Cause-and-effect analysis of major hurricanes that made landfall in Atlantic Canada from 2003 to 2018

Luana Almeida, Floris Goerlandt, Ronald Pelot

Maritime Risk and Safety Research Group, Industrial Engineering, Dalhousie University, Halifax, NS

Introduction

The Atlantic region of Canada is exposed to hurricanes from early June to late November each year. Usually, when a hurricane makes landfall in this region, it changes its state to a "post-tropical" cyclone. Consequently, the expected impacts are different.

Most reports related to hurricanes in North and Central America address the impacts in general terms such as the total cost and fatalities. However, there is a little systematic understanding of those impacts in terms of more specific cause-consequence relationships..

The purpose of this research is to present a cause-and-effect analysis of the impacts associated with major hurricanes that hit Atlantic Canada in the period 2003 to 2018. Four case studies serve as basis for the cause-and-effect analysis, and are linked with hurricanes Juan (2003), Noel (2007), Earl (2010) and Igor (2010).

Categories of impacts

Wind
In post-tropical cyclones the area of stronger winds increases, moves out from the storm center, and the maximum speed drops off.
- Hurricane category 1 = 119 to 153 km/h
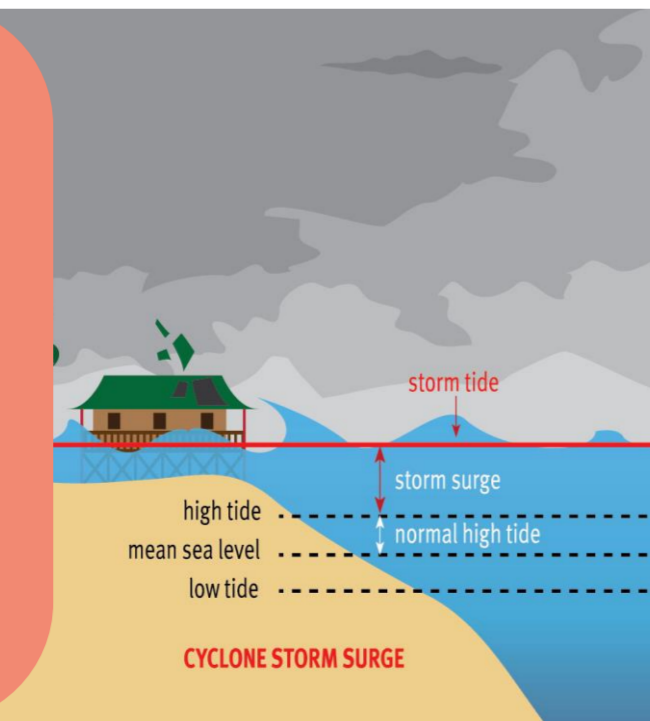- Hurricane category 2 = 154 to 177 km/h

Rain
In post-tropical cyclones the intensity of the rainfall acquires a characteristic of thunderstorm, and usually causes severe flooding. It is harder to predict the precipitation of a post-tropical cyclone than a tropical cyclone.

Storm Surge
Occurs when high winds push the water from the ocean towards the shore raising the normal sea level because of the low pressure at the center of the hurricane. It is a big concern for coastal areas.
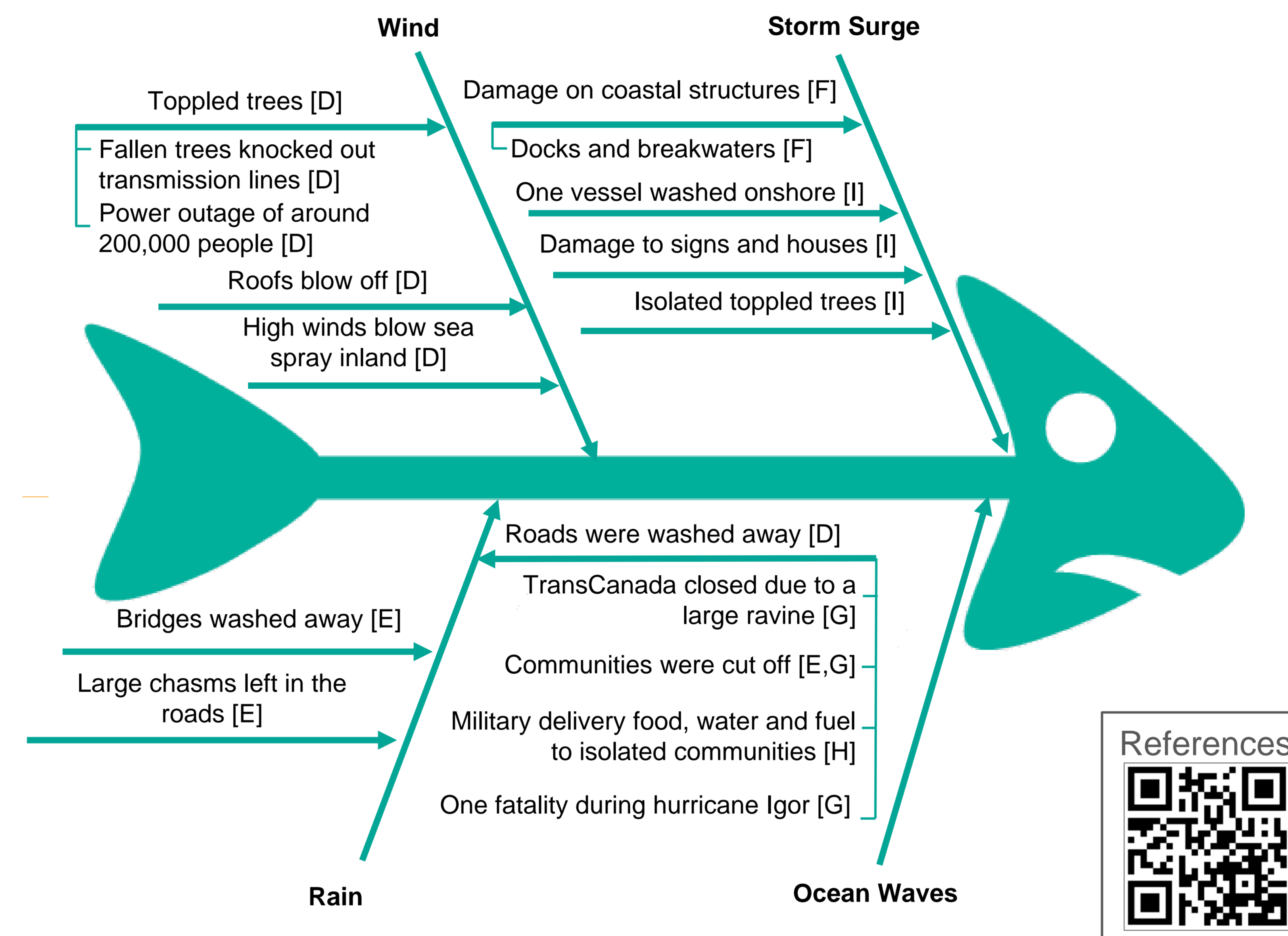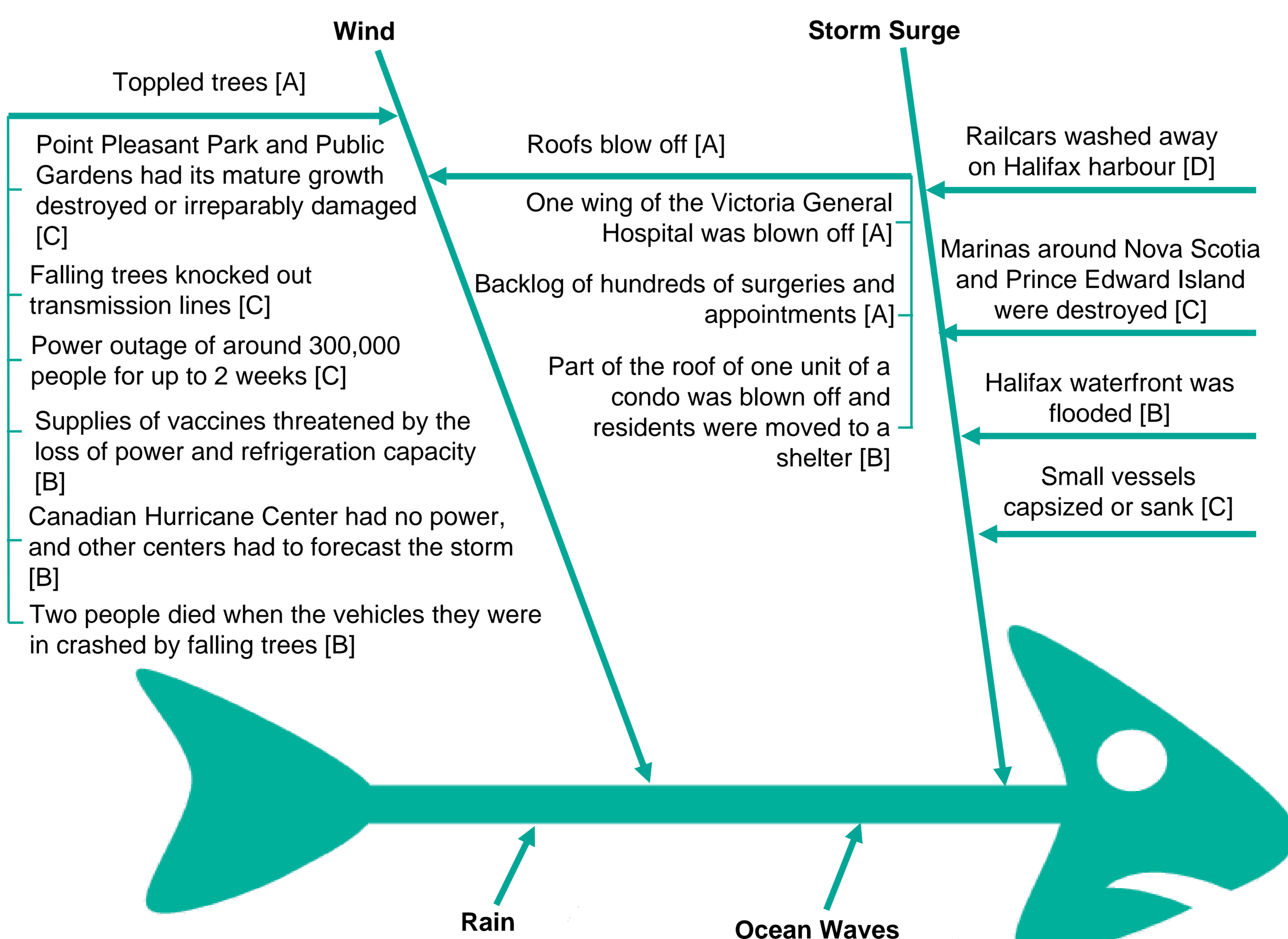
Ocean Waves
Are the development of high waves in the sea. Between 1900 and 1950 it was responsible for 75% of fatalities in Canada during hurricanes.

Cause-and-effect analysis – hurricane category 1

Wind
- Toppled trees [D]
- Fallen trees knocked out transmission lines [D]
- Power outage of around 200,000 people [D]
- Roofs blow off [D]
- High winds blow sea spray inland [D]

Storm Surge
- Damage on coastal structures [F]
- Docks and breakwaters [F]
- One vessel washed onshore [I]
- Damage to signs and houses [I]
- Isolated toppled trees [I]

Rain
- Bridges washed away [E]
- Large chasms left in the roads [E]
- Roads were washed away [D]
- TransCanada closed due to a large ravine [G]
- Communities were cut off [E,G]
- Military delivery food, water and fuel to isolated communities [H]
- One fatality during hurricane Igor [G]

Ocean Waves

References:

Cause-and-effect analysis – hurricane category 2

Wind
- Toppled trees [A]
- Point Pleasant Park and Public Gardens had its mature growth destroyed or irreparably damaged [C]
- Falling trees knocked out transmission lines [C]
- Power outage of around 300,000 people for up to 2 weeks [C]
- Supplies of vaccines threatened by the loss of power and refrigeration capacity [B]
- Canadian Hurricane Center had no power, and other centers had to forecast the storm [B]
- Two people died when the vehicles they were in crashed by falling trees [B]
- Roofs blow off [A]
- One wing of the Victoria General Hospital was blown off [A]
- Backlog of hundreds of surgeries and appointments [A]
- Part of the roof of one unit of a condo was blown off and residents were moved to a shelter [B]

Storm Surge
- Railcars washed away on Halifax harbour [D]
- Marinas around Nova Scotia and Prince Edward Island were destroyed [C]
- Halifax waterfront was flooded [B]
- Small vessels capsized or sank [C]

Rain

Ocean Waves

Conclusion

The classification of the impacts caused by past hurricanes helps to understand the possible impacts in future hurricanes. However, it is difficult to classify an impact exclusively in one category. Further research in cumulative risk assessment of two hazards (i.e. wind and rain) can be even more helpful in terms of preparedness planning.

Even though there was no impact associated with ocean waves in the case studies, it does not mean that the threat does not exist. It is possible that the act of warning the sailors to protect themselves during natural disasters is effective, and, if so, the level of preparedness influences the total impact of hurricanes.

Finally, even though there is more impacts listed in the cause-and-effect analysis of hurricanes category 1, it does not mean that they are worse than category 2. It is important to consider that the diagram for category 1 involves three hurricanes (Noel, Earl and Igor), and the category 2 only states impacts related to hurricane Juan.

Acknowledgements