind engineering, who investigated how wind navigates the obstacle course of the earth's natural and built environments--and how, when not properly heeded, wind causes buildings and bridges to teeter unduly, sway with abandon, and even collapse. In 1964, Davenport received a confidential telephone call from two engineers requesting tests on a pair of towers that promised to be the tallest in the world. His resulting wind studies on New York City's World Trade Center advanced the art and science of wind engineering with one pioneering innovation after another.

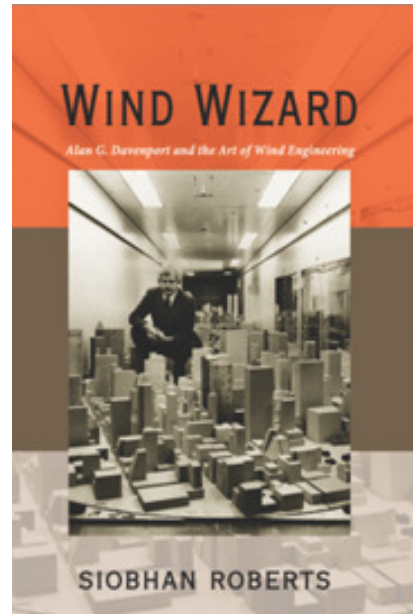
Establishing the first dedicated "boundary layer" wind tunnel laboratory for civil engineering structures, Davenport enabled the study of the atmospheric region from the earth's surface to three thousand feet, where the air churns with turbulent eddies, the average wind speed increasing with height. The boundary layer wind tunnel mimics these windy

marbled striations in order to test models of buildings and bridges that inevitably face the wind when built.

Over the years, Davenport's revolutionary lab investigated and improved the wind-worthiness of the world's greatest structures, including the Sears Tower, the John Hancock Tower, Shanghai's World Financial Center, the CN Tower, the iconic Golden Gate Bridge, the Bronx-Whitestone Bridge, the Sunshine Skyway, and the proposed crossing for the Strait of Messina, linking Sicily with mainland Italy.

Chronicling Davenport's innovations by analyzing select projects, this popular-science book gives an illuminating behind-the-scenes view into the practice of wind engineering, and insight into Davenport's steadfast belief that there is neither a structure too tall nor too long, as long as it is supported by sound wind science.

The book is currently available for sale at Amazon and Indigo/Chapters. 🐾



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Mission

To reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters.

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