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Research capability gaps hinder understanding of the impact of climate change on ecosystem services in the Latin American Pacific coast

Las brechas en la capacidad de investigación dificultan la comprensión del impacto del cambio climático en los servicios ecosistémicos en la costa del Pacífico latinoamericano

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ABSTRACT

Background. Coastal communities are highly dependent on ecosystem services, but the benefits and livelihoods people derive from natural ecosystems are directly and indirectly affected by climate change. The need for a mechanistic understanding of how components of climate change translate into measurable impacts on ecosystems and society is fundamental to the ability to manage, plan and mitigate for the most likely environmental futures, yet progress in this area in tropical and subtropical countries is frustrated by a lack of research capacity at the local and regional level. **Objectives.** Here, we investigate the research capacity of the countries along the Pacific coast, between Mexico and Chile, a region with an extensive coastline (23,191 km) that spans 11 countries of varying socio-economic development status and anticipated to be especially vulnerable to climate change. **Methods.** Specifically, our focus was to explore how the effects of climate change on ecosystem services (provision, regulation and cultural) may relate to research capacity and gross domestic product (GDP) in each country along the Pacific coast of the Americas. **Results.** We find that, since 1980, the number of peer-reviewed scientific studies relevant to this topic strongly correlates with GDP ($r = 0.90$, $p < 0.05$) and that research effort is an order of magnitude lower along the Latin American Pacific coast (13.8 studies 1000 km^{-1}) than in the neighbouring Californian coast (103 studies 1000 km^{-1}). **Conclusions.** Our results highlight the need to better develop the research in the Latin America Pacific, and for more work on the key links between climate change and ecosystem services.

Keywords: Food security, global warming, knowledge gap, natural hazards, poverty

RESUMEN

Antecedentes. Las comunidades costeras son altamente dependientes de los servicios ecosistémicos; sin embargo, los beneficios y el modo de vida de sus habitantes son afectados directa e indirectamente por el cambio climático. Por tanto, es necesario entender cómo el cambio climático se traduce en impactos medibles sobre la sociedad y los ecosistemas para implementar planes de manejo y de mitigación, pero no se cuenta con la capacidad de investigación local y regional para ello. **Objetivos.** Investigar la capacidad de investigación de los países latinoamericanos de la costa del Pacífico, desde México hasta Chile, una región de 23,191 km de largo, que comprende 11 países con diferente grado de desarrollo socio-económico y que serán especialmente vulnerables al cambio climático. **Métodos.** Específicamente, nos enfocamos en explorar como los efectos del cambio climático en los servicios ecosistémicos (provisión, regulación y cultural) se relacionan con la capacidad de investigación y el producto interno bruto de los países en la costa del Pacífico de Latinoamérica. **Resultados.** Encontramos que desde 1980 el número de estudios científicos publicados relacionados con el tema se correlaciona con el PIB ($r = 0.90$, $p< 0.05$) y el esfuerzo de investigación es un orden de magnitud menor en la costa de Latinoamérica (13.8 estudios por 1,000 km) que en la vecina costa de California (103 estudios por 1,000 km). **Conclusiones.** Nuestros resultados resaltan la necesidad de promover la investigación en la zona costera latinoamericana y de realizar más trabajos en aspectos clave de la relación entre cambio climático y servicios ecosistémicos.

Palabras clave: Brecha de conocimiento, calentamiento global, desastres naturales, pobreza, seguridad alimentaria

INTRODUCTION

The Millennium Ecosystem Assessment Report (MEA, 2005) highlighted the links between ecosystem and human well-being and the benefits as goods and services that humanity gets from nature, i.e., ecosystem services. What followed was a new impetus to consider ecosystem services (96% out of 35,284 publications since 2006, Web of Science retrieved May 4, 2020) but very few contributions (19%) that made explicit links between the provision of ecosystem services and climate change. Furthermore, although it is well known that species richness increases from the temperate regions to the tropics, and that biodiversity is fundamental to the natural capital on which many ecosystem services depend (Sandifer *et al.*, 2015), even the most cursory examination of the emergent literature reveals that most of the studies were conducted in developed countries. Additionally, there is a negative correlation between species richness and wealth: the countries of Southeast Asia, Africa, and Latin America harbour high diversity but their gross domestic product (GDP) *per capita* is generally low. Moreover, these regions are considered disproportionately more vulnerable to the direct and indirect effects of climate change because they tend to "*include disadvantaged and vulnerable populations, some indigenous peoples, and local communities dependent on agricultural or coastal livelihoods (high confidence)"* (IPCC, 2018).

Marine environments are likely to be particularly vulnerable to climate change, as coastal and marginal seas host a disproportionately large fraction of productivity, and the marine environment is believed to harbor the highest biodiversity in the world (Mora *et al.*, 2011). Rising atmospheric temperatures have increased global heat content in the upper 300 m of the oceans at a rate of about 0.04ºC decade^{-1} (IPCC, 2018), which has been linked to global sea-level rise (7-82 cm by 2100; (Siddall *et al.*, 2009), and extensive areas of intertidal habitats are predicted to be lost due to a reduction of the intertidal zone (coastal squeeze) associated with thermal expansion (Gabler *et al.*, 2017). Such physical changes will have significant implications for the future distribution and characteristics of coastal, intertidal and near-shelf ecosystems and their associated ecosystem properties (Gabler *et al.*, 2017). Further, these systems are already compromised by multiple human activities, including overfishing, habitat destruction, and pollution (Cinner *et al.*, 2020). Moreover, while coastal ecosystems are likely to experience a sizeable proportional change in their physical, chemical, and biological characteristics, fundamental differences exist between marine and terrestrial systems that lead to varying expectations in their response and adaptation time compared with terrestrial systems (Steele *et al.*, 2019).

Here, we specifically investigate patterns of research capability on ecosystem services and climate change in the coastal ecosystems along the Latin American Pacific coast. This coast covers a total length of 23,191 km from the US-Mexico border to Tierra del Fuego, Chile, and extends across 11 countries (Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Ecuador, Peru, and Chile, figure 1). It encompasses numerous coastal ecosystems within a series of contrasting climate domains (from temperate to tropical) and encompasses four Large Marine Ecosystems (LME; California Current, Gulf of California, Pacific Central American Coast and Humboldt Current (Sherman, 1991, 2014). The coast is also particularly vulnerable to the consequences of climate change including sea level rise, rising sea surface temperatures (SST), changes to circulation patterns, ocean acidification and increasing frequency and strength of storms and hurricanes (Pérez-Maqueo *et al.*, 2018; IPCC, 2018). Human activities that are likely to interact with or modify the ecological outcome of climate change are also prevalent, including extensive aquaculture systems replacing natural systems such as mangroves, tourism, unsustainable and unregulated fishing, untreated discharge of waste waters and agricultural run-off, and construction of harbour infrastructure (such as marinas and seawalls).

It is important to note that inadequacies and opportunities within the study of ecosystem services in Latin America has been highlighted before, but for different purposes. Balvanera *et al*. (2012, 2020) and recently Perevochtchikova *et al*. (2019) provide a comprehensive review and conclude that in Latin America ES supply and links to policy are most frequently assessed. However, the emphasis is placed on a limited number of services, namely carbon capture and water.

Dangles *et al*. (2016) showed that even when the studies were performed on sites located in LAC territories, only one third of the publications were led by Latin American authors, while Europeans authored 2.8 times more publications. Furthermore, those authors point out that only 11% of those studies dealt with marine ecosystems.

This gap is widening national expenditure in ocean science as a percentage of national research and development expenditure has fallen in Colombia (Balvanera *et al.*, 2012) and except for Brazil, the most vigorous relative growth in scientific output has occurred in regions outside of South America (Valdés, 2017). Furthermore, food utilisation, access, and stability, which constitute significant food security challenges in the world, remain under-investigated in developing countries from Asia, Africa, and Latin America (Cruz-Garcia *et al.*, 2016), and few assessments of the risk of ecosystem service provisioning under climate change have taken place across the region (Asmus *et al.*, 2019).

One reason for this low number of studies, at least in part, is that the research capability in Latin America countries (LAC) is comparatively low; for example, in Mexico there are only 244 researchers million^{-1} population, whereas in the UK there are 4,400, and in USA there are 4,300 million^{-1} population (UIS-UNESCO, 2018). Here, motivated by the need to target research effort to areas most likely to be affected by climate change and facilitate directed efforts where most warranted, we provide an overview of 1) the extent of published research on ecosystem services and climate change in coastal ecosystems the Pacific coast of the LAC, and 2) the degree to which these publications correlate with socio-economic status, as quantified by GDP. We hope is that this contribution will be a first step in understanding how existing research capacities are being used to generate knowledge that support ocean management and policy, whilst identifying where further research emphasis is needed to best contribute towards attaining a sustainable future.

METHODS

We performed a systematic review to retrieve papers dealing with ecosystem services and climate change in one or more countries in Latin America. Then we explore the relationship among number of papers and selected geo-statistics of countries, including California, as a reference of what would be a developed country´s investment in research and development on the eastern Pacific coast.

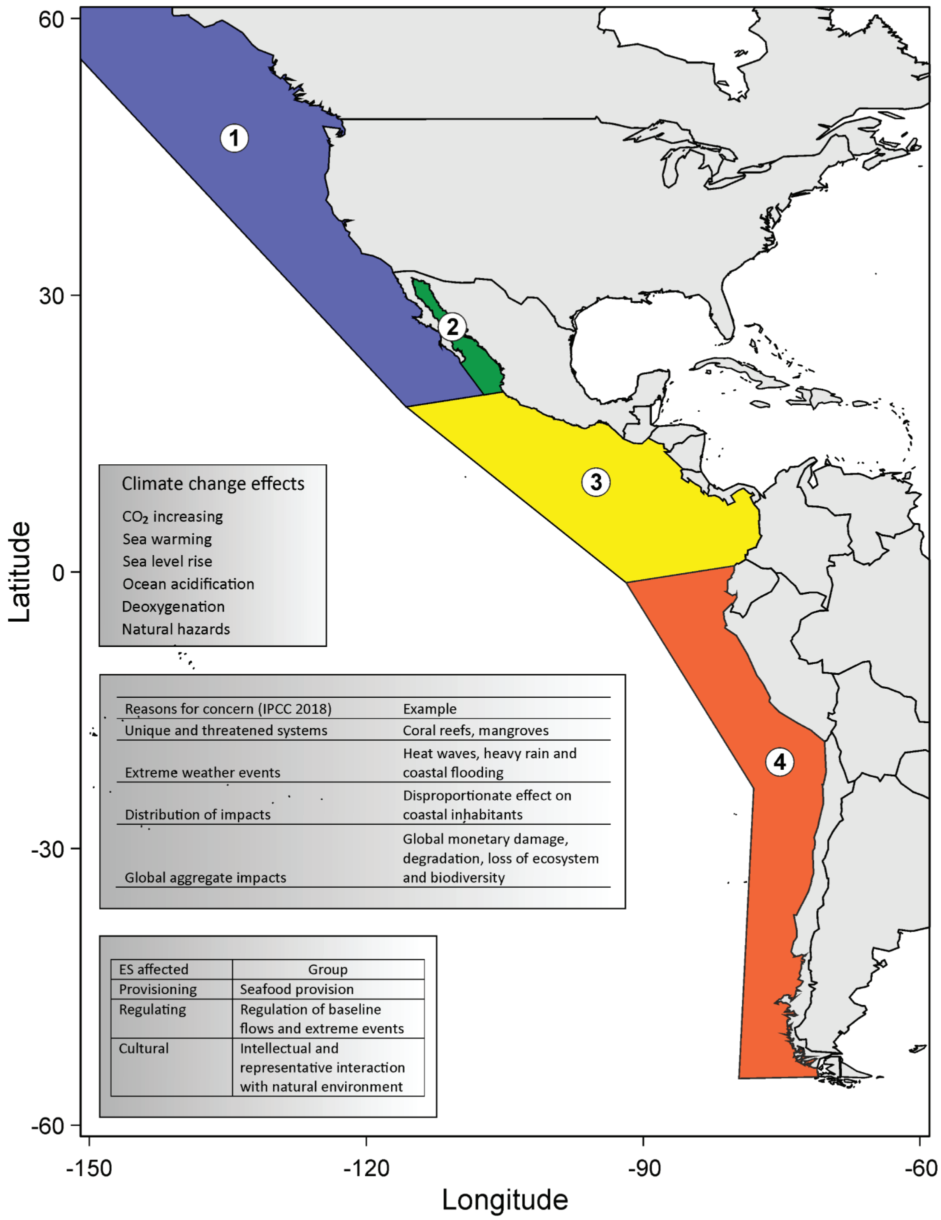

Figure 1. Climate change effects, reasons for concern, and ecosystem affected in coastal and marine ecosystems from Latin American countries. Large Marine Ecosystems are shown: 1. California Current; 2. Gulf of California; 3. Pacific Central American Coastal; 4. Humboldt Current.

Literature review. We searched the Thomson Reuters Web of Science collection (http://www.webofknowledge.com, accessed April 2020) using a 'Basic Search' across all databases with the search term ecosystem service* in the title, abstract, author keywords, and Keywords Plus of all document types, in all languages, for the publication years January 1980 – April 2020. This global search returned 35,359 contributions worldwide from marine and terrestrial systems (#1); we repeated the search but using 'climate change' as the search term and got 212,552 references (#2). We then combine #1 AND #2 and found 6,466 contributions (#3). Subsequently, we used the Advance Search option with the string ALL=("Chile" OR "Colombia" OR "Costa Rica" OR "Ecuador" OR "El Salvador" OR "Guatemala" OR "Honduras" OR "Mexico" OR "Nicaragua" OR "Panama" OR "Panamá" OR "Peru" OR "Perú" OR "Latin America" OR "América Latina" OR "South America" OR "Suramerica" OR "America del Sur" OR "Central America" OR "América Central" OR "Centroamérica" OR "Mesoamérica") NOT ALL=("Gulf of Mexico" OR FLORIDA) to g*et all* references relating to Latin American countries from the Pacific coast, obtaining 978,319 references (#4). Finally, we combined #3 AND #4 to get 616 contributions that meet our selection criteria of dealing with ecosystem services and climate change in one or more countries from Latin America. We manually screened the titles and abstract of the returned subset to retain only contributions focussing on the marine and coastal environment (n = 319, Table 1).

Table 1. Selected geo-statistics from Latin American countries (Full data and sources in appendix 2). Data for California for comparison.

Country	Studies on coastal ecosystem services	Researcher/ million people	Studies on ES/RD	Studies on ES/ Coastal inhab 10^5	HDI	Fisheries Landed Value in 10^3 USD	National Marine area %	Tourism as % of exports	Sea level Anomaly mm
California	139	4245	3.27E-02	0.67	0.92		16.00%	10	103.82
Mexico	130	252	5.16E-01	0.27	0.767	1,745,795	21.55%	5	121.144
Guatemala	1	14	7.11E-02	0.01	0.651	45,279	0.90%	11	177.45
El Salvador	2	66	3.03E-02	0.14	0.667	62,040	0.71%	16	155.61
Honduras	2	35	5.77E-02	0.22	0.623	63,700	4.58%	6	94.46
Nicaragua	1	70	1.42E-02	0.07	0.651	68,030	2.97%	9	111.72
Costa Rica	18	380	4.73E-02	6.95	0.794	37,171	2.61%	20	159.37
Panama	13	39	3.32E-01	1.67	0.795	153,258	1.68%	22	121.24
Colombia	22	89	2.49E-01	0.25	0.761	183,314	17.15%	13	101.99
Ecuador	27	401	6.74E-02	0.36	0.758	1,166,585	13.35%	8	143.88
Peru	19	140	1.35E-01	0.25	0.759	3,911,989	0.48%	9	117.37
Chile	84	502	1.67E-01	4.62	0.847	2,879,355	41.19%	5	78.82

To establish the relative importance of the search terms concerning other regions, we repeated our searches for California, a Pacific state in a highly developed country (the USA) with a population and economy comparable to a medium-sized developed country. A detailed analysis of references found in each query is presented in the online supporting information.

The rationale of proxy variables selection. We selected variables that take us to accomplish our aim to explore the extent each country could cope with climate change impacts based on their R&D capacity and economy. We also wanted to assess the vulnerability of people close to the coast. We selected classes of ecosystem services (ES) of the three sections (provisioning, regulation, maintenance, and cultural) *sensu* the Common International Classification of Ecosystem Services CICES (Haines-Young & Potschin, 2018) for comparison. We used fisheries landed value (FAO, 2018) as a proxy of the service class *Wild animals (terrestrial and aquatic) used for nutritional purposes;* percentage of marine protected areas in waters of natural jurisdiction of each country (UNEP, 2020) as a proxy of service class *Maintaining nursery populations and habitats (including gene pool protection)*, under the assumption that the larger the protected area, the larger the benefit of this ES. Finally, we used tourism percentage of exports (UNWTO, 2020) as a proxy of the ES class *Characteristics of living systems that enable activities promoting health, recuperation, or enjoyment through active or immersive interactions* to have an idea of how much of the country's economy depends on this ES and therefore how much would be affected by climate change. Tourism represents 8.8% of the gross domestic product of Latin America, about 299 billion dollars per year (https://wttc.org/en-gb/Research/Economic-Impact), and the sector creates one in four new jobs. For comparison, we normalised $\left(\frac{x_i}{x_{max}}\right)$ these three variables.

To overcome the lack of information for all countries in some other metrics, we used sea level rise (SLR; World Bank, 2020) as a proxy of the magnitude of climate change impact, under the assumption that the higher the rise, the stronger the impact. SLR and other oceanic climate changes will result in salinization, flooding, and erosion and affect human and ecological systems, including health, heritage, freshwater, biodiversity, agriculture, fisheries, and other services (Weissenberger & Chouinard, 2015; CIA, 2018; see details in supporting information (SI). Because higher SLR is detrimental, once normalized, we multiplied it by -1.

We weighted the number of published studies by the number of coastal inhabitants - Total population by country (CIA, 2018), the number of coastal inhabitants (CEDLAS, 2018), the number of researchers, and the length of coastline (SI). According to UIS (2018), researchers are professionals who conduct research and improve or develop concepts, theories, models, techniques, instrumentation, and operational methods. We acknowledge that the use of the number of researchers will overestimate research expertise, as not all national researchers investigate climate change and ecosystem services. In order to indicate whether research capacity is linked to the nation's wealth, metrics were correlated with the Gross domestic product (GDP) of the countries under study (World Bank, 2018).

To weigh the number of people in each country, we used the gross national income per capita (GNI, formerly GNP per capita), converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (fewer subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad (World Bank, 2018). As a proxy of well-being, we used the Human Capital Index (HCI), which is designed to highlight how improvements in current health and education outcomes shape the productivity of the next generation of workers if children born today experience over the next 18 years the educational opportunities and health risks that children in this age range currently face; see details in SI. Despite both indices being correlated, we also used the Human Development Index (HDI) because it goes beyond the economy of each country and challenges national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes (UNDP, 2020). The HDI is the geometric mean of normalized indices for three critical dimensions of human development: a long and healthy life, being knowledgeable, and having a decent standard of living; see details in SI.

RESULTS

We found that most studies (224/319, = 70%) investigating the impact of climate change on ecosystem services across the Latin America Pacific coast have been published since 2015.

As expected, the number of publications depends on the GDP of the country (adjusted $r^2 = 0.70$, $p < 0.01$), but decreases with the GNI per capita (adjusted $r^2 = 0.45$, $p < 0.01$), this is because Costa Rica and Panama have less GDP and publications than Mexico, but higher GNI per capita. The lack of knowledge from Central America is critical since there is only one paper from Guatemala and Nicaragua and just two from El Salvador and Honduras (Table 1). When weighted by km of coastline, research effort amounts to 13.8 studies 1000 km^{-1} of coastline in the Latin American Pacific, compared to 103 studies 1000 km^{-1} of coastline in California. There are 0.37 studies per 100,000 coastal inhabitants in Latin America, but with huge disparities: from 0.01 in Guatemala to 6.95 in Costa Rica (Table1).

The Pearson correlation matrix among variables is presented in Table 2. Number of studies is significantly correlated ($p < 0.05$) with HCI ($r = 0.66$) and % MPA (0.76) and so HDI with the research capacity (0.71) and studies per 100,000 coastal inhabitants (0.61).

Figure 2 depicts the relative importance of selected ES for the region; Seafood from wild animals and plants is of utmost importance to Peru, followed by Chile, Mexico, and Ecuador, but it is of almost negligible importance for the other countries. Chile has high coverage of MPAs, which help with *Maintaining Nursery Populations and Habitats and Gene pool protection*; levels are also high for Mexico, Colombia, and Ecuador. Peru has little in the way of MPAs despite depending so heavily on fisheries. Central America depends heavily on cultural services since tourism can account for as high as 22% of exports for Panama and 20% for Costa Rica. Ecuador has both high dependence on fisheries and high coverage of MPAs, an a strong dependence on tourism (Figure 2). Using SLR as the metric, vulnerability to climate change indicates that Guatemala, Costa Rica, El Salvador, and Ecuador are the worst affected (SI).

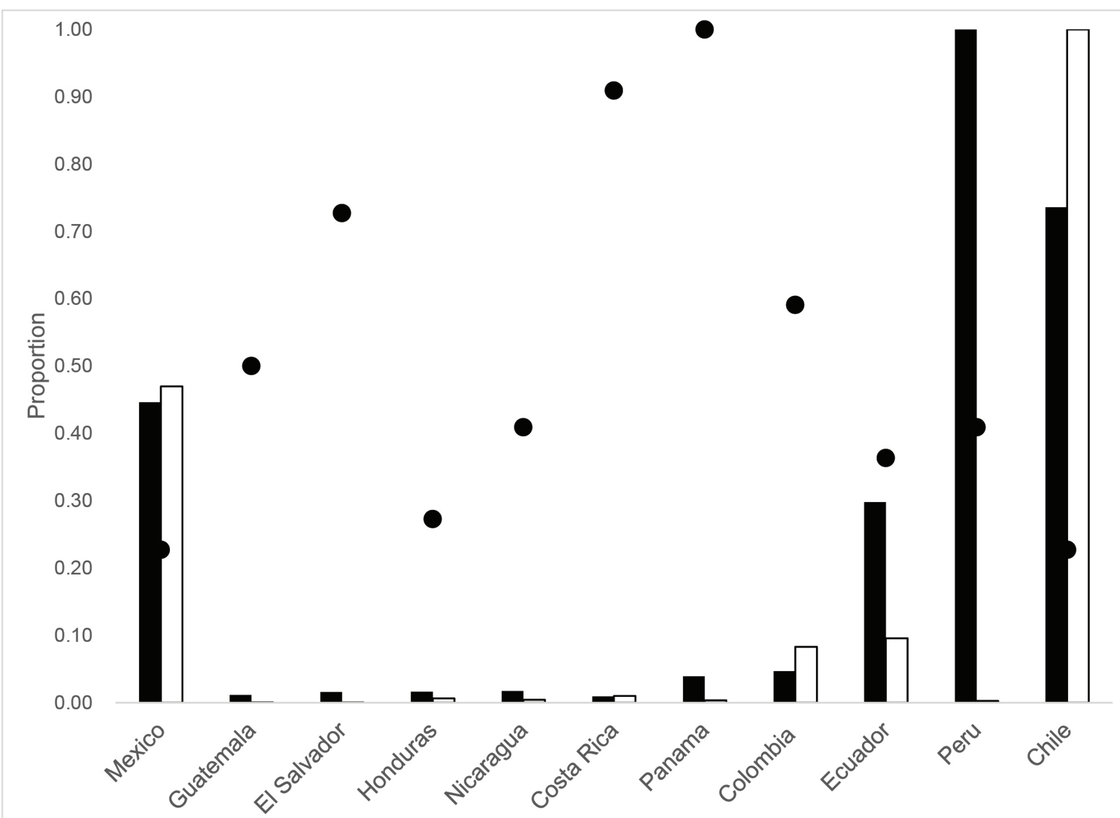

Figure 2. Max normalized value of fisheries landed (black bars), the proportion of marine protected area in waters of national jurisdiction of Latin American countries on the coast of the eastern Pacific (empty bars), and proportion of tourism to exports (black dots).

Table 2. Pearson's correlation matrix of variables. Numbers in **bold** are significant at $p<0.05$. Source of data in supplemental material.

	Studies on coastal ecosystem services	Total Population	Pop region coast	Researcher/ million people	Studies on ES/RD	Studies on ES/Coastal inhab 10^5	Length of coastline km	Studies on ES/1000 km coast	GDP millions USD	HDI	HCI	GNI per capita	Tourism as % of exports	Marine Area of National Jurisdiction km^2	National MPA km^2	National Marine area %	Fisheries Landed Value
Studies on coastal ecosystem services (ES)	1																
Total Population	**0.81**	1															
Pop region coast	**0.79**	**0.97**	1														
Researcher/ million people (RD)	0.57	0.12	0.11	1													
Studies on ES/RD	**0.74**	**0.81**	**0.77**	0.05	1												
Studies on ES/Coastal inhab 10^5	0.17	-0.2	-0.3	0.66	-0.1	1											
Length of coastline km	**0.97**	**0.72**	**0.68**	**0.62**	**0.68**	0.17	1										
Studies on ES/1000 km coast	0.44	0.33	0.25	0.53	0.35	0.6	0.34	1									
GDP millions USD	**0.9**	**0.98**	**0.96**	0.25	**0.84**	-0.1	**0.82**	0.38	1								
Human Development Index	0.56	0.22	0.14	**0.71**	0.49	**0.61**	**0.63**	0.53	0.34	1							
Human Capital Index	**0.66**	0.34	0.23	**0.86**	0.33	0.57	**0.71**	0.59	0.43	**0.86**	1						
GNI per capita	0.49	0.09	0.06	0.56	0.5	**0.69**	0.54	0.48	0.24	**0.9**	**0.6**	1					
Tourism as % of exports	-0.5	-0.4	-0.4	-0.3	-0.1	0.34	-0.5	0.09	-0.4	0.15	-0	0.31	1				
Marine Area of National Jurisdiction km^2	**0.95**	**0.62**	0.57	**0.7**	0.58	0.28	**0.98**	0.38	0.74	**0.63**	**0.8**	0.56	-0.6	1			
National MPA km^2	**0.79**	0.35	0.29	**0.68**	0.37	0.36	**0.86**	0.25	0.49	0.58	**0.7**	0.56	-0.5	**0.93**	1		
National Marine area %	**0.76**	0.4	0.3	**0.68**	0.4	0.28	**0.82**	0.34	0.5	0.59	**0.7**	0.49	-0.5	**0.9**	**0.94**	1	
Fisheries Landed Value	0.51	0.32	0.26	0.46	0.24	0.06	**0.66**	0.03	0.37	0.51	**0.6**	0.31	-0.5	**0.62**	0.53	0.45	1

DISCUSSION

The analysis of studies on ecosystem services in Latin America has been attempted before; Laterra *et al.* (2019) proposed a conceptual model to understand the links between the ecosystem services inequalities and the ES supply in Latin America. They found that the well-being of the most affected by those inequalities enhances the vulnerability of their socio-ecological systems.

Perevochtchikova and others (2019) did a systematic review of published papers focusing only on those that follow what they referred to as an integrated approach, i.e., that explicitly deal with the ecological, social, economic, and political dimensions. That way, from 2,520 papers found in two databases (SCOPUS and SCIELO), their analysis was reduced to a small proportion of the literature base (57 papers). They conclude that the most frequently analyzed services were provisioning and regulating ecosystem services related to hydrological and biodiversity. More recently, Balvanera and colleagues (2020) updated the previous synthesis on the state-of-the-art research on ES (Balvanera *et al.,* 2012), highlighting the achievements of a network that periodically organizes International Congresses on Ecosystem Services in the Neotropics. Noteworthy is that those papers are primarily oriented to terrestrial ecosystems and include Latin America and the Caribbean, whereas we focus only on the Pacific coast and climate change.

Our analysis presented here adds to this literature, indicating that the level of research that has taken place on the Pacific coast of Latin America is likely insufficient to support climate adaptation decisions. This is likely to have detrimental policy implications. The economies of the countries within the Pacific coast region rely very heavily on their natural resources, but levels of ecosystem service inequality are high and enhance the vulnerability of socio-ecological systems to climate change (Laterra *et al.*, 2019). While socio-ecological resilience reflects long-term historical trends, short-term shocks within this history can cause abrupt change (Whitfield *et al.*, 2019). Food provision in the form of seafood is the most critical coastal ecosystem service in the region, providing a significant source of protein, a way of living for marginalized communities, and direct and indirect jobs in artisanal fisheries and small-scale fish farming (Barange *et al.*, 2014). Catches in the whole region peaked in 1995 at over 10 million tonnes, with an average of 7.5 million tonnes annually for the last 20 years (FAO, 2018).

Our results suggest that further studies exploring the countries' capacity to cope with climate change's impact on ES at a spatial scale of policy relevance are urgently needed. General Climate Models help describe the potential effects of climate change on a global scale (Frölicher & Laufkötter, 2018), but they are neither accessible to downscale for policymaking nor useful for site-level decisions. Climate change impacts such as sea level rise are of utmost importance for low-lying and heavy-populated regions (Reyer *et al.*, 2017). Furthermore, ocean acidification threatens natural systems necessary for ecosystem services, such as coral reefs (Cabral-Tena *et al.*, 2018; Norzagaray-Lopez *et al.*, 2017) and detrimentally affects mollusc mariculture (Gazeau *et al.*, 2013); neither can easily be assessed via global-scale models.

In addition to this region's social and economic importance, the Eastern Pacific is a suitable case study to test the potential impacts of climate change on ecosystem service provision since the region is an eastern boundary upwelling system, bringing nutrients to the surface, creating "blooms" of algae and zooplankton, which feed on those nutrients. These, in turn, provide food for fish, marine mammals, and birds, sustaining one of the largest biomass fisheries, such as the Peruvian anchovy and the California sardine (Sydeman *et al.*, 2014). However, upwelling also brings lower pH water to the surface, aggravating the problem of ocean acidification (Manzello, 2010; Agostini *et al.*, 2018). In addition, large-scale events such as the Pacific Decadal Oscillation and the El Niño Southern Oscillation (ENSO) synergize with climate change effects shifting the range of commercially important species to higher latitudes and reducing the productivity of fisheries and aquaculture (Sperling *et al.*, 2016; Pecl *et al.*, 2017). The above makes the Eastern Pacific a natural laboratory to study the impact of climate change on coastal ecosystem services; however, at present, this potential scientific benefit of the region is not being realized due to the research gap documented here and other studies (Muñoz-Sevilla & Le Bail, 2017; Dangles *et al.,* 2016).

In conclusion, the low number of studies from LAC we observed is due to the lack of research capability in the region. The latest figures (June 2018) from the UNESCO Institute of Statistics (UIS, 2018) show that whereas North America and Western Europe have 41% of all world researchers, only 3.8% are in Latin America, spite that these countries make up 8% of the global population, so the research gap we observe is not surprising.

Climate action is one of the United Nations' sustainable development goals that call for urgent action to combat climate change and its impacts. However, with such a limited knowledge of the potential effects of climate change on coastal ecosystem services from the Latin America Pacific and of the community´s dependency on these services, it becomes difficult to establish how achievable this is. For informing decisions and policymaking under a global change scenario, it is pressing to conduct studies along a more significant latitudinal gradient and from different perspectives, as well as strengthen the capacity building of LAC. Therefore, specific and multidisciplinary studies at appropriate scales for policymaking and focused on ecosystem services are much needed in the Pacific coast of Latin America to assess global climate models' limitations and to enable mitigation and adaption to climate change impacts Balvanera *et al.* (2020).

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