Welcome to the Spring 2018 issue of **THE ZONE**, the CZCA digital newsletter.

In this issue

THE ZONE

Coastal Zone Canada 2018 Conference • St. John's, NL

Keith Mercer, Planning Chair: CZC'18

You're all invited to come to St. John's, NL, to attend CZC'18, from July 15th-19th. The conference will be held on the campus of Memorial University of Newfoundland and at other venues in the city. The conference theme is "Seeking Practical Solutions to Real Issues: Communities Adapting to a Changing World". I'm very proud to say that our planning committee has been working hard to make this event both exciting and informative. Our program is filled with fantastic special sessions, concurrent sessions, poster sessions, social events, and more!

We kick off the conference with our Future Leaders Forum, on Sunday, July 15th, at the Delta Hotel Ballroom, in historic downtown St. John's. The event is designed to help young professionals with networking, employment direction, and gaining insight into the future of integrated ocean and coastal management. It will include an opening keynote address, a panel discussion on "Future Trends in Coastal Zone Management", and a speed networking session where delegates will meet mentors from the field of coastal and oceans management.

Sunday evening marks the opening of the main conference, with the keynote address by environmental, cultural and human rights advocate, Sheila Watt-Cloutier. In 2007, Watt-Cloutier was nominated for the Nobel Peace Prize for her advocacy work in showing the impact of global climate change on human rights, especially in the Arctic. This event will be open to the public, and we expect a big turnout!

From Monday to Wednesday, special sessions and concurrent sessions will focus on the three sub-themes of the conference: Change and Challenge – Realizing Opportunity, Engagement and Collaboration – Examples from the Field, and Tools and Technologies – Practical Applications.

The conference will conclude with a half-day on Thursday. The morning will start with a keynote address on the status of Coastal Zone Management in Canada and where we need to go with it in the future. The keynote presentation will be followed by a discussion among panelists from across Canada who will consider how we get there and the role of the Coastal Zone Canada Association in influencing the future of CZM. The morning will also feature the kick-off of our new Cold Regions Living Shorelines Community of Practice.
All work and no play is no fun, so we are hosting a Tuesday evening social event at The Rooms where the Newfoundland Museum, Provincial Archives and Art Gallery are housed. You are encouraged to walk around and explore this beautiful place, while local musicians entertain you.

Registration is still open, so come and attend this important and exciting event. We'll put the kettle on!
http://www.coastalzonecanada.org/czc2018/

Memorial University, St. John's, NL
July 15-19, 2018

Conference Sub-themes:

- **Change and Challenge – Realizing Opportunity**
- **Engagement and Collaboration – Examples from the Field**
- **Tools and Technologies – Practical Applications**

For more information: czc18@mi.mun.ca

2018 COASTAL ZONE CÔTIÈRE CANADA

ST. JOHN'S
NEWFOUNDLAND AND LABRADOR

GET IN THE ZONE

Submit your news items for the next issue of The Zone. We wish to continue the dialogue of coastal zone work across Canada between our biennial conferences, so please consider sharing an update with us to be included in the next issue.

News Items

To submit a news item (maximum 500 words) please send to thezone@coastalzonecanada.org

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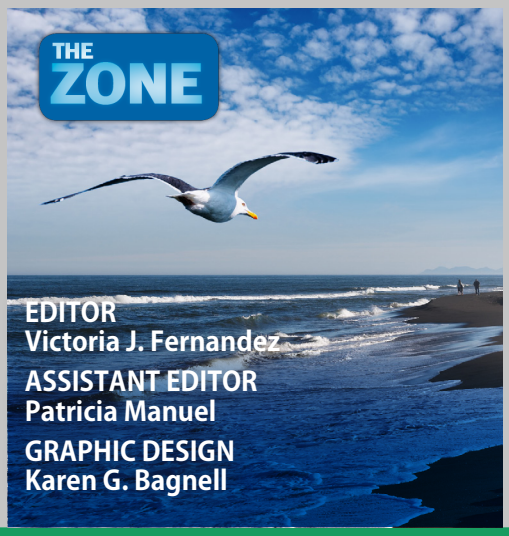
We would like to sincerely thank all of the contributors to this edition of the Zone, the authors of the papers and articles herein, as well as the reviewers.



CALL FOR PAPERS

Please consider submitting a paper to the next issue of the CZCA Newsletter. We are looking for paper submissions of 1000-2000 words on a wide range of topics covering Canada's coastal zone: governance and policy, engineering, ocean science, and social science.

If you wish to submit a paper please submit your abstracts (maximum of 250 words) to thezone@coastalzonecanada.org by September 15, 2018. Papers are due October 30, 2018.

Photo credit: Brian Elliot

Call for French Editors

The Zone is looking for French speaking or bilingual (French and English) volunteer editors. For further information please contact us at thezone@coastalzonecanada.org

CZCA Membership

Registration at the biennial conferences automatically includes CZCA membership dues for two years. If you missed the 2016 conference and would like to update your membership or become a new member, please visit our website for more details. The fee is $20/year or $40 for two years.

www.coastalzonecanada.org

Commentary: Canada's Oceans Act at 20; A Pacific Canada Perspective

Jamie Alley, University Centre of the Westfjords, University of Victoria and Jamie Alley and Associates. Former Vice President, Pacific CZCA

This article is based on a presentation by the author, Collaboration in Delivering the Oceans Act in Pacific Canada; Lessons for Delivering New Governance Models made to the "Oceans[20] Workshop" in Ottawa in June [2017]. The full workshop report may be found at https://www.wcel.org/publication/oceans20-canadas-oceans-act-workshop-report

This commentary is the author's contribution to documenting experiences with the implementation of Canada's Oceans Act in Pacific Canada over the first twenty years of its existence. It is based on personal experiences as the BC government's Director of Oceans and Marine Fisheries, as a member of the national Oceans Task Group of the Canadian Council of Fisheries and Aquaculture Ministers (2004-2009), and as the co-chair of the Canada-BC Oceans Coordinating Committee.

Early efforts at inter-governmental collaboration on coastal and marine management date back to the 1960s and offer lessons and suggestions for improving oceans and coastal management in Pacific Canada. Canada's federal government, coastal provinces and territories, indigenous governments, local governments and coastal communities are at crossroads in each part of the country; they have the opportunity to chose paths that will result in a truly collective national effort to preserve and protect Canada's marine environmental heritage and to provide for its sustainable use. The author offers these comments in the spirit of choosing wise paths. As an ancient mariner once said, "if we don't change course, the ship will end up where it's headed".

Three Underlying Themes

There are three underlying themes to these remarks that should be borne in mind when reviewing experiences with oceans and coastal management in Pacific Canada: firstly, Canada's Oceans Act belongs to everyone; secondly, we need to use all the tools in our toolbox; and thirdly, we need to learn to share out tools better. An explanation.

When I was the BC Ministry of Environment's Director of Policy and Legislation, a Deputy Minister remarked to me that "things that a society passes into statute law, should be a reflection of our highest values, beliefs and aspirations. If they are, the law will endure, and if they are not, the law will ultimately fail". The valuable lesson that I took from this, is that law and social values are intimately connected. In this context I have always found great inspiration in the preamble to the Oceans Act and its **Whereas Clauses**, which present a set of values for Canadians about our oceans. The preamble tells us that our oceans are our common heritage, that we wish to be world leaders in oceans management, and that we will promote sustainable development using an ecosystem approach to maintain biological diversity. The Act also promotes a precautionary approach to protect Canada's natural resources and collaboration to develop a national (not Federal) strategy.

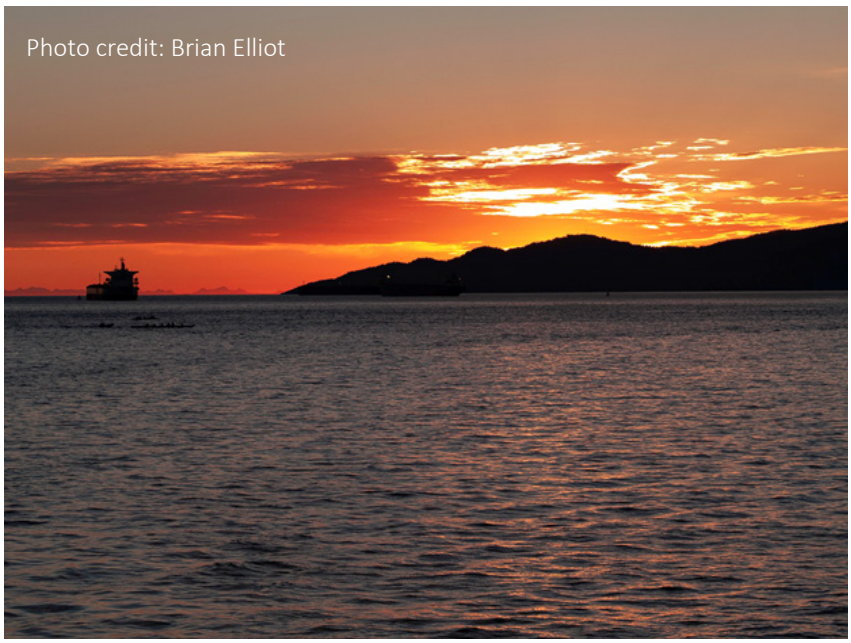


Photo credit: Brian Elliot

With the words of the preamble in mind, I have always believed that the Oceans Act is best seen as not belonging solely to the federal Department of Fisheries and Oceans, nor only to the federal government and its departments and agencies. Rather, with the preamble's calls to world leadership and collaboration, the Act is best thought of as truly national legislation, belonging to all Canadians, and its powers and obligations are to be shared with all orders of government. In a similar vein then, we should also recognize that in a complex federation like Canada, the Oceans Act is only one tool of many needed to fully manage our coastlines and oceans. For example, in Pacific Canada, the province of BC owns most of the seabed and issues tenures under the BC Land Act for activities on crown land covered by water. The province also manages most upland activities that heavily influence the quality of our marine waters. Local and regional governments have zoning powers and control most development on our coastlines and in some cases extend their planning and zoning powers into the marine environment. First Nations also have deep spiritual connections that inform their laws, traditions and protocols, developed over millennia, that have been used to share and wisely manage coasts and ocean resources among their communities. There are lots of tools in our marine management toolbox.

What is needed are approaches across Canada that bring all orders of government and interested Canadians into venues where everyone's legal, financial and scientific capacities can be brought to bear collectivity in caring for our coasts and oceans. In short then, the Oceans Act belongs to all of us. It's one of many important tools, and we need to share these tools in truly collaborative regional and national efforts, in a projet de société, to care

for our oceans and coastal heritage.

Experiences with Ocean and Coastal Collaboration in Pacific Canada

For the first hundred years of Confederation, marine and coastal management in Pacific Canada was focussed largely on fisheries exploitation, regulating marine transportation and navigational safety, developing infrastructure, and providing for the national defence of our coasts. While some migratory waterfowl sanctuaries were established, the focus was primarily on human use. Beginning in the 1960s, the need for better management and conservation became evident and serious initiatives emerged. In the context of the Oceans Act, I have divided theses experiences into four phases and summarized some of the key events.

1960-2003 Preparing to Succeed

In the 1960s, the BC Provincial Parks Branch began to designate provincial marine parks and ecological reserves in nearshore waters. While many of the early park designations were small and focused on recreational features such as small boat anchorages, some marine parks and ecological reserves were much larger, such as the 34,000 ha Checleset Bay Ecological Reserve. These protected marine waters and shorelines included important ecosystems and were often established with a priority conservation emphasis. Parks Canada led a similar initiative when Pacific Rim National Park Reserve was established on the west coast of Vancouver Island to protect important ecological and culturally significant features. In the 1970s, the BC Land Management Branch initiated a marine planning program for "crown lands covered by water" in estuaries, harbours and inlets experiencing growing use, environmental degradation and resource conflict. The Supreme Court of Canada Reference of 1984 confirmed provincial ownership of the seabed of Georgia, Juan de Fuca, and Johnstone Straits, and Queen Charlotte Sound, and marine spatial planning and protected area designations continued in those areas over the next decade.


Photo credit: Brian Elliot

It was in this context of conservation and management of human activities that the Oceans Act came into force in 1996. The legislation importantly enabled the creation of federal marine protected areas and planning for integrated oceans management. In part, these led the BC Government in 1998 to develop a "Coastal Zone Position Paper" setting out provincial interests and objectives for coastal and marine management (https://www.for.gov.bc.ca/hfd/library/documents/bib77287.pdf). Shortly after, Canada and BC issued a joint discussion paper on Marine Protected Areas (MPAs), which committed to collaboration and cooperation in the development of MPAs in Pacific Canada (http://www.dfo-mpo.gc.ca/Library/229062.pdf). The result was the identification of the first potential Oceans Act Areas of Interest for candidate MPAs, and the eventual designation of Canada's first Oceans Act MPA in 2003, over the Endeavour Hydrothermal Vents, 250 km off the southwest coast of BC.

In 2001, one of Canada's first marine co-management bodies, the West Coast Aquatic Management Board, was established on the west coast of Vancouver Island. The Board brought together the governments of Canada, BC, the Nuu-chah-nulth First Nations, local and regional governments along with businesses, conservationists and communities, to implement a coordinated regional approach to marine ecosystem management.

In 2002 after five years in development, DFO released the long anticipated "Oceans Strategy" as directed under the Act (http://waves-vagues.dfo-mpo.gc.ca/Library/264675.pdf). Faced with a series of initiatives under the strategy, and growing concern over the lack of federal coordination between agencies, the BC government developed a DFO Engagement Strategy that was subsequently approved by the BC Cabinet. These initiatives in MPA designation, integrated coastal planning and policy development and coordination, provided a basis for the substantive implementation of the Oceans Act in the following decade.

2004-2007 A Few Steps Forward

Program implementation under the Oceans Act in Pacific Canada took an important step forward in 2004 with the signing of the Canada/ BC Memorandum of Understanding Respecting the Implementation of Canada's Oceans Strategy on the Pacific Coast of Canada (http://www.pncima.org/media/documents/pdf/ mou_canada_oceans_strategy_18sep04.pdf). The MoU committed governments to cooperating formally on coastal and oceans management, and to advance the implementation of specific activities and objectives identified in the 2002 Oceans Strategy. The MoU envisioned sub-agreements on subjects such as marine protected areas, integrated planning and management, oceans information management, state of oceans

reporting, aquaculture management and offshore oil and gas development. Five sub-agreements were completed and while not formally signed, they have provided the basis for collaborative activity since that time. The Canada/BC Oceans Coordinating Committee was established under the MoU to coordinate program implementation, along with subgroups on Integrated Planning, Marine Protected Areas and Data Sharing.

The federal Oceans Action Plan (http://wavesvagues.dfo-mpo.gc.ca/Library/315255e.pdf),released in 2005,promised the first new substantive funding for Oceans Act implementation. Actual funding to DFO's regions did not follow until 2007, however, with the Health of the Oceans initiative it was subject to careful central controls. Shortly after release of the Action Plan, the federal Commissioner on Environment and Sustainable Development issued an audit of DFO's actions to implement the Oceans Act over the previous eight years. The audit found that government had failed to make implementation a priority and that it had "fallen far short of meeting its commitments and targets". At a national level, with DFO's leadership, the National Oceans Task Group under the Canadian Council of Fisheries and Aquaculture Ministers was revitalized and tasked specifically with coordinating actions to support the response to the Commissioner's recommendations. In 2006, DFO initiated the Pacific North Coast Integrated Management Area integrated plan (PNCIMA) and sought formal involvement of Coastal First Nations and the provincial government. In 2007, the second Oceans Act MPA was established in the offshore area of the north coast over the Bowie Seamount in collaboration with the Council of the Haida Nation.

2008-2013 Lost at Sea (for a bit)

With the directions established in the National Strategy and Action Plan, and with some limited funding under the Health of the Oceans initiative, a formal agreement was concluded in late 2008 between Canada and Coastal First Nations to develop the PNCIMA integrated management plan as the major Oceans Act initiative in Pacific Canada (http://www.pncima.org/media/documents/pdf/mou_-pncima_-collaborative_-oceans_-governance_-11dec08.pdf). The province of BC was not originally a signatory to the process due to concern over the lack of clarity around objectives for the process and potential outcomes, but later became a formal participant in 2010, and was a co-signatory to a tripartite funding agreement with an international philanthropic organization. Due to political and policy concerns over scope and focus, the federal government withdrew from the funding agreement in 2011 and moved forward with a more tightly focussed version of PNCIMA with limited stakeholder and BC and First Nations government involvement. The draft plan was completed in 2013, but was not formally endorsed until 2017.

Faced with the withdrawal from the funding agreement and the narrowed scope of the PNCIMA initiative, the BC government and Coastal First Nations signed a Letter of Intent in 2011 to establish the Marine Planning Partnership (MaPP) without the involvement of the government of Canada (http://mappocean.org/wp-content/uploads/2013/10/LOI_Completed_Nov_28_2011-signatures-removed.pdf). This work was to be supported financially through Tides Canada, who would serve to channel third party funds from philanthropic organizations, notably the US-based George and Betty Moore Foundation (http://mappocean.org/wp-content/uploads/2013/10/MaPP_MOU_nosigs.pdf). Under the Letter of Understanding and the new funding agreement, the parties committed to developing a regional strategy and four marine spatial plans, that could also be used to inform the federal PNCIMA plan.


Photo credit: Brian Elliot

In the fall of 2012, the federal Commissioner on Environment and Sustainable Development issued a second audit on Oceans Act implementation which focussed on the lack of progress to establish a network of MPAs and failure to meet international commitments under the UN Convention on Biological Diversity (http://www.oag-bvg.gc.ca/internet/English/parl_cesd_201212_03_e_37712.html). Some federal progress was made when, in 2010 Parks Canada reached agreement with the Council of the Haida Nation to establish Canada's first National Marine Conservation Area to complement the Gwaii Haanas National Park Reserve. The new NMCA would extend ten kilometres offshore from the Park Reserve thus protecting the area "from the mountain tops to the seafloor".

2014-2017 Preparing to Succeed (Again)

In an effort to make substantive progress

on MPA establishment on the west coast, in 2014 the federal and provincial governments released the Canada BC Marine Protected Area Network Strategy (http://waves-vagues.dfo-mpo.gc.ca/Library/363827.pdf). The Strategy proposes a joint federal-provincial approach, collaborative decision-making with First Nations and a participatory process with the public and coastal communities. In 2015, the Marine Planning Partnership completed its four marine spatial plans for Haida Gwaii, the North and Central Coasts and Northern Vancouver Island- an area coincident with the federal PNCIMA plan. These spatial plans were followed in 2016 by a Regional Policy Framework, and Implementation Plans for the four MSPs were endorsed by the BC and First Nations governments.

Later in 2016, the new (Liberal) federal government announced the Oceans Protection Plan indicating a renewed federal priority interest in oceans management and collaboration with other partners as originally envisioned for the Oceans Act in 1996. The draft PNCIMA plan which had been completed in 2013, was finally endorsed by the federal government setting the stage for renewed cooperation with BC and coastal First Nations.

The first major initiative is the planning for a marine protected area network for the Northern Shelf Bioregion- the area covered by PNCIMA and MaPP- by Canada, BC and 17 First Nations (http://mpanetwork.ca/bcnorthernshelf/). In 2017 the third Oceans Act MPA in Pacific Canada was designated with the establishment of the Hecate Strait and Queen Charlotte Sound Glass Sponge Reefs Marine Protected Area. This designation was followed later in the year with the identification of the Offshore Pacific Area of Interest, a 139,700 km^2 area off the west coast of Vancouver Island extending out to Canada's Exclusive Economic Zone boundary.

Lessons from History - The Good and the Bad

Key Accomplishments in Pacific Canada

What We Didn't Do Well

Despite what appears to be slow progress, much has been accomplished in Pacific Canada since the passing of the Oceans Act in 1996. Both the National Oceans Strategy and subsequent Oceans Action Plan have provided an important overarching policy framework and foundation for regional program implementation. The high level goals and objectives in the national documents have been reflected in the PNCIMA and MaPP policy and spatial plans, and in the Coastal Strategy developed by the West Coastal Aquatic Management Board for the west coast of Vancouver Island. Each of these plans demonstrate how an ecosystem-based management framework as envisioned in the Act, can be delivered in a specific geographic setting.


Photo credit: Brian Elliot

First Nations have undertaken major coastal and marine management and planning initiatives on their own, and in partnership with other orders of government, that could point the way for other regions in Canada for successful and respectful partnerships. The unique government-to-government relationships established in the MaPP and PNCIMA plans also demonstrate progress towards reconciliation of First Nations stewardship of marine resources. The Pacific region has also been highly successful in attracting third party investments for planning and research from philanthropic organizations such as the Moore Foundation and the Tula Foundation's Hakai Institute. Along with government funding, our understanding of Pacific Canada's ecosystems has been massively improved though basic scientific and applied research.

Pacific Canada has also led the way in North America on marine spatial planning with most of the coast (except for the Salish Sea), covered by either a regional or local spatial management plan, which in most cases, identify high priority areas for conservation and areas suitable for human use, along with accompanying ecosystem-based management guidelines. Three federal MPAs have been established under the Oceans Act, Canada's first NMCA was established in Gwaii Haanas, and some progress has been made on other areas of interest such as the Southern Strait of Georgia NMCA, Scott Island Marine Wildlife Management Area and Race Rocks MPA proposals. At the same time, the provincial network of marine protected areas has gone through major expansion in nearshore areas, and substantial areas of coastline are in protected status. Through the 2014 MPA Network Strategy and the Northern Shelf Bioregion network initiative, Pacific Canada is

well placed to make rapid progress on oceans and marine conservation.

Much has also been learned in the development of collaborative governance models that bring all parties to the table. Both the PNCIMA and MaPP governance arrangements have evolved through experience to meet their program needs and have been successful in delivering their mandated policy and spatial plans with the strong involvement of First Nations. The West Coast Aquatic Management Board (now West Coast Aquatic http://westcoastaquatic.ca), has been in operation for close to 20 years and has successfully delivered a Coastal Strategy for the region and a unique approach to marine ecosystem management and spatial planning. More importantly, the Board has been a venue and convenor in the traditional territory of the Nuu-chah-nulth nations, and has successfully served as a body for discussion and dialogue. Finally, in Pacific Canada there are a robust number of marine conservation organizations who have played major roles in advocating for better oceans and coastal management, and have ensured that conservation priorities are reflected in program delivery.

What We Didn't Do Well

Amid these successes however, there were many areas of uncertainty and poor performance that hampered progress. The largest gaps were related to the failure to establish functional horizontal and vertical collaborative mechanisms between agencies of all orders of government. At times, the three federal lead agencies on marine protection; DFO, Environment Canada and Parks Canada, appeared to be pursuing separate and uncoordinated initiatives, particularly regarding MPA proposals. This theme was identified in the CESD audits in 2005 and 2012. Lack of coordination horizontally between federal agencies, made vertical collaboration between other orders of government problematic. Despite the National Strategy, there was a lack of clarity on objectives and potential outcomes for various initiatives, as reflected for example, in the BC government's reluctance to fully engage initially in the PNCIMA process. True collaboration and partnerships require respect for each order of government as having legitimate roles and responsibilities, and the willingness to engage as equals.

While the Oceans Act and the National Marine Conservation Act, explicitly state sustainable development objectives, there was a perceived conservation emphasis to federal activities in the Pacific Region that raised concern for the provincial government and coastal communities who feared human use opportunities would be lost or restricted. The location of DFO's Oceans Program in the Pacific Region within the Habitat and Enhancement Branch, without a stand-alone Regional Director, was a poor signal to the provincial government in this regard and it would have been much better placed as a separate program. Its was also clear that within DFO itself, there were tensions between the traditional fisheries management activities and the new oceans initiatives. The communication mechanisms needed to overcome uncertainty and mistrust between the parties were not well developed and have consumed considerable effort by the new Canada/BC Oceans Coordinating Committee from 2005 onward.

While federal funding was slow to reach the region, when it did come, there were considerable central controls and the flexibility on regional approaches needed to co-fund activities proved illusive. After 2006, it became unclear as to the level of political priority the federal government placed on oceans programs, which was reflected in declining budgets and the difficulty in gaining approval for the PNCIMA plan and new MPAs. Many opportunities were lost to build on existing successes such as federal support for conservation outcomes in provincial and First Nations protected areas and marine plans. It has also become increasingly clear that the emphasis on planning and management on the north and central coasts and on the west coast of Vancouver Island, has left a vacuum in the Salish Sea- the most heavily used and endangered region in Pacific Canada.

Moving Forward with the Oceans Act in Pacific Canada - Renewed Commitments

The debate over issues such as Canada's need for a petroleum export terminal on the Pacific coast, the necessity to respond to the impacts of climate change and ocean acidification, and how to accommodate population growth and development, have highlighted the need to renew our commitment to the better management of our oceans and coasts. To move forward, here are some thoughts on priorities based on our experiences in Pacific Canada:

1. We must continue to sell the need for better oceans and coastal management and conservation, and to make this a high national public priority.

2. We need to be clear about objectives; keep them broad and focussed on conservation, human use and sustainability and don't get fixated on targets. Our key goal should be to ensure better oceans and coastal management everywhere, not meeting an international treaty commitment.

3. We need to build a diverse set of inclusive and non-hierarchical governance mechanisms- getting beyond simple advisory committees. Invite everyone to the table and treat them with respect.

4. We must harness the collective energies of the public, private and voluntary sectors in collective efforts- similar to the Puget Sound Partnership in Washington State.

5. 5. We should support sub-regional flexibility on governance and build bridges between initiatives such as MaPP and PNCIMA. The Northern Shelf Bio-region MPA network is a good start.

6. We should continue to support West Coast Aquatic on the west coast of Vancouver Island. This unique model of collaboration is working and can be developed further.

7. We need to examine collaborative governance options for spatial planning and MPA network development in the Salish Sea. This area is among Canada's most heavily used marine waters.

8. We should explore co-designation models involving all orders of government so that future MPAs in non-offshore areas respect

provincial ownership of the seabed and First Nations jurisdiction.

9. We must not get distracted by short term politics- these will always be with us.

10. We need to treat the Oceans Act as belonging to all Canadians.

A Vision for the Future

At the 2017 Oceans20 workshop in Ottawa where these remarks were initially presented, participants were challenged to contribute their vision for oceans management in 2020 and beyond- a thought provoking exercise. This is what I came up with:

My vision for 2020 is that Canadian oceans management will become a truly national movement involving all orders of government -- local, First Nations, provincial, territorial, and federal-- along with a broadly based coalition of partners in our civil society, working together and fully engaged in a collaborative alliance.

We will strive to live up to the inspirational guidance in the preamble to the Oceans Act, and will harness the collective energies of the public, private and voluntary sectors through the development of innovative governance mechanisms.

We will be guided by regional ocean management strategies and marine spatial plans and will use the best available science to create regional networks of coastal and marine protected areas, and will identify and implement collaborative integrative management regimes for conservation and designated use areas.

We will take pride in and care about our coasts and oceans, and our stewardship will be a broadly-based national priority.

I challenge readers to think about their own visions for oceans management in Canada and if you are looking for a little help and inspiration, read the preamble to the Oceans Act. Really, do it. You will be inspired.

http:// laws-lois.justice.gc.ca/eng/acts/O-2.4/page-1. html#h-3

A Scan of the Eastern Canadian Coastal Region

C Fuentes-Yaco a, C Caverhilla, E Devreda, S Parsonsb, E Hornec, B Lawc, C Portera, B DeTraceya

Introduction

Coastal areas are fundamental for fisheries, nurseries, tourism and recreation. They are sensitive regions that need to be monitored and protected. Remote imaging sensors carried on satellites are among the most advanced tools to observe and monitor coastal environments at high temporal frequency in a cost-effective manner.

Satellite optical sensors measure ocean colour to estimate the amount of phytoplankton (microscopic photosynthesising organisms) in the surface waters of the ocean. These sensors that can detect ocean surface colour and, to some extent, that of the near surface water column. Since some of the light penetrates and interacts with water molecules and other constituents in the water, ocean colour varies depending on what is in the water. In off-shore waters the most important constituent that influences water colour is phytoplankton. By detecting pigments in specific parts of the visible light spectrum, the amount and distribution of phytoplankton can be detected in terms of chlorophyll concentration; chlorophyll is present in most phytoplankton. Remotely-sensed estimation of chlorophyll concentration is much more difficult in nearshore waters, where ocean colour is affected by the presence of other components such as coloured dissolved organic matter (CDOM), river runoff, and resuspension of sand and silt.

This summary outlines a selection of satellite-derived products developed by the Remote Sensing Group (RSG) of the Bedford Institute of Oceanography (BIO), and their applications in Eastern Canadian coastal waters.

The RSG processes ocean colour data from sensors on satellites belonging to NASA (National Aeronautics and Space Administration), NOAA (National Oceanic and Atmospheric Administration), ESA (European Space Agency) and EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites). The analyses begin with either the reception of satellite signals at BIO's satellite receiving station, or with downloading Level 1 and 2 data from the space agencies. This information is processed by the RSG to generate Level 3 and Level 4 products, with different spatial and temporal resolutions. NASA defines Level 3 products as "derived geophysical variables that have been aggregated/projected onto a well-defined spatial grid over a well-defined time period" (https://oceancolor.gsfc.nasa.gov/products/). The Level 3 RSG products are mainly derived from the photosynthetic pigment chlorophyll-a. However, other products include total suspended matter (TSM), diffuse attenuation coefficients for downwelling irradiance at 490 nm (Kd490), and at 532 nm (Kd532), Photosynthetically Active Radiation (PAR), coccolithophore concentration and Sea Surface Temperature (SST). Some specific Level 4 products (model output or results from analyses of lower level data) and applications for coastal areas have been developed by RSG, including: primary production estimates, water transparency (Secchi Disk Depth), identification of diatoms and detection of harmful algal blooms (HABs). Level 3 and 4 products are normally computed as semi-monthly images on a 1 km or 4 km grid. Some of the results can be viewed at the RSG website: http://www.bio.gc.ca/science/newtech-technouvelles/sensing-teledetection/index-en.php, and most are available by request to Carla Caverhill (Caverhillc@mar.dfo-mpo.gc.ca).

Case studies of present activities

Water transparency for planning Airborne Lidar Bathymetry

From an ongoing collaboration between RSG and the Canadian Hydrography Service (CHS) for planning their Airborne Lidar Bathymetry (ALB) survey program, water clarity became a fundamental aspect of study for an effective and successful assessment of ocean colour.

In ideal situations the constituents affecting water clarity are present at minimal levels and have little or no impact on the normal attenuation of a lidar signal through the water column. In reality, however, the constituents impacting water clarity are normally present in varying degrees and are the major cause of lidar signal attenuation when conducting ALB surveys. Variations can occur over small distances depending on the causative factors impacting localized water clarity, often making it difficult to predict and detect using individual, in situ observations (e.g. Secchi disk).

There are three main constituents of coastal ocean water that effect clarity: i) Total Suspended Matter (TSM) (e.g. particulate), ii) Coloured Dissolved Organic Matter (CDOM) (e.g. tannins, humic, gelbstoff), and iii) Suspended Organic Matter (SOM) (e.g. phytoplankton, zooplankton). These three constituents occur at varying levels and have different impacts on ALB survey operations depending on their presence. TSM is commonly associated with turbidity, windy conditions, rivers, storm outflow or high sea state. Rapid currents can increase the amount of TSM, while the size of particulate (e.g. silt versus sand) impacts how long it takes for TSM to settle for improved water clarity. CDOM is dissolved (it does not settle out) so its impact on water clarity is only mitigated if another clearer source replaces the heavily coloured water. However, CDOM absorption is reduced through photobleaching. Rivers, outflows and enclosed estuaries are particularly prone to elevated levels of CDOM, which can be a significant water clarity issue preventing effective ALB or imagery data collection. SOM is typically associated with phytoplankton blooms that have widespread effects on water clarity and generally prohibits good ALB data collection. A bloom must run through its cycle (which can

[1]*To whom any correspondence should be addressed.*

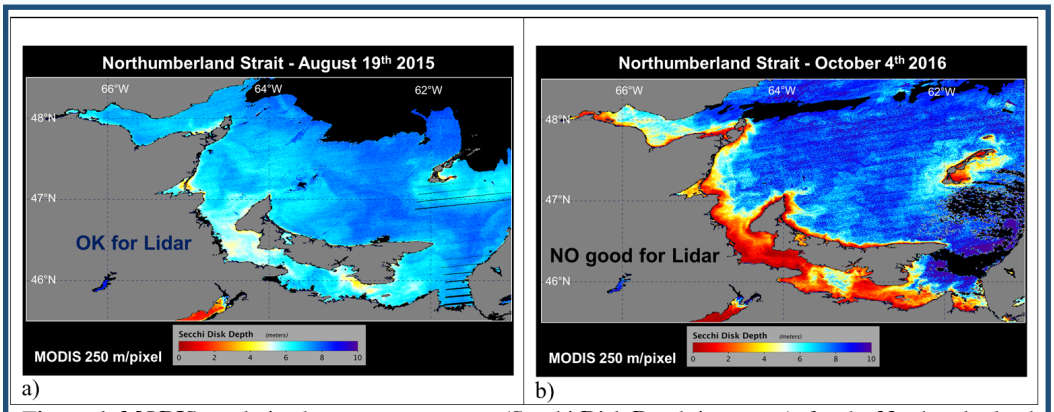


Figure 1. MODIS$_{Aqua}$ derived water transparency (Secchi Disk Depth in meters), for the Northumberland Strait in adequate [a) August 19th 2015], and inadequate [b) October 4th 2016] conditions for Airborne Lidar Survey.

last from days to weeks) and has an overall impact not just at the surface but throughout the water column. The by-products of the bloom must disperse or settle through the water column for a significant period before water clarity, from the water surface to the seafloor, improves and ALB work can continue.

The Remote Sensing Group at BIO developed a method to evaluate water clarity using historical MERIS total suspended matter, current MODIS (250m/pixel) satellite based spectral imaging and Secchi disk depth field observations [1]. The graphical seasonal charts and daily mapping produced were used in December 2015 to aid in the site planning for lidar survey project areas and during water clarity assessments surveys in Atlantic Canada. In addition to maps of Secchi Disk Depth shown in Figure 1, RSG offers complementary and important information in the planning process, such as maps of TSM, Kd490, Kd532, Chlorophyll_a, and SST.

This ensemble of environmental information proved to be an invaluable tool in deciding where and when to best conduct lidar surveys for the most effective and predictable results. The method is also being applied by CHS on the Canadian west coast, in the Haida Gwaii neighbouring waters.

A conceptual warning system for toxic levels of Alexandrium fundyense

A recent scientific study led by an RSG/BIO member [2] developed a novel approach for detecting harmful algal blooms (HABs). The study focused on dinoflagellate Alexandrium fundyense in the Bay of Fundy. A. fundyense is known to produce paralytic shellfish poisoning (PSP) toxins which accumulate in shellfish. Consuming affected shellfish can be fatal to humans, even when A. fundyense abundances are as low as 200 cells·L−1. Since there are wild fisheries as well as Atlantic salmon (Salmo salar) and shellfish aquaculture in the Bay of Fundy, a warning system that detects concentrations of A. fundyense is extremely useful to the industry and consumers. For a warning system to be effective, it must identify toxic blooms in the early stages of development. However, currently it is not possible to directly identify the harmful species with remote sensing.

This study developed an indirect method of predicting HAB occurrence by calibrating in situ measurements of A. fundyense cell abundance with two types of satellite-derived observations: 1) sea-surface temperature (SST) and 2) the occurrence of diatom-dominated phytoplankton populations. The warning system is based on three levels of alert, or colours, which indicate concentrations of A. fundyense: green (low abundance), orange (possible threat) and red (high probability of concentrations that would result in harmful shellfish toxin levels).

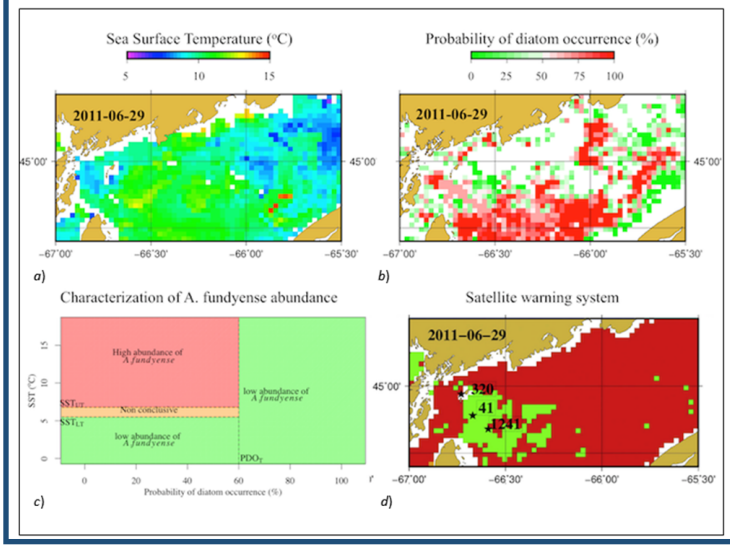


Figure 2. Satellite-based warning system for toxic level of *A. fundyense* in the Bay of Fundy, NB. a) 8-day composite of sea-surface temperature and b) probability of occurrence of diatoms centered on the 29th of June 2011, c) schematic of the warning system based on diatom (PDOT) and sea-surface temperature (SSTU and SSTL) thresholds. d) Illustration of the warning system with green: low-abundance, orange: non-conclusive and red: high-abundance, solid stars indicate location of in situ cell count of *A. fundyense* (number in bracket).

Validation of the new generation of ocean colour sensors

RSG/BIO is participating in the validation of preliminary measurements of a new generation of ocean-colour sensors with specific characteristics for enhanced study of coastal waters. These are the Ocean and Land Colour Instrument (OLCI-A and OLCI-B) aboard ESA and EUMETSAT's Sentinel-3 satellites [3] and the second-generation Global Imager (SGLI) on the Japanese Aerospace Exploration Agency's (JAXA) GCOM-C satellite. The OLCI sensors measure ocean colour at 300m spatial resolution and have neural network algorithms that appear to be more robust for estimating chlorophyll a in coastal areas. Sentinel-3A was launched on 16 February 2016, followed by

Sentinel-3B on 25 April 2018. SGLI has 250m resolution and was launched in December 2017. It is remarkable to have three 250-300m sensors flying at the same time. It makes ocean colour remote sensing of coastal and near-shore waters feasible.

RSG/BIO's validation team uses ship-based data collected as part of their routine monitoring programs on Canada's east coast to compare with the remotely-sensed products from the new sensors. Once validation is complete, data from these sensors will form part of RSG's operational remote sensing program. A preliminary assessment of the performance of OLCI L2 products in waters off the coast of Nova Scotia and Newfoundland, in the Labrador Sea and in Bedford Basin show promising results [3].

Future research

RSG is looking forward to incorporating data from the NASA's PACE (Plankton, Aerosol, Clouds, ocean Ecosystem) hyperspectral microsatellite mission (https://pace.gsfc.nasa.gov/), which is scheduled to launch in 2022. Hyperspectral sensors measure light at many more wavelengths than present ocean colour sensors. This increased spectral resolution will make it easier to detect components in the water by their spectral signature, thus improving remote sensing in coastal areas. Present sensors estimate phytoplankton concentration and distribution, but hyperspectral data will make it possible to derive information on phytoplankton species diversity. This information will be used in HABS detection and ecological studies.

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2. *Devred, E, Martin, J, Sathyendranath, S, Stuart, V, Horne, E, Platt, T, Forget, M-H, Smith, P 2018 Development of a conceptual warning system for toxic levels of Alexandrium fundyense in the Bay of Fundy based on remote sensing data. Remote Sensing of Environment 211 413–424.*
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Coastal Defence Roles of Mangroves on the Amazon-Influenced Coast of Guyana, South America: Review of an Intervention Project in an Eroding Coastline

Johnson-Bhola, Linda and Oyedotun, Temitope D. Timothy

Guyana's coastal zone, consisting of reclaimed wetland, extends 430 kilometres along the Atlantic Coast and varies in width from 26 kilometres to 77 kilometres (Environmental Protection Agency, EPA, 2002). The entire area lies between 0.5 metre and 1.0 metre below the mean Atlantic spring tide mark and it is protected along its coastal boundary by a man-made sea defence system. According to the Environmental Protection Agency (2000), the system consists of approximately 100 kilometres of stone walls (1.3 metres high) installed along some of the most vulnerable areas including 145 kilometres of mangrove forests, 80 kilometres of natural sand banks and 15 kilometres of rip-rap or granitic stone. Unfortunately, in recent years the lack of adequate maintenance of existing sea defences, and the progressive degeneration of mangrove forests by both natural and anthropogenic events have served to expose the coast to the vagaries of high velocity waves (Dalrymple, and Pulwarty 2006). Historically, Guyana's mangrove forests have been recognized as one of the most important natural coastal defences. The forests guard the coast against wave action and saline intrusion onto the low-lying coastal areas inhabited by almost 80% of the country's population, and where most of the country's investments in industries and infrastructure have taken place (Environmental Protection Agency 2002; Guyana Forestry Commission, GFC, 1997). They also trap sediments and stabilize shoreline substrates (National Agricultural Research & Extension Institute, NAREI, Annual Report 2016).

Natural Treats to Mangrove Management

Guyana's coastal mangroves are threatened by erosion cycles, characteristic of the coastline of the Guianas (Amazon to the Orinoco Rivers), and large-scale mud bank movements. Over the past decades, the incessant arrival of unusually high tides to Guyana's seacoast has brought to the fore the view that urgent actions need to be taken to protect the nation's coastal population and infrastructure investment. The country's level of vulnerability is made even graver by projections of sea level rise of as much as 0.88 metres by the end of the century (Government of Guyana 2012a). Increases in storm surges of about 5 meters are expected to affect more than 22,000 hectares of the coastal zone, through further inundation and erosion that can significantly cripple the country's economy (Government of Guyana 2012a; Anthony and Gratiot, 2012). Initially, the extent of mangrove coverage appeared to be adequate, with a minimum width of approximately 200 metres to facilitate recovery after erosion periods, but intensive settlement of Guyana's coastline has allowed erosion cycles to wipe out portions of the mangrove belt (e.g. Figure 1).

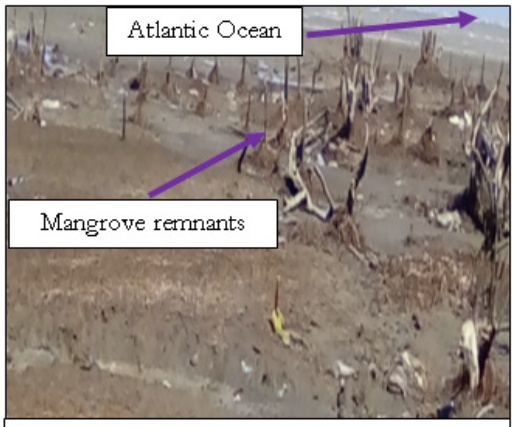

Figure 1: Remnants of mangrove forest at Wellington Park due to erosion, Corentyne, 2018

Estimates in 2011 indicated that the current extent of coastal mangroves is approximately 22,632.4 hectares (NAREI 2016), which is less than previous estimates of 91,000 hectares and 80,432 hectares in 1990 (National Land Use Plan 2013; Guyana Forestry Commission 2011; Government of Guyana 2010). Concern about the potential effects of storm surges was also reinforced by high and continually rising costs of constructing and maintaining concrete walls, the huge financial costs and social dislocation of the coastal population due to property damage and destruction and loss of agricultural lands spoiled by sea water breaching the coastal defences.

Anthropogenic Impacts on Mangrove Management

The management of ecosystems along the coast has been integrally linked to the livelihoods of large numbers of people in coastal communities. These communities have been reliant on coastal and estuarine mangrove forests for a variety of uses that include fisheries, firewood, and honey production. The proximity to, and interaction of many coastal villages with mangrove habitats suggest that these communities have a significant role to play in the sustainable management of this natural resource. Mangroves have occupied hectares of private lands in many coastal communities and they extend from about 0.5 kilometres north of the main road to the reserved area near the seashore as shown in the illustration (in Figure 2). This development has implication for private land ownership; hence the need for a determination of the extent of private lands which ought to be brought under control for protection of the sea coast against the erosive action of the ocean and river currents. The laws and regulations governing the 50ft extent from the shoreline for sea defence protection need to be amended.

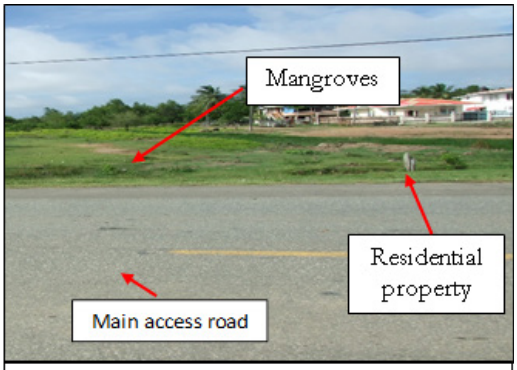

Figure 2: Proximity of Mangroves to Households at Wellington Park, Corentyne, 2016

Institutional Framework for Mangrove Management

A number of key institutions are directly involved in the management of the mangroves. The National Agricultural Research & Extension Institute (NAREI) of the Ministry of Agriculture, Guyana Forestry Commission (GFC), Sea and River Defence Department of the Ministry of Public Infrastructure, Fisheries Department of the Ministry of Agriculture, Environmental Protection Agency (EPA), Guyana Lands and Surveys Commission (GLSC), National Drainage and Irrigation Board of the Ministry of Agriculture, and the Regional Democratic Councils (RDCs) (National Mangrove Management Action Plan 2010). This institutional framework for mangrove management promotes mangrove conservation, Ministerial support and search for guidance However, these objectives seem to be out-weighed by limitations such as overlapping jurisdiction, insufficient stakeholder collaboration and land use conflicts.

The Guyana Mangrove Restoration Project (GMRP)

One of the responses to the alarming rate of mangrove depletion from both natural events and human activities, the potential impact of sea level rise on Guyana's coast, and the rising cost of maintenance of the sea defence structures, was investment in the re-planting, protection and conservation and management of mangroves, especially in areas considered most vulnerable to perceived threats. The Guyana Mangrove Restoration Project (GMRP) was established in 2010 with funding from the Government of Guyana (GoG) and the European Union (EU) under the Global Climate Change Alliance programme. The primary objective of the project was to promote sustainable management of mangroves (Government of Guyana 2010; Ackroyd 2010). The sustainable management of mangroves described in the project document was founded on three key principles (National Mangrove Management Action Plan 2010): ecological sustainability, economic sustainability and sustainability of the social system. Ecological sustainability suggests maintaining the ecological balance of mangrove ecosystems at their restoration sites while utilizing some resources. Economic sustainability identifies opportunities for satisfying some basic needs of the local communities. Sustainability of the social systems is directed to developing infrastructure such as building common facilities for community activities, sustaining local and national traditions and ensuring social justice.

Intervention Strategies aimed at Mangrove Restoration and Rehabilitation for Coastline Protection

Various initiatives have been undertaken since the establishment of the Guyana Mangrove Restoration Project. The initiatives include monitoring restoration sites to collect and store data as part of an integrated monitoring system utilizing GIS technology and human resources, preparing Community Action Plans (CAPs), establishing Village Mangrove Action Committees (VMACs) and Mangrove Reserve Producers Co-op Society (MRPCS) for groups to engage in alternative livelihood activities, and coastal engineering interventions using brushwood dams/sediment traps.

The monitoring system is intended to record and map changes temporally, assess conservation or management efforts, gauging damage, compare developments between restoration sites, and set standards, thresholds and targets for mangrove management. This activity used performance criteria to determine the most suitable restoration techniques, including their application at sites with hard engineering infrastructure. At Wellington Park, for example, where restoration and rapid assessments of relative mud elevation against chart datum were applied, monitoring was done from 2011 through 2017 National Agricultural Research & Extension Institute 2016). Based on 2016 observations, elevation and forest structure data collected at this restoration site, there is a strong positive correlation between erosion of the coastline and the rate of mangroves destruction. Hence, no significant improvement in the regeneration of mangroves occurred due to the erosion cycle. The monitoring system is complemented using GIS, where rangers collected spatial data to assist in determining possible restoration interventions and to monitor change in the quantity and extent of mangrove coverage. VMAC groups, consisting of residents residing along the coast, were established with the mandate of assisting with monitoring mangroves and to advance working relationship with the rangers and the Neighbourhood Democratic Councils (NDCs). Community Action Plans (CAPs) were created for Wellington Park and other VMACs in which issues affecting mangrove restoration, protection and management were identified and public awareness campaigns were undertaken (Figure 3). One of the most striking initiatives was the Mangrove Reserve Producers Co-op Society (MRPCS), an alternative livelihood strategy dedicated to the establishment of an apiculture programme. Initially, brushwood dams/sediment traps, built from local materials, were introduced to assist in curtailing wave action, retain sediments and facilitating the growth of mangroves.

Figure 3: Bill Board on the Mangrove Project erected at Wellington Park, Corentyne, 2017

Conclusion

Overall, the Guyana Mangrove Restoration Project illustrated that suitability of sites for mangrove regeneration has been a key parameter in mangrove management and a better understanding of coastal processes affecting the Guyana coastline could go a long way in improving planning for successful mangrove restoration and management. This is evident in cases where mangrove seedlings

which were cultivated did not always flourish on the sites selected for rehabilitation. Although mangrove restoration effort can be daunting due to the dynamic nature of the coastline and some other factors, the Government of Guyana and key stakeholders have recognized the importance of the mangrove system in coastline and coastal zone protection in Guyana. With the adoption of this form of ecological coastal defence, the rate of landward retreat of the coastline (coastal erosion) can be significantly reduced. The re-introduction and rehabilitation of mangroves along the mud-bank coastline remains the only sound, cost-effective and viable long-term coastal defence mechanism for this wave-exposed coastline. Therefore, the authors recommend that specific hazard-mangrove management interventions and other ecosystem-based coastal defences be considered in suitable locations in the country, especially in the face of persistent global climate change. Mangrove management can be successfully implemented in the tropical coastal zone of the world- on a large scale. Proper implementation of this approach is gaining recognition as sustainable, cost-effective and ecologically sound alternative to conventional coastal engineering (Opperman, 2014).

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