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REVIEW ARTICLE

Climate adaptation in South America with emphasis in coastal areas: the state-of-the-art and case studies from Venezuela and Uruguay

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The South American (SA) region is particularly vulnerable to climate change and El Niño Southern Oscillation (ENSO) events which threaten its economy and sustainable development. Therefore, climate adaptation is a regional priority. At least 6% of SA population live at low-elevation coastal zones (LECZ) exposed to sea-level rise, ENSO variability and storminess. This paper reviews some recent and current adaptation experiences in SA coasts focusing on (i) socioeconomic and vulnerability status, (ii) links between adaptation and sustainable development, and (iii) constraints to adaptation. Despite the regional economic growth and poverty reduction over the last decade, an adaptation deficit to current climate variability persists. Overall, SA countries show a poor link between public policies, adaptation, and theoretical-academic scope. Public adaptation efforts in coastal areas are mostly oriented towards risk assessment, vulnerability and reduction of impacts at urban and touristic settlements. Many experiences developed from the academy follow the community-based adaptation (CBA) approach mainstreamed into local plans. Adaptation constraints are linked with poverty, social priorities, allocation of resources and the multifaceted impacts of climate change. Two coastal CBA case studies in Venezuela and Uruguay based on scientific and local knowledge show that non-structural adaptation measures can improve the populations' perception of risks, provided that stakeholders, mainly the community, are informed and integrated to define adaptation actions. There are lots of plans and less specific actions. We propose that the assessment of adaptation success has to rely on implementation and effectiveness criteria rather than solely on plans.

Keywords: climate change; IPCC; adaptation deficit; sustainable development; community-based adaptation; plans vs. implementation

1. Introduction

Over the years since 1992 when the United Nations Framework for Climate Change stated that adaptation "is of high priority for all countries" (UNFCCC, 1992) several reports from the International Panel on Climate Change (IPCC) have synthesized the main climatic drivers of the current and future vulnerability, impacts and adaptation (VIA) to climate change in Latin America and the Caribbean (LAC) region. Due to the increase in El Niño Southern Oscillation (ENSO) related variability and extreme events over the last few decades (IPCC, 2007, 2013; UNISDR, 2011) these reports have highlighted the adverse consequences from ENSO-related impacts (Field et al., 2012; Magrin et al., 2007; McCarthy, Canziani, Leary, Dokken, & White, 2001).

The Fifth Report of the IPCC (AR-5) divided the LAC into region in Mexico (North America), the Caribbean (among islands), and Central and South America-CSA (IPCC, 2013). In this review we focused on the 10 South American coastal countries with some examples from the CSA region.

The goals of this article are: (i) to review the literature on climate Vulnerability, Impacts and Adaptation focusing just in South America (SA); (ii) to provide update information on the recent and current trends (mostly from 2007 to 2014) on adaptation to climate change and climate variability (ENSO), emphasizing on sea-level rise (SLR) and extremes in coastal areas of SA; (iii) to focus on the adaptation deficit concept, the links between adaptation and sustainable development, and the constraints to

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adaptation; (iv) to discuss experiences in Venezuela and Uruguay, concentrating the analysis on the coastal adaptation progress in these countries, and (v) to render overall, regional (SA) and country-level (Venezuela and Uruguay) key messages, lessons, and recommendations.

This review starts focusing on the IPCC AR-5 VIA Report on Central and South America (Chapter 27; Magrin et al., 2014), aiming to review and update selected literature as following:

(1) The climate vulnerability, impacts, and adaptation in coastal areas of SA emphasizing on SLR, ENSO and extremes mainly based on the IPCC reports (Field et al., 2012; Magrin et al., 2014).
(2) The overall socioeconomic and vulnerability context of both climate change adaptation and climate variability adaptation in SA, with emphasis in coastal areas.
(3) The links between climate adaptation and sustainable development in South American coastal areas.
(4) Cases studies of community-based adaptation (CBA) in coastal areas of Venezuela and Uruguay, and experiences on implementation policies in a few countries in SA.
(5) Regional (SA) and a few local conclusions and key messages.

We believe that the adaptation deficit and the links between adaptation and sustainable development are key aspects in the region.

"In many places the damage is increasing giving evidence of an adaptation deficit, meaning that practices to manage climate hazards are falling short of what can be done" (Burton, 2004).The adaptation deficit concept captures the notion that countries are underprepared for current climate conditions, much less for future climate change. Based on the experience of 26 projects in, including 6 in LAC (www.aiaccproject.org), Leary et al. (2008) stated: "Climate change threatens to widen the adaptation deficit and acting now to narrow the deficit can yield immediate benefits. That will also serve as a first step to adapting to climate change". There is an advantage of integrating adaptation with development because the impacts of current climate hazards and projected climate change undermine development achievements.

In this paper, the adaptation deficit is regarded as any of the following:

- The difference between coping with climate and adapting to climate change (Ashwill, Flora, & Flora, 2011).
- A persistent vulnerability to climate variability in socio-ecological systems (Preston, Dow, & Berkhout, 2013).
- Both a less than optimal use of limited resources and a gap between economic growth and coping capacity to climate threats (EACC, 2012; Nagy, Seijo, Verocai, & Bidegain, 2014).
- A lack of adaptive capacity (Romero-Lankao, 2008) or the inability to cope with current ENSO-related variability (Nagy et al., 2008).

ENSO is the dominant mode of climate variability in LAC (McCarthy et al., 2001). The direct cause of ENSO changes in response to climate changes is generally not straightforward, but there is a substantial amount of cancellation among the effect of the changes in the different ENSO feedbacks (Wang, Deser, Yu, DiNezio, & Clement, 2012).

In addition to considering how climate changes may affect the amplitude and frequency of ENSO, one should also consider that the dominant type of ENSO might be altered as a result. There is still much to learn about the dynamics of the Modoki ENSO and what causes the type of ENSO (El Niño conditions) to vary and alternate. During Modoki El Niño events Sea Surface Temperature (SST) anomaly is concentrated in the Central Pacific (CP mode) region (Ashok, Tam, & Lee, 2009). CP mode El Niño events have occurred more frequently in recent decades and dominated 2000–2010 at a time when ENSO forecast skill decreased (McPhaden, 2013). The CP mode is less intense and more erratic than the classical El Niño (Eastern Pacific-EP El Niño). It is characterized by relatively low temperature anomaly at the Central region of the Pacific Ocean with climatic teleconnections in the Southern Hemisphere (Ashok et al., 2009; Zubiaurre & Calvo, 2012).

Thus, it is hard to say whether ENSO is going to intensify or weakened but it is very likely that ENSO will not disappear in the near future. The tropical Pacific response to global warming has been suggested to be neither El Niño-like nor La Niña-like since the mechanisms for these changes are different from that of ENSO events (Wang et al., 2012).

Taking into account that climate change may mean more frequent extreme events, or more severe extreme events, in the future, adaptation planning for these events will strongly rely on lessons learnt in past events, or "learning from experience" (Kiem, Verdon-Kidd, Boulter, & Palutikof, 2010; Nagy, Seijo, et al., 2014).

Climate adaptation and sustainable development links are explored from the international and regional literature focused on SA (e.g. Metternicht, Sabelli, & Spensley, 2014). Here, sustainable climate adaptation is understood as, according to Eriksen and Brown (2011), "A set of actions that contribute to socially and environmentally sustainable development pathways, identifying principles for sustainable climate adaptation including social justice and environmental integrity". In this regards, Klein et al. (2007) stated “Development paths that contribute to inequity and poverty, or are based on fossil fuel-intensive consumption patterns, are inevitably called into question by the concept of sustainable adaptation”.

There are very few studies on integrated human development policies, sustainability and climate change both globally and in Latin America, and they are still missing indicators, databases and mechanisms to monitoring mitigation and adaptation (González, 2013).

2. Short summary of impacts to climate change and SLR in coastal countries of South America according to IPCC reports

This section is based on IPPC reports on the LAC region, focusing on South America (SA), some global and regional literature, included in IPCC reports, and a few notes from the authors.

Local human activities, ENSO events and windstorms have been identified as the main current (e.g. from ≈1981) impacts on the coastal areas in LAC (Magrin et al., 2007, 2014). Potential impacts of storm surges under SLR scenarios include many social and economic sectors jointly with ecological services (Magrin et al., 2007, 2014; McCarthy et al., 2001). During the last decades of the twentieth century, unusual extreme weather events have been severely affecting the region contributing greatly to the strengthening of the vulnerability of human systems to natural disasters (Field et al., 2012).

SLR in most of South America is expected to be less than 0.40 m by 2050 (90% confidence) (ECLAC, 2011; IPCC, 2013). Exceptions are some shorelines near Sao Paulo in Brazil, Southern Ecuador and Peru with higher SLR, where the threats have become more important (ECLAC, 2011).The most vulnerable coastal linear infrastructure, for example, roads in South America are placed in Brazil and Argentina (IPCC, 2013).Taking into account the percentage of population affected by both SLR and storm surges, risk multiplies and expands (ECLAC, 2011). Medium and high risks of threat spread in the populated Southern Atlantic from north of Rio de Janeiro to Uruguay and Argentina, in the less populated southernmost shores of Buenos Aires Province and Tierra del Fuego, in the Venezuelan extreme Eastern shore, Suriname coastline, and northern Brazil (ECLAC, 2011).

Box 1 summarizes the main observed and projected impacts and vulnerabilities for 2050 in Central and South America reported by the IPCC AR-5, Vulnerability, Impacts and Adaptation, Chapter 27: Central and South America (Magrin et al., 2014).

Box 1. Summary of main observed and projected coastal impacts and vulnerabilities in CSA (source: Magrin et al., 2014, plus notes from the authors).

Overfishing, habitat pollution, habitat destruction, and the invasion of foreign species negatively impact biodiversity and the delivery of ecosystem services (Guarderas, Hacker, & Lubchenco, 2008; Halpern et al., 2008), posing significant challenges and costs for developing countries (Hoegh-Guldberg & Bruno, 2010). For instance, the Ocean Health Index (Halpern et al., 2012) that measures how healthy the coupling of the human-ocean system is for every coastal country (including parameters related to climate change), indicates that Central American countries rank amongst the lowest values.

More than 30% of the population in each of the countries of El Salvador, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, and Ecuador live in coastal areas directly exposed to climatic events (Lacambra & Zahedi, 2011). Note: This short list could also include other countries in SA for example, Guyana, Suriname, Argentina (Buenos Aires Province), and Uruguay (see Section 3). Large coastal populations are related to the significant transformation marine ecosystems have been undergoing in the region (Guarderas et al., 2008).

The current (from ≈1990 on) and predicted coastal impacts and dynamics in response to climate change trends and projections of SLR, storm surges and sediment transport (Figure 1) are focused on flooding, beach erosion, sea-ports, and reliability of coastal structures (ECLAC, 2011). The greatest flooding levels (hurricanes not considered) in the region are found in Rio de La Plata area, which combines a 5 mm yr^{-1} change in storm surge with SLR changes in extreme flooding levels (ECLAC, 2011; Losada et al., 2013). Note: Storm surges have slightly increased over the last 30 years along the Uruguayan coast of the Rio de la Plata (Verocai, Gómez-Erache, Nagy, & Bidegain, 2015) but the rate 5 mm/yr^{-1} seems a little bit high. Beach erosion is expected to increase in southern Brazil and in scattered areas at the Pacific coast (ECLAC, 2011).

The projections of sea surface temperature scenarios indicate that it is possible that the Mesoamerican coral reef will collapse by between 2050 and 2070, causing major economic losses (WB, 2009). In the southwestern Atlantic coast, eastern Brazilian reefs might suffer a massive coral cover decline in the next 50 years (Francini-Filho et al., 2008).

Mangroves losses are affected by anthropogenic drivers for example, deforestation and land conversion, agriculture and shrimp ponds, especially in CA (Polidoro et al., 2010), which in addition to climate change (Alongi, 2008) may lead to total loss in the next 100 years (Duke et al., 2007).

3. Regional and countries’ climate vulnerability context

This section explores some socioeconomic indicators at country-level useful to assess SA countries’ vulnerability and adaptive capacity, focusing on coastal areas.

Table 1 summarizes an updated country-level socioeconomic and human development status of the 10 coastal countries of South America (SA), albeit it was not

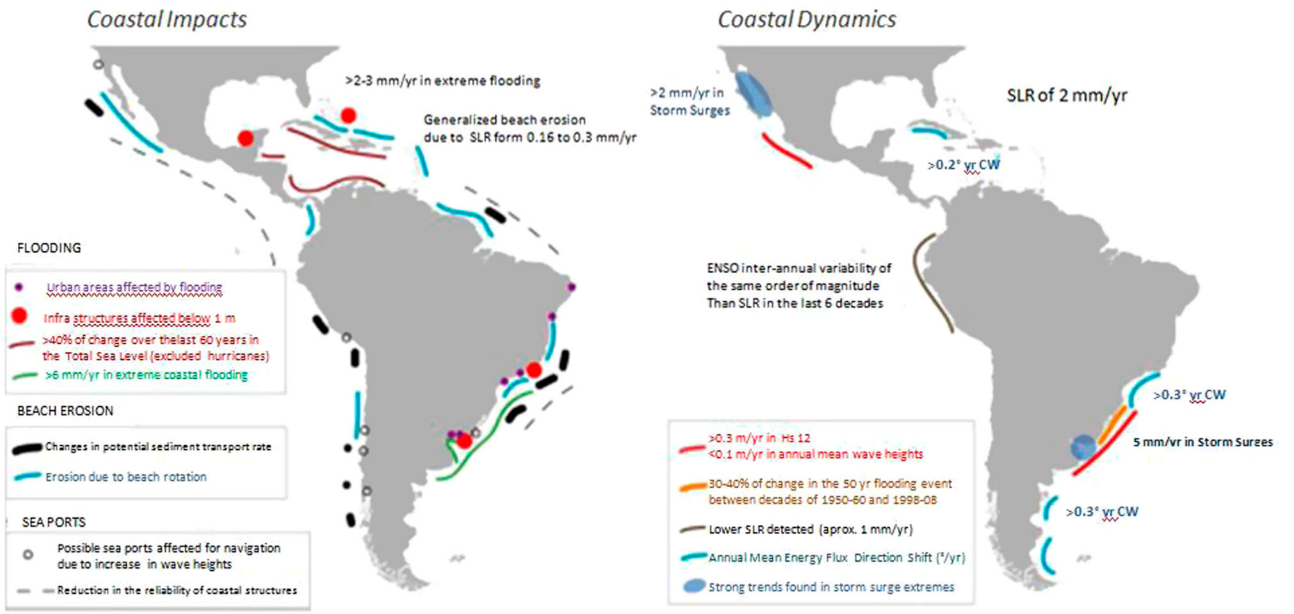

Figure 1. Coastal impacts (left). Based on observed trends and projections (≈2050), the possible distribution of potential future impacts is shown for flooding, beach erosion, sea-ports, and reliability of coastal structures. The figure shows locations where, in the case of having aprotection structure in place, there is a reduction in the reliability of the structures due to the increase in the design wave height estimates (source: ECLAC, 2011). Coastal dynamics (right). Information based on historical time series (data reanalysis, available instrumental information and satellite information) trends including uncertainties (Izaguirre, Méndez, Espejo, Losada, & Reguero, 2013; Losada et al., 2013) (source: Magrin et al., 2014).

possible to discriminate coastal indicators for all of them. The SA region has increased its Gross Domestic Product (GDP) and reduced poverty and inequality over the last decade, although they still remain high (CEPAL, 2013; Magrin et al., 2014). The region has a human population of 388 million, 65% of which live within 200 km of the coast, (CEPAL, 2012a; UNEP, 2007) but only about 6% are directly exposed to coastal impacts (calculated by the

Table 1. Overall socioeconomic and human development of South America (SA).

	Population	GDP (US$) 2013 IMF/WB	IMF +WB/2[3] IMF/WB	Human development (HDI, trend), poverty (as income: P-I and socioeconomic deprivation index: DI), CLProsperity Index (PLI) and equity (E)			
Country	SA: 388 10^6	Country US$ × 10^6	Per Capita[a,b] US$ × 10^3	HDI value, trend	P-I / D-I % of pop.	PLI Regional Rank	E: R/P
Argentina	42	488/612	11.8–14.8	0,81 ↑	5/ 11	5	13
Brazil	202	2,243	11.3	0,74↑	19/16	6	22
Chile	15	273	15.8	0,82↑	11/2	2	15
Colombia	48	380	7.9	0,71↑	33/23	8	20
Ecuador	16	92	5.9	0,71↑	32/22	9	11
Guyana	0,8	2,9	3.8	0,74↑	NA	NA	NA
Peru	30	205	6.7	0,74↑	26/43	11	13
Suriname	0,5	5	9.5	0,71↑	NA	NA	NA
Uruguay	3,3	56	16.5	0,79↑	6/10	1	7
Venezuela	30	374/438	12.5/14.4	0,76↓	24/13	14	9

Notes: Gross Domestic Product (GDP national and per capita in current US$) (According to the International Monetary Fund (IMF, 2014) and the World Bank WB, 2013). United Nations Human Development Index-HDI (UNDP, 2014) (0–1 scale, where 1 is the maximum and 0.798 is very high) and trend (↑= + ↓= negative from previous data). Poverty indicators (% of population): Income (P-I), deprivation (lack of access to basic services) index (D-I), Equity (income distribution: 20% Richer-R/20% Poorer-P) (Equity (Eq) is the ratio between the 20% richer (R) and poorer (P), CEPAL, 2013; WB, 2012). Prosperity Legatum Index (PLI) (overall human, political and socioeconomic prosperity indices) decreasing sub-regional (1 to 17) rank (www.prosperity.com/#!/ranking). Not available, NA.

[a]Countries where the difference between the IMF (left) and WB (right) are greater than 5% (Argentina and Venezuela) both values are shown.

[b]World average = U$ 10,500 and CSA Median: U$ 7900.

[c]Measured in terms of eight indicators of lack of access to basic services such as safe water and sewage, electricity and energy, education, and housing, (PP).

authors from tables shown at Neumann, Vafeidis, Zimmermann, & Nicholls, 2015).

The socioeconomic, political, development, adaptation, readiness, and coping indicators (Table 1) show the best numbers for Chile and Uruguay, followed by Argentina, Brazil, Colombia, Venezuela, Peru, Ecuador, Suriname, and Guyana.

Several authors highlight the existence of great differences in vulnerability, risk, and adaptive capacity indicators on sub-regional and country-level basis in the LAC region (ECLAC, 2011; Leal Filho, Alves, Caeiro, & Azeiteiro, 2014; Magrin et al., 2007, 2014; Nagy et al., 2006).

This too wide assessment of vulnerability seems to be associated with the focus, criteria, and the indicators of exposure and adaptive capacity used. For instance, the UNEP coastal vulnerability index (CVI from 0 to 1), which classifies vulnerability as low ($CVI < 0.1$), moderate ($0.1 < CVI < 0.5$) or high ($CVI > 0.5$) based on socioeconomics, geographical and adaptive capacity indicators of exposure, impacts and vulnerability ((population density (PD), high probability of natural disasters (ND), geographic exposure (GE), low forest cover (1-FC) and human development (HDI), (UNEP, 2005)), does not discriminate country-level coastal vulnerability. All SA countries are classified as moderately vulnerable but Guyana (low). Note: The CVI includes geophysical drivers for example, tsunamis, which should not be used in a climate-risk assessment.

Some CVI indicators are aggregated indices itself, for example, GE and HD, which, together with PD might be key components of vulnerability and coping capacity, resumed as $CVI = f$ (exposure to hazard, PD, coping capacity).

If the UNEP-CVI is re-calculated on a five-class system, the countries might be divided into two or three blocks (depending on the limits) that is, Brazil, Colombia, Ecuador, Venezuela, Guyana, and Suriname are very low vulnerable, whereas Argentina, Peru, Chile and Uruguay are low to moderately vulnerable.

Notwithstanding, according to Hickey and Weis (2012), Guyana is highly susceptible to SLR and flooding – which has been accentuated by multiple recent flood events – and focuses on the need for vast infrastructural rehabilitation and enhancement as the main adaptation priority.

The country-level coastal PD varies in SA from low in Argentina (high for Buenos Aires Province coast), Chile, Guyana, and Suriname to moderate in Brazil, Colombia, Ecuador, Peru, Uruguay and Venezuela (data from UNEP, 2005). When the population living at low elevated coastal zones "LECZ" (less than 10 m above sea level) is analysed (calculated from data published by Neumann et al., 2015), Suriname and Guyana become highly vulnerable (Table 2).

Table 2 shows a set of vulnerability and adaptation indicators at both country level (CyL) and coastal level that supports the analysis of adaptation and development issues.

Although climate vulnerability and adaptive capacity, and their related impacts and risks, are not necessary closely related to economic indicators such as the national or local GDP, the countries already suffering the negative impacts of poverty cannot afford to adapt to climate change. Thus, poverty and inequity indicators are included. The country's GDP gives insight about how large a country is, and per capita GDP (current US$), could be seen as how relatively rich it is. However, great differences between social spending levels between countries in the region reflect important contrasts in social protection schemes, especially on population coverage in services such as health, education, and unemployment benefits.The parity purchase power GDP is included in the calculation of the United Nations Human Development Index-HDI together with education and health indicators (UNDP, 2014) and the in the CVI (UNEP, 2005).

The lack of an appropriate disaggregation of the coastal information which at best is usually available for coastal provinces at most of SA countries hampers integrated regional analysis. There are also great differences in richness distribution in coastal areas among countries and within countries: Colombia and Ecuador have relatively poor coastal populations (despite Guayaquil in Ecuador is the richest city of the country), Uruguay concentrates richness along its coast and Venezuela lies in a mixed situation (CEPAL, 2012b).

The indicators shown in Table 2 suggest that the most exposed coasts are those of Guyana and Suriname, followed by Ecuador and Peru, and the less ones are those from Argentina, Brazil, Uruguay, and Venezuela (which is not the case if the coast of Buenos Aires, Argentina is analysed separately). The most at risk country is Ecuador, and the less ones are Chile (if geophysical threats are not considered) and Suriname.

The Notre Dame-Global Adaptation Index (ND-Gain, 2012) assesses CyL vulnerability (exposure) and readiness (adaptation) to climate change and climate-related hazards, as well as specific sectors that is, the Infrastructure Index which aggregates coasts and energy (I-CET).

Table 3 shows a classification of SA in respect to their climate vulnerability status, based on the data and indicators shown in Tables 1–3, where adaptive capacity is prioritized following Leal Filho and Mannke (2014). These authors classified the LAC region in two main categories: moderately vulnerable and very vulnerable. The former are characterized by the availability of some degree of operational climate change strategies, and investments in climate adaptation and resilience projects. The latter is characterized by lack of investments and/or the adaptation plans are not fully operational. In many of the very vulnerable countries there is "chronic climate

Table 2. Country level and coastal vulnerability, adaptation indicators, and index of South America (SA).

	% Population at LECZ, governance (G), exposure (E), country level and coastal vulnerability (CLV/CV), adaptation, and coping capacity (AC/CC)							Climate Risk Index	OHI (2014)[a]	ND-Gain Index (2012)[b]	
				Vulnerability		Adaptive capacity (AC) and coping capacity (CC)					
	% Pop. at LECZ	Gov (G)	Exp (E)	CLV	CVI-UNEP	AC	CC	CL CRI (2012)	OHI, (2014)	V + R	I-CET
Country	SA:6	Four stars scale						Five stars scale	0–100 scale converted into SA Ranking		
Argentina	10	**	*	*	**/**	***	****	**	3rd	3rd	3th
Brazil	7	***	*	*	**/*	***	***	**	5th	5th	7th
Chile[c]	2	****	**	*	**/***	***	***	*	1th	1th	9th
Colombia	3	***	**	**	**/*	***	***	**	9th	3rd	2nd
Ecuador	14	**	***	**	**/*	**	***	***	2nd	8th	4th
Guyana*	56	NA	****	**	*/ ***/*	*	**	**	8th	10th	8th
Peru	2	**	***	**	**/**	**	***	**	7th	6th	6th
Surinam	68	NA	****	**	**/*	**	***	*	4th	7th	5th
Uruguay	13	****	*	*	**/***	****	***	**	6th	2nd	10th
Venezuela	6	*	*	*	**/*	****	***	**	10th	8th	1th

Notes: Percentage of population living at low elevation coastal zone (% LECZ) (Neumann et al., 2015). Different scales (four or five ranks or world rankings) are used by the generators of these indexes. Here, a four stars scale is used for Governance – G (Legatum Prosperity Index), country-level vulnerability – CLV and coastal vulnerability – CV (UNEP, 2005), exposure – E, adaptive capacity – AC, and coping capacity – CC (World Risk Report WRR, 2012), where, high is ****, upper middle is ***, lower middle is **, and low is *. A five stars scale where medium is *** is used for the overall Climate Risk Index-CRI (German Watch, 2012). A 0–100 scale (0: minimum and 100: maximum) wasconverted into regional (SA) ranking (1th for the best and 10th for the worst one) for the Ocean Health Index (OHI, which world average is 67) (OHI, 2014; where OHI Maximum and world average are 100 and 67 respectively), the Notre Dame-Global Adaptation Index (ND-Gain) overall vulnerability and readiness index (V + R), and for the ND-Gain Infrastructure Index (I-CET) (ND Gain, 2012; where ND-Gain maximum: 100. Infrastructure Index (I-CET) includes coast, energy, and transport, where coast vulnerability is defined by exposure, sensitivity, and adaptive capacity as a function of land less than 10 m above sea level (ASL), population living less than 10 m ASL, and readiness).

[a]Legatum Prosperity Index (2014).

[b]UNEP (2005).

[c]Geophysical disasters (Tsunamis) are not considered.

Table 3. Classification of Central and South American coastal countries in respect to their overall and coastal climate adaptive capacity, exposure, and vulnerability (modified from Leal Filho & Mannke, 2014).

Status of vulnerability	Countries
Moderate	Argentina, Brazil, Chile[a], Uruguay
High	Colombia, Ecuador, Guyana, Perú, Surinam and Venezuela.
Very high or chronic	No countries in SA. Most of Central America (but Costa Rica and Panamá)

[a]Included here if vulnerabilities and risks associated to geophysical hazards and their synergic influence are excluded.

change vulnerability". Often, these countries are not even prepared sufficiently to current impacts of current vulnerability because of scarcity in investments, few or no components of institutional capacity-building, limited or no access to assistance in cases where extreme events affect them, and little social capital, that is, part or sometimes full reliance on external (international) assistance and funds. There are none chronic vulnerable countries in SA but in CA, with the exception of Costa Rica and Panama.

The drivers of vulnerability that is, climate threats and exposure, the adaptive capacity, or the reasons behind any ranking of vulnerability are always partial due to the fact that there is no consensus about the weight of the indices.

Some questions may be raised here from the indicators shown in Tables 1 and 2: which is more important: exposure of adaptive capacity? Which are the main drivers of vulnerability that is, too many people, poverty, low investment, too many coastal disasters, the lacks of institutional capacity-building, or the political will to prioritize coasts and/or of specific adaptation policies? Further insight on these key issues will be given at Section 4.

4. Adaptation and sustainable development in coastal areas of SA

4.1. *Adaptation and sustainable development*

Under the uncertainty of future climate change scenarios, adaptation in coastal areas will require new approaches to sustainable development that should be able to manage this complexity (Barbero & Tornquist, 2012; IPCC, 2013). For instance, increasing SLR and storm surges will put coastal areas and infrastructure at risk, making it more difficult to harmonize goals of economic development, public access, and protection of coastal ecosystems, accentuating the existing trade-offs between coastal development and coastal ecosystem conservation (IPCC, 2013; Naveda, 2013). The extent of vulnerability to SLR in any given country will depend also on the fraction of the population living in low-lying areas (see Table 2), the land inundated, its wealth and economic conditions, and its prevailing political institutions and infrastructure.

During the past 10 years, coastal and marine ecosystems in the region have provided between 15% and 30% of total world fish supplies (UNEP, 2012).The SA coastal areas are both rich on commercial and artisanal fisheries (Salas, Chuenpagdee, Charles, & Seijo, 2011), tourism (Zielinski & Díaz Cano, 2014), ports and shipping worldwide scale (Méndez, 2011),oil, industrial and urban development (Pauchard, Aguayo, Peña, & Urrutia, 2006), and are densely occupied by hundreds of thousands of villages and coastal towns (Cramer, 2013; Lampis, 2010). Several coasts of SA, mainly at the Pacific and the Caribbean, have extraordinary natural capital and business activities, but are also highly degraded (Alvarez-León, 2003; Santibañez & Santibáñez, 2007). Additionally, the region has high poverty levels (Armijo, 2012) and several vulnerabilities to extreme weather events which compromise its institutional capacity to face the impacts and to implement an effective adaptation process to climate change (Ryan, 2012).

Since adaptation involves actions at all geographical, institutional sectors and community scales (Frank, Eakin, & Lopez-Carr, 2011; Herweijer, Ranger, & Ward, 2009; Nelson et al., 2009), for coastal areas the community-based approaches (CBAs) should be necessary to be mainstreamed into local or regional plans (Bassett & Shandas, 2010). Moreover, individual adaptation actions are not autonomous: they are constrained by institutional processes that include regulatory structures, property rights and social norms, especially in coastal areas, a trend identified by Nagy, Seijo, et al. (2014), who undertook an analysis of stakeholders' climate perception and adaptation in coastal Uruguay.

Given that communities along the coastal settings are likely to experience different impacts, state coastal planning mandates will be more effective if they specify the desired outcome, for example, maintaining coastal wetlands or protecting certain infrastructure rather than prescribe a particular set of actions (Buenfil, 2009). In this context, the viability of coastal adaptation should necessarily consider the increased level of vulnerability to disaster risks, which is driven by factors such as climate change (Campos, Herrador, Manuel Valdés, & McCall, 2013), poor planning, absence of an Integrated Coastal Zone Management (ICZM), rapid urbanization, environmental degradation, and loss of biodiversity (CEPAL, 2012a; IPCC, 2007, 2012).

The severity of the impacts of future natural events depend heavily on the ability of countries to reduce their vulnerability and strengthen risk-management capabilities (Field et al., 2012) which in turn is associated with the management of environmental and natural resources, economic and social development, territorial and urban planning, and governance (Perdomo, 2012).

Reducing vulnerability requires tools for prevention and spatial planning, early warning systems, maintenance of vegetation cover, improved local institutions and the construction of appropriate infrastructure. This will enhance the need for integrated approaches to analysis and management of coastal adaptation.

4.2. *Constraints and limits to adaptation*

Constraints to adaptation include several factors such as gaps in databases and monitoring networks (Magrin et al., 2007), availability of resources, uncertainty regarding future climate, risk of disasters and consequences of inherent trade-offs (IPCC, 2013).

Nevertheless, some countries have made efforts to enhance the conservation of ecosystems (Buenfil, 2009), protection of coastal communities through early warning systems, protection against SLR (López Rodríguez, Sierra-Correa, & Lozano-Rivera, 2013; Rojas Giraldo, Sierra-Correa, Lozano-Rivera, & López Rodríguez, 2010), ICZM (Zamora-Bornachera & Meza-García, 2013), social dimensions (Naumann et al., 2013) and the strengthening of their institutional capabilities (Perdomo, 2012). However, a lack of basic information, observation and monitoring systems due to poverty and the settlement of populations in vulnerable areas are perceived (Calvo, 2013).

The adaptation option is the most unattended in terms of overall scale public action in Latin America (Dumas & Kakabadse, 2008; Frickel, 2010; Villamizar, 2011), despite the magnitude of certain impacts on its coastal areas. However, anticipatory adaptation to such changes as increased coastal erosion and extreme events does not need to wait for specific climate scenarios. These threats are more reliant on the examination of current vulnerabilities and the range of possible no-regret strategies (FII, 2006). Thus disasters risk management can play a key role in the region (Leal Filho, 2013).

The United Nations Environment Programme (UNEP) supports various climate change adaptation strategies towards sustainable development and access to financial resources available under international climate finance arrangements (Perdomo, 2012). However, coastal areas are not considered as priorities of these initiatives since they only represent 10% of country's commitments arising from these strategies, lagging behind water resources (35%), agriculture (22%), and health (10%), the three sectors which were selected as priority by most countries (Perdomo, 2012).

In terms of addressing the constraints for the regional coastal adaptation, these initiatives account for a more comprehensive supportive framework for adaptation process at national level, which in turn represents a direct guide to addressing national public investment, limited resource that must be maximized given the impacts and challenges of climate change, for national development. The response capacity varies among different sectors and geographic scales and levels of organizational complexity (Adger, Arnell, & Tompkins, 2005; IPCC, 2007). For instance, Halsnæs and Trærup (2009) have identified four critical aspects that limited the adaptations options having in common the cross-cutting nature of climate change constraints that make adaptation processes more difficult for both human and natural systems:

(i) Addressed as a development problem and linked to environmental issues.
(ii) Its effects on multiple sectors, including natural resources.
(iii) The current impacts of climate extremes and disasters and their links to development like a starting point for assessing future climate change impacts.
(iv) A need for linking climate change impact data and development statistics, which, given uncertainties and data limitations, complicates adaptation studies.

Brondizio, Ostrom, and Young (2009) also recognize the multilevel nature of such constraints and the role of institutions to "help cross-level environmental governance as an important form of social capital that is essential for the long-term protection of ecosystems and the well-being of different populations". In this regard our review shows insufficient support in multiple areas such as social attitudes and behaviour, knowledge, education and human capital, finance, governance, institutions and policy. Also, we identify adaptation and development deficits which together with the last mentioned areas are specific constraints for the implementation of the adaptation process to future climate in SA.

In regards to coastal areas the potential constraints for adaptation appears to be exceeded locally and they are likely related with a range of human values and managed systems (Pineda et al., 2013) that are dependent upon ecosystems goods and services (Campos et al., 2013; Valdés & Herman, 2005). Given the intrinsic spatial-temporal dynamics of coastal areas, the social limits for adaptation are dynamic over space and time in response to diverse and multiple actors, technological change, and emergent issues closely linked, for example, to ancestral cultural values, territorial appropriateness (Tacoli, 2009) and gender-related aspects (Buechler, 2009).Taking into consideration these dynamics and complexity, stakeholders would be able to have an early prospective of potential adaptation constraints and limits. However, it should be noted that this possibility is diminished by the complexity of socio-ecological coastal systems. In this sense, it should be necessary to develop a new institutional and integrative frame under novel governance, as proposed by Adger et al. (2005), if countries really want to prevent the limits for its adaptation processes along their coastal areas.

Few governments have specific focus on coastal areas in SA which in the best case the information is available at national (Argentina, Brazil Chile, and Colombia) or provincial level (Uruguay). This is a constraint for adaptation because the mainstream and bottom-up approaches are needed not only for the direct engagement of the local communities onto the coastal planning processes, but also to know the spatial heterogeneity of areas that home to a rich biodiversity and a myriad of small, isolated settlements where most of the population is poor and remains marginal of the potential benefits of public policies (Ayers & Forsyth, 2009).

Summarizing, although poverty has decreased in South America over the last decade (CEPAL, 2013), it remains significant in most countries (see Table 1) and the identified constraints are linked fundamentally with aspects related to both the livelihoods, multidimensional dynamic and transgenerational poverty, and the multifaceted impacts of climate change (IPCC, 2007, 2013).

4.3. *Climate change, poverty, and sustainable development*

Despite the need to address the effects of climate change on multiple sectors, and to achieve sustainable development, there is an absence of climate change and environmental issues on the agenda of public policies aimed at the reduction of poverty in Latin America (CEPAL, 2012a).

The social policies of Latin America are traditionally focused on demographic and social aspects of education, housing, gender equality, and infrastructure, without integrating an approach between climate change impacts and social issues (Armijo, 2012). Villamizar (2011) stated that adaptation interventions are not considered into public policies, which could compromise the implementation of medium and long-term initiatives on adaptation that several countries have recently planned. This is changing over the last few years; almost all countries in SA at the moment (by 2015) are undergoing processes of mainstreaming climate change within governments and sectors. Ecuador, Peru, Brazil, Chile and Colombia at least are doing it (ADMICCO, 2011; ENCC, 2012; Invemar, Grupo Laera, GCAP y CDKN, 2014; MMA, 2013). A different case is that although it is considered, we are still far away from a solid implementation.

Thus, it is expected that the results of such initiatives that do not fulfil the expectations of governments and hence do not translate in tangible forward steps in adaptation, especially locally, will fail. This will be seen in most coastal areas, particularly the ones located far from populated areas, whose communities depend on the local natural resources. Given this situation, it is required that communities are able to understand the causes and analyse the consequences of climate threats, in order to planning their activities to ensure subsistence. Moraes and Velázquez (2012) stated that "it is required a local level to promote policies on a scale in which the population is organized around their resources, do their business and be able to participate effectively in public policy" in relation to the assessment of social capital and vulnerability to climate change. Local people have a high adaptive capacity to develop novel solutions to adapt to climate changes combining traditional and scientific knowledge, and Latin America is not the exception (Bravo, Hernández, Llatas, & Salcedo, 2010; Ferrara, Martelo, Lairet, Villamizar, & Sánchez, 2012).

Despite some adaptation planning and disaster risk management have been integrated into coastal management (Guenni, Nobre, Marengo, Huerta, & Sansó, 2013), adaptation planning is mainly focused on the implementation of measures to reduce energy and water consumption with co-benefits for climate change adaptation, mainly in large urban areas (Aragón-Durand, 2012; Romero-Lankao, 2008) and planning for SLR just for the most important urban and touristic settlements (Olivo, Lettherny, Ramos, & Sosa, 2001).

4.4. *Some adaptations actions*

It is recognized that adaptation to climate change is a complex political process, whose decision-making is oriented to both the reduction of vulnerability and the increase of resilience of the socio-ecological systems (Torres-Alruiz & Rodríguez, 2013). Table 4 shows some experiences on adaptation in coastal areas for 13 countries in Central and South America indicating the type of action taken at national level. Together, these actions represent formal ways of strengthening the capacity of decision-makers and governmental institutions that formulate policies related to climate change in all its dimensions, involving private sector, civil society, indigenous groups and other stakeholders.

4.5. *CBA as a non-structural adaptation option to building capacity for coastal communities*

Capacity-building is a critical component to facilitate learning and the effective uptake and use of technologies that enable least cost options to achieve mitigation and adaptation objectives (IPCC, 2013). In terms of such considerations, CBA is a viable alternative for building adaptive capacity (Ayers & Forsyth, 2009; Crabbe et al., 2010) particularly for coastal communities in which government presence is relatively weak or absent. There is a need to increase the communication of the knowledge from local communities involved in processes of autonomous

Table 4. Selected examples of adaptation experiences in Central and South America.

Countries	Adaptation experiences	Some results	Author(s)
Venezuela	Community-based adaptation (CBA)	(1) Basic training for community to gather information and transmit scientific rigour with specialized training in risk management and SAT information (2) Participatory risk characterization in the school community and its surrounding (3) Transfer of knowledge. A SAT model developed in a participatory way, validated and operational	Bravo de Guenini et al. (2010)
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama	Medium-term vision for coastal areas	(1) Identify adaptation strategies that could be successfully implemented in Colombia and build adaptation capacity considering the conditions and constraints of coastal areas to SLR (2) Adaptation projects with strong emphasis in adaptation focused projects and programmes on capacity-building, impact assessments and policy research. (3) Mainstreaming of adaptation into national-level development plans	Vides and Sierra-Correa (2014); Keller, Echeverría, and Parry (2011)
Argentina, Colombia, Costa Rica, Ecuador, Honduras, Nicaragua, Perú, Uruguay	Interministerial National Dialogues (*)	(1) Water (32%), agriculture (22%), human health (10%) and coastal areas (10%) sectors were selected as priority by most countries for analysis and future implementation of measures and actions for the adaptation (2) Promotion of the integration of adaptation and mitigation instruments of national development planning in the public budgets and private investment plans	Perdomo (2012)

(*Continued*)

Table 4. Continued.

Countries	Adaptation experiences	Some results	Author(s)
Argentina, Uruguay Brazil	Strategies for adaptation	(1) Development of the component coastal and estuarine “Wetlands” of the National Adaptation Plans (NAPAS), where the values and functions of these ecosystems as potential instruments of adaptation are analysed (Argentina) (2) Promotion and development of Integrated Coastal Zone Management (ICZM) approach as institutional arrangement for sustainable coastal zone (Uruguay) (3) “Pilot adaptation measures to climate change in Coastal Areas of Uruguay” (4) Fisheries co-management, a participatory multi-stakeholder process (Brazil), as an example of adaptation due it favours a balance between conservation of marine biodiversity, the improvement of livelihoods, and the cultural survival of traditional populations	Wetlands InternationalArgentina (2012); Gómez-Erache, Conde, and Villarmarzo (2010); PRODOC (2008), Nagy, Gomez-Erache, and Kay (2015); Hastings (2011); Moura et al. (2009)

(*) Adaptation measurements at national level.

adaptation to policy-makers responsible for strengthening the adaptive capacities in SA (Ashwill et al., 2011).

CBA practitioners are based in non-government organizations (NGOs), and increasingly in government agencies, where it is difficult to dedicate much time to publishing work in academic journals. This means that much of their knowledge and experience is not shared as widely as it could (Reid & Huq, 2014). Table 5 summarizes two CBA case studies in Venezuela (V-CS) and Uruguay (Uy-CS). Both case studies share the following characteristics: (i) coastal areas subject to climate stressors; (ii) stakeholders’ participation was a key factor to implementing actions, and (iii) the mix of top-down and bottom-up approaches. Some differences are: (i) The V-CS is a university project without government participation, whereas the Uy-CS is a GEF-Project, carried out by a Governmental Unit with the participation of UNDP and local authorities and (ii) the V-CS was bottom-up oriented from the beginning, whereas the Uy-CS was top-down oriented at the beginning, with a progressive incorporation of the academia, NGOs, institutional and community stakeholders’ involvement. The Uy-CS followed the UNEP Vulnerability Reduction Assessment (VRA) participatory approach, customized by the project to provide baseline information on stakeholders’ perception of vulnerability and adaptive capacity (Nagy, Seijo, et al., 2014, Nagy et al., 2015).

Both examples show that non-structural adaptation measures such as CBA and VRA can improve the populations’ perception of risk, thus overcoming the different senses of urgency in relation to climate threats, among scientists and stakeholders.

5. Plans vs. implementation: selected examples in SA countries’ policies

Some of the coastal adaptation initiatives shown in Tables 4 and 5 are not fully implemented. The experiences from other sectors that is, agriculture, forestry and water resources in the region give some insight about the status of implementation.

Many Latin American countries have taken relatively important steps in recent years both in the formulation of policies on climate change and the development of specific institutions on the matter (Perdomo, 2012). For instance, the “Latin American Climate Platform” (PCL) is a NGO network that produced a compiled paper (Ryan, 2012) focusing on four dimensions of existing public policies (not including coastal resources)on climate change:

- (i) Their level of implementation.
- (ii) Their political support to climate policies.
- (iii) The quality of the design of these policies.
- (iv) The institutional strength of the national agencies and directorates responsible for formulating and implementing these policies.

Table 5. Adaptation in coastal areas of Latin America.

Title, spatial scale, implementation	Short description	Focus case study
"Adaptation to Climate Change: Implementing Early Warning". Vargas State, Venezuela. Local and Provincial level University Simon Bolivar (USB) and stakeholders	The coastal zone of Vargas state is susceptible to loss of life and/or property damage from extreme weather events Despite the extreme events over the last few years the communities are not prepared yet. The Group of Environmental Risk Management at Simon Bolivar University (USB GERA) raises the implementation of community initiatives for risk management and adaptation to climate change through the platform of Community Early Warning Systems (SATC) on the approach to the CBA	Following the Maskrey model (Maskrey, 1997) this initiative has four steps: (1) Monitoring: local monitoring and forecasting technology precipitations and community pluviometers (2) Preparation: Community training in designing strategies and consensual actions to reduce damage and expected extreme losses and minor events (3) Risk characterization: Identification of risk scenarios and potential impacts of an event on the vulnerable community (4) Communication: transmission of information to achieve consensual actions and strategies. Approximately 1400 children of schools affected by extreme events and 200 adults were trained in risk management and SATC developed by the GERA-USB with the support of stakeholders, which include community maps and flood risk, community gauges and preventive education materials
"Implementing pilot adaptation measures to climate change in Coastal Areas of Uruguay". Local and Provincial GEF-UNDP, Ministry of the Environment and Local Government, and Uruguayan Public University (UdelaR)	Uruguay is one of the most exposed Latin American countries to sea-level rise and flooding Recent coastal climate adaptation and management initiatives have increased the country's capacity to understanding, planning, forecasting, and implementing actions	Following a modified VRA (Droesch et al., 2008) and risk-management model (Nagy et al., 2014, Nagy et al., 2015) this initiative has four main steps: (1) Scientific-driven top-down: climate scenarios and vulnerability assessments (2) CBA bottom-up: community and institutional stakeholders reach minimum agreements which balance scientific and local knowledge with agreed current management issues. (3) Community Involvement:Stakeholders were involved through the application of participatory approaches, for example, focus group and VRA, where community's perception and needs about climate risks, as well as the barriers, opportunities, and willingness to adapt, were included in order to prioritize adaptation actions. The role of the project was to: (i) inform about climate evolution and (ii) facilitate agreement with institutional stakeholders and NGOs. (4) Project and Institutional Implementation: (1) Coastal lagoon sandy bar management protocol (Laguna de Rocha). (2) Follow-up of climate variability and beach quality monitoring; (3) Soft measures to stabilize beach and dunes

Vargas Case Study, Venezuela (Bravo et al., 2010; Guenni et al., 2013) and Uruguay case study (Nagy, Muñoz, Verocai, Bidegain, & Seijo, 2014; Nagy, Seijo, et al., 2014; Nagy et al., 2015; PRODOC, 2008).

Ryan (2012) stated shortfalls in the implementation of core strategies and policies in the existing architecture on climate change in the region. While there is substantial progress in the development of rules and institutions, weakness and delays in policy implementation is a common feature affecting every country. A few examples follow in order to illustrate this statement:

The Uruguayan government approved the National Response Plan to Climate Change (PNRCC) in 2010 (SNRCC, 2010), which is basically a secretariat of a project funded by International Cooperation. This "plan" is a strategic framework that identifies and coordinates lines of action and measures to strengthen resilience to climate impacts. In this sense, it could represent a central instrument of policy on climate change and variability. By 2010 it was barely been complied with actions that do precisely operating, such as the design of the annual operating plan (2010–2011), and the preparation of the five-year budget (2010–2015) for the implementation of the plan medium-term (Ryan, 2012).

Just a few steps promoting the existence of such a Plan were implemented as meetings with civil servants in order to coordinate early warnings and to give input to the Uruguayan delegates to the UNFCCC sessions.

The Chilean National Action Plan on Climate Change (2008–2012: PANCC) is an articulating instrument with action lines to be developed by various ministries focused on catching information on vulnerability and adaptive capacity by different resources and economic sectors. The Ministry of Environment conducted by 2011 a midterm evaluation of its level of implementation founding that only 25% of the plan had been executed. The problems associated with the implementation were mainly related to a lack of budget due to a deficit of coordination between the plan design and approval, and budget approval, in addition to the lack of participation of the Ministry of Finance.

In a context of lack of budgetary allocations, many programmes or agencies with jurisdiction in the climate agenda topics are substantially dependent on international cooperation to work (Ryan, 2012). However, in Colombia the flexibility in the methodology of UNDP proposals for "Investment flows and financing for the implementation of adaptation measures", allows the analysis of investment flows, beyond the contribution of international negotiations, and the improvement of local processes of decision-making (Perdomo, 2012).

In short, there is no single factor explaining the strong implementation deficits suffered by many climate policies in the countries of the region. Rather there are different configurations of factors and conditions that affect the effective implementation of these measures and government actions. In most of the cases, budget and resource shortages are simply indicators of structural causes that affect the state's ability to implement these policies or even the lack of relevance and priority of climate change issues in the domestic agenda. Climate policy implementation problems could be associated with the fact that sub-national strategies of development collide with goals and mandates of the policy formulated and approved by the national level, affecting their effective implementation at sub – national level. In regards to stakeholder's behaviour, their reactions are far from the proactive mood needed to face current and future threats despite claims from communities and NGOs (Ryan, 2012). From these few examples, lack of budget and political will, and institutional capacity seem to be common factors.

Lesnikowski, Ford, Berrang-Ford, Barrera, and Heymann (2013) applied a systematic approach to measuring adaptation initiatives and recommendations being undertaken by 117 countries reported through the national communications to the UNFCCC. From this analysis the authors separate the top 10% countries (leaders) and the bottom 10% (laggards). There are no laggard countries in SA whereas Uruguay is the only leader country.

We believe that because this approach does not assess the level of implementation, it is not a strong estimate of the capacity of countries to reduce vulnerability but of the level of readiness or preparedness.

6. Conclusions

This article explores the theoretical and empirical work on the socioeconomic and vulnerability status, development policies, adaptation to climate change, and adaptation to climate variability in coastal areas of SA.

The linking of public policies with adaptation is perceived as being marginal in SA, which could partly explain the existence of a debate within the theoretical-academic scope, but a large absence of adaptation issues in the public administration arena. This is partly due to the fact that climate change is still considered as an environmental problem rather than a development one. The current focus on climate change is largely oriented towards its impacts on resources and strategic sectors for national development, such as water resources, agriculture, and health.

Our review highlights that there is insufficient support to coastal adaptation despite of the already observed and likely future increase in climate-related risks that threaten the sustainable development of the coastal zones.

A key regional strategy should be to prioritize adaptation to current climate threats that is, El Niño and/or storminess, the projected changes in SLR in the short- and medium-term (2030–70), together with mitigation, sustainable and efficient use of natural resources. A few countries show evidence of further interest and understanding of the need to incorporate climate change issues into their development plans, some of which are national in scope, such as in Chile and Colombia. There are also regional adaptation plans developed by Argentina, Uruguay, and Brazil, as well as in Peru, Chile, and Ecuador. By 2015 the number of plans is increasing.

Most adaptation initiatives are oriented towards risk assessment, vulnerability and adaptive capacity, and some of them are CBA approach experiences.

Some identified constraints are linked fundamentally with aspects related to the livelihoods, multidimensional dynamic and transgenerational poverty, and the multifaceted impacts of climate change.

The case studies show that non-structural adaptation measures such as CBA and VRA can improve the populations' perception of risk, thus overcoming the different senses of urgency related to climate threats among scientists and stakeholders.

There is a lack of implementation regarding plans and from knowledge into action. This is mostly related to the appropriate allocation of resources, the lack of political will, the lack of integration of public policies on environment, development, and climate change. Many agencies, programmes and projects devoted to climate change adaptation are substantially dependent on international cooperation to work.

A consequence of the lack of implementation of specific actions, plus the increasing local human direct impacts and climate threats such as ENSO-related variability, SLR and storminess, is an adaptation deficit to current coastal climate threats across the region.

The same conclusion made by Bierbaum et al. (2013) for the United States: "More than before, but less than needed", is also valid for the status of current adaptation in SA coastal countries.

The authors propose that the assessment of adaptation progress should be based on the results of implemented actions rather than on plans and recommendations.

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References

Adger, N. L., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. *Global Environmental Change*, *15*, 77–86.

ADMICCO. (2011). Proyecto de Adaptación y Mitigación al Cambio Climático en Zonas Costeras (Chile, Ecuador, Perú). Boletín ADMICCO N°3. Asociación Civil LABOR, CooperAcción (Perú); CEDESUS (Chile); EcoCostas (Ecuador); IST (Portugal). Retrieved from http://admicco.labor.org.pe/

Alongi, D. M. (2008). Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change. *Estuarine Coastal and Shelf Science*, *76*(1), 1–13.

Alvarez-León, R. (2003). Los manglares de Colombia y la recuperación de sus áreas degradadas: revisión bibliográfica y nuevas experiencias. *Madera y Bosques*, *9*(1), 3–25.

Aragón-Durand, F. (2012). Regional workshop on disaster risk reduction and climate change adaptation in urban settings: From theory to practice: Memories. Tegucigalpa, Honduras. Retrieved from http://www.cridlac.org/digitalizacion/pdf/eng/doc18882/doc18882contenido.pdf

Armijo, M. (2012). Planes Nacionales de Desarrollo en países de América Latina y el Caribe: análisis preliminar de sus propuestas para el desarrollo. Instituto Latinoamericano y del Caribe de Planificación Económica y Social (ILPES), Comisión Económica para América Latina y el Caribe (CEPAL), Santiago de Chile, p. 30. Retrieved from http://sispalc.cepal.org/Sispalv2/Documentos/Planes_Nacionales_Desarrollo.pdf

Ashok, K., Tam, C. Y., Lee, W. J. (2009). Enso Modoki impact on the Southern Hemisphere storm track activity during extended austral winter. *Geophysical Research Letters*, *36*, L12705. doi:10.1029/2009GL038847

Ashwill, M., Flora, A., & Flora, J. (2011). Building community resilience to climate change. Testing the adaptation coalition framework in Latin America. Retrieved from http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/Adaptation-Coalition-Framework-Latin-America_web.pdf

Ayers, J., & Forsyth, T. (2009). Community-based adaptation to climate change. *Environment: Science and Policy for Sustainable Development*, *51*(4), 22–31.

Barbero, J. A., & Tornquist, R. R. (2012). Transporte y cambio climático: hacia un desarrollo sostenible y de bajo carbono. *Revista Transporte y Territorio*, *6*, 8–26. Retrieved from http://revistascientificas.filo.uba.ar/index.php/rtt/article/view/273]

Bassett, E., & Shandas, V. (2010). Innovation and climate action planning. Perspectives from municipal plans. *Journal of the American Planning Association*, *76*(4), 435–450.

Bierbaum, R., Smith, J. B., Lee, A., Blair, M., Carter, L., Chapin, S.III, … Verduzco, L. (2013). A comprehensive review of climate adaptation in the United States: More than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change*, *18*, 361–406. doi:10.1007/s11027-012-9423-1

Bravo, L., Hernández, R. J., Llatas, I., & Salcedo, A. (2010). Desarrollo de un sistema de alerta temprana comunitario en el Estado Vargas. Revista temas de coyuntura, 61. Retrieved from http://revistasenlinea.saber.ucab.edu.ve/temas/index.php/temasdecoyuntura/issue/view/102/showToc

Brondizio, E., Ostrom, E., & Young, O. (2009). Connectivity and the governance of multilevel social-ecological systems: The role of social capital. *Annual Review of Environment and Resources*, *34*, 253–279. doi:0.1146/annurev.environ.020708.100707

Buechler, S. (2009). Gender, water, and climate change in Sonora, Mexico: Implications for policies and programmes on agricultural income generation. *Gender & Development*, *17*(1), 51–66. SocINDEX with Full Text, EBSCOhost (3). doi:10.1080/13552070802696912

Buenfil, J. (2009). Adaptación a los de Impactos del Cambio Climático en los humedales Costeros del Golfo de México. Volumen II. INE-SEMARNAT. Retrieved from http://books.google.co.ve/books?hl=en&lr=&id=Arpffj30pfkC&oi=fnd&pg=PA385&dq=Buenfil+J+28200929+AdaptaciC3B3n+a+los+de+Impactos+del+Cambio+ClimC3A1tico+en+los+humedales+Costeros+del+Golfo+de+MC3A9xico.+Volumen+II.+INE-SEMARNAT&ots=I3BVEr5maB&sig=MHD9zB3gEUiDAZ434LmxpMXttbA#v=onepage &q&f=false

Burton, I. (2004). Climate change and the adaptation deficit. Occasional paper 3, Adaptation and Impacts Research Group, Environment Canada, Ottawa, Canada, p. 33. Retrieved from http://projects.upei.ca/climate/files/2012/10/Book-5_Paper-3.pdf

Calvo, J. D. (2013). Integración de la gestión de riesgo de desastres y la adaptación al cambio climático en la inversión pública: Centroamérica. Regional Policy Dialogue: Climate Change & Disaster Risk Management Network. Retrieved from http://www.iadb.org

Campos, M. Herrador, D., Manuel Valdés, C., & McCall, M. (2013). Experiencias locales de adaptación al cambio climático en dos comunidades rurales de México y El Salvador. Retrieved from http://www.boletinage.com/61/16-CAMPOS.pdf

CEPAL. (2012a). La sostenibilidad del desarrollo a 20 años de la Cumbre de la Tierra. Avances, brechas y lineamientos estratégicos para América Latina y el Caribe. Naciones Unidas. P. 273. Retrieved from http://www.cepal.org/publicaciones/xml/7/46097/2012-65-RIO+20-ESPANOL-WEB.pdf

CEPAL. (2012b). Efectos del cambio climático en las costas de América Latina y El Caribe. Impactos y exposición. Retrieved from http://www.cepal.org/publicaciones/xml/0/46750/2011-786-.460_Vulnerabilidad_y_exposicion_WEB.pdf

CEPAL. (2013). Panorama Social de América Latina, p. 45. Retrieved from http://www.cepal.org/publicaciones/xml/9/51769/panoramasocial2013docinf.pdf

Crabbe, M. J., Martínez, E., García, C., Chub, J., Castro, L., & Guy, J. (2010). Is capacity building important in policy development for sustainability? A case study using action plans for sustainable marine protected areas in Belize. *Society and Natural Resources*, *23*, 181–190. doi:10.1080/08941920802409593.181

Cramer, K. L. (2013). History of human occupation and environmental change in western and central Caribbean Panama. *Bulletin of Marine Science*, *89*(4), 995–982.

Duke, N. C., Meynecke, J., Dittmann, S., Ellison, A. M., Anger, K., Berger, U., … Dahdouh-Guebas, F. (2007). A world without mangroves? *Science*, *317*(5834), 41–42. doi:10.1126/science.317.5834.41b

Dumas, J., & Kakabadse, Y. (2008). Cambio climático y pobreza en América Latina y el Caribe. Consulta Regional. Quito: FuturoLatinoamericano. Report to the International Development Research Center of Canada, 2008. ISBN: 978-9978-9960-3-4

EACC. (2012). The costs to developing countries of adapting to climate change new methods and estimates. The global report of the economics of adaptation to climate change study. Consultation Draft, p. 102. Retrieved from http://documents.worldbank.org/curated/en/ 2010/01/12563514/costs-developing-countriesadapting-climate-change-new-methods-estimatesglobal-report-economics-adaptation-climate-changestudy

ECLAC. (2011). Effects of climate change on the coast of Latin America and the Caribbean: Dynamics, trends and climate variability *LC/W.447*. United Nations, Economic Commission for Latin America and the Caribbean (ECLAC), Santiago de Chile, Chile. P. 263. Retrieved from http://www.cepal.org/portofspain/…/xml/8/…/lcarl362.pdf

ENCC. (2012). Estrategia Nacional de Cambio Climático del Ecuador: ENCC 2012–2025. Ministerio del Ambiente. Gobierno Nacional de la República del Ecuador, p. 142. Retrieved from http://www.redisas.org/pdfs/ENCC.pdf

Eriksen, S., & Brown, K. (2011). Sustainable adaptation to climate change. *Climate and Development*, *3*(1), 3–6. doi:10.3763/cdev.2010.0064

Ferrara, G., Martelo, M. T., Lairet, R., Villamizar, A., & Sánchez, J. C. (2012). Una propuesta de sensibilización y capacitación de comunidades para la adaptación al cambio climático: caso parroquia San Pedro, Caracas. ABES. Retrieved from http://www.acfiman.org/cambioclimatico/descargas/documentos/memorias_primer_simposio_nacional_sobre_cambio_climatico.pdf

Field, C., Barros, V., Stocker, T. F., Qin, D., Dokken, D. J., Ebi, K. L., … Midgley, P. (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation* (A special report of working groups I and II of the intergovernmental panel on climate change) p. 582. Cambridge: Cambridge University Press. ISBN: 978-1-107-02506-6. Retrieved from https://www.ipccwg1.unibe.ch/srex/downloads/SREX-All_FINAL.pdf

FII. (2006). Estudio de prospección tecnológica sobre cambio climático. Fundación Instituto de Ingeniería (FII). Ministerio de Ciencia y Tecnología. Venezuela. Retrieved from http://saber.ucv.ve/jspui/bitstream/123456789/4664/1/T026800008121-0-Tesis_Freddy_Blanco-2013-000.pdf

Francini-Filho, R. B., Moura, R. L., Thompson, F. L., Reis, R. M., Kaufman, L., Kikuchi, R. K. P., & Leão, Z. M. (2008). Diseases leading to accelerated decline of reef corals in the largest South Atlantic reef complex (Abrolhos Bank, eastern Brazil). *Marine Pollution Bulletin*, *56*(5), 1008–1014.

Frank, E., Eakin, H., & Lopez-Carr, D. (2011). Social identity, perception and motivation in adaptation to climate risk in the coffee sector of Chiapas, Mexico. *Global Environmental Change*, *21*(1), 66–76. doi:10.1016/j.gloenvcha.2010.11.001

Frickel, S. (2010). Global environmental and human development. *Review Essays*, *39*, 131–135.

German Watch. (2012). Global climate risk index (CRI) 2012: Who suffers most from extreme weather events? Weather-related loss events in 2010 and 1991 to 2010. Sven harmeling. briefing paper. p. 27. German Watch. Retrieved from http://www.germanwatch.org/klima/cri.pdf

Gómez-Erache, M. G., Conde, D., & Villarmarzo, R. (2010). *The sustainability of integrated management in the coastal zone of Uruguay: Connecting knowledge to action*. Montevideo: EcoPlata. Retrieved from http://www.ecoplata.org/documentos/

González, S. (2013). La Dimensión Humana del Cambio Climático. In: Primer simposio nacional sobre cambio climático: perspectivas para Venezuela. 28–29 de Noviembre 2013. Retrieved from http://www.acfiman.org/cambioclimatico/descargas/documentos/memorias_primer_simposio_nacional_sobre_cambio_climatico.pdf

Guarderas, A. P., Hacker, S. D., & Lubchenco, J. (2008). Current status of marine protected areas in Latin America and the Caribbean. *Conservation Biology*, *22*(6), 1630–1640.

Guenni, L., Nobre, C., Marengo, J., Huerta, G., & Sansó, B. (2013). Oceanic influence on extreme rainfall trends in the north central coast of Venezuela: Present and future climate assessment. *CompAMA*, *1*(2), 7–45.

Halpern, B. S., Longo, C., Hardy, D., McLeod, K. L., Samhouri, J. F., Katona, S. K., … Zeller, D. (2012). An index to assess the health and benefits of the global ocean. *Nature*, *488*(7413), 615–620. doi:10.1038/nature11397

Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C., … Watson, R. (2008). A global map of human impact on marine ecosystems. *Science*, *319*(5865), 948–952. doi:10.1126/science.1149345

Halsnæs, K., & Trærup, S. (2009). Development and climate change: A mainstreaming approach for assessing economic, social, and environmental impacts of adaptation measures. *Environmental Management*, *43*(5), 765–778. doi:10.1007/s00267-009-9273-0

Hastings, J. G. (2011). International environmental NGOs and conservation science and policy: A case from Brazil. *Coastal Management*, *39*(3), 317–335.

Herweijer, C., Ranger, N., & Ward, R. E. (2009). Adaptation to climate change: Threats and opportunities for the insurance industry. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *34*(3), 360–380. doi:10.1057/gpp.2009.13

Hickey, C., & Weis, T. (2012). The challenge of climate change adaptation in Guyana. *Climate and Development*, *4*(1), 66–74. doi:10.1080/17565529.2012.661036

Hoegh-Guldberg, O., & Bruno, J. F. (2010). The impact of climate change on the world's marine ecosystems. *Science*, *328* (5985), 1523–1528. doi:10.1126/science.1189930

IMF. (2014). World economic outlook database-April 2014. International Monetary Fund. Retrieved from http://www.imf.org/…/pubs/…/weo/2014/…/weodata/index

Invemar, Grupo Laera, GCAP y CDKN (Eds.). (2014). Adaptación al cambio climático en ciudades costeras de Colombia. Guía para la formulación de planes de adaptación. Seriede Publicaciones Generales del Invemar No. 65. Santa Marta. p. 40. ISBN 978-958-8448-65-7. Retrieved from http://www.oceandocs.org/bitstream/handle/1834/6611/Guia_planes_Adaptacion_CiudadesCosteras.pdf

IPCC. (2007). Climate change 2007: Impacts, adaptation and vulnerability. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change* (p. 976). Cambridge: Cambridge University Press. Retrieved from http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm

IPCC. (2013). Summary for policymakers. In T. F. Stocker, D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, … P. M. Midgley (Eds.), *Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change* (p. 29). Cambridge: Cambridge University Press. Retrieved from http://www.climatechange2013.org/…/WG1AR5_SPM_FI

Izaguirre, C. F., Méndez, A., Espejo, I., Losada, J., & Reguero, B. G. (2013). Extreme wave climate changes in Central-South America. *Climatic Change*, *119*(2), 277–290. doi:10.1007/s10584-013-072-9

Keller, M., Echeverría, D., & Parry, J. (2011). Review of current and planned adaptation action: Central America and Mexico. Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico and Panama. *International Institute for Sustainable Development (IISD), Adaptation Partnership*, 143. Retrieved from http://www.adaptationpartnership.org/

Kiem, A. S., Verdon-Kidd, D. C., Boulter, S. L., & Palutikof, J. P. (2010). Learning from experience: Historical case studies and climate change adaptation, National Climate Change Adaptation Research Facility, Gold Coast, p. 33. ISBN: 978-1-921609-26-8. Retrieved from http://www.nccarf.edu.au/content/learning-experience-historicalcase-studies-and-climate-change-adaptation

Klein, R. J. T., Eriksen, S., Næss, L. O., Hammill, A., Robledo, C., & O'Brien, K. (2007). Portfolio screening to support the mainstreaming of adaptation to climate change into development. *Climatic Change*, *84*(1), 23–44. doi:10.1007/s10584-007-9268-x

Lacambra, C., & Zahedi, K. (2011). Climate change, natural hazards and coastal ecosystems in Latin-America: A framework for analysis. In H. G. Brauch, A. Oswald Spring, C. Mesjasz, J. Grin, P. Kameri-Mbote, B. Chourou … J. Birkmann (Eds.), *Coping with Global Environmental Change, Disasters and Security* (pp. 585–601). Volume 5, Hexagon Series on Human and Environmental Security and Peace. Berlin Heidelberg, Germany: Springer. Retrieved from http://www.academia.edu/4312958/_Introduction_Coping_with_Global_Environmental_Change_in_the_Anthropocene_of_the_Book_Coping_with_Global_Environmental_Change

Lampis, A. (2010). Challenges to adaptation for risk-prone coastal livelihoods in Tumaco, Pacific Coast (Colombia). In Integrative perspectives on urbanization and climate change. UGEC Viewpoints No. 3. *Urbanization and Global Environmental Change* (UGEC), 18–22. Retrieved from https://sites.google.com/site/lampisndr/publications

Leal Filho, W. (2013). Understanding the links between climate change and disaster management in pacific island countries. In W. Leal Filho (Ed.), *Climate change and disaster risk management* (p. 692). Berlin: Springer. ISBN 978-3-642-31110-9. Retrieved from http://www.springer.com/economics/environmental/book/978-3-642-31109-3

Leal Filho, W., Alves, F., Caeiro, S., & Azeiteiro, U. S. (Eds.). (2014). *International perspectives on climate change: Latin America and beyond*. Springer-Verlag. March 2014. ISBN 978-3-319-04489-7. Retrieved from http://link.springer.com/book/10.1007%2F978-3-319-04489-7

Leal Filho, W., & Mannke, F. (2014). Managing the impacts of climate change in Latin America: The need for technology transfer. In W. Leal Filho, F. Alves, S. Caeiro, & U. S. Azeiteiro (Eds.), *International perspectives on climate change: Latin America and beyond* (Chapter 7, pp. 95–106). Springer-Verlag. March 2014. ISBN 978-3-319-04489-7. Retrieved from http://link.springer.com/book/10.1007%2F978-3-319-04489-7

Leary, N., Adejuwon, J., Barros, V., Batimaa, P., Biagini, B., Burton, I., … Wehbe, M. (2008). *A stitch in time: General lessons from specific cases.* In N. Leary, J. Adejuwon, V. Barros, I. Burton, & R. Lasco (Eds.), *Climate change and adaptation* (Vol. 1, pp. 1–27). London: Earthscan. ISBN 9781844074709.5

Lesnikowski, A. C., Ford, J. D., Berrang-Ford, L., Barrera, M., & Heymann, J. (2013). How are we adapting to climate change? A global assessment "Mitig Adapt Strateg Glob Change". doi:10.1007/s11027-013-9491-x

López Rodríguez, A., Sierra-Correa, P. C., & Lozano-Rivera, P. (2013). Criteria for incorporating the guidelines of the integrated coastal zone management (ICZM) in territorial land use planning: Study case for the Colombian pacific coastal area. *International Journal of Marine Science*, *3*(29), 225–237. doi:10.5376/ijms.2013.03.0029

Losada, I. J., Reguero, B. G., Méndez, F. J., Castanedo, S., Abascal, A. J., & Mínguez, R. (2013). Long-term changes in sea-level components in Latin America and the Caribbean. *Global and Planetary Change*, *104*, 34–50. doi:10.1007/s10236-005-0008-3

Magrin, G., Gay, C., Cruz Choque, D., Gimenez, J. C., Moreno, A. R., Nagy, G. J., … Villamizar, A. (2007). Chapter 13 "Latin America', 583–615. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability* (pp. 581–615). *Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate* *change*. Cambridge: Cambridge University Press. ISBN 978 0521 88010-7

Magrin, G., Marengo, J., Boulanger, J. P., Buckeridge, M., Castellanos, E., Poveda, G., … Vicuña, S. (2014). Chapter 27 "Central and South America". In V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, … & L. L. White (Eds.). *Climate change 2014: Impacts, adaptation and vulnerability. Part B: Regional aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change IPCC, 2014*. Cambridge: Cambridge University Press, pp. 1499–1566. ISBN 978-1-107-68386-0. Retrieved from http://ipcc-wg2.gov/AR5/report/citations/

Maskrey, A. (1997). IDNDR early warning programme – Report on national and local capabilities for early warning. Retrieved from http://www.unisdr.org/2006/ppew/whats-ew/pdf/national-andlocal-capabilities-ew-maskrey.pdf

McCarthy, J., Canziani, O., Leary, N. A., Dokken, D., & White, C. (Eds.). (2001). *Climate change 2001: Impacts, adaptation, and vulnerability*. Cambridge: Cambridge University Press. IPCC, 2001, p. 1032. ISBN 0 521 01500 6

McPhaden, M. J. (2013). A 21st century shift in ENSO properties. NOAA/Pacific Marine Environmental Laboratory Seattle, Washington, USA CLIVAR ENSO Diversity Workshop Boulder, Colorado 6–8 February 2013. Retrieved from http://www.usclivar.org/sites/default/files/meetings/ensodiversity2013/mcphaden_m_ppt.pdf. Accessed 27 Feb 2015

Méndez, A. (2011). Puertos comerciales y áreas costeras protegidas: Dilema legislativo entre desarrollo y conservación. Tesis de Maestría. Universidad Simón Bolívar. Caracas. Venezuela

Metternicht, G., Sabelli, A., & Spensley, J. (2014). Climate change vulnerability, impact and adaptation assessment: Lessons from Latin America. *International Journal of Climate Change Strategies and Management*, *6*(4), 442–476. doi:/10.1108/IJCCSM-06-2013-0076

MMA. (2013). "Política Nacional de Adaptación al Cambio Climático en Brasil: Situación Actual. Secretaria de Cambio Climático y Calidad Ambiental. Ministerio do Meio Ambiente. Retrieved from http://www.mma.gov.br/clima/adaptação

Moraes, D., & Velázquez, S. (2012). Capitales comunitarios y vulnerabilidad social frente al cambio climático en un municipio de Yucatán. *Trayectorias*, *14*(33–34), 51–75.

Moura, R. L. D., Minte-Vera, C. B., Curado, I. B., Francini Filho, R. B., Rodrigues, H. D. C. L., Dutra, G. F., … Souto, F. J. B. (2009). Challenges and prospects of fisheries co-management under a marine extractive reserve framework in northeastern Brazil. *Coastal Management*, *37*(6), 617–632.

Nagy, G. J., Bidegain, M., Norbis, W., Ponce, A., Pshennikov, V., & Severov, D. N. (2008). Fishing strategies for managing climate variability and change in the estuarine front of the Río de la Plata. In N. Leary, J. Adejuwon, V. Barros, I. Burton, J. Kulkarni, & R. Lasco (Eds.), *Climate change and adaptation* (Chapter 20, pp. 353–370). London: Earthscan. ISBN: 978-1844074709

Nagy, G. J., Caffera, R. M., Aparicio, M., Barrenechea, P., Bidegain, M., Giménez, J. C., … Wehbe, M. (2006). "Understanding the potential impacts of climate change and variability in Latin America and the Caribbean". Report prepared for the stern review on the economics of climate change. Department for International Development-DFID, HM Treasury, United Kingdom. Retrieved from http://www.dfld.de/Presse/PMitt/2006/061030cA.pdf

Nagy, G. J., Gomez-Erache, M., & Kay, R. (2015). A risk based and participatory approach to assessing climate vulnerability and improving governance in coastal Uruguay, Ch. 16: 357–378. In B. Glavovic, R. Kay, M. Kelly, & A. Travers (Eds.), *Climate change and the coast: Building resilient communities*. London: CRC Press, Taylor & Francis Group. Print ISBN: 978-0-415-46487-1, eBook ISBN: 978-1-4822-8858-2; doi:10.1201/b18053-23. Retrieved from http://www.crcpress.com/

Nagy, G. J., Muñoz, N., Verocai, J. E., Bidegain, M., & Seijo, L. (2014). Adjusting to current climate threats and planning adaptation: The case of the Uruguayan Coastal zone within the Rio de la Plata river estuary. *Journal of Integrated Coastal Management, Special Issue on "Lay Rationalities of Climate Change in the Coastal Zone"*, *14*(4), 1–15. doi:10.5894/rgci472

Nagy, G. J., Seijo, L., Verocai, J. E., & Bidegain, M. (2014). Stakeholders' climate perception and adaptation in coastal Uruguay. *International Journal of Climate Change Strategies and Management*, *6*(1), 63–84. doi:10.1108/IJCCSM-03-2013-0035

Naumann, S., Davis, M. C., Munag, R., Andrews, J., Thiaw, I., Alverson, K., … Han, Z. (2013). The social dimension of ecosystem-based adaptation. Ecologic Institute, United Nations Environment Programme (UNEP) Policy Series, Ecosystem Management, Cornell University, p. 16. Retrieved from http://www.ecologic.eu/de/10251

Naveda, J. (2013). Posibles Impactos en la zona Costera Venezolana por efecto del cambio del nivel del mar como consecuencia del Cambio Climático Global: En primer simposio nacional sobre cambio climático: perspectivas para Venezuela. 2 Academia de Ciencias Físicas, Matemáticas y Naturales de Venezuela (ACFIMAN). 8–29 de Noviembre 2013. Retrieved from http://www.acfiman.org/cambioclimatico/descargas/documentos/memorias_primer_simposio_nacional_sobre_cambio_climatico.pdf

ND-Gain. (2012). Notre dame global adaptation index. Retrieved from http://index.gain.org

Nelson, G., Rosegrant, C., Koo, M. W., Robertson, J., Sulser, T., Zhu, T., & Lee, D. (2009). *Climate change: Impact on agriculture and costs of adaptation (Vol. 21)*. Intl Food Policy Res Inst. Retrieved from http://www.ifpri.org/sites/default/files/…/pr21.pdf

Neumann, B., Vafeidis, A. T., Zimmermann, J., & Nicholls, R. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding – A global assessment. *PLoSONE*, *10*(3), e0118571. doi:10.1371/journal.pone.0118571

Ocean Health Index-OHI. (2014). Ocean health index. Retrieved from http://www.oceanhealthindex.org

Olivo, M., Lettherny, E., Ramos, C., & Sosa, M. (2001). Pérdidas de tierra en la costa venezolana debido al incremento del nivel del mar. *Interciencia*, *26*(10), 463–468. Retrieved from http://www.redalyc.org/pdf/339/33906107.pdf

Pauchard, A., Aguayo, M., Peña, E., & Urrutia, R. (2006). Multiple effects of urbanization on the biodiversity of developing countries: The case of a fast-growing metropolitan area (Concepción, Chile). *Biological Conservation*, *127*(3), 272–281.

Perdomo, M. (2012). Proyecto Políticas Climáticas 2012: preparando estrategias climáticas. Programa para el Desarrollo de Naciones Unidas, Centro Regional LAC, Panamá, Panamá. Retrieved from http://www.undp.org/content/dam/…/JTPoliticas-2012-Enfrentadas_rev_jt.pdf

Pineda, J., Starczak, V., Tarrant, A., Blythe, J., Davis, K., Farrar, T., & da Silva, J. C. (2013). Two spatial scales in a bleaching event: Corals from the mildest and the most extreme thermal environments escape mortality. *Limnology and*

Oceanography, *58*(5), 1531–1545. doi:10.4319/lo.2013.58.5.1531

Polidoro, B. A., Carpenter, K. E., Collins, L., Duke, N. C., Ellison, A. M., Ellison, J. C., … Hong Yong, W. H. (2010). The loss of species: Mangrove extinction risk and geographic areas of global concern. *PloS One*, *5*(4), e10095. doi:10.1371/journal.pone.0010095

Preston, B. L., Dow, K., & Berkhout, F. (2013). The climate adaptation frontier. *Sustainability*, *5*, 1011–1035. doi:10.3390/su5031011

PRODOC. (2008). Pilot sites of adaptation measures to climate change in the Uruguayan Coastal areas, project document prepared for UNDP/GEF Trust Fund, p. 131. Retrieved from http://www.undp.adaptationlearning.net/spa

Reid, H., & Huq, S. (2014). Mainstreaming community-based adaptation into national and local planning. *Climate and Development*, *6*(4), 291–292. doi:org/10.1080/17565529.2014.973720

Rojas Giraldo, X., Sierra-Correa, P., Lozano-Rivera, P. C., & López Rodríguez, A. (2010). Guía metodológica para el manejo integrado de las zonas costeras en Colombia, manual 2: planificación de la zona costera. Serie de Documentos Generales INVEMAR No. 44, p. 74. Retrieved from http://www.cbd.int/doc/meetings/mar/mcbem-2014-04/other/mcbem-2014-04-co-manual-2-en.pdf

Romero-Lankao, P. (2008). The challenge of climate change in Latin America. Newspaper Essay, South America, December 2008. Urban Age. The London School of Economics and Political Science, Retrieved from http://www.urban-age.net, p. 4

Ryan, D. (2012). Report on the state and quality of public policy on climate change and development in Latin America – Agriculture and forestry sector. Plataforma Climática Latinoamericana, Lima, Ryan D. (comp.) September 2012. Retrieved from http://intercambioclimatico.com/wp-content/uploads/Regional-Report31.pdf

Salas, S., Chuenpagdee, R., Charles, A., & Seijo, J. C. (Eds.). (2011). Coastal fisheries of Latin America and the Caribbean. Fao fisheries and aquaculture technical paper 544

Santibañez, Q. F., & Santibáñez, V. (2007). Trends in land degradation in Latin America and the Caribbean, the role of climate change. In *Climate and land degradation world meteorological organization* (pp. 65–81). Geneve: Springer Verlag.

SNRCC. (2010). Plan Nacional de Respuesta al cambio Climático: Diagnostico y lineamientos estratégicos. Sistema Nacional de Respuesta al Cambio Climático y la Variabilidad (SNRCC), Montevideo, MVOTMA. Retrieved from http://www.preventionweb.net/files/21530_15250pnralcclimuruguay20101.pdf

Tacoli, C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment & Urbanization*, *21*(2), 513–525. Retrieved from http://eau.sagepub.com/content/21/2/513.short

Torres-Alruiz, M., & Rodríguez, D. (2013). A topo-dynamical perspective to evaluate indirect interactions in trophic webs: New indexes. *Ecological Modelling*, *250*, 363–369. doi:10.1016/j.ecolmodel.2012.11.024

UNDP. (2014). Human development report 2014. Retrieved from http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

UNEP. (2005). Assessing coastal vulnerability: Developing a global index for measuring risk. United Nations environment programme. Assessing coastal vulnerability: Developing a global index for measuring risk, PDF. P. 54. Retrieved from http://www.unep.org/publications/search/pub_details_s.asp?ID=3752. ISBN No: 92-807-2577-7

UNEP. (2007). Annual report. United Nations environment program. Retrieved from http://www.unep.org/PDF/AnnualReport/2007/AnnualReport2007_en_web.pdf

UNEP. (2012). Latin American and the Caribbean: Atlas of our changing environment. UNEP/CATHALAC/UNDP.Atlas.pdf. p. 26.Retrieved from http://www.cathalac.org/lac_atlas/imagefull/Top10_LAC-

UNFCCC. (1992). Union nations framework convention on climate change. Retrieved from http://unfccc.int/essential_background/convention/items/6036.php

UNISDR. (2011). United nations international strategy for disaster reduction secretariat. Global assessment report on disaster risk reduction 2011: Revealing risk, redefining development. p. 178. Retrieved from http://www.unisdr.org/we/inform/publications/19846

Valdés, C., & Herman, H. (2005). Cooperación internacional en el manejo integrado de la zona costera de México. *Gobernanza*, *11*, 151–162. Retrieved from http://etzna.uacam.mx/epomex/pdf/mancos/cap11.pdf

Verocai, J. E., Gómez-Erache, M., Nagy, G. J., & Bidegain, M. (2015). Addressing climate extremes in coastal management: The case of the Uruguayan Coast of the Rio de la Plata system. *Revista de GestãoCosteiraIntegrada / Journal of Integrated Coastal Zone Management*, *15*(1), 91–107. Retrieved from http://www.aprh.pt/rgci/pdf/rgci-555_Verocai.pdf. doi:10.5894/rgci555

Vides, M. P., & Sierra-Correa, P. C. (2014). Environmental policy analysis and institutional mapping: Towards an integrated climate policy to reduce Colombian Caribbean's sea level rise risk. *bol.invemar*, *43*(2), 307–328. Santa Marta July/Dec. 2014 ISSN 0122-9761

Villamizar, A. (2011). Adaptación al cambio climático y políticas públicas: Una deuda de alto riesgo para América Latina? *Mundo Nuevo, 3*, *1*(6), 301–338. Retrieved from http://www.iaeal.usb.ve/Mundo%20Nuevo/MN%206/art9.pdf

Wang, C., Deser, C., Yu, J.-Y., DiNezio, P., & Clement, A. (2012). El Niño-Southern Oscillation (ENSO): A review. In P. Glymn, D. Manzello, & I. Enochs (Eds.), *Coral reefs of the Eastern Pacific*. Springer Science Publisher (in press). Retrieved March 27, 2015, from http://www.aoml.noaa.gov/phod/docs/ENSO_Revision.pdf

WB. (2009). Assessing the potential consequences of in America climate destabilization in Latin America. In: Latin America and Caribbean region sustainable development working paper No. 32 [Vergara, W. (ed.)]. The World Bank, Latin America and the Caribbean Region, Sustainable Development Department (LCSSD). P. 118. Retrieved from https://openknowledge.worldbank.org/…/899220Ass

WB. (2012). The world bank data. World development indicators, urban development, urban population (% of total) and population in the largest city (% of urban population).Retrieved from http://data.worldbank.org/topic/urban-development The World Bank

WB. (2013). World development indicators database, World Bank. Retrieved from http://data.worldbank.org

Wetlands International. (2012). Desarrollo del componente #humedales" del Plan Nacional de Adaptación al Cambio Climático de Argentina. Retrieved from http://lac.wetlands.org/WHATWEDO/Adaptaci%C3%B3nalCambioClim%C3%A1tico/tabid/2127/Default.aspx

WRR. (2012). World risk report 2012. Alliance development works. Focus: Environmental degradation and disasters. United Nations University and Nature Conservancy. P. 74. ISBN 978-3-9814495-0-3. Retrieved from http://www.ehs.unu.edu/file/get/10487.pdf

Zamora-Bornachera, A. P., & Meza-García, A. G. (2013). Behavior of the economic revenues of the artisanal fishery in Ciénaga Grande de Santa Marta and complejo de Pajarales, Colombian Caribbean. Boletín de Investigaciones Marinas y Costeras-INVEMAR. Retrieved from http://www.scielo.org.co/scielo.php?pid=S0122-97612013000100005…sci…

Zielinski, S., & Díaz Cano, M. (2014). Los esquemas de certificacion de playas turisticas en Americ Latina: Evaluación del componente socio-cultural y el nivel participativo. *Estudios y perspectivas en turismo*, *23*(1), 156–175.

Zubiaurre, I., & Calvo, N. (2012). The El Niño–Southern Oscillation (ENSO) Modoki signal in the stratosphere. *Journal of Geophysical Research*, *117*, D04104. doi:10.1029/2011JD016690