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Editorial note / *Nota editorial*

THE ROLE OF MONITORING IN COASTAL RESILIENCE ASSESSMENT

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Monitoring plays a crucial role in assessing coastal resilience by providing essential, long-term data that is vital for understanding coastal processes and measuring the global recovery after disturbances. This approach enables evidence-based management by tracking morphological changes, the environmental health of habitats, and climate-driven risks, thereby supporting the development of adaptive strategies to protect vulnerable communities. Long-term monitoring efforts, such as tracking physical changes in beaches and land cover through aerial and satellite imagery, create a comprehensive dataset that helps identify potential risks, opportunities, and the consequences of various coastal management actions. Remote sensing and satellite observations provide large-scale, low-cost monitoring tools, while in situ measurements of, for example, water and/or sediment quality, ensure localised, short-term assessments. Furthermore, monitoring helps identify thresholds of physical and ecological changes in coastal systems, enabling managers to implement flexible, timely, and effective adaptation strategies rather than relying solely on static, long-term management measures.

The research presented in this edition offers two contrasting examples of monitoring, one on a large-scale that includes the use of satellite imagery to assess coastline dynamics, and a second case study, involving the local assessment of beach environmental quality, based on sediment sampling at urban beaches. Shoreline positions were extracted based on SPOT (Satellite Pour l'Observation de la Terre) imagery datasets, to assess spatial erosion and accretion trends and changes in land cover due to storms and human activities (Airawati *et al*., 2025). In Purworejo Regency (Indonesia), human activities and strong coastal storms make the area highly vulnerable to changes in coastline and land cover. A 15-year monitoring identified significant changes in the coastal area driven by economic growth, especially from rapid aquaculture expansion. This development has altered land use and contributed to environmental degradation, Airawati *et al*., 2025. The study highlights the complexity of coastal interactions and the need for further investigation into the factors impacting shoreline stability.

At a local scale, Souza *et al*. (2025) provided a detailed analysis of the environmental quality of three urban beaches in the Northeast of Brazil. The study concludes that the recorded high concentration of coliform bacteria is likely associated with nearby pollution sources and abnormal waste production. Quality assessments were based on sand samples collected monthly during low tide in both the dry and rainy seasons. This study enabled the identification of local pollution sources and highlighted critical periods of environmental degradation, contributing to more effective coastal environmental management (Souza *et al*., 2025).

From a socio-ecological perspective, two additional studies, on resilience assessment and monitoring, offer valuable insights into public policy analysis and participatory processes for maritime spatial planning and sustainable livelihoods in fishing communities.

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These studies emphasize social engagement and document behaviours related to resource utilization that promote sustainability without compromising the ecosystems involved. Junior *et al*. (2025) demonstrates that strategic initiatives for managing Brazil's coastal and marine environments within a Marine Spatial Protection framework can significantly enhance the conservation and organization of marine space usage. The authors examined Marine Spatial Protection models implemented in the European Community, identified relevant public management policies, reviewed Brazil's federal legal framework regarding Marine Spatial Protection, and conducted interviews with a focus group of experts. Additionally, the study proposes strategic initiatives aimed at managing marine and coastal environments in Brazil for incorporation into national legislation.

In Palawan, Philippines, local fishermen participated in training programs on aquaculture, and enterprise management, supported by academics and conservation organizations. Plasus *et al*. (2025), evaluated the effectiveness of these programs and alternative livelihood efforts through participatory surveys and statistical analysis. The authors' findings provide guidance for government and development organizations to create targeted support for small-scale fishing communities, helping to reduce pressure on overexploited fisheries and enhance coastal community resilience.

O PAPEL DA MONITORIZAÇÃO NA AVALIAÇÃO DA RESILIÊNCIA COSTEIRA

A monitorização desempenha um papel crucial na avaliação da resiliência costeira, fornecendo dados essenciais e de longo prazo, vitais para compreender os processos costeiros e medir a recuperação global após perturbações. Esta abordagem permite uma gestão baseada em evidências, rastreando mudanças morfológicas, a saúde ambiental dos habitats e os riscos impulsionados por fatores climáticos, apoiando assim o desenvolvimento de estratégias adaptativas para proteger comunidades vulneráveis. Os esforços de monitorização de longo prazo, como o acompanhamento das modificações físicas em praias e na cobertura do solo, através de imagens aéreas e de satélite, criam um conjunto de dados abrangente que ajuda a identificar potenciais riscos, oportunidades e as consequências de várias ações de gestão costeira. A deteção remota e as observações por satélite proporcionam ferramentas de monitorização em larga escala e a baixo custo, enquanto as medições in situ sobre, por exemplo, a qualidade da água e/ou sedimentos, garantem avaliações localizadas e de curto prazo. Para além disso, a monitorização ajuda a identificar limiares de mudança física e ecológica nos sistemas costeiros, permitindo que os gestores implementem estratégias de adaptação flexíveis, oportunas e eficazes, em vez de depender exclusivamente de medidas de gestão estáticas e de longo prazo.

A investigação apresentada nesta edição trata dois exemplos contrastantes de monitorização, o primeiro em larga escala, que inclui o uso de imagens de satélite para avaliar a dinâmica costeira, e um segundo estudo de caso, envolvendo a avaliação local da qualidade ambiental costeira, com base na amostragem de sedimentos em praias urbanas. No estudo de Airawati et al. (2025), as posições de linha de costa foram extraídas com base em conjuntos de dados de imagens SPOT (Satellite Pour l'Observation de la Terre), para avaliar as tendências espaciais de erosão e acreção e as mudanças na cobertura do solo, devido a tempestades e atividades humanas. Em Purworejo (Indonésia), as atividades humanas e as fortes tempestades costeiras tornam a área altamente vulnerável a mudanças sedimentares e na cobertura do solo. Uma monitorização de 15 anos constatou alterações significativas na zona costeira impulsionadas pelo crescimento económico, especialmente pela rápida expansão da aquicultura. Esse desenvolvimento alterou o uso do solo e contribuiu para a degradação ambiental (Airawati et al., 2025). O estudo destaca a complexidade das interações costeiras e a necessidade de realizar mais investigação sobre os fatores que afetam a estabilidade na posição da linha de costa.

À escala local, a investigação de Souza et al. (2025) fornece uma análise detalhada da qualidade ambiental de três praias urbanas no Nordeste do Brasil. O estudo conclui que a registada alta concentração de bactérias coliformes está provavelmente associada a fontes de poluição próximas e à produção anormal de resíduos. As avaliações de qualidade foram baseadas em amostras de areia colhidas mensalmente durante a baixa mar, tanto na estação seca quanto na estação chuvosa. Este estudo permitiu a identificação de fontes locais de poluição e destacou períodos críticos de degradação ambiental, contribuindo para uma gestão ambiental costeira mais eficaz (de Souza et al., 2025).

Numa perspetiva socio-ecológica, dois estudos adicionais, nesta edição, sobre a avaliação e a monitorização da resiliência, oferecem informações valiosas para a análise de políticas públicas e processos participativos no ordenamento do espaço marítimo e meios de subsistência sustentáveis em comunidades pesqueiras. Estes estudos enfatizam o envolvimento social e documentam comportamentos relacionados com a utilização de recursos que promovem a sustentabilidade sem comprometer os ecossistemas envolvidos.

O estudo de Junior et al. (2025) demonstra que iniciativas estratégicas para a gestão dos ambientes marinhos e costeiros no Brasil, no seio de uma estrutura de Proteção Espacial Marinha, podem melhorar significativamente a conservação e organização do uso do espaço marinho. Os autores examinaram modelos de Proteção Espacial Marinha, implementados na Comunidade Europeia, identificaram políticas de gestão pública relevantes, reviram a estrutura jurídica federal do Brasil em relação à Proteção Espacial Marinha e realizaram entrevistas em grupo de foco com especialistas locais. Além disso, o estudo propõe iniciativas estratégicas destinadas a gerir os ambientes marinhos e costeiros no Brasil para incorporação na legislação nacional.

Em Palawan, nas Filipinas, pescadores locais participaram de programas de formação em aquicultura e gestão empresarial, com o apoio da academia e organizações de conservação locais. O estudo de Plasus et al. (2025) avaliou a eficácia desses programas e esforços de meios de subsistência alternativos por meio de aplicação de métodos participativos e análises estatísticas. As conclusões dos autores fornecem orientações para que o governo e as organizações de desenvolvimento criem apoios direcionados para as comunidades pesqueiras de pequena escala, ajudando a reduzir a pressão nas pescarias sobre-exploradas e a aumentar a resiliência das comunidades costeiras.

REFERÊNCIAS

Sousa, Josielma Priscila P. de; Araújo, Maria Christina B. de; Costa, Ivaneide Alves S. da; Costa, Cibele Rodrigues (2025). Avaliação de coliformes na areia de praias urbanas do Rio Grande do Norte (nordeste do Brasil), 25(1). pp. 9-19. DOI: 10.5894/rgci-n602

Airawati, M.N.; Mardiatno, Djati; Khakhim, Nurul (2025). Coastal environmental dynamics in purworejo regency, central Java, Indonesia, 25(1). pp. 21-30. DOI: 10.5894/rgci-n609

Prearo Junior, Paschoal; Barros, Sérgio Ricardo da Silveira; Meiriño, Marcelo Jasmim (2025). The marine spatial planning and the adoption of a model of strategic initiatives for its implementation in Brazil, 25(1). pp. 31-55. DOI: 10.5894/rgci-n630

Plasus, Leo N.; Pentang, Jupeth T.; Rosero, Maria Cristina C.; Abatay, Elleonor P.; Nicolas, Mary Divina A.; Gacer, Vincent F.; Plasus, Maria Mojena G. (2025). Sustainable Livelihoods and Coastal Resilience: Lessons from Fisherfolk Communities in Dumaran and Araceli, 25(1). pp. 57-69. DOI: 10.5894/rgci-n655

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AVALIAÇÃO DE COLIFORMES NA AREIA DE PRAIAS URBANAS DO RIO GRANDE DO NORTE (NORDESTE DO BRASIL)

Josielma Priscila P. de Souza[1] @, Maria Christina B. de Araújo[1], Ivaneide Alves S. da Costa[2], Cibele Rodrigues Costa[3]

RESUMO: As praias configuram-se como espaços amplamente acessíveis à população em geral, sobretudo no que se refere às atividades de lazer. Também são bastante expostas às variações ambientais e impactos antrópicos, o que afeta diretamente a sua qualidade geral. O objetivo do presente estudo foi analisar a areia de três praias urbanas do Rio Grande do Norte (Redinha, Ponta Negra e Pirangi), para identificar a presença ou não de bactérias do grupo dos coliformes, avaliando sua relação com o período do ano e a frequência de usuários. As análises mostraram que a quantidade de microrganismos é influenciada pela entrada de água doce (pluvial e fluvial) no sistema e pela intensidade de uso das praias. A alta concentração de coliformes observada nas praias de Redinha e Pirangi durante o período chuvoso, provavelmente está relacionada com a proximidade em relação aos rios Potengi e Pirangi, muito poluídos, sugerindo a ocorrência de lançamento de esgoto no curso dos rios. Já no período seco, a quantidade de coliformes esteve relacionada ao uso da praia, quando há um aumento na produção de resíduos, como no caso de Ponta Negra. Monitorar parâmetros relacionados à qualidade microbiológica das praias é essencial para que os usuários possam garantir a segurança do seu lazer, bem como para que os gestores públicos possam tomar decisões, principalmente de natureza sanitária.

Palavras-chave: microrganismos indicadores; ambientes costeiros; poluição marinha; praias urbanas; qualidade da areia.

ABSTRACT: *Beaches are very accessible environments for the entire population when it comes to leisure. They are also very exposed to environmental variations and anthropogenic impacts, which directly affects their general quality. The objective of the present study was to analyse the sand from three urban beaches in Rio Grande do Norte, to identify the presence or absence of bacteria from the coliform group, evaluating their relationship with the period of the year and the frequency of users. The analyses showed that the number of microorganisms is influenced by the entry of fresh water (river and rainwater) into the system and the intensity of use by users. The high concentration of coliforms observed on the beaches of Redinha and Pirangi during the rainy season is likely related to their proximity to the highly polluted Potengi and Pirangi rivers, suggesting the occurrence of sewage discharge into the river courses. In contrast, during the dry season, the amount of coliforms was linked to beach use, when there is an increase in waste production, as is the case in Ponta Negra. Monitoring parameters related to the microbiological quality of beaches is essential so that beach users can guarantee the safety of their leisure, as well as so that public managers can make decisions, mainly of a sanitary nature.*

Keywords: indicator microorganisms; coastal environments; marine pollution; urban beaches; sand quality.

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1. INTRODUÇÃO

Nenhum outro ambiente natural recebe mais visitantes do que as praias. A qualidade da praia tem sido destacada como um fator muito importante na atração de usuários (Semeoshenkova *et al*., 2017; Costa & Costa, 2020), mas segundo Araújo e Costa (2008), o uso recreativo de uma praia pode ter efeitos diretos e indiretos. Nos ambientes costeiros de áreas urbanizadas e de uso intenso, as condições naturais tendem a ser perturbadas, e o grau de perturbação varia de quase imperceptível a grave.

As praias podem ser contaminadas por resíduos sólidos, incluindo restos de comida, dejetos de animais ou águas residuais descarregadas diretamente na areia. Esses problemas podem favorecer o aparecimento de microrganismos patogênicos e parasitas. Os organismos patogênicos encontrados na areia são de inúmeros grupos, incluindo bactérias, vírus, protozoários, helmintos e fungos (Pond, 2005; Solo-Gabriele *et al*., 2016; Zuza-Alves *et al*., 2016, 2019; Ramos *et al*., 2020; Santos *et al*., 2021; Echevarría, 2022; Frenkel *et al*., 2022; Costa *et al*., 2024).

Em todo o mundo, a água da praia é frequentemente monitorada quanto à qualidade microbiológica para detectar a presença de indicadores de contaminação humana por esgoto, a fim de evitar surtos de saúde pública associados ao contato com a água. Porém, monitorar a qualidade da água de praias recreativas é apenas um passo para entender a contaminação microbiana (a principal causa da interdição de praias). O reservatório de sedimentos da zona de arrebentação é tipicamente negligenciado e também pode ser importante (Lee *et al*., 2006; Frenkel *et al*., 2020, 2022). Há muitas evidências de que a areia das praias pode servir como reservatório de microrganismos, muitas vezes em concentrações superiores à água da praia, tornando-se veículos de transmissão de doenças (Beversdorf *et al*., 2007; Sabino *et al*., 2011, 2014; Frenkel *et al*., 2020; Brandão *et al*., 2021; Costa *et al*., 2024). As políticas atuais em todo o mundo dão pouca atenção ao impacto das areias na saúde dos usuários das praias (Solo-Gabriele *et al*., 2016).

Segundo Nascimento *et al*., (2021), o litoral do Rio Grande do Norte (Nordeste do Brasil) possui um cenário de atividades econômicas e concentração populacionais consideráveis, local este que vem se alterando com a intensificação dos processos degradantes da paisagem, como a produção de lixo e processos erosivos. Além das inconveniências decorrentes da ocupação desordenada de espaços importantes para o equilíbrio ecológico da interface entre os ambientes aquáticos e terrestres, a orla incorporou diversos problemas advindos da ausência de planejamento para sua ocupação, a utilização predatória dos manguezais e o lançamento de grande carga de esgotos domésticos no estuário de importantes rios, sem tratamento prévio. Muitas praias do estado apresentam alto nível de utilização tanto por usuários locais como por turistas, praticamente durante o ano todo, e elevada atividade comercial, fato que potencializa a geração de lixo. Em algumas praias é frequente a presença de "línguas negras" decorrentes de ligações clandestinas e descarte de águas servidas na praia (Rodrigues *et al*., 2021). Estudos que avaliaram a presença de fungos na areia da praia de Ponta Negra (Zuza-Alves *et al*., 2016; 2019) encontraram dados preocupantes. Os resultados apontaram alta incidência desses organismos.

A circulação oceânica na plataforma oriental do Rio Grande do Norte é marcada pelo deslocamento para norte da Corrente Norte do Brasil, que se origina da bifurcação da Corrente Sul Equatorial nas proximidades do litoral sul da Bahia, que compõe igualmente a Corrente do Brasil que flui para sul acompanhando o litoral do país (Stramma *et al*., 2003). Nessa região, os ventos apresentam uma proveniência predominante do quadrante SE, com velocidade variando entre 3,8 e 5 m/s, gerando uma deriva litorânea que flui sempre no sentido de sul para norte (Chaves, 2000; Ribeiro, 2014).

O objetivo do estudo foi analisar a areia de praias urbanas para identificar a presença ou não de bactérias do grupo dos coliformes, avaliando sua relação com o período do ano e a frequência de usuários.

2. MATERIAIS E MÉTODOS

2.1. Área de estudo

O estudo foi desenvolvido em três praias urbanas (Redinha – RE; Ponta Negra – PN e Pirangi – PI do Norte) do Rio Grande do Norte (Nordeste do Brasil) (Figura 1). Em todas elas a frequência de usuários ocorre praticamente durante o ano todo, no entanto, há locais dentro de cada praia, onde a concentração de banhistas e atividades comerciais são mais intensas, em relação a outros, menos utilizados. As praias de Redinha e Pirangi estão localizadas na margem norte dos rios Potengi e Pirangi, respectivamente. A praia de Ponta Negra está localizada praticamente no centro da área de estudo (considerando as três praias) e aproximadamente a 14 km de ambos os rios (Potengi e Pirangi). Ambos os rios exibem na foz um estado crítico de poluição ambiental, apresentando águas muito escuras o que pode ser reflexo das condições impróprias.

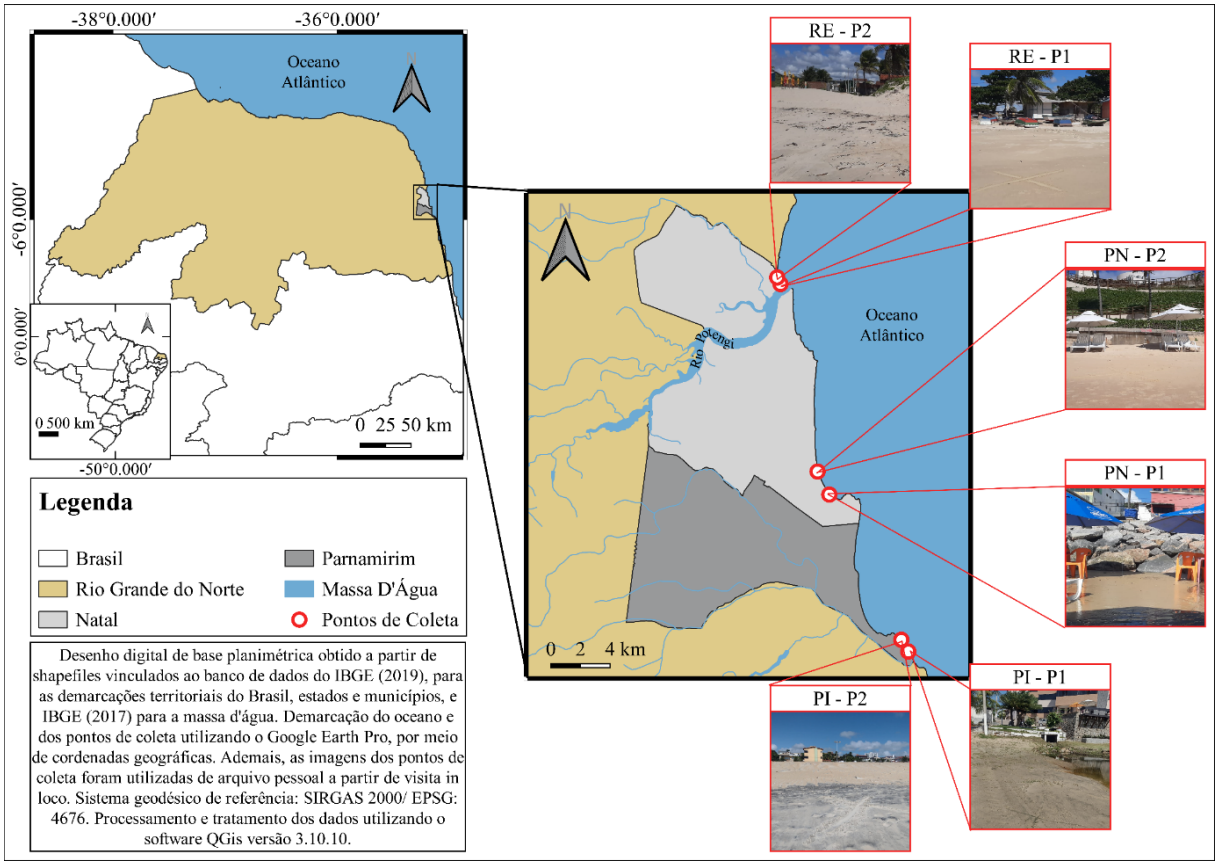

Figura 1. Localização da área e pontos de coleta.

2.2. Coleta de dados

A coleta de areia das praias foi realizada com periodicidade mensal, de novembro de 2019 a janeiro de 2020 (estação seca) e de abril a junho de 2020 (estação chuvosa), sempre pela manhã durante a baixa-mar, em dois ciclos (estação seca e chuvosa). Em cada praia foram utilizados dois pontos de amostragem (Figura 1), determinados em locais com diferentes características relacionadas com o uso da praia; o ponto 1 (P1) foi determinado no local com maior fluxo e concentração de banhistas e comércio (quiosques, barracas e ambulantes). O ponto 2 (P2), foi determinado no local com menor movimentação de banhistas e baixa atividade comercial. Foi coletado um total de 36 amostras de areia nas três praias estudadas, sendo 18 no período seco e 18 no período chuvoso.

Para cada ponto de coleta foi utilizado um kit composto por luvas de procedimento, uma colher inox e nove potes de Falcon de 20 mL, estes devidamente autoclavados. A delimitação amostral do P1 e P2 constou de um transecto confeccionado por uma lona medindo 1,20 m x 1,20 m, com 9 (nove) furos de 15 cm de diâmetro cada (Figura 2). Após a coleta de um ponto a lona era higienizada com álcool 70%.

Para obtenção das amostras de areias em P1 e P2 foram coletadas nove subamostras retiradas da camada superficial (0–5 cm) de cada ponto (Figura 2). As subamostras contidas nos tubos de Falcon foram acondicionadas em caixas térmicas e conduzidas para o laboratório de Microbiologia Aquática - LAMAQ/UFRN para realização da análise bacteriológica.

Para obtenção de uma amostra única de cada ponto de coleta, foi realizado no laboratório a integração e homogeneização em um béquer estéril das nove subamostras coletadas em campo. Em seguida, foi pesada uma amostra de 100 g em uma balança de precisão, em condições de assepsia e despejada em um erlenmeyer contendo 1 L de água destilada estéril, onde foi agitada vigorosamente à mão por 5 minutos para suspender as células bacterianas da matriz de areia. A partir deste lavado de areia, transferiu-se, em condições de assepsia, a alíquota de

Figura 2. Lona utilizada na coleta de areia.

200 mL do líquido sobrenadante para um frasco âmbar com auxílio de uma proveta. A metodologia de coleta da areia seguiu as orientações do Monitorização da Qualidade das Areias da Zona Balnear (Brandão *et al*., 2008).

As alíquotas da areia foram então submetidas à enumeração bacteriana de coliformes totais (CT) e termotolerantes (CTT), determinada pelo Número Mais Provável (NMP). A técnica utilizada foi a dos tubos múltiplos de três séries (100; 10^{-1}; 10^{-2}), com 05 (cinco) tubos cada e Colillert diluído em 100 mL de água estéril como meio de cultivo. Após diluição das alíquotas em análise, os tubos foram incubados a 35ºC durante 24h.

2.3. Análise dos dados

Para análise dos resultados encontrados de coliformes totais e termotolerantes foi utilizada a tabela de NMP para expressão final do resultado em NMP mL^{-1} (Lipps *et al*., 2022).

A análise estatística utilizou os métodos não paramétricos Kruskal-Wallis e Wilcoxon. O primeiro teste verifica se duas ou mais amostras possuem a mesma distribuição. Se sim, há indícios de que essas amostras são estatisticamente iguais. De forma análoga, o segundo teste informa se as amostras são estatisticamente iguais com a diferença dos testes serem pareados. Todas as análises estatísticas foram realizadas no *software R* versão 2.13 (*R Core Team*, 2013) e adotaram o nível de significância de 5% (Zar, 1996). As únicas exceções foram a comparação das distribuições das variáveis de coliformes totais e termotolerantes por praia.

3. RESULTADOS

Durante o período de estudo as praias de Pirangi (PI) e Redinha (RE) mostraram índices de coliformes totais superiores aos de coliformes termotolerantes, com exceção da praia de Ponta Negra (PN) (Tabela 1). No entanto, as três praias apresentaram um padrão semelhante na distribuição das concentrações de coliformes totais (CT) e termotolerantes (CTT).

A variação de valores de CT e CTT foi mínima de < 1,8 NMP mL^{-1} e máxima de > 1600 NMP mL^{-1}, para ambas. A praia de Pirangi foi a que apresentou maiores concentrações de CT com médias de $7,64x10^2$ (± $7,8x10^2$) NMP mL^{-1} e $4,02x10^2$ (± $7,22x10^2$) NMP mL^{-1} para CTT, seguido da praia da Redinha com densidades médias de $8,10x10^2$ (± $8,25x10^2$) NMP mL^{-1} para CT e $1,54x10^2$ (± $4,56x10^2$) NMP mL^{-1} para CTT. Comparativamente, a praia de Ponta Negra mostrou menores médias de CT ($2,05x10^2$ (± $4,65x10^2$) NMP/100mL) e CTT ($2,97x10^2$ (±$6,17x10^2$) NMP mL^{-1}) (Tabela 1).

Em relação ao percentual total de CT para CTT, as praias de Redinha e Pirangi registraram concentrações de coliformes totais

Tabela 1. Concentrações totais, mínimos, máximos, médias e desvio padrão de Coliformes Totais (CT) e Termotolerantes (CTT) nas praias de Pirangi, Ponta Negra e Redinha durante o período de estudo.

Praias	**Pirangi**		**Ponta Negra**		**Redinha**	
Coliformes	CT	CTT	CT	CTT	CT	CTT
Total (NMP/100ml)	$9{,}169x10^3$	$4{,}825x10^3$	$2{,}460x10^3$	$3{,}569x10^3$	$9{,}721x10^3$	$1{,}848x10^3$
Mínima (NMP/100ml)	1,8	1,8	1,8	1,8	1,8	1,8
Máxima (NMP/100ml)	$1{,}6x10^3$	$1{,}6x10^3$	$1{,}6x10^3$	$1{,}6x10^3$	$1{,}6x10^3$	$1{,}6x10^3$
Média (NMP/100ml)	$7{,}64x10^2$	$4{,}02x10^2$	$2{,}05x10^2$	$2{,}97x10^2$	$8{,}10x10^2$	$1{,}54x10^2$
Desvio Padrão (NMP/100ml)	$7{,}8x10^2$	$7{,}22x10^2$	$4{,}65x10^2$	$6{,}17x10^2$	$8{,}25\ x10^2$	$4{,}56\ x10^2$

de $9{,}721x10^3$ NMP mL^{-1} (84,03%) e de $9{,}169x10^3$ NMP mL^{-1} (65,52%), respectivamente. Diferentemente, a praia de Ponta Negra atingiu maior percentual de Termotolerantes, obtendo densidade de $3{,}569x10^3$ NMP mL^{-1} (59,20%) em relação a de coliformes totais cujo valor foi de $2{,}46x10^3$ NMP mL^{-1} (40,80%). Estatisticamente não houve diferença significativa (> 0,05) ao comparar as distribuições das variáveis de coliformes totais e termotolerantes por praia (Tabela 1).

Quanto à influência do parâmetro uso e ocupação das praias, nos pontos 1 e 2, foi observado o mesmo padrão de variação da relação da densidade entre coliformes totais (CT) e termotolerantes (CTT), sendo maiores valores de CT em relação à CTT. Da mesma forma, ocorreram maiores densidades de CT e CTT no ponto de maior fluxo de pessoas (P1) em relação ao P2, em todas as praias (Figura 3).

A Redinha foi a praia que registrou o maior nível de coliformes totais (CT) no P1 e no P2, obtendo valores de $8{,}18x10^2$ (± $8{,}57x10^2$) NMP mL^{-1} e $8{,}02x10^2$ (± $8{,}74x10^2$) NMP mL^{-1}, respectivamente; seguida pela praia de Pirangi com densidades de $9{,}54x10^2$ (± $7{,}83x10^2$) NMP mL^{-1} em P1 e de $5{,}74x10^2$ (± $8x10^2$) NMP mL^{-1} em P2. Na praia de Ponta Negra constatou-se índices de CT de $4{,}07x10^2$ (± $6{,}16x10^2$) NMP mL^{-1} em P1 e de 3,45 (± 2,99) NMP mL^{-1} em P2 (Figura 3).

Em relação à densidade de coliformes termotolerantes (CTT) nos pontos 1 e 2, a praia de Pirangi se destacou apresentando índices de $5{,}35x10^2$ (± $8{,}25x10^2$) NMP mL^{-1} em P1 e $2{,}69x10^2$ (± $6{,}52x10^2$) NMP mL^{-1} em P2; seguida pela praia da Redinha com concentrações de $2{,}92x10^2$ ($6{,}42x10^2$) NMP mL^{-1} e $1{,}6x10^1$ (± $1{,}7x10^1$) NMP mL^{-1} em P1 e P2, respectivamente. Na praia de Ponta Negra foram observados os menores índices de CTT nos pontos 1 (± $3{,}27x10^2$) e 2 (± $2{,}68x10^2$).

As praias de Pirangi e Redinha apresentaram proporcionalmente maior densidade relativa dos níveis de CT em relação à CTT nos dois pontos estudados (P1 e P2), embora o ponto 1 tenha apresentado maior densidade nas duas praias. Por outro lado, a praia de Ponta Negra apresentou proporcionalmente maior densidade relativa dos níveis de CTT em relação à CT, somente no ponto 2, mostrando comportamento inverso as praias de Redinha e Pirangi (Figura 3).

O padrão temporal dos níveis de coliformes totais (CT) e termotolerantes (CTT) em todas as praias mostrou tendência mais expressiva com maiores densidades durante o período chuvoso em relação ao período seco, tendo como destaque a praia da Redinha com concentrações médias de CT de $1{,}6x10^3$ (± 0) NMP mL^{-1} e CTT de $3{,}06x10^2$ (± $6{,}34x10^2$) NMP mL^{-1}, seguido da praia de Pirangi com densidade média de CT de $1{,}26x10^3$ (± $5{,}69x10^2$) e CTT de $5{,}36x10^2$ (± $8{,}24x10^2$). Ponta Negra mostrou valores médios de CT de $2{,}93x10^2$ (± $6{,}42x10^2$) e CTT de $5{,}93x10^2$ (± $7{,}92x10^2$) (Figura 4).

O grau de associação entre as variáveis foi significativo (p-valor < 0,05) de acordo com o teste de correlação de Pearson para as praias de Redinha e Ponta Negra. Observou-se uma correlação positiva (r = 0,29) entre as variáveis de coliformes (CT e CTT) analisando os dois pontos na mesma praia. Uma correlação mais fraca foi observada em praias diferentes. As exceções a esse padrão foram detectadas nas praias de Pirangi e Ponta Negra. A maior correlação positiva foi observada entre as concentrações de coliformes totais e termotolerantes nos

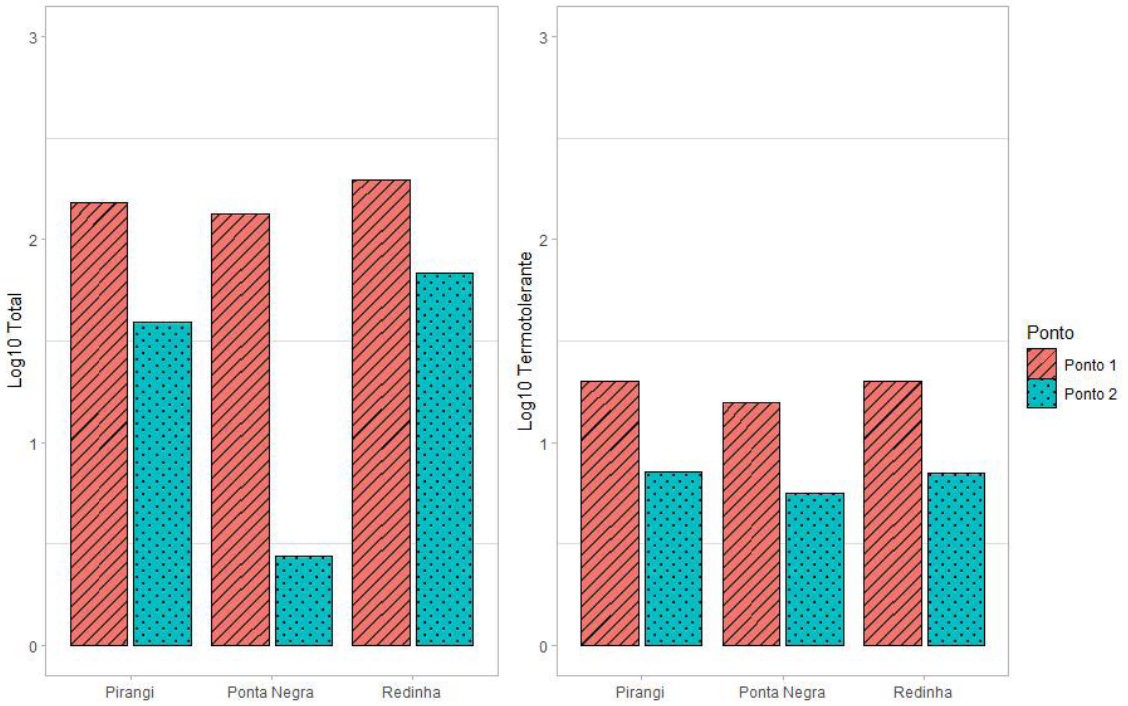

Figura 3. Níveis de Coliformes Totais (CT) e Termotolerantes (CTT) nos pontos P1 e P2 nas praias de Pirangi, Ponta Negra e Redinha durante o período de estudo (Nov/2019 à Jun/2020).

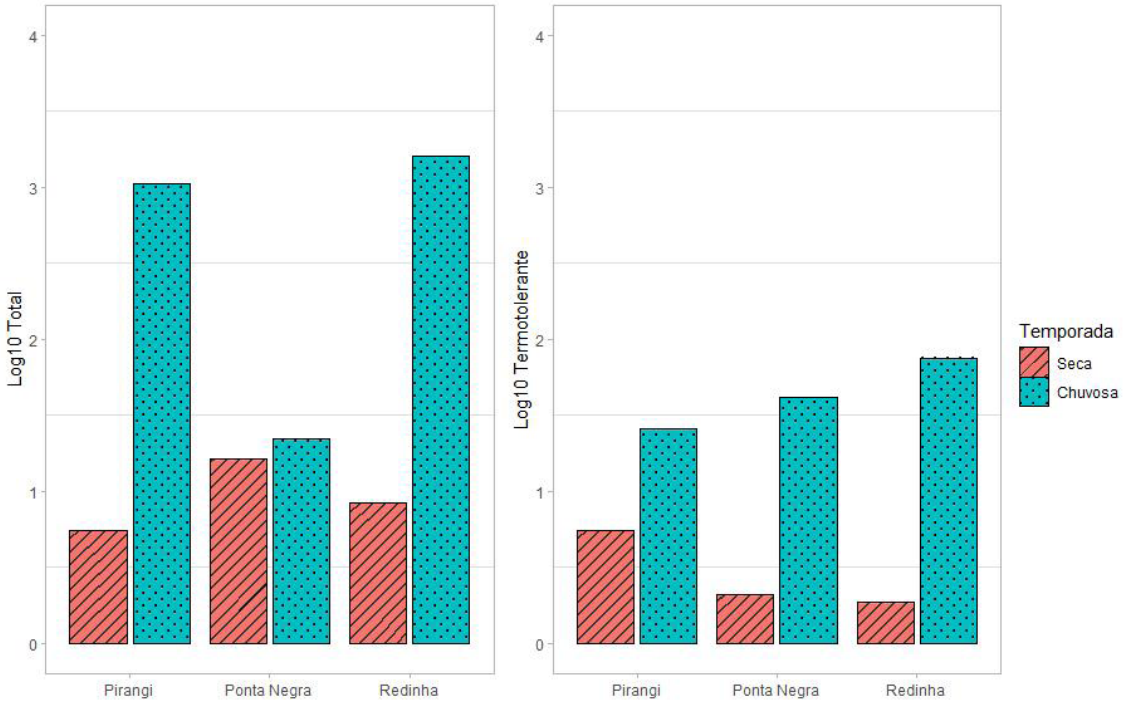

Figura 4. Concentração de Coliformes Totais (CT) e termotolerantes (CTT) nas praias de Pirangi, Ponta Negra e Redinha durante a estação de seca (Nov/2019 à Jan/2020) e chuvosa (Abr à Jun/2020).

pontos 1 e 2 na praia da Redinha (r = 0,83) e Pirangi (r = 0,63), o que não foi percebido na praia de Ponta Negra, que não mostrou correlação entre estas variáveis (Figura 5).

A análise multivariada mostrou que a dimensão principal da PCA – Dimensão 1 explicou 42,8% da variabilidade dos dados em relação a temporalidade e ao padrão do número mais provável de coliformes totais e termotolerantes em todas as praias e pontos analisados (Figura 6).

Figura 5. Coeficientes de correlação de Pearson entre as variáveis Coliformes Totais e Termotolerantes nos pontos 1 e 2 nas mesmas praias durante o período de estudo.

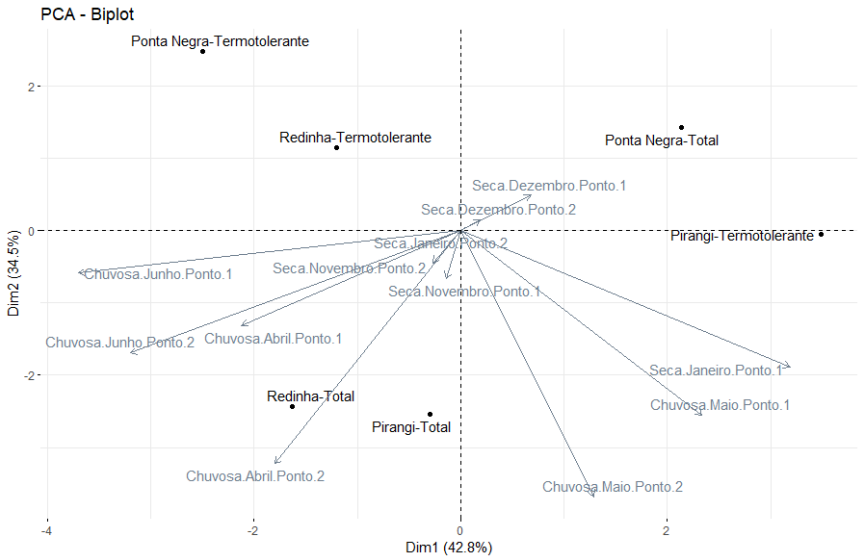

Figura 6. A análise de componentes principais (PCA) para contaminação microbiológica de Coliformes Totais e Termotolerantes considerando os pontos 1 e 2 nas praias de Pirangi, Ponta Negra e Redinha.

Foi observado que a dimensão 1 agrupou os pontos que mostraram padrões diferentes. Já a dimensão 2 mostrou agrupamentos para diferenciar CT de CTT. A maior parte das variáveis de coliformes termotolerantes se agruparam acima da dimensão 1 e a maioria dos coliformes totais abaixo. Quanto à sazonalidade a análise mostrou o agrupamento de todos os pontos para as variáveis no período seco (dezembro e janeiro), conforme visto na Figura 6 e na Tabela 2.

Tabela 2. Valores das variâncias amostrais dos índices de Coliformes Totais (CT) e Termotolerantes (CTT) em escala logarítmica por estação nas praias de Pirangi, Ponta Negra e Redinha.

Praia	Estação	Variância amostral CT	Variância amostral CTT
Pirangi	Seca	1,45	1,45
	Chuvosa	0,11	1,98
Ponta Negra	Seca	1,07	0,019
	Chuvosa	1,30	0,006
Redinha	Seca	0,407	0,000558
	Chuvosa	0	0,480

Observando a sazonalidade da densidade de coliformes totais e termotolerantes nas três praias, Ponta Negra e Redinha apresentaram o mesmo padrão para termotolerantes em termos de maiores densidades em relação à praia de Pirangi. Diferentemente, para CT as praias da Redinha e Pirangi apresentaram o mesmo padrão de maiores índices na época de chuvas, enquanto Ponta Negra apresentou maiores índices na seca, no mês de janeiro.

4. DISCUSSÃO

Água e sedimentos de rios e córregos que fluem para o mar são considerados fontes de contaminação para areia da praia (Chávez *et al*., 2018). Além disso, de acordo com Destro *et al*., (2020), a presença de animais, descarga de esgoto sanitário, mudança de estação do ano, e um grande número de banhistas contribuem para a sobrevivência e dispersão de microrganismos patogênicos em areia de praia.

Os rios são importantes fontes de inúmeros compostos que podem contaminar tanto a água marinha na foz e regiões adjacentes, como o sedimento das margens e das praias próximas. Como a corrente de deriva, na área de estudo, se dirige de sul para norte, a praia de Pirangi recebe resíduos e outros compostos diretamente do rio Pirangi, enquanto que na praia de Redinha a fonte de resíduos é principalmente o rio Potengi. Já a praia de Ponta Negra, em virtude de sua localização (mais afastada dos rios), sofre uma menor influência do rio Pirangi.

A alta concentração de coliformes totais (CT) e termotolerantes (CTT) tanto no P1 e como no P2 nas praias de Redinha e Pirangi durante no período chuvoso, pode estar relacionada exatamente com a proximidade em relação aos rios, sugerindo a ocorrência de lançamento de esgoto em seus cursos, resultados que corroboram os resultados apresentados por Rocha *et al*., 2020.

Os índices pluviométricos no município de Natal/RN (que abrange as praias da Redinha e Ponta Negra) foram de 158,9 mm, 196,0 mm e 56,1 mm, respectivamente, para os meses de abril, maio e junho (período chuvoso); totalizando um acumulado de 441,0 mm nesse trimestre. Já os índices para o município de Parnamirim/RN (praia de Pirangi) para os meses já mencionados foram de 143,0 mm, 154,0 mm e 79,0 mm, respectivamente, somando 376,0 mm de chuva para o período. A soma do acumulado pluviométrico na estação de seca no município de Natal foi de 205,2 mm e em Parnamirim 86,5 mm. A estação chuvosa apresentou um aumento de chuva de 114,9% em Natal e 334,6% em Parnamirim em relação à estação de seca (http://www.emparn.rn.gov.br/).

As águas pluviais podem ser uma fonte não pontual de contaminação da areia, isso porque o escoamento das águas pluviais lava as ruas, galerias, infraestruturas de esgotamento sanitário envelhecidas, dejetos de animais, resíduos orgânicos descartados de forma incorreta, entre outros. Conduzidas pelas galerias pluviais até o oceano, essa água da chuva pode apresentar diversos microrganismos, inclusive os de indicação fecal oriundos destes ambientes (Kongprajug *et al*., 2021; Ben-Haddad *et al*., 2023). O aumento da frequência e intensidade de eventos de precipitação pode levar ao colapso da infraestrutura de águas residuais já tributadas, resultando em aumento de pontos fontes de contaminação fecal das praias (Brandão *et al*., 2021; Brandão *et al*., 2008).

A relação entre o acumulado precipitado e os altos índices de coliformes é citada em vários estudos (Abdallah *et al*., 2005; Beversdorf *et al*., 2007; Halliday & Gast, 2011). Entretanto, vale ressaltar que a concentração de coliformes totais também pode apresentar positividade em baixos índices pluviométricos como observado durante a estação de seca neste trabalho. As altas concentrações de CT em P1, na praia de Ponta Negra, seguida da praia da Redinha indicam outros modos de contaminação, como possíveis falhas no sistema de esgotamento sanitário e presença de resíduos sólidos. O P1 é caracterizado pelo alto fluxo

de banhistas locais, turistas, presença de quiosques, ambulantes e presença de animais domésticos. Com isso há um aumento na produção de resíduos domésticos deixados pelos visitantes e comerciantes, além dos rejeitos dos animais domésticos que acompanham seus donos. Esses resíduos, por sua vez, atraem animais indesejáveis como os ratos, passíveis de disseminação de doenças. A presença de matéria orgânica em abundância favorece a proliferação de microrganismos nos ambientes.

Com relação à influência da quantidade de usuários nos níveis de contaminação da areia por coliformes, é esperado que o maior uso da praia seja responsável por um maior consumo de alimentos, o que comprovadamente gera resíduos, principalmente de origem orgânica, fato que favorece a proliferação da microbiota no ambiente. Nas praias avaliadas foi observada claramente essa influência na quantidade de coliformes totais, durante o período seco, que inclui a estação balnear (dezembro a fevereiro) quando o uso da praia é sempre maior. Na praia de Pirangi, houve também um expressivo valor para CTT no P1; esse fato pode estar associado à presença de um grande acúmulo de água residual que é descartada diretamente na areia (na área adjacente ao local de coleta), mesmo durante o período seco. Já no período chuvoso, a forte influência da pluviometria e aumento da vazão dos rios, fornecendo muita água para a zona marinha adjacente, pode justificar a ocorrência de altos valores de coliformes totais e tolerantes de forma muito semelhante em ambos os pontos (P1 e P2), fazendo com que a quantidade de usuários fosse bem menos importante na contaminação das áreas.

No Brasil, ainda não existe nenhuma legislação específica para definição dos limites bacteriológicos para a areia de praias, ao contrário do que ocorre para a água marinha, onde a presença de coliformes é monitorada regularmente e divulgada para a população. Apesar disso, o art. 8º da Resolução nº 274/2000 do Conselho Nacional de Meio Ambiente (CONAMA), que define os critérios de balneabilidade em águas brasileiras, recomenda aos órgãos ambientais a avaliação das condições parasitológicas e microbiológicas da areia, para futuras padronizações (CONAMA, 2000).

Em outros países já foram definidos critérios para orientação quanto aos limites seguros para esses organismos na areia. Por exemplo, em 2001-2002, a Associação Bandeira Azul da Europa, estabeleceu valores limites para indicadores sanitários, como coliformes totais, *Escherichia coli*, Enterococos intestinais e outros microrganismos, que estão apresentados na Tabela 3 (Brandão *et al*., 2008).

Tabela 3: Valores limites de indicadores bacteriológicos para areia (NMP/g de areia). Fonte: Brandão *et al.*, 2008.

Indicador	Valor Máximo Recomendável	Valor Máximo Admissível
Coliformes totais	5	100
E. coli	1	20
Enterococos intestinais	1	20

A análise da literatura apontou que, além de ser frequente a ocorrência de bactérias na areia de praias, esses organismos possuem uma boa sobrevivência neste ambiente. Portanto, a falta de legislação pode representar um sério risco aos usuários.

5. CONCLUSÕES

A avaliação da contaminação de praias turísticas em Natal-RN constatou que fatores como precipitação e proximidade de rios poluídos, aliados ao uso das praias foram determinantes na quantidade de microrganismos presentes nas areias. A situação é muito preocupante e provavelmente deve se repetir em outras praias brasileiras.

De maneira geral, a areia se manteve com uma melhor qualidade durante a época com menor concentração de chuvas em todos os pontos amostrados, porém, vale ressaltar que a concentração de coliformes totais também pode apresentar valores elevados mesmo nesta época, resultante de outras formas de contaminação, como por exemplo, a localização das praias em relação à foz de rios. Rios que atravessam áreas urbanas, normalmente chegam ao mar com condições impróprias, relacionadas com a carga orgânica. Outra importante questão é a elevada quantidade de resíduos produzida e descartada nas praias, nos meses de maior uso balnear.

Do ponto de vista recreativo, as praias de areia são os ambientes mais procurados, especialmente em países tropicais. Normalmente, o tempo gasto na areia é maior do que na água. Portanto, sugere-se maior atenção às areias das praias, não só para as zonas secas, mas também para as úmidas. Para uma maior segurança na estimativa de sobrevivência, fatores ambientais podem ser analisados conjuntamente.

É extremamente importante que sejam definidos critérios para análise microbiológica padronizada da areia de praias, especialmente nas urbanas e/ou turísticas. Estimar, monitorar e divulgar informações relacionadas à presença desse tipo de

contaminação nas praias é essencial para que os usuários possam garantir a segurança do seu lazer, bem como para que os gestores públicos possam tomar decisões, principalmente de natureza sanitária ajudando a reduzir a exposição, especialmente entre crianças pequenas.

REFERÊNCIAS BIBLIOGRÁFICAS

Abdallah, SA.; Elmanama, AA.; Fahd, MI.; Afifi, S. (2005) - Microbiological Beach Sand Quality in the Gaza Strip in Comparison to Seawater. *Polish Journal of Environmental Studies*, 14 (6):841-850. DOI: https://doi.org/10.1016/j.envres.2004.12.014

Araújo, MCB.; Costa, MF. (2008) - Environmental quality indicators for recreational beaches classification. *Journal of Coastal Research*, 24:1439–1449. DOI: https://doi.org/10.2112/06-0901.1

Beversdorf, LJ.; Bornstein-Forst, SM.; McLellan, SL. (2007) - The potential for beach sand to serve as a reservoir for Escherichia coli and the physical influences on cell die-off. *Journal of Applied Microbiology*, 102:1372–1381. DOI: https://doi.org/10.1111/j.1365-2672.2006.03177.x

Ben-Haddad, M.; Charroud, I.; Mghili, B.; Abelouah, MR.; Hajji, S.; Aragaw, TA.; Rangel-Buitrago, N.; Alla, AA. (2023) - Examining the influence of COVID-19 lockdowns on coastal water quality: A study on fecal bacteria levels in Moroccan seawaters. *Marine Pollution Bulletin*, 195. DOI: https://doi.org/10.1016/j.marpolbul.2023.115476

Brandão, J.; Silva, C., Alves, C.; Cunha, MA.; Moura, I.; Veríssimo, C.; Wergikoski, B.; Parada H.; Falcão, F.; Barroso, M.; Rodrigues, R.; Sabino R.; Rosado, L. (2008) - *Monitorização da qualidade das areias em zonas balneares – Época Balnear de 2008*. ae35p. Associação Bandeira Azul da Europa, Instituto Nacional de Saúde Dr. Ricardo Jorge, Lisboa, Portugal. https://bandeiraazul.abaae.pt/wp-content/uploads/sites/2/2015/02/relatorio-areias-nov2008.pdf

Brandão, J.; Gangneux, JP.; Arikan-Akdagli, S.; Barac, A.; Bostanaru, AC.; Brito, S.; Bull, M.; Çerikçioğlu, N.; Chapman, B.; Efstratiou, M.A.; Ergin, Ç.; Frenkel, M.; Gitto, A.; Gonçalves, C.I.; Guégan, H.; Gunde-Cimerman, N.; Güran, M.; Irinyi, L.; Jonikaitė, E.; Kataržytė, M.; Klingspor, L.; Mares, M.; Meijer, WG.; Melchers, WJG.; Meletiadis, J.; Meyer, W.; Nastasa, V.; Babič, MN.; Ogunc, D.; Ozhak, B.; Prigitano, A.; Ranque, S.; Rusu, RO.; Sabino, R.; Sampaio, A.; Silva, S.; Stephens, JH.; Tehupeiory-Kooreman, M.; Tortorano, AM.; Velegraki, A.; Veríssimo, C.; Wunderlich, GC.; Segal, E. (2021) - Mycosands: Fungal diversity and abundance in beach sand and recreational waters – Relevance to human health. *Science of The Total Environment*, 781:146598. DOI: https://doi.org/10.1016/j.scitotenv.2021.146598

Brandão, J.; Weiskerger, C.; Valério, E.; Pitkänen, T.; Meriläinen, P.; Avolio, L.; Heaney, C. D.; Sadowsky, M J. (2022) - Climate Change Impacts on Microbiota in Beach Sand and Water: Looking Ahead. *International Journal of Environmental Research and Public Health*, 19: 1444. DOI: https://doi.org/10.3390/ijerph19031444

Chaves, MS. (2000) - Vulnerabilidade Costeira entre as Praias da Redinha e Genipabú Natal/RN. 94p., Dissertação de Mestrado, Universidade Federal de Pernambuco, Recife, PE, Brasil. Não publicado.

Chávez, L.; Gulloso, E.; Murgas, Y.; Veja, J. (2018) - A Baseline Study of Fecal Indicator Bacteria on Caribbean Beach Sand from Riohacha, La Guajira, Colombia. *Contemporary Engineering Sciences*, 11(104): 5093 – 5107. DOI: https://doi.org/10.12988/ces.2018.89497

CONAMA - CONSELHO NACIONAL DO MEIO AMBIENTE (2000) - Resolução CONAMA N° 274, de 29 de novembro de 2000: Define os critérios de balneabilidade em águas brasileiras. 3p., Conselho Nacional de Meio Ambiente, Ministério do Meio Ambiente, Brasília, Brasil. https://cetesb.sp.gov.br/aguas-interiores/wp-content/uploads/sites/12/2018/01/RESOLU%C3%87%C3%83O-CONAMA-n%C2%BA-274-de-29-de-novembro-de-2000.pdf

Costa, CR., Costa, MF. (2020) - Revisão de metodologias do monitoramento microbiológico da qualidade da água em praias recreativas. *Revista Brasileira de Meio Ambiente* (ISSN: 2595-4431), 8(3): 092–113, Piauí, Brasil. Disponível on-line em https://revistabrasileirademeioambiente.com/index.php/RVBMA/article/view/403

Costa, C. R.; Araújo, M. C. B.; Silva-Cavalcanti, J.S. (2024). Beach quality: let's not overlook fungal sand contamination. *Arq. Ciên. Mar*, 57(1): 1 – 14. http://dx.doi.org/10.32360/acmar.v57i1.92864

Destro, JO.; Rosa, VT.; Pinto, FST.; Soares, C.J. (2020) - Qualidade microbiológica das areias de Praias do litoral norte gaúcho. *Scientia Prima* (ISSN 2318-4299), 6(1):48-58. Disponível on-line em http://www.abric.ong.br/ojs/index.php/scientiaprima/article/view/15/8

Echevarría, L. (2022) - Inventory of Filamentous Fungi and Yeasts Found in the Sea Water and Sand of the Beach of Pier in Arecibo Puerto Rico. *PSM Microbiology* (ISSN: 2518-3834), 7(1): 4-11. Disponível on-line em https://psmjournals.org/index.php/microbiol/article/view/602/494

Frenkel, M.; Yunik, Y.; Fleker, M.; Blum, SE.; Sionov, E.; Elad, D.; Serhan, H.; Segal, E. (2020) - Fungi in sands of Mediterranean Sea beaches of Israel - Potential relevance to human health and well-being. *Mycoses*, 63:1255–1261. DOI: https://doi.org/10.1111/myc.13144

Frenkel, M.; Serhan, H.; Blum, SE.; Fleker, M.; Sionov, E.; Amit, S.; Gazit, Z.; Gefen-Halevi, S.; Segal, E. (2022) - What Is Hiding in the Israeli Mediterranean Seawater and Beach Sand. *Journal of Fungi*, 8(9): 950. DOI: https://doi.org/10.3390/jof8090950

Halliday, E.; Gast, RJ. (2011) - Bacteria in beach sands: an emerging challenge in protecting coastal water quality and bather health. *Environmental Science & Technology*, 45(2): 370–379. DOI: https://doi.org/10.1021/es102747s.

Kongprajug, A; Denpetkul, T.; Chyerochana, N.; Mongkolsuk, S.; Sirikanchana, K. (2021) - Human Fecal Pollution Monitoring and Microbial Risk Assessment for Water Reuse Potential in a Coastal Industrial–Residential Mixed-Use Watershed. *Frontiers in Microbiology*, 12. DOI: https://doi.org/10.3389/fmicb.2021.647602.

Lee, CM.; Lin, TY.; Lin, C.; Kohbodi, GA.; Bhatt, A.; Lee, R.; Jay, JA. (2006) - Persistence of fecal indicator bacteria in Santa Monica Bay beach sediments. *Water Research*, 40:2593–2602. DOI: https://doi.org/10.1016/j.watres.2006.04.032.

Lipps, W. C.; Braun-Howland, E.B.; Baxte, T. E. (2022) - Standard Methods for the Examination of Water and Wastewater. 1624p., APHA-American Public Health Association, AWWA-American Water Works Association, WEF-Water Environment Federation, Denver, Estados Unidos da América. ISBN: 978-0-87553-299-8

Nascimento, R. L. X.; Souza, C. C. de.; Oliveira, M. A. das N. de. (2021) - Caderno de caracterização: estado do Rio Grande do Norte. Companhia de Desenvolvimento dos Vales do São Francisco e do Parnaíba – CODEVASF, Brasília, Brasil. https://www.codevasf.gov.br/acesso-a-informacao/institucional/biblioteca-geraldo-rocha/publicacoes/outras-publicacoes/caderno-de-caracterizacao-estado-do-rio-grande-do-norte.pdf/view

Pond, K. (2005) - Water recreation and disease: plausibility of associated infections: acute effects, sequelae and mortality. 239 p., IWA Publishing, London, United Kingdom. ISBN electronic: 9781780405827

Ribeiro, F. (2014) - Caracterização das correntes da plataforma continental interna da praia de Ponta Negra. 54p., Monografia de graduação, Universidade Federal de Santa Catarina, Florianópolis, SC, Brasil. Não publicado.

Ramos, ELP.; Gómez-Hernández, C.; Queiroz, LG.; Moura, RGF.; Nogueira, NP.; Ferreira, G. LS.; Rezende-Oliveira, K. (2020). Parasite detection in sand from bays on the north coast of São Paulo state, Brazil. *Journal of Tropical Pathology*, 49(3): 91-205. DOI: https://doi.org/10.5216/rpt.v49i3.63783

Rocha, A.; Araújo. A.; Angelini, R. (2020) - Frequência de coliformes termotolerantes em praias do litoral potiguar (Rio Grande do Norte, Brasil). *Brazilian Journal of Development*, 6(11):88498-88515. DOI: https://doi.org/10.34117/bjdv6n11-320

Rodrigues, BT.; Bastos, AL.; Rodrigues, MT (2021) - Identificação das línguas negras provenientes das galerias pluviais e bacias hidrográficas nas praias urbanas de Maceió - AL. Em: Frederico Celestino Barbosa (org.), *Ciências agrárias: a multidisciplinaridade dos recursos naturais*, pp 10-18, Editora Conhecimento Livre, Piracanjuba, Goiás, Brasil. ISBN: 978-65-89145-90-5. Disponível on-line: https://api.conhecimentolivre.org/ecl-api/storage/app/public/L.234-2021.pdf

Stramma, L.; Fischer, J.; Brandt, P.; Schott, F. (2003) - Circulation, variability and near-equatorial meridional flow in the central tropical Atlantic. *Interhemispheric water exchange in the Atlantic Ocean*, Elsevier, 68:1-22. DOI: https://doi.org/10.1016/S0422-9894(03)80141-1

Sabino, R.; Veríssimo, C.; Cunha, MA.; Wergikoski, B.; Ferreira, FC.; Rodrigues, R.; Parada, H.; Falcão, L.; Rosado, L.; Pinheiro, C.; Paixão, E.; Brandão, J. (2011) - Pathogenic fungi: An unacknowledged risk at coastal resorts? New insights on microbiological sand quality in Portugal. *Marine Pollution Bulletin*, 62: 1506–1511. DOI: https://doi.org/10.1016/j.marpolbul.2011.04.008

Sabino, R.; Rodrigues, R.; Costa, I.; Carneiro, C.; Cunha, M.; Duarte, A.; Faria, N.; Ferreira, FC.; Gargaté, MJ.; Júlio, C.; Martins, ML.; Nevers, MB.; Oleastro, M.; Solo-Gabriele, H.; Veríssimo, C.; Viegas, C.; Whitman, RL.; Brandão, J. (2014) - Routine screening of harmful microorganisms in beach sands: Implications to public health. *Science of The Total Environment*, 472: 1062–1069. DOI: https://doi.org/10.1016/j.scitotenv.2013.11.091.

Solo-Gabriele, HM.; Harwood, VJ.; Kay, D.; Fujioka, RS.; Sadowsky, MJ.; Whitman, RL.; Wither, A.; Caniça, M.; Carvalho da Fonseca, R.; Duarte, A.; Edge, TA.; Gargaté, MJ.; Gunde-Cimerman, N.; Hagen, F.; McLellan, SL.; Nogueira da Silva, A.; Novak Babič, M.; Prada, S.; Rodrigues, R.; Romão, D.; Sabino, R.; Samson, RA.; Segal, E.; Staley, C.; Taylor, HD.; Veríssimo, C.; Viegas, C.; Barroso, H.; Brandão, JC. (2016) - Beach sand and the potential for infectious disease transmission: observations and recommendations. *Journal of the Marine Biological Association of the United Kingdom*, 96:101–120. DOI: https://doi.org/10.1017/S0025315415000843

Semeoshenkova, V.; Newton, A.; Contin, A.; Greggio, N. (2017) - Development and application of an Integrated Beach Quality Index (BQI). *Ocean & Coastal Management*, 143:74–86. DOI: https://doi.org/10.1016/j.ocecoaman.2016.08.013

Santos, AR.; Oliveira, HC.; Silva, AMC.; Alves, RR.; Andrade, BRD.; Silva, MLRB. (2021) - Identificação e caracterização de bactérias potencialmente patogênicas isoladas de duas praias do litoral norte de Pernambuco. *Research, Society and Development*, 10(11):e184101119402. DOI: https://doi.org/10.33448/rsd-v10i11.19402

Zar, J. H. (1999) - *Biostatistical analysis*. 255p, Fifth Edition, New Jersey, United States or America. ISBN: 978-0-13-100lW6·5

Zuza-Alves, DL.; Medeiros, SSTQ.; Souza, LBFC.; Silva-Rocha, WP.; Francisco, EC.; Araújo, MCB.; Lima-Neto, RG.; Neves, RP.; Melo, ASA.; Chaves, GM. (2016) - Evaluation of Virulence Factors In vitro, Resistance to Osmotic Stress and Antifungal Susceptibility of Candida tropicalis Isolated from the Coastal Environment of Northeast Brazil. *Frontiers in Microbiology*, 7:1783. DOI: https://doi.org/10.3389/fmicb.2016.01783

Zuza-Alves, DL.; Silva-Rocha, WP.; Francisco, EC.; Araújo, MCB.; Azevedo Melo, A.; Chaves, GM. (2019) - Candida tropicalis geographic population structure maintenance and dispersion in the coastal environment may be influenced by the climatic season and anthropogenic action. *Microbial Pathogenesis*, 128:63-68. DOI: https://doi.org/10.1016/j.micpath.2018.12.018.

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COASTAL ENVIRONMENTAL DYNAMICS IN PURWOREJO REGENCY, CENTRAL JAVA, INDONESIA

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ABSTRACT: The coastal environment can change naturally or be influenced by human economic activities. Purworejo Regency, in Central Java, is a developing area being the vaname shrimp main activity of the coastal community's economy. Various anthropogenic factors and high sea waves in coastal areas make this area vulnerable to changes in shoreline and land cover. In this study, the shoreline was extracted from SPOT time series spatial data (2007, 2011, 2017, and 2020) using the on-screen digitization method, while land cover changes were analyzed using the overlay method. The most significant sedimentation increase occurred from 2011 to 2017 with an additional area of 29.67 ha, while the smallest sedimentation occurred from 2017 to 2020 with an additional area of 9.09 ha. The worst erosion was detected from 2017 to 2020, which caused the loss of an area of 17.52 ha. The type of land cover that is developing rapidly in Purworejo Regency is shrimp ponds, which have been widely developed since 2014. Cross-profile analysis concluded that there was no link between changes in shoreline and changes in land cover.

Keywords: shoreline, land cover, dynamic, shrimp pond, Purworejo.

RESUMO: *O ambiente costeiro pode sofrer alterações de forma natural ou ser influenciado por atividades económicas de origem antropogénica. A região de Purworejo, localizada em Java Central, encontra-se em processo de desenvolvimento, sendo a aquicultura de camarão vannamei (Litopenaeus vannamei) o principal vetor económico das comunidades costeiras. A ação combinada de diversos fatores antropogénicos, associada à forte agitação marítima nas zonas costeiras, confere a esta região uma elevada vulnerabilidade a alterações na linha de costa e na cobertura do solo. Neste estudo, a linha de costa foi extraída a partir de dados espaciais de séries temporais do satélite SPOT (2007, 2011, 2017 e 2020), por meio do método de digitalização em ecrã. As alterações na cobertura do solo foram analisadas utilizando o método de sobreposição de dados geoespaciais. O incremento mais expressivo de sedimentação foi registado entre 2011 e 2017, com um acréscimo de 29,67 hectares, enquanto o menor aumento ocorreu entre 2017 e 2020, com 9.09 ha adicionais. A erosão mais significativa foi observada no período de 2017 a 2020, resultando na perda de uma área de 17.52 ha. A forma de ocupação do solo que mais se tem expandido na região de Purworejo corresponde aos viveiros de camarão, amplamente desenvolvidos desde 2014. A análise de perfis transversais permitiu concluir que não existe uma correlação significativa entre as alterações na linha de costa e as modificações na cobertura do solo.*

Palavras-chave: costa, cobertura do solo, dinâmica, viveiro de camarão, Purworejo.

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1. INTRODUCTION

Purworejo is a regency in Central Java Province, Indonesia (Figure 1). The shoreline in the coastal area of Purworejo Regency extends for 21 km and is used by the community for various activities such as fishing, tourism, settlements, ports, and industry. The dynamics of the use of the coastal zone as a transitional area cannot be separated from the interrelationship between the functions of land and sea. This connection causes very complex problems and can increase vulnerability in coastal areas (Zhao *et al*., 2021). Historically, this coastal area has experienced land dynamics, including areas designated for mining and shrimp farming, starting in 1987 and continuing to this day (Pelly *et al*., 2018). Research finding by Damayanti *et al*., (2019) show that settlements in the coastal areas of Purworejo Regency experienced development covering an area of 460 ha from 2002 to 2017. Land use patterns in coastal areas can influence the natural balance in this area or other related areas. For example, mangrove forests converted into ponds or residential areas can cause erosion due to reduced shoreline protection (Polidoro *et al*., 2010).

The susceptibility of coastal areas to abrasion or sedimentation is influenced by shoreline dynamics. Research on the rate of change in shorelines helps provide information on coastal areas planning and management process. Factors influencing shoreline changes include sediment movement, wind, tides, longshore currents, waves and land use. These factors cause shorelines to experience reduction (erosion) or accretion (sedimentation) (Cahyono *et al*., 2017; Raimundo Lopes *et al*., 2022; Yum *et al*., 2023).

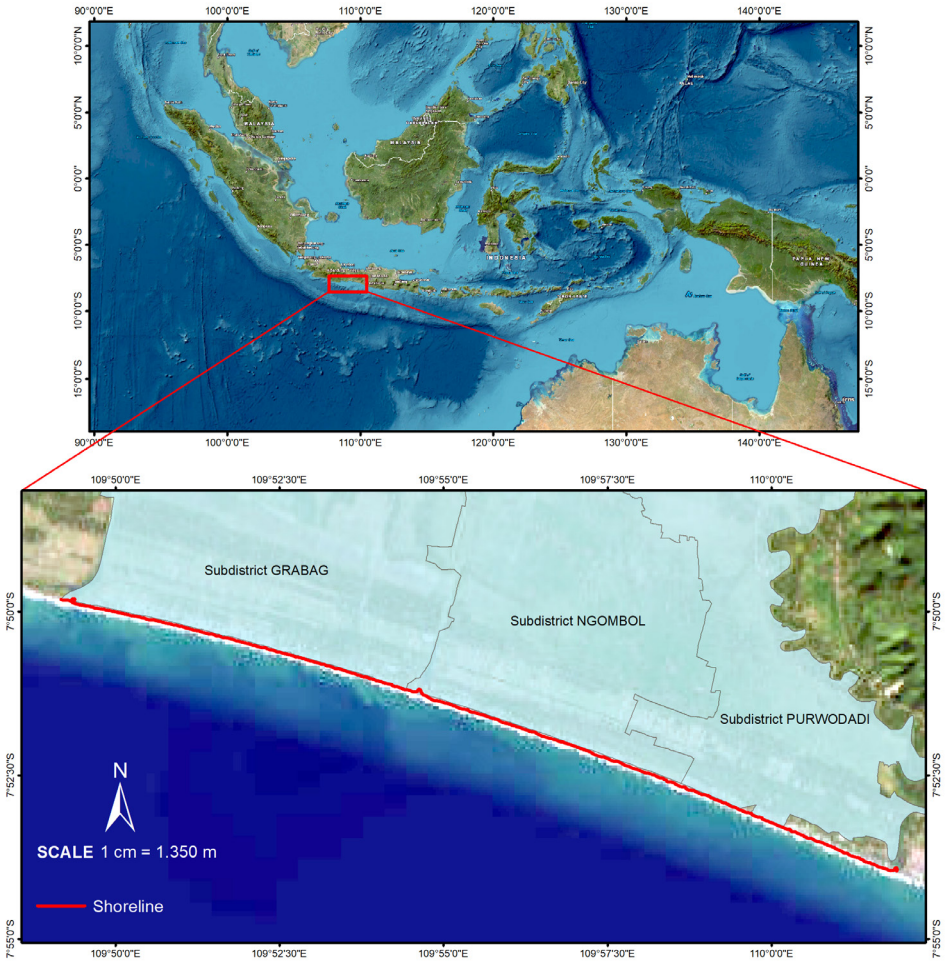

Figure 1. Location of Purworejo Regency.

Changes in shoreline can affect land cover, and conversely, land cover can affect the dynamics of the shoreline. Land cover reflects human activities in a specific area. In Purworejo Regency, human activities, particularly shrimp farming, are extensive. To understand the relationship between erosion or sedimentation susceptibility and land cover in this region, a spatio-temporal analysis is required. The results of this analysis can help to determine shoreline dynamics, which are indicators of erosion or sedimentation susceptibility.

The objective of this study was to evaluate the impact of shoreline dynamics susceptibility on land cover and shoreline changes in Purworejo Regency from 2007 to 2020. The findings of this research can inform decisions regarding coastal protection infrastructure and detailed coastal spatial planning (Taveira-Pint *et al*., 2022). The combination of remote sensing technology and Geographic Information Systems (GIS) has been widely applied to obtain quantitative and qualitative information regarding changes in coastal morphology in a region (De Freitas *et al*., 2019). This research investigates the relationship between changes in land cover, in particular shrimp farming, and changes in shoreline, a relationship that has not been fully explored.

2. METHODOLOGY

The methods used include image correction, shoreline digitization, land cover analysis and analysis of the relationship between shoreline dynamics and land cover. The research flowchart is shown in Figure 2. The spatial data used in this study uses SPOT imagery from 2007, 2011, 2017 and 2020 which were selected in the same time period (Mullick *et al*., 2020). The sharpening and geometry correction process uses PCI Geomatic software. Georeferencing all images used the Universal Transverse Mercator (UTM) 49 S zone projection and the WGS 1984 datum (Aldogom *et al*., 2020; Murali *et al*., 2015). Geometry correction of the SPOT satellite image used the orthorectification to reduce the influence of distortion. Geometry correction used the Ground Control Points (GCP) obtained from Indonesian topographic maps and Indonesian Digital Elevation Model (DEM) data from the Geospatial Information Agency (Loebis, 2015). This correction ensures that all images used in this study have the same spatial and temporal resolution.

2.1 Shoreline Digitization

Shoreline digitization uses a combination of red (R), green (G), and blue (B) color bands. On-screen digitization of the shoreline visually corresponds to the appearance of the dry and wet line boundaries seen in the image per year. The digitized and corrected shorelines were then analyzed to determine the rate of change using the DSAS plugin contained in ArcGIS software. The statistical methods used to calculate the rate of shoreline change are Net Shoreline Movement (NSM) and End Point Rate (EPR). The application of the DSAS methodology allows the resulting dataset to be easily compared with previously collected datasets (Rebêlo & Nave, 2022). The baseline for this research was created using a 2007 shoreline buffer of 75 m. Approximately 1335 transects were placed at 20 m intervals along the studied shorelines. The results of the shoreline digitization were then compared with the results of the field survey.

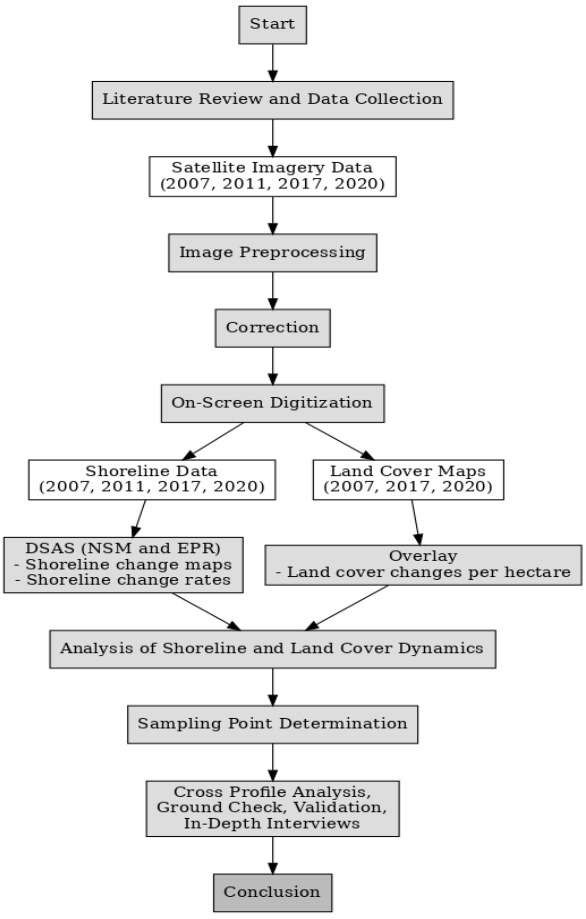

Figure 2. Flow chart of the research.

2.2 Land Cover Analysis

Classification of land types used in the analysis of land cover dynamics is based on the types of land contained in the land

use map from the Department of Public Works and Spatial Planning of Purworejo Regency in 2016. The resulting land cover map was then analyzed to determine the extent of change in each land cover class. Data analysis was carried out using the overlay technique. The overlay method is used to obtain changes in the land cover area from year to year. The overlay technique is carried out with ArcGIS so that changes around each land cover can be known.

2.3 Analysis of the Relationship between Shoreline Dynamics and Land Cover

The relationship between shoreline dynamics and land cover in the coastal area of Purworejo Regency was analyzed using the modified cross-profile (Marfai *et al*., 2011; Pratama *et al*., 2021). Cross-profile samples were determined from the coast in each sub-district that experienced the highest levels erosion, sedimentation, and land cover dynamics.

3. RESULTS AND DISCUSSION

3.1 Analysis of Shoreline Dynamics

The shoreline used for calculating the rate of change in this study is the shoreline recorded by SPOT satellite imagery on April 8, 2007, March 1, 2011, May 18, 2017, and June 27, 2020. The shoreline changes in this study were measured and analyzed using the DSAS application with the NSM and EPR methods. The number of transects produced for this study was 1335, with an interval of 20 m for each transect. The map of shoreline changes in the Grabag, Ngombol and Purwodadi Districts can be seen in Figure 3. The results of the NSM measurements obtained showed that the shoreline changed more from 2007 to 2020, by 60.1 m and -29.24 m while the EPR result was 4.58 and -2.23 m/y.

Shoreline change analysis using SPOT imagery has been widely carried out. García-Rubio *et al*., (2015) and Ruiz-Beltran *et al*., (2019) used SPOT 5 imagery to identify shoreline changes in Progreso, Yucatàn, Mexico. The average Root Mean Square Error (RMSE) value obtained during the image accuracy test was 4.151.

The SPOT imagery used in this study can detect the shoreline and land cover dynamics. The land area in the coastal area of Purworejo Regency has increased and decreased in land area over 13 years. The total land area in 2007, 2017 and 2020, respectively, was 18,329.74 ha, 18,334.47 ha and 18,325.42 ha. Based on observations using remote sensing data, the area has significantly increased due to sedimentation in the river mouth. The shoreline began to experience significant changes from 2011 to 2017. The position of the shoreline in 2020 has shifted away from the 2007 shoreline towards the sea. The coastal area of Purworejo Regency has predominantly experienced accretion (sedimentation) over 13 years. The largest sedimentation process was obtained in Kertojayan Village, Grabag District. Sedimentation occurred on the eastern banks of the Wawar River from 2007 to 2020. According to data from the Public Works, Water Resources and Spatial Planning Service of Central Java Province in 2010, sedimentation occurred on the east side of the Wawar River estuary, and erosion occurred on the west side of the Wawar River. Based on the results of the analysis of shoreline changes, the highest sedimentation was experienced around the eastern part of the Wawar River estuary with an increase of the area 0.43 ha from 2007 to 2020.

The results of previous study (Saputro, 2013) state that shoreline dynamics are more dominant towards the sea or that the shoreline is progressing (sedimentation). Analysis conducted by Biantara *et al*., (2016) using Landsat satellite imagery in 2014 and 2015 also showed relatively high sedimentation results along the shoreline of the coastal area of Purworejo Regency with the highest sedimentation located east of the Wawar River. The most significant increase in sedimentation occurred from 2011 to 2017, with an additional area of 29.67 ha, while the least sedimentation occurred from 2017 to 2020, with an additional area of 9.09 ha. The rate of change in the shoreline in the coastal area of Purworejo Regency has an average change of 1.02 m per year, a high sedimentation class, according to Natesan *et al*., (2015). Shoreline has retreated towards land in Munggangsari Village with a value of -2.23 m/year indicating erosion. The most severe erosion was detected from 2017 to 2020, which caused the loss of an area of 17.52 ha, while the smallest erosion occurred from 2011 to 2017, which reduced the coastal area by 3.93 ha.

3.2 Analysis of Land Cover Dynamics

The classification of land cover changes is based on land cover maps published by the Department of Public Works and Spatial Planning of Purworejo Regency, which are classified into fields, vacant land, settlements, plantations, swamps, rice fields, bushes, ponds, and water bodies.

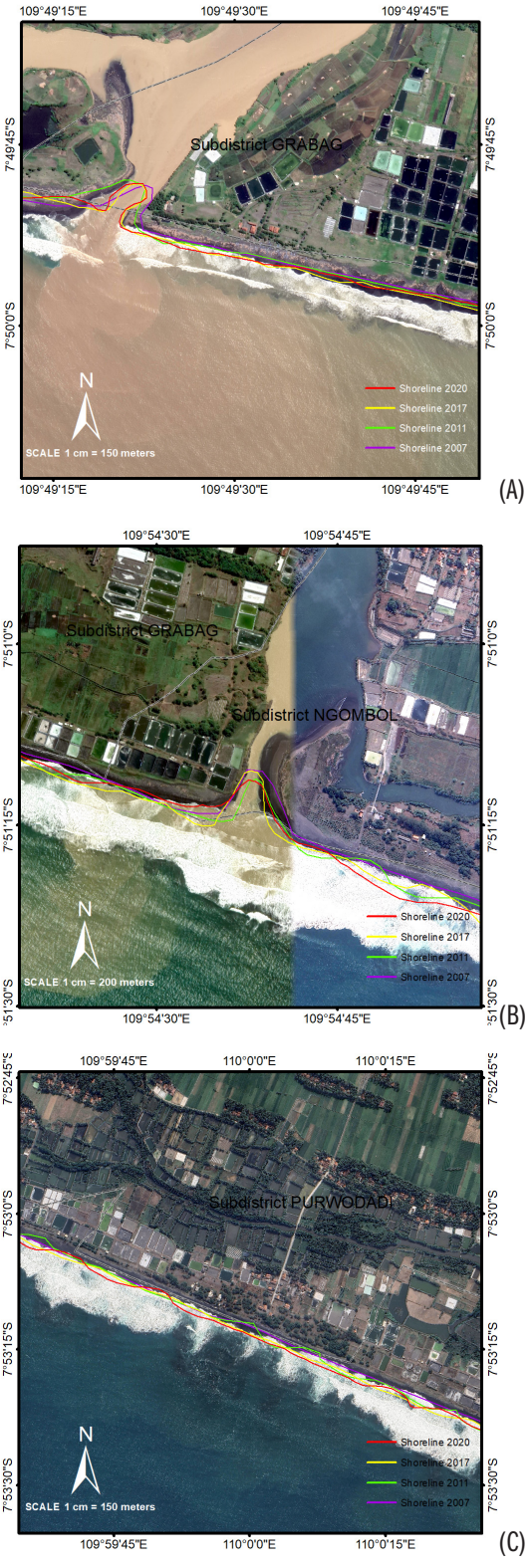

Figure 3. Shoreline Change. (A) Grabag Subdistrict; (B) Ngombol Subdistrict; (C) Purwodadi Subdistrict.

Table 1. Matrix of land cover change 2007 – 2017.

Category	2007		2017		Change in area (ha)
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)	
Agricultural land	345.99	1.9	1,899.08	10.4	1553.09
Bare land	645.57	3.5	42.8	0.2	-602.77
Settlement	4160.90	22.7	4,253.98	23.2	93.08
Plantation	1408.26	7.7	1,752.47	9.6	344.21
Swamp	354.57	1.9	27.39	0.1	-327.18
Rice Field	10832.70	59.1	9,605.92	52.4	-1226.78
Shrubs	194.54	1.1	60.37	0.3	-134.17
Water body	387.21	2.1	174.17	0.9	-213.04
Pond	-	-	518.29	2.8	518.29
	18329.74	100.0	18334.47	100.0	

Table 2. Matrix of land cover change 2017 – 2020.

Category	2017		2020		Change in area (ha)
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)	
Agricultural land	1,899.08	10.4	931.82	5.1	-960.26
Bare land	42.8	0.2	32.59	0.2	-10.21
Settlement	4,253.98	23.2	4,278.28	23.3	24.30
Plantation	1,752.47	9.6	1,755.68	9.6	3.21
Swamp	27.39	0.1	32.27	0.2	4.88
Rice Field	9,605.92	52.4	10,567.90	57.6	961.98
Shrubs	60.37	0.3	10.57	0.1	-49.80
Water body	174.17	0.9	190.65	1.1	16.48
Pond	518.29	2.8	525.66	2.9	7.37
	18334.47	100.0	18325.42	100.0	

The results of land cover map processing in the coastal area of Purworejo Regency were obtained from the interpretation of SPOT satellite imagery in 2007, showing that land cover in the area dominated by rice fields with an area of 10,832.7 ha (59.1%) (Table 1). The second largest land cover is settlements, with an area of 4,160.9 ha (22.7%) of the study area. The settlement land cover is becoming dense and spreading north of Daendels Highway. The dominant land cover in areas adjacent to the shoreline is vacant land. This vacant land is a coastal boundary area approximately 400 m from the shoreline. Small settlements are in 3 sub-districts in the coastal area: Jatimalang

Village, Ngentak, Girirejo, Wero, Pagak, Malang, Keburuhan and Kertojayan. In 2007, the coastal area in Grabag District entered the final phase of iron sand mining carried out by Antam Company. The implementation of iron sand mining activities began in 1987. In 2017, rice fields dominated the land cover in the coastal area of Purworejo Regency, covering 9,605.92 ha (52.4%). The area of rice fields decreased by around 7% compared to 2007. The second type of land cover is settlements, with an area of 4,254 ha (23.2%). The area of settlements increased slightly by around 90 ha compared to 2007.

The coastal land cover map of Purworejo Regency obtained from SPOT image interpretation shows that land cover in the form of rice fields in 2020 is still dominant, with an area of 10,567.90 ha (57.6%) (Table 2). The second largest land cover is settlements, with an area of 4,278.28 ha (23.3%). Changes in land cover in 2017-2020 also experienced additions and reductions in land. The land cover that experienced the most significant increase was rice fields and settlements, while fields and bushes experienced the most significant decrease in area. Ponds still experienced an increase in area compared to 2017, namely to 525.66 ha with an increase rate of around 2.5 ha per year.

The SPOT imagery used in this study can detect the dynamics of the shoreline and land cover that occur. The land area in the coastal area of Purworejo Regency has increased and decreased in land area over 13 years. The total land area in 2007, 2017 and 2020, respectively, was 18,329.74 ha, 18,334.47 ha and 18,325.42 ha. From the results of observations using ArcGIS tools, areas that experienced an increase in the average area were in coastal and river border areas, such as Kertojayan Village in Grabag District. Kertojayan Village, based on the results of the analysis of shoreline changes, experienced the highest sedimentation with an increase in the area around the eastern part of the Wawar River estuary of 0.43 ha from 2007 to 2020.

3.3 Relationship between shoreline and land cover dynamics

Observation of the relationship between the dynamics of changes the shoreline and land cover was done using the cross-profile method (Marfai *et al*., 2011; Pratama *et al*., 2021) in areas that have experienced the highest changes. The cross-profile method was carried out on several beaches, namely Kertojayan Beach and Munggangsari Beach in Grabag District, Keburuhan Beach and Wero Beach in Ngombol District, and Jatimalang Beach and Jatikontal Beach in Purwodadi District. These beaches were chosen because they experienced the most dynamic shoreline change and land cover compared to other beaches. The cross-profile method combines data on the rate of shoreline change, the slope of the beach shelf, landform, genesis, flora, economic activity, socio-culture, and land planning so that a comprehensive understanding will be obtained to prepare a coastal area management strategy (Pratama *et al*., 2021). Tables 3-8 contain the cross-profile profiles description of each beach. Figure 4 shows the cross profile of the beach with the types of land cover.

Munggangsari, Keburuhan, and Jatimalang beaches were selected as samples in the cross-profile because all of them have erosion conditions and genesis processes produced by marine processes. Jatimalang Beach is a priority tourist attraction in Purworejo Regency, while Munggangsari and Keburuhan beaches are mostly vaname shrimp ponds (Figure 5). Shrimp ponds in Jatimalang located behind the tourist area, while the shrimp ponds in Munggangsari are located directly opposite the beach. Shrimp Pond management in Munggangsari, Keburuhan, and Jatimalang is carried out intensively. From the analysis using remote sensing technology, the rate of change in the three shorelines shows an erosion trend, as evidenced by the presence of unused and damaged buildings on the beach

Kertojayan, Wero, and Jatikontal Beaches were selected as samples in cross-profile analysis because they all have sedimentation conditions Kertojayan Beach was formed from fluvio-marine processes, while Wero and Jatikontal Beach were formed from marine processes. The beaches in the coastal areas of Purworejo Regency that are close to rivers, such as the Kertojayan, Keburuhan, and Pasir Puncu Beaches, have a tendency toward sedimentation. Sedimentation happens because, during the dry season, the river water discharge will decrease, causing sediment to be unable to flow towards the sea and become trapped in the estuary area, then causing sedimentation on the surrounding beaches. Kertojayan, Wero, and Jatikontal Beaches have different socio-economic characteristics. Economic activities in Kertojayan Beach are fishing and shrimp farming, economic activities in Wero Beach are entirely shrimp farming, while economic activities in Jatikontal Beach come from tourism and shrimp ponds. Coastal environmental conditions of Kertojayan, Wero and Jatikontal Beaches can be seen in Figure 6.

Changes in land cover are inevitable to meet economic needs. This change also occurs in the coastal areas of Purworejo Regency, which is located on the south coast of Java Island. Changes in land cover occurred in the area under study; the most significant changes were observed in areas designated as ponds, of about 500 ha. Ponds located in the coastal areas of

Purworejo Regency are mainly used for vaname shrimp farming activities. In 10 years, from 2007 to 2017, the pond area grew by 518.29 ha or around 51 ha per year. From the results of the land cover analysis in 2007, ponds were yet to be available in the area. Based on interviews with related parties, shrimp ponds grew around 2014. In 10 years, the bare land area around the coastal boundaries was mainly turned into ponds.

Based on cross-profile analysis, it was found that there was no relationship between the dynamics of the shoreline and the dynamics of land cover. All beaches in Purworejo Regency that carry out shrimp farming activities show different patterns of coastal dynamics, namely sedimentation and erosion. Erosion usually occurs due to hydro-oceanographic factors such as waves that erode coastal areas. Shrimp cultivation must be considered as a primary factor in the preparation of coastal management strategies within Purworejo Regency. From the results of interviews with communities in the coast, the detrimental impacts of shrimp cultivation activities have begun to emerge, such as decreased rice harvests in rice fields due to intrusion and water pollution from shrimp waste, the pungent smell of ammonia that can be smelled in the shrimp pond area and river water around the shrimp which is indicated to be polluted by shrimp waste. The results of ammonia tests in water in Grabag District (Choeronawati *et al*., 2019) showed that the levels exceeded the standard quality standards at all research location points. This ammonia comes from shrimp excretion and hydrolysis of feed protein dissolved in water.

Table 3. Cross-Profile of Kertojayan Beach.

Position	X1:370255.672 mT, Y1:9134169.886 mU X2:370281.978 mT, Y2: 9134265.827 mU
Shoreline change rate	+4.58 m/year
Landform	beach
Genesis	Fluvio-Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae, Cocos nucifera*
Cultural landscape	Wild fishery, shrimp pond
Settlement pattern	None
Economy	Capture fish, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond, bare land
Land planning	Dryland agriculture, coastal setback

Table 4. Cross-Profile of Munggangsari Beach.

Position	X1:375807.809 mT, Y1: 9132860.483 mU X2: 375834.789 mT, Y2: 9132944.305
Shoreline change rate	-2.23 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Dryland agriculture, coastal setback

Table 5. Cross-Profile Keburuhan Beach.

Position	X1:379762.131 mT, Y1: 9131682.514 mU X2:379785.026 mT, Y2: 9131778.893 mU
Shoreline change rate	-1.71 m/year
Landform	Beach
Genesis	Fluvio-Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Coastal setback, riparian zone

Table 6. Cross-Profile Wero Beach.

Position	X1:384794.033 mT, Y1: 9129984.095 mU X2: 384841,704 mT, Y2: 9130081,938 mU
Shoreline change rate	+4.51 m/year
Landform	Beach
Genesis	Marine
Flora	*Ipomoea pes-caprae, Pandanus tectorius*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Coastal setback, riparian zone

Table 7. Cross-Profile Jatimalang Beach.

Position	X1:387839.135 mT, Y1: 9128834.627 mU X2: 387865.470 mT, Y2: 9128930.886 mU
Shoreline change rate	-1.36 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia, Spinifex littoreus*
Cultural landscape	Tourism, wild fishery
Settlement pattern	Linear to the beach
Economy	Trade, wild fishery, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Trading, pond, settlement
Land planning	Coastal setback, settlement and dryland agriculture

Table 8. Cross-Profile Jatikontal Beach.

Position	X1: 389739.462 mT, Y1: 9128070.173 mU X2: 389773.117 mT, Y2: 9128160,343 mU
Shoreline change rate	+2.24 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia*
Cultural landscape	Wild fishery
Settlement pattern	Linear to the street
Economy	Trade, wild fishery, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Bareland, trading, settlement, pond
Land planning	Coastal setback, riparian zone and dryland agriculture

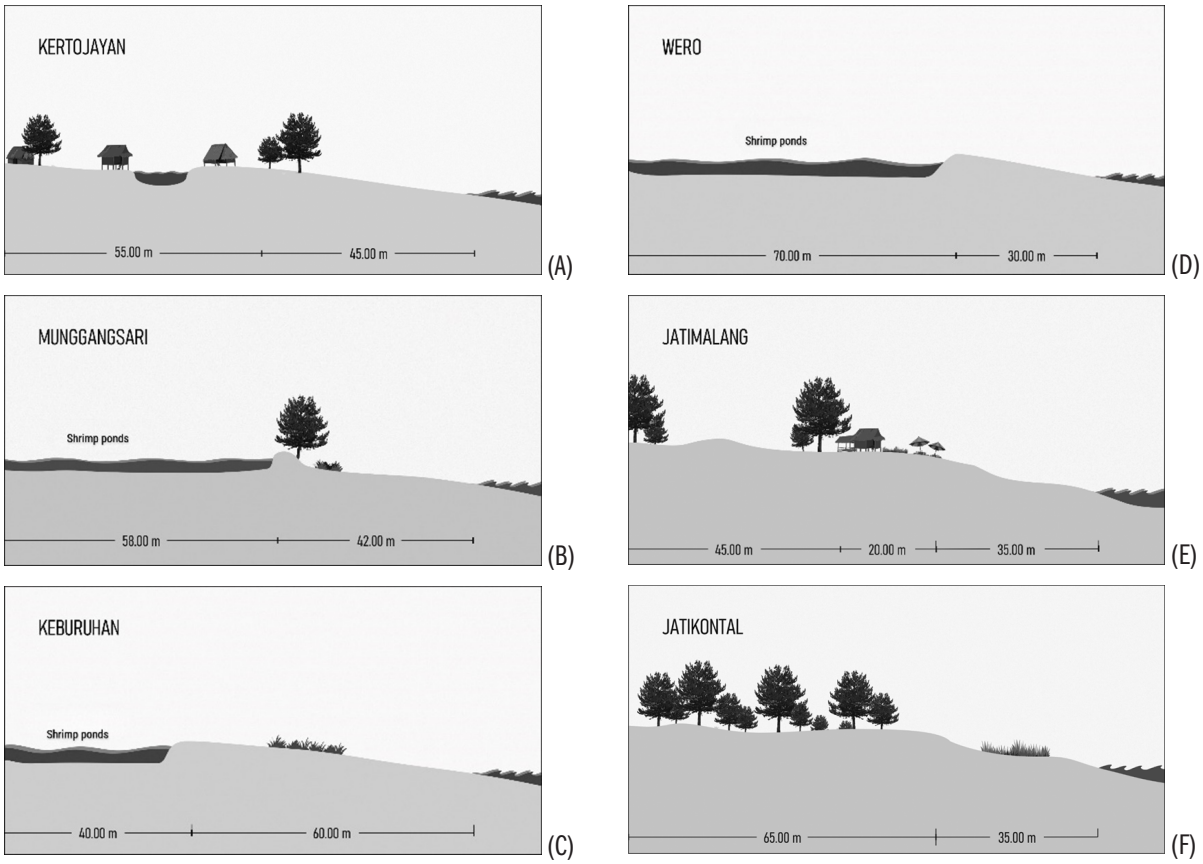

Figure 4. Cross-Profile Beach. (A) Kertojayan Beach; (B) Munggangsari Beach; (C) Keburuhan Beach; (D) Wero Beach; (E) Jatimalang Beach; (F) Jatikontal Beach.

(A)

(B)

Figure 5. Environmental Condition. (A) Munggangsari Beach; (B) Keburuhan Beach; (C) Jatimalang Beach.

(A)

(B)

Figure 6. Environmental Condition. (A) Kertojayan Beach; (B) Wero Beach; (C) Jatikontal Beach.

4. CONCLUSIONS

This study provides important insights into coastal dynamics and land cover changes in Purworejo Regency between 2007 and 2020. The findings indicate that shoreline changes during this period were largely driven by sedimentation processes, with the most significant sedimentation and erosion rates occurring in Grabag District at 9.06 and -2.08 m per year. Land cover in the area has undergone significant changes, which are closely related to economic growth. While rice fields dominated the area in 2007 and remained until 2020, the coastal border area experienced significant conversion to vannamei shrimp ponds, especially after 2014. Rapid aquaculture expansion has resulted in extensive changes in land use and has contributed to environmental degradation, including coastal pollution. The analysis of this study did not reveal a direct correlation between shoreline dynamics and land cover changes, as the same land cover type is associated with varying shoreline behavior. These results underscore the complexity of coastal systems and highlight the need for integrated coastal management and continuous environmental monitoring to support sustainable regional development.

This study has limitations in terms of data sources and information, and the images used are of medium resolution, which affects the level of detail of the analysis. Therefore, further research is needed on the natural and anthropogenic factors that determine the dynamics in coastal areas. Another limitation of this study is the lack of long-term data. Changes in shorelines and land cover in coastal areas are long-term and continuous processes. Therefore, this study is limited by using only short-term data. This can lead to a lack of precision and accuracy in predicting long-term trends or in formulating effective strategies for the long-term future.

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6. AUTHOR CONTRIBUTION

M.N. Airawati: Conceptualization, methodology, data collection, analysis and writing and editing manuscript; Djati Mardiatno: Methodology development, review of data analysis, manuscript writing and study advisor; Nurul Khakhim: Methodology development, data collection, review of data analysis and study advisor.

REFERENCES

Aldogom, D., Albesher, S., Mansoori, S. Al, & Nazzal, T. (2020). Assessing Coastal Land Dynamics Along UAE Shoreline Using GIS and Remote Sensing Techniques. IOP *Conference Series: Earth and Environmental Science*, 540, 012031. https://doi.org/10.1088/1755-1315/540/1/012031

Biantara, B., Hartoko, A., & Purwanti, F. (2016). Analisa Kerentanan Pantai Dan Sumberdaya Perikanan Dengan Pendekatan Sig Di Pantai Kabupaten Purworejo. *Diponegoro Journal Of Maquares Management Of Aquatic Resources*, 5(2), 1–10.

Cahyono, H., Wulan, T. R., Musrifah, & Maulana, E. (2017). Analisis perubahan garis pantai dengan menggunakan data citra landsat di pesisir Kabupaten Kulonprogo. *Bunga Rampai Kepesisiran Dan Kemaritiman Jawa Tengah*, 2(December 2017), 1–12.

Choeronawati, A. I., Prayitno, S. B., & Haeruddin, . (2019). Studi kelayakan budidaya tambak di lahan pesisir kabupaten purworejo. *Jurnal Ilmu Dan Teknologi Kelautan Tropis*, 11(1), 191–204. https://doi.org/10.29244/jitkt.v11i1.22522

Damayanti, A. P., Hardiana, A., & Rahayu, P. (2019). Faktor-faktor yang Mempengaruhi Perkembangan Permukiman di Wilayah Pesisir Kabupaten Purworejo The Factors Influencing The Development of Settlements in The Coastal Area. *Jurnal Pembangunan Wilayah Dan Perencanaan Partisipatif*, 14(2), 154–172.

De Freitas, R. R., Tagliani, P. R. A., Wasielesky, W., & Da Silva Poersch, L. H. (2019). Coastal planning and land use of marine shrimp farming in southern Brazil. *Journal of Integrated Coastal Zone Management*, 19(2), 61–69. https://doi.org/10.5894/n118

García-Rubio, G., Huntley, D., & Russell, P. (2015). Evaluating shoreline identification using optical satellite images. *Marine Geology*, 359, 96–105. https://doi.org/10.1016/j.margeo.2014.11.002

Li, R., Di, K., & Ma, R. (2001). A comparative study of shoreline mapping techniques. *GIS for Coastal Zone Management, Juni 18-20 2001*. https://doi.org/10.1201/9781420023428.ch3

Loebis, A. (2015). Pemanfaatan perangkat lunak pci untuk meningkatkan akurasi analisis spasial. *Jupiter*, 26–31.

Marfai, M. A., Pratomoatmojo, N. A., Hidayatullah, T., Nirwansyah, A. W., & Gomareuzzaman, M. (2011). *Model kerentanan wilayah pesisir berdasarkan perubahan garis pantai dan banjir pasang (Studi Kasus : Wilayah Pesisir Pekalongan)* (Issue July 2016).

Mullick, M. R. A., Islam, K. M. A., & Tanim, A. H. (2020). Shoreline change assessment using geospatial tools: a study on the Ganges deltaic coast of Bangladesh. *Earth Science Informatics*, 13(2), 299–316. https://doi.org/10.1007/s12145-019-00423-x

Murali, R. M., Dhiman, R., Choudhary, R., Seelam, J. K., Ilangovan, D., & Vethamony, P. (2015). Decadal shoreline assessment using remote sensing along the central Odisha coast, India. *Environmental Earth Sciences*, 74(10), 7201–7213. https://doi.org/10.1007/s12665-015-4698-7

Natesan, U., Parthasarathy, A., Vishnunath, R., Kumar, G. E. J., & Ferrer, V. A. (2015). Monitoring Longterm Shoreline Changes along Tamil Nadu, India Using Geospatial Techniques. *Aquatic Procedia*, 4(Icwrcoe), 325–332. https://doi.org/10.1016/j.aqpro.2015.02.044

Pelly, D. A., Fauziah, N., & Susanti, R. C. (2018). Arahan fungsi kawasan pesisir untuk peningkatan ekonomi masyarakat menuju perencanaan tata ruang wilayah pesisir yang berkelanjutan (studi kasus di Kecamatan Grabag, Kabupaten Purworejo). *October 2018*.

Polidoro, B. A., Carpenter, K. E., Collins, L., Duke, N. C., Ellison, A. M., Ellison, J. C., Farnsworth, E. J., Fernando, E. S., Kathiresan, K., Koedam, N. E., Livingstone, S. R., Miyagi, T., Moore, G. E., Nam, V. N., Ong, J. E., Primavera, J. H., Salmo, S. G., Sanciangco, J. C., Sukardjo, S., … Yong, J. W. H. (2010). The loss of species: Mangrove extinction risk and geographic areas of global concern. *PLoS ONE*, 5(4). https://doi.org/10.1371/journal.pone.0010095

Pratama, D. N. D., Khakhim, N., Wicaksono, A., Musthofa, A., & Lazuardi, W. (2021). Spatio-temporal analysis of abrasion susceptibility effect on land cover in the coastal area of Bantul Regency , Yogyakarta , Indonesia. 17(4), 109–126.

Raimundo Lopes, N. D., Li, T., Qian, D., Matomela, N., & Sá, R. M. (2022). Factors influencing coastal land cover change and corresponding impact on habitat quality in the North-western Coastline of Guinea-Bissau (NC-GB). *Ocean and Coastal Management*, 224(October 2021), 106181. https://doi.org/10.1016/j.ocecoaman.2022.106181

Rebêlo, L., & Nave, S. O. (2022). Long-term coastline evolution of figueira da foz – nazaré sector (Portugal). *Journal of Integrated Coastal Zone Management*, 22(2), 145–168. https://doi.org/10.5894/rgci-n507

Ruiz-Beltran, A. P., Astorga-Moar, A., Salles, P., & Appendini, C. M. (2019). Short-Term Shoreline Trend Detection Patterns Using SPOT-5 Image Fusion in the Northwest of Yucatan, Mexico. *Estuaries and Coasts*, 42(7), 1761–1773. https://doi.org/10.1007/s12237-019-00573-7

Saputro, A. D. (2013). Kajian perubahan garis pantai dengan menggunakan citra landsat multitemporal tahun 2002 dan 2013 di wilayah pesisir Kabupaten Purworejo (Issue 3). Universitas Negeri Yogyakarta.

Taveira-Pint, F., Henriques, R., Rosa-Santo, P., Fazeres-Ferrados, T., Das Neves, L., Pinto, F. V. C. T., & Sarmento, M. F. (2022). Hazard mapping based on observed coastal erosion rates and definition of set-back lines to support coastal management plans in the north coast of portugal. *Journal of Integrated Coastal Zone Management*, 22(3), 225–239. https://doi.org/10.5894/rgci-n546

Yum, S. G., Park, S., Lee, J. J., & Adhikari, M. Das. (2023). A quantitative analysis of multi-decadal shoreline changes along the East Coast of South Korea. *Science of the Total Environment*, 876(February), 162756. https://doi.org/10.1016/j.scitotenv.2023.162756.

Zhao, Y., An, R., Xiong, N., Ou, D., & Jiang, C. (2021). Spatio-temporal land-use/land-cover change dynamics in coastal plains in hangzhou bay area, china from 2009 to 2020 using google earth engine. *Land*, 10(11). https://doi.org/10.3390/land10111149.

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THE MARINE SPATIAL PLANNING AND THE ADOPTION OF A MODEL OF STRATEGIC INITIATIVES FOR ITS IMPLEMENTATION IN BRAZIL

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ABSTRACT: Several interests, such as urban expansion, coastal development, industrial pollution and fishing, are intertwined with the use and protection of coastal and marine resources. However, disjointed regulation of maritime activities and conflicting pressures have led to a lack of strategic and integrated spatial management. The rational use of the ocean has become a major challenge for coastal countries and regions around the world, and Marine Spatial Planning (MSP) has become a valuable and effective tool to achieve these goals. This article aims to present proposals for strategic initiatives for the management of coastal and adjacent oceanic environments in Brazil to make the MSP viable. The federal legal basis for the MSP in Brazil was analyzed, as well as the models, experiences and practices of the MSP adopted in other countries, the proposals and methodologies for the management of conflicts of marine uses and activities, and interviews were conducted with a focus group of experts. As a result, proposals were identified to be internalized in the legal system, such as the adoption of a Directive adopted by the countries of the European Community or an IOC-UNESCO guide, the adoption of financial tools to support the implementation of the MSP, the interaction of the planning and implementation of the MSP with public policies for coastal management, the pre-establishment of zoning rules for the use of maritime spaces, the identification of parameters to be adopted in determining the use or prevailing activity in cases of conflicts and the establishment of a methodology that strengthens social participation. It is concluded that the implementation of the MSP in Brazil faces a series of complex challenges, but that there are opportunities for the adoption of these proposals, adjusting them to their specific needs, becoming a fundamental tool for the sustainable management of the Brazilian marine heritage.

Keywords: Conflicts, Marine Spatial Planning, Legal Certainty.

RESUMO: *Diversos interesses, como a expansão urbana, o desenvolvimento costeiro, a poluição industrial e a pesca, estão interligados com o uso e a proteção dos recursos costeiros e marinhos. Entretanto, a regulamentação desarticulada das atividades marítimas e pressões conflitantes levaram à falta de gestão espacial estratégica e integrada. A utilização racional do oceano tornou-se um grande desafio para os países e regiões costeiras do mundo, e o Planejamento Espacial Marinho (PEM) tornou-se uma ferramenta valiosa e eficaz para alcançar estes objetivos. Este artigo tem como objetivo apresentar propostas de iniciativas estratégicas para a gestão dos ambientes costeiros e oceânicos adjacentes no Brasil para a viabilização do PEM. Foi analisada a base legal federal do PEM no Brasil, além dos modelos, as experiências e as práticas do PEM adotados em outros países, as propostas e metodologias para o gerenciamento de conflitos de usos e atividades marinhas, e foram efetuadas entrevistas com um grupo focal de especialistas. Como resultados, foram identificadas propostas para serem internalizadas no ordenamento legal, como a adoção de uma Diretiva adotada pelo países da Comunidade Europeia ou guia da IOC-UNESCO, a adoção de ferramentas financeiras para apoiar a implementação do PEM, a interação do planejamento e implementação do PEM com políticas públicas de gerenciamento costeiro, o preestabelecimento de regras de zoneamento para a utilização dos espaços marítimos, a identificação de parâmetros a serem adotados na determinação do uso ou da atividade prevalecente em casos de conflitos e o estabelecimento de uma metodologia que fortaleça a participação social. Conclui-se que a implementação do PEM no Brasil enfrenta uma série de desafios complexos, mas que existem oportunidades para a adoção destas propostas, ajustando-as para suas necessidades específicas, tornando-se uma ferramenta fundamental para a gestão sustentável do patrimônio marinho brasileiro.*

Palavras-Chave: Conflitos, Planejamento Espacial Marinho, Segurança Jurídica.

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1. INTRODUCTION

According to recent data, the ocean plays a central role in the global economy, being essential for maritime cargo transport, accounting for 90% of global trade volume, and for energy production, with over 6,000 oil and gas facilities operating worldwide and supplying nearly 30 percent of the world's energy. This dual role highlights the strategic importance of the seas for global economic development (Gonçalves and Polejack 2022). Various interests, such as urban expansion, coastal development, industrial pollution, and fishing, are interconnected with the use and protection of coastal and marine resources. Activities such as aquaculture, renewable energy, mineral extraction, and recreation also influence marine ecosystems and coastal waters in different ways (Grip and Blomqvist 2021). However, the fragmented regulation of maritime activities and the cumulative measures and conflicting pressures have led to a lack of strategic and integrated spatial management (Ritchie and McElduff 2020).

Moreover, due to the intensifying spatial competition within and between coastal countries and regions, as well as the diversity of sea uses and the lack of coordination mechanisms among maritime departments, conflicts between different uses of the sea are becoming increasingly prominent. In light of these situations, the rational and scientific use of the ocean has become a major challenge for all coastal countries and regions around the world, and Marine Spatial Planning (MSP) has become a valuable and effective tool to achieve these objectives (Hou *et al*., 2022). The objective of MSP is to promote the efficient and sustainable use of marine space, ensuring the protection of fragile ecosystems. MSP also aims to facilitate balanced interactions between different marine users, reconciling economic development, human well-being, and environmental conservation (Jentoft and Knol, 2014).

MSP is a fundamental tool for providing legal certainty and predictability to the private sector, allowing companies from various industries, such as oil and gas, aquaculture, and renewable energy, to operate more efficiently and sustainably. By clearly defining areas of use, promoting regulatory integration, and ensuring mechanisms for environmental compensation, MSP creates a more stable and attractive environment for investment, while also minimizing the risks of use conflicts and environmental damage. Marine resources are essential for economic and social progress, as various industries, such as fishing, tourism, and mining, depend on them. The growing consumer demand, coupled with technological advancements and population growth, has intensified this dependency. In this context, it is crucial to balance economic development with social needs and environmental preservation in ocean management (Ansong *et al*., 2017).

Brazil, encompassing 17 states and 443 municipalities along the terrestrial strip of its Coastal Zone (CZ), made a commitment in 2017 during the United Nations (UN) Ocean Conference to implement its MSP by 2030. MSP is one of the integrated actions under the Sectoral Plan for Marine Resources (PSRM) and is coordinated by the Secretariat of the Interministerial Commission for Marine Resources (SECIRM) and the Ministry of the Environment and Climate Change (MMA).

This article aims to demonstrate that a proposal of strategic initiatives for the Brazilian management of coastal and adjacent ocean environments within a MSP framework can provide a practical way to better organize the use of marine space. The analysis of MSP models adopted especially in the European Community, the identification of public management policies and the federal legal basis in Brazil on MSP and the proposals for strategic initiatives aimed at the management of coastal and adjacent oceanic environments in Brazil, to be incorporated into national legislation, were considered. In this way, it tends to promote improved interaction among its users, minimizing or eliminating conflicts, and seeking to balance development demands with the need to preserve the environment—especially by ensuring legal certainty, increasing investor confidence, and fostering transparency and predictability.

2. METHODOLOGICAL PROCEDURES

2.1 Methods and techniques

The proposal of a model for strategic initiatives for the implementation of MSP in Brazil is the central point that motivates the research and guides the choice of methods employed. Thus, the research methodology includes the following stages: (A) theoretical framework, (B) documental research, and (C) development and application of a semi-structured interview with the focus group. The theoretical framework (A) was established through a bibliographic survey, based on specific databases using specific search terms. To conduct the bibliographic survey, the consultation was made through the virtual library of electronic journals from the Coordination for the Improvement of Higher Education Personnel (CAPES). The main sources were compiled from three specific databases: *Scopus*, *Web of Science*, and *Springer Link*, covering the period

from 2014 – the year the EU Directive 2014/89/EU (Directive 2014/89/EU 2014) was published – until June 2024, with the search filters applied were the terminology "Marine Spatial Planning AND Conflict", with quotation marks. Table 1 presents the selected articles and their categories.

Information from the website The European Maritime Spatial Planning Platform (European MSP Platform) was also used, which deals with MSP information in Europe. A "Global MSP Inventory" is available, designed to provide an updated characterization of MSP processes in Europe and allow for an analysis of the characteristics of these processes. Documentary research (B) involved researching and analyzing relevant Brazilian federal legislation on the topic, conducted through a bibliographic analysis of articles and research published on the websites of federal agencies, in addition to a search in the *Legis*Ambiental database (software), which gathers Brazilian legislation issued by public agencies. The criteria used for the search in the software were the keywords of the research – Marine Spatial Planning and MSP – considering only the current federal legislation, without limiting the publication period. Finally, regarding the application of the semi-structured interview (C), the aim was, through the focus group of experts, to obtain responses about the particularities of experiences, issues, and MSP models worldwide and how these could also be applied as proposals for strategic initiatives for the Brazilian management of adjacent coastal and oceanic environments in the implementation of MSP. For the purposes of preparing this questionnaire, questions were formulated based on an extensive literature review of MSP models. The questions presented to the experts are available in Supplementary Information. A total of fourteen experts were contacted by email, with a response of eight experts. Experts were invited to represent the coastal regions of Brazil, specifically the South, Southeast, and Northeast regions. All of the experts hold a doctoral degree and have experience in different disciplines and areas of expertise. They are considered informant voices who helped to clarify the conclusions of this documentary study and were identified as "experts" due to their extensive knowledge of the interests and activities of institutions related to marine science and MSP. The interviews were initially scheduled by email and conducted with two of the experts, in Portuguese via "Google Meet," with video recordings. At the end, the interviews were transcribed and sent to the experts via email, along with the video link. Later, due to the low response rate for confirming the interviews, a form was created on "*Google Forms*" containing the same questions as the interview. The form link was sent to the other six experts by email.

Table 1. Articles selected by the author.

Category	Source
Conflicts	Jentoft and Knol (2014); Tafon *et al*. (2023); Ye *et al*. (2021); Freeman *et al*. (2016); Wang *et al*. (2024); Pınarbaşı *et al*. (2017); Moore *et al*. (2017); Hou *et al*. (2022); Ramos *et al*. (2015); Tafon *et al*. (2022); Knol-Kauffman *et al*. (2023); Agapiou *et al*. (2017); Prestrelo and Vianna (2016); Yang *et al*. (2024); Fang *et al*. (2019).
Sustainable Development	Qi (2023); Grip (2016); Harris *et al*. (2022).
Renewable Energy	García *et al*. (2020); Young (2015); Christie *et al*. (2014); Azzellino *et al*. (2019); Steins *et al*. (2021); Bonnevie *et al*. (2023); Schupp *et al*. (2021); Zhang *et al*. (2017); Kerr *et al*. (2014); Weiss *et al*. (2023); Tafon *et al*. (2023).
Blue Economy	Gustavsson and Morrissey (2019); Wickliffe *et al*. (2023); Cavallo *et al*. (2020); Tailor *et al*. (2021); Knol-Kauffman *et al*. (2023).
Ocean and Coastal Governance	Gerhardinger *et al*. (2022); Jentoft and Knol (2014); Edwards and Evans (2017); Schupp *et al*. (2019); Wilke, (2023); Chang and Lin (2016); Gogoberidze *et al*. (2021)
Integrated Coastal Management and Coastal Management	Margeson *et al*. (2023); Tuda *et al*. (2014)
Risk Assessment	Muñoz *et al*. (2018).
Data Management, Indicators, and Geographic Information Systems (GIS)	Edwards and Evans (2017); Gimpel *et al*. (2018); Sullivan *et al*. (2015); Yang *et al*. (2024); Pataki and Kitsiou (2022); Wen *et al*. (2022); Zhang *et al*. (2022); Ferreira *et al*. (2018); Danezis *et al*. (2020); Flynn *et al*. (2023); Moore *et al*. (2017); Tuda *et al*. (2014).
Marine/Ocean Zoning and Land Use Planning	Madarcos *et al*. (2022); Lester *et al*. (2017); Rempis and Tsilimigkas (2023); Wang *et al*. (2024).
Stakeholders and Public Participation	Wen *et al*. (2022); Wilke (2023); García-Sanabria *et al*. (2021); Jentoft and Knol (2014); Margeson *et al*. (2023); Steins *et al*. (2021); Madarcos *et al*. (2022); Zhang *et al*. (2017).
Coastal and Marine Tourism	Papageorgiou (2016)
Offshore Hydrocarbon Exploration	Verón *et al*. (2022)
Learning Experiences	Ullah *et al*. (2021)

3. LITERATURE REVIEW

3.1 WHAT IS MSP?

MSP is a public process of analyzing and assigning the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives, which are typically specified through a political process (Ehler and Douvere 2009). MSP can be defined as a process through which the competent authorities of Member States analyze and organize human activities in marine areas to achieve ecological, economic, and social objectives (Directive 2014/89/EU 2014). Thus, MSP is a management process that organizes and coordinates the use of marine space and resources in a sustainable manner, considering environmental, social, and economic aspects, with the goal of minimizing conflicts and preserving marine ecosystems.

MSP has been widely recognized as a crucial regional policy to replace the fragmented and sometimes contradictory approach of sectoral policies, adopting a more integrated, holistic, multisectoral, and participatory model. Based on the concept of sustainable development, MSP seeks to achieve interconnected ecological, economic, and social objectives, thus aligning with the goals of the United Nations (UN) 2030 Agenda for Sustainable Development and the global movement toward sustainable ocean economies (IOC-UNESCO 2022). Marine zoning alone, without adequate planning, cannot be considered a MSP. Although some marine sites that have adopted zoning without structured planning, it is important to highlight that an effective MSP process should result in a comprehensive and adaptive marine spatial management plan. This plan should be the main output of the MSP process, setting goals, objectives, and a vision for the future, and serving as a guide for decision-making throughout the implementation of the plan (Ehler 2021). Figure 1 shows the continuous MSP cycle.

When developed properly, MSP can bring significant economic, social, and environmental benefits. Table 2 presents some of the most important benefits of MSP.

3.2 ENGAGEMENT IN MSP INITIATIVES

International practices clearly indicate that MSP is a multidisciplinary approach, and its implementation can help reduce conflicts, improve socioeconomic activities, promote sustainable development, and build a friendly environment among different stakeholders. Several global, regional, and national initiatives have been implemented to date. Numerous marine countries have also analyzed the practices adopted in other developed and developing countries for integrated coastal and marine area management and have subsequently adopted the proposed MSP based on what they consider appropriate and feasible for their geopolitical environments (Ullah *et al*., 2021).

In 2013, the European Parliament and the Council adopted Directive 2013/133 (European Parliament and of the Council 2013) creating an integrated framework for Marine Spatial Planning and Integrated Coastal Zone Management (ICZM).

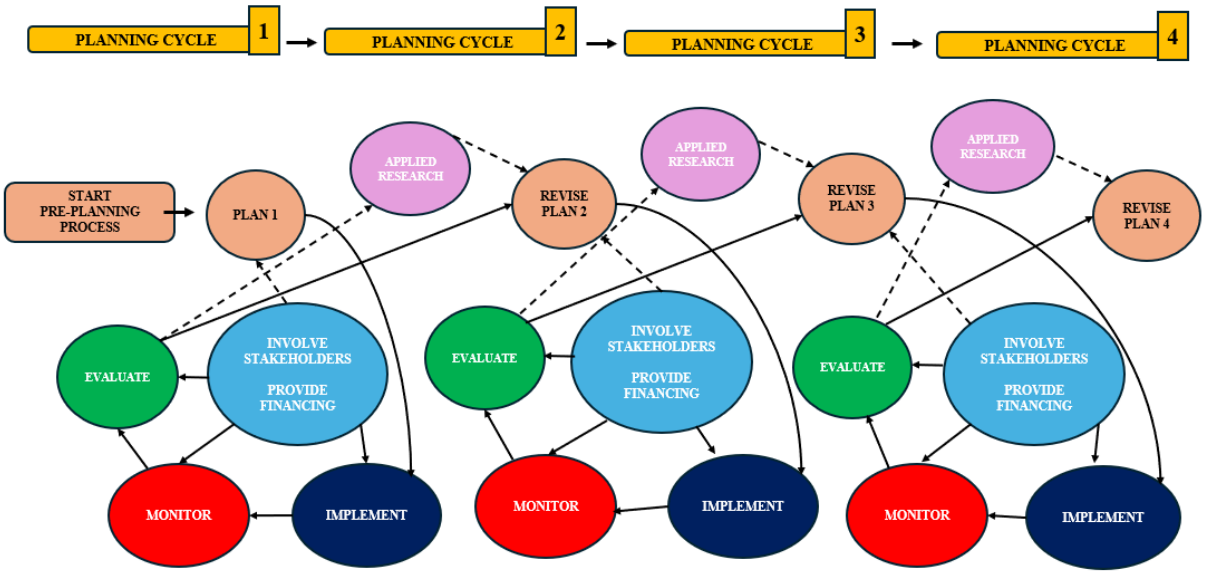

Figure 1. MSP continuous cycle (adapted from Ehler and Douvere, 2009).

Table 2. Most Important Benefits of MSP. (Adapted from Ehler and Douvere, 2009).

Ecological/ Environmental Benefits	Identification of biological and ecological important areas
	Biodiversity objectives incorporated into planned decision-making
	Identification and reduction of conflicts between human use and nature
	Allocation of space for biodiversity and nature conservation
	Establish context for planning a network of marine protected areas
	Identification and reduction of the cumulative effects of human activities on marine ecosystems
Economics Benefits	Greater certainty of access to desirable areas for new private sector investments, frequently amortized over 20-30 years
	Identification of compatible uses within the same area of development
	Reduction of conflicts between incompatible uses
	Improved capacity to plan for new and changing human activities, including emerging technologies and their associated effects
	Better safety during operation of human activities
	Promotion of the efficient use of resources and space
	Streamlining and transparency in permit and licensing procedures
Social Benefits	Improved opportunities for community and citizen participation
	Identification of impacts of decisions on the allocation of ocean space (e.g., closure areas for certain uses, protected areas) for communities and economies onshore (e.g., employment, distribution of income)"
	Identification and improved protection of cultural heritage
	Identification and preservation of social and spiritual values related to ocean use (e.g., the ocean as an open space)

Then, in July 2014, Directive 2014/89/EU (Directive 2014/89/EU 2014) was adopted, which established the key guidelines for a common framework for the implementation of MSP. (Tsilimigkas and Rempis 2018).

A total of 126 countries/territories were identified, by the end of 2023 as engaged in MSP initiatives – an increase of 20% from the assessment completed for the 2022 Pilot StOR (IOC-UNESCO, 2022), according to Figure 2.

The adoption of MSP continues to accelerate worldwide, with the approval and implementation of marine spatial plans still relatively low beyond Europe, perhaps due to the lack of legal frameworks. Monitoring and evaluation of MSP around the world is important to understand how the plans are implemented and can be improved (IOC-UNESCO 2024).

According to Directive 2014/89/EU (Directive 2014/89/EU 2014), Member States are free to design and determine the format and content of their marine spatial plans, including institutional arrangements and the allocation of maritime activities (Directive 2014/89/EU 2014). As an example, in April 2014, before the publication of the European Union (EU) MSP Directive, the first Portuguese MSP framework law was promulgated – Law Nº 17/2014 (Portugal 2014). As a "framework law", the diploma had a very broad nature, laying the foundations for national ocean planning and management, establishing the general framework for legal licensing regimes, and identifying "preference criteria" for the use of maritime space. Yet, it did not specify operational details (Calado *et al*., 2023). Afterwards, the Decree-Law Nº 38/2015 (Portugal 2015), published in March 2015, further develops key aspects of the Law and transposed the EU MSP Directive. It defines two types of maritime spatial planning instruments, the Situation Plan (PSOEM) and the Allocation Plan (AP) (Fernandes *et al*., 2020). The Decree-Law also brings an important point, regarding the evaluation of preference criteria when there is a conflict between existing or potential uses or activities in the same area or volume of the national maritime space, the public entity responsible for preparing the allocation plan, for the purposes of determining the prevailing use or activity.

3.3 PUBLIC POLICIES AND THE NATIONAL LEGAL BASIS FOR MSP

3.3.1 Public Management Policies

Brazilian initiatives related to maritime issues result from specific public policies focused on the sea. Notably among them are the National Maritime Policy (PMN), the National Policy for Marine Resources (PNRM), the Sectoral Plan for Marine Resources (PSRM), and the National Coastal Management Plan (PNGC).

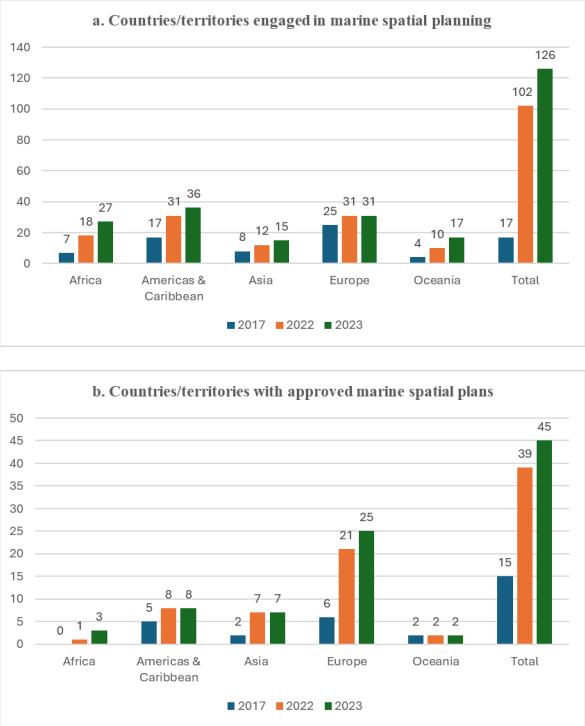

Figure 2. IOC-UNESCO assessments about marine spatial planning status around the world. (Adapted from IOC-UNESCO, 2024).

The PMN, initially established in 1984 and later revised in 1994, approved by Decree Nº 1.265 (Brasil 1994), which repealed the previous version, aims to guide and develop the country's maritime activities in an integrated and harmonious manner. Its focus is on the effective, rational, and full utilization of the sea and inland waterways, aligned with national interests. The PNRM, approved by Decree Nº 5.377/2005 (Brasil 2005) in turn, aims to guide the development of activities aimed at the effective use, exploration, and utilization of living, mineral, and energy resources in the Territorial Sea, the Exclusive Economic Zone, and the Continental Shelf, in accordance with national interests. In alignment with the PNRM, the Interministerial Commission for Marine Resources (CIRM) published a Resolution Nº 6, in November 2023 approving the 11th PSRM (CIRM 2023), which will be in effect from January 1, 2024, to December 31, 2027.

Regarding the CZ, as an integral part of the PNRM and the National Environmental Policy (PNMA), approved by Law Nº 6.938/1981 (Brasil 1981) the PNGC, approved by Law Nº 7.661/1988 (Brasil 1988), with its details and operationalization outlined in CIRM Resolution Nº 01/1990 (CIRM 1990). In 1997, CIRM Resolution Nº 05 (CIRM 1997) approved the PNGC II. One of its core principles is the integrated management of terrestrial and marine environments within the CZ, ensuring the development and maintenance of transparent and participatory decision-making mechanisms based on the best available information and technology, as well as the convergence and harmonization of public policies at all levels of administration. Subsequently, Decree Nº 5.300/2004 (Brasil 2004) regulated Law Nº 7.661/1988 (Brasil 1988), establishing various articulated and integrated instruments for CZ management. The CZ plays a fundamental role in MSP, and its management is crucial to the success of any marine spatial planning initiative. As the interface between land and sea, the CZ is a highly dynamic and vital area, both ecologically and economically. Therefore, its integration into MSP processes brings a range of benefits.

3.3.2 The legal basis for MSP in Brazil

In 2013, the CIRM published the Resolution Nº 1 (CIRM 2013), which approved the creation of a Working Group (WG) for the analysis, study, and proposal of guidelines and recommendations, as well as its institutional, normative, and regulatory framework, related to the "shared use of the marine environment" (WG-UCAM). With the publication of Ordinances Nº 18 and Nº 19, both in 2014, by the Secretariat of the Interministerial Commission for Marine Resources (SECIRM), working groups on Marine Spatial Planning (MSP) and Legislation (LEG) were established to conduct the necessary studies for implementing the shared use of the marine environment. Subsequently, in 2019, Ordinance Nº 236/MB of the Brazilian Navy (MB 2019) established the MSP Technical Group (TG-MSP), replacing WG-UCAM and its two working subgroups (MSP and LEG).

In 2015, the United Nations General Assembly approved the 2030 Agenda for Sustainable Development. In the same year, Brazil ratified the adoption of the 2030 Agenda, including its 17 Sustainable Development Goals (SDGs) and 169 targets. Subsequently, with the publication of the Decree Nº 8.892/2016 (Brasil 2016), the country established the National Commission for the Sustainable Development Goals. In December 2018, Ordinance Nº 386/MB (MB 2018) was published, established by the CIRM Resolution No. 2 (CIRM 2018), to approve the creation of the SDG 14 – Life Below Water – Working Group, with the purpose of contributing to, discussing, and monitoring the implementation of the SDG targets.

In 2020, Ordinance Nº 235/2020/MB (MB 2020) created the Executive Committee "EC - MSP", with the purpose of carrying out the tasks necessary to meet the goals and achieve the objective established for the "MSP" Action, part of the PSRM. Later,

the CIRM Resolution Nº 7/2023 (CIRM 2023) was published, approving the proposal for the Vision and Principles of MSP in Brazil, aiming to support the development and implementation of MSP processes in the country.

The Decree Nº 12.363/2025 (Brasil 2025), substitute for Decree Nº 10.544/2020 (Brasil 2020), approves de XI PSRM, having as one of its objectives to promote the establishment of shared and sustainable use of the marine environment in the country, through the development and implementation of the MSP in a participatory and ecosystem-based manner. On June 5, 2025, World Environment Day, Decree Nº 12.491 (Brasil 2025) was published, establishing basic and general information for the Marine Spatial Planning, presenting, among others, the objective, guidelines and principles, as well as determining that the first PEM must be completed by 2030 and that it will also be submitted to the CIRM for consideration and consolidated by an act of the federal Executive Branch. The table 3 presents a summary of the legal basis for MSP in Brazil.

Conversely, in 2013, Bill 6969 (Brasil 2013) was introduced in the Chamber of Deputies, aiming to "Establishes the National Policy for Integrated Management, Conservation and Sustainable Use of the Coastal-Marine System (PNGCMar)", also called "Law of the Sea". In May 2025, the Bill was approved by the Chamber of Deputies and is now awaiting analysis by the Federal Senate, now as Bill Nº 2673/2025 (Brasil 2025).

For the implementation of the national MSP, the Brazilian maritime space was divided into four sections: South, Southeast, Northeast, and North, starting with the MSP Pilot Project in the Marine Region of Southern Brazil. This project is particularly significant as it covers a maritime area of more than 10% of Brazil's total area and provides the opportunity to consider planning alongside an international border (Uruguay). The creation and establishment of a marine spatial management plan not only enhance legal security but also serve as a more rational way to organize the use of marine space and the interactions between its various uses (Andrade *et al*., 2024). The Project involves three phases, and includes the activities described as shown in figure 3.

4. RESULTS AND DISCUSSIONS

This chapter presents the summary of the expert's responses, presented in Table 4, and an analysis with the context of the literature, according to the questions of the interview conducted by the researcher.

Regarding question number 1, according to the presented responses, it was not possible to confirm a consensus among the research participants. A smaller portion of the participants believes it would not be appropriate to use a Directive for South American countries to establish a framework and a common set of requirements for MSP. The reasons given for this position include the distinct realities between South America and Europe, the absence of a unifying instrument for this joint institutionalized cooperation in South America, the need for a public policy analysis and the standardization of instruments, guidelines, and objectives among countries. Participants suggested that a preliminary diagnosis should first take place before MSP is subsequently elaborated and implemented individually, the different legal status and the financial support capacity provided by the European Union to its member states

Table 3. The legal basis for MSP in Brazil

Responsible body	Legal Requirement	Publication Year	Objective
CIRM	Resolution Nº 1	2013	Working Group-UCAM
SECIRM	Ordinances Nº 18 and Nº 19	2014	Working Group-MSP and Working Group-LEG
Brazilian Navy	Ordinance Nº 236/MB	2019	Technical Group-MSP
Federal Government Brazilian Navy	Decree Nº 10.544 Ordinance Nº 235/MB	2020	X PSRM EC-MSP
CIRM	Resolution Nº 7	2023	Vision and Principles of MSP
Federal Government	Decree Nº 12.363	2025	XI PSRM
Federal Government	Decree Nº 12.491	2025	Establishes Marine Spatial Planning

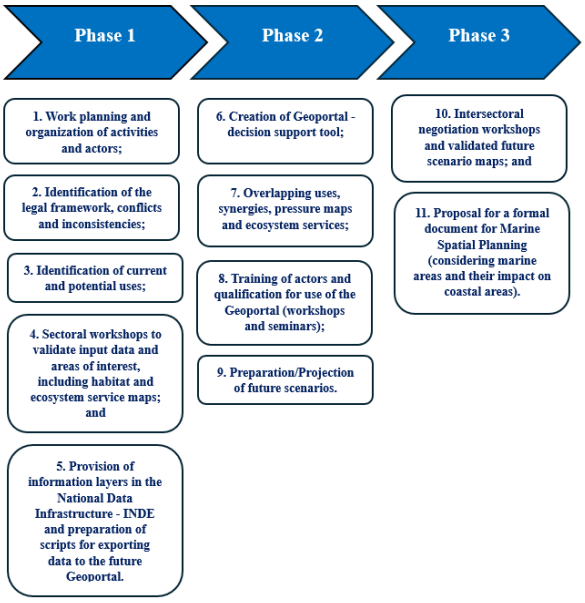

Figure 3. Activities to be developed in the 3 phases and activities of the technical study for the implementation of the MSP Pilot Project in the Southern Marine Region of Brazil.

(Adapted from BNDES, 2022).

and the existence of the IOC-UNESCO guidance document for MSP, which was pointed out as a relevant reference for the Brazilian case, with the necessary adaptations.

According to the considerations of Directive 2014/89/EU, "an integrated approach to the planning and management of oceans and maritime governance has been developed within the framework of MSP for the European Union, including, as its environmental pillar, Directive 2008/56/EC" (Directive 2014/89/EU 2014). In all coastal EU Member States, "MSP has been developed in accordance with the EU MSP and the Maritime Spatial Planning Directive" (Lahde *et al*., 2024). Member States have the responsibilities and abilities to design and determine the format and content of these plans for their marine waters (Stan 2022). As established by the European MSP Directive, each Member State of the European Union will have the autonomy to plan its own maritime space, while regional planning in shared basins should be harmonized through common requirements. This coordinated MSP approach aims, among other benefits, to reduce conflicts, stimulate investment, strengthen cooperation both between national administrations and between countries sharing the same basin, and finally, contribute to the protection of the marine environment, through the assessment of challenges and opportunities related to the sustainable and integrated use of maritime space (Abramic *et al*., 2018). Checking the calls for proposals of the MSP in Brazil, it was pointed out that the UNESCO guide (2009) constituted the great conceptual and methodological reference for the MSP Projects for the South, Southeast and North regions of the country.

Regarding funding, comparing the European reality with the Brazilian case of MSP implementation, the calls for proposals of the MSP Pilot Project in the Southern Marine Region of Brazil (BNDES 2022), and the Southeast (BNDES 2023) and North (BNDES 2024) regions, foresee financial support from the National Bank for Economic and Social Development (BNDES), through the Project Structuring Fund - "BNDES FEP", while the terms of reference for the MSP Project for the Northeast region foresee support from the Brazilian Biodiversity Fund (Funbio), "being financed with resources from the Commitment Term nº 1777032 between Petrobras and IBAMA, as part of the environmental compensation for the adaptation of the company's offshore production platforms in relation to the disposal of produced water" (Funbio 2023). In the European case, to support its implementation, Directive 2014/89/EU determined that "the European structural and investment funds, including the European maritime and fisheries fund, shall provide opportunities to support the application of this directive for 2014-2020" (Directive 2014/89/EU 2014). MSP is not possible without adequate financial resources (Ehler and Douvere 2009).

Regarding question number 2, participants generally reported that the land-sea interaction and the involvement of coastal states and municipalities represent one of the major challenges for MSP. The land-sea interaction is a complex phenomenon that involves both natural processes along with the land-sea interface and the measurement of the socio-economic impact of human activities occurring in the CZ (Aivaz *et al*., 2021). MSP has the potential to be a tool with a broader scope than Integrated Coastal Management (ICM), encompassing the ocean depths and the Exclusive Economic Zone (EEZ) up to the inner regions of the CZ, where dynamic interactions intensify, both between human uses and between these and the environment (Papageorgiou 2016). Coastal areas are interdependent with the sea in both human uses and natural conditions, and therefore, most human marine activities are functionally connected to the coast and vice versa (Stanchev *et al*., 2018). MSP employs two integrated concepts, the ecosystem-based approach and land-sea interactions (Lahde *et al*., 2024). Therefore, land-sea planning has been incorporated as an integral part of the European MSP preparations (Hietala *et al*., 2021). Although terrestrial activities can directly impact marine areas, MSP focuses only on maritime activities and

Table 4. Summary of expert's responses

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 1	"In Europe, the problem there has a characteristic of conflict. Because many countries with a lot of capacity are trying to explore a relatively small and shared oceanic space, comparatively with others (...) If I make a comparison with the South American reality, we don't have the same necessity. Brazil, pragmatically, perhaps, I don't know if it would have much to gain from a directive, because it would have to concede (...) thinking in the long term, inevitably we will have border issues (...) in the short term, I wouldn't see this need as so important, it doesn't have the same importance. Brazil can handle its MSP without having a South American Directive. In the medium and long term, I think the needs and advantages begin to appear".	"And politically, well, that's a decision, it's not whether the MSP policy will advance to the interaction zone or whether there will have to be a harmonization of policies, or whether the MSP will necessarily have to interact with the CZM (Coastal Zone Management), if it wants to have minimum success, because there's no way around it, and the examples are various (...) Regarding the state coastal management plan and the municipal plan, where 'everyone' must 'talk' to have an interaction, 'that's a problem, because the MSP is characteristically federal, although the State may have one, but the problem is that even if the State has the interest and participation in this, the waters are federal, beyond the Territorial Sea and the Continental Shelf.' So, reconciling state and municipal policies with federal policy is more complicated".	"So, what is expected from these guidelines? First, that they improve the efficiency of use, even if it is shared. Some places, for some reason, will not allow the sharing of use, and perhaps they will only allow exclusive use, which would make sense to grant a concession! (...) Suddenly, it can present some possibilities for combination or public use, right, or shared use, use even if authorized. So, again, the guidelines, recommendations, or criteria, these are established on the 'board'. Now, the final decision, again, is made by the government, by a manager, by a group of stakeholders, which can be more or less participatory – it's good if it's participatory – the economic interests will appear".	"The question is whether this is the best criterion to define conflict. I think, in summary, it's a matter of policy. I think criteria, let's call them 'tie-breaker criteria,' could be a mix of the three things (environmental, economic, and social). And not necessarily just one line like that, a more economic predominance. (...) This is clearly an economic development criterion. Can it be used in Brazil? Yes. Is it the best? Well, to be discussed. Are there alternatives? Certainly there are alternatives, right? It has to be discussed. It's politics!".	"The involvement of these social actors from the beginning is a fundamental pillar for the success of any spatial planning, and Marine Spatial Planning (MSP) is no exception. The lesson learned from Coastal Zone Management (CZM) about the importance of participation is crucial and cannot be ignored. As you rightly point out, even the most basic level of participation, which is informing and obtaining feedback, is already an essential starting point for engaging social actors. When people feel part of the process, understand the advantages, and have their interests considered, the probability of successful approval and implementation increases significantly. Imposition without participation, as you put it, usually leads to resistance and the constant need for oversight. Your two pillars for the functioning of any coastal management program – a coordination mechanism and a formal participation mechanism, preferably with a legal basis – are equally valid for the MSP. Coordination ensures articulation between different bodies and levels of government, while participation ensures the involvement of various social actors. Your warnings about the risks of a restrictive or overly universal plan are also important. The MSP needs to be directed at an objective case, with clear limits, and participation must be carefully managed to ensure that all relevant voices are heard without compromising the feasibility of the process. Participation in all stages, from conception to implementation, and the leadership of people with knowledge of the dynamics are key elements for effective governance of the MSP. Understanding the need for participation and the ability to define the relevant universe of actors are crucial to prevent the process from getting lost. This is called governance".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 2	"Yes. It should be sufficiently flexible to accommodate national particularities. Furthermore, it would be necessary to create a regional forum for discussion focused on the sea, which does not exist at the moment".	"States and municipalities have their participation guaranteed to the extent that representatives and rounds of debates, in addition to the normative and regulatory issue itself, are included in the winning proposals of the South, Southeast, and Northeast MSPs. Previous plans need to be considered in the MSP to avoid rework and conflicts of interest, policies, and norms".	"It is possible that there are pre-established rules for the coexistence of uses and activities, considering regional particularities, seasonality, national priorities, and social returns. The definition of a zoning will eventually occur due to the nature of certain activities carried out at sea. For the last question, yes. The challenge lies in how to operationalize this".	"In the decree, I missed the environmental/climatic issue. The mention of 'ensured the singular values of identified biodiversity, the good environmental status of the marine environment, and the good status of coastal and transitional waters' is very broad and vague, without any parameters pointed out".	"The effective participation of the population in the process is KEY. I emphasize that this should occur not only throughout the development of the national MSP, but even after and throughout its implementation. Due to the asymmetry of the actors in question, lobbies can occur and jeopardize the transparency and effectiveness of the MSP in the country. Simple language, with infographics and other knowledge transfer dynamics, are certainly key to engaging the population in the process".
Specialist nº 3	"I consider this joint institutionalized articulation in South America difficult. There is a lack of an aggregating instrument in this regard, and on top of that, South America is one of the most complex regions in terms of 'full adherence to the United Nations Convention on the Law of the Sea of 1982'. Perhaps through the lens of a call in the area of Security and Defense, it would be easier to do so in the context of ZOPACAS".	"This is one of the biggest challenges for the MSP-Brazil, even more so with the design of the Federative Pact established in the Federal Constitution. This vertical coordination does not exist, and even if it is agreed upon, it is not guaranteed that it will be accepted by all the entities involved (17 coastal states and more than 430 coastal municipalities)".	"The question makes several considerations that cannot be taken as premises. There is no provision for 'areas of common use' nor for 'areas of private use' - these are not the guidelines of UNESCO that underpin the design of Brazil's INTENDED MSP. Coexistence or even alteration should be managed by the MSP Management Plan, and it is this capacity for swift and well-founded management that can increase the sense of 'legal certainty'".	"While ONE MORE possible parameter to be considered in the Management Plan to be proposed in the MSP - yes, it can serve with adjustments. However, the Portuguese case does not serve as a parameter to be 'applied' because, there, the Brazilian federative pact with distinctions of competencies does not exist. At a minimum, coastal management would also have to be considered".	"The question also induces several premises. One moment is social participation in the formulation of current uses, conflicts, and potential utilizations - AT THIS MOMENT, it is fundamental and should be as comprehensive as possible. And there are methodologies in the calls for proposals requiring these debate workshops - sectoral and intersectoral. Another moment is 'during the period of validity and the possibility of evolution of the MSP'; in this phase, social participation is not the reason for existence and could make swift management with legal certainty unfeasible; at this point, it is specific in the face of conflicts to be weighed. Regarding the eventual prominence of a more economic view of the MSP, this is an induction that does not correspond to what is foreseen in the Calls for Proposals already launched for the South-Southeast-Northeast MSPs; on the contrary, the view on the study of habitats and ecosystem uses and services reinforces a diametrically opposite fundamental position to that indicated at the beginning of the question".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 4	"Yes, that would be interesting".	"Within the MSP process, the definition of the study area and its limits is the basis for the application of the diagnosis, analyses, and evaluations; this definition must consider the limits and responsibilities of action. Furthermore, before the development of the MSP (Plan), exercises to reconcile visions and strategic plans should be carried out to align the goals (direction/destination) of the plan. This should contribute to minimizing conflicts between the entities and their planning. The influence should be defined according to the role and responsibility that each administrative entity commits to, voluntarily and legally. The planning systems should serve as the basis for defining the long-term vision, goals, objectives, and activities of the marine management plan".	"Zoning is a technique and/or instrument that can be used during the analysis and identification stages of areas allocated for each activity. If the zoning described only considers the 3 types of areas, it would only hinder the process. The definition of activity coexistence and/or conflicts should be flexible and, preferably, negotiated among stakeholders. Leaving rigid coexistence/conflict criteria can bring greater divergences. Before focusing on what can or cannot be done, we should focus on how to make them coexist. In conclusion, there should coexist cyclical and negotiable coexistence agreements with a regular periodicity".	"The methodology could be taken as a reference and adapted to the Brazilian reality. The most important thing when defining fixed evaluation criteria is to define the measurement indicators to be able to establish when there is or is not conflict, e.g., How do I determine the 'social responsibility of stakeholders'?"	"The activities are being confused with the participants/stakeholders and the participation methodologies. In other words, an indigenous land area may have some economic or conservation activity. The aptitude of the space should define the best use. Public hearings/consultations are not necessarily the best participation techniques for a strategic study like the MSP. This does not mean that the local or regional population cannot participate. For this participation, techniques that are more suitable for the collection of information and consensus on the compatibility/conflict of use of the marine and coastal space should be defined".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 5	"I think it would be interesting. I think it would be very important to have, right? This document. However, the big question is that when we do a comparative analysis, right? Of the European Directive document, we have to understand that when we do coastal management, one of the fundamental issues is the analysis of public policies (...) And for this, it would be necessary to exactly standardize the instruments, the guidelines, the objectives among the countries, right? In such a way that there can also be a standardization. Standardization, but a consensus on sectoral issues, right? (...) So, this framework and common requirements for the Countries, right? And it's a herculean challenge, right? Because, for you to have a common framework, and a set of requirements to implement an MSP among nations... I think it's a very complex issue, mainly because what weighs most in this process, right, is the military strategic issue, right? (...) So I think this is a very complex issue, in my view, and then you propose that these countries can, from it, legally internationalize this directive. I think it's very difficult in my opinion, right? To legally internationalize this Directive regarding the use of marine space between countries, right? You are talking about territories with mineral and natural resources, and that's a very complex issue that needs to be first diagnosed and studied, raised, so that you can later, logically, elaborate and implement the MSP individually".	"So, for us to understand this, within the land-sea interactions, then logically a question that comes up again is public policies, because there's no way to understand this land-sea interaction. When we think about the land-sea interaction, we are already talking about the coastal zone. It is exactly this interaction between land, sea, and air – and I think it would even be important for you to include the air as well, because the relationships between air and sea, and air and land and sea, are fundamental, including for understanding the issue of climate change and everything else (...) This is an issue that I am even addressing in the South MSP, because coastal management will only regulate the area up to 12 nautical miles, also taking into account this limit of the Orla Project. The MSP, however, does not. The MSP goes from the high tide line up to 200 nautical miles. So this is a very important issue to consider. States and municipalities will not legislate from the territorial sea up to 200 nautical miles. Municipalities, for example, I believe they have the capacity to regulate their sea up to the limit of the Orla Project, which is the 10m depth, maybe even that. And states may have this capacity to manage up to 12 nautical miles. But then there is a very important issue. Neither recognizes the sea as their territory, because these are areas of the Union (...) So, I think the first thing that needs to happen is the recognition of these areas by municipalities and states".	"So, this is a coexistence plan, that is, you have economic and leisure activities that you logically have to seek to establish these coexistence plans, right? But I think this is very important, but logically, for this always, right, there must be regulation, laws, so that this can be established, right? As you put it, to guarantee legal certainty".	"So, one of the important issues, more than perhaps what is written there, would be how to establish, through these parameters, indicators. Because, in reality, what would be better are indicators rather than parameters (...) But I think this methodology could indeed be applied, as long as it is adapted to Brazil".	"So, like this, how to be inclusive and accessible, I think there isn't, there's no way to be perfectly inclusive and accessible (...) I think better than the public hearing is the formation of committees. It's, I think, more like the functioning of the hydrographic basin committees, where you have representatives from society, from users, who could be the sea users. Yes, organized civil society and governments, because I think there you will have much more possibility to negotiate. Not only to negotiate, but to converse, to reflect, to learn from each other. And so I believe that a public hearing is a moment, and that moment never expresses the whole truth. It expresses the truth of an interest. So the development of documents, infographics, non-technical language, ah, I think that's super cool. But for that, I think we have to have an instrument that I think is fundamental and little talked about, which is communication and information and education. And that falls within the national policy on environmental education".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 6	"I find it difficult to implement something along the lines of the European Union for use in South America (Mercosur framework?). This is because legally the status is very different, as is the capacity for financial support provided by the European Union to the member states of Parliament. We already have a UNESCO guidance document for MSP that is relevant to the Brazilian case and can logically be adapted to the social, economic, environmental, and cultural conditions of the Global South, especially Brazil".	"The compatibility of the MSP with the EEZC, CZM, Orla Project, and other municipal and state plans is fundamental. The current MSP is macro and does not have a smaller scale. I believe that soon the states (after the execution of the 4 MSPs - North, Northeast, Southeast, and South) could advance, improve, and refine the scale of data and management plans. We cannot forget that many states in Brazil are much larger than European countries (which have their MSPs)".	"This topic is relevant; I mean the establishment of rules (general criteria) for the coexistence of uses and activities. Zoning, I think, is difficult to carry out due to the scale of the proposed analysis. It is more likely that the current MSP will generate a macro-diagnosis that points to possible 'areas of common use and areas of private use.' A coexistence plan is necessary for individual activities currently underway. The ports themselves establish agreements with fishermen within their licensing processes for coexistence, conflict reduction, and socio-environmental gains. The MSP does not necessarily need to do this because this is already done individually in the case of specific licenses, again for a reason of scale".	"The methodology for hierarchizing is interesting; however, I find its application difficult because it is old and not updated with current models of public management and activities that use the 17 SDGs and the 2030 Agenda to establish goals and uses".	"The effectiveness of social participation is a cornerstone. The models of hearings and workshops can and should be used. However, the big problem with artisanal fishing is the widespread absence of spatialized data and information that leads to invisibility in the MSP and other public policies. The Northeast MSP plan includes social cartography. Social cartography is a branch of cartographic knowledge and has become an important participatory methodology with a social focus, due to the fact that it offers possibilities to empower, give visibility, and voice to traditional peoples and marginalized social groups. It depends a lot on what was approved in each MSP based on the launched calls for proposals and the teams' proposals. The methodology of the South and Southeast MSP should also involve social cartography. Without the use of these tools, it is likely that what happened in European countries will happen again here".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 7	"It is recommended that Brazil adopt a guidance document similar to Directive 2014/89/EU of the European Parliament for the construction of its MSP. This type of guide offers several advantages that can be fundamental for the effective development and implementation of the national MSP, among which we can highlight a) Structuring of the MSP construction process; b) Standardization of methodologies to be used; c) Transparency and Inclusion during the elaboration; d) Legal and Regulatory Basis; and e) Consideration of local realities and characteristics. In this way, the adoption of a guidance document can become an important tool for building an MSP that promotes sustainable management and the conservation of the environment and marine resources in the country".	"The spatial planning of the maritime area, especially in the coastal region where land-sea interactions are intense, is a highly complex process due to the overlap of uses and the diversity of economic, social, and environmental activities and interests. In this context, it is fundamental to consider an integrated approach among the various actors, which allows for taking into account local specificities and the complexity of the interactions between the various ecosystems, in order to involve coastal communities, allowing their knowledge and aspirations to be considered in the construction of the MSP. Another important aspect is related to building a consensus so that cooperation can be established between the various institutions (public and private) involved, so that there can be a spatial planning based on an efficient management policy with social, economic, and environmental responsibility".	"It is fundamental to establish rules for the utilization of maritime spaces in order to ensure the effective coexistence of different uses and activities. Maritime spaces are widely used for various activities, including navigation, fishing, tourism, natural resource exploration, and environmental conservation. Each of these activities can significantly impact the others, making it crucial to implement a set of rules and guidelines to balance interests and minimize conflicts. Some principles and approaches can be adopted to ensure an effective coexistence of different uses and activities in order to help in the organization and management of the use of maritime space in an integrated manner. Among them, we can mention: a) elaboration of a Marine Spatial Planning; b) environmental impact assessment of existing activities; c) elaboration of specific regulations and norms for the uses of spaces; d) participation of all interested parties (public, private, and civil society); e) adoption of monitoring and inspection tools adequate to the utilization of existing uses and activities in the maritime space".	"The Decree-Law nº 38/2015 of Portugal establishes the 'Legal Regime of the Maritime Space Planning' and, in its Article 27, addresses criteria and principles for the planning and management of the use of maritime spaces, among which we can cite: a) the coexistence of activities and environmental sustainability; and b) the integrated planning and management. Relevant criteria for Brazil, especially considering the contextual similarities, such as the vast maritime area of the country, its environmental policy focused on the sustainable use of the environment, and the beginning of the elaboration of a maritime spatial planning at a national level. Thus, the criteria of Article 27 can serve as a valuable model for the elaboration of the planning and management of the maritime space in Brazil, provided they are adapted to national specificities and needs".	"The effectiveness of social participation is fundamental to the success of MSP for several reasons: a) it allows for the inclusion of local and traditional knowledge; b) it promotes the transparency and legitimacy of the actions to be implemented; c) it allows for a better reconciliation of conflicts of uses of existing resources. In this context, effective social participation in marine spatial planning is crucial to ensure that the plans are coherent, fair, equitable, and sustainable. This participation is fundamental to structure the necessary support for the construction, implementation, and maintenance of socially and economically sustainable marine management policies".

Table 4. Summary of expert's responses (Cont.)

	Compiled from the Answer to question nº 1	Compiled from the Answer to question nº 2	Compiled from the Answer to question nº 3	Compiled from the Answer to question nº 4	Compiled from the Answer to question nº 5
Specialist nº 8	"Yes, of course. In this way, we could ensure greater cohesion among maritime spatial planning policies in the region, facilitating cross-border cooperation and promoting the sustainable development of marine resources. The harmonization of guidelines would also allow for better management of environmental impacts and the protection of marine ecosystems, ensuring that economic activities, such as fishing, tourism, and the exploitation of natural resources, are conducted in a responsible and balanced manner".	"To effectively carry out the spatial planning of the maritime area, it is essential to adopt an integrated approach that considers both the physical and institutional aspects of land-sea interactions. This forms the conceptual basis for the implementation of the MSP itself, which aims to organize human activities at sea in order to achieve ecological, economic, and social objectives in a sustainable manner. Coastal States and Municipalities play a crucial role in the elaboration of the MSP, as they possess specific knowledge about the particularities of their coastal areas and can provide relevant data on local land-sea interactions. The active participation of these federative entities ensures that the planning is more coherent with local needs and realities. To integrate the urban planning/zoning system with the marine system planning, some actions can be adopted: a) Creation of Interinstitutional Committees (Here in Bahia there is already one - and we will have the 2nd Meeting next week); b) Mapping and Sharing of Data; c) Harmonization of Policies and Regulations; d) Education and Training; e) Continuous Monitoring and Evaluation. I believe that if these practices are adopted, it is possible to create an integrated MSP that respects the complexities of coastal environments and promotes a harmonious and sustainable development of maritime and terrestrial areas".	"These questions are extremely complex, just like the marine and coastal dynamics. It would be fundamental to consider the creation of an integrated management committee, composed of representatives from all interested parties, to monitor and periodically review the implementation of these rules and zonings. This committee could act as a mediator in potential conflicts and ensure that the activities carried out respect both environmental and socioeconomic criteria. Community participation is another essential aspect. Involving local communities throughout the decision-making process, from the planning phase to execution and oversight, can provide greater acceptance and compliance with the established norms. Transparency and effective communication are key to the success of any coexistence plan".	"That's excellent news that Portugal's MSP will be one of the references for our Northeast MSP! Getting to know the functioning of the Portuguese MSP in detail will certainly bring valuable insights and learnings for the Brazilian context. You accurately highlight the potential benefits of applying a similar methodology in Brazil, considering the similarities in the challenges of managing maritime spaces faced by both countries. Brazil, with its vast coast and rich marine biodiversity, frequently faces conflicts of use that need to be resolved in a balanced way to ensure both economic development and environmental preservation. The adoption of the preference criteria established by Portugal's Decree-Law nº 38/2015 could offer a structured framework for decision-making, prioritizing social and economic advantage, as well as the coexistence of multiple uses. This would be particularly useful in areas where fishing, tourism, natural resource exploitation, and environmental conservation compete for space and resources".	"Yes, Yes, and Yes. However, given the conditions of institutional articulations involving large players engaged in the economic exploitation of the seas, such initiatives for maximum socialization of the MSP face significant challenges imposed by these groups. On the other hand, Brazil has shown strength in securing rights for less favored classes. In this sense, the rights of less affluent classes, such as fishing communities, should be included in the MSP, with the Public Prosecutor's Office acting as a guardian of these actions. In Bahia, for example, we have the Mata Atlântica Nucleus – Numa, a special task force of the Public Prosecutor's Office of Bahia, focused on the defense and protection of the Atlantic Forest. Something in this logic of NUMA needs to be conceived to be the guardian of the MSP".

coastal waters. However, it is important to highlight that the long-term success of MSP depends on the integration between terrestrial planning, especially coastal planning, and maritime planning (Schaefer and Barale 2011). The Directive 2014/89/EU (Directive 2014/89/EU 2014) determined that the Maritime spatial planning will contribute to the effective management of marine activities and the sustainable use of marine and coastal resources by creating a framework for a coherent, transparent, sustainable and informed decision-making process, and that, in order to achieve these objectives, this Directive should provide for obligations to establish a maritime planning process, leading to a maritime spatial plan or plans; this planning process should take into account land-sea interactions and promote cooperation between Member States (Directive 2014/89/EU 2014).

Regarding question number 3, here, too, a consensus was not reached among the participants. Some participants believe it is possible to pre-establish rules for the coexistence of uses and activities, while considering regional particularities, seasonality, national priorities, and social returns. In the same vein, they understand that it is fundamental to establish rules for the use of maritime spaces to ensure the effective coexistence of different uses and activities. This makes the implementation of a set of rules and guidelines crucial for balancing interests and minimizing conflicts. The establishment of rules and coexistence plans would guarantee legal certainty.

In the case of multi-use/coexistence of activities in the same maritime zone, multi-use is a management option in MSP and as such, there is no need for rigid regulations, but rather for flexible and transparent management arrangements within the framework of national MSP laws and supranational initiatives and strategies (Kyvelou and Ierapetritis 2019). The multi-utilization of maritime space is often presented as a "technological solution" to the challenge of resource allocation. In this context, the issue of allocation is treated as a "design problem," which can be, at least in part, solved through a planning process, aiming to organize an efficient and integrated use of space (Steins *et al*., 2021).

Analyzing the calls for proposals for the implementation of MSP in Brazil, among the proposed activities related to this issue, regarding the elaboration of a proposal for a Marine Spatial Management Plan (PGEM), all four documents stipulate that priority areas for certain sectors, exclusive use or common use, and their respective limits and boundaries that avoid unwanted conflicts and increase opportunities for sustainable investment, must be described.

Regarding question number 4, the majority of participants offered a positive evaluation of adopting the criteria from Portuguese legislation for determining the prevailing use or activity in cases of conflicts. However, they presented some reservations. The main one was that a mixture of environmental, social, and economic parameters should be adopted, instead of a necessary predominance of the economic criterion. They also believe this should be discussed, and that other alternatives should be considered.

To mitigate the conflicts resulting from multiple overlapping uses and to ensure the sustainable development of all sectors, it was necessary to carry out conflict analyses and assessments of potential future uses. In this process, use compatibility matrices were developed, with conflicts being assessed according to national legislation. Based on Portuguese legislation and the concept of public interest, hierarchical criteria were defined for the organization of overlapping activities (Calado and Bentz 2013). Applying the methodology of Portuguese legislation for resolving conflicts of uses or activities in the maritime space within an MSP model in Brazil requires careful adaptation to the Brazilian legal, environmental, and institutional context, given the absence of Brazilian regulation. In Portugal, the resolution of maritime space use conflicts is facilitated by objective legislation, in force since 2015.

Regarding the last question, number 5, the participants responses regarding the effectiveness of representation and transparency in social participation throughout the MSP process were almost unanimous. In the Portuguese case, the participation of stakeholders was a vital element in the MSP development process. Thus, efforts were undertaken to promote the acceptance, participation, and support of stakeholders, as well as to ensure the collection of information and the sharing of knowledge among all sectors involved. To facilitate the acquisition of data on activities under Portuguese maritime jurisdiction, a website was developed as a communication platform, with the purpose of encouraging stakeholder participation and strengthening the interaction between the members of the multidisciplinary team, the ministries involved, national institutions, and the general public (Calado and Bentz 2013). The involvement of stakeholders goes beyond maritime sectors and representatives of specific activities, also encompassing the general public, Non-Governmental Organizations (NGOs), and any individual with an interest or concern in the development of a specific coastal region. These parties are essential sources of knowledge, whose contribution

can considerably enrich the quality of the MSP (Jajac *et al*., 2019). To achieve broad acceptance, ownership, and support for implementation, it is equally important to involve all relevant stakeholders, including coastal regions, at the earliest possible stage of the planning process (Schaefer and Barale 2011).

Presentation of the strategic initiatives proposal

As identified in the notices for the implementation of the MSP, in Brazil, the execution of the MSP is coordinated by CIRM, through the MSP Executive Committee (EC-MSP), with its composition defined in Ordinance Nº 235/MB/2020 (MB 2020). In addition, Decree Nº 12.491/2025 (Brasil 2025) states that the MSP will be submitted to CIRM for review and consolidated by an act of the federal Executive Branch, and that the governance of the MSP will be exercised within the scope of CIRM, with joint coordination by the Brazilian Navy and the Ministry of Environment and Climate Change. These bodies will carry out the necessary articulations with other federal Executive Branch bodies and federal entities, with a view to the coordinated and participatory development of MSP actions. Therefore, by virtue of this legal competence, the implementation of the proposals listed below would be your responsibility.

In light of the analysis presented earlier, below is a proposal for strategic initiatives aimed at managing Brazil's coastal and adjacent ocean environments within a MSP framework, to be incorporated into national legislation:

a) Adoption of a guideline, such as an advisory "Directive", similar to the one adopted by European Union countries or the IOC-UNESCO guidance document, establishing a "Policy" for MSP. This would provide Brazil with a standardized methodology for developing an effective implementation process for its MSP. However, it is also necessary to adapt this approach to the Brazilian reality, particularly considering social, economic, environmental, and cultural conditions.

Analyzing it from a more practical and realistic standpoint, and in light of the publication of the calls for proposals for the MSP in Brazil, which addresses Methodological Aspects, it is mentioned that the IOC-UNESCO guide constitutes the major conceptual and methodological reference for the MSP Project in the South, North, and Southeast regions of Brazil. Thus, it can be seen that, with the conceptual and methodological reference in the calls for proposals for the implementation of the MSP in Brazil, their implementation becomes viable.

Adopting a standardized policy for MSP would encourage cooperation among the coastal countries of South America, creating a common approach to the management of marine and coastal areas, considering that many of these ecosystems are transboundary. This would facilitate joint efforts to solve regional problems, such as coastal erosion, the management of fishery resources, and the impact of climate change. Furthermore, with a standardized methodology, the coastal countries of South America could have a clearer and longer-term view of the impacts of human activities and environmental changes on coastal and marine areas, allowing planning strategies to be better grounded and adapted to local and regional needs.

Another point to this question included the need to adopt financial tools to support the implementation and, especially, the maintenance of the MSP process. Possible approaches include allocating budgetary resources within the multi-year plan; Creating a national fund, financed by sources such as: a percentage of revenue from companies engaged in marine activities or public fund models, similar to the Special Environmental Control Fund (FECAM) established under Rio de Janeiro state legislation. However, as pointed out in the calls for proposals for the implementation of the MSP in Brazil, they already include financial support from the BNDES and the Brazilian Biodiversity Fund (Funbio), making its implementation viable. Nevertheless, the adoption of financial tools, such as tax incentives, government subsidies, or blue funds, could attract private investment and encourage the formation of public-private partnerships (PPPs) for the development of sustainable infrastructure projects, in addition to also enabling the financing of technological innovations.

b) Integration of MSP planning and implementation with coastal management public policies, such as Coastal Ecological-Economic Zoning (ZEEC), State Coastal Management Plans, Territorial Planning Plans for Coastal Municipalities, the Orla Project, among others. This approach should consider marine areas and their impacts on CZ, recognizing the need for land-sea interaction.

The interaction between the planning and implementation of the MSP and the public policies for coastal management in Brazil is a central theme for the sustainable management of coastal and marine zones. The MSP seeks to integrate the ecological, economic, and social dimensions of the use and conservation of marine space, focusing on the rational use of resources and the protection of ecosystems. Meanwhile, public policies for coastal management have the function of coordinating and guiding the land use and natural resources of coastal regions and their adjacent territories. This interaction is fundamental to ensuring sustainable development, respecting the complexity of marine

and coastal ecosystems. Therefore, the MSP requires effective coordination among the federal, state, and municipal levels, especially in relation to the Territorial Zoning Plans of Coastal Municipalities and the State Coastal Management Plans. This coordination is essential to implement coastal management policies effectively and avoid overlapping or conflicts of use. The sustainability of coastal and marine zones depends on the ability to articulate these planning instruments, respecting both the social and economic needs of local populations and the protection of natural ecosystems. In order to facilitate its implementation, the calls for proposals for the implementation of the MSP in Brazil, activities developed in the marine environment and their impact on coastal areas are already included in several work planning activities and the correlation of territorial management instruments with the MSP proposal.

c) Pre-establishment of zoning rules for the use of maritime spaces to ensure the effective coexistence of different uses and activities (multi-use). Implementing a clear set of rules and guidelines is crucial to balancing interests, minimizing conflicts, and ensuring legal security for all stakeholders. The "final decision" on these predefined rules should be made by a manager or a group of stakeholders, along with the prior establishment of a committee representing all involved parties. This committee would be responsible for monitoring and periodically reviewing these zoning regulations, what could be the responsibility of CIRM, also becoming a viable action for its implementation in the Brazilian MSP.

The pre-establishment of clear and transparent rules for the use of marine space provides legal certainty for all stakeholders involved. Investors, businesses, and local communities that depend on the sea for their activities can operate with greater confidence when they know exactly which norms and regulations must be followed. Furthermore, zoning helps resolve legal disputes and avoid the creation of uncertainty zones, in which users of marine space may question their usage rights. Thus, the pre-establishment of marine zoning is a complex process that requires integrated, multidimensional, and flexible planning, based on a solid scientific foundation and a multi-sectoral governance process, ensuring the articulation between different levels of government and the various interests involved.

Although the calls for proposals for the implementation of the MSP in Brazil mention, in the chapter referring to the development of a proposal for a Marine Spatial Management Plan (PGEM), that the main management measures for marine space and their impacts on the coastal environment should be listed, among other things, along with the identification of interested parties and institutions responsible for the executive actions to meet the guidelines and achieve the objectives, there is no definition of a committee to monitor and periodically review the rules of a pre-established marine zoning, which could also be the responsibility of CIRM. However, it is known that the MSP is dynamic, cyclical, and subject to a permanent process of monitoring, evaluation, and performance.

d) Identification of parameters and/or indicators to be used in determining the prevailing use or activity in case of conflicts between uses or activities.

This approach should also consider coastal management and, preferably, incorporate a balanced mix of environmental, social, and economic parameters and/or indicators, rather than prioritizing a single aspect. This integrated and strategic perspective would promote a more comprehensive approach, ensuring that ecological, social, and economic objectives are effectively achieved. Although provided in the calls for proposals for the implementation of the MSP in Brazil, the Marine Spatial Management Plan (PGEM) must contain the rules for each management area and those pertinent to resolving conflicts of use, in addition to restrictions and prohibitions, compatibilities and incompatibilities. However, it does not present any methodology for how this will be carried out.

Establishing parameters and/or indicators to be adopted in determining the prevailing use or activity in cases of conflicting uses or activities, in addition to providing greater legal certainty for all stakeholders involved, is fundamental for environmental sustainability, economic efficiency, and social harmony. The parameters and/or indicators help identify more sensitive areas, such as marine reproduction zones or critical habitats, and ensure that human activities do not compromise biodiversity and marine ecosystems. This makes it possible to define specific zones for different activities, avoiding overload in areas that do not have the capacity to support certain activities.

These parameters and/or indicators can be adjusted according to the evolution of scientific knowledge and changes in environmental and socioeconomic conditions, allowing for a more dynamic and adaptive approach to the MSP. With a focus on continuous monitoring, the parameters and/or indicators enable the tracking of the effectiveness of marine spatial management policies, ensuring that adjustments can be made over time to improve outcomes.

e) Establishment of a methodology to strengthen cooperation

and social participation, ensuring the broadest possible involvement of society, marine users, organized civil society, and other stakeholders.

This methodology should clearly define when and how stakeholders should be engaged at the appropriate stages of the MSP process. Additionally, the adoption of social participation tools, such as debate workshops and the formation of committees, is essential to promote extensive engagement in the process. It is crucial that stakeholders, authorities, and the public are properly consulted at all key stages of the MSP development and implementation.

As provided for in the calls for proposals for the implementation of the MSP in Brazil, among the activities indicated, we have the identification of interested parties, in addition to planning, organization, carrying out training and updating of public managers, civil society agents, local communities, among other actors.

The active participation of society in decisions regarding the use of marine space increases the legitimacy of the adopted policies. When communities, fishermen, entrepreneurs, and civil society organizations feel part of the process, there is greater acceptance of the measures and the implementation of the policies. Social participation allows for the inclusion of social groups often neglected, such as traditional fishing communities, indigenous peoples, vulnerable coastal communities, or groups with less access to political power. This ensures that MSP decisions benefit a wide range of people and respect territorial rights.

A point of concern regarding the lack of representativeness is that social participation is not always representative of the entire diversity of social groups that use marine space. This can result in decisions that favor certain interests over others, such as the interests of large corporations in relation to those of local communities. In some cases, government authorities may be unwilling to adopt an effective social participation model, either due to a lack of interest in listening to communities or because they prefer a more centralized and rapid decision-making process.

Thus, for social participation to be truly effective, it is necessary to ensure that all involved groups have equitable opportunities to contribute to the process, with access to clear information, and that there is a continuous effort to mediate and reconcile diverse interests in a fair and balanced manner.

Table 5 presents a consolidation of the information presented.

The table 6 summarizes the information presented, organized into two categories: Challenges and Proposals for the Implementation of the PEM in Brazil:

5. CONCLUSIONS

Brazil made a voluntary commitment during the United Nations Ocean Conference in 2017 to implement MSP nationwide by 2030. As part of this effort, the MSP Pilot Project has already begun in the marine region of Southern Brazil, funded by BNDES. Additionally, public selection calls have been completed for contracting technical studies aimed at characterizing and mapping current and potential uses of the marine environment for the development of the MSP project. These include calls for the MSP-Southeast, MSP-Northeast (excluding Maranhão), and MSP-North, which covers the marine regions of Maranhão, Pará, and Amapá. However, it is evident that Brazil still has a long way to go in fully implementing MSP.

For the proposal of strategic initiatives for the Brazilian management of adjacent coastal and oceanic environments within a MSP framework, to be internalized into national legislation in Brazil, it is important to follow a structured process that encompasses all the necessary elements for the effective operationalization of these proposals. This includes ensuring that these strategies are aligned with national and international policies and regulations, engaging stakeholders, establishing institutional partnerships with research bodies and universities, and especially defining and monitoring specific actions for each strategy. This should involve setting an implementation schedule divided into phases, establishing performance, evaluation, and monitoring indicators to measure the effectiveness of the strategies and the achievement of the proposed objectives, and making adjustments to the strategies and actions to correct deviations and improve effectiveness.

To overcome these challenges, it is essential to adopt an integrated, collaborative, and adaptive approach. Several strategic initiatives can help to address these obstacles, including increasing investments in research and monitoring of marine ecosystems through scientific studies and continuous environmental assessments. This also includes spatial planning to allocate specific areas for different activities, reconciling various interests and creating an integrated governance structure, with a central coordinating body responsible for intersectoral cooperation and the joint implementation of public policies, which, in the Brazilian case, the execution of the MSP is coordinated by CIRM.

Table 5. summary of the proposal for strategic initiatives

Component of the Proposal	Description	Rationale and Adaptation
Adoption of a Guideline (e.g., Consultative "Directive") **Adoption of Financial Tools**	Adoption of a guidance document, similar to those used by the European Union or IOC-UNESCO, that establishes a policy for MSP. Implementation of mechanisms to finance and maintain the MSP process.	This would provide Brazil with a **standardized methodology** for the effective implementation of MSP. However, it is essential that this approach be adapted to the Brazilian reality, considering the specific **social, economic, environmental, and cultural conditions** of the country. The implementation and maintenance of MSP require resources. The proposals include: allocating budgetary resources within the multi-year plan; creating a national fund (financed by revenue from marine activities or public fund models like the FECAM/RJ). The viability is reinforced by the existing financial support already provided in the calls for proposals from BNDES and Funbio. Additionally, the adoption of tax incentives, government subsidies, and "blue funds" can attract private investment, foster public-private partnerships (PPPs), and finance technological innovations.
Integration with Coastal Management Policies	Articulation of MSP with public policies such as **Coastal Ecological-Economic Zoning (ZEEC)**, State Coastal Management Plans, and Municipal Master Plans, considering the land-sea interaction.	Integration is essential for the **sustainable management** of coastal and marine zones, as it aligns the use of marine space with land use. It requires **effective coordination** between the federal, state, and municipal levels to avoid conflicts of use. The viability is facilitated by the fact that the Brazilian calls for proposals for MSP already account for this correlation between territorial management and the MSP proposal.
Pre-establishment of Zoning Rules	Creation of a clear set of rules and guidelines to ensure the effective coexistence of different uses and activities (multi-use). The final decision would be made by a manager or a stakeholder group, with a dedicated **monitoring committee** that could be under CIRM's responsibility.	This provides **legal certainty** for all stakeholders, minimizes conflicts, and facilitates dispute resolution. Although Brazilian calls for proposals mention listing management measures, there is no explicit definition of a committee for monitoring and review, which is crucial for a dynamic and cyclical process like MSP.
Identification of Parameters for Conflict Resolution	Establishment of parameters and/or indicators to determine the prevailing use or activity in case of conflicts, using a balance of environmental, social, and economic aspects.	The adoption of a clear and integrated methodology provides **legal certainty**, promotes sustainability and efficiency, and helps protect sensitive areas. While the Brazilian calls for proposals require rules for conflict resolution, they do not present the **methodology** for doing so, making this a strategic initiative. These parameters can be adjusted for a more **dynamic and adaptive** planning approach.
Strengthening Social Participation	Creation of a methodology to strengthen cooperation and social participation, defining **when and how stakeholders should be engaged** through tools like **workshops and committees**.	Social participation increases the **legitimacy** and acceptance of policies, ensuring the inclusion of diverse and vulnerable social groups. Although Brazilian calls for proposals mention stakeholder identification, a formal methodology for participation is not yet defined, which could lead to a bias in representation. A fair and balanced approach is necessary to mediate and reconcile different interests.

Table 6. Challenges and Proposals for the Implementation of MSP in Brazil.

Category	Description
Current Context and Challenges	Brazil made a voluntary commitment to implement MSP by 2030, and pilot projects are already underway. However, the country still lacks a **specific legal framework** for MSP, which creates legal uncertainty and may lead to conflicts. The existing legislation is **fragmented and sectoral**, requiring effective coordination among federal, state, and municipal levels.
Proposed Strategic Initiatives	**1. Alignment with Policies:** Strategies must be aligned with national and international policies and regulations. **2. Partnerships and Engagement:** It is essential to involve stakeholders, establish partnerships with research institutions and universities, and ensure social participation. **3. Research and Monitoring:** Increase investments in research and monitoring of marine ecosystems to support decision-making. **4. Integrated Governance:** Create an integrated governance structure, with a central body (CIRM, in the Brazilian case) to coordinate the implementation of intersectoral policies. **5. Implementation Measures:** Define an implementation schedule, establish performance, evaluation, and monitoring indicators, and make continuous adjustments. **6. Integration with International Experiences:** Adopt models and best practices from other countries, such as Europe, and adapt them to the Brazilian reality. The integration of multi-use areas, the use of advanced technologies, stakeholder engagement, and the promotion of the Blue Economy are examples.
Addressed vs. Unaddressed Points	**Addressed:** The adoption of the UNESCO guide, financial support from BNDES and Funbio, the inclusion of the impact on coastal areas, and the identification and training of stakeholders. **Unaddressed:** The definition of a **monitoring and review** committee for zoning rules and the specification of a **methodology for resolving conflicts** of use.

Marine zone management is complex, involving multiple levels of authorities, diverse economic actors, and various stakeholders. An MSP should aim to identify and encourage multiple uses in accordance with national legislation and public policies. In the current context, the absence of a legal framework that regulates the requirements for the development and implementation of an MSP in Brazil creates legal uncertainty for all involved parties. The MSP Pilot Project in the marine region of Southern Brazil is being developed without a specific national legal framework governing MSP planning and implementation. This lack of regulation could, in the future, lead to legal inconsistencies and conflicts between regulations, resulting in unnecessary disputes and increased legal uncertainty for activities carried out in the marine environment, as well as for their respective investors.

For MSP to be effective, it is essential to achieve harmonious integration of existing policies and legislation, ensuring that all levels of government operate in a coordinated manner. Brazil has an extensive legislative framework addressing coastal and marine management. However, many of these regulations were developed in a fragmented and sectoral manner, creating challenges for their integrated and coordinated application. Effective coordination among federal, state, and municipal governments will be crucial to overcoming these challenges and ensuring the successful implementation of MSP.

As previously mentioned, some of the proposed legal strategies are already clearly included in the notices for implementing the MSP in Brazil, such as, for example, the adoption of the UNESCO guide as a conceptual and methodological reference, the inclusion of financial support from BNDES and Funbio, the impact on coastal areas of activities developed in marine areas and the correlation of territorial management instruments with the MSP proposal, in addition to the identification of interested parties, planning, organization, training and updating of public managers, civil society agents, local communities, among other actors. It was found that other points were not included in these documents, such as, for example, the definition of a monitoring committee and periodic review of the rules of a pre-established marine zoning and the rules and methodologies pertinent to the resolution of conflicts of use.

When developing a strategic initiative proposal for coastal and adjacent ocean environments within an MSP, it is crucial to recognize the limitations and uncertainties associated with various implicit assumptions underlying this proposal. These factors serve as constraints to the work presented. Such assumptions, like environmental, social, and economic characteristics of a given marine and/or coastal region, or the effectiveness of pre-established policies, can vary significantly depending on local contexts and the dynamic conditions of the marine and coastal environment. Therefore, the implementation of these strategic initiatives within MSP must carefully consider regional specificities, including environmental, socioeconomic, and cultural factors, to ensure their effectiveness and adaptability.

In conclusion, the practical feasibility and applicability of adopting these strategic initiatives can only be assessed after the implementation of MSP in Brazil. However, only future studies, conducted during the monitoring and performance evaluation phases, along with adaptive management processes, will determine whether the objectives of these proposals are being met and allow for necessary adjustments.

Additionally, international experiences, models, and best practices from other countries, especially from Europe, can provide valuable insights and contributions to Brazil. These references offer a solid foundation for developing an effective and sustainable MSP.

The integration of multiple-use areas, the application of advanced technologies, stakeholder engagement, the creation of marine protected areas, and the promotion of the Blue Economy are some of the valuable lessons that can be applied in practice in Brazil, with the necessary adaptations to the local context. Brazil can benefit from these experiences in the development of a legal framework for MSP, tailoring it to its specific needs. By incorporating these international practices, the implementation of MSP in Brazil can be accelerated, making it a key tool for the sustainable management of the country's vast marine resources.

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REFERENCES

Abramic, A.; Bigagli, E.; Barale, V.; Assouline, M.; Lorenzo-Alonso, A.; Norton, C. (2018). Maritime spatial planning supported by infrastructure for spatial information in Europe (INSPIRE). Ocean & Coastal Management, v. 152, p. 23-36, 2018. DOI: https://doi.org/10.1016/j.ocecoaman.2017.11.007

Aivaz, K.-A.; Stan, M.-I; Vintilăf, D.-F. (2021). Why Should Fisheries and Agriculture Be Considered Priority Domains for Maritime Spatial Planning in the Black Sea? A Stakeholder Perspective. Ovidius University Annals, Economic Sciences Series, Ovidius University of Constantza, Faculty of Economic Sciences, v. 0(2), p. 12-20, Dec. 2021. In: https://ideas.repec.org/a/ovi/oviste/vxxiy2021i2p12-20.html.

Andrade, I. de O.; Carvalho, A. B.; Silva, S. T. da; Mont'alverne, T. C. F. (2024) - Economia azul e crescimento econômico: o mar brasileiro em perspectiva. Rio de Janeiro: Ipea, 57 p. (Texto para Discussão, n. 3027). DOI: http://dx.doi.org/10.38116/td3027-port

Ansong, J.; Gissi, E.; Calado, H. (2017) - An approach to ecosystem-based management in maritime spatial planning process. Ocean & Coastal Management, v. 141, p. 65-81, DOI: http://dx.doi.org/10.1016/j.ocecoaman.2017.03.005

BNDES - BANCO NACIONAL DO DESENVOLVIMENTO ECONÔMICO E SOCIAL (2022). Seleção Pública BNDES FEP Fomento nº 03/2022. Edital de Seleção Pública de Parceiro Executor de Estudo Técnico voltado à implementação de Projeto Piloto do Planejamento Espacial Marinho – PEM na Região Marinha do Sul do Brasil. In: https://www.bndes.gov.br/wps/wcm/connect/site/40880c72-cb96-4ced-b186-08a9a6f9310e/Edital+PEM.pdf?MOD=AJPERES&CVID=ojPKh6I.

BNDES - BANCO NACIONAL DO DESENVOLVIMENTO ECONÔMICO E SOCIAL (2023). Seleção Pública BNDES/FEP Fomento - Prospecção e Pesquisa nº 01/2023. Edital de Seleção Pública de Parceiro Executor de Estudo Técnico voltado à implementação de Projeto do Planejamento Espacial Marinho - PEM na Região Marinha do Sudeste do Brasil. In: https://www.bndes.gov.br/wps/wcm/connect/site/99be21e7-8b64-4258-8f86-e1efe19c64b8/Edital+PEM+Sudeste.pdf?MOD=AJPERES&CVID=oNoPR8P.

BNDES - BANCO NACIONAL DO DESENVOLVIMENTO ECONÔMICO E SOCIAL (2024). Seleção Pública BNDES/FEP Fomento - Prospecção e Pesquisa nº 01/2024. Edital de Seleção Pública de Parceiro Executor de Estudo Técnico voltado à implementação de Projeto do Planejamento Espacial Marinho - PEM na Região Marinha do Norte do Brasil. In: https://www.bndes.gov.br/wps/wcm/connect/site/871a2478-3418-483f-99f4-c643a9511322/Sele%C3%A7%C3%A3o+P%C3%Bablica+BNDES+-+FEP+Fomento+-+Prospec%C3%A7%C3%A3o+e+Pesquisa+n%C2%BA+01-2024+-+FEP+PEM+Norte.pdf?MOD=AJPERES&CVID=pbUmhHw.

BRASIL (1994). Decreto nº 1.265, de 11 de outubro de 1994. Aprova a Política Marítima Nacional (PMN). In: https://www.planalto.gov.br/ccivil_03/decreto/1990-1994/d1265.htm.

BRASIL (2004). Decreto n° 5.300, de 07 de dezembro de 2004. Regulamenta a Lei n° 7.661, de 16 de maio de 1988, que institui o Plano Nacional de Gerenciamento Costeiro - PNGC, dispõe sobre regras de uso e ocupação da zona costeira e estabelece critérios de gestão da orla marítima, e dá outras providências. In: https://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/decreto/d5300.htm.

BRASIL (2005). Decreto nº. 5.377, de 23 de fevereiro de 2005. Aprova a Política Nacional para os Recursos do Mar - PNRM. In: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2005/decreto/d5377.htm.

BRASIL (2013). Projeto de Lei PL 6969, de 2013. Institui a Política Nacional para a Conservação e o Uso Sustentável do Bioma Marinho Brasileiro (PNCMar) e dá outras providências. In: https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=604557.

BRASIL (2016). Decreto nº 8.892, de 27 de outubro de 2016. Cria a Comissão Nacional para os Objetivos de Desenvolvimento Sustentável. In: https://legislacao.presidencia.gov.br/atos/?tipo=DEC&numero=8892&ano=2016&ato=392cXU61EeZpWT961.

BRASIL (2020). Decreto nº 10.544, de 16 de novembro de 2020. Aprova o X Plano Setorial para os Recursos do Mar. In: https://www.in.gov.br/en/web/dou/-/decreto-n-10.544-de-16-de-novembro-de-2020-288552390.

BRASIL (2025). Decreto nº 12.363, de 17 de janeiro de 2025. Aprova o XI Plano Setorial para os Recursos do Mar. In: https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2025/decreto/D12363.htm.

BRASIL (2025). Decreto nº 12.491, de 5 de junho de 2025. Institui o Planejamento Espacial Marinho. In: https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2025/decreto/d12491.htm.

BRASIL (2025). Projeto de Lei PL 2673, de 2025. Institui a Política Nacional para a Gestão Integrada, a Conservação e o Uso Sustentável do Sistema Costeiro-Marinho (PNGCMar); e altera a Lei nº 8.617, de 4 de janeiro de 1993. In: https://www.congressonacional.leg.br/materias/materias-bicamerais/-/ver/pl-6969-2013.

BRASIL (1981). Lei nº 6.938, de 31 de agosto de 1981. Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências. In: http://www.planalto.gov.br/ccivil_03/leis/l6938.htm

BRASIL (1988). Lei n° 7.661, de 16 de maio de 1988. Institui o Plano Nacional de Gerenciamento Costeiro e dá outras providências. In: https://www.planalto.gov.br/ccivil_03/LEIS/L7661.htm

Calado, H.; Bentz, J. (2013). The Portuguese maritime spatial plan. Marine Policy, v. 42, p. 325-333, Nov. 2013. DOI: https://doi.org/10.1016/j.marpol.2013.03.014

Calado, H.; Santos, C. F.; Quintela, A.; Fonseca, C.; Gutierrez, D. (2023). The ups and downs of maritime spatial planning in Portugal. Marine Policy, v. 160, 105984, 2023. DOI: https://doi.org/10.1016/j.marpol.2023.105984

CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. Portal de Periódicos da CAPES. In: https://www.periodicos.capes.gov.br/.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (1990). Resolução nº 001, de 21 de novembro de 1990. Aprova o Plano Nacional de Gerenciamento Costeiro (PNGC). In: https://www.gov.br/mma/pt-br/acesso-a-informacao/acoes-e-programas/programa-projetos-acoes-obras-atividades/programas-projetos-acoes-obras-e-atividades-finalizados/PNGC_I.pdf.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (1997). Resolução nº 005, de 03 de dezembro de 1997. Aprova o Plano Nacional de Gerenciamento Costeiro II (PNGC II). In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/resolucao-5-1997.pdf.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (2013). Resolução nº 001, de 23 de abril de 2013. Uso compartilhado do Ambiente Marinho. In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/resolucao-1-2013.pdf.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (2018). Resolução nº 2, de 10 de dezembro de 2018. Criação do GT ODS 14 – "Vida na Água". Comissão Interministerial para os Recursos do Mar. In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/documentos/atas/resolucao-2-2018.pdf.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (2023). Resolução nº 6, de 21 de novembro de 2023. Aprova o XI Plano Setorial para os Recursos do Mar (PSRM). Comissão Interministerial para os Recursos do Mar. In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/documentos/cirm/cirm211/resolucao-n6.pdf.

CIRM – COMISSÃO INTERMINISTERIAL PARA OS RECURSOS DO MAR (2023). Resolução nº 7, de 21 de novembro de 2023. Aprova a Visão e os Princípios do Planejamento Espacial Marinho no Brasil. Comissão Interministerial para os Recursos do Mar. In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/documentos/cirm/cirm211/resolucao-n7.pdf.

Directive 2014/89/EU (2014). European Parliament and of the Council of 23 July 2014. Establishing a framework for maritime spatial planning. Official Journal of the European Union, L257/135, p. 135-145, 28 ago. 2014. In: https://eur-lex.europa.eu/legalcontent/EN/TXT/?uri=celex%3A32014L0089.

Ehler, C. (2021). Two decades of progress in Marine Spatial Planning. Marine Policy, v. 132, 104134. DOI: https://doi.org/10.1016/j.marpol.2020.104134

Ehler, C.; Douvere, F. (2009) - Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. Paris: UNESCO. IOC Manual and Guides No. 53, ICAM Dossier No. 6

European Commission. Integrated Maritime Policy. In: https://research-and-innovation.ec.europa.eu/research-area/environment/oceans-and-seas/integrated-maritime-policy_en

EP&C (European Parliament and of the Council) (2013). (Proposal for a) Directive 2013/133, establishing a framework for marine spatial planning and integrated coastal management. COM (2013) 133, Brussels. In: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0133

EUROPEAN MSP PLATFORM. In: https://maritime-spatial-planning.ec.europa.eu/.

Fernandes, M.L.; Sousa, L.P., Quintela, A.; Marques, M.; Reis, J.; Simão, A.P.; Castro, A.T.; Marques, J.M.; Alves, F.L. (2020). Mapping the future: Pressures and impacts in the Portuguese maritime spatial planning. Science of the Total Environment 715 (2020) 136863. DOI: https://doi.org/10.1016/j.scitotenv.2020.136863

FUNBIO - Fundo Brasileiro para a Biodiversidade (2023). Termo de referência nº 2023.1208.00057-9. Termo de referência para contratação de consultoria pessoa jurídica especializada que irá elaborar o estudo técnico voltado à implementação de projeto piloto do Planejamento Espacial Marinho - PEM na região marinha do nordeste do Brasil. In: https://www.funbio.org.br/wp-content/uploads/2023/12/TdR-2023.1208.00057-9_sem-anexos.pdf.

Gonçalves, L. R.; Polejack, A. de A. S. (2022). Governança, cooperação e diplomacia no oceano. In: Santos, T.; Beirão, A. P.; Araujo Filho, M. C. de; Carvalho, A. B. (org.). Economia azul: vetor para o desenvolvimento do Brasil. Rio de Janeiro: Marinha do Brasil, 2022. p. 137-149. In: https://www.marinha.mil.br/sites/all/modules/livro_economia_azul/book.html

Grip, K.; Blomqvist, S. (2021). Marine spatial planning: Coordinating divergent marine interests. Ambio, v. 50, p. 1172–1183, 2021. DOI: https://doi.org/10.1007/s13280-020-01471-0.

Hietala, R.; Ijäs, A.; Pikner, T.; Kull, A.; Printsmann, A.; Kuusik, M.; Fagerholm, N. (2021). Data integration and participatory process in developing integrated coastal zone management (ICZM) in the northern Baltic Sea. Journal of Coastal Conservation, v. 25, 47, 2021. DOI: https://doi.org/10.1007/s11852-021-00833-4

Hou, Y.; Xue, X.; Liu, C.; Xin, F.; Lin, Y.; Wang, S. (2022). Marine Spatial Planning Scheme evaluation based on the conflict analysis system - A case study in Xiamen, China. Ocean and Coastal Management, v. 221, 106119, 2022. DOI: https://doi.org/10.1016/j.ocecoaman.2022.106119

IOC-UNESCO (2024). State of the Ocean Report. Paris, IOC-UNESCO. (IOC Technical Series, 190). DOI: https://doi.org/10.25607/4wbg-d349. In: https://unesdoc.unesco.org/ark:/48223/pf0000390054.locale=en.

IOC-UNESCO (2022). State of the Ocean Report, pilot edition. Paris, IOC-UNESCO (IOC Technical Series, 173). In: https://unesdoc.unesco.org/ark:/48223/pf0000381921.

Jajac, N.; Kilić, J.; Rogulj, K. (2019). An Integral Approach to Sustainable Decision-Making within Maritime Spatial Planning - A DSC for the Planning of Anchorages on the Island of Šolta, Croatia. Sustainability, v. 11, n. 1, 104, 2019. DOI: https://doi.org/10.3390/su11010104.

Jentoft, S.; Knol, M. (2014) - Marine spatial planning: risk or opportunity for fisheries in the North Sea? Maritime Studies, v. 13. DOI: https://doi.org/10.1186/2212-9790-13-1

Kyvelou, S. S.; Ierapetritis, D. (2019). Discussing and Analyzing "Maritime Cohesion" in MSP, to Achieve Sustainability in the Marine Realm. Sustainability, v. 11, n. 12, 3444, 2019. DOI: https://doi.org/10.3390/su11123444

Lahde, E.; Pohja-Mykra, M.; Schreck, J. (2024). Co-creation of socio-ecological systems knowledge to adopt an Ecosystem-based Approach and Land-Sea Interactions in Maritime spatial planning. Marine Policy, v. 163, 106079, 2024. DOI: https://doi.org/10.1016/j.marpol.2024.106079

MB - MARINHA DO BRASIL (2018). Portaria nº 386/MB, de 10 de dezembro de 2018. Cria o Grupo de Trabalho "Objetivo de Desenvolvimento Sustentável 14 (ODS 14) – Vida na Água" e designa sua composição. In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/documentos/atas/port-386-2018.pdf.

MB - MARINHA DO BRASIL (2019). Portaria nº 236/MB, de 23 de agosto de 2019. Institui Grupos Técnicos para assessoramento da Comissão Interministerial para os Recursos do Mar (CIRM). In: https://www.marinha.mil.br/secirm/sites/www.marinha.mil.br.secirm/files/documentos/atas/port-236-2019.pdf.

MB - MARINHA DO BRASIL (2020). Portaria nº 235/MB, de 30 de julho de 2020. Cria o Comitê Executivo "PEM", subordinado à Subcomissão para o Plano Setorial para os Recursos do Mar e designa sua composição. In: https://www.in.gov.br/web/dou/-/portaria-n-235/mb-de-30-de-julho-de-2020-269967372.

Papageorgiou, M. (2016). Coastal and marine tourism: A challenging factor in Marine Spatial Planning. Ocean & Coastal Management, v. 129, p. 44-48, 2016. DOI: https://doi.org/10.1016/j.ocecoaman.2016.05.006

PORTUGAL. Lei nº 17/2014 (2014). Estabelece as Bases da Política de Ordenamento e de Gestão do Espaço Marítimo Nacional (LBOGEM). In: https://www.dgpm.mm.gov.pt/_files/ugd/eb00d2_825d3806cac74a96a511d1955558d1d4.pdf.

PORTUGAL. Decreto-Lei nº. 38/2015 (2015). Estabelece as Bases da Política de Ordenamento e de Gestão do Espaço Marítimo Nacional. In: https://data.dre.pt/eli/dec-lei/38/2015/p/cons/20150730/pt/html.

Ritchie, H.; Mcelduff, L. (2020). The whence and whither of marine spatial planning: revisiting the social reconstruction of the marine environment in the UK. Maritime Studies, v. 19, p. 229–240, 2020. DOI: https://doi.org/10.1007/s40152-020-00170-6

Schaefer, N., Barale, V. (2011). Maritime spatial planning: opportunities & challenges in the framework of the EU integrated maritime policy. J Coast Conserv, v. 15, p. 237–245, 2011. DOI: https://doi.org/10.1007/s11852-011-0154-3

Stan, M.I. (2022). The MSP Stakeholders' Perception of Port and Coastal Protection Activity. "Ovidius" University Annals, Economic Sciences Series, v. XXII, iss. 1, p. 157-165, 2022. In: https://EconPapers.repec.org/RePEc:ovi:oviste:v:xxii:y:2022:i:1:p:157-165

Stanchev, H.; Stancheva, M.; Young, R.; Palazov, A. (2018). Analysis of shoreline changes and cliff retreat to support Marine Spatial Planning in Shabla Municipality, Northeast Bulgaria. Ocean & Coastal Management, v. 156, p. 127-140, 2018. DOI: https://doi.org/10.1016/j.ocecoaman.2017.06.011

Steins, N. A.; Veraart, J. A.; Klostermann, J. E. M.; Poelman, M. (2021). Combining offshore wind farms, nature conservation and seafood: Lessons from a Dutch community of practice. Marine Policy, v. 126, 104371, 2021. DOI: https://doi.org/10.1016/j.marpol.2020.104371

Tsilimigkas, G.; Rempis, N. (2018). Marine uses, synergies and conflicts. Evidence from Crete Island, Greece. J Coast Conserv., v. 22, p. 235–245. DOI: https://doi.org/10.1007/s11852- 017-0568-7

Ullah, Z.; Wu, W.; Wang, X. H.; Pavase, T. R.; Shah, S. B. H.; Pervez, R. (2021). Implementation of a marine spatial planning approach in Pakistan: An analysis of the benefits of an integrated approach to coastal and marine management. Ocean and Coastal Management, v. 205, 105545. DOI: https://doi.org/10.1016/j.ocecoaman.2021.105545.

SUPPORTING INFORMATION - QUESTIONS USED IN SEMI-STRUCTURED RESEARCH

1) In the case of South American countries, would it be interesting to have a "macro" document, a "guidance guide", along the lines of Directive 2014/89/EU of the European Parliament, with the adoption of financial tools to support its implementation and the establishment of a framework and a set of common requirements for the PEM, so that these countries can, from there, legally internationalize this "Directive", and subsequently prepare and implement the PEM individually?

2) How can maritime spatial planning be carried out, taking into account land-sea interactions, given that it is an area prone to planning conflicts due to the physical and institutional complexity inherent to coastal environments? How would coastal states and municipalities influence the development of the PEM? How can the urban planning/ zoning system be integrated with the planning of the marine system?

3) Should rules (general criteria) be pre-established for the coexistence of uses and activities? Would it be necessary to define a "zoning" in advance, defining, for example, "areas of common use" and "areas of private use", the latter being granted by a title of use, for example, a concession (prolonged use of an area or volume, carried out uninterruptedly and lasting 12 months or more) or a license (temporary, intermittent or seasonal use of a reserved area or volume)? In the case of multi-use use/coexistence of activities in the same maritime zone, would it be necessary to establish a "coexistence plan", mutually agreed between the user parties, as a way of ensuring legal certainty?

4) Decree-Law No. 38/2015 of Portugal determines in its article 27 the criteria in cases of conflicts of uses or activities, ongoing or to be developed, in the national maritime space, in determining the prevailing use or activity, the following preference criteria are followed in determining the prevailing use or activity, provided that "the identified singular biodiversity values, the good environmental status of the marine environment and the good status of coastal and transitional waters are ensured:

a) Greater social and economic advantage for the country;

b) Maximum coexistence of uses or activities.

The preference criterion referred to in paragraph a) of the previous number is assessed according to the following parameters:

a) Creation of number of jobs;

b) Qualification of human resources;

c) Volume of investment;

d) Economic viability of the project;

e) Forecast of results;

f) Contribution to sustainable development;

g) Creation of value;

h) Expected synergies in related activities;

i) Social responsibility of those interested in the development of the use or activity.

Could this methodology be applied in Brazil? Why?

5) When assessing the implementation of the PEM in other countries, one situation that has been highlighted is the effectiveness of social participation. It was found that in some European countries, PEM responsibilities have been delegated to authorities with an economic focus and that many PEM processes are initiated with specific economic objectives in mind, that is, some activities (e.g., maritime transport, ports, offshore extraction, renewable energy, etc.) have greater economic importance compared to other activities (e.g., small-scale fishing). So, how can we be inclusive and accessible, and ensure effective representation and transparency of social participation throughout the process, considering sociocultural and geographic diversity, as well as guaranteeing the rights of traditional peoples and communities and the maintenance of their rights and traditions? Would the use of a model similar to the "public hearings" provided for in some EIA/ RIMA cases in Brazilian legislation be a methodology? Would the development of comprehensive non-technical documents and infographics on the PEM and plans to make the content more understandable for different audiences be a way forward?

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SUSTAINABLE LIVELIHOODS AND COASTAL RESILIENCE: LESSONS FROM FISHERFOLK COMMUNITIES IN DUMARAN AND ARACELI

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ABSTRACT: Alternative livelihood programs have been promoted to reduce fishing pressure and improve coastal community resilience. In Palawan, Philippines, fisherfolk from Dumaran and Araceli participated in training programs supported by WPU-ATBI and PBCAI, covering aquaculture, processing, and enterprise management. This study assessed training outcomes using a survey adapted from USAID and analyzed responses with descriptive and inferential statistics. Results showed that men and lower-income households (≤ ₱10,000) perceived training as more effective, while no significant differences were observed by household size, education, or policy participation. Women represented a majority (53.70%), reflecting their cultural assignment to post-harvest and marketing roles, as well as their growing participation in fisheries value chains.

Program outcomes revealed mixed results: 63.89% of participants continued their projects, yet nearly half of initiatives faced discontinuation due to financial and management challenges. Aquaculture and processing were the most frequently adopted livelihoods, showing alignment with local skills and resources. Financial literacy and business management training helped some participants sustain enterprises, but limited time, market access, and contextual gaps constrained broader success. Income improvements were reported by 70.67% of households, though gains in housing and education were modest.

The findings underscore that one-time training is insufficient; sustained support, access to finance, and stronger market linkages are crucial. Tailoring training to local contexts, fostering collective organization, and building long-term support systems can enhance the sustainability of alternative livelihoods. By addressing financial and operational barriers while leveraging women's active roles, livelihood programs can strengthen both household resilience and resource sustainability in coastal communities.

Keywords: Alternative Livelihoods, Fisherfolk, Training Effectiveness, Sustainable Development, Welch's ANOVA.

RESUMO: *Os programas de meios de subsistência alternativos têm sido promovidos com o objetivo de reduzir a pressão sobre a pesca e reforçar a resiliência das comunidades costeiras. Em Palawan, nas Filipinas, pescadores de Dumaran e Araceli participaram em ações de formação apoiadas pela WPU-ATBI e pela PBCAI, abrangendo áreas como a aquacultura, o processamento e a gestão de empresas. Este estudo avaliou os resultados das formações através de um inquérito adaptado da USAID e analisou as respostas com recurso a estatísticas descritivas e inferenciais. Os resultados mostraram que os homens e os agregados familiares de menor rendimento (≤ ₱10 000) consideraram a formação mais eficaz, não se tendo verificado diferenças significativas em função da dimensão do agregado, do nível de escolaridade ou da participação em políticas públicas. As mulheres representaram a maioria (53,70%), refletindo a sua tradicional associação às atividades pós-colheita e de comercialização, bem como a sua crescente participação nas cadeias de valor das pescas.*

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Os resultados do programa revelaram um impacto misto: 63,89% dos participantes continuaram com os seus projetos, embora quase metade das iniciativas tenham sido interrompidas devido a dificuldades financeiras e de gestão. A aquacultura e o processamento foram as atividades alternativas mais frequentemente adotadas, demonstrando coerência com as competências e recursos locais. A formação em literacia financeira e gestão empresarial ajudou alguns participantes a manter as suas iniciativas, mas o tempo limitado, o difícil acesso aos mercados e as lacunas contextuais limitaram o sucesso mais amplo. Verificou-se uma melhoria nos rendimentos em 70,67% dos agregados familiares, embora os progressos ao nível da habitação e da educação tenham sido modestos. As conclusões sublinham que uma formação pontual é insuficiente; são essenciais um apoio continuado, o acesso a financiamento e ligações mais fortes aos mercados. A adaptação das formações aos contextos locais, a promoção da organização coletiva e a criação de sistemas de apoio a longo prazo podem reforçar a sustentabilidade dos meios de subsistência alternativos. Ao ultrapassar barreiras financeiras e operacionais e ao valorizar o papel ativo das mulheres, estes programas podem fortalecer simultaneamente a resiliência das famílias e a sustentabilidade dos recursos nas comunidades costeiras.

Palavras-chave: Meios de Subsistência Alternativos, Pescadores, Eficácia da Formação, Desenvolvimento Sustentável, ANOVA de Welch.

1. INTRODUCTION

Coastal community, specifically small sacale fishers livelihood and survival depend on healthy marine systems (Funk *et al*., 2022). Across Asia, fishery resources show clear signs of overexploitation (Lungren *et al*., 2006), particularly in coastal areas where habitat degradation intensifies fishing pressure (Etongo and Arrisol, 2021; Tahiluddin and Sarri, 2022; Guimmayen *et al*., 2024), and in inshore waters where weak governance undermines effective resource management (Daw *et al*., 2009). In the Philippines and Southeast Asia, serial depletion of local stocks and unchecked fishing effort have further driven long-term declines (Anticamara & Go, 2016; Suh & Pomeroy, 2020), while illegal and unreported fishing exacerbates biodiversity loss and resource competition from industrial fleets (Arbiol and Minh, 2023). To address these pressures, agencies promote alternative livelihoods—such as jewelry-making and handicrafts (Aguilar, 2022; Isip, 2022), aquaculture (Plasus, 2024), eco-tourism, value-adding enterprises, and even innovative projects in waste reclamation and repurposing (Serrona & Yu, 2009)—to reduce dependence on capture fisheries and build economic resilience (FAO, 2020). These efforts are particularly critical in coastal communities, where poverty rates are high and dependence on fishing leaves households especially vulnerable to environmental and economic shocks (Etongo & Arrisol, 2021). These initiatives not only provide new income streams but also offer long-term ecological and economic benefits by reducing reliance on marine and coastal resources.

In Palawan, particularly in Barangays Tinintinan and Dalayawan in the Municipality of Araceli, as well as Barangays Catep, Bacao, and Calasag in the Municipality of Dumaran, several alternative livelihood training programs have been rolled out. These aim to empower fisherfolk with the knowledge and skills necessary to choose and establish sustainable sources of income. However, the success and longevity of these efforts vary across individuals and households, often influenced by a mix of social, economic, and environmental factors.

This study looks into how the training programs have made a difference and where the alternative livelihood efforts currently stand in Dumaran and Araceli, Palawan. More specifically, we employ descriptive statistics and regression analysis to examine the relationship between household socioeconomic conditions, fishing dependence, and access to alternative livelihoods, as these methods allow us to capture both trends and explanatory factors influencing livelihood choices. The case study focuses on small-scale fisherfolk in Dumaran and Araceli, Palawan, with key variables including household income, fishing effort, livelihood diversification, and access to support programs.

The findings of this study can be directly applied by government agencies and development organizations in designing targeted livelihood support programs for small-scale fisherfolk. By identifying the socioeconomic and ecological factors that influence the adoption of alternative livelihoods, policymakers can allocate resources more efficiently—such as prioritizing training, microfinance, or market linkages for households most dependent on fishing—thereby reducing pressure on overexploited fisheries while strengthening coastal community resilience.

2. MATERIALS AND METHODS

2.1 Study site and selection of participants

In the third quarter of 2023, planning for the initiative for awarding of alternatice livelihood for fisherfolk in Dumaran and Araceli, Palawan, Philippines began through the collaboration

of Western Philippines University-Agri-Aqua Technology Business Incubation (WPU-ATBI) and Palawan Biodiversity Conservation Advocates Inc. (PBCAI), a non-government organization based in Palawan. The WPU-ATBI, support the incubation, development, and commercialization of Agri-aqua technologies and innovations in the province of Palawan through a funding of Department of Science and Technology- Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD). By November 2023, WPU-ATBI and PBCAI initiated discussions with the local government units (LGUs) of Dumaran and Araceli, along with fisherfolk associations from these municipalities. A total of eight fisherfolk associations—four from Dumaran and four from Araceli—were identified as beneficiaries of alternative livelihood assistance approximately USD 3,000 per association. Each association, composed of 30–50 members, participated in a one-year series of training programs. These covered the selection of suitable alternative livelihoods—such as milkfish culture, oyster culture, mud crab culture, fish processing, giant freshwater prawn culture, and sea cucumber culture—together with site suitability assessments, business planning, bookkeeping, enterprise management, aquaculture techniques, and marketing, among other skills. Trainings were conducted across the barangays of Tinintinan and Dalayawan in Araceli, and Catep, Bacao, and Calasag in Dumaran, Palawan. To evaluate the impact of these trainings and the NGO's provision of livelihood support, a survey was also administered in the eight barangays where the beneficiary associations were located. Figure 1 presents the map of the study site locations.

The participants for the survey were 108 fisherfolk beneficiaries of alternative livelihood training courses and events. Using simple random sampling, participants were chosen to guarantee thorough data representation, where qualified and available beneficiaries were involved.

2.2 Survey questionnaire

The survey questionnaire used in the study was adopted from the published report of United States Agency for International Development (USAID) (Crawford and Herrera, 2008). The questionnaire was divided into three sections: the first section consisted of the socio-demographic profile of the respondents, capturing essential details regarding the respondents' age, household composition, educational attainment, length of stay in the area, religion, and sources of income; second section covered the status of the individual prior to the intervention of the training and establishment of alternative livelihood; while the last section assessed the socio-economic status of the fisherfolk after the establishment and management of their respective livelihood initiatives.

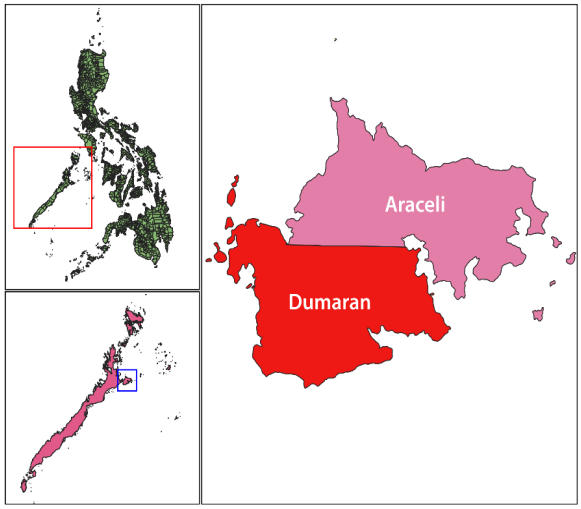

Figure 1. Map of the Study Site.

The survey covered a total of 108 respondents drawn from fisherfolk association beneficiaries in Municipality of Dumaran and Araceli. Respondents were distributed across eight barangays, ensuring representation of both coastal and island communities. The sample included a mix of male and female household members, with most respondents falling within the 21-67 age bracket. For analysis, answers were classified into major categories such as demographic information (age, education, household size), livelihood and income sources, fishing effort and practices, and access to alternative livelihood or support programs. This sampling strategy provides a representative snapshot of the socioeconomic conditions of small-scale fisherfolk in the study area.

2.3 Data Gathering Instrument

A structured survey questionnaire was developed to collect data corresponding to the study objectives. Part I identified the participants' profile (age, sex, educational attainment, household size, income, etc.). Parts II, III, and IV focus on training relevance and satisfaction, application of learnings and livelihood ventures pursued, and implementation outcomes and household improvements, respectively. Lastly, Part V was used to gather feedback and suggestions for future training. The questionnaire included closed-ended questions (multiple response scale and Likert scale). To ensure the validity and reliability of the survey form, the instrument was pilot-tested by trained enumerators with WPU-ATBI incubatees to check its consistency.

2.4 Data Collection Procedure and Analysis

Before data collection, orientation was conducted, and consent was secured from participants. Participants voluntarily responded to the study and were assured anonymity and privacy. Trained enumerators facilitated data collection through face-to-face surveys, ensuring that responses were accurately recorded, especially for participants with limited literacy. The collected data were only used for the research.

The collected data were analyzed using descriptive statistics such as frequency, percentage, mean, and standard deviation to interpret participants' profiles and training effectiveness. To see if the results varied based on different participant profiles, tests like the Mann-Whitney U and Welch's were applied. Tables were used to clearly present the findings and make comparisons easier. All the data were organized, cleaned, and processed in a spreadsheet, then analyzed using the jamovi software (The jamovi project, 2022; R Core Team, 2021).

3. RESULTS AND DISCUSSION

3.1 Profile of the Participants

The profiles of the participants give a hopeful view of how alternative livelihood programs can truly impact the lives of fisherfolk in Dumaran and Araceli. The data shows promising signs, suggesting that these initiatives have the potential to create real, lasting change (Table 1).

Sex. In the fishing communities of Dumaran and Araceli, women account for 53.70% of surveyed participants, reflecting a majority presence that aligns with broader evidence showing women's predominance in post-harvest, processing, and market functions within small-scale fisheries. These shore-based, value-adding roles both reproduce culturally embedded gender divisions of labour and provide strategic pathways for women's economic agency and increased participation in local fisheries governance. Thus, the observed female majority likely indicates a combination of persistent traditional role differentiation and a potential shift toward greater gender equity – particularly if interventions support women's access to alternative livelihood activities, organizational leadership, and market-level resources. (Alonso-Población & Siar, 2018; Harper *et al*., 2013; Pedroza-Gutiérrez & Hapke, 2022; Siar, 2003).

Educational Attainment. Educational backgrounds vary, with the majority comprising both those who have reached the high school level and those who are high school graduates (53.71%), followed by those who have reached and finished the elementary level (31.48%). Amadu *et al*. (2021) noted that fisherfolk with some level of formal education—whether it's primary, secondary, or higher—often have more stable and resilient livelihoods. Education likely gives them the tools to understand and take advantage of alternative livelihood options. This highlights just how important it is to keep investing in skills training and to actively involve local stakeholders if we want to see real, lasting improvements in places like Dumaran and Araceli.

Household Size. Household sizes range, with the largest group having four members (39.81%), followed by those having five members (22.22%). This reflects the existence of a nuclear family among the fishing villages in Dumaran and Araceli. Household size can impact the distribution of resources, labor availability for other livelihood activities, and general family economic resilience (Muallil *et al*., 2013; Nguyen and Le, 2020). While smaller households may have a limited workforce and fewer dependents to support them, larger homes may benefit from more working-age members.

Years Stay in the Area. Most participants (97.22%) have lived in the area for over five years. Living in the same place for a long time often means people develop a deep understanding of their environment, local resources, and how their community works. This kind of rootedness can make alternative livelihood projects more sustainable, as locals are more likely to support efforts that benefit their surroundings. Their firsthand experience and traditional knowledge also help ensure these efforts are practical and respectful of local culture and the environment (Pukkalla & Rama Mohan, 2021).

Religion. The predominant religion is Roman Catholicism (92.59%). This common religious affiliation could help to foster great community cohesiveness and group involvement in livelihood projects. In many fishing communities, faith-based values and church groups do more than offer spiritual support—they often serve as trusted spaces where people come together, share knowledge, and work toward common goals. In Catanduanes, for example, a church-sponsored livelihood project led by the Diocese of Virac helped women not only earn income but also build confidence, take part in community decisions, and care more deeply for the environment (Pesimo, 1997). This shows how religious networks can play a vital role in supporting alternative livelihoods and strengthening community ties. In Dumaran and Araceli, religious events and church-based groups could efficiently share knowledge, organize involvement, and support alternative livelihood projects.

Sources of Income. Fishing remained the primary source of income (94.44%), followed by farming (86.11%) and livestock (81.48%), with women demonstrating a strong presence in fisheries-related activities. This pattern was shaped not only by household labor dynamics but also by broader cultural, economic, and institutional drivers. In this study, the category "fisheries" encompassed processing activities that used fish as the primary raw material, which partly explains why many female respondents reported fisheries as their main livelihood. Women's roles were often concentrated in shore-based and post-harvest tasks traditionally regarded as extensions of domestic responsibilities (Siar, 2003). Beyond cultural assignment, processing and marketing provided more stable and immediate income streams compared to the risks and seasonality of capture fishing (Harper *et al*., 2013). Their prominence was further reinforced by fisherfolk organizations and development programs that actively promoted women's participation in training, microfinance, and decision-making processes (Alonso-Población & Siar, 2018). Moreover, women's simultaneous engagement in farming, fisheries, and small-scale enterprises reflected broader livelihood diversification strategies that enhanced household resilience to environmental and market shocks (Pedroza-Gutiérrez & Hapke, 2022).

Household Income per Month. In Dumaran and Araceli, most households (67.59%) earn ₱10,000.00 or less per month during the fishing season, with 26.85% earning between ₱10,001.00 and ₱15,000.00. In the off-season, income drops sharply, with 98.15% earning ₱10,000.00 or less. These fluctuations highlight the economic vulnerability of fishing communities, as seen in other coastal areas, where seasonal changes impact household income and food security (Joquiño *et al*., 2021; Macusi *et al*., 2021; Gonzales and Plasus, 2023). The pandemic further exposed how income instability worsens food insecurity (Palanca-Tan, 2020; Ungkakay-Bagsit *et al*., 2025). This emphasizes the need for alternative livelihoods to reduce reliance on fishing and improve year-round financial stability.

House Structure. The majority (65.74%) of the households surveyed live in houses made of light materials such as bamboo, wood, or nipa. Others reside in concrete (17.59%) or semi-concrete 16.67% structures. The predominance of light-material housing reflects the limited financial capability of many fisherfolk families to make more durable house investments. Apart from increasing their vulnerability during typhoons and floods, this condition emphasizes the need for housing improvement support in livelihood and community development initiatives in Dumaran and Araceli.

Revenues Generated from the Alternative Livelihood Project. Many fisherfolk in Dumaran and Araceli are still in the early stages of their alternative livelihood projects. Nearly half (48.15%) have yet to earn, while 36.11% report modest earnings of ₱10,000.00 or less. Despite these small returns, they signal progress in diversifying income and reducing dependence on uncertain fishing yields. Similar trends have been seen in other Philippine communities, such as in Moalboal, Cebu, where marine ecotourism provided new income through herring aggregations (Cusack *et al*., 2021), and in Negros Occidental, where organic farming improved financial stability (Makita, 2016). These examples show that with proper support and training, alternative livelihoods can become vital sources of income and community empowerment.

Association Membership. The participants belong to several community associations, with the largest groups being the Calasag Fisherfolk/Farmers Association and the Catep Fisherfolk Association, each making up 25.93% of the total. According

Table 1. Frequency distribution of the participants' profiles. (n = sample size).

Profile Variables	Categories	Frequency (n = 108)	Percentage (%)
Sex	Male	50	46.30
	Female	58	53.70
Educational Attainment	Did Not Attend School	1	0.93
	Elementary Level	14	12.96
	Elementary Graduate	20	18.52
	High School Level	33	30.56
	High School Graduate	25	23.15
	College Level	10	9.26
	College Graduate	5	4.63

Table 1. (cont) Frequency distribution of the participants' profiles. (n = sample size).

Profile Variables	Categories	Frequency (n = 108)		Percentage (%)	
Household Size	1	1		0.93	
	2	11		10.19	
	3	17		15.74	
	4	43		39.81	
	5	24		22.22	
	More than 5	12		11.11	
Years of Stay in the Area	5 years or less	3		2.78	
	More than 5 years	105		97.22	
Religion	No Religion	1		0.93	
	Roman Catholic	100		92.59	
	Christian	5		4.63	
	Baptist	2		1.85	
Sources of Income (multiple responses)	Fishing	102		94.44	
	Aquaculture	1		0.93	
	Construction	13		12.04	
	Farming	93		86.11	
	Livestock	88		81.48	
	Tourism	2		1.85	
	Salary from the Government	6		5.56	
	Others	5		4.63	
		Fishing Season	Off-season	Fishing Season	Off-season
Household Income per Month	Less than or equal to ₱10,000.00	73	106	67.59	98.15
	₱10,001.00 to ₱15,000.00	29	1	26.85	0.93
	₱15,001.00 to ₱20,000.00	5	0	4.63	0.00
	₱20,001.00 to ₱25,000.00	0	1	0.00	0.93
	₱25,001.00 to ₱30,000.00	1	0	0.93	0.00
House Structure	Light Materials	71		65.74	
	Concrete	19		17.59	
	Semi-Concrete	18		16.67	
Revenues Generated from the Alternative Livelihood Project	Not Yet Harvested	52		48.15	
	Less than or equal to ₱10,000.00	39		36.11	
	₱10,001.00 to ₱15,000.00	4		3.70	
	₱20,001.00 to ₱25,000.00	1		0.93	
	₱60,001.00 to ₱100,000.00	12		11.11	
Association Membership	No Fisherfolk/Farmers Association Identified	4		3.70	
	Bacao Fisherfolk/Farmers Association	22		20.37	
	Catep Fisherfolk Association	27		25.00	
	Calasag Fisherfolk/Farmers Association	28		25.93	
	Dalayawan Fisherfolk/Farmers Association	12		11.11	
	Tinintinan Fisherfolk Association	15		13.89	
Participation in Fisheries Policy Decision-Making	Participated	63		58.33	
	Did Not Participate	45		41.67	

to the Food and Agriculture Organization (FAO), strong local organizations play a vital role in supporting small-scale fisherfolk. Beyond simply organizing members, these associations serve as spaces where skills are sharpened, resources are shared, and collective goals are pursued. With consistent support and capacity-building, these groups can become even stronger—helping fisherfolk in Dumaran and Araceli build more stable and sustainable livelihoods.

Participation in Fisheries Policy Decision-Making. Just over half of the participants (58.33%) reported participated in fisheries policy decisions, which is a positive sign that more fisherfolk are becoming engaged and aware of the issues that impact them. However, this also means that many are still left out of these important discussions. To change that, it's crucial to strengthen community involvement and provide more training and support. By doing so, more people in Dumaran and Araceli will be empowered to speak up and contribute to decision-making, ensuring that their local knowledge and experiences play a key role in shaping more sustainable fisheries management (Cusack *et al*., 2021; Gonzales *et al*., 2021; Almendras *et al*., 2022; Mololos *et al*., 2024).

3.2 Effectiveness of Training and Skills Development in Alternative Livelihoods

With a mean score of 3.01 (Table 2), the overall effectiveness of the training is considered *high*, suggesting that participants found it successful in building their skills and preparing them for alternative livelihood activities. Specifically, the applicability of the training received a mean score of 2.96 (SD = 1.02), reflecting participants' belief that the content was generally relevant to their daily work and community needs. Meanwhile, improvements in management and social skills scored 3.04 (SD = 0.97 and 0.95, respectively), pointing to meaningful growth in both practical business abilities and interpersonal communication. While these scores are encouraging, they remain just below the *very high* range. This suggests room for enhancement in how training programs are designed and delivered—particularly in ensuring that skills are not only learned but effectively applied in real-life settings across communities like Dumaran and Araceli.

These findings align with other research that highlights the powerful impact of well-designed livelihood programs. For instance, Aguilar and Tabujara (2022) found that fisherfolk in Negros Occidental who took part in conservation-based livelihood projects gained practical skills that were closely tied to their environment and daily lives. This hands-on approach not only helped them build useful skills but also led to stronger engagement and a greater sense of ownership over their work. Similarly, Cosejo (2025) shared that fisherfolk involved in the DOLE Integrated Livelihood Program became more confident in running small businesses. They learned valuable skills in budgeting, planning, and managing resources—essential tools for supporting their families. Beyond just the technical skills, these programs also helped build a sense of community. Participants often worked together in groups, which improved their ability to communicate, make decisions, and collaborate—skills that are key to individual success and the overall resilience of the group (Aguilar & Tabujara, 2022). Taken together, these insights show that alternative livelihood training isn't just about surviving financially; it's about empowering communities to grow, adapt, and thrive.

3.3 Profile Differences in the Effectiveness of Training and Skills Development in Alternative Livelihoods

Significant profile differences [e.g., sex, household size, and household income (fishing season)] were observed in the effectiveness of training and skills development in alternative livelihoods (Table 3). Male participants (Mean = 3.39) view the training effectiveness significantly differently than females (Mean = 2.68), $t = 807$, $p < .01$. This gender-based difference can reflect different access to resources, possibilities, or society expectations about livelihood roles for men and women. Men often report higher effectiveness. Thus, more research on gendered experiences and opportunities in the training process could provide an understanding of how training programs could be customized to meet the particular needs of female participants more successfully.

Table 2. Descriptive analysis of the effectiveness of training and skills development in alternative livelihoods. [1.00-1.75 (Low), 1.76-2.50 (Moderate), 2.51-3.25 (High), 3.26-4.00 (Very High)]

Indicators	Mean	SD
Level of Applicability of Training for Alternative Livelihoods Provided	2.96	1.02
Level of Improvement in the Level of Managing Skills Upon the Grant of Alternative Livelihood	3.04	0.97
Level of Social Skills Developed Upon the Grant of Alternative Livelihood	3.04	0.95
Overall Effectiveness	3.01	0.98

In addition, the analysis reveals a significant difference between participants with household incomes equal to ₱10,000 or less (Mean = 3.29) and those with incomes over ₱10,000 (Mean = 2.89), $t = 920$, $p < .05$. Lower-income participants believe the training to be more successful, which could reflect the

direct advantages they gain from livelihood training. For those from lower-income backgrounds, the training could be a crucial chance to raise their standard of living, thus enhancing their evaluation. Higher-income participants might already have access to other sources of income or might be more critical of the training if it does not fit their expectations or needs. Furthermore, participants who generated greater than ₱10,000.00 (Mean = 3.24) view the project more favorably, compared to those who earned less than or equal to ₱10,000.00 (Mean = 2.62), $t = 194$, $p < .05$. Those who made more money from the alternative livelihood project often have better opinions. This could result from their direct gains from the project, increasing their impression of its success. On the other hand, those who produced smaller income could view the project as less successful, maybe because of difficulties scaling or implementing the initiative. These findings underline the need for income generation in assessing the success and influence of livelihood programs and imply that projects could have to concentrate on increasing income potential to raise participant satisfaction and perceived effectiveness.

On the other hand, the study reveals that the perceived effectiveness of the alternative livelihood training is not much influenced by household size, educational level, or involvement in fisheries policy decision-making ($p > .05$). Participants' view of the training's effectiveness is not influenced by educational level. This implies that people with different educational backgrounds view the effectiveness of the alternative livelihood training in same terms. It could suggest that, independent of the participants' official education, the skills being taught in the livelihood program are sufficiently broad and pragmatic to be useful. The effectiveness of the training is not influenced with the size of the household. One could argue that the effect of the training is more individualistic than family-oriented, thus each participant may evaluate its relevance and impact depending on their personal experience instead of on the structure of the house regardless of the number of household members.

The type of household structure also does not influence perceptions of training effectiveness. Although household structure could reflect elements like socioeconomic level or living circumstances, in this case these elements seem to have no bearing on how valuable or relevant the training participants got. This could be the result of the practical character of the training, in which participants concentrate more on the acquired skills than on their living surroundings. The degree of training effectiveness is not influenced by involvement in fisheries policy decisions. This could imply that although participation in policy decision-making offers some insights or benefits, it has no direct influence on the impressions of the training received by individuals. It could be that the content of the training is seen as equally relevant to both groups, independent of their involvement in policy decisions, or that other elements, such personal experiences or outside conditions, exceed the impact of policy participation on the general impression of the effectiveness of the training.

3.3 Implementation Outcomes and Stakeholder Feedback on Alternative Livelihood Projects

Implementation Outcomes and Stakeholder Feedback on Alternative Livelihood Projects were determined by understanding the participants' Continuation of the Management of Alternative Livelihood, Success of the Alternative Livelihood, Factors Appreciated Much in the Training, Application of Learnings Regarding Alternative Livelihood in Daily Life, Household Improvement after Engaging in Alternative Livelihood, and Things to Improve in Future Alternative Livelihood Training (Table 4).

Continuation of the Management of Alternative Livelihood. In evaluating the sustainability of alternative livelihood programs, it was observed that 63.89% of the 108 participants continued operating their livelihood projects, suggesting a promising level of program continuity and a strong community drive toward diversified income generation. However, 36.11% discontinued their initiatives, pointing to underlying issues such as a lack of ongoing support, insufficient monitoring, and burnout. This pattern aligns with findings from Roe *et al*. (2015), who emphasized that many alternative livelihood programs fail to achieve long-term success due to inadequate post-project support and weak institutional follow-through. The need for continued engagement is particularly relevant in fishing communities, where alternative livelihoods often involve a transition to entirely new skill sets and market environments. Supporting this, Fabinyi *et al*. (2014) examined livelihood diversification among coastal fishers in Southeast Asia and noted that while many were willing to engage in new activities, sustained participation heavily depended on the availability of financial resources, training, and follow-up mechanisms.

Success of the Alternative Livelihood. An evaluation of the outcomes from alternative livelihood programs for fisherfolk showed a nearly equal split: 50.93% of the projects were considered successful, while 49.07% faced challenges that led to their discontinuation. The main reasons for these setbacks included financial struggles (47.17%), issues with management and operations (32.08%), product and market-related problems (18.87%), and other external factors (1.89%). This balance

between successes and failures highlights important gaps in how these programs are designed and implemented.

Table 3. Comparative analysis determining profile differences in the effectiveness of training and skills development in alternative livelihoods.

Profile	Group	Mean	Statistic	p
Sex	Female	2.68	807a	.001
	Male	3.39		
Educational Attainment	Elementary Level/Graduate	3.18	1.27b	.291
	High School Level/ Graduate	2.99		
	College Level/Graduate	2.73		
Household Size	1 to 2	3.39	1.20b	.315
	3 to 4	2.95		
	5 to 6	2.99		
Household Income (Fishing Season)	Less than or equal to ₱10,000	2.88	920a	.011
	More than ₱10,001	3.29		
Household Structure	Light Materials	2.96	1170a	.335
	Semi-concrete/Concrete	3.12		
Revenues Generated from the Alternative Livelihood Project	Less than or equal to ₱10,000.00 (*n* = 39)	2.62	194a	.010
	Greater than ₱10,000.00 (*n* = 17)	3.24		
Association Membership	Bacao Fisherfolk/Farmers Association	2.95	3.06b	.062
	Catep Fisherfolk Association	2.56		
	Calasag Fisherfolk/Farmers Association	3.30		
	Dalayawan Fisherfolk/ Farmers Association	3.36		
	Tinintinan Fisherfolk Association	3.18		
Participation in Fisheries Policy Decision-Making	Participated	2.81	1192a	.143
	Did Not Participate	3.15		

Note: aMann-Whitney U was used. bWelch's was used.

One of the biggest challenges for small-scale fishers is financial pressure, mainly due to limited access to formal loans. Many end up relying on informal lenders, leading to debt and instability (Mozumder *et al*., 2024). To address this, the alternative livelihood training in Dumaran and Araceli included modules on financial literacy and business management. However, due to limited time and budget, these topics may not have been explored in enough depth—possibly contributing to why financial and management issues remain the most common challenges faced by fisherfolk associations in sustaining their projects. The findings highlight that financial literacy and business management are essential components of alternative livelihood training, as they help fisherfolk manage income and sustain500 small businesses—an approach proven effective in other regions (Tilley *et al*., 2020).

But one of the biggest challenges is securing a stable market for their products. Without it, fisherfolk may struggle to sell what they produce, putting both their income and motivation at risk (Lovita *et al*., 2020). This shows the need for a more well-rounded approach—one that not only builds skills but also connects communities to reliable markets and long-term support. That kind of strategy is crucial for making livelihood programs truly sustainable.

Factors Appreciated Much in the Training. The training provided under the alternative livelihood program was generally well-received. The most appreciated aspects included assistance in livelihood setup (85.19%), knowledge and skills gained (64.81%), support from the speaker or consultant (56.48%), and food provisions (38.89%). High satisfaction rates with setup assistance and skill acquisition underscore the value of practical, hands-on training. Positive feedback about facilitators and logistical support (e.g., food provisions) highlights the importance of well-organized and client-centered training environments.

Application of Learnings Regarding Alternative Livelihood in Daily Life. In assessing the practical application of alternative livelihood training among fisherfolk, it was observed that 70.37% of participants implemented the skills they acquired, while 29.63% did not. Among the 76 alternative livelihoods pursued, oyster culture and bangus (milkfish) cage farming were the most common, each accounting for 23.68%, followed by sea cucumber culture and food processing (17.11% each), mud crab culture (11.84%), and dishwashing soap making (6.58%). The high uptake of aquaculture-based livelihoods, such as oyster and bangus culture, suggests that these activities align well with the local knowledge and resource availability of the communities involved. This trend is consistent with findings from Baticados (2015), who noted that aquaculture technologies, when tailored to the capacities and contexts of rural communities, are more likely to be adopted and sustained. Furthermore, the integration of social capital through fish farmers' associations has been shown to enhance the agency of small-scale aquaculture producers, facilitating better access to resources and support systems (Marin *et al*., 2023). These insights underscore the importance of aligning livelihood training programs with the existing skills and environmental contexts of fisherfolk to ensure higher rates of application and sustainability.

Household Improvement after Engaging in Alternative Livelihood. The program's favorable results were seen in household improvement; 69.44% of participants reported improvements mostly in household income (70.67%), then, to a lesser degree, in house structure (17.33%) and education (12.00%). Though gains in housing and education remain limited, participants' household income shows that alternative livelihoods can favorably impact economic well-being. This implies that income increases could be modest rather than long-term investments, or given top priority for urgent needs.

Things to Improve in Future Alternative Livelihood Training (multiple responses). In evaluating the outcomes of alternative livelihood training programs for fisherfolk, participants highlighted several areas for improvement to enhance the effectiveness and sustainability of such initiatives. A significant 67.59% of participants emphasized the need for better production processes, while 54.63% pointed to improvements in packaging and marketing strategies. Additionally, 38.89% underscored the importance of tailoring livelihoods to fit the local context, and 20.37% identified the enhancement of managerial skills as crucial. These insights underscore the necessity for comprehensive, context-sensitive capacity-building approaches in future training programs.

Research supports these findings, emphasizing that aligning livelihood interventions with local contexts and needs is vital for their success. According to the study by Tilley *et al*. (2021), small-scale fisheries programs need to be supported over an appropriate period and use participatory methods that build capacity in order to achieve positive outcomes. Similarly, Nuraini *et al*. (2022) show that teaching fishermen effective marketing strategies and better product packaging can significantly improve their access to markets and reduce their reliance on middlemen, leading to better economic outcomes.

4. CONCLUSIONS

The alternative livelihood training programs in Dumaran and Araceli had a positive impact, helping participants build practical skills, improve their management abilities, and strengthen social ties. While there was noticeable progress, the results also highlighted areas that need improvement in both the content and delivery of the training. About 63.89% of participants continued with their livelihood projects, but nearly half faced challenges, mostly related to financial and management issues. The training on financial literacy and business management was especially helpful, with 70.37% of participants successfully applying what they learned. However, there's still room to improve, particularly in areas like production, marketing, and tailoring the training to better fit local needs. These findings show that while the programs can boost household income, ongoing support is essential for ensuring their long-term success.

CONTRIBUTIONS

Leo N. Plasus – Conceptualized the study, conducted the training sessions, and contributed to the writing and revision of the paper. Jupeth T. Pentang – Performed statistical analysis, interpreted the data/ result, assisted in drafting the manuscript, and contributed to the revision of the paper. Maria Cristina Rosero – Conducted the training and facilitated the survey process. Elleonor Abatay – Led the training sessions and facilitated the survey process. Vincent Gacer – Conducted the survey. Mary Divina Nicolas – Conducted the survey and provided support in drafting the manuscript. Maria Mojena G. Plasus – Conceptualized the research, secured funding, designed the survey form, and contributed to writing the draft and revising the manuscript.

RECOMMENDATIONS

To make future alternative livelihood training more effective, it's essential to focus on hands-on learning that connects directly to the daily lives of fisherfolk. Training should teach practical skills like financial literacy, planning, and marketing to help ensure the programs are sustainable. Regular support and check-ins can help tackle any challenges and reinforce what participants have learned. Encouraging group-based learning can also strengthen community ties and create a sense of shared responsibility.

For long-term success, the training programs need to be more closely tailored to the local context, especially in areas like production, marketing, and management. Improving market access and aligning activities with local resources will be crucial for sustainability. Rather than offering one-time training, it's important to establish ongoing, community-based support systems that foster skill development and incorporate local knowledge. This approach will make the programs more resilient and impactful.

Table 4. Frequency distribution of the implementation outcomes and stakeholder feedback on alternative livelihood projects. (n = sample size)

Factors	Categories	Frequency (n = 108)	Percentage (%)
Continuation of the Management of Alternative Livelihood	Continued	69	63.89
	Did Not Continue	39	36.11
Success of the Alternative Livelihood	Successful	55	50.93
	Not Successful1	53	49.07
Reasons Why it Was not Successful (n = 53)1	Financial Issues	25	47.17
	Managerial/Operational Challenges	17	32.08
	Product and Market Challenges	10	18.87
	External Factors	1	1.89
Factors Appreciated Much in the Training (multiple responses)	Assistance in Alternative Livelihood Setup	92	85.19
	Speaker/Consultant	61	56.48
	Knowledge and Skills	70	64.81
	Food	42	38.89
Application of Learnings Regarding Alternative Livelihood in Daily Life	Applied2	76	70.37
	Did Not Apply	32	29.63
Alternative Livelihood Implemented (n = 76)2	Dishwashing Soap Making	5	6.58
	Sea Cucumber Culture	13	17.11
	Mud Crab Culture	9	11.84
	Oyster Culture	18	23.68
	Food Processing	13	17.11
	Bangus Fish Cage	18	23.68
Household Improvement after Engaging in Alternative Livelihood	Improved3	75	69.44
	Did Not Improve	33	30.56
Ranked Improvement upon Engagement in the Alternative Livelihood (n = 76)3	House Structure	13	17.33
	Income	53	70.67
	Education	9	12.00
Things to Improve in Future Alternative Livelihood Training (multiple responses)	Improve the Production Process	73	67.59
	Improve the Packaging and Marketing	59	54.63
	Improve the Managerial Skills	22	20.37
	Livelihood Suitable for the Location	42	38.89

REFERENCES

Aguilar, V. R., & Tabujara, D. I. M. (2022). Engaging fisherfolk organizations in conservation-based alternative livelihoods and conservation of the habitats of Irrawaddy dolphins in Negros Occidental. *The Philippine Journal of Fisheries, 29(1)*, 53–66. https://doi.org/10.31398/tpjf/29.1.2021-0027

Alonso-Población, E., & Siar, S. V. (2018). Women's participation and leadership in fisherfolk organizations and collective action in fisheries: A review of evidence on enablers, drivers and barriers. *FAO Fisheries and Aquaculture Circular No. 1159*. Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/handle/20.500.14283/i8480en

Amadu, I., Armah, F. A., & Aheto, D. W. (2021). Assessing Livelihood Resilience of Artisanal Fisherfolk to the Decline in Small-Scale Fisheries in Ghana. *Sustainability, 13(18)*, 10404. https://doi.org/10.3390/su131810404

Anticamara, J. A., & Go, K. T. B. (2016). Spatio-temporal declines in Philippine fisheries and its implications to coastal municipal fishers' catch and income. *Frontiers in Marine Science, 3*, 21. https://doi.org/10.3389/fmars.2016.00021

Arbiol, J., and Minh, P. Q. (2023). Combating illegal, unreported, and unregulated fishing in the ASEAN region. *The ASEAN Magazine*. https://theaseanmagazine.asean.org/article/combating-illegal-unreported-and-unregulated-fishing-in-the-asean-region/

Baticados, D. B. (2015). Reaching the poor through aquaculture: The case of technology adoption in rural communities at west central Philippines. In M. R. R. Romana-Eguia, F. D. Parado-Estepa, N. D. Salayo, & M. J. H. Lebata-Ramos (Eds.), *Resource Enhancement and Sustainable Aquaculture Practices in Southeast Asia: Challenges in Responsible Production of Aquatic Species: Proceedings of the International Workshop on Resource Enhancement and Sustainable Aquaculture Practices in Southeast Asia 2014 (RESA)* (pp. 251–260). Tigbauan, Iloilo, Philippines: Aquaculture Department, Southeast Asian Fisheries Development Center.

Cosejo, G. (2025). Impact evaluation of livelihood program (DILP) in Tigaon, Camarines Sur. *International Journal of Research and Innovation in Social Science (IJRISS), 9(2)*, 152–214. https://dx.doi.org/10.47772/IJRISS.2025.915EC0012

Cusack, C., Sethi, S. A., Rice, A. N., Warren, J. D., Fujita, R., Ingles, J., Flores, J., Garchitorena, E., & Mesa, S. V. (2021). Marine ecotourism for small pelagics as a source of

alternative income generating activities to fisheries in a tropical community. *Biological Conservation, 261*, 109242. https://doi.org/10.1016/j.biocon.2021.109242

Daw, T., Adger, W. N., Brown, K., & Badjeck, M.-C. (2009). Climate change and capture fisheries: Potential impacts, adaptation and mitigation. In K. Cochrane, C. De Young, D. Soto, & T. Bahri (Eds.), *Climate change implications for fisheries and aquaculture: Overview of current scientific knowledge* (FAO Fisheries and Aquaculture Technical Paper No. 530, pp. 107–150). Food and Agriculture Organization of the United Nations. http://www.fao.org/3/i0994e/i0994e00.htm

Etongo, D., & Arrisol, L. (2021). Vulnerability of fishery-based livelihoods to climate variability and change in a tropical island: Insights from small-scale fishers in Seychelles. *Discover Sustainability, 2*, 48. https://doi.org/10.1007/s43621-021-00057-4

Fabinyi, M. (2020). The role of land tenure in livelihood transitions from fishing to tourism. *Maritime Studies, 19*, 29–39. https://doi.org/10.1007/s40152-019-00145-2

Fabinyi, M., Foale, S., & Macintyre, M. (2014). Managing inequality or managing stocks? An ethnographic perspective on the governance of small-scale fisheries. *Fish and Fisheries, 16(3)*, 471–485. https://doi.org/10.1111/faf.12069

Funk, L., Wilson, A. M. W., Gough, C., Brayne, K., & Djerryh, N. R. (2022). Perceptions of access and benefits from community-based aquaculture through Photovoice: A case study within a locally managed marine area in Madagascar. Ocean & Coastal Management, 222, Article 106046. https://doi.org/10.1016/j.ocecoaman.2022.106046

Food and Agriculture Organization. (2016). Strengthening organizations and collective action in fisheries: Towards the formulation of a capacity development programme. *FAO Fisheries and Aquaculture Proceedings No. 41*. Rome, FAO. https://openknowledge.fao.org/items/baac96a0-182b-47e1-8a74-02a42f8d5474

Food and Agriculture Organization of the United Nations. (2020). *The state of world fisheries and aquaculture 2020: Sustainability in action*. FAO. https://doi.org/10.4060/ca9229en

Guimmayen, S. E. R., Cerro, P. A. P., & Vallespin, M. R. D. (2024). Synthesizing the ecological and societal ramifications of environmental stressors on Philippine marine ecosystems: A comprehensive literature review. *International Journal of Current Science Research and Review, 7(5)*, 2541-2547. https://doi.org/10.47191/ijcsrr/V7-i5-13

Gonzales, B. J., Dalumpines, R. H., Dagaraga, R. S., Sariego, R. S., Manarpaac, E. P., Lariza, C. L. S., & Plasus, M. M. G. (2021). Implementing environmental plans and laws at rural grassroots, Palawan, Philippines: Status, factors, and moving forward. *The Palawan Scientist, 13(1)*, 59-77.

Gonzales, B. J., and Plasus, M. M. G. (2023). The opportunities and plight of a fish corral fisher in Inner Malampaya Sound of Taytay, Northern Palawan. *In A. J. G. Ferrer & H. M. Monteclaro (Eds.), Portrait of small-scale fishers in the Philippines* (pp. 150–154). TBTI Global Publication Series. TBTI Philippines, Iloilo, the Philippines.

Harper, S., Zeller, D., Hauzer, M., Pauly, D., & Sumaila, U. R. (2013). Women and fisheries: Contribution to food security and local economies. *Marine Policy, 39*, 56–63. https://doi.org/10.1016/j.marpol.2012.10.018

Isip, M. I. G. (2022). Adaptive capability of micro agribusiness firms: Qualitative evidence from the Philippines. *Research in Globalization, 5*. https://doi.org/10.1016/j.resglo.2022.100087

Joquiño, C. M., Sarmiento, J. M. P., Estaña, L. M. B., Nañola Jr., C. L., & Alviola IV, P. A. (2021). Seasonal change, fishing revenues, and nutrient intakes of fishers' children in Davao Gulf, Philippines. *Philippine Journal of Science, 150(1)*, 307–323. https://doi.org/10.56899/150.01.28

Lovita, F., Satria, A., & Hakim, D. B. (2020). Adaptive financing pattern for small-scale fisheries with case study of Pajeko fisheries in Bitung. *Jurnal Manajemen & Agribisnis, 17(2)*, 173–182. https://doi.org/10.17358/jma.17.2.173

Lungren, R., Staples, D., Funge-Smith, S., & Clausen, J. (2006). *Status and potential of fisheries and aquaculture in Asia and the Pacific 2006 (RAP Publication 2006/22). FAO Regional Office for Asia and the Pacific.* https://www.fao.org/3/ag110e/ag110e00.htm

Makita, R. (2016). Livelihood diversification with certification-supported farming: The case of land reform beneficiaries in the Philippines. *Asia Pacific Viewpoint, 57(1)*, 1–16. https://doi.org/10.1111/apv.12106

Marin, A., Roldan, M., & Alibuyog, J. (2023). Social capital strengthens agency among fish farmers: Small scale aquaculture in Bulacan, Philippines. *Frontiers in Aquaculture, 2*, 1106416. https://doi.org/10.3389/faqu.2023.1106416

Marine Conservation Philippines (n.d.). Alternative livelihoods. https://www.marineconservationphilippines.org/projects/community/alternative-livelihoods/

Malolos, C. F., Maga-ao, M. A. D., Cea, A. P., Magallanes, S. S., Diamante, J. T., Venturillo, R., Plasus, M. M. G., & Gonzales, B. J. (2025). Implementation of area-specific action plans (ASAP) for community-based MPAs in Cagayancillo, Palawan, Philippines: Funded versus not funded. *The Palawan Scientist, 17(1)*, 1-7. https://doi.org/10.69721/TPS.J.2025.17.1.01

Mozumder, M. M. H., Schneider, P., Islam, M. M., & Rahman, M. M. (2024). Bridging the gap: Enhancing socio-ecological resilience by breaking the debt cycle among small-scale hilsa fishers in Bangladesh. Maritime Studies, 23(10). https://doi.org/10.1007/s40152-024-00355-3

Muallil, R. N., Geronimo, R. C., Cleland, D., Cabral, R. B., Doctor, M. V., Cruz-Trinidad, A., & Aliño, P. M. (2013). Socioeconomic factors associated with fishing pressure in small-scale fisheries along the West Philippine Sea biogeographic region. *Ocean & Coastal Management, 82*, 27–33. https://doi.org/10.1016/j.ocecoaman.2013.04.013

Novilla, C. T. T., & Fabinyi, M. (2025). Coral reefs and small pelagic fisheries: Livelihood and governance interactions in Southern Luzon, Philippines. *Maritime Studies, 24(26)*. https://doi.org/10.1007/s40152-025-00417-0

Nguyen, T. T., & Le, T. H. (2020). Adaptive livelihood strategies among small-scale fishing households to climate change-related stressors in Central Coast Vietnam. *International Journal of Climate Change Strategies and Management, 12(4)*, 479–494. https://doi.org/10.1108/IJCCSM-04-2020-0034

Palanca-Tan, R. (2020). Social capital and vulnerability to extreme climate in a semi-urban fishing community in Laguna de Bay, Philippines. *Journal of Environmental Science and Management, 23(2)*, 60–69. https://doi.org/10.47125/jesam/2020_2/10

Pedroza-Gutiérrez, C., & Hapke, H. M. (2022). Women's work in small-scale fisheries: A framework for accounting its value. *Gender, Place & Culture, 29(12)*, 1733–1750. https://doi.org/10.1080/0966369X.2021.1997936

Pesimo, M. L. L. C. (1997). Church-sponsored livelihood project among women in five forest-based communities in Catanduanes [Philippines]. *FAO AGRIS Record*

Plasus, M. M. G. (2024). Case Study: Aquaculture in Palawan. In Haworth, B. T., Cadigal, G. M., Zabala Jr, E. C., Gonzales, B. J., Jalover-Par, C. L. S., Dolorosa, R. G., Gonzales-Plasus, M. M., Jontila, J. B. S., Cabrestante Jr, M. P., Bruce, E., & Baker, E. (2024). Palawan (UNESCO Biosphere Reserve), Philippines: State of the Marine Environment 2024. (pp. 88–96). Palawan Council for Sustainable Development Staff, Puerto Princesa City, Philippines.

Pukkalla, D., & Rama Mohan, K. R. (2021). Local knowledge and marine livelihoods among the South Indian fishing community. *Journal of Asian and African Studies, 56(3)*, 514–530. https://doi.org/10.1177/0021909620931524

R Core Team. (2021). *R: A language and environment for statistical computing* (Version 4.1) [Computer software]. Retrieved from https://cran.r-project.org. (R packages retrieved from MRAN snapshot 2022-01-01).

Roe, D., Booker, F., Day, M., Zhou, W., Allebone-Webb, S., Hill, N. A. O., ... & Sunderland, T. C. H. (2015). Are alternative livelihood projects effective at reducing local threats to specified elements of biodiversity and/or improving or maintaining the conservation status of those elements? A systematic review. *Environmental Evidence, 4(1)*, 22. https://doi.org/10.1186/s13750-015-0048-1

Serrona, K. R. B. (2009). Finding urban waste management solutions and policies: Waste-to-energy development and livelihood support system in Payatas, Metro Manila, Philippines. *Journal of Environmental Sciences, 21(1)*, S40-S43. http://dx.doi.org/10.1016/S1001-0742(09)60033-4

Siar, S. V. (2003). Knowledge, gender, and resources in small-scale fishing: The case of Honda Bay, Palawan, Philippines. *Environmental Management, 31(5)*, 569–580. https://doi.org/10.1007/s00267-002-2872-7

Suh, D., & Pomeroy, R. (2020). Projected economic impact of climate change on marine capture fisheries in the Philippines. *Frontiers in Marine Science, 7*, Article 232. https://doi.org/10.3389/fmars.2020.00232

Tahiluddin, A. B., & Sarri, J. H. (2022). An overview of destructive fishing in the Philippines. *Acra Natura Et Scientia, 3(2)*, 116-125. https://doi.org/10.29329/actanatsci.2022.352.04

The Jamovi Project. (2022). *Jamovi* (Version 2.3) [Computer software]. Retrieved from https://www.jamovi.org.

Tilley, A., Wilkinson, S. P., Kolding, J., López-Angarita, J., Pereira, M., & Mills, D. J. (2020). Financial inclusion to build economic resilience in small-scale fisheries. *Marine Policy, 118*, 103982. https://doi.org/10.1016/j.marpol.2020.103982

Ungkakay-Bagsit, F., Badayos-Jover, M. B. P., Pavo, R. R., & Cambronero-Tumabiao, P. (2025). Livelihood and food acquisition challenges in island communities during the global pandemic. *Marine and Fishery Sciences, 38(2)*, 111–125. https://doi.org/10.47193/mafis.3822025010113.