A climate change vulnerability framework for Corales del Rosario y San Bernardo National Natural Park, Colombia

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Table S1. Key definitions related to the development of climate change vulnerability indices for biological and socio-economic resources within PNNCRSB. For the purpose of this research, variables of interest related to climate change included: changes in sea surface and air temperature, precipitation, ocean acidification, and sea level rise and inundation. These definitions are a combination of definitions provided in different sources (Holling 1973, Burton 1993, Cutter 1996, Gunderson 2000, Walker et al. 2004, Adger 2006, Parry et al. 2007, Comer 2012, Doney et al. 2012).

Criteria	Definitions	
	Habitats and biological resources	**Infrastructure, tourism, socio-economic resources**
Sensitivity		
The extent to which a resource is susceptible or sensitive to changes induced by one or more climate change variables and is a function of resource-specific thresholds and tolerances to specific climate change related stressors. For example, sea turtles nesting beaches are sensitive to changes in sea level and to accelerated beach erosion rates.		
Exposure		
The extent to which a resource is directly and physically impacted by changes induced by one or more climate change variables. Exposure depends on the degree of exceedance of resource-specific thresholds, as well as to the degree of physical exposure experienced by the resource. For example, exposure of sea turtle nesting sites to inundation would result in massive mortality of eggs and loss of nests.		
Adaptive capacity		
The potential capacity of a resource to adapt, adjust or cope with changes induced by one or more climate change variables moderating, reducing or minimizing the magnitude of adverse direct effects. These include responses leading to restored essential function, identity, structure and feedbacks. Adaptive capacity is a function of resource-specific characteristics.		

Criteria	Definitions	
	Habitats and biological resources	**Infrastructure, tourism, socio-economic resources**
Dependency	Degree to which a resource depends on another resource that generates habitat or that is a required habitat. For example, dependency of sea turtles on nesting beaches.	Degree to which a resource depends on a particular type of substrate, feature or specific location. For example, tourism dependency on recreational beaches.
Level of specialization	Degree to which a resource has specialized features rendering it dependent on other species. For example feeding and bioenergetics dependencies on a select number of resources (e.g., single prey, limited diet). For example, dependency of corals on zooxanthellae.	Degree to which a resource provides specific services to the local communities and tourists that cannot be provided by another resource. For example, docks provide a point of access that cannot be provided by another resource.
Dispersal/movement	Degree to which a resource depends on other species for dispersal, or degree to which a resource is able to move or migrate. For example, high dispersal capacity of migratory birds.	Degree to which a resource could be relocated to an equally suitable location providing similar functions to those of the original location. For example, permanent structures cannot be relocated due lack of land availability, or degradation in the quality of services.
Functional diversity	Diversity within functional group within a given community. The more diverse the resources, or resources within a habitat, the greater the likelihood that one or more species would allow the community continue to perform its function and ecological roles. For example, high biological diversity of coral reefs.	Degree to which a resource provides a diversity of services to the local communities and tourists. For example, access points that facilitate access to diving areas and recreation beaches.
Key features, uniqueness	Degree to which a resource is considered a key species, a species that is ecologically important, or a species that is endemic, unique or rare. For example, mangroves play an important role in shoreline stabilization.	Degree to which a biological resource is considered unique and limited in the area, and consequently it provides unique recreational services that cannot be provided by another resource. For example, hypersaline lagoons provide a unique recreational area not available in the mainland. A clear distinction between this criteria and "level of specialization", is that it encompasses biological and ecological services provided by the socio-economic resource.
Conservation status, conservation priority	Degree to which a resource is considered a conservation priority, or have a conservation designation (e.g., threatened, endangered, critically endangered, etc.). For example, all sea turtles have a conservation designation).	Degree to which the loss of a particular resource would limit, reduce or eliminate the functions and benefits derived from the resource. For example, hotels provide a critical source of income to the local communities.
Existing threats	Degree to which a resource is currently under stress, pressures and threats that may render them less able to compensate for additional sources of stress (e.g., high degree of human intervention of dry forests).	Degree to which a resource is currently under stress, pressure or threats that may render it less able to compensate for additional sources of stress. For example, the poor condition of docks due to lack of maintenance.

Criteria	Definitions	
	Habitats and biological resources	**Infrastructure, tourism, socio-economic resources**
	Vulnerability	
The propensity or predisposition of a resource to be vulnerable or adversely impacted by climate change. Vulnerability is a function of **sensitivity**, **exposure,** and **adaptive capacity**		

Table S2. Information sources used during the development of climate change vulnerability indices for biological and socio-economic resources within PNNCRSB. In the absence of readily available information, best professional judgment (BPJ) was used based on technical knowledge on each off the resources of interest.
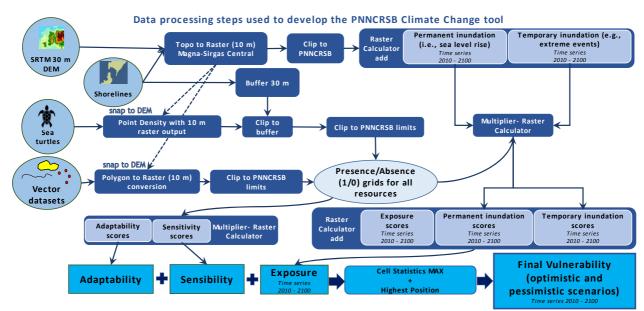
Resource	References
Sea turtles	Ceballos-Fonseca 2004, Fish et al. 2005, Cambers 2009, Fish et al. 2009, Fuentes et al. 2009, Hawkes et al. 2009, Zarza-González (2011), CEPAL 2013, Brost et al. 2015
Birds	Cambers 2009, Zarza-González (2011), Foden et al. 2013, Velásquez-Tibatá et al. 2013, Burthe et al. 2014, Galbraith et al. 2014
Rocky shores	Raven et al. 2005, Cambers 2009, Zarza-González (2011), CEPAL 2013
Algae	Zarza-González (2011); **BPJ**
Soft bottoms	Magrin 2007, Schlacher et al. 2008, Zarza-González (2011), Schoeman et al. 2014
Dry forest	Fischlin et al. 2007, Magrin 2007, Zarza-González (2011), INVEMAR-MADS 2012
Corals	Díaz et al. 2000, Garzón-Ferreira et al. 2001, Raven et al. 2005, Cambers 2009, Donner 2009, Byrne 2011, Pandolfi et al. 2011, Zarza-González (2011), Doney et al. 2012, INVEMAR-MADS 2012, Foden et al. 2013, Kroeker et al. 2013, NOAA Coral Reef Watch 2015
Coastal lagoons	Zarza-González (2011), INVEMAR-MADS 2012
Mangroves	Snedaker 1995, Sanchez-Paez et al. 1997, Schaeffer-Novelli et al. 2002, McLeod & Salm 2006, Magrin 2007, Alongi 2008, Cambers 2009, Uribe Perez & Urrego Giraldo 2009, INVEMAR-MADS 2012, Polanía et al. 2015
Sea grasses	Díaz et al. 2003, Waycott et al. 2007, Bjork et al. 2008, Cambers 2009, Gallegos Martínez 2010, Zarza-González (2011), INVEMAR-MADS 2012
Socioeconomic	Zarza-González (2011), INVEMAR-MADS 2012; **BPJ**

Table S3. Representative example (pessimistic scenario, year 2100) of the scoring matrices developed as part of this research. Not all resources are shown. Symbols: H: high, M: moderate, L: low, * values assigned based on site-specific georeferenced information. The final vulnerability score is based on numerical values assigned to each cell.

Resource	Sensitivity (H=3, M=2, L=2)						Exposure (H=3, L=2)					Adaptive Capacity (H=1, M=2, L=3)						
	Air and sea Surface temperature	Precipitation and hydrological regimes	Ocean acidification (pH)	Sea level rise	Shoreline changes	Inundations and storm surge	Sea level rise	Air and sea Surface temperature	Precipitation	pH	Inundations and storm surge	Dependency	Level of specialization	Dispersal/movement	Functional diversity	Key features, uniqueness	Conservation status, conservation priority	Existing threats
Sea turtles	H	M	M	H	H	H	*	H	H	H	*	L	H	L	L	L	L	L
Birds	M	M	M	H	M	M	*	H	L	H	*	M	H	M	M	L	M	M
Rocky shores	M	L	M	M	M	L	*	H	L	H	*	L	H	M	M	L	H	M
Algae	L	M	L	L	L	L	L	L	L	H	L	M	H	H	H	H	H	M
Soft bottoms	M	H	H	L	L	M	L	L	L	H	L	M	H	H	H	M	M	L
Dry forest	L	M	L	H	H	H	*	L	L	L	*	L	H	L	H	M	M	M
Corals	H	H	H	M	M	M	L	H	L	H	L	L	H	L	H	H	L	L
Coastal lagoons	M	H	M	H	H	H	*	L	H	L	*	L	M	L	H	L	M	M
Mangroves	L	M	L	H	M	H	*	L	L	L	*	L	M	L	H	M	M	M
Sea grasses	L	M	L	L	M	M	L	L	L	L	L	L	M	L	H	M	M	L
Sediments	L	M	L	L	L	M	L	L	L	H	L	M	H	H	H	H	H	L
Crops	L	M	L	M	M	H	*	L	L	L	*	L	M	L	M	H	H	M
Vegetation mosaic	L	M	L	M	M	H	*	L	L	L	*	L	M	L	M	H	H	M
Housing	L	L	L	M	M	M	*	L	L	L	*	L	M	L	M	L	M	M
Recreational beaches	L	L	L	H	H	H	*	L	L	L	*	L	M	L	M	M	M	L
Recreational lagoons	L	L	L	H	H	H	*	L	L	L	*	L	M	L	M	M	M	M
Shoreline protection	L	L	L	H	M	L	*	L	L	L	*	M	H	M	M	H	H	H
PNNCRSB facilities	L	L	L	M	M	M	*	L	L	L	*	L	M	L	M	H	M	M

Table S4. Color scales of the final vulnerability of the combined sensitivity, exposure and adaptive capacity scores for each cell equally binned based on the entire range of final scores. Weighted scores, using a multiplier of final scores, were used based on the location of the resource in relation to the boundaries of the PNNCRSB management areas: high conservation priority area= 1.5, natural recovery area=1.25 and recreational area=1.

Final vulnerability score	Final weighted vulnerability score
20-22	20.00-24.75
23-25	24.76-29.50
26-28	29.51-34.25
29-30	34.26-39.00
31-33	39.01-43.75
34-35	43.76-48.50
36-38	48.51-53.25
39-40	53.26-58.00
41-43	58.01-62.75
44-45	62.76-67.50

Figure S1. Summary of the data processing steps used to develop the PNNCRSB climate change spatial tool.

Literature Cited S1. Complete list of references included in the Supplemental Material section.

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Titles of Supplemental Videos

Video S1. Changes in vulnerability scores as a function of time under the pessimistic scenario for Barú Island and its surrounding waters.

Video S2. Changes in vulnerability scores as a function of time under the pessimistic scenario for Ceycén Island and its surrounding waters.

Video S3. Changes in vulnerability scores as a function of time under the pessimistic scenario for Grande Island and its surrounding waters.

Video S4. Changes in vulnerability scores as a function of time under the pessimistic scenario for Mangle Island and its surrounding waters.

Video S5. Changes in vulnerability scores as a function of time under the pessimistic scenario for Múcura Island and its surrounding waters.

Video S6. Changes in vulnerability scores as a function of time under the pessimistic scenario for Panda Island and its surrounding waters.

Video S7. Changes in vulnerability scores as a function of time under the pessimistic scenario for Rosario Island and its surrounding waters.

Video S8. Changes in vulnerability scores as a function of time under the pessimistic scenario for Tesoro Island and its surrounding waters.

Video S9. Changes in vulnerability scores as a function of time under the pessimistic scenario for Tintipán Island and its surrounding waters.