UNIVERSIDADE FEDERAL DE ALAGOAS
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Programa de Pós-Graduação em Diversidade Biológica e Conservação nos Trópicos

EVELYNNE LETICIA DOS SANTOS FARIAS CARDOSO DE BARROS

VIDA SOB IMPACTO: ADAPTAÇÃO E VULNERABILIDADE DE COMUNIDADES PESQUEIRAS ARTESANAIS APÓS FORTES EVENTOS NA COSTA BRASILEIRA

MACEIÓ - ALAGOAS
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Dissertação/Tese apresentada ao Programa de

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Orientador: Dr. João V. Campos-Silva

Coorientadoras: Dra. Ana Claudia M. Malhado e Dra. Priscila F. Macedo Lopes.

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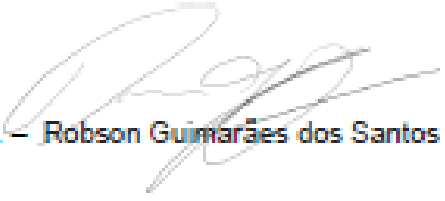

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Dedico essa vitória aos meus parentes amados que se foram ao longo desses dois anos, e não puderam me ver chegando ao fim dessa jornada.

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“Quando é mar a maré

E quando já não dá pé

Não me revolto ou me queixo

E tal qual um barco solto

Salvo do alto mar revolto

Volto firme pro meu eixo

E em noite assim como esta

Eu cantando numa festa

Ergo o meu copo e celebro

Os bons momentos da vida

E nos maus tempos da lida

Eu envergo, mas não quebro...”

(Lenine)

RESUMO

O litoral da região Nordeste do Brasil é marcado pela pesca artesanal, atividade que desempenha um papel cultural e econômico em escala nacional e local. Em agosto de 2019 as comunidades pesqueiras artesanais foram surpreendidas pelo mais extenso derramamento de óleo em regiões tropicais e, poucos meses depois, também tiveram que lidar com as restrições econômicas da pandemia do COVID-19. Esses impactos subsequentes exigiram que eles desenvolvessem estratégias de enfrentamento para superar a falta de renda, uma vez que a pesca não era permitida e/ou produtiva. Realizamos entrevistas semiestruturadas online e presenciais em três estados do Nordeste para entender como as comunidades pesqueiras costeiras lidaram com o derramamento de óleo e a pandemia e quais características impulsionaram a capacidade de enfrentamento.

Palavras-chave: Pesca artesanal. Derramamento do óleo. COVID-19 (Pandemia).

ABSTRCT

The coast of the Northeast region of Brazil is marked by small-scale fishing, an activity that plays a cultural and economic role at national and local scale. In August 2019 the small-scale fishing communities were surprised by the most extensive oil spill in tropical regions and, in a few months after, they also had to deal with the economic restrictions of COVID-19 pandemic. These subsequent impacts required them to develop coping mechanisms to overcome the lack of income, once fishing was not allowed and/or productive. We conducted online and presential semi-structured interviews in three states in the Northeast to understand how coastal fishing communities dealt with the oil spill and pandemic and what characteristics drove the ability to cope.

Key-words: Artisanal fishing. Oil spill. Pandemic. Vulnerability.

SUMARIO

1 APRESENTAÇÃO

A pesca artesanal contribui fortemente com a economia global, gerando renda para milhões de famílias (FAO, 2020). Em escala local, esta atividade também é fundamental, sobretudo para garantir a segurança alimentar, geração de renda e manutenção cultural das comunidades pesqueiras (BÉNÉ; FRIEND, 2011; MEA, 2005; FAO, 2020). Neste contexto, o Brasil se destaca ao abrigar um grande número de comunidades tradicionais que dependem substancialmente da pesca, especialmente a região Nordeste onde estão localizadas diversas comunidades pesqueiras artesanais (DIEGUES et al., 2005; MATTOS; WOJCIECHOWSKI; GANDINI, 2020).

Essas comunidades pesqueiras dependem profundamente dos recursos naturais e são bastante vulneráveis no contexto de mudanças globais, incluindo as mudanças climáticas, poluições e extirpação dos recursos pesqueiros (FAO, 2009; ANDERSON et al., 2011; PINKSY et al., 2019). As mudanças no ambiente podem gerar respostas e adaptações de comunidades humanas dependentes de recurso, estas respostas compõem a capacidade adaptativa (ADGER, 2006). Os chamados mecanismos de são as respostas emergenciais adotadas pelas comunidades para contornar os efeitos imediatos das mudanças ambientais. Com o passar do tempo e a manutenção das alterações, os mecanismos de enfrentamento podem se tornar estratégias adaptativas, que são respostas de longo prazo, e envolvem alterações culturais mais profundas (BERKES; JOLLY, 2001).

Nos últimos três anos as comunidades pesqueiras da costa do Basil foram surpreendidas com dois grandes eventos sem precedentes que resultaram em impactos impressionantes nos sistemas socioecológicos. O primeiro impacto, em agosto de 2019, quando mais de 3000 quilômetros da costa do Nordeste em diversos estados foram surpreendidos por uma grande quantidade de óleo cru que deu ao evento o status de derramamento de óleo mais grave já registrado em regiões tropicais costeiras (MAGRIS; GIARRIZZO, 2020a; SOARES et al., 2020a, 2022). Durante o desastre, as pessoas que

utilizam da pesca como seus modos de vida e sobrevivência sentiram os efeitos nas suas vendas e capturas, que reduziram substancialmente, e também se expuseram a impactos à saúde e segurança alimentar (ESTEVO et al., 2021; RAMALHO, 2019). Do primeiro registro de óleo nas praias do Nordeste, em agosto de 2019, ao último, em junho de 2020, houve uma sobreposição temporal com um outro evento de grande impacto: a Pandemia do COVID-19 (MAGALHÃES et al., 2021). O contexto pandêmico também gerou forte impacto nas comunidades pesqueiras do Nordeste, que, num curto espaço de tempo, mais uma vez tiveram que lidar com a redução nas vendas, e queda nos preços do pescado devido às consequências econômicas e comerciais da pandemia (SMITH et al., 2020b; BENNETT et al., 2020).

Com o objetivo de avaliar a capacidade adaptativa das comunidades pesqueiras artesanais do Nordeste ao óleo de 2019 e da pandemia do COVID-19, foram realizadas entrevistas semiestruturadas cem diferentes comunidades pesqueiras de três estados do Nordeste. A dissertação está estruturada em dois capítulos: um primeiro, com uma breve revisão da literatura que situa o contexto da pesquisa e a base teórica; e um segundo, onde são apresentados e discutidos os resultados da pesquisa, em forma de artigo científico que tem como título "*Adaptation and vulnerability of coastal fishing communities after strong impact events on Brazilian coast*" e será submetido à revista *Marine Pollution Bulletin.* Ao final, são feitas conclusões gerais acerca da pesquisa.

2 REVISÃO DE LITERATURA

2.1 A pesca e comunidades pesqueiras no Brasil

O Brasil é um importante país produtor de pescado (MATTOS; WOJCIECHOWSKI; GANDINI, 2020). Segundo os últimos dados disponíveis oficiais, (MPA, 2011) o Brasil está na 19ª colocação no ranking mundial de produtores de pescado, produzindo 1.431.974,4 toneladas no ano do relatório, especialmente a região Nordeste, que abriga a maior parte dos pescadores brasileiros e também a produção (MAIA; MAIA, 2011), seguida das regiões Sul, Norte, Sudeste e Centro-oeste (Tabela 1).

Tabela 1 – Dados oficiais de produção pesqueira por região do Brasil, segundo o último Boletim Estatístico da Pesca e Aquicultura (MPA, 2011).

Região do Brasil	Produção (toneladas)	Percentual
Nordeste	454.216,9	31,7%
Sul	336.451,5	23,5%
Norte	326.128,3	22,8%
Sudeste	226.233,2	15,8%
Centro-oeste	88.944,5	6,2%
Total	1.431.974,4	100%

Esta produção vem principalmente da pesca artesanal e de pequena escala e os dados oficiais distinguem as produções advindas da pesca extrativa e da aquicultura marinhas e continentais. Dentre estas, a pesca extrativa marinha representa a principal fonte da produção, responsável por 31% do pescado produzido no Brasil. De Norte a Sul, principalmente na região costeira onde a pesca é de grande importância para as populações costeiras (CASTELLO, 2007).

A origem da pesca no país vem desde as práticas indígenas de subsistência, antes da chagada dos portugueses (LERY, 1964, *apoud,* DIEGUES, 2005. Com o passar dos séculos, e devido às influências dos europeus na costa Brasileira, a pesca foi

se modificando e agregando saberes indígenas, mas também práticas tragas pelos europeus durante o período colonial. Um outro momento histórico da pesca se deu com a instalação de camponeses pobres sem-terra e ex-escravizados em rios e zonas costeiras, após a instalação da república, que migraram dos centros urbanos para zonas costeiras em busca de terra e renda (MATTOS et al., 2017). Assim a pesca originou o estabelecimento de diversas comunidades pesqueiras, com diferentes culturas e variações regionais, como os caiçaras, açorianos e os jangadeiros (DIEGUES et al., 2005).

Em linhas gerais, existem duas modalidades de pesca no brasil: A pesca industrial e a pesca artesanal. A legislação que regula as atividades pesqueiras no Brasil define esta última como aquela pesca que é:

> [...] praticada diretamente por pescador profissional, de forma autônoma ou em regime de economia familiar, com meios de produção próprios ou mediante contrato de parceria, desembarcado, podendo utilizar embarcações de pequeno porte (BRASIL, 2009).

No Brasil, nesta modalidade, há um alto grau de informalidade, e seus praticantes têm pouca tecnologia associada às etapas da cadeia produtiva (MATTOS; WOJCIECHOWSKI; GANDINI, 2020). O que difere de outro tipo de pesca, a industrial, que é praticada geralmente por empresas (ou pessoas físicas) que contratam a mão de obra de pescadores, e utilizam embarcações de maior porte (BRASIL, 2009) com objetivos comerciais. Apesar da incerteza e desatualização dos dados oficiais do país, estima-se que de 60% da captura nacional seja advinda da pesca em pequena escala, atividade que em 2010 empregava mais de 600 mil pessoas no Brasil (MPA, 2010). Além desta importância nacional, diferente da pesca industrial - que tem como principal objetivo suprir o mercado externo - a pesca artesanal supre a demanda local e destina-se ao consumo direto da população local garantindo um papel social importante à atividade (MATTOS; WOJCIECHOWSKI; GANDINI, 2020).

Ao longo de todo o litoral existem diversas destas comunidades que historicamente utilizam o recurso pesqueiro e desenvolvem suas práticas culturais (DIEGUES, 1994). São as comunidades pesqueiras artesanais, um todo sociocultural que tem localização geográfica definida e uma rede de interrelações, não apenas no âmbito produtivo, mas com uma evidente estrutura histórico-cultural (MATTOS et al., 2020, *apoud* BUZETA, 1987). Nestas comunidades, há uma grande diversidade de social, cultural resultante das diferentes espécies-alvo, habitats, tecnologias empregadas, práticas e conhecimentos acumulados (SILVA; LOPES, 2015).

O conhecimento ecológico local é um corpo de conhecimentos acumulados que surgem a partir da estreita relação entre as comunidades tradicionais e os recursos naturais. Ele está envolvido por processos adaptativos e mantidos por entre as gerações por meio da transmissão cultural (BERKES; COLDING; FOLKE, 2000) e é de extrema valia para a conservação marinha, pois têm uma acurácia e especificidade (DREW, 2005). É desta manutenção de tradições e do equilíbrio social, econômico e ambiental (MATTOS; WOJCIECHOWSKI; GANDINI, 2020)que emerge a importância cultural da pesca artesanal.

2.2 Comunidades pesqueiras e ameaças

As condições da pesca extrativa em todo o globo têm caminhado em direção ao colapso, pois 80% dos recursos pesqueiros estão em um status de máxima explotação, sobre explorados, esgotados ou em recuperação de um colapso (FAO, 2009). Além disto, a pesca encontra-se com a produção estagnada desde a década de 80 (CC), reflexo das consequências das atividades antropogênicas que tem colocado os ecossistemas e os serviços ecossistêmicos ao seu limite (ASWANI et al., 2018; RIPPLE et al., 2017).

A exaustão dos recursos naturais e a atual crise na biodiversidade (CORLETT, 2015) afeta a provisão de serviços ecossistêmicos essenciais para a vida (CARDINALE et al., 2012). A depleção dos estoques pesqueiros ameaça também os modos de vida

(KLEISNER et al., 2013; TEH; SUMAILA, 2013) como por exemplo, a degradação dos recifes de corais (HUGHES et al., 2017), causando flutuações nas capturas (POMEROY et al., 2016), reduzindo a biodiversidade e afetando a provisão dos serviços ecossistêmicos marinhos (CHRISTENSEN et al., 2014). A situação é dramática para as comunidades pesqueiras, que num contexto social lidam com históricas desigualdades e uma complexa relação com a pobreza (BÉNÉ; FRIEND, 2011) exacerbada pela degradação ambiental (GAO; XU; YUAN, 2021).

Já se sabe que comunidades humanas afetadas por grandes impactos podem responder e se adaptarem a mudanças ambientais, o que chamamos de capacidade adaptativa (ADGER, 2006). Um dos componentes da capacidade adaptativa são os mecanismos de enfrentamento, que são respostas emergenciais adotadas como forma de contornar os efeitos imediatos de tal mudança. Geralmente emergem em escalas locais e no nível individual. As estratégias adaptativas, por outro lado, são aquelas respostas mais persistentes, que envolvem alterações culturais, para proteger seus modos de vida. Os mecanismos de enfrentamento podem ser observados em escalas temporais e espaciais menores, enquanto que as estratégias adaptativas, em escalas maiores. Entretanto, ao longo do tempo, os mecanismos de enfrentamento podem se tornar estratégias adaptativas (BERKES; JOLLY, 2001) (Tabela 2).

Tabela 2 – Diferenças entre os tipos de respostas a mudanças ambientais por comunidades dependentes de recurso (BERKES; JOLLY, 2001).

	Mecanismos de enfrentamento	**Estratégias adaptativas**
Tipo de resposta	Curto-prazo	Longo-prazo
Escala espacial	Menor	Maior
Nível	Individual e familiar	Comunidades e modos de vida
Exemplos	Respostas emergenciais em estações anormais	Alteração de atividades produtivas e regras locais para proteção dos modos de vida

Entretanto, a capacidade de responder não necessariamente implica a manutenção ou melhoria de vida das comunidades (SILVA; PENNINO; LOPES, 2020). E considerando que estas não são sistemas homogêneos, determinados indivíduos e famílias podem se ajustar melhor a novos cenários, enquanto outros podem se tornar ainda mais vulneráveis (BENNETT; DEARDEN; PEREDO, 2015).

A vulnerabilidade é entendida como um estado de susceptibilidade de um indivíduo ao dano (CINNER et al., 2013). Apesar de serem necessárias à sobrevivência dos modos de vida diante de um impacto, os mecanismos de enfrentamento não reduzem a vulnerabilidade diante da exposição futura ao mesmo perigo, ao contrário das estratégias adaptativas (VINCENT et al., 2013).

2.3 Os impactos de derramamentos de óleo

Nas últimas décadas, apesar de muito já ter avançado em relação à prevenção dos acidentes de derramamento de óleo, a crescente tendência do mercado e transporte de óleo se mantém, assim como a ocorrência de acidentes principalmente nas maiores rotas de transporte (CHEN et al., 2019; VIEITES et al., 2004). Estes acidentes acarretam uma série de efeitos que atingem espécies em todos os níveis tróficos (HUANG et al., 2011). Alguns são imediatos como a contaminação do fitoplâncton, mortandade em massa de peixes e outros, de médio e longo prazo. (BARRON, 2012; LAW; HELLOU, 1999; OLSEN et al., 2019; XIONG et al., 2019).

Derramamentos de óleo alteram toda a estrutura do ecossistema, mudanças que podem ser manter por longos períodos, após a contaminação (CHANG et al., 2014; OLSEN et al., 2019). Mas os impactos ecológicos e ambientais se ampliam à sociedade. E da mesma maneira, os efeitos podem ser de imediatos a tardios. A contaminação de espécies de importância alimentar representa risco às pessoas que consomem tais recursos (LAW; HELLOU, 1999). Consequentemente, em regiões costeiras, a contaminação do pescado impacta atividades centrais na economia local destas áreas, como a pesca e o turismo (GARZA et al., 2009; PASCOE, 2018). Isto gera sérias

implicações sociais, sobretudo para as comunidades que têm uma forte relação e dependência dos recursos naturais, pois estão na linha de frente dos prejudicados e sofrem os impactos de curto a longo prazo (CROISANT; SULLIVAN, 2018; GILL; RITCHIE, 2020).

2.4 O caso do derramamento do óleo de 2019 no Nordeste

Até 2019, o Brasil não havia encarado um desastre de derramamento de óleo de grandes proporções. Mas no mês de agosto deste ano, o litoral brasileiro foi surpreendido por uma grande uma descarga de óleo advinda do alto mar, que em pouco tempo já havia se espalhado para 11 estados litorâneos e quase 3000 quilômetros da costa (MAGRIS; GIARRIZZO, 2020; IBAMA, 2020). Por ter sido um desastre sem precedentes nas regiões tropicais costeiras, o acontecimento logo se tornou foco na mídia e comunidade científica (SOARES et al., 2020b, 2022).

Além das características do próprio derramamento (como volume de óleo e extensão da área atingida), o tempo de resposta ao desastre e ações de manejo influenciam diretamente a severidade dos impactos de um derramamento (CHANG et al., 2014). Neste sentido, além deste desastre ter tido proporções catastróficas, um sério agravante foi a inércia do governo brasileiro na tomada de ações para o enfrentamento do desastre (SOARES et al., 2020; BRUM; CAMPOS-SILVA, OLIVEIRA, 2020). Os impactos do derramamento para as comunidades pesqueiras eram anunciados e o resultado disto foram sérios prejuízos econômicos e sociais (ARAÚJO; RAMALHO; MELO, 2020; RAMALHO, 2019; ESTEVO, 2020).

2.5 Os efeitos da Pandemia na pesca e o recorte do Nordeste brasileiro

Desde o fim de 2019 o mundo vem enfrentando um novo tipo de mudança, gerada pela Pandemia do COVID-19. O início de tudo se deu quando uma pneumonia causada por um coronavírus beta anteriormente desconhecido (2019-nCOV) vinculado a um mercado atacadista de frutos do mar em Wuhan (China) (ZHU et al., 2020) se

espalhou para diversas partes do mundo, por meio da transmissão de humano para humano (RIOU; ALTHAUS, 2020) e por volta de 40 dias se tornou uma pandemia global de proporções nunca vistas antes.

Além das irrecuperáveis 80 milhões de vidas perdidas em todo o mundo (painel internacional da Organização Mundial da Saúde (https://covid19.who.int), também persistem graves consequências socioeconômicas, incluindo forte impacto na pesca de pequena escala. Diante do fechamento do mercado (BENNETT et al., 2020; CAMPBELL et al., 2021), as comunidades pesqueiras experimentaram a redução nos dias de pesca e, consequentemente, na produção diária e na renda (HOQUE et al., 2021).

Em fevereiro de 2020, devido aos casos de infecções, óbitos e internações motivados pelos casos de COVID-19, o Brasil declarou estado de emergência em saúde pública (BRASIL, 2020). Mas enquanto o Brasil alcançava o maior número de casos da América Latina e também altas taxas de transmissão, ao invés de seguir as recomendações para diminuir o avanço da pandemia (SILVA; FILHO; FERNANDES, 2020), o governo brasileiro não agiu rapidamente (THE LANCET, 2020) e isto catalisou os, já sérios, impactos da pandemia no país.

O contexto pandêmico resultou em forte impacto nas comunidades pesqueiras, que tiveram que lidar com interrupções nos mercados de exportação, perda de vendas, queda nos preços do pescado (SMITH et al., 2020a) fechamentos completos de algumas pescarias, perda de receita a interrupções de mercado (BENNETT et al., 2020) questões de transporte e também localizações geográficas e reduções de viagens de pesca (HOQUE et al., 2021). No nordeste do Brasil, tudo isto aconteceu num intervalo de poucos meses, e cerca de 503.692 pescadores artesanais ainda se recuperavam dos fortes impactos como queda no preço, produção e renda dos recursos pesqueiros (ARAÚJO; RAMALHO; MELO, 2020; ESTEVO et al., 2021; RAMALHO, 2019).

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THE VULNERABILITY OF FISHING COMMUNITIES ON BRAZILIAN COAST: COPING WITH SYNERGISTIC STRONG IMPACTS TO ARTISANAL FISHERIES

Target journal: Global Environmental Change

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Abstract

The coast of Northeast region of Brazil is marked by small-scale fishing, that is an activity that plays a cultural and economic role at national and local scale. Between 2019 and 2020 these communities were surprised by an extensive oil spill in tropical regions and the economic restrictions of COVID-19 pandemic. This article examines the adaptive capacity and vulnerabilities of coastal fishing communities in the face of the combined impacts. We conducted online and presential semi-structured interviews in three states on the Northeast to understand how coastal fishing communities dealt with the oil spill and pandemic and what characteristics driven the ability to cope. Our findings highlight the significant pressures faced by fishers to seek alternative sources of income during both events and the lack of adequate support and resources provided to artisanal fishers, resulting in their increased vulnerability and we call attention to the cryptical situation of Brazilian fishing communities which were even more neglected by the Brazilian government during the synergetic impacts of the 2019's Oil spill and the COVID-19 Pandemic. Future research should focus on understanding the long-term socio-economic and ecological impacts of such events and identify ways to improve government assistance programs.

Key-words: Artisanal fishing. Oil spill. COVID-19.

1. Introduction

Artisanal fisheries play a critical role in sustaining the livelihoods of more than 38 million individuals worldwide, making substantial contributions to regional and global economic security and income (FAO, 2020). These fisheries also have significant implications for local food security, income generation, and cultural preservation, particularly in developing nations (BÉNÉ; FRIEND, 2011; MEA, 2005; FAO, 2020). Despite their undeniable importance, fishing communities often are exposed to consequences of global changes, including the decline of fish stocks, pollution, and ocean warming (MEA, 2005).

Dealing with changes within socioecological systems involves two temporal scales: the short-term emergency response known as coping mechanisms or coping ability, and the long-term sustainable adjustments, called adaptive strategies. So, coping mechanisms refer to immediate responses to threats that jeopardize the socioecological system, while adaptive strategies involve long-term adjustments made by communities to protect their livelihoods (BERKES; JOLLY, 2001; SMIT; WANDEL, 2006). These responses are integral aspects of resilience. A term that ecologically, is defined as the system's ability to absorb changes and maintain persistence (HOLLING, 1997); while socially, it refers to the capacity of humans to absorb changes while preserving their livelihoods (ADGER, 2000). Within socioecological systems, these two concepts are intertwined, once human and natural elements are interconnected through community dependence on ecosystems and economic and cultural activities (BERKES; FOLKE, 1998; ADGER, 2000).

In December 2019, an outbreak of pneumonia cases caused by a novel beta coronavirus (2019-nCOV) was initially identified in a seafood wholesale market in Wuhan, Hubei province, China (ZHU et al., 2020). The new coronavirus disease (COVID-19) rapidly spread across China through human-to-human transmission (RIOU; ALTHAUS, 2020), taking just 30 days to extend beyond Hubei and reach other regions of Mainland China (WANG et al., 2020). In approximately 40 additional days, it evolved into a global pandemic affecting over 115 countries. After a year of the pandemic, COVID-19

has resulted in an estimated 80 million deaths worldwide (World Health Organization international dashboard, (https://covid19.who.int), along with severe socioeconomic consequences. Small-scale fisheries have been particularly impacted by this global crisis. The closure of markets has led to a reduction in fishing trips, daily production, and income for fishing communities (BENNETT et al., 2020; CAMPBELL et al., 2021; HOQUE et al., 2021).

In February 2020, Brazil declared a state of emergency in public health due to the escalating cases of COVID-19 infections, deaths, and hospitalizations (BRASIL, 2020). Brazilian government did not take action (THE LANCET, 2020), and did not follow the restrictions to curb the pandemic (SILVA; FILHO; FERNANDES, 2020). As a result, Brazil had the highest number of cases in Latin America (BHATIA et al, 2020), with significant transmission So, pandemic has had a profound impact on fishing communities, who faced loss of sales, decline in seafood prices, complete shutdowns of some fisheries, reductions in fishing trips and disruptions in export markets (SMITH et al., 2020; HOQUE et al., 2021).

In the months preceding the arrival of the COVID-19 pandemic in Brazil, fishing communities in the Northeast region were already grappling with the aftermath of the largest recorded oil spill in coastal tropical regions (SOARES et al., 2020). From August to December 2019, approximately 3000 kilometres of coastline were affected by a significant volume of crude oil, constituting the most extensive oil disaster ever documented in tropical oceans (MAGRIS; GIARRIZZO, 2020; SOARES et al., 2022; SOARES et al., 2020, 2022; IBAMA, 2019). This environmental catastrophe had profound social and ecological impacts on over than 500,000 small-scale fishers, leading to decreased prices, production, and income from fishing resources (ARAÚJO; RAMALHO; MELO, 2020; DE OLIVEIRA ESTEVO et al., 2021; RAMALHO, 2019).

Brazil is a major fish producer, with the Northeast region being home to a significant portion of the country's fishers and production (MATTOS; WOJCIECHOWSKI; GANDINI, 2020), The majority of these fishers belong to small-scale fishing communities (MAIA;

MAIA, 2011), whose majority are small-scale fishing communities (CASTELLO, 2007; DIEGUES, 1994; MATTOS; WOJCIECHOWSKI; GANDINI, 2020).

In this study, we aimed to evaluate how fishing communities in the Brazilian Northeast coast cope with the combined impacts of the 2019 oil spill and the COVID-19 pandemic. We conducted semi-structured interviews using both online and in-person approaches to investigate the adaptive capacity of these vulnerable fishing communities in the face of these challenges, including their coping mechanisms.

To adhere to the recommended social isolation measures and restrictions during the pandemic, we distributed kits for online interviews and followed a specific online protocol. These interviews were conducted at the appropriate stages of the pandemic, aligning with the guidance provided by health authorities. Our study explores how these communities responded to the synergistic impacts along the Brazilian coast and identifies the characteristics that facilitated individuals' abilities to cope with such significant events. The research highlights the vulnerability of small-scale fishers in Northeast Brazil and emphasizes the slow and inadequate government responses in mitigating the socioeconomic impacts and supporting affected families.

2. Material and Methods

This study was conducted as part of the Future Pact research network, an interdisciplinary group of researchers specializing in fish and fisheries. The network aims to comprehensively examine, forecast, and mitigate future impacts on coastal communities. The study specifically focused on three northeastern states in Brazil: Rio Grande do Norte, Alagoas, and Bahia. Researchers from these states collaborated closely in the data collection process, employing a coordinated approach to gather relevant information. The interdisciplinary nature of the research network ensured a comprehensive understanding of the various factors affecting coastal communities in the study regions.

2.1 Study area: Small-scale fishing communities in Brazilian northeast coast

Brazilian northeast coast an important region to marine resources uses. Due to its natural diversity and concentration of coastal-marine resources there are diverse fishing communities that strongly relies on fish resources and use different fishing strategies, target species and types of vessels (DIEGUES et al., 2005). The study was conducted in 17 coastal municipalities in the Brazilian states of Rio Grande do Norte, Alagoas, and Bahia. These localities were chosen due to (i) the presence of small-scale fishing communities, (ii) previous studies conducted in these regions, and (iii) their exposure to the impacts of the oil spill and the COVID-19 pandemic. This allowed us to investigate the adaptation strategies and vulnerabilities of these communities facing multiple stressors (Fig.1).

Several of our study sites are situated within protected areas. These include the Sustainable Development Reserve (SDR) Ponta do Tubarão and the Environmental Protected Area (EPA) Recife de Corais in Rio Grande do Norte state, the EPA Recife de Corais in Alagoas state, and the Environmental Protected Area Litoral Norte and Environmental Protected Area Rio da Capivara in Bahia state (Fig. 1).

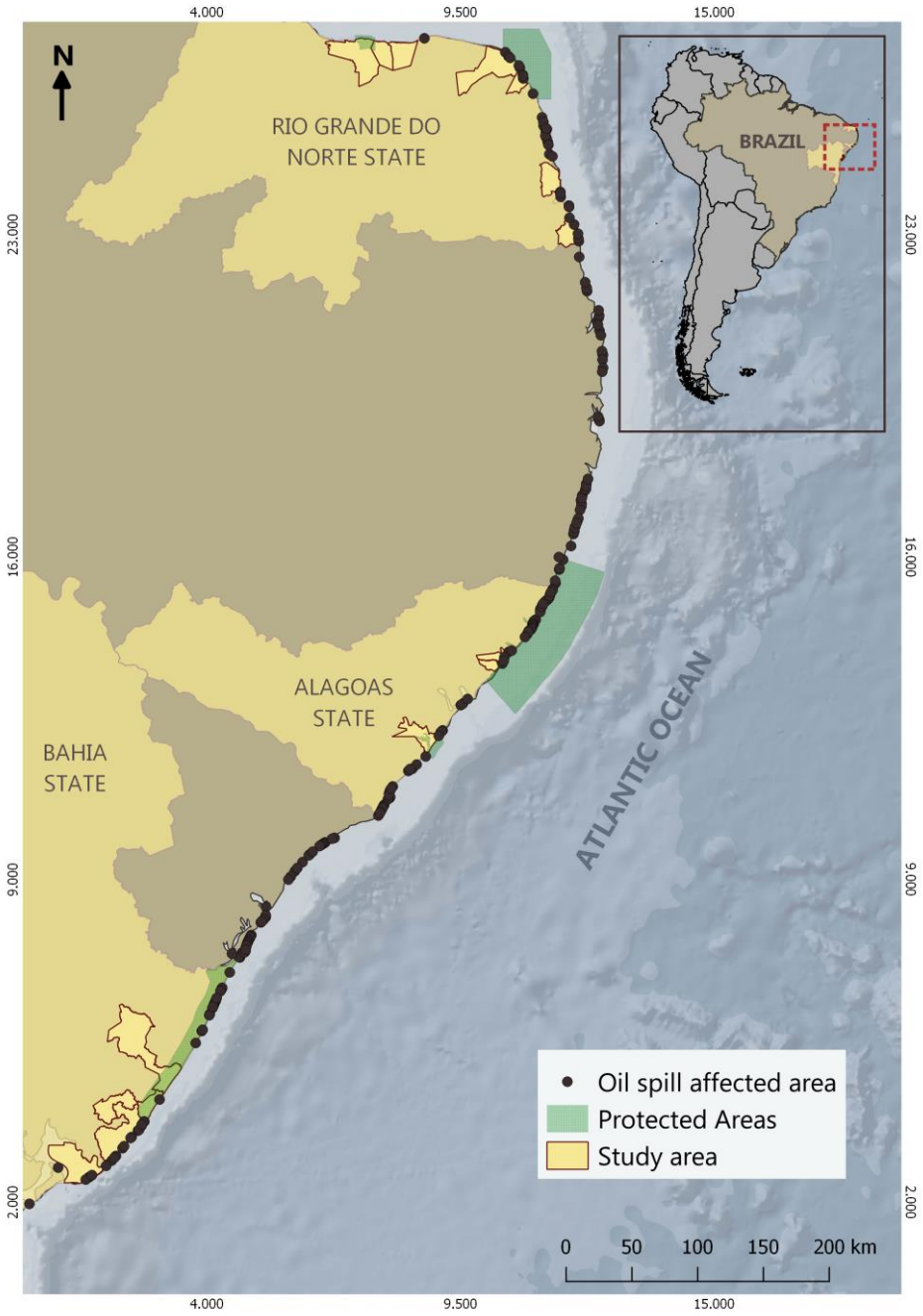

Figure 1 – Study area, Brazilian coastal cities of three states.

2.2 Data collection

The data collection for this study was conducted by a team led by researchers from Future Pact, utilizing the snowball sampling method. The process involved initially interviewing an expert individual, also known as a key informant or focal point. This

individual then provided recommendations for additional participants, leading to a person-to-person indication approach for data collection (VINUTO, 2016). Between May and August 2022, semi-structured interviews were carried out with coastal and oceanic fishers as well as shellfish gatherers. Considering the need to prevent the spread of COVID-19, interviews were conducted using a combination of video calls through the WhatsApp application and face-to-face meetings when it was deemed safe to do so.

After the online phase, the data collection process involved the transfer of interview materials from the focal point to another local fisher who agreed to participate in the research. Equipped with a smartphone, the interviewee contacted the coordinator through WhatsApp to schedule a suitable day and time for the interview. During the interview, the questionnaire was transcribed into an online form using the Google Forms application, and the responses were recorded and saved in an online spreadsheet stored in the cloud.

During the in-person interviews, safety measures were implemented, including the use of masks and hand sanitizers. The questionnaire was printed, and the responses were recorded on paper. Afterwards, the data was transferred to a Google Form, allowing for centralized data collection and storage in the cloud. The questionnaire had two sessions of questions to access, through fishers' knowledge and perception, individual socioeconomic information and coping strategies adopted by them after Oil spill and Pandemic and after impacts (see in Supplementary material).

2.5 Statistical analyses

To test the influence of socioeconomic and cultural variables on the coping ability of fishers and determine the factors that contributed to varying levels of resilience, we conducted Generalized Linear Mixed Models (GLMM) using the R software (R Development Core Team, 2023). The GLMM analysis was performed using the 'MuMIn' package, allowing us to explore the relationships between the response variable and the predictors.

During the most severe periods of the oil spill and the COVID-19 impacts on Brazilian coastal fishers, the ability to engage in fishing activities became impractical due to the negative effects on catch and sales (ARAÚJO; RAMALHO; MELO, 2020; DE OLIVEIRA ESTEVO et al., 2021), and the restrictions, declining sales, and pricing challenges driven by pandemic restrictions, as well (BENNETT et al., 2020; HOQUE et al., 2021; SMITH et al., 2020b; SCHAEFER et al., 2020; SILVA; FILHO; FERNANDES, 2020).

Considering these immediate responses to both impacts and coping mechanisms, the capacity to adopt alternative income sources becomes crucial. So, our analysis involved constructing models with the interviewee's capacity to find an alternative activity when fishing was not viable as a proxy for their ability to cope during the impact events.

The capacity of adapt to such an abrupt impact is context dependent (SMIT; WANDEL, 2006; TOLENTINO-ARÉVALO et al., 2019). The small-scale fishing communities in Bahia state, for example, are inside Salvador city, a huge capital, while other communities, on the country side of the states. So, the models included the state as a random effect.

We used as predictors the number of beaches affected by the oil spill, the number of people infected by COVID-19, age, years of formal education, income before the impacts, gender, government aid support, and whether the community is located within a Protected Area. This approach enabled us to gain insights into the factors influencing fishers' ability to cope with the impacts and identify potential drivers of resilience within these communities.

3. Results

Between May 2021 and August 2022, a total of 394 artisanal fishers were interviewed, with 65 from Alagoas, 183 from Bahia, and 146 from Rio Grande do Norte. The sample consisted of 78% men and 22% women, with an average age of 50 years.

The majority of the northeast artisanal fishers could not cope with both impacts (in terms of finding other activity as source of income). We found that over 60% of the interviewed fishers were unable to find alternative sources of income to cope with both situations. Despite the lack of alternatives, the main sources of income mentioned by the fishers during both impacts were predominantly jobs in civil construction (45% during the oil spill and 41% during the lockdown) and domestic services (20% during the oil spill and 19% during the lockdown). In addition, a smaller percentage of fishers mentioned engaging in services related to the maintenance of fishing gears and vessels (8% during both events), sales (6% during the oil spill and 7% during the lockdown), and various other activities (6% during the oil spill and 8% during the lockdown) (Fig. 2).

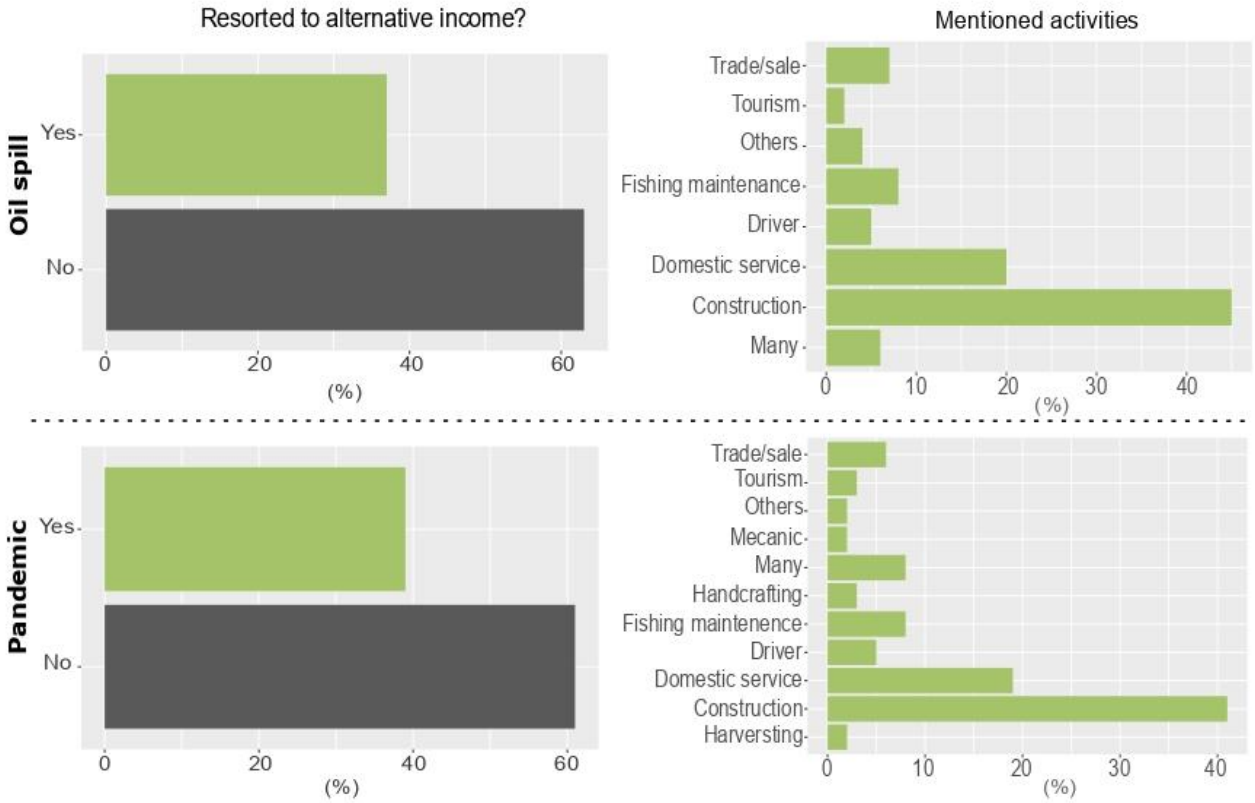

Figure 2 – The frequency of fishers who resorted to alternative jobs during the oil spill and the pandemic events, as well as the mentioned activities

Overall, despite the evident impacts, the government aid provided during the oil spill was largely ineffective. Our findings revealed that 32% of the fishers did not receive any government assistance, while only 14% received aid during this period. In contrast,

during the pandemic, 46% of the fishers received government aid, while only 9% received assistance during the oil spill.

In addition to exploring the fishers' capacity to find alternative sources of income as a coping mechanism, we also examined changes in the number of fishing grounds utilized. Interestingly, more than 60% of the fishers reported that the number of fishing grounds they used remained unaffected (63% during the pandemic and 58% during the oil spill). However, there were reports of changes in the number of fishing grounds during the oil spill (42%) and the pandemic (37%) (Fig. 3a, b).

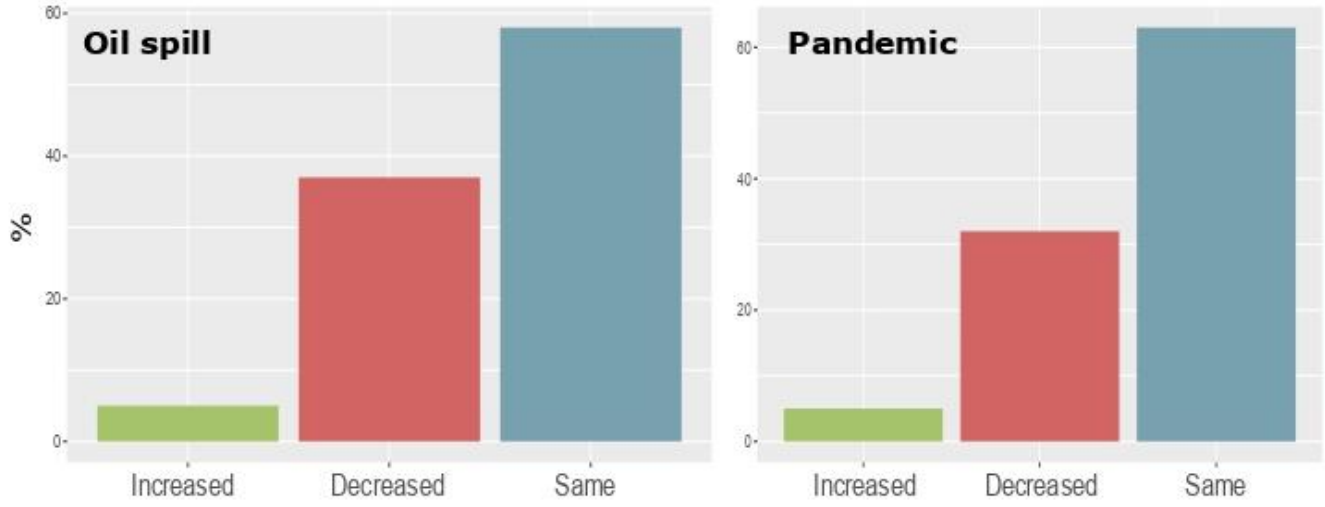

Figure 3 – The frequency of changes related to the number of fishing areas during the oil spill (3a) and the pandemic (3b).

During the Oil spill, most fishers reported a decreasing of the number of fishing grounds visited, mainly due to the presence of oil on those areas when they had to avoid oiled areas so as not to lose gears (Table 1). On the other hand, the presence of oil on late fishing grounds also motivated the increasing on the number of fishing grounds, once they look for clean grounds to fish. During the pandemic, there was a decrease in the number of fishing grounds visited by fishers. This was primarily due to the need to avoid contact with other fishers in order to minimize the risk of COVID-19 transmission.

Additionally, factors such as declining pricing and reduced sales also contributed to the decision to reduce fishing activities. It is worth mentioning that 5% of the fishers reported an increase in their fishing areas as a strategy to avoid contact with other fishers and potentially increase their income while minimizing financial losses.

Table 1 – Reported changes on the number of fishing grounds during oil spill and pandemic.

Related changes during Oil spill		**Mentions (%)**
Increased		5%
	Presence of oil in fishing areas	57%
	Absence/reduction of fish in fishing grounds	36%
	Fear of contamination	7%
Decreased		37%
	Presence of oil in fishing areas	53%
	Inability to fish	20%
	Fear of contamination	9%
	Absence/reduction of fish in fishing grounds	9%
	Decline in sales/marketing	11%
Related changes during Pandemic		
Increased		5%
	Avoiding the former fishing spots	31%
	To increase income	31%
	Absence/reduction of fish in fishing grounds	19%
	More available areas	13%
	Fishing not allowed	6%
Decreased		32%
	Fear of contamination	38%
	Stopped fishing/reduced frequency	28%
	Decline in sales/prices	22%
	Fishing not allowed	9%
	Others	3%

During the oil spill, fishers residing in areas heavily impacted by the crude oil spill faced significant pressures to seek alternative sources of income. The Generalized Linear Mixed Models (GLMM) analysis further revealed a strong association between the level of impact on their communities and the likelihood of engaging in alternative activities to sustain their livelihoods (Fig. 5b).

Similarly, during the pandemic, fishers who received government aid support were more inclined to adopt alternative income-generating activities (Fig. 5a). This suggests that government support played a crucial role in enabling fishers to adapt and find alternative means of sustaining their income during the pandemic.

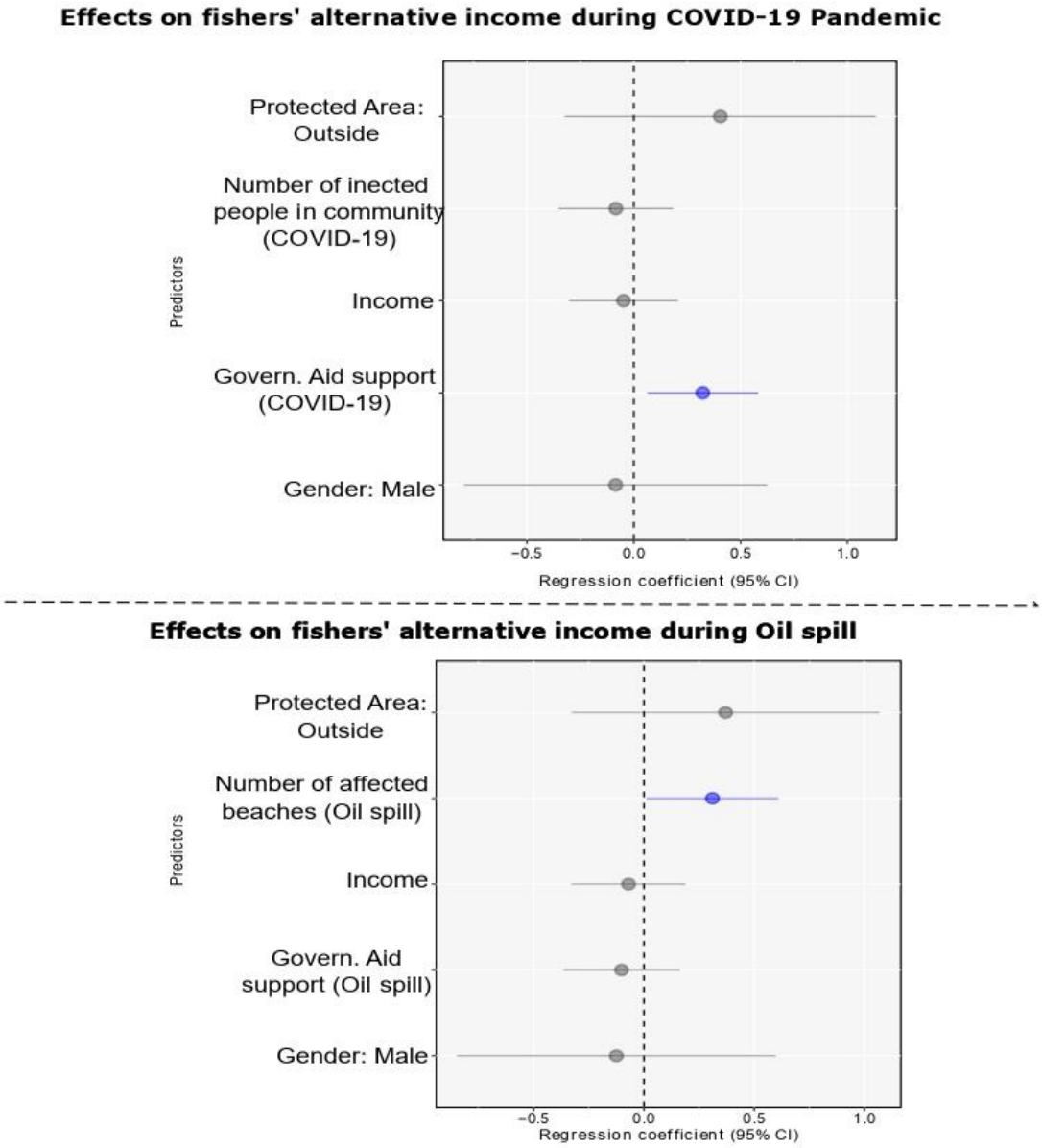

Figure 4 - GLMM plot. Response variable is the capacity to resort to other job during the Oil spill (b) and Pandemic (a).

Discussion

Despite the historical vulnerability and threats that fishers in Brazil have been subjected (NAYAK; OLIVEIRA; BERKES, 2014), there is no register of other environmental hazard that affected so strongly small-scale fishers as the 2019's Oil spill did (SOARES et al., 2020, 2022). These communities were absolutely surprised by the large amount of crude oil that contaminated seafood (MAGALHÃES et al., 2022) and interrupted sell and consume (ARAÚJO; RAMALHO; MELO, 2020; RAMALHO, 2019), giving them no chance to anticipate or respond to the impact. The decline in seafood consumption during the Oil spill (ARAÚJO; RAMALHO; MELO, 2020; DE OLIVEIRA ESTEVO et al., 2021) was overlapped by the social isolation due to COVID-19 and lockdowns in Brazil and also by the commercial activities shutdowns.

Fishing dependency and flexibility to learn other activities is essential for the adaptive capacity (SILVA; PENNINO; LOPES, 2020). In this way, the less "specialist" fishers are, the more economically flexible they are in adapting for changes (MARSHALL et al., 2007; SILVA; LOPES, 2015). The level of specialization matters when fisher communities face environmental changes and disasters, once flexibility of resource users (to resort to another livelihood strategy) (BERKES; SEIXAS, 2005) is essential to cope with disturbances, be resilient and take advantage of the new opportunities in socioecological systems (IPCC, 2007).

Beyond being strongly dependent on natural resources, artisanal fishers did not have an effective government support to deal with the catastrophe. During both impacts, fishers in northeast had to deal with these strong events, once in both cases Brazilian government action was late, uncoordinated and week (BRUM; CAMPOS-SILVA, OLIVEIRA, 2020; THE LANCET, 2020).

First, that the national contingency plan for oil and water pollution incidents under national jurisdiction was only formalized by the Minister of Environment 41 days after the disaster. Second, the federal government implementation "emergency" aid of cash assistance during the Oil spill, only arrived to fishers three months after the Oil spill (BRASIL, 2019). Beyond late, major part of fishers did not received the government aid

support, as found (DE OLIVEIRA ESTEVO et al., 2021). This catastrophic scenario put fishers in hard situations, as said a fisher: *“We have no money and we will not stop feeding our children. What do we have to offer them?! Our fish. They may be contaminated but what can we do? My God!... The government gives us no other way”* (ARAÚJO; RAMALHO; MELO, 2020).

During pandemic, the was not a specific policy to include fishing as an essential activity during lockdown (BRASIL, 2020). Do not considering even the most recent vulnerable situation of small-scale fishers in northeast due to the oil spill.

The government aid support during oil spill was implemented as an emergency measure, aiming to provide to fishers with a minimum wage during four months ( ). However, the extent of coverage and effectiveness of this policy was found to be limited. The lack of reliable and consistent official fisheries data in Brazil further could have exacerbated the challenges in reaching and supporting the affected fishermen. For several years, the absence of a comprehensive registry to monitor fishing landings has been a persistent issue, and a significant proportion of fishermen operate in the informal sector without formal association affiliations ( ). Consequently, the majority of fishermen impacted by the oil spill did not receive the anticipated financial assistance.

In contrast, the government aid support implemented during the pandemic was not specifically designed to address the needs of artisanal fishers. However, due to the inclusion of many fishermen in the government's income distribution policies, a relatively larger number of individuals within this group were able to access some form of assistance compared to the oil spill period. It is important to note, however, that the financial aid provided during the pandemic amounted to only half of the minimum wage (). This amount fell considerably short of the average income reported by the surveyed fishermen. These findings underscore the limitations and potential inadequacy of the government aid program in effectively supporting the livelihoods of artisanal fishers during times of crisis.

Vulnerability is a susceptibility to harm, a potential for a change or transformation of the system when confronted with a perturbation, rather than as the outcome of this confrontation (GALLOPÍN, 2006).

Our findings indicate that fishers residing in the most heavily affected areas faced significant pressures to explore alternative sources of income. This situation arose as a consequence of the delayed and ineffective policies implemented to mitigate the negative impacts of the oil spill on the northeast coast, as the financial support (not) given. Related to the pandemic, our results revealed a relation between government assistance and the fishers' capacity to pursue alternative livelihood strategies during this challenging period. One potential factor than can be contributing to this association is the insufficient amount of aid provided, which falls short of even the minimum wage ( ). This discrepancy may have compelled individuals to seek additional means of supplementing their income.

Conclusions

It is evident that the COVID-19 pandemic has exacerbated the already recent negative impacts of the oil spill on vulnerable communities, resulting in a continuous and synergistic effects across socio-cultural, economic, and ecological dimensions of artisanal fisheries in Brazilian coast (MAGALHÃES et al., 2021).

This situation is particularly alarming considering the marginalized and neglected status of fishing communities (KALIKOSKI et al. 2009; RAMALHO; DOS SANTOS, 2020) as well as the increasing vulnerability they face in the context of environmental changes and their impacts on coastal and marine environments (GAO; XU; YUAN, 2021). This vulnerability is of significant concern in the regional context of our study, as the northeastern states of Brazil heavily rely on coastal resources and exhibit high levels of social inequality (CÂMARA et al., 2021; FIGUEIREDO MENDES et al., 2021).

For these communities, fishing is not just an occupation and a source of income, but an integral part of their heritage and identity (CLARKE; MAYER, 2017; DIEGUES, 1994). The profound connection between fishing and livelihood amplifies the potential

loss and trauma experienced by these communities (MARSHALL et al., 2007)**.** Thus, beyond the socioeconomic vulnerability, there exists a cultural vulnerability, as the very activity that defines their identity becomes increasingly challenging.

Our study highlights the precarious situation faced by artisanal fishing communities in the northeastern region of Brazil, who have become even more vulnerable due to the 2019 oil spill and the subsequent COVID-19 pandemic. We suggest to scientific community interested in artisanal fishing in Brazil, explore the long-term socio-economic and ecological impacts of these events on fishing communities, once this catastrophe should be used as an opportunity to understand the weaknesses and vulnerabilities that must be addressed by artisanal fishing communities in the face of multiple stressors. For public authorities and decision-makers, we suggest to improve and create new fishing policy and programs to support their resilience and quality of life when facing other impacts in future.

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Supplementary material

Questionnaire

Individual and socioeconomic information

1. State:
[ ]Alagoas [ ]Bahia [ ]Rio Grande do Norte
2. City:_____
3a. Community/locality:_____ 3b. Inside protected area?_____
4. Age:_____
5. Gender:
[ ]Woman [ ]Man [ ]Other:_____
6. Education/until which age studied? _____

7. Is it associated with fishing local activity (*Colônia de Pesca*) or other?
[ ]Yes [ ]No
8. Which environment do you frequent when fishing?
[ ]Ocean [ ]Beach [ ]Estuary [ ]River [ ]Inland

Coping strategies adopted during impacts

9. What moment was the worst, during the oil spill (the height)?
_____

10. How many beaches were affected by the oil spill in your city?
[ ] Any [ ] Less than a half [ ]A half
[ ] More than a half [ ] All of them

11. What moment was the worst, during the Pandemic (the height)?
_____

12. How many people are infected with COVID-19 do you know?
a. In your house:_____
b. In your family: _____
c. In your livelihood: _____
d. Friends of you: _____
e. In your community: _____

13. How much was your monthly income:
a. On the oil spill : R$_____

b. On the Pandemic: R$ _____
c. Today: R$ _____
d. After impacts: R$ _____
14. Do you resort to another activity, during:
a. The oil spill : [ ] Yes [ ] No Wich ones?_____
b. Pandemic: [ ] Yes [ ] No Wich ones?_____

15. The number of fishing areas changed during the oil spill ? Why?
_____
_____

16. The number of fishing areas changed during the Pandemic? Why?
_____
_____
17. During the impacts. Do you think you could adapt better, same or worse than others in your community?
a. Oil spill: [ ]Better [ ]Same [ ]Worse
b. Pandemic: [ ]Better [ ]Same [ ]Worse

18. How Much satisfied are you with the government action:

a. Before impacts:

Totally unsatisfied Unsatisfied Neutral Satisfied Totally unsatisfied

b. During the oil spill:

Totally unsatisfied Unsatisfied Neutral Satisfied Totally unsatisfied

c. During the Pandemic:

Totally unsatisfied Unsatisfied Neutral Satisfied Totally unsatisfied

d. Today:

Totally unsatisfied Unsatisfied Neutral Satisfied Totally unsatisfied

19. Did you receive governmental aid?
a. During Oil spill : [ ] Yes [ ] No
b. During Pandemic: [ ] Yes [ ] No

3 CONCLUSÕES

A falta de alternativa de renda e as dificuldades somando-se ao pouco suporte do governo durante os piores períodos dos eventos ilustra a capacidade adaptativa a pesca artesanal do Nordeste não só diante destes impactos específicos, mas dão *insights* que podem servir como ponto de partida para ações políticas que garantam uma maior capacidade adaptativa destes modos de vida tão importantes cultural, econômica, local e nacionalmente. Desta maneira, nossos resultados chamaram atenção para a situação crítica dos pescadores artesanais do Nordeste brasileiro diante de dois impactos subsequentes que afetaram seus modos de vida.

Apesar de a capacidade de recorrer a alternativas de renda ser um tipo de mecanismo de enfrentamento, nossos resultados podem ser um ponto de partida da discussão acerca do efeito das Áreas Protegidas na proteção de modos de vida dependentes do recurso natural. Especialmente quando se trata de áreas de uso sustentável, que têm como premissa a compatibilização da conservação da natureza com o uso sustentável dos recursos, este é um ponto que merece investigação. Além disto, a alta especialidade das comunidades pesqueiras artesanais pode gerar uma incapacidade das mesmas se adaptarem aos cenários futuros, o que as coloca numa situação de vulnerabilidade, num cenário de mudanças cada vez mais intensas. Desta maneira, sugerimos que pesquisas sejam desenvolvidas no intuito de investigar outros aspectos e tipos de mecanismos de enfrentamento, especialmente em países em desenvolvimento, onde a pesca artesanal tem um importante papel sociocultural e econômico.