TOWARDS ECOSYSTEM-BASED MANAGEMENT OF THE HUMBOLDT CURRENT LARGE MARINE ECOSYSTEM

THEMATIC REPORT:

Module IV – Socioeconomic aspects of the Humboldt Current Large Marine Ecosystem

– Extended summary –

Peru – June 2013

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INTRODUCTION

Between July and September 2010, the governments of Peru and Chile, the UNDP and UNOPS signed and approved the project entitled: “Towards ecosystem-based management of the Humboldt Current Large Marine Ecosystem (HCLME)”.

The goal of the project is to move towards a sustainable and resilient HCLME, ensuring the ecosystem’s integrity, biodiversity and services for present and future generations despite the changing social and climate conditions. Its objective is to advance towards the ecosystem-based management (EBM) of the HCLME through a coordinated framework that strengthens the governance and sustainable use of living marine resources and of the ecosystem services.

To achieve its goals and objectives, this project must formulate a Strategic Action Program (SAP) based on a Transzonal Diagnostic Analysis (TDA) which requires five thematic reports (for Peru and Chile) describing: (i) productivity, (ii) fisheries, (iii) pollution, (iv) socio-economic aspects and (v) the governance aspects of the HCLME (Olsen et al., 2006).

This is an extended summary of the IV Thematic Report which aims to update the information on the socio-economic aspects of the HCLME in Peru, extending the scope of the TDA-SAP evaluations conducted in 2002.

This report compiles, systematizes and analyzes a variety of data on the human dimensions of the HCLME in Peru, covering the following aspects: describing the main local stakeholders in the use of marine and coastal natural resources; where possible, estimating the value of these resources; pointing out the gaps in current knowledge; and suggesting possible lines of research to facilitate future exercises for establishing the ecological and economic value of the goods and services of the HCLME.

In addition, the report describes the main socioeconomic problems faced by the HCLME,and identifies a number of leverage points and recommendations for tackling them.

CONTEXT

The Humboldt Current Large Marine Ecosystem (HCLME) stretches along the coasts of Chile and Peru. Peru alone has sovereignty in the HCLME over an area of approximately 906,000 square kilometers extending all along its coastline (3080 kilometers) and for 200 nautical miles offshore.

The Peru Coastal Current (PCC), or the Humboldt Current, flows northwards close to the coast up to 7 or 6° South latitude, where it turns westward towards the Galapagos Islands (Wyrtki, 1967). Northern Peru, in the areas where the PCC meets a number of tropical water bodies, has ecotones of great biodiversity that harbor invertebrates, fish, reptiles, birds and marine mammals of both cold and warm waters. As a result, Peru’s greatest biodiversity is found along the coast of Piura and around the Lobos de Afuera and Lobos de Tierra islands (Majluf, 2002)

Not only do the currents affect atmospheric patterns and regulate the coastal climate, they also play a critical ecological role. Due to the wind, the cold, dense waters of the Humboldt Current are brought to the surface, heavy with nutrients, fertilizing the surface levels of the sea and fostering great primary productivity (Chávez et al., 2008). This is one of the world’s most important upwelling systems because of its primary productivity and fish production, as well as for sustaining biodiversity of global importance (Rodíguez & Young, 2000; Spalding et al., 2007).

As in other upwelling systems, Peru’s sea has a relatively short trophic chain in which the anchoveta (*Engraulis ringens*) is mainly responsible for channeling primary productivity to higher trophic levels (Pauly, 1987; Cury et al., 2000; Jahncke et al., 2004; Pikitch et al., 2012). Other species, such as the Panama lightfish (*Vinciguerria lucetia*) and the squat lobster (*Pleuroncodes monodon*), also play an important role in the Peruvian marine food webs,

mainly when there is little anchoveta available (Gutiérrez et al., 2008; Tam et al., 2008; Ballón et al., 2011; Espino & Yamashiro, 2012).

Marine fish biodiversity off the coast of Peru totals over 1000 species (Chirichigno & Cornejo, 2001) and almost 60% of these are coastal and benthic. In addition, 917 species of mollusks, 502 species of crustaceans, 687 species of algae, over 30 species of marine mammals, over 100 species of birds and at least 4 species of sea turtles have been reported (Majluf, 2002; Reyes, 2009).

However, this large ecosystem is extremely variable, chiefly because of the changes in the atmospheric circulation patterns at different geographical and temporal scales (Heileman et al., 2009).

It is important to stress the inter-annual variability of the upwelling due to the El Niño Southern Oscillation. For example, during "El Niño" events, the intrusion of water pulses from the east and north affects the intensity, depth and coastal proximity of the upwelling fronts (Bertrand et al., 2008). This in turn affects the availability of nutrients and primary productivity in the ecosystem.

Climate change is expected to have diverse and adverse effects on marine ecosystems around the world (Doney et al., 2012). In Peru, the El Niño events may become more frequent, intense and have a greater area of influence (IPCC, 2007; Ashok & Yamagata, 2009). This is expected to result in negative impacts on coastal infrastructure and cause high levels of mortality among fish and invertebrates, harming the national economy (Arntz & Fahrbach 1996, Bertrand et al., 2008).

It is also believed that climate change will have a general negative effect on the world's oceans, changing upwelling patterns and the primary productivity of Peru's sea, and in turn changing the distribution and abundance of small pelagic fish (like anchoveta). This could set off a series of impacts on other trophic levels and thus alter the composition, structure and function of the ecosystem (Bertrand et al., 2010).

Conversely, decreased upwelling could lead to increases in populations of species like sardines (*Sardinops sagax*), jack mackerel (*Trachurus murphyi*), tuna (*Thunnus* sp.) and hake (*Merluccius gayi peruvianus*) over the next 15 to 20 years (Bertrand et al., 2010).

In 2009, Peru was identified as one of the countries whose economies were most vulnerable to climate change (Allison et al., 2009). This vulnerability was suggested to be due to the combined effect of ocean warming, the relative importance of fisheries for the national economy and nutrition, as well as the limited capacity of societies for adapting to potential impacts and opportunities. It is no surprise that climate change is also expected to produce drastic increases in the price of marine living resources (Badjeck, 2008; Bertrand et al., 2010).

According to the literature, climate change may have various positive impacts on marine aquaculture, such as an increase in the growth rate of cultivated species (De Silva & Soto, 2009), but also severe negative impacts, including: increases in temperature and acidity beyond the tolerance of farmed fish and invertebrates; increases in pathogens and harmful algae density; increased cost of animal feed; reduced availability of seed, and losses due to more extended extreme events (Sueiro et al., 2012).

UNIQUE COMMUNITIES AND PROTECTED AREAS

The HCLME is home to a series of unique ecological and/or fragile communities associated with ecosystems such as estuaries (and mangroves), sandy beaches and rocky beds, islands, islets and the pelagic zone.

Estuaries, ecosystems which are formed in areas where fresh- and saltwater mix through contact between rivers and the sea (Day et al., 1989), play a key role in the life cycle of many vertebrates and invertebrates. They are home to many species of great commercial interest, for either direct or indirect use , including: nature tourist routes through the mangroves for bird watching and seeing the Tumbes crocodile (*Crocodylus acutus*); high-commercial value

fishing for mangrove cockle (*Anadara* sp.), the red crab (*Ucides occidentalis*), snails (*Melongena patuna*) and oysters (*Crassostrea columbiensis*); as well as shrimp (*Litopenaeus vannamei*) aquaculture, which are exported frozen.

Sandy-bed beaches, where sediment is deposited on the sea-shore, harbor large populations of the Pacific mole crab (*Emerita analoga*), red ghost shrimp *(Neotrypaea uncinata)* and Ocypodes (*Ocypode gaudichaudii*), species used as bait by hook-and-line fishermen. These areas are also home to species of high-commercial value such as the fine flounder (*Paralichthys adspersus*), corvina drum (*Cilus gilberti*) and razor clams (*Ensis macha*), as well as species attractive for tourism, such as flamingos (*Phoenicopterus chilensis*) and the South American sea lion (*Otaria flavescens*).

Rocky beds shelter commercial species such as the Peruvian morwong (*Cheilodactylus variegatus*), the Peruvian grunt (*Anisotremus scapularis*), Peruvian rock seabass (*Paralabrax humeralis*), keyhole limpets (*Fissurella latimarginata*), mussels (*Aulacomya ater*), crabs (*Cancer setosus, Platyxanthus orbignyi*) and sea urchins (*Loxechinus albus*), kelp forests of great ecological and economic importance (Christensen et al., en prep.), as well as species attractive for tourism, such as South American fur seal (*Arctocephalus australis*), sea otters (*Lontra felina*) and Inca terns (*Larosterna inca*).

The islands and islets, extensions of land surrounded by water, generally have great biological diversity and a high degree of endemism (Majluf, 2002). There are 77 islands along the Peruvian coastline, most with less than 5 hectares of surface area and concentrated in the northern-central areas of the country within 12 miles of the coast (Majluf, 2002). These islands have great bird populations such as the guanay cormorant (*Phalacrocorax bougainvillii*), the Peruvian booby (*Sula variegata*) and the brown pelican (*Pelecanus thagus*). Because of local climate conditions, guano (bird droppings) accumulates and is harvested and sold as a highly commercial organic fertilizer. It is also the main nesting material used by endangered species of touristic value, such as the Humboldt penguin (*Spheniscus humboldti*) (Paredes & Zavalaga, 2001) and the Peruvian diving petrel (*Pelecanoides garnotii*).

The pelagic zone, the open water bodies that are not above the continental shelf (Longhurst, 1998), are home to many species of commercial interest including anchoveta, jack mackerel, chub mackerel (*Scomber japonicus*), Pacific menhaden (*Ethmidium maculatum*), bonito (*Sarda chiliensis*), jumbo squid (*Dosidicus gigas*), mahi-mahi (*Coryphaena hippurus*), among others (Christensen et al., in prep.); as well as species attractive for tourism such as cetaceans, seabirds and marine turtles.

The National System of Natural Protected Areas protects 718,746 hectares of Peru's marine and coastal territory, covering sandy beaches, rocky beds, kelp forests, guano headlands and islands, coastal deserts, mangroves, dry forest, lomas and coastal wetlands, in 2 national sanctuaries, 4 national reserves, 1 wildlife refuge, 4 reserved zones and 5 regional conservation areas. However, these areas only cover 0.44% of Peru's marine territory.

NATURAL RESOURCES

Fishing is one of the most important socio-economic activities in the HCLME. In the last ten years, average annual landings of marine living resources were 7.50 ± 1.54 million metric tons (FishStat Plus, 2013). Some 350 species of fish, invertebrates and algae are caught in Peru, but fishing is mainly directed at catching anchoveta, jumbo squid, jack mackerel, chub mackerel, mahi-mahi and hake. About 98% of all anchoveta catch (86% of Peru's total annual catch) is used for fishmeal and fish oil production. The rest of marine living resources are used for direct human consumption, producing frozen, canned and cured products, or commercialized as fresh/refrigerated goods. Although trends in the state of resources are often disguised by fluctuations in the anchoveta catch, there is solid evidence of a gradual reduction in the mean trophic level of the Peruvian marine ecosystems (Pauly & Palomares, 2005; Caillaux, 2010).

Aquaculture is another activity that has gained importance in Peru over the last ten years (PRODUCE, 2013), although in comparison to other countries in the region, it remains hardly developed. Peru's main aquaculture resources, produced within the HCLME, are scallops

(*Argopecten purpuratus*) and shrimp. These together represent 99.5% of all marine aquaculture production and 72.89% of national aquaculture production (FishStat Plus, 2013). Almost all marine aquaculture production is exported overseas (Christensen et al., en prep).

The Peruvian agricultural "export boom" has been developed mainly in Peru's coastal valleys. Production of various agricultural resources such as asparagus, paprika, grapes, mango, avocado and artichoke, mainly in the valleys of La Libertad and Ica, have generated a large number of jobs. In 2007, these departments had practically full employment (Leon, 2009). In the last ten years, coastal agriculture has contributed an average of 15% of the regional GDP (INEI, 2013). Coastal agriculture is strongly influenced by the climate variability of the HCLME. In the 1982/1983 El Niño, the agricultural sector suffered severe damage from heavy flooding on the northeastern coast, and a ravaging drought in the southwest of the country. In 1983, a state of emergency was declared in the agriculture, fishing and transport sectors (MEF, 2013).

The exploration and exploitation of mining resources and fossil fuels (oil and natural gas) has grown considerably in the last ten years and currently threaten the ecological integrity and health of the HCLME (Fajardo, 2013). There are currently no deep sea oil exploitation projects – the platforms operate on the continental shelf (Kameya, 2003). In 2011, 242 wells were drilled (15 exploratory wells and 227 developed wells). This activity has had an average annual growth of 38.8% between 2003-2011; 82.6% of the wells were drilled on the northeastern coast (MINEM, 2013). Coastal mining, on the other hand, is concentrated in the southern central area of the country, near Lima, Ica, Arequipa, Moquegua and Tacna, mainly working on iron, copper, zinc and tin deposits (MINEM, 2013).

HUMAN RESOURCES

The communities in the coastal provinces grew by an annual average rate of 1.9% between 1993 and 2007, totaling 13.5 million people; with 96% living in urban areas (INEI, 2013). During that same period, school attendance rate of children aged 6-11 and 12-16 rose by 0.4% and 0.6% respectively, literacy rate rose from 93.1% to 95.4%, educational achievement rose from 89.8% to 92.5% and school attendance levels were slightly higher than the national average (PNUD, 2009).

On average, the proportion of under-fives suffering from chronic malnutrition by 2009 was only 13.96% in these provinces, a figure below the national average of 23.8% (INEI, 2013). By 2010, the coastal provinces concentrated 49% of all human resources for health nationwide (INEI, 2013). They also had a better quality of life, according to the Human Development Index (PNUD, 2009), and less inequality, according to the Gini coefficient (CEPLAN, 2011).

The Economically Active Population (EAP) of the coast has risen at an average annual rate of 2.8% in the last ten years (INEI, 2013). Until 2011, only 9.4% of the coastal EAP was working in agriculture, fishing or mining (INEI, 2013).

Nevertheless, jobs in the fishing sector have increased significantly in recent years. The number of artisanal fishermen, for example, rose from 28,082 to 37,727 between 1995-2005 and to 44,161 by 2012 (PRODUCE, 2013). Christensen et al. (*in prep.*) estimated that the extraction of marine living resources employed 79,459 people in 2009, of which 69.77% were artisanal fishermen, 21.53% were industrial fishermen, 8.17% were marine aquacultures and 0.53% were guano harvesters.

The Trade and Other Services sectors occupied 21.8% and 38.5% of the EAP for 2011, respectively (INEI, 2013). The latter sector includes tourism, one of the major economic sectors of the coast (Schulte, 2003). In 2011, 81% of all national and foreign visitors stayed in collective accommodation establishments in the coastal regions of Peru (MINCETUR, 2013).

According to the most recent National University Census, by 2010, only 12 of the 51 private universities and the 18 national universities along the Peruvian coast taught university degrees directly related to the sea, such as biology, fisheries engineering, environmental engineering, maritime engineering and aquaculture (INEI, 2013).

Nevertheless, there are many professionals from the schools of anthropology, law, sociology and economics etc. who also conduct research on marine and fishing issues. Unfortunately, there is no official registry of their work, and so it is impossible to monitor the development of knowledge in these fields.

Finally, while the coastal regions receive economic resources from the resources taxes (canon) and royalties for fishing and mining exploitation – money which should be earmarked specifically for scientific and technological research – their use is deficient and limited.

GOODS AND SERVICES

Marine coastal ecosystems provide a series of goods and services including food, biosorption of pollutants and climate regulation. Nevertheless, an important component of this flow of services is in the form of non-material benefits that influence peoples' social, spiritual and cultural dimensions (Ghermandi et al., 2011).

The main exercises valuing the environmental goods and services of the HCLME in Peru include:

- Cuadros (2001) aims to determine the Total Economic Value of the biodiversity of Bahía Independencia, with reference to marketable consumptive and non-consumptive products and the environmental service of carbon sequestration. The study measured the Direct Use Value, Indirect Use Value, Potential Value and Existence value. It studied the valuation of the productive flow of biodiversity and environmental services for 2000. The study estimates that the annual Total Economic Value (TEV) of the biodiversity of Bahía Independencia totals US$29'848,017.00 (Dollars for the current period), from TEV per hectare and square meter of US$ 4,929.00 and US$ 0.49 respectively.

- Rivas (2001) seeks to determine the economic costs and benefits of the conservation of biodiversity of the guano system versus the option of management centered on guano as a resource. This study found that the main commodity with a market value was guano, estimating that the annual benefit earned from it was US$ 3'296,793.30. He also calculated that the annual benefit generated by local tourism was US$ 10'117,585.00, including hotels, restaurants, tour companies and street vendors.

- Paredes & Gutiérrez (2008) analyzed the costs and benefits of the Peruvian anchoveta industry. The authors make an analysis of the importance of the species for the Peruvian economy; they evaluate the regulatory framework and propose the use of a bio-economic model for estimating the sector's efficiency. They conclude that there is severe over-investment in the fishing sector, evident in fishing and processing overcapacity, which is the result of the sector's weak and corrupt administration. They also estimate that with a reduction of 50% of the number of vessels, profits would be increased by US$ 176 million, 160% more than estimates based on the current (2008) fleet size.

- Paredes (2012) makes an overall analysis of the performance of the Peruvian fishing sector, looking at the anchoveta, jumbo squid, jack mackerel, chub mackerel and hake fisheries, examining their biological, economic and regulatory characteristics, with the aim of providing a trade-off scheme for the benefits, costs, opportunities and hazards that result from the "rights-based management" system implemented on the anchoveta fishery three years earlier. The study concludes that the government established a fishing right that was unrelated to the price of the resource or the profit resulting from its extraction. It mentions that while the big fishing companies paid US$ 4.1 million in 2011 for the concept of "fishing rights" of the analyzed fisheries, they received an export subsidy from these equivalent to US$ 50.5 million. In other words, the paid "fishing rights" represented 8% of what the government had granted as a "drawback".

- Carrasco et al. (2012) estimated the economic value of the main environmental goods and services from the San Fernando National Reserve, in the San Juan de

Marcona district, with the aim of showing its importance for the provision of ecosystem services. They looked at nine environmental services and determined that the annual value of the protected area totaled US$ 44.813 million, or S/. 122.9 million.

- Christensen et al. (*in prep.*) made an evaluation of the value and employment generated by Peruvian marine fisheries, differentiating the extraction, processing, distribution and commercialization phases. The authors developed cost structures for each stakeholder in the productive chain in US Dollars per metric ton and estimated the number of jobs generated per metric ton. They concluded that the value from Peru's sea for fishing, aquaculture and guano sectors for 2009 was US$ 3,430'601,232.00, employing 232,357 people. The production phase generated US$ 1,164'120,832.00, while the transformation or processing phase generated US$ 1,152'922,624.00, the distribution phase generated US$ 82'330,440 and the wholesale and retail phase generated 30.1% of the income from the sector with a value of US$ 117'491,272 from the wholesale markets and US$ 913'736,064 in retail markets.

STAKEHOLDERS RELATED TO THE USE OF HCLME GOODS AND SERVICES

Business associations are an important group of stakeholders in the dynamics of the HCLME. The National Fishing Society is the main business association in the fisheries sector, mainly representing the large fishmeal and fish oil producing companies, although it also includes committees representing companies working for direct human consumption and aquaculture.

The Direct Human Consumption Fishing Committee of the National Society of Industry is composed of companies that work, as its name indicates, in the extraction and/or processing of fishing recourses for direct human consumption.

For over a decade, fishmeal plant owners' associations have existed in the various regions along the Peruvian coast. They were created to address security issues in the bays, to finance joint infrastructure for submarine outfalls and to deal with local and regional governments over environmental issues. The first to be created was Apro Pisco in 1999. Since then nine more have appeared, some of which are still struggling to be formalized.

The New Vessel Owners Association, the National Vessel Owners Association of Law 26920, the Chimbote Artisanal Vessel Owners Association, the Canners Association of the Santa Province and the National Society of the Direct Human Consumption Industry, are all associations of industrial fishing boat owners.

There are also a large number of fishermen guilds and associations, highlighting how fragmented the unions and federations are, and how their power has fluctuated over time. Main examples are: the Peruvian Fishermen's Federation, the New Fishing Vessel Union, the Peruvian Federation for the Integration and Unification of Artisanal Fishing, and the Peruvian Association of Artisanal Fishing Businesses.

According to official figures of the Ministry of Production (February 2013), there are 1041 Artisanal Fishermen's Social Organizations registered. It should be noted that locally there are not only fishermen's and collectors' organizations, but also those of dockworkers, processers and retailers, which are not only representative but also regulate access to work.

The variety of associations reflects the importance of the fishing and aquaculture sector for job creation in the coastal regions. The fishmeal industry is the major activity in Peruvian fisheries: it has over 100 fishmeal plants with a processing capacity of just under 9000 metric tons of fish per hour, and a fleet of about 1000 boats that are subject to an individual quota system per fishing vessel.

The industry for direct human consumption includes the canning, freezing and curing plants, in addition to fresh fish markets. 67 canning plants currently operate with a license, located mainly in Chimbote and processing both anchoveta and other species. Processing of frozen

products mainly involves jumbo squid and to a lesser extent mackerel, scallops, mahi-mahi and hake.

Industrial-scale cured fish production mainly applies to anchoveta. There are 15 processing plants nationwide with a current operating license, based largely around Pisco. Artisanal cured-fish processing takes place mainly in the north of Peru (Lambayeque and Piura), dealing mainly with mullet, mackerels, bonito, sharks and rays. Fresh marine living resource commercialization covers a greater number of species, landing sites, workers, markets and restaurants.

Christensen et al. (*in prep.)* estimated that the sector employs 79,459 people in the production phase (extraction of fish, invertebrates and guano, macroalgae extraction, aquatic production), 50,390 people in the transformation or processing phase (fishmeal, fish oil, freezing, curing, canning and algae-drying industries), 953 people in the distribution phase and 101,555 people in the commercialization phase (6,260 in wholesale markets and 95,295 devoted exclusively to the sale of live marine resources, including retail markets, supermarkets, restaurants and shops).

Among the stakeholders directly involved in fisheries there are those concerned with prospecting and exploitation of non-renewable resources on the coast or sea bed, which are represented in the National Society of Mining and Oil, and others involved in tourism, like the national tour operators with routes along various parts of the coast.

Finally, a number of NGOs and/or academic centers run activities, projects and conduct research related to marine resources. These include the Peruvian Association for the Conservation of Nature, Cruzada por la Vida, the Peruvian Nature Conservation Foundation, Pro-Naturaleza, Mundo Azul, EKODES Consultores S.A., Centro de Datos para la Conservación, Conservation International, The Nature Conservancy, the Association for the Conservation of the Peruvian Sea, the Center for Environmental Sustainability of the Cayetano Heredia University, the Research Center of the *Universidad Pacífico* and the Peru Institute of the San Martin de Porres University.

SOCIAL AND CULTURAL ASPECTS

The close links between people and the sea go back to the beginnings of civilization in Peru, and are present throughout its history. Evidence of the sea's nutritious, cultural and religious importance can be found from the ruins of Caral, all the way to the Incas, and is displayed in museums across the country. One should also keep in mind that the gods of pre-Hispanic myths, Pizarro and General San Martin all came to Peru by sea (Trillo, 2003).

The hunting of whales and smaller cetaceans along the Peruvian coast (17th and 19th Centuries) produced the fuel that powered the industrial revolution (Trillo, 2003; Reyes, 2009) In the early years of the Peruvian Republic, the fertilizing capacity of guano was rediscovered, enabling Peruvians to live tax-free for decades (Cushman, 2003).

The sea and Peru's coastline also plays an important role in Peru's art and literature. Notable books include "*El zorro de arriba, el zorro de abajo*", which deals with the expansion of fishmeal production in Chimbote, and "La antología del cuento: La costa en la narración peruana" of 1970, and a number of stories by urban writers, such as Julio Ramón Ribeyro and other contemporary researchers in Chimbote linked to the *Isla Blanca* publishers.

In films, Kon-Tiki, a film that tells the story of a raft that travels from Callao to Polynesia, won the Oscar for best documentary in 1950. The story was again told on film in 2012 by the directors Joachim Rønning and Espen Sandberg.

Many painters incorporate the sea and its qualities in their work. Artists since Guamán Poma, who illustrated the Conquest, Rugendas in the 19th Century, Izcue, Luza, Codesido, Tsuchida, Blas, Humareda, Chávez, Quispe, Pastorelli, Silva, Hare, Boyer, Mauricio, Salazar, Tardito and others, produced works inspired by the coast, both of the sea and the desert; painting sceneries, bays and sunsets, detailed descriptions of fishing activity mainly against

the backdrop of northern Peru, women gathering or selling fish, and small fishing vessels, usually rowing or sailing boats.

The mass-produced “popular paintings” widely sold at fairs picture wide coastal landscapes or seascapes and often include images of fishing and fish markets.

Along the coast, people have developed the skill to make crafts from marine materials, like “totoras” or “juncos”. Originally, these were promoted as alternative activities for producing income in fishing communities, as well as for prisoners. However, these have a limited local market, poor quality finish and repeatedly use the same, stereotypical seafaring figures.

It is important to point out that in recent decades Peru has witnessed a major population shift. People have moved mainly to urban areas of the coast (Sueiro et al., 2005). This has brought more people in contact with the sea, increased the prevalence of fish in their diets and its use as a source of employment.

Industrial fishing and its impact on the surrounding area has resulted in cities being known for their strong smell. This coined the expression “the smell of money” in Chimbote, to describe that the reduction plants had started working.

In recent years, Peru has produced a number of successful and highly competitive athletes in individual maritime sports, which has brought these, and the areas in the country where they can be practiced, to the attention of the public. They include surfing, windsurfing, regattas etc. Nevertheless, fishing as a sport is not properly regulated and there is no record of it in terms of fishing effort, catch, areas and seasons.

It is worth mentioning some contemporary myths and beliefs: for example that “you should not eat fish at night” or that species like mahi-mahi “give you parasites” or that mullets “feed on rubbish”. Many of these beliefs are unfounded and refer to problems linked to how the fish is preserved rather than the toxic properties of the fish itself. But perhaps the most ingrained belief on the coast is that the way to measure success for artisanal fishermen is by the volume of their catch rather than its quality or relative price. This view is inherited from the industrial anchoveta fishery for indirect human consumption and may be a cultural legacy associated with the scant use of ice in artisanal fishing vessels.

Furthermore, as fishers face very dynamic environmental conditions and need great adaptive capacity - particularly in artisanal fishing - formalization is seen as a major restriction to adaptation (Sueiro & De la Puente, 2012).

Finally, one should not forget that in the coastal cities of Peru many people go to the seaside during summer. The beach circuit on the Costa Verde in Lima is the best example of this, where a great many people go for fun and rest. This also produces activities related to transport, security, food, beach gear, etc.

Cultural services provided by the HCLME are very diverse, but as in other parts of the world many are hardly visible and even fewer are recognized and valued (Primack et al., 2010).

LEGAL AND INSTITUTIONAL ASPECTS

Government institutions for the management of marine living resources, territorial management, protected areas and the protection of human life at sea include the Ministry of Production, the Peruvian Marine Research Institute, the Technology Institute for Production, the National Fund for Fishing Development, the Peruvian Port Authorities and Coastguard, the Environment Ministry, the National Service of Natural Protected Areas and regional and local governments.

The government grants concessions, licenses, permits, authorizations and other instruments for the exploitation of natural resources. For fishing, the Ministry of Production grants aquaculture concessions and authorizations for aquaculture in private property, fish extraction permits and processing licenses, permits for increasing fleet size and for conducting research (Decreto Ley No. 25977 y Decreto Supremo No. 012-2001-PE).

There are currently ten Regulations for Fishery Management (ROP) for individual species or groups of species, which deal with the governance of resource extraction. Depending on the information available and the degree of exploitation of a particular resource, the regulations cover catch shares, quotas, fishing seasons and areas, minimum landing sizes, vessel conditions and allowable fishing gears.

Hake and anchoveta fisheries, for example, have a catch-share system. The ROPs regulate species of national importance such as jumbo squid, jack mackerel and chub mackerel, but there is very little enforcement capacity. The artisanal fleet catches most of the species; however, many have no ROPs, fishing seasons or minimum landing sizes.

The Peruvian government began establishing the institutions and regulations for pollution prevention and mitigation in the 1990s. Following the creation of the Ministry of Environment in 2008, the government established independent environmental departments per sector to monitor, evaluate and approve the Environmental Impact Assessments of new investment projects. This process has not been free from tensions.

In the specific case of the fisheries sector, while maximum permissible limits (MPLs) were established for effluents from the fishmeal industry in the mid 1990s, these were suspended. Nearly a decade had to pass for the MPLs to be implemented again (Decreto Supremo No. 010-2008-PRODUC). Similarly, in the case of the rules governing shoreline environment protection, although the technical debate has concluded, the Ministry of the Environment has not yet enacted the regulation.

The percentage of public resources for fisheries management is hardly representative of the annual national budget, but has been shrinking in recent years. In the 2007-2012 period, the budget earmarked for the fisheries sector, a percentage of the national budget, fell from 0.31% to 0.17%; and compared with the value of the total exports of the sector, this ratio also fell from 3.6% to 2.6% in the same period. In this five-year period, the national government's budget and spending in the fisheries sector fell significantly, reflecting the decentralization process and the transfer of functions to the regional and local governments, which received budget increases of about 4 and 9 million in the same period.

However, it should be stressed that local governments' spending was under 60% of their budget in 2012 and the national government's spending was about 18% below the approved level. The reasons for this include the tiresome procedures of the National Public Investment System, the limited technical capacity of local governments, the lack of political will and/or the 'red tape' typical of the sector.

The Peruvian government, through the Fund for Innovation, Science and Technology, holds tenders for co-funding research projects into productive activities. Projects for the fisheries sector are regularly submitted and funded. Even though projects are quite small and last a maximum of three years, this Fund is an important tool for promoting research in the sector. Its institutional budget in 2012 was about US$ 10 million and in 2013 it rose to about US$ 25 million.

Similarly, IMARPE - the National Marine Research Institution - needs to be strengthened to foster better and more comprehensive scientific research and biological monitoring of marine living resources and biodiversity. In 2013, IMARPE received a budget of S/. 44 million (about US$16 million), of which 75% were allocated for research purposes. As this shows, Peru allocates barely 0.38% of the value of its fishing exports to the research of marine resources and their environment.

MAIN PROBLEMS

I. Non-sustainable use of marine living resources

In Peru, many marine living resources (fish, invertebrates and algae) are captured, extracted or gathered unsustainably. These practices tend to distort the composition, structure and functions of the marine ecosystems, altering the supply of ecological goods and services and generating unemployment, cost overruns and economic losses.

Direct causes of these problems include: volumes caught exceed the natural limits of the targeted populations for making their use a renewable activity; fishing practices used directly harm the species or their environment; the species' natural history is ignored; a precautionary principle is not exercised in the face of uncertainty and management is not adapted to changing circumstances.

This can be explained in terms of indirect or underlying factors. For example, there is a deficient structure of incentives in these activities. This occurs when (i) the profits from illegal practices are high, (ii) the monitoring and surveillance systems are inefficient, obsolete, biased, do not cover all those who exploit the resources, do not have trained staff or solid sources of funding; and (iii) enforcement and sanctioning systems are defective and not an effective deterrent, either because the infractions are badly described, or because the sanctions are mild or are unlikely to be applied.

Critics of the monitoring and surveillance systems of industrial fisheries argue that there may be conflicts of interest among the supervisory companies, as these are directly hired by the fishing companies and only have an agreement with the Ministry of Production for conveying information. Moreover, the companies that supervise the landings also certify the fishmeal quality, and their main clients are the companies supervised (De la Puente et al., 2011; Paredes & Letona, 2013).

Scientific monitoring of the landings of artisanal fishing catch depends on IMARPE. This entity samples ports and vessels and then estimates national landings per species depending on the type of fishing gear or vessel, or landing point, etc. This process, for regulatory purposes, is carried out by inspectors from the Regional Production Departments of the 11 regional governments along the Peruvian coast.

However, they only monitor a very small fraction of the catch, and almost none of the artisanal catch on the shoreline (beyond artisanal landing piers - DPAs) are recorded. Another important failure is that, not all the landings in the DPAs are recorded or have receipts, particularly for anchoveta fishing for direct human consumption (De la Puente & Sueiro, 2013).

It must also be mentioned that the sanctions system for fishing activity has a number of legal gaps and errors in the characterization of infractions, which must be resolved for it to be more efficient and effective. De la Puente et al. (2011) and Paredes & Letona (2013) gather this information and discuss it in detail and propose several critical issues that must be resolved, including the concepts of "second offenses" and fines for the concept of "juvenile catch".

In general, sanctions for extracting, storing, processing, commercializing, transporting or discarding resources during closed season or of sizes or weights lower than those established by law (juveniles), are not harsh enough to discourage such behavior. This problem is shared for species caught as by-catch.

Aimed to monitor and sanction failure to comply with regulations, the Decreto Supremo No. 015-2007-PRODUCE created the sanctions registry, currently under the jurisdiction of the General Direction for Sanctions of the Viceministry of Fisheries. However, this registry is clearly ineffective.

Nevertheless, problems and shortcomings related to the effective sanctioning for illegal fishing and aquaculture activities are not just responsibility of the fisheries sector. There is also considerable interference from the Judiciary (De la Puente et al., 2011) that undermines the fisheries sector's enforcement capacity and is justified by the application of the Ley No. 26979, Ley de Cobranzas Coactivas enactd in 2008 (De la Puente & Sueiro, 2013).

It is also important to bear in mind that if these systems do not offer adequate economic incentives for fishermen and businesses to protect resources, ecosystems and their future economic income, they will not do so on their own volition (Gordon, 1954; Hannesson, 1991; McCay et al., 1995; Grafton et al., 2006; Symes & Hoefnagel, 2010). In theory and practice, "open access" and "common property" in fisheries foster practices that are not sustainable

and lead to the “tragedy of the commons” (Gordon, 1954; Hardin, 1968; Bjørndal & Conrad, 1987).

Under “open access” regimes, restrictive measures such as a total allowable catch (TAC) aimed at securing the maximum sustainable yield for a species and the implementation of minimum landings sizes and fishing seasons (Winter, 2009), creates an incentive for each fisherman to try to get the greatest possible catch before their competitors, encouraging investment in more boats, which leads to over-capacity (Gordon, 1954; Fréon et al., 2008). This massive increase in fishing capacity, through the increased number of boats, leads to a gradual reduction in the length of fishing seasons (Fréon et al., 2008; De la Puente, in prep.); this phenomenon is colloquially known as the “race for fish”.

In general, limiting “open access” via rights-based management is not a direct conservation measure, but it can help improve fishermen’s appreciation of the resources (Gordon, 1954; McCay et al., 1995) and even to protect fisheries from collapsing (Costello et al., 2008).

In Peru, industrial fishing efforts for anchoveta was limited by the Decreto Legislativo No. 1084 (Paredes, 2012; De la Puente, *en prep*.). However, this regulation did not include all the stakeholders in the quotas and the construction of new fishing vessels continues despite regulations that explicitly forbid it (Paredes & Letona, 2013; Sueiro & De la Puente 2012; De la Puente, *in prep*.).

At the national level and in a significant percentage of governmental institutions, there is a great lack of transparency and public participation in the decision-making processes. Few such processes have clear regulations, showing valuation mechanisms, the information used, the objective of the regulations and the stakeholders involved in the decision-making.

An example is the absence of an official public document or legal instrument that describes and/or regulates the process for IMARPE to gather and use information about acoustic and reproductive prospecting, setting target biological reference points, indicating confidence intervals, incorporating oceanographic variables and consolidating the information for making estimates for suggesting a fishing quota (De la Puente et al., 2011).

Furthermore, there is no clarity about the “socioeconomic aspects” considered by PRODUCE, how it values them in view of IMARPE’s recommendations and how it incorporates them when granting a TAC (De la Puente et al., 2011). The “social quota” granted for the anchoveta fishery in the second season of 2012 is a clear example (De la Puente, *in prep*.).

In addition, although official Peruvian government websites contain much information online, very little is disaggregated and available in a form that can be used to conduct independent analyses.

Finally, it is important to mention that government efforts to (i) disseminate information which explains its decision-taking procedures, (ii) communicate the reasons behind the regulations, (iii) communicate the progress in enforcing the law for achieving its objectives, (iv) raising community awareness about current regulations, have been deficient and reactive.

The non-sustainable use of marine living resources is a problem shared with Chile, and is aggravated when dealing with transboundary resources whose management is fragmented. For example, in only two decades, the jack mackerel stocks, which extend from Peru and central southern Chile to the open waters of the Southeastern Pacific, were reduced from thirty million to less than three million metric tons (Paredes, 2012).

In a context of insufficient scientific knowledge, the member states of the South Pacific Regional Fisheries Management Organization (SP-RFMO) pledged to keep their annual catch below 40% of the 2010 catch, while the scientific group updates its diagnostic and recommendations. However, as Peru caught this resource in its waters in 2010, it argued that the reduction in catch was not binding for it, producing additional bilateral tensions (Paredes, 2012).

Additionally, Peru and Chile are not the only users of this fishery. Beyond Chile's waters, foreign fleets from China, the Netherlands, Korea, Vanuatu, Belize, the Faroe Islands and the Cook Islands catch significant amounts of this resource (Chocair, 2012).

This problem is not unique to jack mackerel outside national waters (it is similar for jumbo squid, mahi-mahi and chub mackerel), but also applies to shared species with a more coastal distribution like anchoveta, Peruvian weakfish, and kelp, among others. The absence of joint resource assessments and the incompatibility of fishing regulations weaken the capacity for ecosystem-based resource management in the HCLME.

The recent history of both countries has fostered a bilateral vision of competition instead of alliance. In the south of Peru for example, anchoveta has always been less important in acoustic prospection (Simmonds et al., 2009) and even the legal frameworks are weaker and more lax (De la Puente et al., 2011).

II. Incompatible use of marine commons

Another key problem for the HCLME is the incompatible use of marine commons. The use of the coastal and marine areas of Peru has intensified in the last ten years. Growth has been unplanned and has led to disorganization and lack of formality. As a result, there are incompatible economic activities take place simultaneously in common areas. These overlaps of incompatible economic activities puts great pressure on the marine and coastal ecosystems which translates into: (i) the loss of revenue and jobs (ii) degradation of the ecosystem by pollution, (iii) the loss of habitat of species of ecological, touristic and economical interest, and (iv) the alteration of the structure, composition and function of the ecosystem. This affects the supply of the environmental services from the HCLME and can even spark social and economic clashes over the use of and access to areas and resources.

A problem Peru faces in the administration of the coastal and marine areas is the absence of a national policy regulating and guiding their use. The Peruvian government has only recently understood that it must seek a harmonious development over its territory, setting priorities for the use of resources and areas that provide the best living standards for the population – understanding that areas are also limited resources, that there are incompatible and exclusive economic activities and that these must be coherently distributed to avoid contradicting the aims of local, regional and national development.

However, there has been minimal progress in zoning marine and coastal areas. In fact, while there are policy guidelines and a variety of laws that promote and regulate environmental and economic zoning (EEZ), there are no clear development goals for the marine and coastal areas, or channels for coordination between the various ministries, regional governments, local governments and civil society organizations, for pooling efforts and integrating knowledge and establishing the priorities for activities to be held in particular areas in Peru.

It is important to point out that while there are channels for coordination between sectors and government levels, they are rather ineffective and inefficient. This can be seen in the lack of registration of appropriating land for economic activities and the poor government enforcement capacity for the use of areas, due – in part – to the lack of one particular governmental institution responsible for leading the process and the lack of a clear definition of the limits of the competencies of the current entities involved in the marine and coastal areas.

Decision-making processes should consider accurate, pertinent and timely information, for conducting cost-benefit analyses and giving priority to or restricting certain activities in the coastal and marine areas. However, there is often no adequate information for defining regulations or zoning; moreover, the measures the government adopts in view of this uncertainty are hardly clear, for example: how does the Government use the precautionary principle in spatial planning?

Regarding socio-economic information, there is a great lack of transparency in registering tax contributions or collection for fishing rights, operating licenses etc.. There is no official, visible information about the amount of jobs, income, costs, taxes, fines and other sanctions in the

fisheries and aquaculture sector, or a disaggregate of the sector's contribution to the GDP in each phase.

In addition, to increase our understanding of the social-economic activities conducted by coastal communities and learn how they are impacted by the various economic endeavors being developed on the same grounds, it is necessary to use the socio-economic indicators provided by the Central Bank and the National Statistics Institute. However, with their estimates and use, which distorts the truth about these communities' circumstances.

For spatial planning, organization and development, the Peruvian government requires that EEZs have to be complemented by "Specialized Studies", which are strategic technical instruments used for conducting a comprehensive diagnostic of the territory and which define the characteristics and conditions of its configuration and current dynamic. Very little progress has been made in the EEZ for the 11 regions on the coast, and no specialized study has been finished or published.

Furthermore, the government's information generating systems are inadequate. This is because of budget problems that: (i) limit research and monitoring activities, or (ii) do not keep or attract high-level professionals. Scant budgets and low salaries demonstrate that the government does not prioritize research.

The problems that arise at the national level are even more complex at the regional level, with potentially even more critical repercussions. Because the HCLME is extensive and dynamic, there remain severe information gaps about a number of topics and fields; and there is a great lack of understanding of the human dimensions of the HCLME at the transnational level.

The lack of information increases uncertainty, nationally and regionally, hindering efforts for managing marine living resources and developing spatial planning from an ecosystem perspective. This is particularly true for shared resources or the impacts of the construction of megaprojects or urban discharges, which decrease the ecosystem's health.

Relations between the dynamics of the HCLME, global warming and socio-economic indicators (such as the GDP, HDI etc.) are not known in detail. The latter is a priority field for research given the dependence of economic growth of Peru and Chile on industries sensitive to climate change, such as fisheries, agriculture and aquaculture (Allison et al., 2009).

Knowledge about the magnitude and diversity of the environmental goods and services of the HCLME, as well as their relationship with ecological integrity and human wellbeing, is fragmented and unclear,, Both Chile and Peru have limited economic resources for research, far below the requirements for the implementation of ecosystem-based management of the HCLME. Additionally, there is still no access to a platform for integrating information that would strengthen cost-benefit analyses at national and regional levels and thereby improve bilateral decisions and the countries' individual capacities for managing the resources of the HCLME.

III. Degradation of the marine and coastal area

The degradation of the marine and coastal area is a problem shared by Peru and Chile that affects the health of the HCLME, and is a consequence of (i) the incompatible use of common areas, (ii) the lack of an incentive structure to promote the sustainable use of live marine resources and (iii) the lack of information to inform decision-making.

Environmental degradation entails the loss of ecological functions. The past decade has not witnessed substantial improvements in the prevention and mitigation of coastal erosion, the alteration of the seabed, sedimentation and the emission of untreated urban, agricultural and industrial discharges.

General pollution from the land is a major contributor to the degradation of the marine and coastal areas, be it from agricultural fertilizers and chemicals or tailings from mines mainly from Callao, Ilo and Ite in Peru and Concepción, San Vicente and the River Bio-Bio in Chile (Fajardo, 2013).

The main socio-economic consequences of pollution include the loss of investment and job opportunities, reduced productivity in fisheries and less competitiveness on the markets (PNUD, 2009) and outbreaks of epidemics and other health problems which can cause infant mortality and learning problems.

In Peru, the bays of Supe, Paramonga, Pisco, Chimbote, Huarmey-Ancash and Callao are polluted by mining, especially due to port activities (loading mineral concentrates) (IMARPE, 2003). In Chile, according to Buschmann and Fortt (2005) the main environmental problems in the San Vicente bay are the pollution of the water body by discharges of liquid waste, congestion and disorganization in the port area, industrial, tourist and recreation activities and the discharge of organic material from the fishing industry, while the bay of Concepción is polluted by the fishing industry, sewage, industrial waste water and liquid waste from port activity.

IV. Lack of appropriate infrastructure

Nationwide, there is a considerable shortage of infrastructure for unloading, preserving and handling marine living resources caught by the artisanal or smaller-scale fishing fleets. This problem is not only seen on land, since many boats lack the proper insulation for preserving the catch in their holds. Importantly, this catch is what is later sold for direct human consumption industries (frozen, canned and cured products) or that will be sold directly as "fresh-refrigerated" fish, invertebrates or algae (Christensen et al., *in prep.*).

No economic compensation is offered for preserving fish well; instead volume is preferred over quality. Nor is there an inter-connected structure for promoting and enforcing the use of ice on board while fishing. Ice is perhaps the main, and the most lacking, input necessary for ensuring better sanitary quality in fishing.

Additionally, the boats and docks (landing sites) discharge their effluents in the surrounding areas, producing major pollution points which directly damage the ecosystems' health. Together, these problems also have repercussions on the health of those who eat the fish and invertebrates, reduce the potential profit from the extractive activities and encourage the informal sector.

The root cause of these problems is the government's lack of attention on artisanal fishing over the last ten years, and the failure to provide public goods efficiently that would promote the sustainable development of the artisanal fisheries.

V. Deficient marketing and commercialization systems

The supply of national fish products is characterized by large volumes and low prices, a reflection of (i) the deficiencies in the marketing systems and (ii) an incentives structure that does not encourage commercial effectiveness and which is organized by traders to maximize their income at the expense of fishermen and artisanal boat owners.

First, the fact that boat-owners and artisanal fishermen are not registered and formalized means that they do not have access bank loans. As a result, they can only borrow money at very high interest rates from the municipal loan offices or individuals (mostly buyers or middlemen).

Moreover, buyers take advantage of the lack of information about prices and artisanal fishermen's catch volumes, as they set the prices and keep them low. As fishermen cannot refrigerate their catch, or are in urgent need of cash, they have to sell their fish before it rots.

When middlemen working for freezing or curing companies buy fish, they always underpay and argue the catch is worth little, since often what is produced and subsequently exported is the raw material of another industrial process and thus also has a low price.

These inadequate commercialization and marketing systems, in addition to open access and common property, promote the unsustainable use of marine living resources, as fishermen

and boat-owners try to pay their debts and increase their profit at the cost of the sustainability of the target populations in the short term.

LEVERAGE POINTS

Leverage points are places in the system structure where a small change can lead to a great change in the system's behavior. For the purposes of this report, they represent key areas and priorities for action that will help solve the various problems that threaten and negatively impact the HCLME.

I. **Developing a coordinated monitoring system of shared resources:** This system must take into account pelagic, demersal and coastal resources. To reduce uncertainty in resource management, as well as to evaluate progress in management measures towards the medium- and long-term objectives – which include the adoption of an ecosystem-based management of the HCLME – one priority must be the development of systems for coordinated (i) resource research and assessment, (ii) management, and (iii) monitoring the human activities that have an effect on the ecosystem.

II. **Improving the monitoring and surveillance systems in the maritime area:** This will strengthen the development of an incentives structure that encourages the sustainable use of the goods and services of the HCLME. Priority must be given to (i) restructuring procedures for administrative sanctions, (ii) improving monitoring of human activities in the marine and coastal areas, (iii) strengthening regional governments so that they improve their monitoring and surveillance capacities, and (iv) creating (a) an inter-agency committee for regulating and monitoring fishing and (b) the National Fishing Superintendence in charge of centralizing the functions of monitoring, enforcement and control.

III. **Developing regional cross-sector committees to move towards integrated coastal and marine management:** These could be used to characterize the marine and coastal areas and develop (i) a national shoreline policy and (ii) the legal and institutional framework for addressing spatial planning and management from an ecosystem perspective. This would tackle the problem of overlapping incompatible economic activities that can have local and transboundary environmental, social and economic impacts.

RECOMMENDATIONS

Below is a list of recommendations linked to the above leverage points, which will allow us to move towards solving the problems identified in this report.

1. Promoting added value in the productive chains of the various sectors associated with the sea; and seeking to effectively position these sectors on world markets with differentiated and diversified products with a clear competitive advantage.

2. Comprehensively evaluating current fishing regulations; subsequently introducing the amendments needed to produce incentive structures that encourage responsible behaviors that ensure resource sustainability.

3. Restricting access to commercial artisanal fishing fleets.

4. Drafting regulations for fishing of coastal species.

5. Amending the Law on enforced collections (Ley de Cobranzas Coactivas) in which administrative sanctions lead to prosecution, so that they perform their intended function of discouraging illegal behavior and do not provide perverse incentives.

6. Defining the budget needs of the fishing sector, and its funding sources, from an ecosystem perspective and extending the budget for monitoring and surveillance of the Environment Ministry and the Office of the Port Authorities and Coastguard of Peru.

7. Defining new fishing rights: all economic stakeholders who use the nation's marine living resources should pay for access rights, which should be established on the basis of revenue, fisheries administration costs and the environmental value of the natural resources.

8. Evaluating and improving the vessel monitoring systems (satellite tracking) of industrial, small-scale and artisanal fishing fleets.

9. Creating the National Fishing Superintendence in charge of surveillance, enforcement and monitoring, and providing it with an adequate budget.

10. Generating a budget for the conditional use of the resources tax (CANON) by regional governments, in order to fund a regional surveillance and monitoring program of the artisanal fishery.

11. Creating an cross-sector coordination committee for regulating and monitoring fishing activity.

12. Strengthening the artisanal fishing outreach program of the Ministry of Production, in order to promote sustainable and profitable artisanal fishing activity.

13. Capacity-building for artisanal fishermen's associations with the aim of optimizing the development of fishing activity.

14. Incorporating the value of marine and coastal ecosystems in the national curriculum (at middle-school, high-school, university and postgraduate levels).

15. Establishing inter-institutional outreach and educational programs on marine and coastal issues in order to incorporate marine living resources into the daily life of Peru's population.

16. Strengthening regional governments in order to allow them to effectively lead ZEE and spatial planning.

17. Promoting effective cross-sector coordination and coordination between government levels for spatial planning.

18. Incorporating spatial planning into government management instruments.

19. Establishing a National Program for the Comprehensive Management of the Marine and Coastal Area that fosters a more efficient management of resources by authorities.

20. Prioritizing investments that improve infrastructure for hygiene and preservation of marine living resources, in order to improve product quality for national and international markets.

21. Promoting public-private associations to develop the marine infrastructure required for artisanal fishing.

22. Encouraging research nationwide into marine issues to meet the information needs for sustainable development and the adoption of ecosystem-based management of the HCLME.

23. Improving and validating the systems for gathering socio-economic information and promoting the economic valuation of the goods and services of the HCLME.

24. Promoting public participation in decision-making processes.

CONCLUSIONS

The HCLME in Peru is facing major threats, including harmful fishing practices and overlapping, incompatible economic activities. These could jeopardize the integrity of Peru's marine and coastal ecosystems, altering their composition, structure and function, and distorting the supply of ecosystem goods and services.

Economic dependence on the extraction of natural resources, weak national governance systems and the poor adaptive capacity of Peru's natural resource management leave the country particularly vulnerable to environmental dynamics and uncertainty. Therefore, Peru must begin to design measures for adapting to climate change in marine ecosystems.

Economic growth in Peru over the last ten years has had a positive effect on Peruvian society, but has also increased the disorganized and sub-optimal use of marine and coastal areas and resources.

The development in Peru's productive activities has not been accompanied by (i) a process of regulation and formalization, or by (ii) consistent spatial management or effective control of human activities in the marine and coastal areas, thereby generating high social and environmental costs that are not assumed by those who produce them, but by the entire Peruvian population.

Currently, Peru lacks the information and the technical tools necessary for applying an ecosystem-based management of the HCLME. It is therefore imperative that research and development programs to design such management measures are well funded.

Appreciation of the economic value of the ecosystem services of the HCLME must be developed in Peru, as well as linking these to social wellbeing nationwide. This initiative must be accompanied by a continuous environmental, economic and social monitoring system that oversees the mechanisms that regulate the productive activities carried out in marine and coastal areas, and by a process of legal adaptation that allows for regulations compatible with the dynamic nature of the Peruvian marine ecosystem, as well as the needs for ecosystem-based management of the HCLME.

While it is true that the HCLME in Peru is facing serious problems, these can be resolved through bilateral cooperation and the adoption ecosystem-based management that fosters the sustainable use of its resources and areas.

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