SCIENCE SPOTLIGHT

SEA LEVEL RISE: RISING TO THE CHALLENGE

GEN ACTION

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Canada

SCIENCE WORLD

Sea Level Rise: Rising to the Challenge

Origin Story: WHAT IS A FLOOD RISK ASSESSMENT?

A flood is when there is an overflowing of water onto dry land. Floods can happen when rivers overflow, when dams break, or during heavy rain. Flooding near coastal areas is caused by a combination of extreme weather and high tides. During these events, ocean water and waves come up farther on shore than normal, impacting local environments and infrastructure.

A flood risk assessment is a tool used by scientists to determine the potential for damage from a flood. Flood hazard assessments are used by scientists to look at where water will go during both frequent and rare flood events. To measure potential flood damages, scientists look at what is in the flood's way and see what impacts flooding will have on people, buildings and infrastructure, natural environments, the economy, and anything else we care about that might be damaged.

Flood risk assessments are completed by coastal engineers, civil engineers, or flood scientists usually with the help of others, like economists. While making one, scientists make models to visualize the patterns and frequency of floods, determine the area where flooding is likely to occur, and talk to people, businesses, and community leaders to understand the vulnerability of the areas. These assessments provide vital information for the local governments, stakeholders, city planners, and engineers to protect cities and critical local environments, making them safer from floods.

Planning for Future Coastlines Due to Sea Level Rise

The coastline is where the sea or ocean meets the land. Along Canada's coastline, we can find beaches, cliffs, bays, and even cities, like Vancouver! Canada is home to the longest coastline in the world, about 243,797 kilometres[1] – it would wrap around Earth a little over 6 times!

1. McCann, S.B. , and R.B. Taylor. "Coast." ***The Canadian Encyclopedia***. Historica Canada. Article published March 29, 2009; Last Edited March 04, 2015. https://www.thecanadianencyclopedia.ca/en/article/coast

WHAT IS CHANGING ALONG OUR COASTLINES WITH CLIMATE CHANGE?

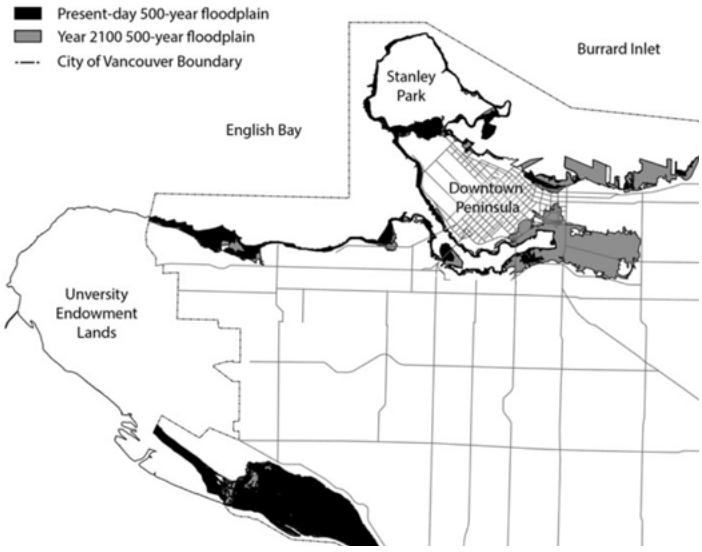
Climate change is warming the oceans, and warmer water takes up more space or volume. With rising temperatures, glaciers and ice sheets on land are melting, adding more water to the ocean. The global sea level is rising, and local water levels are also becoming higher. One consequence of rising sea levels is an increase in coastal flooding.

As sea levels rise close to shore, it is easier for ocean waves to come onto shore. Add a storm, and the coastal winds will push the waves further inland. Make that storm happen when water levels are high during a high tide, and the waves come further inshore. Every centimetre of sea level rise can change how often, how severe, and how far coastlines will flood.

Can you imagine walking through a city full of water? The City of Vancouver is listed as one of the most vulnerable cities in the world to coastal flooding and sea level rise. Scientists anticipate that Vancouver will see about a metre of sea level rise by 2100. The City of Vancouver tasked a group of scientists, including lead scientist Tamsin Lyle, to conduct a coastal flood risk assessment to better understand how coastal flooding might change in the future and its impacts.

IDENTIFYING HAZARDS

First, the team modeled how increases in sea level rise will cause changes in where the flooding will go across Vancouver. Using five different scenarios, with different frequencies of flooding conditions and amounts of sea level rise, scientists were able to map the present and future coastal floodplains for the Metro Vancouver area. They found major differences with wider spread flooding in the future.



T.S. Lyle and and T. Mills, *Assessing coastal flood risk in a changing climate for the City of Vancouver* (Canadian Water Resources Journal/Revue canadienne des ressources hydriques, 2016), 347, fig. 6.

CAN YOU IMAGINE WALKING THROUGH A CITY FULL OF WATER?

SCIENTISTS ANTICIPATE THAT VANCOUVER WILL SEE ABOUT A METRE OF SEA LEVEL RISE BY 2100.

IDENTIFYING WHAT IS EXPOSED

Given these maps, scientists reached out to people in the community and asked a simple question: what is in the way of future floods that we care about? Specifically,

1. What are the infrastructure services? (i.e., electrical lines)
2. What is the critical infrastructure? (i.e., a hospital)
3. What areas are important to the economy? (i.e., a shopping centre)
4. What services or community locations are there? (i.e., a school)
5. What areas for recreation and culture are present? (i.e., a museum)
6. What key environmental areas or habitats would be affected? (i.e., a park)

UNDERSTANDING THE CONSEQUENCES

Using a computer model and a risk assessment tool, the team calculated the direct tangible damages and losses using the identified hazards and exposure inventory for each scenario. Scientists discovered that one metre of sea level rise caused a large increase in the amount of damage the flood would cause. The same storm event with sea level rise would result in 2300 more displaced households and 300 more damaged buildings. City workers would need to clean up more than 4500 trucks full of debris, a huge job!

PLANNING PROTECTIONS WITH IMPERFECT INFORMATION

Throughout this process, scientists created a series of visual tools for planning, engagement, and education with community members. While there were many potential damages and vulnerabilities that they could not estimate the direct damage costs, they still learned enough information for future planning. Good decisions can still be made, even without all the information. To build resilient cities and protect coastal wildlife from the impacts of sea level rise, city planners need to choose adaptable solutions which can adjust to different future scenarios.

Time for GENACTION!

Try This at Home:
INVESTIGATE AND DESIGN A SOLUTION

Grab some sand, water, a spoon, and a shallow bin or paint pan liner to explore how sea level rise causes flooding! Pile the sand to one side of your tin, form a shoreline, and then add a paper structure on the sand to represent your house – or even Science World! Add some water to the other side and move a spoon up and down to create waves. What happens to your shoreline? Now, pour some more water into the pan – this added water represents rising sea levels. What happens when you created waves now? How much farther in do the waves go?

Time to protect your structure from sea level rise! You could **resist** flooding by building structures like walls or building up the shoreline with stabilizing vegetation to shelter buildings. If you want to allow flooding to happen, you could **accommodate** it by raising the building higher. Relocating structures away from the shoreline would **avoid** areas where flooding happens. Try to **advance** the shoreline forward and build it up – do not forget to add places for wildlife to live! Grab some more materials and try to build a solution!

See full details for this activity and others at scienceworld.ca/resource/save-science-world-from-sea-level-rise and scienceworld.ca/resources.

Climate Action:
WORKING TOGETHER

COASTAL CITIES NEED YOUR HELP.

As climate change and sea level rise are caused by activities that release greenhouse gases, everyone can work together to help. Reducing the amount of greenhouse gases you or your community contributes is as easy as riding a bike instead of taking a car somewhere. Organize a group of your friends or classmates and form an environmental club. As a group, see if you can identify areas in your home, school or neighbourhood where less energy or a greener source of energy could be used.

BE AN ADVOCATE!

If you live along the coast, research if your community has a plan to adapt to sea level rise. Write a letter to your local government and share why planning for increased coastal flooding is important and which places you want to protect. Tamsin Lyle reminded us to not forget to look out for our scaly, furry, and feathered neighbours, to make sure that they are not squeezed out of their homes as the sea level rises too! No matter where you live, make sure your friends, class, neighbours, and elected officials know that sea level rise and climate change are happening.

MEET OUR LOCAL SCIENCE HERO:

Tamsin Lyle is a flood scientist.

How did your interest in flooding and climate change come about?

"In one word: rivers."

What is your favourite part of being a scientist?

"You can never be bored. There is always something to explore. And, as an engineer, especially one working in an interdisciplinary field, it means that I get to learn from a vast number of totally different people on any given day."

If you could share one call to action with Canadian youth, what would you say?

"Engage. Lots of decisions being made today, by governments and others, will impact your lives for years to come. Your voice matters. Make sure you use it."

What has happened since this research?

"So much! Immediately following this original research, we helped the city set some timelines for action based on the anticipated risk associated with future flooding, as well as an exploration of what the city and future residents might tolerate in terms of damages and disruption (to businesses, to roads, to water supply, etc.). The city then did detailed studies for the Fraser River floodplain, and then ran the Sea2City design challenge, which focused on long-term visions for False Creek, including Science World."

This Science Spotlight was written based on Lyle, T. S., and T. Mills. "Assessing coastal flood risk in a changing climate for the City of Vancouver." Canadian Water Resources Journal/ Revue canadienne des ressources hydriques 41, no. 1-2 (2016): 343-352. https://doi.org/10.1080/07011784.2015.1126695.

Climate Change
Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining

Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.

Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions.
Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance truth and reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.