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PESCADORES E PESQUISADORES: INTERESSES E DETERMINANTES NA PERCEPÇÃO DE RISCO AMBIENTAL

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Orientador(a): Prof. Dr. Vandick da Silva Batista

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RESUMO

A pesca tem sido uma atividade ameaçadora, principalmente pela sobrepesca que é considerada um dos maiores impactos antropogênicos a biodiversidade marinha, além das mudanças climáticas. No entanto, também é uma atividade ameaçada pela ocorrência de mudanças estruturais profundas nos ecossistemas marinhos, ameaçando pessoas que dependem desses recursos, pescadores artesanais. O objetivo dessa dissertação é investigar as temáticas relacionadas a pesca e seus estressores e como esses põe em risco os pescadores artesanais. No segundo capítulo testamos a hipótese que a produção de conhecimento científico sobre pesca e mudanças climáticas são impulsionadas por impactos socioeconômicos negativos, sendo encontrado que a riqueza econômica é essencial para uma maior produção científica nos países e confirmamos o aumento da ênfase em temas socioeconômicos. No terceiro capítulo testamos a hipótese que aspectos socioeconômicos, como idade, religião, renda e ambiente de pesca influenciam na percepção de risco de pescadores artesanais da APA Costa dos Corais, sendo encontrado que o ambiente de alto mar representa maior risco de perdas, como também os pescadores desse ambiente possuem maior percepção de riscos ligados a conflitos e integridade física do que os pescadores costeiros. Com isso, é necessário que haja um equilíbrio entre pesquisas entre dimensões humanas e dimensões naturais para uma melhor gestão pesqueira.

Palavras-chave: Mudanças ambientais; Pesca; Pescadores de pequena escala.

ABSTRACT

Fishing has been a threatening activity, overfishing is considered as one of the biggest anthropogenic impacts to marine biodiversity, in addition to climate change. However, it is also an activity threatened by the occurrence of structural changes in marine ecosystems, threatening people who depend on these resources, artisanal fishermen. The objective of this dissertation is to investigate the issues related to fishing and its stressors and how these put artisanal fishermen at risk. In the second chapter, we tested the hypothesis that the production of scientific knowledge on fisheries and climate change is driven by negative socioeconomic impacts, finding that economic wealth is essential for greater scientific production in countries and we confirm also the increased emphasis on socioeconomic issues. In the third chapter, we tested the hypothesis that socioeconomic aspects, such as age, religion, income and fishing environment influence the perception of risk of artisanal fishermen from APA Costa dos Corais, and it was found that the high seas environment represents a greater risk of losses, as well as fishermen in this environment have a greater perception of risks related to conflicts and physical integrity than coastal fishermen. So, there needs to be a balance between research between human dimensions and natural dimensions for better fisheries management.

Keyword: Environmental change; Fisheries; Small scale fisheries.

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1 APRESENTAÇÃO

Impactos antropogênicos têm ameaçado a biodiversidade marinha mundial, seja por poluição ambiental, como acúmulo de lixo nos oceanos e derramamento de óleo (DERRAIK, 2002; MAGRIS; GIARRIZZO, 2020; SHAHIDUL ISLAM; TANAKA, 2004) ou por pesca excessiva (PAULY et al., 2002). Mudanças climáticas também são um componente agravante para impactos globais cumulativos, afetando ecossistemas e sociedades (HALPERN et al., 2008). Apesar desses impactos afetarem as dimensões humanas dependentes de recursos marinhos, ainda há forte desassociação dos sistemas naturais dos sociais nas abordagens científicas (SYED; BORIT; SPRUIT, 2018). Essa desassociação vem mudando nas últimas décadas, quando temáticas associadas a dimensões humanas estão cada vez mais sendo vinculadas a biodiversidade, conservação e ecologia.

Estudos de temáticas socioeconômicas de pescadores tem sido abordado sob diferentes abordagens (CINNER; MCCLANAHAN, 2006; DE OLIVEIRA ESTEVO et al., 2021). Além disso, também se têm investigado como características socioeconômicas, tais como, idade, renda e escolaridade de pescadores influenciam na sua percepção de risco, podendo ser ambiental ou risco financeiro (e.g., MCCLANAHAN ET AL., 2005; SILVA E LOPES, 2015).

Nesse contexto, o presente trabalho é composto estruturalmente por três capítulos, sendo o primeiro uma revisão de literatura que embasa conceitualmente os leitores sobre os temas mais pertinentes. O segundo capítulo, por sua vez, é um artigo científico intitulado “Climate change on global fisheries: drivers to scientific production” que contribui para a visualização das temáticas abordadas por pesquisadores dentre os eventos naturais ou antropogênicos, tais como mudanças climáticas, relacionadas a pesca mundial. Já o terceiro capítulo é um artigo científico intitulado “Drivers to artisanal fishers risk perception in a tropical marine protected area” que aborda a influência de características socioeconômicas e ambientais nas percepções de pescadores artesanais em uma área marinha protegida. Por fim, é apresentada uma discussão geral dos capítulos abordados.

2 REVISÃO DA LITERATURA

2.1 A pesca artesanal e industrial: atividades ameaçantes e ameaçadas

Pescarias são normalmente divididas em pequena e grande escala, também chamadas respectivamente de pesca artesanal e industrial (BATISTA et al., 2014; SMITH; BASURTO, 2019). Essa classificação usualmente se embasa em combinações do tipo de arte, tamanho das embarcações e distribuição da captura desembarcada (CARVALHO; EDWARDS-JONES; ISIDRO, 2011). A pesca industrial é dominante em alto mar, utilizando tecnologias mais recentes em grandes embarcações e tripulações, frequentemente baseada a partir de países desenvolvidos e industrializados, sendo usualmente considerada responsável por grande parte da falta de sustentabilidade da pesca, causando colapso de várias populações marinhas e degradação ambiental (CARVALHO; EDWARDS-JONES; ISIDRO, 2011; MCCAULEY et al., 2018). A pesca artesanal, por sua vez, é caracterizada por métodos mais simples (HAWKINS; ROBERTS, 2004), como a utilização de redes de emalhar, anzol e linha, explorando uma diversidade muito maior de espécies do que a pesca industrial (BATISTA et al., 2014). Além disso, a maioria dos pescadores artesanais são de países em desenvolvimento, ao contrário dos países desenvolvidos, onde a pesca industrial é predominante (ALLISON; ELLIS, 2001). Outros termos são utilizados como sinônimos de “pesca artesanal”, como pesca de pequena escala, subsistência, tradicional, pesca local e costeira (ALLISON; ELLIS, 2001; ANDREW et al., 2007; JOHNSON, 2006), como também, há diferença entre os termos entre culturas, enquanto países anglo-saxões preferem “pequena escala”, os países latinos preferem “artesanal” (GARCÍA-FLÓREZ et al., 2014; ROUSSEAU et al., 2019b). Apesar dessa gama de termos, caracterizam um setor que possui técnicas e usos variados de tecnologia simples, que se adequam a diversidade de recursos capturados.

A pesca artesanal representa mais de um quarto das capturas em volume (WATSON; TIDD, 2018) e 90 % da geração de emprego na pesca de captura (FAO, 2015a; ROUSSEAU et al., 2019a). Apesar da importância da pesca artesanal para subsistência, geração de emprego e diminuição da pobreza (BÉNÉ et al., 2016b; BÉNÉ;

MACFADYEN; ALLISON, 2005), há um déficit de estudos científicos voltados para o setor, considerando que a riqueza é fator chave que comanda a produção do conhecimento científico (ALLIK; LAUK; REALO, 2020), e não a importância socioambiental. Se a pesca industrial é avaliada globalmente contando com pesquisas quantitativas e comparativas, a pesca artesanal conta com número limitado de centros de pesquisas e raramente abrangem dados globais, concentrando-se em estudos de caso (OLIVEIRA JÚNIOR et al., 2016). Dessa forma, a avaliação e gestão da pesca artesanal, assim como, a gestão em países em desenvolvimento são tipicamente classificadas como inadequadas ou ausente (ANDREW et al., 2007; RUDDLE; HICKEY, 2008).

Embora a pesca industrial tenha sido vinculada a explotação insustentável dos recursos marinhos, tem ficado claro que a pesca artesanal também pode causar graves consequências na biomassa, populações e comunidades de peixes (AYUNDA; SAPOTA; PAWELEC, 2018; RUTTENBERG, 2001). A pouca atenção dada a pesca artesanal ou de pequena escala pelos países ao redor do mundo, se manifesta até nas estatísticas divulgadas pela Organização das Nações Unidas para Agricultura e Alimentação (FAO), potencialmente subestimadas (CASHION; BAILLY; PAULY, 2019; FREIRE; PAULY, 2015; PAULY; ZELLER, 2003), como também omissão e subnotificação de muitos dados de capturas ilegais e não declaradas (PAULY; ZELLER, 2016; ZELLER et al., 2015). Assim, é necessário que haja uma melhora no monitoramento de todas as pescarias, principalmente a pesca artesanal geralmente muito negligenciada (PAULY; ZELLER, 2016).

Apesar da pesca ser uma atividade ameaçadora para ecossistemas marinhos (JACKSON, 2001; WORM et al., 2006), também é uma atividade ameaçada pelas mudanças ocorridas ao longo dos séculos. Os recursos pesqueiros são ameaçados por mudanças climáticas, degradação ambiental e outros impactos antropogênicos (ARNELL, 1999; CHOU, 1994), assim como pela própria sobrepesca (JACKSON et al., 2001; WORM et al., 2006). Por consequência, as capturas globais vem diminuindo nas últimas décadas e aproximadamente metade dos estoques pesqueiros mundiais são considerados totalmente explotados (MARTIN-SMITH et al., 2004; PAULY; ZELLER, 2016). Com isso, a crise nas pescarias mundiais ocasionada pelos impactos nos recursos tem ameaçado a atividade pesqueira de milhões de pessoas, sendo um risco para a segurança alimentar da população mundial (COULTHARD; JOHNSON; MCGREGOR, 2011).

2.2 Riscos socioambientais

O conceito de risco é concentrado na probabilidade de ocorrência de eventos e a magnitude das consequências (KASPERSON et al., 1988). O conceito busca responder as seguintes perguntas: “o que pode acontecer?” e “o que precisa ser feito?” (KAPLAN; GARRICK, 1981). No entanto, não existe um consenso na definição de risco, podendo ser baseado em probabilidade, chance de ocorrência, eventos inesperados ou perigos, e incertezas (AVEN, 2012). O termo “risco” pode ainda se referir a algo positivo ou negativo, no qual a pessoa pode assumir riscos quanto arriscar perdas (AVEN, 2012). Os estudos de riscos tem empregado aspectos relacionados ao seu nível, como número de fatalidades, magnitude do risco, potencial catastrófico e quanto as características qualitativas, como fatores que diminuem e aumentam a percepção do risco, sua aceitabilidade; entre outros (ROHRMANN; RENN, 2000).

Os riscos podem ainda ser associados a eventos contínuos ou extremos, no qual o evento extremo usualmente tem baixa probabilidade de ocorrência (SLOVIC; WEBER, 2013). Também podem se diferenciar quanto a magnitude das consequências e quebra de padrão, onde os eventos extremos são desvios excepcionais de padrões que causam sérios impactos a sociedade e ecossistemas, alterando seu funcionamento normal (BROSKA; POGANIETZ; VÖGELE, 2020). Os eventos contínuos são comumente considerados aqueles que não excedem níveis críticos, onde um padrão pode ser definido (GERSICK, 1991). A percepção do risco se constrói a partir de uma base de experiências vividas ou aprendidas, onde duas teorias são mais relevantes na tomada de decisão: 1. Teoria da aprendizagem, onde o conhecimento do risco se acumula e pode levar a comportamentos sociais aprendidos e possivelmente repetidos, o caso de eventos contínuos (BOONE; REILLY; SASHKIN, 1977; SCHWARTZ, 1982); 2. Teoria do prospecto, que é concentrada na estrutura de decisões, onde as pessoas decidem de acordo com os potenciais valores de ganhos e perdas (KAHNEMAN; TVERSKY, 1979). Essas teorias não funcionam adequadamente para eventos extremos, pois esses não fornecem conhecimentos suficientes para definir padrões, podendo ser completamente ignorados pela probabilidade muito baixa de ocorrência (ROGERS, 1997). Dessa forma, as pessoas costumam lembrar de riscos ocasionados por eventos contínuos de frequência de ocorrência maior do que eventos raros, inclusive no ambiente das publicações científicas.

Os eventos extremos apresentam uma condição distante do equilíbrio, como exemplo os causados por impactos químicos e físicos resultantes de derramamento de óleo, guerras, crises econômicas ou doenças (como a pandemia da COVID-19) (BELHABIB et al., 2018; BENNETT et al., 2020). Além desses podem estar relacionados a eventos climáticos extremos, como secas e inundações intensas, estando entre as questões mais abordadas em pesquisas recentes (CAMACHO GUERREIRO; LADLE; DA SILVA BATISTA, 2016; JENTSCH; KREYLING; BEIERKUHNLEIN, 2007; STOTT et al., 2016). Esses eventos costumam ser definidos pelos seus impactos nas sociedades, podendo envolver perdas de vidas e econômicas. Entretanto, para as sociedades em geral e aos cientistas em particular, esses eventos ou estressores extremos não necessariamente são tratados como algo remediável e costumam ser esquecidos (KAHNEMAN; TVERSKY, 1982). Ao contrário, o risco de determinados estressores, como riscos socioeconômicos, parece ser lembrado de forma mais enfática em pesquisas e pelas pessoas.

Os estudos sobre riscos abordam tanto conjuntos heterogêneos de fatores causais ou apenas um tipo específico, sendo frequentemente associado a eventos naturais (BRÜNDL et al., 2009), condições de trabalho, riscos ambientais, ligados a saúde, tecnológicos, entre tantos outros. Os riscos têm sido avaliados por aplicação de métodos quantitativos, qualitativos e semiquantitativos, onde os quantitativos utilizam uma escala numérica, os qualitativos produzem um sentido subjetivo limitado do risco, enquanto que os semiquantitativos permite uma classificação relativa, utilizando faixas de frequência (KAPPES et al., 2012). Em geral, os artigos sobre risco têm empregado predominantemente abordagens quantitativas (MACGREGOR, 1991; SMITH; BARRETT; BOX, 2000). Assim, sejam quais forem as técnicas, o uso de diferentes métodos e abordagens pode auxiliar no gerenciamento de risco, para o qual tanto acadêmicos quanto especialistas afirmam que pesquisas futuras devem levar em consideração diferentes os contextos sociais e econômicos, em vez de focar apenas nos aspectos instrumentais, como mapas e registros de risco (SOIN; COLLIER, 2013).

2.3 Percepção e atitude de risco socioambiental de atores sociais interrelacionados: pescadores artesanais e os pesquisadores da pesca

A percepção de risco refere-se aos julgamentos subjetivos que as pessoas fazem em relação a probabilidade de ocorrência e gravidade de um risco (PAEK; HOVE, 2017; SLOVIC, 2016). A percepção de risco determina quais perigos preocupam e como as pessoas lidam com eles. Três linhas principais têm sido trilhadas para abordar a percepção de risco: 1. abordagem psicológica (heurística e cognitiva) (KAHNEMAN; TVERSKY, 1982), no qual a percepção de risco é avaliada pela consciência de alguns riscos pelas pessoas os relacionando com a frequência de ocorrência, lembrando assim de riscos mais frequentes que outros menos frequentes; 2. abordagem social (antropológica), a qual afirma que percepção de risco é socialmente construída, altamente influenciada por crenças e valores incorporados pela sociedade (BOHOLM, 1996) e 3. abordagens interdisciplinares, no qual a percepção de risco é abordada conceitualmente sob combinação de perspectivas psicológicas e sociais (KASPERSON et al., 1988).

Estudos psicológicos apontam que fatores contextuais moldam as avaliações de risco individual, identificando fatores como medo, familiaridade com o perigo e o potencial catastrófico, os quais podem fornecer informações essenciais sobre como os indivíduos interpretam os riscos (RENN; ROHRMANN, 2000b). Fatores socioeconômicos e culturais também são conhecidos como influentes no processo de construção da percepção de risco e respostas ao risco (VAUGHAN, 1995). Adicionalmente, o enquadramento de riscos por indivíduos, filtrados e processados como escolhas e preferências, muitas vezes derivadas do contexto sociocultural, experiências passadas e valores, no qual as respostas aos riscos podem evoluir (BEACH, 1992; VAUGHAN, 1995). Assim, tem-se sugerido que as sociedades escolhem riscos particulares de acordo com os aspectos culturais e sociais, e pela influência de avaliação individual de riscos, fazendo com que as pessoas percebam certos riscos e ignorem a ocorrência de outros (GARVIN, 2001; SPANGLER, 1987).

Cada sociedade ou grupo social tem seu conjunto específico de riscos, os quais têm percepções determinadas pelos valores e idiossincrasias culturais (ROHRMANN, 1994; ROHRMANN; RENN, 2000). Os grupos de trabalhadores que tem informações, deveres e riscos parecidos podem ter vieses de informações compartilhadas, podendo formar um consenso do grupo (TVERSKY; KAHNEMAN, 1974). Outros grupos ocupacionais podem então contrastar em suas percepções e atitudes de risco (BELLROSE; PILISUK, 1991), as quais podem ser dimensionadas por técnicas psicométricas adequadas para obter diferenças e semelhanças entre grupos, uma vez que os perigos sejam identificados quanto suas características e potencial catastrófico (SLOVIC; FISCHHOFF; LICHTENSTEIN, 1982).

As diferenças individuais e de grupo na preferência por alternativas de decisão arriscadas e as diferenças situacionais na preferência de risco tem sido associada a percepções distintas do risco relativo das opções de escolha (WEBER; BLAIS; BETZ, 2002; WEBER; MILLIMAN, 1997), em vez de diferenças de atitude em relação ao risco (percebido), ou seja, uma tendência de evitar ou se se aproximar de opções percebidas como arriscadas. A atitude de risco refere-se a preferência por opções arriscadas que possam refletir compensação, ou seja, os indivíduos podem perceber os riscos que envolvem apenas perdas ou ganhos como semelhantes, podendo ter uma atitude negativa para ganhos (aversão ao risco) e atitude positiva para perdas (propensão ao risco) (WEBER, 1999; WEBER; BLAIS; BETZ, 2002). Assim, as diferenças na percepção de risco tendem a ser na direção das diferenças observadas entre grupos e indivíduos na tomada de decisão de risco (BONTEMPO; BOTTOM; WEBER, 1997).

2.4 Pesquisa científica sobre pesca e eventos extremos/contínuos: abordagens socioeconômicas

O interesse pela ciência da pesca têm aumentado, devido principalmente aos estoques pesqueiros estarem severamente esgotados e ameaçados de extinção (JARIĆ et al., 2012; PAULY et al., 2002). Entretanto, usualmente os estudos sobre pesca se concentram em pesquisas biológicas e ecológicas com base em metodologia quantitativas, abordagem de sistemas e modelagem (DRECHSLER et al., 2007; IAN PERRY; OMMER, 2010). Pesquisadores tem desenvolvido métodos de avaliar os aspectos sociais na gestão de recursos naturais, como também governos estão incorporando indicadores sociais no planejamento da gestão (TRIANTAFILLOS et al., 2014). Embora os estudos se concentrem em pesquisas biológicas e ecológicas, tem sido cada vez mais associado a estudos socioeconômicos e a gestão pesqueira (BARCLAY et al., 2017). Dessa forma, abordagens interdisciplinares e transdisciplinares de ciências sociais, econômicas e naturais incentivam uma gestão pesqueira integrada (PHILLIPSON; SYMES, 2013).

Quando se tratando de estudos sobre estressores relacionados a pesca, evidências tem mostrado que eventos extremos causam mudanças inesperadas e podem ter impactos severos no bem-estar das pessoas, as afetando socioeconomicamente (BÉNÉ et al., 2016a; CAMACHO GUERREIRO et al., 2020). Esses estudos têm lacunas para entendimento das respostas frente a eventos raros, estando concentrado na percepção das comunidades aos diferentes tipos de evento (BELHABIB et al., 2018; RAMENZONI et al., 2020; SOARES et al., 2020). No entanto, apesar desses eventos causarem impactos de proporções maiores no setor pesqueiro, ainda sim na gestão de risco, publicações científicas e para a sociedade, segue uma lacuna de destaque em comparação aos eventos e estressores contínuos e mais frequentes. Dessa forma, é importante além de se estudar os eventos mais comuns obter informações sobre os eventos extremos, buscando abranger os eventos contínuos e extremos no gerenciamento de risco.

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3 CLIMATE CHANGE ON GLOBAL FISHERIES: DRIVERS TO SCIENTIFIC PRODUCTION

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3.1 Abstract

Climate change has direct consequences on marine biodiversity, leading to a decrease in species richness. Moreover, resource-dependent societies are impacted by changes in fisheries, which are important for people's livelihoods and food security. However, human, resources and environment dimensions information is still unbalanced in fisheries research. Realizing that climate change affects fishing, we sought to verify the main predictors of scientific production that mention fisheries and climate change themes. Using a bibliography approach, we tested the hypothesis that negative socio-economic impacts increasingly drive the production of scientific knowledge on the themes. Our analysis revealed that GDP and HDI were positively significant for our model, and the average fisheries production contribution was negative. Results indicate that economic wealth is crucial for greater scientific production in countries on fisheries and climate change issues. Furthermore, we identified a difference in the proportion of

articles on continuous and extreme weather events, where 80% focused on continuous events. Finally, we confirmed the increased emphasis on socio-economic themes as justification to the research done in parallel with the reduction in the proportion of themes associated with biology and ecology. This trend is related to the interest in improving management effectiveness and building a more viable political action.

3.2 Introduction

Climate change has become a central theme of public, scientific, and political debate (HAUNSCHILD; BORNMANN; MARX, 2016), facing growing evidence of its impacts on the biodiversity, ecosystems and human dimensions (KARVONEN et al., 2010; WALTHER et al., 2002). Forecasts based on climate models indicate that climate changes will alter the chemical and physical properties of the oceans, affecting the distribution, productivity, seasonality, and efficiency of marine ecosystems (CHEUNG et al., 2010). Furthermore, the impacts of the increase in temperature and the acidification of the oceans have direct consequences on biodiversity, such as changes in the physiological, behavioral and demographic characteristics of organisms, leading to a decrease in the richness of marine species (DONEY et al., 2012). Societies, in turn, will be harmed by these changes, inclusive by impacting on fisheries, which is important for livelihoods and food security (CHEUNG et al., 2009; DING et al., 2017; MCCLANAHAN; ALLISON; CINNER, 2015).

Climate change effects on fisheries resources can significantly negatively impact their population dynamics, generating socio-economic consequences (ALLISON et al., 2009; PAULY, 2008; TEIXEIRA et al., 2020). Furthermore, fishing plays an essential role in poverty reduction (BÉNÉ et al., 2016b; HIGH LEVEL PANEL OF EXPERTS (HLPE) ON FOOD SECURITY AND NUTRITION, 2014), especially on artisanal fisheries, which mainly generate a direct supply of food to people and is an essential pillar for the sustainable use of resources (FAO, 2015b). Unfortunately, various anthropogenic stressors that affect marine ecosystems, such as overfishing, habitat loss and climate change (JACKSON et al., 2001; LING et al., 2009), are compromising the social, economic and cultural security of artisanal fishers, as they are highly vulnerable to environmental changes (BADJECK et al., 2010; MORZARIA-LUNA; TURK-BOYER; MORENO-BAEZ, 2014). Thus, it is expected that current scientific studies have been directed towards themes that cover the impacts of climate change on ecosystems and their resources (HENSON et al., 2017) and socio-economic matters (POMEROY, 2016).

Alternatively, in recent decades there has been a rise in publications with a continuing transformational perspective on climate change-related events (TERMEER; DEWULF; BIESBROEK, 2017). Proponents of this approach understand that management continuously adapts to resources or societies for weather events that do not exceed critical levels (CHAN et al., 2005; GERSICK, 1991). This perspective is distinct from unusual climatic conditions caused by extremes on meteorological conditions generating events such as floods, cyclones, high temperatures and heat waves which would help understand themes (STEPHENSON, 2008; STOTT et al., 2016). Thus, those conditions are expected to focus on fisheries and climate change, which also support objectives helpful to managing fisheries resources facing the vulnerability to climate change.

Themes such as global warming, greenhouse gases and CO2 emissions are at the top of the world's political agendas (LI; WANG; HO, 2011), as the Paris Agreement, signed in 2015 during the United Nations Conference on Climate Change. The agreement was the first to contain obligations related to global climate change and was designed to have international transparency of mitigation (DIMITROV, 2016). Furthermore, the co-benefits of the reactions are highlighted to persuade society and political leaders of the importance of mitigating climate change, some of which include improvements in health, poverty reduction, and economic development, by the sustainable use of resources and pollution reduction (BAIN et al., 2012, 2016; NEMET; HOLLOWAY; MEIER, 2010). These shared interests have shown that an alignment between the interests of governments, society and researchers has been increasingly required, influencing the priorities of themes in scientific production.

In another sense, scientific knowledge production is driven by the budget allocation for research and development (GONZALEZ-BRAMBILA et al., 2016). Additionally, countries' social and political status influences scientific priorities and the research funding allocation (KING, 2004; MAY, 1997), making most effort and conditions to be strengthened in developed ones (COLE; PHELAN, 1999; DOCAMPO; BESSOULE, 2019; KING, 2004). Concurrently, other predictors influence publications quantity and quality, such as higher levels of international collaboration (ALLIK; LAUK; REALO, 2020) and human development in terms of social health, material well-being and education (RANIS; STEWART; SAMMAN, 2006). In addition, research themes are mainly chosen worldwide on impacting topics pulling social attention (NATIONAL ACADEMIES OF SCIENCES AND MEDICINE, 2017). For example, fisheries are a hot theme facing social and economic importance and ecosystem balance, dragging conservationists and resource managers' efforts to avoid environmental damage and resource stocks collapse (PAULY et al., 2002). Knowledge on drivers and trends of resource health and abundance allows decision-makers to effectively use evidence related to reaching the management goals (FULTON et al., 2011) or, at least, to direct policies towards resource use and conservation threshold reference points.

Despite the expansion of studies on topics like environment, climate change, and fisheries, the use of those scientific evidences by stakeholders and consumers is still challenging (HORTON; BROWN, 2018). It is required to produce information of evident public interest to increase social visibility of environment and fisheries concerns related to climate change outputs (HORTON; HORTON, 2019), including socio-economic approaches, climate events effects and their impacts on economies and societies. Understanding that critical changes affect societies and scientific production as a consequence, we verified the main predictors of scientific production, mentioning themes on fisheries and climate change, identifying drivers of change. We tested the hypothesis that the production of scientific knowledge that mentions fishing and climate change is increasingly driven by negative socio-economic impacts, influencing more articles with justifications on this topic. We also test that these socio-economic determinants have been used as attributes in analyzing climate change impacts related to fisheries.

3.3 Material and Methods

3.3.1 Data collection

Data were extracted from the Web of Science Core Collection (WoS) in March 2021 using the following sequences: ("disturbance" OR "extreme event" OR "climate change" OR "hazard" OR "disaster") AND ("fisheries"), for the period from 2000 to 2019. After the search, the article's duplicity was verified by comparing their titles.

The articles were filtered in three stages: at first, we discarded books, symposiums and conference materials, keeping only the peer-reviewed articles. In the second stage, from the titles, keywords and abstracts, the articles were classified by the type of corresponding condition (extreme or continuous). Finally, it was verified whether the events were related to cause-consequences of climate change issues. Articles that did not fit into climate change or were not related to impacts on fishing were excluded. For the articles considered, we extracted the following information: title, keywords, abstract, year of publication and country corresponding to the first author.

We categorized the environments present in the studies into freshwater, general and marine, mainly based on the title and keywords and secondarily based on the abstract. The justification was usually taken from the objective or results and classified as socio-economic (SOE), environmental (ENV), fisheries resources (RES) or both. Thematic drivers of the indicator variable were also usually taken on the abstract results; after that, they were categorized into twelve themes (Table 1) and separated into four periods of four years from 2000 to 2019.

Table 1. Classification of articles by driving themes and their descriptions

Themes	Description
Aquaculture	Impacts related to breeding, rearing, and harvesting of organisms in water environments.
Biodiversity	Impacts on biodiversity, including species richness and diversity.

Themes	Description
Biology	Biologically related drives, including feeding, diseases, genetics, migration, physiology and species invasions.
Community	Impacts on community ecology, assemblage, and biological interaction.
Culture	Impacts on society's culture, including conflicts between communities and local ecological knowledge (LEK).
Economy	Impacts on the economy, including socio-economic, financial and tourism.
Environment	Impacts on the environment, including habitats, ocean acidification, pollution, temperature, trawling and contaminants.
Megafauna	Impacts on the megafauna, including dolphins, whales, sharks, and turtles
Population	Impacts on population ecology, including abundance, density, mortality and growth.
Rights	Impacts of events on laws, rights, policies and jurisdictions.
Social	Social related drivers including surveys and research on health, fishers communities, governance, labor, livelihoods and management.
Systems	Impacts on systems ecology, including themes as ecosystems, food web and socio-ecological systems.

The economic and social data related to the countries scientific production was taken from the following possible predictors: Gross Domestic Product (GDP) and Human Development Index (HDI) - 2019 data on The World Bank Data (data.worldbank.org/); Gross domestic expenditure on research and development (R&D) - 2015 to 2018 on the UNESCO database (http://uis.unesco.org/); marine fisheries production - 2009 to 2019 was downloaded from FishStatJ (FAO, 2020). Countries that did not have data available for all predictors used in the model were excluded from this analysis.

Density, distance and transitivity parameters (An, 2012) were obtained for each four years. The countries' scientific production data were categorized into "high", "moderate", "low", "very low" quartiles, except for the HDI, for which we used the World Bank Data classification (data.worldbank.org).

3.3.2 Data analysis

We built social networks to analyze the relationships between variables: justification, themes and significant predictors of scientific production that mention climate change and fisheries. Different networks were built for each four years using these attributes recorded for each article. The network nodes (here, the themes) represented identified variables connected by edges (here, the simultaneous citation), which vary in their characteristics (SCOTT, 1988). After the network analysis, the network clusters were detected, representing a group of nodes with more robust connections between its members than others (LESKOVEC; LANG; MAHONEY, 2010; RADICCHI et al., 2004).

From the Akaike Criterion Analysis corrected for small sample sizes (AICc), we tested which model (linear, exponential or potential) best fits the trend of articles per year on climate change in fisheries. We then used the chi-square test (5% significance) to compare the proportion of the type of event (continuous or extreme) and the environment (marine or freshwater).

A generalized linear model (GLM) was applied to verify the factors that drive the countries' scientific production. The predictive attributes of countries for the model were: (1) HDI; (2) GDP; (3) R&D; and (4) Total fish production. For this, we used the mean to select the models with the best explanation for the response variable, electing only models with AICc less than 4. Then, the hierarchical partition of all explanatory variables was calculated. Next, we tested the models' assumptions (ZUUR; IENO; ELPHICK, 2010). For this, we use the lme4 packages to adapt the models and MuMIn (BARTON, 2019) to examine each combination of models. Later, the Igraph package was used to obtain the networks and their parameters (CSARDI G, 2006). These procedures were performed on the R statistical platform (R CORE TEAM, 2017). Finally, an analysis of covariance (ANCOVA) was performed on the annual relative frequency of justifications.

3.4 Results

We identified 4,098 articles published for proposed sequences, approximately 40% linked to continuous or extreme events. However, 1.022 articles (24.9%) related to climate change in the fisheries sector met our search criteria.

In 15 years, the number of publications about these events in fishing grew over time, standing out between 2015 and 2019. An increase in scientific production, with a better fit for the exponential model, was obtained both for continuous and extreme events in general (AICc = 31.27, r^2 = 0.95, p-value = 0.001), and for climate change events (AICc = 25.27, r^2 = 0.96, p-value = 0.001). The proportion of articles that mention climate change was similarly related to the number of publications about the events between 2000 and 2015 (Figure 1).

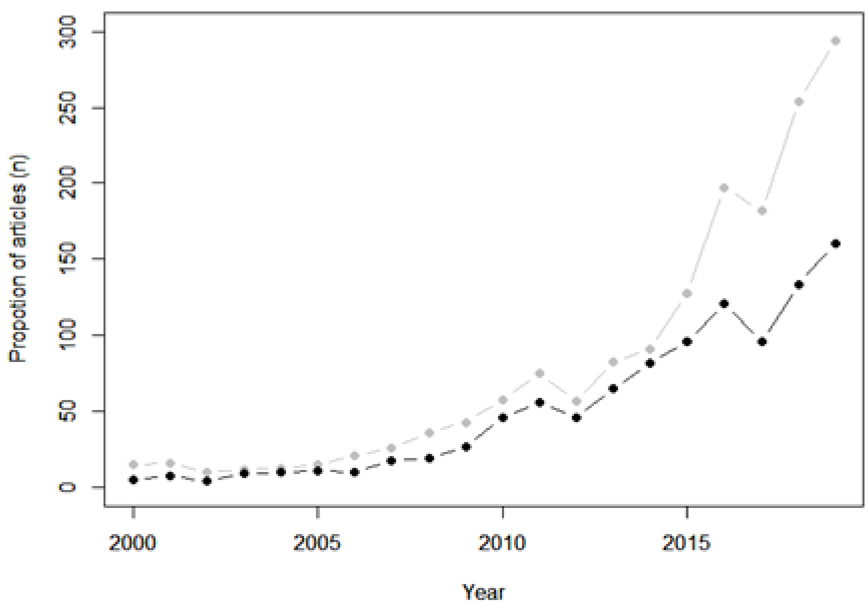

Figure 1. Yearly scientific production on fisheries that mention events in general (gray) and those that deal with cause-consequences of climate change (black line).

The GDP and HDI predictors were significantly influenced positively the number of articles published in each country, while the average fishing production influence was negative. Investment in research and development (R&D) was the only non-significant one (Figure 2) in the complete model.

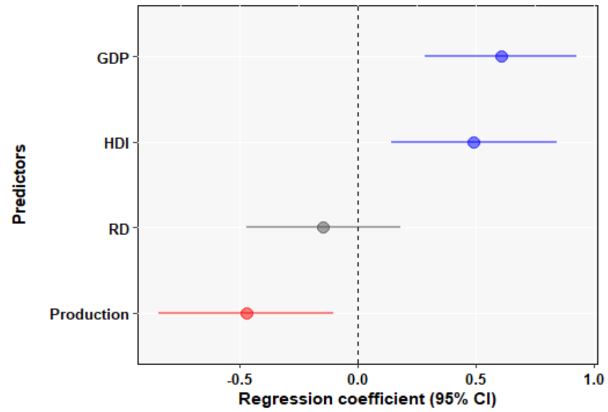

Figure 2. Coefficient estimates with 95% confidence intervals for the model of the countries scientific production on climate change in fisheries. Blue=positively significant, gray=not significant and red=negatively significant. For the details of parsimonious models, see table S1.

The results point to a growing trend for the diversity on themes, mainly the interval from 2015 to 2019. Publications focusing on extreme events were rare in all periods. Differences in 80% of the articles focused on continuous events (p-value < 0.001 for both cases). Furthermore, articles focusing on ENV were the most constant compared to the other groups (Figure 3).

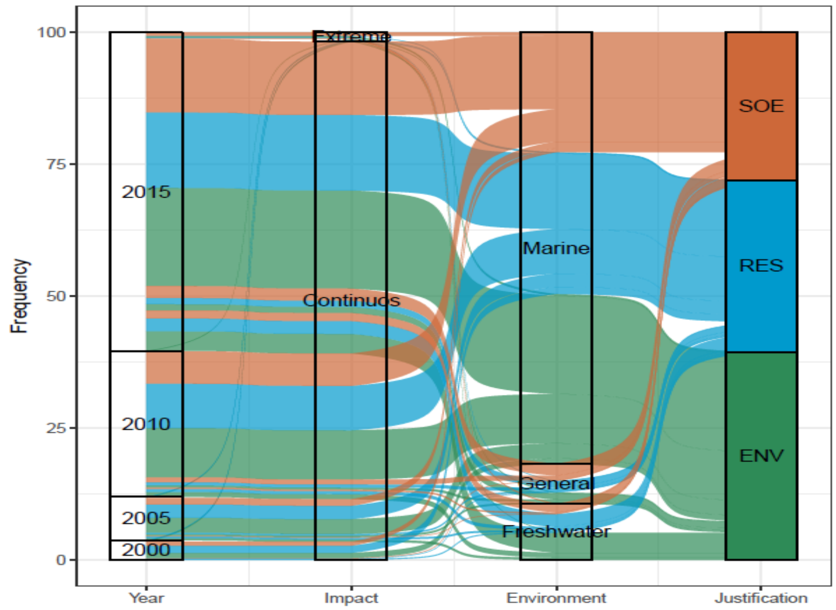

Figure 3. Frequency of relationship between period (4 years), type of impact, environment, and justification of publications on climate change. Acronyms: ENV (Environment); RES (Fisheries resources); SOE (Socioeconomic); Environment — FR (Freshwater); MA (Marine); GE (General).

Social themes (culture, economy, rights, social) have increased at each period, emphasizing the last one (Figure 4). On the contrary, the frequency of the themes on the environment category decreased over time, and the ecology theme (biodiversity, community, population, and systems) varied randomly. The proportion of themes on biology and megafauna decreased mainly between 2015 and 2019, reducing interest in these themes.

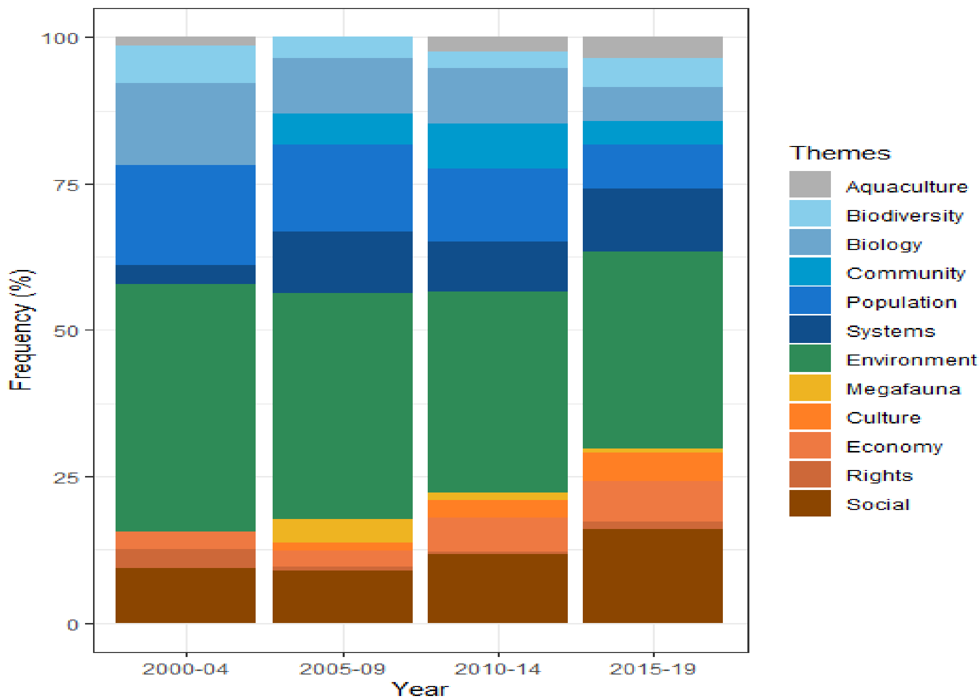

Figure 4. Frequency of themes on climate change in fisheries by period, details see table S2.

Over time, the network analysis showed an increase in the transitivity and density parameters and a decrease in the distance parameter (Table 2). We observed that three distinct communities were formed between 2000 and 2014 except for the last period, when there was only a connection to the justification of ENV and RES, leaving SOE isolated. In addition, there was a trend for all periods towards network centrality of very high and high HDI and high-income GDP. The marine environment is also central to all networks, and there was a change in priority themes in the periods, demonstrating an increase in publications with SOE justification and themes focused on social issues. The network of the last period was the largest density and transitivity, expressed on the greatest number of connections between the themes among the different communities, particularly the community with the SOE justification (Figure 7).

Table 2. Parameters of network analysis by period.

Year	Density	Average distance	Transitivity
2000-2004	2.748	1.468	0.668
2005-2009	5.788	1.379	0.733
2010-2014	17.463	1.306	0.796
2015-2019	36.328	1.149	0.878

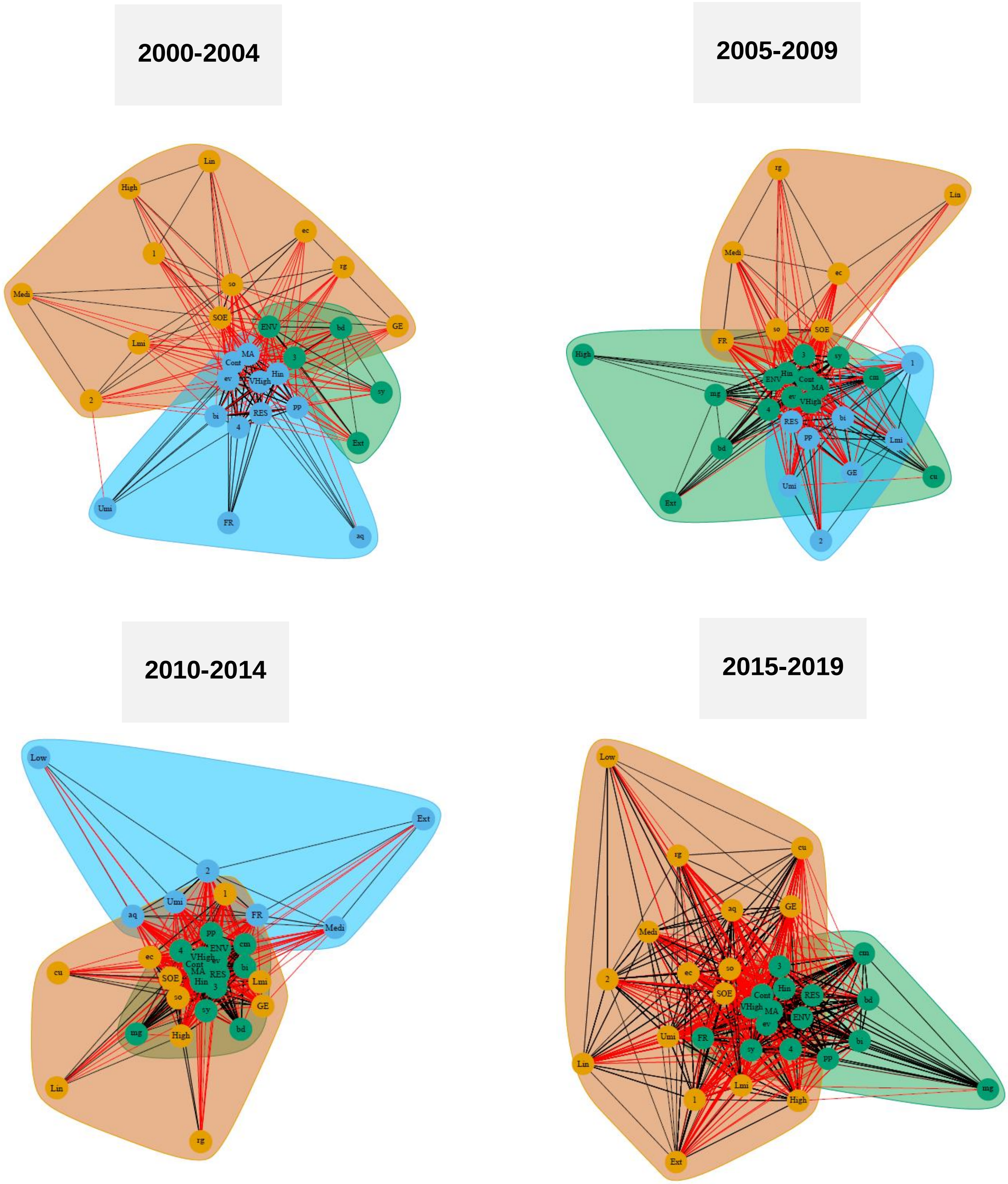

Figure 5. Networks formed based on publications on climate change in fisheries from a sample of 1019 articles. The results were for the four periods: 2000-2004; 2005-2009;

2010-2014; 2015-2019. Acronyms: Themes: aq (Aquaculture); bd (Biodiversity); bi (Biology); cm (Community); ec (Economy); cu (Culture); ev (Environment); mg (Megafauna); pp (Population); rg (Rights); only (Social); sy (Systems). GDP: Hin (High income); Umi (Upper-middle); Lmi (Lower Middle); Lin (Low income). Fishery production: 4 (High production); 3 (Upper-middle production); 2 (Lower-middle production); 1 (Low production). HDI: VHigh (Very High); High; Medi (Medium); Low

Over the years, the proportion of justification among socio-economic, fisheries resources, and environment has changed (ANCOVA; df = 58; p-value = 0.001). Moreover, only articles focusing on RES showed a downward trend while the SOE and ENV grew (Figure 6).

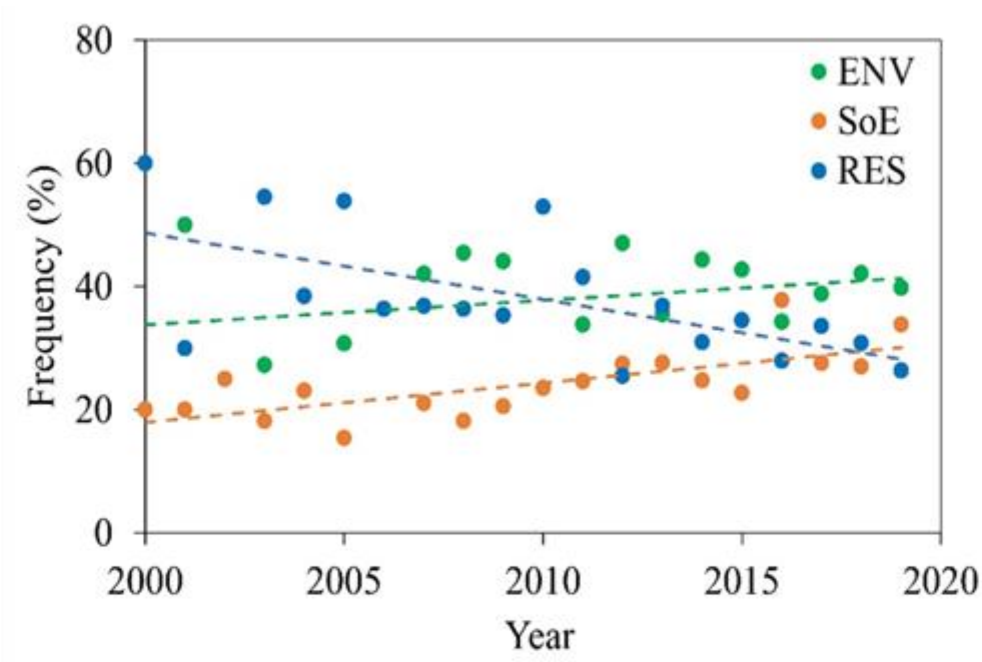

Figure 6. Relative frequency of thematic justifications for articles found between 2000 - 2019.

3.5. Discussion

Articles mentioning climate change have increased in recent decades, making the topic a top trend in research (HAUNSCHILD; BORNMANN; MARX, 2016). However, analyzing the focus of those articles, we found that climate change is targeted by research in the fisheries-related arena, but not on themes related to cause-effect impacts. As fishing is an activity intrinsically associated with the environment, climate change effects are potentially notable (COCHRAN et al., 2009; JOHNSON et al., 2019). Even so, articles on climate modeling or production simulations to fisheries productivity are not working on predicted scenarios outputs. More typical are articles using statistical methods relations environmental factors and populations abundances, with little experimental or processing modeling (BRANDER, 2010). Currently, research uses climate models and simulation tools applied to topics related to the fisheries sector, including impacts on marine ecosystems and human populations. However, although scientific studies are expanding exponentially (GRIENEISEN; ZHANG, 2011; MINX et al., 2017), there is an uneven geographical and methodological distribution (BRANDER, 2010), which can compromise the usefulness of fisheries science and, consequently, food security global as local knowledge appropriation is missing in producing countries.

If there are negative consequences of climate change on societies, it is expected that the most sensitive societies would be better informed to react to the impacts, taking greater precautions for their social security, where fishing is contained. Such changes potentially impact populations, their economies and livelihoods, as well as ecosystems, reducing livelihoods and food production, including the fisheries and aquaculture sectors (COCHRAN et al., 2009). Thus, it is predicted that the sensitivity to climate change is slightly different between countries, considering the importance of fishing for the economy and food (ALLISON et al., 2009), indicating that these changes would have more significant impacts for less developed countries in which the inhabitants are among the poorest and most dependent on fishing (BARANGE et al., 2014; WORM et al., 2009).

Our results also show that GDP and HDI, two key countries’ development indicators (KUMMU; TAKA; GUILLAUME, 2018), were the main causal factors in producing scientific articles. The negative correlation between fisheries and scientific production was determined by the limited research capacity of fishery products exporters of developing countries (HENSON; BROUDER; MITULLAH, 2000; SUMATHIPALA; SIRIBADDANA; PATEL, 2004). Considering the complete model, we have economic wealth as a critical attribute for larger scientific production. For poorer countries, it is unfeasible to manage effectively renewable resource uses and adapts practices to climate change based on the knowledge they would appropriate or develop. This context is not exclusive to fisheries, a case where developed nations emphasize the knowledge economy, aiming at long-term economic prosperity (ASONGU; NWACHUKWU, 2016; TCHAMYOU, 2017), meanwhile developing ones are still trying to deal with short-term needs. Alternatively, nations can reduce the differences between their scientific productions by monitoring partnerships between institutions from richer consumer countries and poorer producers (COSTELLO; ZUMLA, 2000), thus generating win-win solutions. This would allow consumers' societies to support the sustainability of the resources they use, avoiding or reducing the risks of collapse due to this mismatch between knowledge and production (e.g., Teixeira et al., 2020). In this way, facing that the scientific productivity of countries is related to their economic wealth (KING, 2004), developing countries are fragile and dependent, increasing the risks of resource collapse and food insecurity.

The known negative association between economic wealth and GDP reflecting on countries' research performance and academic results, consequently on policy and management formulation generate perverse outputs (LASHITEW; ROSS; WERKER, 2021). Our social networks demonstrate this association when the ENV and RES network communities are mainly centered on and linked to countries with high HDI and GDP. Thus, resource-import countries usually perform better in resource-related scientific research than resource-producers, behaving more as knowledge developers than knowledge promoters.

Considering knowledge as an essential input to improve effectiveness on resource use and conservation (BENNETT et al., 2015; BERKES; TURNER, 2006; RUDD et al., 2011), it is not surprising that articles assessed were more focused on understanding processes behind continuous effects related to climate changes than to uncertain extreme ones. So, assessments of impacts and ongoing adaptations are more empathetic than studies of the effects of extreme events. Gradual climate change effects are supposed to allow more time for debate and development of adaptations to mitigate impacts more effectively (LAUKKONEN et al., 2009), unlike unexpected extreme events. In this case, forecasting extremes is still a challenge due to their sporadic nature limiting data (RUMMUKAINEN, 2012). In fisheries sciences, the effects of climate-related events have been a concern for researchers and industry, affecting fleet composition, target species and fishing areas (HAYNIE; PFEIFFER, 2012), but few are directly related to climate change. At first, facing the multidisciplinary nature of fisheries activity, involving ecology, biology, anthropology, sociology, and economy, varied thematic objectives were expected but were found in the last period indicating a shifting thematic baseline. Interdisciplinary approaches that incorporate economic, social and natural sciences encourage integrated management (PHILLIPSON; SYMES, 2013), which has shown more effective results in response to the impacts of climate events than disciplinary approaches. Therefore, whether they are related to the effects of extreme or continuous weather events, this innovative approach is mandatory no matter related to extreme or continuous events in fisheries, enabling effective mitigation and adaptive strategies.

The diversity of thematic causal attributes increased over time but followed thematically unequal towards bioecological sciences. The recent reduction in the proportion of themes associated with biology and ecology, in parallel to increased emphasis on socio-economic themes, does not mean a reduction in the bioecological research, but the faster growth of themes that include cultural studies, rights, community organization, and economics. This represents a promising trend to improve management effectiveness and build more feasible political action facing environmental change effects. Unfortunately, the social sciences approach related to climate change is rarely mentioned even in the IPCC assessment reports (CALLAGHAN; MINX; FORSTER, 2020), implying few practical solutions for the issue. The impacts of climate change on humans require knowledge of the communities' socioeconomics and fishing fleets dynamics and their capacity to adapt to these changes (ALLISON et al., 2009). However, there is still little knowledge of those fisheries' ecosystems' consequences on humans, particularly for artisanal fishers, who are the most vulnerable to climate change

(MCCLANAHAN et al., 2008; MORZARIA-LUNA; TURK-BOYER; MORENO-BAEZ, 2014). Furthermore, despite the expansion of social research in fisheries, other knowledge is also needed to adequately qualify the human dimensions in question (e.g., social network dimensions), providing politically viable and environmentally adequate solutions facing climate change challenges to traditional cultures.

Interestingly, publications mentioning climate events in fisheries have predominantly addressed impacts on marine environments compared to continental ones. The greater human density in coastal areas, driven by urbanization and migration (HUGO, 2011; NEUMANN et al., 2015), causes greater interest in understanding the impacts and interactions between man-environment in marine regions and particularly in coastal regions (VISBECK et al., 2014). The declining health of the oceans currently driven by anthropogenic outputs has been debated not only in academia but also in society (e.g., IPCC, 2021; Laffoley and Baxter, 2016). On the contrary, studies on fisheries impacts of climate change were comparatively scarce in continental environments, even considering an increase in scientific productivity in themes like ichthyology (AZEVEDO; MESQUITA; YOUNG, 2010) or ecosystems (RAMÍREZ; GUTIÉRREZ-FONSECA, 2020). Thus, despite climate change affecting different aquatic environments and fishing, the lack of research and knowledge about the effects on continental environments is worrying.

In the network analyses, the connection between the RES, SOE and ENV themes was lower in older articles (until 2009) with three easily separate clusters (communities), where the themes are addressed in a more isolated way; what has changed in recent years when transitivity increased. Since 2010 the RES and ENV communities have increased their interaction, strengthening the link between the topics. Socio-economic topics formed a separate community in all periods, replicating the classic division in the dialogue between the human and life sciences (BRANDT et al., 2013; JAHN; BERGMANN; KEIL, 2012), highlighting the difficulty in relating societies and the non-human environment to deal with the interdependencies, even in scientific arenas. The human and natural dimensions of fishing systems are still strongly unbalanced (SYED; BORIT; SPRUIT, 2018), often being treated separately without any relation. The transitivity increase indicates the development of the topic's connection between different clusters (JEH; WIDOM, 2002), which is expected to occur as new topics are addressed to understand the transdisciplinary system better. For sustainable fisheries balancing human interests and resources conservation, the development of interdisciplinarity and even transdisciplinarity between dimensions is essential (PHILLIPSON; SYMES, 2013; TURNER, 2000). Therefore, research on fisheries seems to engage greater interconnection between knowledge areas allowing to build more balanced resources management.

3.6. Conclusion

We identified a correlation between socio-economic aspects of countries, GDP and HDI, and the production of scientific knowledge related to climate change and fisheries, with fish production being carried out mainly by poor developing countries. Our model indicates that nations with greater economic wealth publish more articles that mention fishing and climate change, pointing out that poor producer countries have strong limitations in conducting research. Solutions must be designed by active research in situ focusing on transdisciplinary and participative research. In addition, socio-economic research themes increasingly connect to the already connected community thematic groups of resources and environment. However, the mere thematic connection will not be enough if producers are not appropriating knowledge, putting the food security of their people and the buyers in danger. We recommend policies increasing connection between the interests of scientific communities and producers-buyers societies to design effective adaptative strategies to mitigate climate change effects.

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4 DRIVERS TO ARTISANAL FISHERS RISK PERCEPTION IN A TROPICAL MARINE PROTECTED AREA

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Keywords: Coastal, Offshore, small-scale fisheries, risk drivers

4.1 Abstract

Artisanal or small-scale fisheries are relevant in developing countries, reducing poverty and increasing food security. However, they face several stressors, e.g., economic and social marginalization, conflicts, and overfishing, which potentially impact their perceptions and attitudes towards the risks of the activity, still under the potential influence of several socio-economic attributes. In this article, from interviews using semi-structured questionnaires, we tested the hypothesis that socio-economic (age, scholarly, religion) and environmental (costal vs. offshore) attributes influence the risk perception of artisanal fishers in the APA Costa dos Corais. We noted a high relationship between the perception of risk in fishing and the attitude expressed by the fishers, a significant positive influence of the fishing environment and a negative influence of not having a religion. Furthermore, fishers are aware that fishing in the offshore environment demands more operating conditions and more time at sea, representing more risk of losses than fishing in coastal environments. They also have a greater perception of health risks and conflicts, while fishers focused on coastal environments had a greater perception of environmental degradation. Therefore, since artisanal fishers do not constitute a homogeneous group in terms of capture, environmental perception, socio-environmental

risks, and exploited resource characteristics, we suggest that management plans be built and applied separately for offshore and coastal fisheries.

Keywords: Artisanal fishers; Environment cultural drivers; Marine protected area; Small-scale fisheries.

4.2 Introduction

Artisanal fishing is complex from its conception, through the diversity of species used, techniques practiced, and resources involved in the related socio-economic and environmental risks (BATISTA et al., 2014). Although called small-scale in Anglo-Saxon cultures and artisanal in Latin cultures, commonly involve small to medium-sized vessels with low to moderate technological investment (BATISTA et al., 2014; RUTTENBERG, 2001), and play a role essential in poverty reduction and food security where they are developed (BÉNÉ et al., 2016b; FAO, 2015b). It is an activity that has high levels of exposure to environmental and socio-economic risks (BÉNÉ; FRIEND, 2011; FAO, 2015a), being highly impactable by the effects of environmental changes (CAMACHO GUERREIRO; LADLE; DA SILVA BATISTA, 2016; GALAPPATHTHI et al., 2021; RUIZ-DÍAZ et al., 2020).

Events or phenomena in which the consequences are uncertain, and something of human value is in danger are considered risks (AVEN; RENN, 2009). For artisanal fishers, many risks are inherent to the fishing activity, such as physical, security (conflicts), financial, and social demands, affecting the temporal amount and variability in fishers' income (KASPERSKI; HOLLAND, 2013; SETHI, 2010). In addition, risks have possible sources in environmental impacts, including those induced by climate (ALLISON et al., 2009; KOLDING; BÉNÉ; BAVINCK, 2014) and others that directly or indirectly affect the resources on which fishers depend (BADJECK et al., 2010), such as environmental pollution, habitat loss, or changes in atmospheric or oceanographic cycles (HOEGH-GULDBERG; BRUNO, 2010; JACKSON et al., 2001). However, the probabilistic existence of risks does not necessarily make them perceived by societies (WILKINSON, 2001). So, the main attributes must be identified to enable more effective responses from those directly involved and societies as a whole.

Risk perception is how individuals perceive the dangers to which they are or may be exposed, usually generating an attitude towards risk as a first response, representing the externalized assessment of people in the face of a risk situation (RENN; ROHRMANN, 2000a). Risk attitudes are commonly categorized into two groups: 1. risk propensity, when there is a willingness to accept risks for a particular marginal increase in return, and 2. risk aversion, when the perceived risk is not accepted (PENNINGS; GARCIA, 2001), it is understood that taking a risk is associated with the expectation of some gain within the scope of the society involved (KAHNEMAN; TVERSKY, 1979).

Risks are also frequently classified by perceived impact severity and frequency of occurrence (HASAN; NURSEY-BRAY, 2018; QUINN et al., 2003), potentially affecting the risk attitude of those involved. In the case of artisanal fishers, the perception of risk is usually associated with threats and uncertainties related to the operational activity, whether in the environmental dynamics of fishing or that related to the use of fish by society (CINNER et al., 2019; FICKE; MYRICK; HANSEN, 2007; HILBORN; WALTERS, 1992; SIEVANEN, 2014; VAN PUTTEN et al., 2011). In these fisheries, variation in resource availability, environmental degradation and climate change, variation in costs and availability of inputs and products, as well as health risk stand out (BEN-YAMI, 2000). Furthermore, in addition to the inherent characteristics of risk, perception can vary between different groups of people who have different cultural characteristics (CINNER; SUTTON; BOND, 2007; GRANDERSON, 2014) or related to operational scale between different times and environments (ANDALECIO, 2010; KIMANI et al., 2020).

Socio-economic characteristics such as age, education, income, and religion are also determinants of risk perceptions and attitudes (ARMAŞ, 2006; BOTZEN; AERTS; VAN DEN BERGH, 2009). However, the causal effect tends to be differentiated and determined in the societies involved (DOSMAN; ADAMOWICZ; HRUDEY, 2001; SIEVANEN, 2014). In the case of age, it is usually related to the contribution to predicting individual risks, which is expected to increase for older or more experienced individuals (BOUYER et al., 2001). Considering the educational level, more schooled people may have more information and training, so they may have more risk perceptions than others with less training (SUN; HAN, 2018). Religion and religiosity potentially affect self-confidence and pragmatism in the decisions of less religious social groups, while Catholics would be more sensitive to decisions and risks (BAKER; GORSUCH, 1982; DELENER, 1990), and protestants may have more focus on productivity (NUNZIATA; ROCCO, 2018). Thus, identifying potential sociocultural attributes for risk perception is essential for interpreting how fishers make decisions and, hence, to build effective public policies for risk mitigation (HO et al., 2008).

Even in Marine Protected Areas - MPAs under a narrower management regime, the risks are present in the fishing sector. These risks usually come from little or no implementation of management rules (JAMESON; TUPPER; RIDLEY, 2002; JESSEN et al., 2017) or from the conflicts inherent to multiple-use protected areas, such as Environment Protected Areas - EPAs (SNUC, 2000). Facing such hazards, the protected area would not change the risks associated with the activity. Consequently, the perception of risk may be more related to the dynamics of the fisherman's environment relationship and the financial responses obtained in the activity.

Fishers, especially those who exploit offshore resources, are under various risks associated with sociocultural conditions (e.g., Kolawole and Bolobilwe, 2019) and diverse health threats (BYE; LAMVIK, 2007). The offshore environment, located close to the continental shelf break, has species of greater commercial value, such as large offshore fish (HISSA; HAZIN; TRAVASSOS, 2007; RANGELY et al., 2010). However, it presents more risks (BYE; LAMVIK, 2007) away from the coast, demanding greater autonomy and more investments in inputs than inshore fishing (BARROS, 2001). Thus, it is riskier but economically more attractive, even for small artisanal vessels (DA SILVA; CHAVES; FONTELES-FILHO, 2013; HAZIN; BROADHURST; HAZIN, 2000). If there are differences in the fishery product, environmental, social, and economic risks, the perception of risk between offshore and coastal fishers might be different, generating different scenarios in fisheries management.

Understanding fishers' risk perception is essential to provide a basis for effective fisheries management that considers perceived and other existing risks, allowing managers to understand the world view of those managed, increasing the effectiveness of fisheries management. Hence, we tested the hypothesis that the type of environment (coastal vs. offshore), schooling level, age, religion, and fishing income are influential attributes in the artisanal fishers' risk perception.

4.3 Material and methods

4.3.1 Data collection and processing

A survey was carried out interviewing artisanal fishers on their socio-economic characteristics and risk perceptions in the coastal municipalities of the Costa dos Corais Environmental Protection Area (APACC) (Figure 7). Fishers were randomly selected for interviews in coastal villages and fishing colonies from among those residents over 18 years old who voluntarily agreed to participate. The interviews were conducted by researchers from the Costa dos Corais Long-Term Ecological Research Program in Alagoas (PELD-APACCAL), resulting in 165 semi-structured questionnaires completed between 2018 and 2019 (Table 3) among the approximately 6,000 commercial fishers present on this coast (estimated from the General Fisheries Registry/RGP and the percentage of fishers in the APACC with RGP recorded between 2018 and 2019).

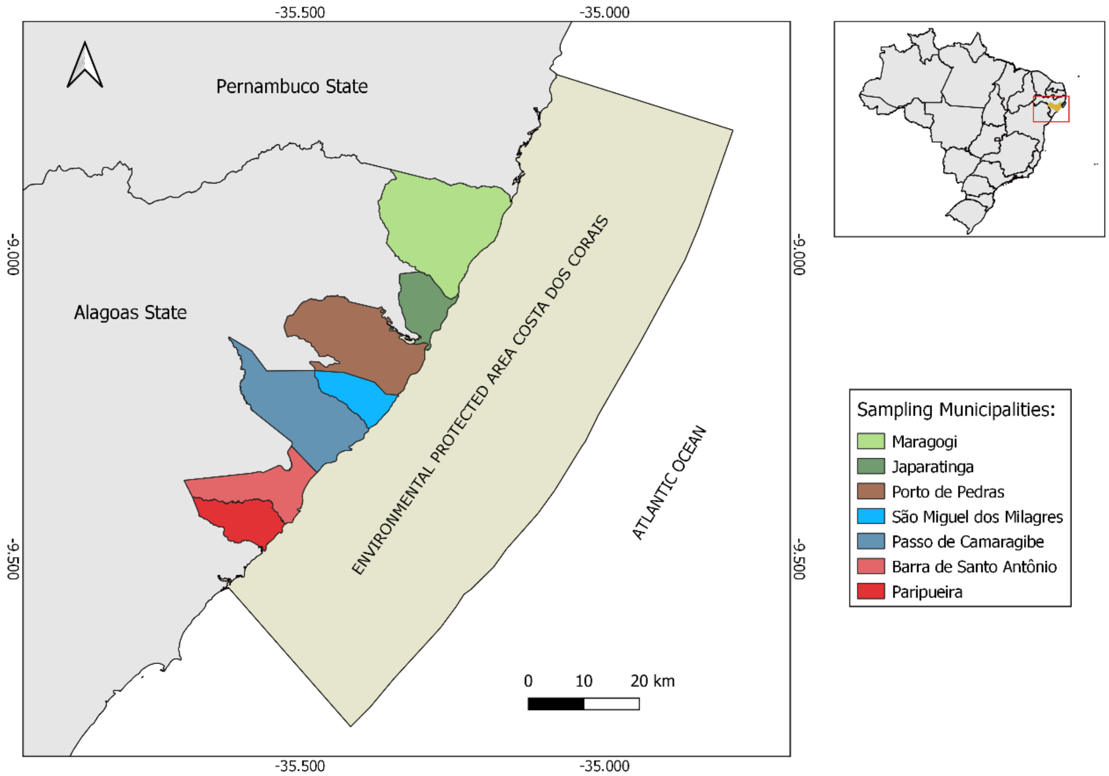

Figure 7. Municipalities sampled in the Environmental Protected Area Costa dos Corais, Northeast Brazil.

Table 3. Number of interviews with groups of fishers in the municipalities throughout the EPA.

MPA municipalities	**Offshore fishers**	**Inshore fishers**
Barra de Camaragibe	9	28
Barra de Santo Antônio	15	25
Japaratinga	6	13
Maragogi	13	4
Paripueira	11	2
Porto de Pedras	6	23
São Miguel dos Milagres	4	2
Total	64	101

The questionnaires contain information on 1. Socio-economic characteristics (age, schooling, income from fishing, religion, and fishing environment); 2. Risk perception and its severity ask what the main problems threaten their fisheries activity and the related environment; 3. Attitude towards risk asking how they propose to solve the cited problems.

The present research has registration and authorization from the Ethics Committee of the Federal University of Alagoas (CEP: 2.857.876) and authorization from SISBIO because it deals with the collection of socio-environmental data in a Federal Conservation Unit (SISBIO: 62035-1).

4.3.2 Data analysis

We categorized risk perception responses into six themes based on the fishers responses (Table 4). Interviews that did not contain information on all items analyzed were discarded.

Table 4. Themes on risk perception identified among coastal and offshore fishers

CATEGORY	DESCRIPTION
CONFLICTS	RISKS RELATED TO CONFLICTS OF FISHERS WITH GOVERNMENTS, ENVIRONMENTAL AGENCIES (IBAMA AND ICMBIO), NGOS AND THE TOURISM SECTOR.
ENVIRONMENTAL DEGRADATION	WIDESPREAD POLLUTION, HABITAT DEGRADATION, SEWAGE AND GARBAGE RELEASED WITHOUT ADEQUATE TREATMENT.
CLIMATIC CHANGE	ASPECTS THAT INVOLVE CHANGES IN THE CLIMATE (E.G., SEA EROSION, HEAVY RAINS OR DROUGHTS).
HEALTH HAZARD	RISKS RELATED TO THE HEALTH HAZARDS TO THE FISHERS OR THE CREW (ACCIDENTS AT WORK AND ILLNESSES).
SOCIO-ECONOMIC SECURITY	RISKS RELATED TO INSTABILITY IN INCOME, CUTS IN SOCIAL BENEFITS, SOCIAL SECURITY, AND FOOD.
IRRESPONSIBLE	RISKS RELATED TO ILLEGAL/IRRESPONSIBLE USE OF FISHING

CATEGORY	DESCRIPTION
USE	RESOURCES (OVERFISHING) OR ENVIRONMENTAL RESOURCES (NETS INCORRECTLY DISCARDED).

The risk perception score was defined by a numerical ordinal scale, corresponding to the sum of the weights of the risk citation (sensu Bernard, 2011; Sousa et al., 2016) and its severity, obtaining a weighted value of the risk importance for the interviewee (Table 5).

Table 5. Risk perception score, corresponding to the sum according to the order of the citation and its severity.

RISK ORDER (VALUE)	SEVERITY (VALUE)	RISK PERCEPTION SCORE
1ST (3)	HIGH (3)	6
	REGULAR (2)	5
	LOW (1)	4
	NA (0)	3
2ND (2)	HIGH (3)	5
	REGULAR (2)	4
	LOW (1)	3
	NA (0)	2
3RD (1)	HIGH (3)	4
	REGULAR (2)	3
	LOW (1)	2
	NA (0)	1

Fishers risk attitudes towards solving perceived problems were classified into four levels based on theoretical frameworks related to proactiveness in organizations (MENSMANN; FRESE, 2016; SPITZMULLER et al., 2015), attribution and commitment theory (MEYER; ALLEN, 1991). Thus, considering the intention expressed by the user to solve the problem, we identified the following levels in the allocation of those responsible for executing the solution expressed in the attitude towards risk: 1.Personal, referring to risk actions carried out by the person himself; 2.Community, responses linked to collective actions, 3.Governments, actions demanded from government agencies and 4.Indefinite, when they did not indicate an entity to solve the problem. In addition, the solution proposed by the fishers for each risk was classified separately by three researchers as proactive (weight 2), passive (weight 1), or undefined (weight 0), seeking consensus in case of divergence. With that, we created a table with different scores according to the agent to which the externalized attitude should be allocated (Table 6), assigning a higher score to personal commitments, and a lower score to more distant instances for action.

Table 6. Risk attitude score, corresponding to the sum according to the order of the citation and its severity.

ATTRIBUTED LEVEL (VALUE)	COMMITMENT LEVEL (VALUE)	RISK ATTITUDE SCORE
HIM/HERSELF (3)	PROACTIVE (2)	5
	PASSIVE (1)	4
	INDEFINITE (0)	3
COMMUNITY (2)	PROACTIVE (2)	4
	PASSIVE (1)	3
	INDEFINITE (0)	2
GOVERNMENT (1)	PROACTIVE (2)	3
	PASSIVE (1)	2
	INDEFINITE (0)	1

A Generalized Linear Model (GLM) was used to test how the fisherman's perception of risk is influenced by schooling, age, environment, religion and fishing income. In the complete model, we tested the combination of all predictor variables, with risk perception as the response variable. Then, the model was reduced by removing the parameters without significance, leaving the variables environment, religion, and income from fishing as predictors.

After testing the assumptions of normality, the response variable was logarithmized for normalization. Collinearity between the explanatory variables was tested using a Pearson correlation matrix, with a high correlation between risk perception and risk attitude being detected, which was then excluded. Then, using the MuMIn package (BARTON, 2015) of the R platform (R CORE TEAM, 2017), the Akaike Information Criterion (AIC) was evaluated to identify the most parsimonious models, here considered those with AICc <4 (BURNHAM; ANDERSON; HUYVAERT, 2010). To identify the explanatory power of each explanatory variable on the response variable, a hierarchical partition analysis was used, using the hier.part package (NALLY; WALSH, 2004). The difference between fisher environment groups (coastal and offshore) to religion levels (Catholic, Protestant and no religion) was tested with the non-parametric Kruskal Wallis test.

4.4 Results

From the 154 interviews full answered (nine discarded), we found higher income (+31%) for offshore fishers (Table 7). Fishers low educational level is usually low, where about 50% declared incomplete elementary education. Coastal fishers declared mainly to be Catholics and Protestants at similar proportion (40%, but for offshore fishers those without a declared religion were the second (35%), and protestants were just 23%.

Table 7. Description of the socio-economic profile of artisanal fishers

Variable	Level	Coastal fishers	Offshore fishers
Fishers mean age (years)	-	43	47
Mean income (month)	Winter	R$ 626	R$1098
	Summer	R$793	R$1145
Literacy	Illiterate	18%	18%
	Fundamental uncompleted	49%	54%
	Fundamental completed	9%	9%
	Intermediate uncompleted	15%	11%
	Intermediate completed	7%	5%
	Graduate completed	2%	3%
Religion	Catholic	40%	42%
	Protestant	40%	23%
	None	20%	35%

Assessing the effect of the perception on the attitude using the Pearson's matrix we found a positive correlation by the linear model (R^2= 0.77) (Figure 8).

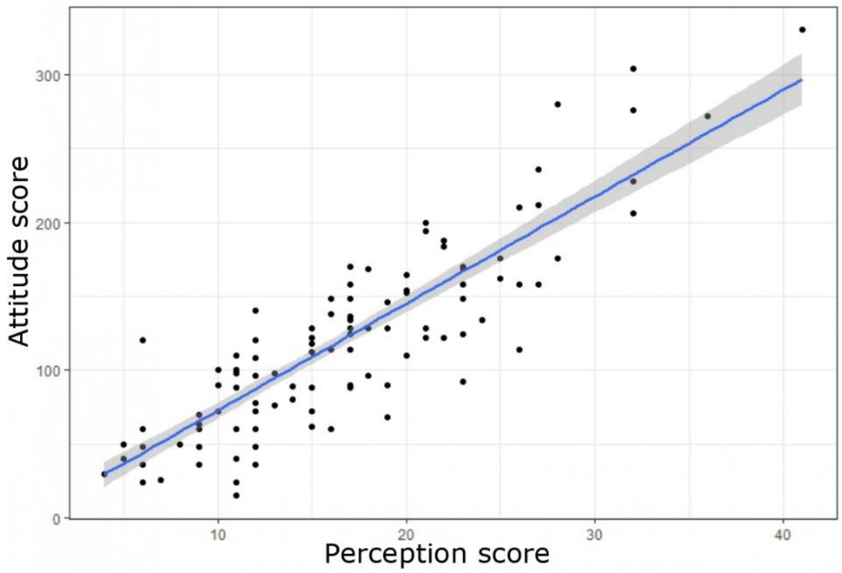

Figure 8. Correlation between attitude and perception risk score.

The GLM result on risk perception influential attributes indicated a significant ($p \leq 0.05$) and positive influence of the offshore environment and a negative influence on those who did not declare religion (Table 8). According to the hierarchical partition analysis, the offshore environment explains 36% and those having no religion explains 59% of the variability in the fishers risk perception (Figure 9).

Table 8. Generalized model (GLM)

VARIATION	ESTIMATE	ERROR	Z VALUE	P- VALUE
INTERCEPT	**15.2361**	**1.2057**	**12.576**	**<2E-16 *** **
ENVIRONMENT: OFFSHORE	**2.3774**	**1.1856**	**1.989**	**0.0467 ***
RELIGION: NONE	**-3.2023**	**1.2485**	**2.544**	**0.0109 ***
RELIGION: PROTESTANT	**-1.7264**	**1.6581**	**1.033**	**0.3017**
FISHERY INCOME	**0.2211**	**0.6061**	**0.362**	**0.7173**

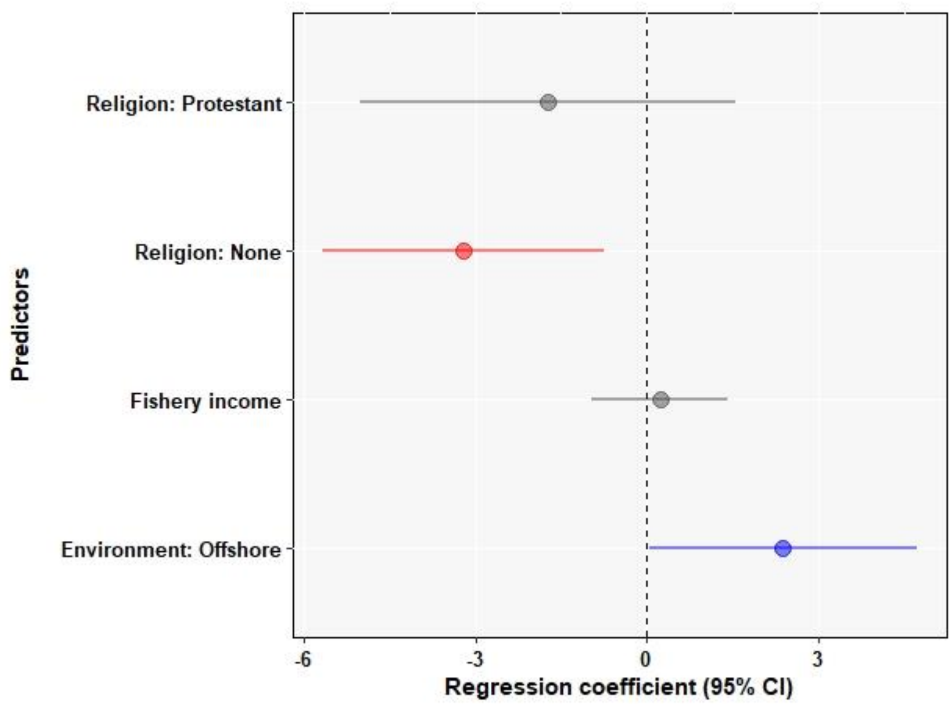

Figure 9. Coefficient estimates with 95% confidence intervals for the model showing the effects of predictors on the perception risk score. Blue point=positively significant; gray points=not significant; and red= negatively significant. More details see table S3.

From 383 citations of sources of perceived risks by coastal and offshore fishers related to nature and their fishing profession, coastal fishers were richer, citing 59% of all (Figure 10). The risks referring to "environment degradation" concentrated 42% of the citations, followed by "socio-economic security" (19%). For offshore ones, "hazard to health" category (24%) highlighted, followed by "conflicts" with 18% and "socio-economic security" with 16%.

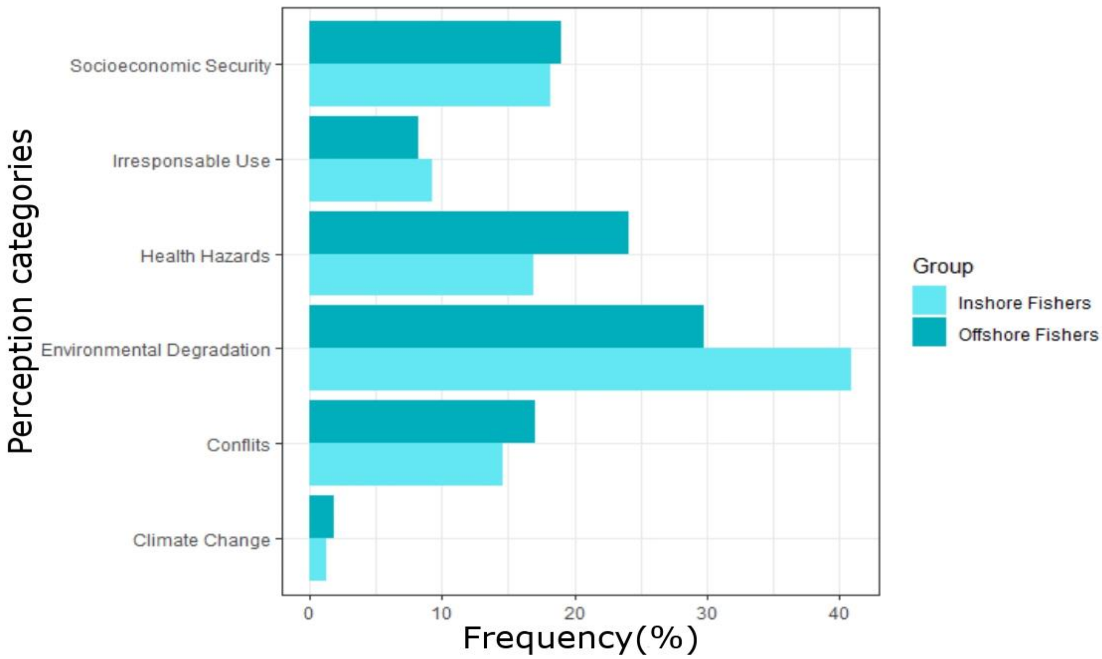

Figure 10. Risk frequency by category perceived by inshore and offshore fishers.

Comparing the risk perception score by religious segment (Catholic, Protestant or none) between coastal and offshore fishers (Figure 11), the highest median risk perception was recorded for no religion offshore fishers (χ^2=4.7009; p=0.03).

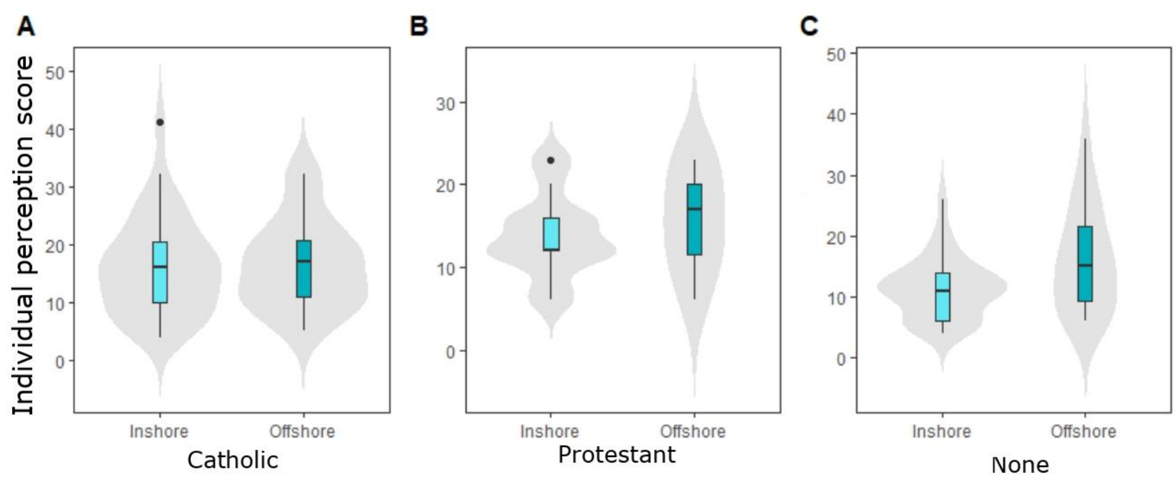

Figure 11. Violin boxplot of perception score of offshore and inshore fishers by religion.

4.5 Discussion

The risk perception of commercial artisanal fishers was significantly determined by the fishing environment and secondarily by the declared religious option, particularly in the case of pelagic fishers. Contrary to what was expected, schooling, age or income did not generate a significant influence on the general model of risk perception, which already indicates that these attributes in themselves are not highlighted for these fishers as determinants, but we emphasize that differentiated measures should be considered in studies futures. This is the case of schooling and age, which may be more relevant if indicators of local ecological knowledge and time of experience in fishing would be used alternatively. However, the significant difference in risk perception of coastal and pelagic fishers already indicates that different approaches and management strategies are required according to the domain involved.

In addition to these general results of the model, the results obtained show a socio-economic profile of low education, high average age (43 years for coastal and 47 years for offshore fishers), indicating that fishers are aging without renewal. Similar results of fishers socio-economic profiles in other conservation units in Brazil (SANTOS, 2015; SILVA; LOPES, 2015). We also found that the pelagic environment provides an individual income from fishing greater than the coastal environment, which is expected considering that this environment concentrates a greater production of species of higher commercial value (BA et al., 2017; RANGELY et al., 2010), generating more income. Knowing the socio-economic profiles, perceptions and attitudes of social actors in the sector is relevant for planning fisheries management, whether in protected areas (DE ANDRADE; DE OLIVEIRA SOARES, 2017; PITA; PIERCE; THEODOSSIOU, 2010; SILVA; LOPES, 2015) or outside them (FABRÉ et al., 2012; RIBEIRO; FABRÉ, 2003), as well as for risk management in these locations.

We also found a strong correlation between perception and risk attitude for artisanal fishers, which is an expected relationship, but rarely proved. Risk perception is a determinant of risk attitude, as both risk perception and attitude influence the behavior of individuals (SITKIN; PABLO, 1992). Studies in several areas (e.g., social behavior; perception and attitude of social actors in protected areas) have shown this positive correlation between perception and attitude (FAZIO; WILLIAMS, 1986; SIRIVONGS; TSUCHIYA, 2012) that remains, however, little used by managers. For marine protected areas, understanding fishers risk perception can determine the success of fisheries management (DIMECH et al., 2009; PITA; PIERCE; THEODOSSIOU, 2010).

The GLM model indicated that the pelagic environment positively influences the risk perception of fishers and that not having a religion negatively influences it. Fishers do not constitute a homogeneous group in their professional activity, differing in the target species, where they fish, and in the technologies used, having highly varied objectives and interests (JENTOFT; MCCAY, 1995; PITA; THEODOSSIOU; PIERCE, 2013), so their perception of risk must also have to be different. The simplification of the division of fisheries into large-scale industrial and small-scale artisanal fisheries is limited (BATISTA et al., 2014), being a simplification that does not contribute to the development of participatory management, with the perception of risk is a component in making decisions in multilevel organizations decision-making (CHAN et al., 2020; HOOPER; ASHLEY; AUSTEN, 2015; KEINAN; BEREBY-MEYER, 2017; ULLAH; SHIVAKOTI; ALI, 2015).

Artisanal fishing is versatile in the exploitation of diversified environments that generate diversity of objectives, techniques, needs, risks, knowledge, and gains, among other attributes. Pelagic resources fishers are under extreme conditions compared to coastal environments (Figure 12), having to navigate more, explore environments further away from the coast, seek resources of greater size and value that offset the higher costs. Vessels are usually motorized, larger, operating with specific fishing gear, such as handline and longline (MISUND; KOLDING; FRÉON, 2002; RANGELY et al., 2010; WARD; HINDMARSH, 2007). Coastal fishers, on the other hand, exploit environments close to the terrestrial environment (e.g., estuaries and coral reefs), with smaller vessels and more diverse fishing strategies in response to diverse habitats (e.g., Hilborn et al., 2003; McClanahan et al., 1997; Wiyono et al., 2006). Such operational and environmental differences make the fishery product different, the knowledge different, as well as the risks, representing a force that filters information and generates a different perception of risk. Thus, in the same region there are groups that do not share the same risks, gains, and perceptions. Although pelagic and coastal fishers share the status of small-scale fishers (JENTOFT; DAVIS, 1993; JENTOFT; MCCAY, 1995), they have perceptions, express attitudes and behaviors that are often divergent and often conflicting.

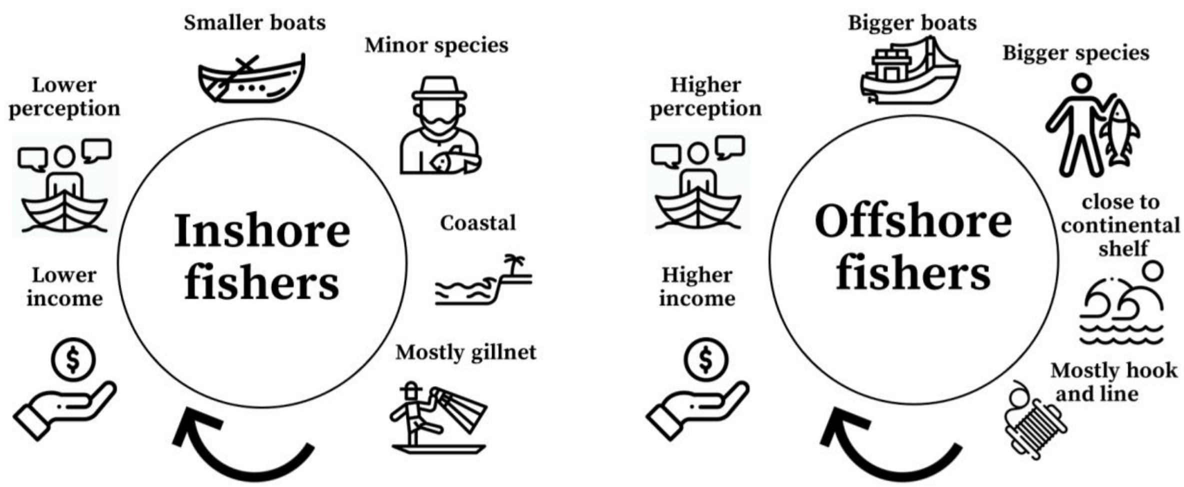

Figure 12. Schematic drawing of main attributes in inland and offshore fisheries.

Religion can influence people's risk perception and attitudes, through exchanges in social networks in religious groups (HALUZA-DELAY, 2014) affecting people's behavior and their perceptions about aspects of life (HUBER; HUBER, 2012). Such a relationship is even supported by the use of rituals, amulets, mythology and customs in fishing that influence the perceptions and behavior of fishers (LOWE et al., 2019; MCCLANAHAN et al., 1997). This seems to be reaffirmed by the significant result of risk perception being negative for deistic beliefs, representing a relaxation of agnostic fishers in the perception of risk in fishing, which makes believers in a more precautionary group regarding the risks of pelagic fishing.

Although the association of socio-economic attributes with perceptions and attitudes among different groups is common (MCCLANAHAN; DAVIES; MAINA, 2005; SILVA; LOPES, 2015), the inclusion of education, age and income as influential in risk perception did not generate a significant result. In the case of educational level, the majority of low schooling, related to the early start in fishing activity (OLIVEIRA; BENEDITTO; ..., 2016), and the lack of connection between formal education and the reality of fishing are factors that hinder the appropriation of knowledge relevant to the risk perception (e.g., Botzen et al., 2009; Qasim et al., 2015). On the other hand, if the variation in age affects risk perception (BOTZEN; AERTS; VAN DEN BERGH, 2009), there are several cases where this effect is not expressed (e.g., Akerlof et al., 2015; Saleh Safi et al., 2012), and locally the horizontal transmission of experience between fishers generations may be homogenizing this perception, or simply by a bias of success, which should be tested in the future. On the other hand, the attribute income in fishing, which is potentially impacting on perception (ARMAŞ, 2006; BOTZEN; AERTS; VAN DEN BERGH, 2009), did not have a significant effect due to the low variability of reported monthly income, with frequent statements highlighting the lack of income control by fishers. Therefore, parallel systems of income scaling in artisanal fisheries are necessary, and the declared time estimates are unreliable.

Risk situations can be experienced in different ways, with high predictable risks, such as environmental degradation, and less predictable risks, such as health-related (BECK, 1999; MINNEGAL; DWYER, 2006). We found that the risk perception related to health and conflicts differed between coastal and pelagic fishers, with the latter having a higher perception of risk. As they fish further from the coast and spend more time on the high seas, they identify more risks associated with their physical integrity. People who feel less secure, experience higher levels of stress and work overload, increase their sensitivity to hazards, increasing awareness (BECK, 1999; MINNEGAL; DWYER, 2006). In response to attitude, the adaptive strategy used by fishers is the denial and trivialization of risks, reducing anxiety and stress, allowing them to continue working in a very dangerous profession (POLLNAC; POGGIE; VANDUSEN, 1995).

The greatest diversity of risks related to environmental degradation was recorded for coastal fishers, precisely those whose activity occurs in the area closest to urban centers. Perception grows with contact with disturbance as expected (RENN; ROHRMANN, 2000a), which is most intense in urbanized coastal areas where typically environmental impacts are more severe, affecting coastal ecosystems and associated fisheries (NEUMANN et al., 2015; SHAHIDUL ISLAM; TANAKA, 2004). The most cited impacts in relation to environmental degradation were litter in the oceans, untreated sewage, and pollution in general in the sea and estuaries. Such items are perceived to have a more marked negative impact on coastal fishing activities by fishers (e.g., Gelcich et al., 2008; Wootton et al., 2022) and managers (e.g., Burger et al., 1999), while in pelagic environment the effect is dispersed and not necessarily related to the abundance of resources.

We understand also that other factors not considered here may affect the perception and attitude of risk in fishing, such as the local ecological knowledge (LEK) (JOA; WINKEL; PRIMMER, 2018; TSIKLIRAS; POLYMEROS, 2014), dependence on fishing income (OSTROM, 1999; ZHAO; JIA, 2020), or even the life history of fishers, e.g., considering that those born locally tend to have a greater perception of impacts and awareness of resource conservation (SILVA E LOPES, 2015). In the same way that attributes that are often influential in some fisheries were not shown to be significant here, such attributes must be contributing to the high dispersion in the perception of environmental risks. Thus, being treated in a less homogeneous way by managers, communities with traditional cultures can have their perceptions and attitudes better used to promote a shared management of fisheries resources.

The lack of these attributes generates misunderstanding of needs, losses and intra and intersectoral conflicts. Such conflicts regarding the use of fishing resources, as well as the use of space, are common in fisheries (BENNETT et al., 2001; CHARLES, 1992), highlighting those among fisher groups, which fragment the sector's objectives, and those among fishers with similar sectors, such as tourism operators and biodiversity managers (CAVALCANTE DE OLIVEIRA JÚNIOR et al., 2021). Despite fishing being considered one of the most dangerous professions (MARKKANEN, 2005; PETURSDOTTIR, G.; HANNIBALSSON, O.; TURNER, 2001), fishers do not react homogeneously to risk, having this strong relationship with their work environment.

Thus, on the one hand, it is essential that the effect of the specificity of the fishing environment and the sociocultural attributes of those involved in the use of resources in a given environment be identified and politically articulated for the elaboration of effective management plans, seeking to gather similar perceptions and build dialogue. between those different. On the other hand, it is essential to identify the divergences and affinities between the cognitive perceptions of the interested parties and how they are articulated with the attitudes of the groups involved, enabling participation and management to be effective and successful.

4.6 Conclusion

Aiming to identify socio-economic variables that influence the risk perception of artisanal fishermen based on the case of APA Costa dos Corais. We found that only the environment and religion influencing fishers perception of risk, bringing the fishing environment to the center of planning. On the other hand, other socio-economic characteristics, such as education, age and fishing income were not significant in the general model, indicating the need for greater specificity in the identification of influential themes. The mere identification of exploited resources and the communities that exploit them does not seem to be enough to measure the perception of risk in fishing, and it is suggested that a better cultural, psychosocial and historical understanding be developed to support the decision-making of management plans that allow the effectiveness of their actions. Finally, in the case studied, it is considered essential that pelagic and coastal fishermen are treated separately in the elaboration of fisheries management plans.

CRediT authorship contribution statement

Aline Olimpio dos Santos: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **José Gilmar Cavalcante de Oliveira Júnior:** Conceptualization, Data curation, Formal Analysis, Investigation, Validation, Writing – original draft, Supervision. **Vandick da Silva Batista:** Data curation, Investigation, Funding acquisition, Resources, Supervision, Writing – review & editing.

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5 DISCUSSÃO GERAL

Nossos resultados apontam que características socioeconômicas e culturais são temáticas em ascensão para a compreensão da percepção de risco de pescadores, como também, da percepção dos pesquisadores sobre temáticas relacionadas a pesca e estressores diversos, incluindo mudanças climáticas. Os estudos da pesca tem descentralizado as temáticas abordadas, antes concentradas em pesquisas biológicas e ecológicas, hoje tendo uma abordagem interdisciplinar e transdisciplinar, desenvolvendo estudos biológicos, ecológicos, socioeconômicos e gestão pesqueira de forma integrada (COCHRAN et al., 2009; PHILLIPSON; SYMES, 2013).

Além disso, as atividades pesqueiras são interligadas ao ambiente de pesca e recursos. Os impactos antropogênicos nos ambientes e ecossistemas marinhos põe em risco socioeconômico aqueles que dependem da pesca como fonte de renda e subsistência, pescadores artesanais, assim como a segurança alimentar mundial (BADJECK et al., 2010; MORZARIA-LUNA; TURK-BOYER; MORENO-BAEZ, 2014). Dessa forma, podemos afirmar que as dimensões humanas (aspectos socioeconômicos e culturais) e dimensões naturais (conservação e biodiversidade) são cada vez mais abordadas em pesquisas sobre pesca, podendo influenciar numa gestão pesqueira mais abrangente e eficaz.

Gestores e pesquisadores têm desenvolvido cada vez mais métodos para análises sociais e econômicas buscando uma integração com abordagens biológicas para o gerenciamento da pesca (BARCLAY et al., 2017). A utilização de questionários e análises estatísticas podem auxiliar na compreensão das percepções sobre questões de pesca, sendo útil para elaboração de políticas que busquem estratégias para gestão pesqueira (BARCLAY et al., 2017; VOYER, M., BARCLAY, K., MCILGORM, A., MAZUR, 2016). No entanto, ainda há muito o que ser pesquisado para entender o comportamento humano em torno da pesca, no qual busque um equilíbrio social, economica e biologicamente. Recomendamos assim, políticas e pesquisas que conectem esses temas para projetar estratégias mais eficacazes e eficientes para a gestão pesqueira, buscando também um maior entendimento socioeconômico e cultural.

6 ANEXOS

Material suplementar: Artigo 1

Table S 1. List of parsimonious models for number of scientific articles, with value AICc, delta and weight.

Model	(Intercept)	Fisheries.Production	GDP	HDI	R.D	df	logLik	AICc	delta	weight
2	3.068299	-0.01789				3	-213.997	434.4646	30.00729	1.11E-07
3	2.702436		0.495821			3	-202.789	412.0481	7.590795	0.008182
4	2.654057	-0.62358	0.808247			4	-201.029	410.8586	6.401263	0.01483
5	2.87759			0.6183		3	-208.754	423.9788	19.52147	2.10E-05
6	2.871629	0.088651		0.63245		4	-208.593	425.9851	21.52778	7.70E-06
7	2.570291		0.472653	0.502409		4	-197.953	404.7055	0.24818	0.321573
8	2.537804	-0.47567	0.727688	0.482528		5	-196.616	404.4573	0	0.364059
9	3.057627				-0.16526	3	-213.719	433.9093	29.45193	1.46E-07
10	3.057509	-0.01479			-0.16506	4	-213.716	436.2324	31.77502	4.58E-08
11	2.693484		0.504681		-0.1396	4	-202.473	413.7461	9.288784	0.003501
12	2.646003	-0.6154	0.807515		-0.13425	5	-200.741	412.7057	8.248411	0.005889
13	2.866204			0.621116	-0.17857	4	-208.411	425.6227	21.16533	9.23E-06
14	2.859537	0.094862		0.636668	-0.18226	5	-208.228	427.6799	23.22254	3.30E-06
15	2.56073		0.480466	0.505187	-0.15135	5	-197.563	406.35	1.892633	0.141316

16	2.529831	-0.45935	0.720046	0.483389	-0.13744	6	-196.305	406.36	1.902676	0.140608

Table S 2. Relative frequencies in percentage of themes on climate change in fisheries by period.

Period	Aquaculture	Biodiversity	Biology	Community	Population	Systems	Environment	Megafauna	Culture	Economy	Rights	Social
2000-2004	1.56	6.25	14.06	0	17.19	3.13	42.19	0	0	3.13	3.13	9.38
2005-2009	0	3.55	9.47	5.33	14.79	10.65	38.46	4.14	1.18	2.96	0.59	8.88
2010-2014	2.47	2.96	9.38	7.73	12.34	8.55	34.38	1.32	2.96	5.76	0.49	11.68
2015-2019	3.53	4.98	5.78	4.1	7.55	10.68	33.57	0.64	5.06	6.83	1.29	15.98

Material suplementar: Artigo 2

Table S 3. List of parsimonious models for risk perception, with value AICc, delta and weight.

Model	(Intercept)	Group	Religion	Z_Escolaridade_Class	Z_Renda	df	logLik	AICc	delta	weight
2	13.63158	+				3	-519.753	1045.666	2.328672	0.079749
3	16.23188		+			4	-518.515	1045.299	1.961583	0.095815
4	15.20859	+	+			5	-516.466	1043.337	0	0.255498
5	14.61039			0.618687		3	-521.522	1049.204	5.867306	0.013593
6	13.58884	+		0.717339		4	-518.966	1046.201	2.863793	0.061027
7	16.20633		+	0.531854		5	-518.076	1046.558	3.22106	0.051044
8	15.13546	+	+	0.623942		6	-515.849	1044.269	0.931791	0.160344
9	14.61039				0.605098	3	-521.547	1049.254	5.917022	0.013259
10	13.69297	+			0.286363	4	-519.637	1047.542	4.204742	0.031213
11	16.17834		+		0.422403	5	-518.241	1046.888	3.5513	0.043275
12	15.22236	+	+		0.122618	6	-516.444	1045.459	2.122152	0.088424
13	14.61039			0.592858	0.578634	4	-521.021	1050.31	6.973372	0.007819
14	13.64053	+		0.701776	0.236819	5	-518.886	1048.178	4.84096	0.022708
15	16.15596		+	0.516863	0.402977	6	-517.826	1048.224	4.886958	0.022192
16	15.14542	+	+	0.619076	0.083627	7	-515.838	1046.444	3.106992	0.05404

Perguntas aplicadas nas entrevistas para coleta de dados sobre a percepção de risco dos pescadores

Aspectos socioeconômicos

<table>
<tr><td colspan="2">Gênero:Femnino( )
Masculino ( )</td><td>Idade:</td><td colspan="3">Há quanto tempo é morador do local?</td></tr>
<tr><td colspan="6">Religião: Católica ( ), Protestante (), Não tem ()</td></tr>
<tr><td colspan="6">Não frequentou a escola/analfabeto( ) Fund. incomp.( ) Fund. comp.( ) Médio incomp.( ) Médio comp.( ) Superior incomp.( ) Superior comp.( ) Pós-graduação( )</td></tr>
<tr><td colspan="4">Participa de movimentos sociais? Sim( ) Não( )</td><td colspan="2">Participa da liderança? Sim( ) Não( )</td></tr>
<tr><td colspan="4">Participa de alguma associação? Sim( ) Não( )</td><td colspan="2">Qual?</td></tr>
<tr><td colspan="2">Possui casa própria? Sim() Não( )</td><td colspan="4">Quantas pessoas moram na sua casa?</td></tr>
<tr><td>Ocupação/profissão</td><td colspan="3">Renda individual no inverno</td><td colspan="2">Renda individual no verão</td></tr>
<tr><td>1-</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>2-</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>3-</td><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td>Recebe auxilio do governo?</td><td colspan="3"></td><td colspan="2"></td></tr>
</table>

Percepção e atitude de risco do pescador

<table>
<tr><td colspan="2">Quais os maiores problemas que ameaçam:</td><td>Gravidade (Alto/ médio/ baixo)</td><td>Como você faz para evitar esse problema?</td></tr>
<tr><td rowspan="3">seu</td><td>1.a.____________________________</td><td></td><td>____</td></tr>
<tr><td>1.b.____________________________</td><td></td><td>____</td></tr>
<tr><td>1.c.____________________________</td><td></td><td>____</td></tr>
</table>

A	3.a.______________________________		____
	3.b._______________________________		____
	3.c.______________________________		____