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OFFSHORE WIND ENERGY ON THE COAST OF THE BRAZILIAN STATE OF RIO GRANDE DO NORTE: A CASE STUDY WITH ARTISANAL FISHING COMMUNITIES

ENERGIA EÓLICA OFFSHORE NO LITORAL BRASILEIRO DO ESTADO RIO GRANDE DO NORTE: UM ESTUDO DE CASO COM COMUNIDADES DE PESCA ARTESANAL

ENERGÍA EÓLICA MARINA EN LA COSTA BRASILEÑA DEL ESTADO DE RIO GRANDE DO NORTE: UN ESTUDIO DE CASO CON COMUNIDADES DE PESCA ARTESANAL

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Mariana de Souza Sacramento[1], Renelle Gomes Teixeira[2], André Felipe Simões[3], Fábio de Oliveira Neves[4], Mateus Cury[5], Rodrigo Massao Kurita[6], Camila Savastano de Queiroz[7], Mariana Soares Domingues[8]

ABSTRACT

Offshore wind farms (OWF) have become a vital renewable energy source and represent a promising sector for electricity generation in Brazil. Consequently, the country already has 59 projects registered with IBAMA, with 8 located along the coast of Rio Grande do Norte. In this context, there is a need to recognize the socio-environmental externalities related to their implementation. This study analyses the potential socio-environmental impacts of these projects, focusing on local fishing communities. The research involved a literature review, interviews with 54 fishermen and the use of georeferenced data to identify environmentally sensitive areas. The results indicate that 79% of the fishermen are unaware of project details, and 67% believe that no fair compensation will be provided. Additionally, 51 fishermen expressed opposition to OWFs, while only three showed support. The presence of marine mammals, chelonians, and seabirds was confirmed, and a significant portion of artisanal fishing areas may be affected. The analysis suggests that the lack of marine spatial planning

[1] Master of Science. Institution: Institute of Energy and Environment, University of São Paulo (USP). E-mail: marianasacramento@usp.br Orcid: https://orcid.org/0000-0003-0238-5357

[2] Undergraduate Student in Environmental Management. Institution: School of Arts, Sciences and Humanities, University of São Paulo (USP). E-mail: renellegomes@usp.br Orcid: https://orcid.org/0009-0004-8410-7696

[3] PhD Energy and Environmental Planning. Institution: Institute of Energy and Environment and School of Arts, Sciences and Humanities, University of São Paulo (USP). E-mail: afsimoes@usp.br Orcid: https://orcid.org/0000-0003-4887-309X

[4] PhD Environmental Sciences. Institution: Institute of Energy and Environment, University of São Paulo (USP). E-mail: fabio.neves@usp.br Orcid: https://orcid.org/0000-0003-1751-2064

[5] Master's degree Student in Biotechnology. Institution: Institute of Exacts Science, Federal University of Alfenas (UNIFAL). E-mail: mateuscury9@gmail.com Orcid: https://orcid.org/0009-0002-9552-0262

[6] PhD Candidate in the Sustainability Graduate Program. Institution: School of Arts, Sciences and Humanities, University of São Paulo (USP). E-mail: rodrigo.massao.kurita@usp.br Orcid: https://orcid.org/0000-0002-6228-6441

[7] PhD Candidate in the Energy Graduate Program. Institution: Institute of Energy and Environment, University of São Paulo (USP). E-mail: camilasavastano@usp.br Orcid: https://orcid.org/0000-0003-2808-1239

[8] PhD Physical Geography. Institution: Federal Institute of Espírito Santo. E-mail: msdomi@gmail.com Orcid: https://orcid.org/0000-0001-6107-364X

and inadequate project delineation contributes to licensing delays and insufficient compensation measures. The study concludes that, although OWFs are essential for diversifying the energy mix, their implementation must consider local contexts to promote a just and sustainable energy transition.

Keywords: Artisanal Fisheries. Northeast of Brazil. Socio-environmental Externalities. Energy Transition. Environment and Development.

RESUMO

Parques eólicos offshore (PEO) tornaram-se uma fonte vital de energia renovável e representam um setor promissor para a geração de eletricidade no Brasil. Consequentemente, o país já possui 59 projetos registrados no IBAMA, com 8 localizados ao longo da costa do Rio Grande do Norte. Neste contexto, existe a necessidade de reconhecer as externalidades socioambientais relacionadas à sua implementação. Este estudo analisa os possíveis impactos socioambientais desses projetos, com foco nas comunidades de pescadores locais. A pesquisa envolveu uma revisão da literatura, entrevistas com 54 pescadores e o uso de dados georreferenciados para identificar áreas ambientalmente sensíveis. Os resultados indicam que 79% dos pescadores desconhecem os detalhes do projeto, e 67% acreditam que nenhuma compensação justa será fornecida. Além disso, 51 pescadores expressaram oposição aos PEOs, enquanto apenas três mostraram apoio. A presença de mamíferos marinhos, quelônios e aves marinhas foi confirmada, e uma porção significativa das áreas de pesca artesanal pode ser afetada. A análise sugere que a falta de planejamento espacial marinho e a delineação inadequada dos projetos contribuem para atrasos nas licenças e medidas de compensação insuficientes. O estudo conclui que, embora os PEOs sejam essenciais para diversificar a matriz energética, sua implementação deve considerar contextos locais para promover uma transição energética justa e sustentável.

Palavras-chave: Pesca Artesanal. Nordeste do Brasil. Externalidades Socioambientais. Transição Energética. Meio Ambiente e Desenvolvimento.

RESUMEN

Los parques eólicos offshore (PEO) se han convertido en una fuente vital de energía renovable y representan un sector prometedor para la generación de electricidad en Brasil. En consecuencia, el país ya tiene 59 proyectos registrados ante el IBAMA, con 8 ubicados a lo largo de la costa de Río Grande del Norte. En este contexto, existe la necesidad de reconocer las externalidades socioambientales relacionadas con su implementación. Este estudio analiza los posibles impactos socioambientales de estos proyectos, enfocándose en las comunidades locales de pescadores. La investigación implicó una revisión de la literatura, entrevistas con 54 pescadores y el uso de datos georreferenciados para identificar áreas ambientalmente sensibles. Los resultados indican que el 79% de los pescadores desconoce los detalles del proyecto, y el 67% cree que no se proporcionará compensación justa. Además, 51 pescadores expresaron oposición a los PEO, mientras que solo tres mostraron apoyo. Se confirmó la presencia de mamíferos marinos, quelonios y aves marinas, y una porción significativa de las áreas de pesca artesanal puede verse afectada. El análisis sugiere que la falta de planificación espacial marina y la delineación inadecuada de proyectos contribuyen a retrasos en las licencias y medidas de compensación insuficientes. El estudio concluye que, aunque los PEO son esenciales para diversificar la matriz energética, su

implementación debe considerar contextos locales para promover una transición energética justa y sostenible.

Palabras clave: Pesca Artesanal. Noreste de Brasil. Externalidades Socioambientales. Transición Energética. Medio Ambiente y Desarrollo.

1 INTRODUCTION

Offshore wind energy has rapidly emerged as a key component of global energy transition strategies, driven by the need to reduce greenhouse gas emissions and diversify energy sources [1]. In Brazil, this sector has gained increasing attention, with 59 offshore wind projects currently registered with the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), totalling 134,255 MW, of these, eight projects are located along the coast of Rio Grande do Norte, corresponding to 12,768 MW in licensing [2]. Despite this expansion, offshore wind development in Brazil remains at an early stage, particularly regarding environmental licensing procedures and marine spatial planning frameworks [3].

While offshore wind farms offer significant potential for clean energy generation, their implementation may generate socio-environmental externalities at the local level, especially in regions where communities depend directly on natural resources [4]. In northeastern Brazil, research onshore wind energy has documented impacts such as land-use changes, restricted access to natural resources and conflicts affecting traditional livelihoods, particularly in contexts with limited stakeholder participation [4] [5]. Those studies provide evidence that the expansion of wind energy, if not well planned, may reproduce or intensify existing socio-environmental inequalities.

In the context of offshore wind energy, the interaction between energy infrastructure and marine activities introduces additional challenges, because offshore wind farms may affect fisheries through spatial exclusion, displacement of fishing effort, and changes in access to fishing areas [3], [6]. In general, in the Global South, these challenges are often intensified by governance gaps, lack of participatory planning, and limited integration between energy and environmental policies [6]. In the Brazilian context, the absence of consolidated marine spatial planning frameworks further increases the risk of spatial conflicts between offshore wind projects and existing marine uses, such as artisanal fisheries [3].

Furthermore, the literature on low-carbon energy transitions highlights that renewable energy projects may generate distributive and procedural inequalities when affected communities are not adequately included in decision-making processes [7], this issue is particularly relevant in coastal regions of northeastern Brazil, where artisanal fishing communities already face socio-environmental vulnerabilities related to territorial disputes, restricted access to resources, environmental degradation, and human rights violations [8].

Despite the growing interest in offshore wind energy, there is still limited empirical evidence on its socio-environmental implications in Brazil, particularly from the perspective

of local communities [6], [9]. This gap is especially critical in regions such as Rio Grande do Norte, where high offshore wind energy potential and projects under environmental licensing overlap with coastal areas historically used by artisanal fishing communities and other marine related activities [2], [8].

Therefore, this study aims to analyse the potential socio-environmental impacts of offshore wind projects along the coast of Rio Grande do Norte, with a focus on artisanal fishing communities. With that, it is expected to contribute to a better understanding of socio-environmental risks associated with offshore wind development and to support more sustainable and inclusive energy planning.

2 MATERIALS AND METHODS

This study adopted a predominantly qualitative approach, with a descriptive and applied nature, organized into two complementary stages. The first stage consisted of data collection through literature review, documentary analysis, and critical assessment of selected materials. The review included scientific studies published in journals, as well as national and international reports from specialized organizations, allowing a broader understanding of offshore and onshore wind energy projects, with particular attention to the context of Rio Grande do Norte.

In this stage, documents related to offshore wind projects under environmental licensing were also analysed, including information available in IBAMA's Electronic Information System (SEI) and updated public databases on offshore wind projects. These documents provided technical and spatial information on project location, number of turbines, installed capacity, and licensing status. Georeferenced data were also considered to analyse the spatial distribution of offshore wind projects and their relationship with environmentally sensitive areas, including areas associated with marine fauna, avifauna, coral reefs, conservation units, and coastal uses.

The second stage involved field data collection through semi-structured interviews with fishermen from regions potentially affected by offshore wind energy projects. Semi-structured interviews were adopted because they allow respondents to express their perceptions, concerns, and experiences while maintaining a common set of guiding questions. The interview script included questions on socioeconomic profile, fishing activity, knowledge of offshore wind projects, perceived impacts, expectations regarding compensation, and participation in decision-making processes.

The interviews were conducted between January 3 and January 15, 2024, in the municipalities of Areia Branca, Porto do Mangue, Macau, Guamaré, Galinhos, Caiçara do Norte, Pedra Grande, and Touros, in the state of Rio Grande do Norte. In addition to autonomous fishermen, contact was established with fishermen associated with fishing colonies, seeking to include different local fishing groups. The interviews aimed to assess the level of awareness of fishing communities regarding offshore wind projects and to evaluate their degree of participation in decision-making processes, particularly in relation to dialogue among government agencies, project developers, and local communities.

In the Brazilian context, artisanal fishing is understood in this study as small-scale fishing activities characterized by family-based labour, low technological intensity, small vessels, and strong dependence on local marine ecosystems for subsistence and income. The interviews were recorded with prior consent from participants and later transcribed, preserving the confidentiality and privacy of the interviewees.

3 RESULTS

3.1 WIND ENERGY DEVELOPMENT AND COASTAL CONTEXT IN RIO GRANDE DO NORTE

With Brazil's development of renewable energy sources, Rio Grande do Norte has taken a prominent position due to its wind potential. In 2004, Petrobras began installing the first wind turbines in Macau, with a total capacity of 1.8 MW [10]. Two years later, in 2006, the Rio do Fogo Wind Farm comprised 62 wind turbines with a total capacity of 49 MW. In 2010, the third wind farm with 31 wind turbines and a total capacity of 51.15 MW was inaugurated in Guamaré [11]. In 2021, electricity generation from wind sources reached 22,099 GWh [3], and by November 2022, the state had 224 operational wind farms, representing 29.7% of the entire national wind power production [11]. The extent of the Brazilian coastline is 8,500 km, and the Exclusive Economic Zone (EEZ) extends 200 nautical miles from the coast (321.86 km) [12]. Coastal areas have strategic ecological and economic points. Several economic activities depend on the interconnection between the aquatic, terrestrial, and aerial environments, and as a result, over 26% of the Brazilian population lives in areas close to the coast [12], leading to intense occupation and exploitation of resources.

Rio Grande do Norte has a coastal extension of approximately 400 km, encompassing 28 municipalities along the coast [12]. The proportion of the population residing in the coastal zone reaches 50% of the total residents of the state [12], and among the main economic

activities with significant importance for these municipalities are Fishing and Aquaculture, Salt Production, and Tourism [11]. In this context, it is evident that the coastal strip of the state holds environmental, economic, and social significance as it is inhabited by traditional populations with cultural and historical ties to the coastal environment, concentrates relevant economic activities, and possesses diverse ecosystems. Table 1 presents the study area and the environmentally sensitive coastal and marine areas considered in the spatial analysis, including areas relevant to marine fauna, avifauna, coral reefs, conservation units and other coastal uses.

Table 1

Offshore Wind Projects under environmental licensing in Rio Grande do Norte according to IBAMA's 2026 database

Project	Developer	IBAMA process	Turbine model	Unit power (MW)	No. of turbines	Total capacity (MW)	Overlap
Pedra Grande	Pedra Grande	02001.027228/2020-14	Haliade-X 12 MW	12	52	624	Yes
Maral	Ventos do Atlântico	02001.000036/2021-41	NGT236	13.5	149	2,012	Yes
Ventos Potiguar	Ventos Potiguar Offshore Energia S.A.	02001.008883/2021-54	HaliadeX - GE	12	207	2,484	Yes
Beta	Beta Wind Energias Offshore SPE	02001.018349/2021-56	V236-15MW	15	200	3,000	Yes
Sítio de Testes SENAI	SENAI/RN	02001.000678/2023-11	Aerogerador 7 e 15 MW	11	2	22	No
Costa Branca I	Petrobras	02001.031356/2023-13	Aerogerador 18 MW	18	81	1,458	No
Costa Branca II	Petrobras	02001.031349/2023-11	Aerogerador 18 MW	18	117	2,106	Yes
Ginga	Petrobras	02001.031357/2023-50	Aerogerador 18 MW	18	59	1,062	Yes

Overlaps refers to projects with partial or total overlap with another project polygon, as indicated in IBAMA's updated 2026 database [2].
Source: IBAMA (2026).

3.2 SOCIAL CONFLICTS RELATED TO ONSHORE WIND FARMS IN RIO GRANDE DO NORTE

In this study, the definition of environmental impact proposed by Sánchez [13] is adopted, which refers to modifying natural or social processes resulting from human activity,

leading to a change in environmental quality. Furthermore, in this study, social impact is understood as any change resulting from human or natural actions in a specific population or territory, which can have both positive and negative effects. To characterize the socio-environmental impacts resulting from the installation and operation of onshore wind farms in Rio Grande do Norte, Hofstaetter [14] conducted a field study that identified several social impacts associated with these projects, including effects on local communities and territorial dynamics.

Additionally, in a field study conducted by Costa [15], through interviews with residents of rural settlements and public officials from the municipalities of Rio do Fogo, João Câmara, Parazinho, and Pedra Grande, it was identified that during the installation phase of wind projects, there was a significant increase in labour demand.

However, such an increase led to the emergence or exacerbation of criminality, illicit drug consumption, an increase in child and adolescent prostitution, an increase in the number of single pregnant women, and the spread of sexually transmitted diseases [15]. In a study conducted by Cruz [16], analysing the perceptions of residents from the municipalities of Lagoa Nova and Tenente Laurentino Cruz, there was no significant increase in employment generation (most employed individuals came from other regions and were already hired by the responsible company), but rather an increase in temporary work opportunities. The municipalities' infrastructure remained unchanged after the arrival of the wind parks, with improvements mainly limited to access roads to the facilities (investments made by the developers themselves).

In another research by Queiroz [17], an interview was conducted with 20 heads of households in the Morro dos Martins region in the municipality of São Miguel do Gostoso, where there are settlements with 143 residences. The interviewees expressed dissatisfaction with the value received for the sale of their properties for the installation and operation of the União dos Ventos wind project. The interviewees' perception was that by selling their lands, they parted with their means of production, as most relied on agriculture for subsistence. Now, they depend mainly on public social programs.

Improta [18] discussed a significant result regarding the level of knowledge of a community regarding the installation, operation, and importance of a wind park in a study. The researcher interviewed residents of Praia do Zumbi in Rio do Fogo and settlers from the rural settlement of Zumbi (the first settlement to receive this type of project). The results indicated that the population in the vicinity viewed the wind park installation positively due to

the employment opportunities during the installation phase. However, there was no further contact with workers or the company after this phase.

On the other hand, the relationship of the settlers with the project showed that, due to the legal obligations of the entrepreneur to carry out compensations required by the National Institute for Colonization and Agrarian Reform - INCRA for the project's licensing, this community had a better understanding of the wind park's functioning. They even used technical terms such as "aerogenerators" to describe its operation, while some residents of Zumbi could not name the structures [18].

3.3 OFFSHORE WIND FARM PROJECTS UNDER ENVIRONMENTAL LICENSING PHASE

A documentary analysis was conducted based on information filed in IBAMA's Electronic Information System (SEI!) and on the updated IBAMA database for offshore wind projects under environmental licensing. According to IBAMA's 2026 updated database, Rio Grande do Norte has eight offshore wind projects under environmental licensing, totalling 12,768 MW of planned installed capacity. These projects correspond to different developers, turbine configurations, and generation capacities, as summarized in Table 1.

The updated database indicates that offshore wind development in Rio Grande do Norte remains in a planning and licensing stage. Therefore, the analysis of these projects should be understood as an assessment of potential socio-environmental risks associated with proposed infrastructure, rather than as an evaluation of operational impacts.

Considering the socioeconomic relevance of fishing, aquaculture, salt production, and tourism in the coastal zone, the licensing process requires careful assessment of spatial conflicts, environmentally sensitive areas, and the participation of affected communities.

These results reinforce that offshore wind licensing in the state should not be guided only by installed capacity and wind potential, it also requires integration with marine spatial planning, transparent project information, and early engagement with fishing communities, especially because the projects are planned in coastal areas where traditional livelihoods and ecological sensitivities overlap.

3.4 SOCIOECONOMIC PROFILE OF INTERVIEWED FISHERMEN

The questions regarding monthly income from fishing, family work and income, and the type of navigation aimed to understand the economic dependence of fishing communities

on artisanal fishing. Also, in this context, artisanal fishing refers to small-scale fishing activities characterized by family-based labour, low technology intensity, small vessels, and strong dependence on local marine ecosystems for subsistence and income. The analysis revealed that the income of the 54 fishermen ranges from R$ 300.00 to R$ 3,000.00 (from USD 59.07 to USD 590.67, considering the exchange rate on June 4th, 2026), with an average of R$ 1,045.93 (USD 205.93, considering the exchange rate on June 4th, 2026) which is below the 2024 minimum wage of R$ 1,412.00 (USD 278.01, considering the exchange rate on June 4th, 2026) [19]. Additionally, 35 out of the 54 fishermen are the primary providers for their families, with 111 people directly dependent on this income, totalling 179 individuals, including direct and indirect dependents, who rely on artisanal fishing. Furthermore, 92% of the fishermen do not navigate alone due to the inherent risks of the sea and the need for assistance with heavy loads, involving an additional 86 people. Moreover, 9 fishermen, despite being the main family providers, do not own their own boats and rely on third parties for their livelihoods.

The variation in individual incomes and the total number of 256 people connected to fishing activities (based solely on the number of interviews conducted) reveals the complexity of artisanal fishing in the region, highlighting not only its economic role but also its fundamental support for family subsistence. The average distance of 30 km mentioned by most fishermen, along with the maximum distance of 100 km cited, indicates that all the evaluated energy projects are located within these communities fishing areas. To reach the most mentioned distance, the fishermen would have to cross the offshore parks.

3.5 PERCEPTIONS OF ONSHORE AND OFFSHORE FARMS WIND FARMS

Out of 54 fishermen interviewed, 18 mentioned positive impacts from onshore wind farms, with 5 specifically citing job creation. However, 36 expressed negative opinions, highlighting noise from turbines, deforestation, and a perceived link between wind farms and the displacement of fish species, although no scientific studies were found to confirm this connection.

Opposition to the installation of offshore wind farms was prevalent in the interviews, with only three fishermen expressing support. Among them, one fisherman justified his support, acknowledging the impact on fishing but citing financial compensation. Despite some positive responses, all 54 interviewees expressed concerns, based on past regional conflicts with oil platforms and onshore wind farms, even without detailed project information.

The fishermen's main concerns regarding the installation of offshore wind farms center on the potential loss of biodiversity and the reduction of fishing areas. Additionally, based on their experience with oil platforms and onshore wind farms, many fishermen believe they will be restricted from approaching the towers even after installation. While platform structures can function as artificial reefs, the minimum safety distance for offshore wind farms has not yet been specified. For oil platforms, the minimum distance is 500 meters, as established by the Brazilian Navy's NORMAM 08/DPC [20]. If this same distance is required for the wind farm areas outlined in the projects, it would create a barrier, further restricting the fishermen's free movement.After expressing their concerns, the questions “Do you think the operation of an offshore wind farm could bring any positive impact to your activity?” and “Is there any compensation you believe could help you?” were asked. Four fishermen believed that offshore wind farms could benefit fishing, all of whom supported the installation of the farms. One fisherman, who opposed the installation, mentioned that if fishing near the turbines were allowed, it could create a beneficial fishing area due to fish gathering near the structures. However, with the required minimum distance, this benefit is unlikely. The majority, 35 fishermen, identified financial compensation as the primary way to mitigate the potential impacts, reflecting their immediate concern to maintain a stable income if fishing were affected. However, some fishermen expressed skepticism about the implementation and sustainability of such compensation.

This reflects the shared sense of uncertainty about the realization of possible agreements and whether financial assistance, if granted, will be sufficient and continuous. Eleven fishermen also suggested that job opportunities would be an effective form of compensation to support their families considering potential changes in fishing activities. Five fishermen mentioned that material support, such as equipment or infrastructure, would be a useful form of compensation. One fisherman cited that information would be important, highlighting the need for transparency and clarity on how the wind farms might impact fishing. Five fishermen were unsure what type of compensation would be helpful.

Regarding the question “Do you think this wind farms would bring any environmental benefit?”, only two respondents believed there could be some environmental benefit. In contrast, 16 interviewees thought there would be benefits for the tourism sector. Some fishermen suggested that the offshore towers could attract tourists interested in seeing them up close. The lack of clarity about the commitment of the responsible agencies and the private

sector, as seen in previous projects, reinforces the community's distrust that any compensation will be consistent.

3.6 KNOWLEDGE AND PARTICIPATION OF FISHING COMMUNITIES

Even though the study is a small sample, it still highlights the exclusion of the fishing community from regional decision-making on offshore wind projects. None of the 54 fishermen interviewed had been approached by developers or public officials about these projects, and no fishing colonies had been contacted by early 2024. Some fishermen mentioned seeing project maps, but there was widespread skepticism about their influence on decisions. This disengagement reflects a lack of meaningful participation, with many fishermen expressing doubts about compensation and feeling that decisions will proceed regardless of their input.

4 DISCUSSION AND CONCLUSION

The results of this study show that offshore wind development in the Rio Grande do Norte can generate socio-environmental conflicts if fishing communities keep being excluded from the planning and licensing processes. This lack of engagement is particularly relevant because most interviewees expressed concerns regarding biodiversity loss, reduced fishing areas, restrictions on access to marine spaces and insufficient compensation. In this sense, the results suggest that the main challenge is not only the potential physical presence of offshore wind farms, but also the absence of meaningful participation in decisions that may directly affect the local livelihoods.

The results are also consistent with broader debates on energy justice and renewable energy development in the Global South. For example, as shown previously, studies evidence that low-carbon energy may reproduce socio-environmental inequalities when affected communities are not adequately included in decision-making processes [7]. Recent research on offshore wind development in Brazil also warns that power and information asymmetries may limit the participation of marginalized coastal communities in siting and licensing decisions [6]. In this sense, the results from Rio Grande do Norte reinforce the need to evaluate offshore wind energy not only in terms of generation potential and climate mitigation, but also in terms of procedural justice, distributive justice and local territorial impacts.

The spatial dimension of fishing activity is central to this discussion. Interviewed fishermen report fishing distances commonly reaching 30 km and, in some cases, up to 100

km from the coast, indicating potential overlap between fishing areas and planned offshore wind projects. This overlap may create barriers to mobility and access, especially if safety exclusion zones are established around turbines. Although Brazilian rules for minimum safety distances around offshore wind turbines remain undefined, existing restrictions around oil platforms provide a reference point for fishermen's concerns [20]. This way, uncertainty regarding future access rules contributes to distrust and strengthens local opposition to the projects.

Compensation was another important issue identified in the interviews, most fishermen who mentioned possible mitigation measures referred to financial compensation, while others suggested job opportunities, material support, infrastructure or access to information. However, many interviewees expressed skepticism about whether compensation would be fair, continuous or effectively implemented. This skepticism appears to be related to previous experiences with oil platforms and onshore wind farms in the region, where local communities reported limited benefits, temporary employment and insufficient dialogue with developers [15], [18]. Thus, compensation should not be treated as a substitute for participation, but as one element within a broader governance strategy that includes transparency, prior consultation and long-term monitoring.

In addition to this, the results also show a need for continuous socio-economic monitoring of fishing communities throughout the offshore wind project cycle. For instance, a recent study suggests that the socio-economic impacts of offshore wind development on fisheries should be monitored through standardised indicators, including changes in access to fishing grounds, fishing operations, navigation, income, costs, and community well-being [21]. In the RN context, monitoring would be particularly relevant to distinguish direct project-related impacts from broader changes affecting fishing activity, while supporting adaptive mitigation measures and reducing conflicts over time.

The results have implications for environmental licensing, offshore wind projects analysed are in areas associated with mammals, chelonians, seabirds, coral reefs, conservation units, tourism and artisanal fishing. This indicates that project evaluation must consider cumulative and spatially distributed impacts, rather than assessing each project only as an isolated enterprise. Recent counter-mapping can help identify fishing territories and routes that are often invisible in official planning models [9]. A similar approach could support licensing processes in Rio Grande do Norte by making fishing areas, navigation routes, and community concerns more visible before project siting decisions are consolidated.

The interviewees showed concern about the biodiversity loss and fish displacement, although these concerns are interpreted as local perceptions and risk expectations, because the study does not measure changes in fish abundance or biodiversity, this evidence reinforces the existence of perceived socio-environmental risks and potential spatial conflicts.

In general, the study suggests that offshore wind energy can contribute to the diversification of Brazil's electricity matrix, but its implementation must be accompanied by clear socio-environmental safeguards. Public policies should require early engagement with fishing communities, transparent disclosure of project information, participation mapping of fishing areas, clear criteria for compensation and integration between environmental licensing and marine spatial planning. Without these factors, offshore wind development can reproduce conflicts already observed in other renewable energy projects in northeastern Brazil, weakening both local trust and legitimacy of energy transition.

Finally, this study has some limitations, the sample of 54 fishermen does not allow statistical generalization to all fishing communities in Rio Grande do Norte. Although, the interviews provide relevant qualitative evidence of perceptions, concerns and vulnerabilities among communities potentially affected by offshore wind development. Future research should expand the number of communities analysed, quantify spatial overlaps between fishing areas and offshore wind projects, assess cumulative impacts on marine ecosystems and monitor how licensing decisions incorporate community participation over time.

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