



# Sea Level Rise in BC: mobilizing science into action

## SUMMARY

In the last decade, events such as storm surges, the Kelowna wildfires, and the windstorms razing Stanley Park have alerted British Columbians to the potential risks of climate change. Regional sea level rise and the projected impacts on coastal communities and shorelines are now seen as important issues for the province: a rising sea level and storm surges could increase flooding and damage to coastal infrastructure, property loss from erosion, habitat loss, decreasing biodiversity, saltwater intrusion into coastal aquifers, and loss of cultural and historical sites.

In 2008, the Government of British Columbia (BC) examined projections of sea level rise up to the year 2100. With funding from the BC Regional Adaptation Collaborative, the Province completed [a series of technical studies](#) to assist local governments and qualified professionals to incorporate sea level rise into coastal flood plain mapping, sea dike design, and land use planning. The Province also developed an [online map](#) to visually display projected sea level rise along the BC coast.

In 2013, the BC Climate Action Secretariat partnered with [Natural Resources Canada](#) (NRCan) to develop a case study to examine the conditions that led to the successful integration of projected sea level rise science into BC government policy. This case study provides an overview of the BC experience with sea level rise adaptation, the drivers behind sea level rise action in BC, and highlights lessons learned in integrating science into government policy. Nine interviewees identified these drivers and lessons as factors that have increased awareness and action on sea level rise in the province. These interviewees remain anonymous throughout the document, but are represented by a number.

### Drivers of Action on Sea Level Rise in BC

1. Leadership on policies and initiatives contributed to raising the profile and legitimacy of adaptation.
2. Existing local projects and initiatives helped to build awareness and strengthen networks.
3. Access to external funding enabled research and pilot projects and contributed significantly to building momentum around sea level rise.
4. Innovative tools and communications raised the profile of sea level rise by communicating complex science to decision-makers and the general public.

### Key Lessons Learned from the BC Case Study

1. Describing climate scenarios at a localized level helped local governments to understand the problem at a scale that was relevant to them.
2. Specific guidance on what to plan for simplified decision-making by local governments.
3. Injections of funding boosted the existing capacity of governments at the provincial, regional and local levels to understand the problem.
4. Collaboration between different levels of government and intermediaries contributed to innovation.
5. Scenarios and visualizations were effective in communicating the science to both decision-makers and the general public.



## OVERVIEW OF ADAPTATION ISSUE

The United Nations International Panel on Climate Change’s (IPCC) [Fourth Assessment Report](#) (IPCC 2007) raised the profile of climate change adaptation internationally by stating that human induced-climate change was unequivocal and that appropriate responses to inevitable climate change would be required. The IPCC report helped to shift the perception that climate change adaptation was an admission of defeat to an acknowledgement that adaptation was now a necessary response to climate change.

In 2008, the Climate Change Branch within the BC Ministry of Environment commissioned the report: [An Examination of the Factors Affecting Relative and Absolute Sea Level in British Columbia](#) (Thomson et al. 2008). This report examined the principal factors contributing to regional sea level rise in BC, including vertical land movements and thermal processes. A [summary report](#) (Bornhold, B.D. 2008) conveyed this information to policymakers using three sea level rise scenarios - low, mean and extreme high, for select locations in the province (see Table 1). The extreme high scenario was used in the summary report to better represent the range of sea level rise projections reported in the scientific literature after the release of the IPCC’s Fourth Report. The combination of a shift in attention toward adaptation and the development of localized science showing the regional implications resulted in the emergence of sea level rise as a “signature issue” in the province.

Within the province, intergovernmental and non-governmental networks were already considering sea level rise and floodplain management. For example, the Joint Program Committee (JPC) for Integrated Flood Hazard Management, coordinated by the [Fraser Basin Council \(FBC\)](#) since 1998, commissioned the 2008 [Fraser River Hydraulic Model Update](#). This report concluded that impacts of climate change on Fraser River peak flows warranted specific

investigation and revised flood frequency analysis to identify methods for assessing expected impacts of snowmelt and precipitation.

From 2006 to 2009, the coastal community of Delta was the site of university-led climate change and sustainability planning research, which included visualizing projected sea level rise scenarios. Using regionally available and community based data, the University of British Columbia’s [Collaborative for Advanced Landscape Planning \(CALP\)](#) developed visual scenarios to help residents understand the potential impacts of sea level rise to Delta. The visualizations also showcased various adaptation measures, which significantly increased residents’ understanding of the community’s options to protect against sea level rise. The Ministry of Community, Sport and Cultural Development (MCSCD) provided funding to support the development of [CALP’s Local Climate Change Visioning “Guidance Manual”](#) and to make the visioning tool available for use by other local governments. Around the same time, the cities of Vancouver and Richmond were exploring adaptation strategies for sea level rise based on regional sea level rise information from Washington State. These initiatives were generating interest amongst other local governments in the province.

In 2010, BC’s Adaptation Strategy, [Preparing for Climate Change](#), signaled to regional and local governments that adaptation was a current priority for the Province. The strategy recognizes that:

- historical experiences are no longer sufficient for addressing future risks;
- adaptation needs to be incorporated into future planning; and
- cross-government coordination and stakeholder engagement is necessary.

The strategy also highlights that “the projected increases in the frequency of extreme precipitation events and in sea levels increase the risk of flooding” adding further momentum to the focus on sea level rise planning in the province.

Table 1: Relative sea level rise by 2100 for selected locations

Location	Sea Level Rise based on <i>extreme low</i> estimate of global sea level rise (m)	Sea Level Rise based on <i>mean</i> estimate of global sea level rise (m)	Sea Level Rise based on <i>extreme high</i> estimate of global sea level rise (m)
Prince Rupert	0.10–0.31	0.25–0.46	0.95–1.16
Nanaimo	–0.04	0.11	0.80
Victoria	0.02–0.04	0.17–0.19	0.89–0.94
Vancouver	0.04–0.18	0.20–0.33	0.89–1.03
Fraser River Delta	0.35	0.50	1.20

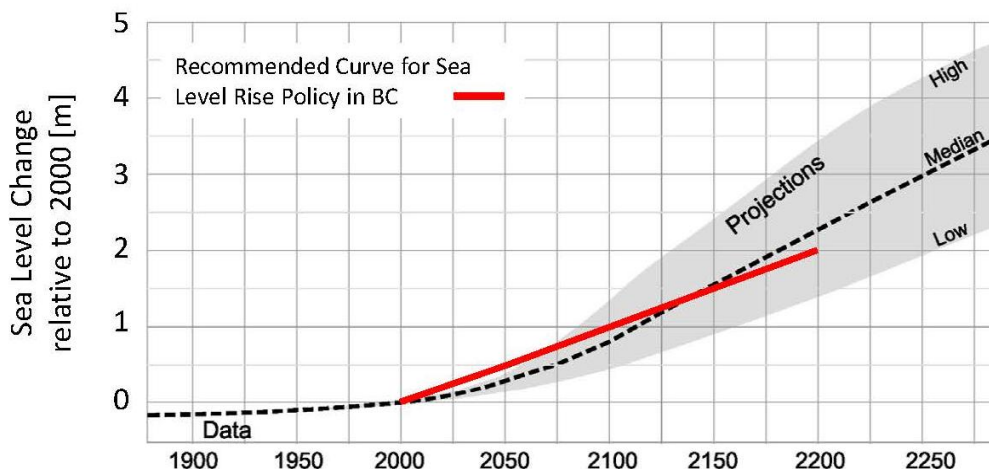
Beginning in 2009, the BC Regional Adaptation Collaborative (RAC), funded by NRCan, the BC Government, local governments and other key stakeholders, helped to accelerate processes and planning on sea level rise. A number of projects

funded focused on sea level rise and flood management, including examining the potential impacts, engaging communities and ultimately developing guidelines to help adapt and respond to the issue of sea level rise.

**Table 2: Regional Adaptation Collaborative (RAC) funded projects on sea level rise**

Title of Key Project Report	Purpose
<a href="#">Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (2011)</a>	Update provincial guidelines for sea dike design and coastal flood hazard land management to address climate change factors in coastal waters of BC. Three reports were produced under this project, including the Recommended Curve for Sea Level Rise Policy in BC (see Figure 1).
<a href="#">Coastal Floodplain Mapping Guidelines and Coastal Flood Hazard Areas (2011)</a>	Standardize the methodology to produce floodplain maps that account for sea level rise for coastal communities. The report also includes a sample coastal floodplain map prepared for the City of Campbell River.
<a href="#">APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in BC (2012)</a>	Guide professional practice for flood assessments, to help identify the circumstances when risk assessments are needed and to emphasize the need to consider climate change and land use changes in such assessments.
<a href="#">Cost of Adaptation - Sea Dike and Alternative Strategies (2012)</a>	The costing study provided a \$9.47 billion estimate for upgrading infrastructure works required along 250 km of diked shorelines and low-lying areas in Metro Vancouver to meet the rise in sea level predicted for 2100, including necessary seismic upgrades.
<a href="#">Sea Level Rise Adaptation Primer - A Toolkit to Build Adaptive Capacity on Canada's South Coasts (2013)</a>	The Primer is a toolkit for coastal management authorities (mainly local governments) to help them to identify, evaluate and compare options for adapting to the impacts of sea level rise and associated coastal hazards.

**Figure 1: Recommended sea level rise curve for planning and design in BC**



In parallel with the RAC efforts, CAS and MCSCD staff and CALP researchers were increasing awareness about sea level rise among professional networks such as the Association of Professional Engineers and Geoscientists in BC (APEGBC), Globe BC, Planning Institute of BC and Union of British Columbia Municipalities. [The King Tide Photo Initiative](#) captured images of coastlines around BC where infrastructure and ecosystems are vulnerable to flooding due to sea level rise and helped raise the profile of sea level rise in the province [1][2][4][6][8].

In 2013, acting on information developed through the RAC, in particular the costing study, the Fraser Basin Council convened local governments in the lower mainland region and other stakeholders to discuss ways to harmonize dike upgrades through the development of a regional flood protection strategy.

## DRIVERS OF ACTION

Four drivers were identified as contributing to the emergence of sea level rise action by governments and other organizations across BC.

1. Leadership on policies and initiatives contributed to raising the profile and legitimacy of adaptation;
2. Existing local projects and initiatives helped to build awareness and strengthen networks;
3. Access to external funding enabled research and pilot projects and contributed significantly to building momentum around sea level rise; and,
4. Innovative tools and communications raised the profile of sea level rise by communicating complex science to decision-makers and the general public.

Each driver contributed to BC's success in linking

science to policy and local government action.

## Leadership and Policy Readiness

Leadership and policy readiness has contributed to raising the profile and legitimacy of adaptation. The 2008 regional information emphasized the importance of building awareness about sea level rise in BC's coastal communities [1][2][4]. This facilitated the Climate Action Secretariat's ability to take leadership and act on the priority, even amongst shifting priorities and political cycles [6].

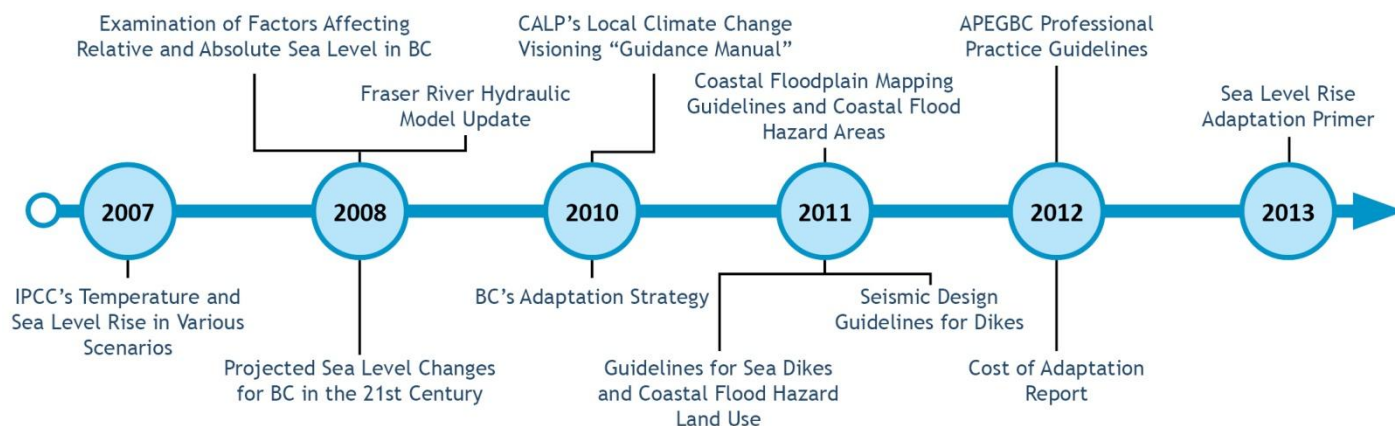
## Cross-Government Coordination

Cross government coordination was enhanced with the creation of a dedicated position on coastal adaptation in the Climate Action Secretariat. This position serves as a clearinghouse for information and a central hub for relationships with federal and local governments, reinforcing a diverse network of existing collaborations [1][6][10].

## Inclusion of Extreme Sea Level Rise Scenario in Regional Estimates

The sea level rise estimates by the IPCC (IPCC 2007), ranging between 0.18-0.59m by 2100, were considered by many to be inaccurate, since the estimate did not sufficiently account for rapidly diminishing Greenland and West Antarctic ice sheets. The addition of an 'extreme high sea level rise' scenario for consideration in the 2008 (Bornhold, B.D. 2008) regional study proved to be prudent, and consistent with more recent estimates of sea level rise. Locally scaled estimates that account for uplift, subsidence, etc. along the coastline have been helpful for building the legitimacy of these numbers in different coastal communities [1][3][8].

## Timeline of Sea Level Rise Adaptation Milestones



## Dissemination of Relevant Regional Science

The recommended sea level rise curve (Fig. 1) communicated reasonable information to governments for planning purposes, in light of the range of projections published in the scientific literature. This communication was viewed as a critical piece for emphasizing sea level rise both in policy and among the public. Already, developments in the City of Vancouver have begun to integrate these sea level rise parameters [1][3].

## Alignment with Networks to Build Awareness and Leverage Support

Cross-governmental efforts have helped to build awareness around sea level rise among professionals and leverage support for technical research developments. Linkages with professional and private associations also enhanced the mobilization of sea level rise information among policy makers and decision-makers. [The Association of Professional Engineers and Geoscientists of BC \(APEG\) 2012 report](#) created strong linkages with the Association of Professional Engineers. Government champions have also been making presentations at annual conventions such as the [Union of British Columbia Municipalities \(UBCM\)](#). Ministries including the Ministry of Environment, the Ministry of Forests, Lands and Natural Resource Operations and Emergency Management BC are all trying to align forces and work together to be more systematic in their approach [1].

## Development of Decision Support Information for Regional and Local Governments

[The Cost of Adaptation - Sea Dike and Alternative Strategies \(2012\) study](#), further raised the profile of sea level rise as a critical policy issue [3][4][5][6][7][9]. The \$9.47 billion estimate to construct appropriate flood protection in Metro Vancouver to meet the rise in sea level projected for 2100, raised additional questions regarding acquisition of lands and compensation, as well as land-use development into the future. This amplified the importance of intergovernmental collaboration to address the scale of upgrades required over time [1][2][3] [6].

## Building on Existing Local Projects and Initiatives

### Connecting with Leading Communities Taking Adaptation Action

Leading communities have been taking action based

on their own sense of risk and/or fiduciary responsibility. A keen executive, planning and/or engineering staff, facilitated by external funding, has largely motivated sea level rise initiatives. Identifying co-benefits, or areas where adaptation to sea level rise aligns with other efforts is an approach advocated by the City of Vancouver. For example, the City is currently linking resilient infrastructure with urban forest management and stormwater planning [3]. The Capital Regional District of Victoria is currently working to identify ways to integrate adaptation into other plans in order to better coordinate funding.

## Intergovernmental and Researcher-Practitioner Engagement

Connecting provincial staff and academic researchers with local governments through workshops and involvement at annual conventions (such as the Union of British Columbia Municipalities (UBCM)) helped build awareness and strengthen networks. These types of forums have helped leverage support for initial technical developments, such as research, technical reports, and specific case studies on adaptation planning (e.g. Delta, Elkford, Kimberley, City of Vancouver, City of Saanich) in the province.

## Adding Sea Level Rise to Existing Flood Risk and Flood Protection Frameworks and Forums

The Joint Program Committee (JPC) for Integrated Flood Hazard Management was re-engaged to bring diverse local governments and other relevant actors together to discuss river flooding, institutional readiness and social capacity. This became a critical forum for introducing the three policy-relevant technical guideline reports.

## Access to External Funding for Research and Pilot Projects

Access to external funds to support research and pilot projects contributed significantly to increasing awareness and building momentum around sea level rise in BC. The RAC funds enabled technical reports and collaboration that otherwise may not have occurred [10], which in turn facilitated the policy innovation and scale of local government action across the province.

## Innovative Planning and Visualization Tools to Communicate the Impacts of Climate Change

Innovative communications, such as the CALP

visualizations and the King Tide Photo initiative also helped to raise the profile of sea level rise [1][2][4][6][8]. Of all the climate change issues, sea level rise has become one of the most prominent amongst the public because it is something the public can 'see' and it is seemingly inevitable [4][1][6].

## LESSONS LEARNED

Five key lessons emerged from the BC experience.

**1. Describing climate impacts at a localized level was necessary to move the issue forward.** Access to information at a regional scale allowed local governments to 'see' the scale of direct 'place-based impacts' on their particular communities. Technical staff were able to better understand the implications and possible responses to projected sea level rise impacts and to communicate the results to elected officials and community members.

**2. Clear and specific guidance for decision-making eliminated uncertainty about what to plan for.** The development of sea level rise estimates that set aside the considerable uncertainty around climate change projections enabled municipalities to move forward and incorporate those estimates into their planning documents and engineering standards.

**3. Targeted funding increased the capacity of governments to consider a new problem (at the provincial, regional and local levels).** Climate change adaptation is a new responsibility for both municipalities and the provincial government and, as such, funding for analysis and projects has to come from existing budget envelopes. The BC RAC funding enabled a more detailed and comprehensive analysis, jumpstarting a process that would otherwise have been difficult to advance with existing resources.

**4. Collaboration between different levels of government and intermediaries contributed to local level innovation.** Policy coherence and alignment between the Province and local governments was instrumental to regional consensus and more coordinated action between local governments. Collaboration between local governments and intermediaries such as Fraser Basin Council with researchers already working in the area also contributed to increasing awareness and stimulating further local innovation.

**5. Scenarios and visualizations were an effective way to communicate complex science to decision-makers and the general public.** Using visuals demonstrating different scenarios was an effective way to communicate the science to both decision-makers and the general public. People were able to

understand the ramifications of the best science predictions on their place, contributing to more informed place-based and evidence-based decision-making.

## CONCLUSION

Targeted provincial policies and initiatives complementing and supporting local adaptation action created a rich context for progress on sea level rise adaptation in BC. Access to external funding allowed for development and translation of sea level rise science into various tools to support and/or drive local action. The choice to include in regional projections a sea level rise scenario considered "extreme" at the time anticipated the evolving science and facilitated the subsequent introduction of a planning target of 1m by 2100. Innovative planning and visualization tools have helped to communicate the impacts of climate change and raise the profile of sea level rise. Active engagement and co-ordination across ministries and collaboration with local governments, intermediaries, researchers and professional organizations have also contributed to success of sea level rise policy and planning in BC.

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