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Social and environmental insights of a fishing population in the Yucatan Peninsula, Mexico

Perspectivas sociales y ambientales de una población pesquera en la Península de Yucatán, México

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ABSTRACT

Coastal communities face significant environmental and socioeconomic challenges including climate change, pollution, and overexploitation of marine resources. Developing countries, such as Mexico, are vulnerable due to overcapacity fisheries and inaccurate resource estimates. Approximately 13.6% of global marine re-sources are severely deteriorated, leading to declining populations of key species, such as grouper, octopus, and lobster. This research identified environmental, social and economic issues from El Cuyo, a fishing community in Yucatan, México. The main factors affecting the community of El Cuyo are natural phenomena such as tropical storms and hurricanes, resource degradation in size and catch, and distancing of resources from the coast. This study highlights the need for measures to reduce fishing efforts and develop alternative economic activities.

Keywords: Coastal communities, overexploitation, fisheries management and climate change.

RESUMEN

Las comunidades costeras enfrentan importantes desafíos ambientales y socioeconómicos como el cambio climático, la contaminación y la sobreexplotación de los recursos marinos. Los países en desarrollo, como México, son vulnerables debido al exceso de capacidad pesquera y a las estimaciones inexactas de los recursos. Aproximadamente el 13,6% de los recursos marinos mundiales están gravemente deteriorados, lo que provoca una disminución de las poblaciones de especies clave como el mero, el pulpo y la langosta. Esta investigación identificó problemáticas ambientales, sociales y económicas de la comunidad pesquera de El Cuyo, Yucatán. Los principales factores que afectan a la comunidad de El Cuyo son los fenómenos naturales como las tormentas tropicales y los huracanes, la degradación de los recursos en tamaño y captura y el alejamiento de los recursos de la costa. Este estudio pone de manifiesto la necesidad de adoptar medidas para reducir el esfuerzo pesquero y desarrollar actividades económicas alternativas.

Palabras clave: Comunidades costeras, sobreexplotación, manejo pesquero, cambio climático.

INTRODUCTION

Coastal tropical communities face multiple challenges affecting ecosystem health and the well-being of inhabitants, such as climate change, pollution, and overexploitation of marine resources (Delgado *et al*., 2024). Developing countries are susceptible to the adverse effects of climate change, exacerbating the issue of overexploited or overcapacity fisheries (Gutiérrez-Pérez, 2014).

Fishing, as a means of economic remuneration, entails environmental risks (e.g., extreme weather, resources far from the coast, deterioration of marine resources) that have repercussions on social (e.g., increase of decompression sickness, high-risk activities, increase of fishing efforts) and economic (e.g., high cost of inputs) aspects. Globally, approximately 13.6% of marine resources are severely deteriorated,

26% overexploited and, 25.6% in maximum exploitation (Arreguín-Sánchez & Arcos-Huitrón, 2011). Several factors contribute to the persistence of overexploitation of fisheries, i.e., 1) the increase in the world population, 2) economies that do not account for environmental and social costs, 3) erroneous estimates of the abundance of fishing stocks, and 4) illegal catches (Méndez-Cárdenas *et al*., 2013). In Mexico, fisheries management measures have not addressed the impacts of overexploitation and climate change on commercial resources, including grouper, octopus, and lobster (Hernández-Delgado *et al*. 2024; Méndez-Cardenas *et al*., 2013; Casado-Izquierdo & Crespo-Guerrero, 2023). Most of these fisheries exhibit negative trends in both size and landings, and yet they remain the mainstay of fishing communities in the Yucatan Peninsula, Mexico, comprised of approximately 95,498 individuals (Arreguín-Sánchez & Arcos-Huitrón, 2011; Méndez-Cárdenas *et al*., 2013).

A key example is the grouper (*Epinephelus morio*), with its current population size being one-third of that estimated in the early 1970s (Arreguín-Sánchez & Arcos-Huitrón, 2011). This confers a state of alarm and economic insecurity that has forced social processes such as migrations in search of new opportunities (Méndez-Cárdenas *et al*., 2013), the practice of illicit activities such as illegal fishing and increased fishing effort, which is related to the development of high-risk activities and the increase of decompression sickness (Aguiñaga-Malanco, 2022; Huchim-Lara *et al*., 2018). Some studies (e,g, Méndez-Cárdenas *et al*., 2013) have reiterated the capacity of fishing communities in the Yucatan Peninsula for the development of alternative strategies that allow the management and preservation of resources founded on a community-based perspective, as fishermen actively deploy strategies to the problems generated by the environment through the need to know the dynamics of the marine habitat, the impacts to it and the intent of the administration of scarce resources; even so, there are

many variables beyond the control of fishermen, such as the morbidity of marine organisms due to the effects of pollution; nevertheless, fishing as poorly regulated economic activity provides an outlet for pollution (mainly gas leaks and fishing residues) that potentially influence the state of the ecosystem (Méndez-Cárdenas *et al.* , 2013). The objective of this study was to determine the main factors (environmental, social, and economic) affecting the fishing community of El Cuyo, Yucatan, Mexico.

MATERIAL AND METHODS

Study area

El Cuyo (Fig. 1) belongs to the municipality of Tizimin, Yucatan, Mexico. It is a fishing port and has a total population of 1,787 inhabitants (Aguiñaga-Malanco, 2022). It has a warm subhumid climate, with an average annual temperature of 25.6°C; rainfall is frequent during the summer but increases during September. Along the coastline, there are regions with algae, bivalves, and sediment that are mostly biogenic (Aguiñaga-Malanco, 2022).

El Cuyo is located within the Ria Lagartos Biosphere Reserve, which harbors a great diversity of terrestrial and aquatic organisms distributed mostly in a mangrove-type ecosystem, which is a feeding and reproduction zone for important and commercially valuable resources (e.g., shrimp, lobster, and grouper) (Aguiñaga-Malanco, 2022). There are species recognized by the NOM-059-SEMARNAT-2010 and international agreements like CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) such as *Phoenicopterus ruber* (pink flamingo), *Chelonia mydas* (green turtle), *Eretmochelys imbricata* (hawksbill turtle), and *Crocodylus moreletii* (Mexican crocodile) (Fig. 2).

Figure 1. Town of El Cuyo, Yucatan, Mexico.

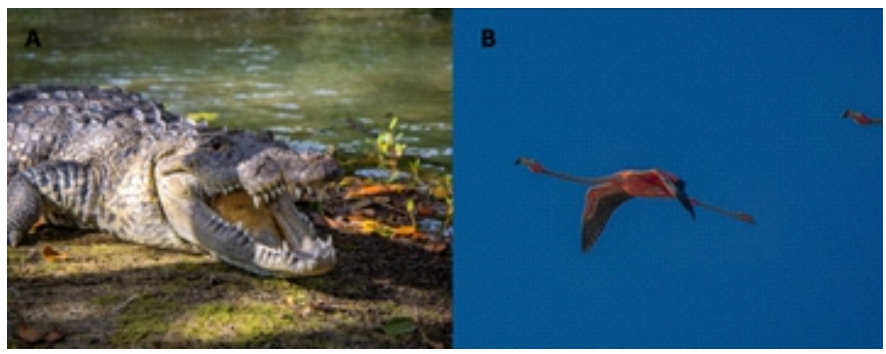

Figure 2. Protected species of Ria Lagartos A) *Crocodylus moreletii* and B) *Phoenicopterus ruber*. Photos by: Diego Morales Chulines.

Sampling design

Guided personal interviews were conducted in June 2024 with fishermen and community members of El Cuyo, Yucatan, Mexico. Before conducting the interviews, voluntary consent was kindly requested from those interested in participating and the confidentiality of data use was informed. The interviews covered three topics: 1) general data, 2) main problems affecting the fishermen, and 3) possible solutions. To calculate the sample size of the number of fishermen, the following formula was used for finite populations:

$$n = \frac{Nz^2pq}{(N-1)d^2 + z^2pq}$$

Where n is the estimated sample size, z=1.96, p=0.5 estimated proportion, q=1-p, d=0.1 (estimation error), and N=400 which is the estimated number of local fishermen active in El Cuyo.

Consequently, about 30 fishermen represented an adequate sample size. Simple random sampling was used to select the fishermen based on a numbered list.

Data analysis

The coding of 30 interviews was carried out through the inductive method, from which the main themes were identified; subsequently, a matrix was made based on the interaction of the themes and their frequency to develop a social network graph in the Gephi software version 0.10.1 (Bastian *et al.,* 2009).

RESULTS

Twenty-seven of the 30 interviewed stakeholders were fishermen (90%) and three belonged to a waste management program (El Cuyo es tuyo). The average age of fishermen was 45 years old and showed an average experience of 29 years (Fig. 3).

The main issues identified were grouped into four categories: 1) environmental, 2) social, 3) economic, and 4) tourism. Within the environmental category were identified a) extreme weather (hurricanes, tropical storms, etc.), b) deterioration of marine resources (diminishment of size, catch, and biodiversity), c) resources significantly far from the coast, d) eutrophication events (eutrophication of the sea bottom and complications derived from it) and, e) pollution (mainly from anthropogenic activities). Within the social aspect, the following were

identified: a) lack of government programs or support, b) lack of alternative income sources, c) increase of decompression sickness (related to lobster divers), d) high-risk activities (fishing in adverse weather, risk of shipwreck), e) illegal fishing and invasion of fishing zones and, f) increase of fishing efforts (rise in the number of active-fishing vessels). In the economic category, a) low value of marine products (regarding the price offered to the fisherman) and b) high cost of inputs (rise in the prices for factors of production) were identified. Finally, in the tourism aspect, a) interest in touristic activities was identified (Fig. 4).

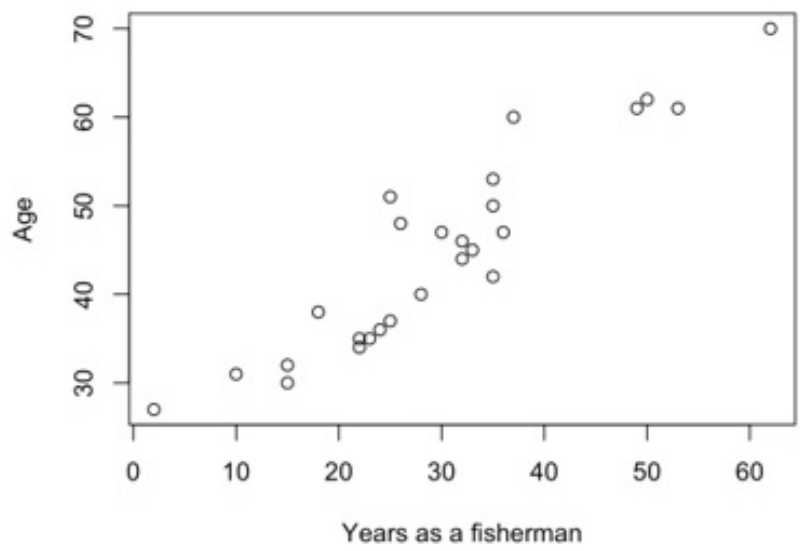

Figure 3. Insights on the sample selected.

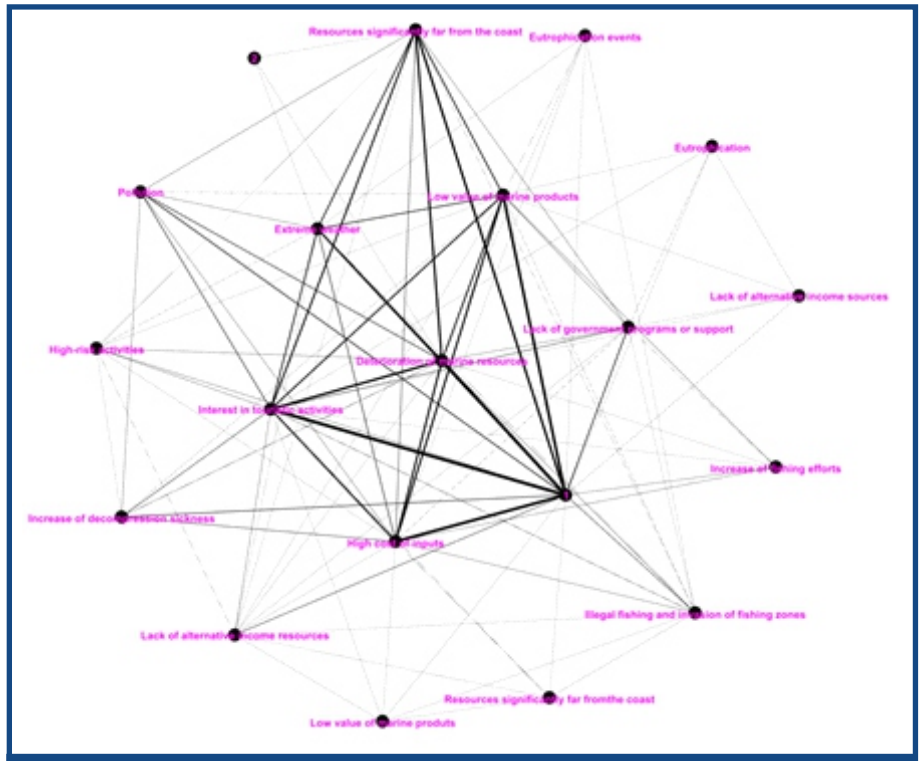

Figure 4. Social network graph.

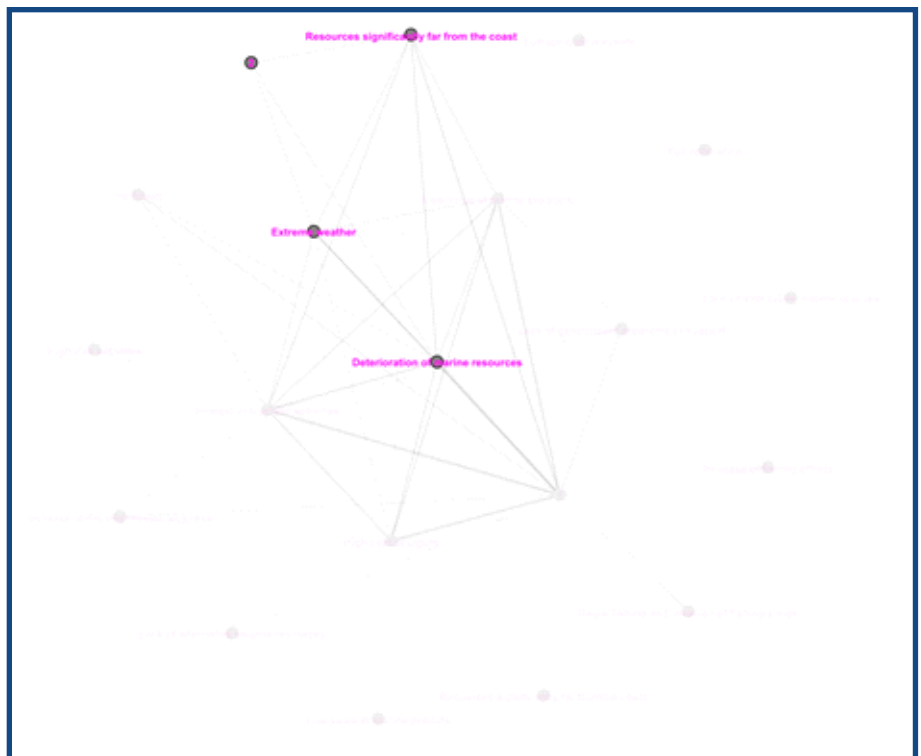

Figure 5. Identified tendencies.

Figure 6. Fishermen interviewed. Photos by: Diego Morales Chulines.

DISCUSSIÓN

There is a significant trend evidenced by the nodes (factors) that have the greatest number of shared connections (edges), specifically between marine resources far from the coast (approximately 50 miles), extreme weather, and resource degradation (Fig.5), which is supported by Arreguín-Sánchez & Arcos-Huitrón (2011), Gutiérrez-Pérez (2014), and Méndez-Cárdenas *et al*. (2013). These factors directly condition the functioning and reproduction of fishing activities and therefore the normal access and exploitation of resources (Méndez-Cárdenas *et al*., 2013). This is a clear example of how climate change and overexploitation are shaping fisheries and affecting artisanal fleet fishers, who are extremely vulnerable to these and other related factors, causing a reduction in income and economic efficiency (Gutiérrez-Pérez, 2013).

The absence of strategies to undermine the economic lag resulting from the problems above generates a negative gap that is visible in a greater increase in fishing efforts (fishing vessels, nets, etc.) and a high cost of inputs in contrast to a low catch and a low value of marine products (Fig. 4). It is essential to implement effective measures to reduce the fishing effort (Hernández-Delgado *et al*., 2024) and develop alternative

economic production areas in the coastal communities of Yucatan (Gutiérrez-Pérez, 2013).

The economic incursion into tourism as an alternative to the deterioration of the fishery was one of the main suggestions made by the fishers in this study, however, certain limitations hinder this strategy, including the high number of requirements and permits required and their associated costs. Despite this, 27% of the fishermen interviewed work in this area and encourage the community to take part in these activities, indicating that fishing no longer satisfies their basic economic requirements.

Among the main factors affecting the community of El Cuyo are natural phenomena such as tropical storms and hurricanes, resource degradation in size and catch, and distancing of resources from the coast. Future perspectives include the creation of effective management plans that target general and local issues as well as encouraging community-based strategies and efforts, which are supported by individual and federal actions.

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