



Rethinking Makran Coastal Region Development Plans: Policy Gaps and Pathways within the Planetary Boundaries Framework

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ABSTRACT

Objective: The study evaluates development approaches in the Makran region in southeastern Iran, examining their compatibility with ecological capacities using the planetary boundaries and resilience theory frameworks. It aims to identify shortcomings in addressing environmental thresholds and social-ecological resilience within key planning documents.

Methods: A critical-analytical approach and content analysis were applied to major planning documents, including the Strategic Development Document for the Makran Coasts, provincial land-use plans, and free zone programs. The analysis focused on how these documents address climate change, land-use change, biodiversity loss, freshwater scarcity, community participation, and strategic environmental assessments.

Results: The review reveals that dominant development approaches prioritize infrastructure expansion and lack adequate ecological assessment, placing pressure on natural resources and reducing social-ecological resilience. The documents show critical shortcomings in addressing environmental thresholds related to climate change, land-use change, biodiversity loss, and freshwater scarcity. Limited opportunities for community participation and the absence of strategic environmental assessments further weaken resilience. International experiences from the European Union and Southeast Asia demonstrate more effective integration of environmental frameworks and participatory governance.

Conclusion: The study argues that policy-making for Makran's development must be restructured around ecological thresholds, local capacities, and resilience principles. Without such reform, ongoing trends risk exacerbating environmental degradation, social vulnerability, and ecological insecurity. The findings provide pathways for revising development documents, strengthening environmental governance, and promoting sustainable coastal development within the planetary boundaries framework.

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Introduction

Coastal regions around the world today play a decisive role in national and regional sustainable development. The Makran coasts in southeastern Iran, due to their strategic location connecting the land to the open waters of the Indian Ocean, possession of diverse natural resources, and potentials in ecotourism, agriculture, fisheries, and commerce, are recognized as one of the priority areas in the country's macro development plans. The development of this region not only strengthens the national economy but also enhances Iran's geopolitical influence in the South and West Asia corridors (Ghanavati et al., 2021; Veicy, 2023).

However, the implementation of extensive construction and industrial projects without precise environmental considerations can lead to irreversible degradation of native ecosystems, reduction of ecological capacity, and instability in social and natural systems. A review of official development documents indicates that although the necessity of environmental protection is mentioned, these documents generally lack precise and quantitative frameworks for assessing environmental pressures. This gap, especially under critical conditions such as climate crisis, water scarcity, biodiversity loss, and drastic land-use changes in the region, can have severe consequences (Kashef et al., 2022).

In this context, the "planetary boundaries" framework, first introduced by Rockström et al (2009) and revised by Steffen et al (2015), is recognized as one of the most innovative analytical tools for measuring sustainability at global and regional scales. This framework identifies nine critical biophysical boundaries, including climate change, biosphere integrity, nitrogen and phosphorus cycles, ocean acidification, freshwater use, land-use change, suspended particulate matter loading, chemical pollution, and ozone depletion, proposing thresholds for each beyond which the risk of ecosystem collapse increases. Moreover, Rockström et al (2024) conducted a detailed revision of the planetary boundaries framework, demonstrating through analysis of the nine key environmental boundaries that currently six have been crossed beyond safe limits.

Simultaneously, the concept of "social-ecological system (SES) resilience," articulated by researchers such as Folke (2006) and Walker and Meyers (2004), provides a framework for understanding the dynamics, adaptability, and recovery capacity of systems in the face of human and natural shocks and stresses. The integration of these two approaches—planetary boundaries and social-ecological resilience—has recently emerged as an innovative conceptual model in sustainable resource management (Drees, 2021; Robèrt et al., 2013; Williams et al., 2025).

At the national level, studies such as Barati et al (2023) critically analyzing Makran's development plans have pointed to the challenges in marine-oriented development of the Makran coasts, emphasizing the shortcomings in high-level policy documents. Investigations into the environmental impacts of infrastructure development in the Makran coasts, particularly in the

Chabahar area, reveal serious challenges due to the lack of environmental considerations in construction projects. According to Kashef et al (2022), infrastructure developments have significantly contributed to environmental pollution and threats to biodiversity along the Makran coasts, and this trend, without strategic environmental assessment frameworks, could lead to the destruction of native ecosystems. Their findings stress that the absence of effective mechanisms for evaluation and monitoring of development impacts threatens the ecological capacity of the region and the continuation of such trends may result in irreversible consequences for the environmental and social sustainability of the area. These findings reveal a significant disconnect between development planning and the ecological capacity of the region.

Under such circumstances, it appears that a systematic analysis of Makran's development documents based on the planetary boundaries framework can expose existing conceptual and practical gaps and offer pathways for policy revision and enhancement.

The aim of this article is to conduct a content analysis of macro development documents for the Makran coasts with an emphasis on planetary boundaries and to examine the potential of this framework to enhance the resilience of the region's social-ecological systems. Through a critical and analytical lens, this research seeks to facilitate a scientific dialogue between development and environmental concerns at policy-making and regional planning levels.

By combining the "planetary boundaries" framework and "social-ecological system resilience," this study presents an innovative and interdisciplinary approach to analyzing Makran's development documents, comprehensively identifying policy gaps and proposing practical solutions for sustainable development.

- **Theoretical and Conceptual Framework**

The theoretical framework of this study centers on four key interrelated concepts that collectively provide an analytical basis for evaluating development patterns in the Makran region. These concepts include: planetary boundaries, social-ecological resilience, environmental governance, and sustainable development in coastal areas.

1. **Planetary Boundaries:** This framework was first introduced by Rockström et al (2009) and aims to define biogeochemical thresholds which, if crossed, threaten the stability of the Earth system. The nine identified boundaries include climate change, biodiversity loss, disruption of nitrogen and phosphorus cycles, land-use change, ocean acidification, freshwater use, atmospheric aerosol loading, chemical pollution, and ozone layer depletion. This framework enables the assessment of human impacts on a global scale and the formulation of policies aligned with planetary sustainability (Rockström et al., 2009). Planetary boundaries indicate that human activities have significantly increased pressures on these systems in recent

decades, in some cases, such as climate change and biodiversity loss, surpassing safe thresholds (Steffen et al., 2015).

Applying this framework at regional and local scales helps managers and policymakers identify ecological limits and define development within the natural capacities of the region (Hoff, 2022; Steffen et al., 2015). For the Makran coasts, planetary boundary analysis can serve as a tool to evaluate the impacts of development projects on natural resources, biodiversity, and environmental quality.

2. **Social-Ecological Resilience:** Resilience refers to a system's capacity to absorb shocks, return to its initial state, or adapt to new conditions. In the social-ecological approach, resilience goes beyond mere survival to encompass the ability of human communities to adapt and transform in response to environmental changes. According to Folke et al (2010), ecosystem resilience is maintained only through participatory institutions, social learning, and ecological feedbacks (Biggs et al., 2015; Folke et al., 2010). Studies have shown that enhancing resilience in social-ecological systems enables these systems to rapidly recover from crises and pursue new sustainable development pathways (Walker & Meyers, 2004).

In the context of the Makran coasts, resilience includes the capacities of local communities, marine and terrestrial ecosystems, and natural resource management institutions to cope with development pressures, climate change, and other stressors.

3. **Integration of Planetary Boundaries and Resilience in Natural Resource Management:** Combining the planetary boundaries framework with social-ecological resilience provides a powerful approach to sustainable resource management. While planetary boundaries define environmental safety thresholds, resilience focuses on the system's capacity to adapt and recover (Folke et al., 2016). This integration can assist regional policymakers in designing development plans not solely based on economic goals but also considering environmental capacities and local communities' adaptive abilities. For example, development planning in the Makran coasts should ensure the protection of sensitive ecosystems such as mangrove forests, coral habitats, and freshwater resources, while enhancing local communities' resilience against natural and anthropogenic hazards.
4. **Sustainable Coastal Development:** Sustainable development in coastal areas requires balancing economic exploitation, protection of sensitive ecosystems, and empowerment of local communities. This model relies on integrated assessments of environmental capacities, climate vulnerability, and multi-level participation in decision-making. Successful international experiences show that designing foresight scenarios, cumulative impact assessments, and participatory decision-making models are key tools for achieving this goal (Olivares-Aguilar et al., 2022).
5. **Application of the Theoretical Framework to the Makran Coasts Study:** Given the pressures from extensive development projects in the Makran coasts and the region's future

environmental challenges, utilizing the planetary boundaries framework alongside resilience concepts can facilitate comprehensive and precise analysis of development documents. This approach helps identify planning deficiencies, assess risks, and propose solutions grounded in the region's actual capacities.

In summary, these concepts improve understanding of human-nature interactions within the coastal development context and pave the way for proposing localized and sustainable development models.

The region's hot and arid climate, characterized by long, high-temperature summers and mild winters, creates unique living conditions for both ecosystems and local communities (Najafi & Alizadeh, 2023; World Bank (n.d.)). Ecologically, Makran hosts valuable habitats such as mangrove forests, coastal wetlands, and coral reefs that not only serve as habitats for diverse species of flora and fauna but also play crucial roles in maintaining the ecological balance of the area (Ghanavati et al., 2021; IMNA, 2024). These ecosystems are highly sensitive to environmental changes and require careful management and protection.

The local population primarily consists of indigenous Baluch communities and other ethnic minorities, whose culture and lifestyle are deeply intertwined with their surrounding environment (Pezeshkian announces comprehensive plan for Makran region development, 2024). Their livelihoods, often based on fisheries, limited agriculture, and traditional activities, heavily depend on natural resources, making them vulnerable to environmental and economic changes that can significantly affect their quality of life and social stability. Additionally, demographic changes and seasonal migrations, especially in urban and port areas, influence development patterns and environmental pressures in the region (IMNA, 2024).

Economically, despite facing challenges, the Makran region possesses substantial capacities that could contribute to sustainable development. The ports of Chabahar and Jask, as the main maritime gateways of Iran located within the region, play strategic roles in the transit of international goods and the development of logistical infrastructure (Makran Coasts; Trade Development Highway with Russia and India (n.d.)); Pezeshkian announces comprehensive plan for Makran region development, 2024). Furthermore, abundant oil and gas resources, the potential for renewable energies such as solar and wind power, and the promising marine tourism sector represent opportunities that could drive economic growth in the area (FMso, 2024). The fisheries and port service industries also constitute significant economic sectors, generating considerable employment and revenue (Ghanavati et al., 2021).

Materials and Methods

- **Study Area**

The Makran region, located in southeastern Iran along the coastlines of the Gulf of Oman (Figures 1 and 2), is one of the country's most extensive and significant coastal areas, encompassing parts of the provinces of Sistan and Baluchestan and Hormozgan. Due to its impressive scale and strategic geographic position, the region serves as a vital link between the open waters of the Indian Ocean and Iran's domestic ports (Atlantic Council, 2016). Its proximity to major international shipping routes, rich biodiversity, and unique geographic location have made Makran a key focal point for blue economy development (Press TV, 2025).

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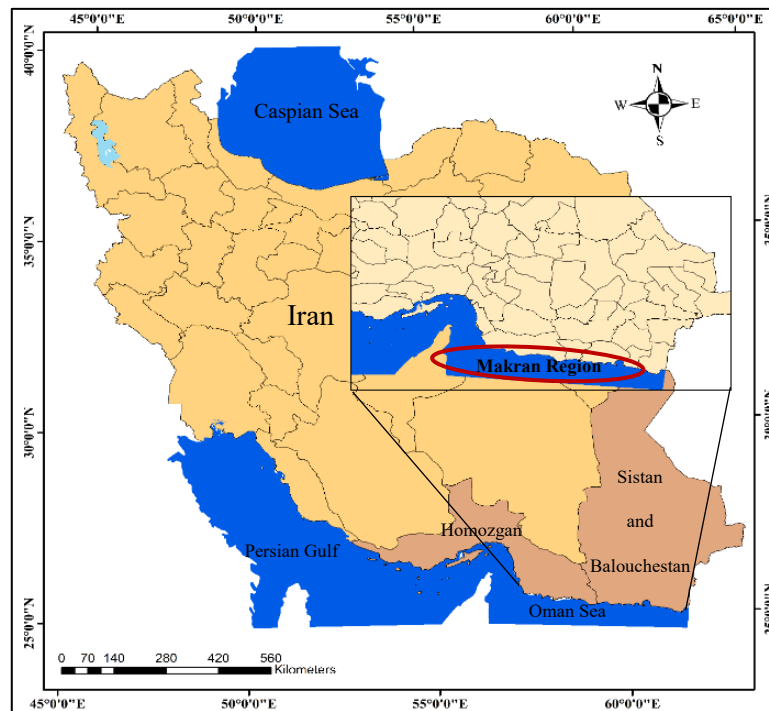


Figure. 1. The geographical location of the Makran coastal region in Iran

• Research Methods

This study adopts a descriptive-analytical approach based on the review of secondary sources, aiming to rethink development models of Iran's southern coasts—particularly the Makran region—through the lens of the Planetary Boundaries framework and enhancing the resilience of social-ecological systems. This approach enables an in-depth and systematic analysis of existing development patterns and is especially useful for identifying challenges and opportunities for sustainable development within ecological and social constraints (Creswell & Creswell, 2017).

The study is descriptive-analytical in nature and involves the comprehensive collection and analysis of secondary data to examine various dimensions of regional development. The main focus is on critical analysis of development plans, policies, and documents using content analysis methodology (Krippendorff, 2018).

Data were gathered from diverse sources including domestic and international scientific articles, official reports from organizations and institutions involved in regional development, statistical and environmental data, and national and provincial development planning documents.

Data analysis was conducted through content analysis, which included coding of the data, identification of patterns, and extraction of key concepts related to social-ecological resilience and planetary boundaries (Miles et al., 2014). A comparative analysis was also performed between

development plans and the theoretical framework of planetary boundaries to assess the alignment or deviation of development policies.

Limitations such as restricted access to certain confidential documents, lack of independent environmental assessments for some Makran projects, and scarcity of up-to-date environmental data for the region posed challenges to this research. These constraints were partially mitigated by relying on published documents and critical interpretive analysis. The reliance on secondary data and limited access to new field data are among the primary limitations. Additionally, the ecological and social complexities of the region may have led to partial coverage of some aspects; however, the use of multiple sources and comprehensive analysis aimed to reduce these limitations (Creswell & Creswell, 2017).



Figure. 2. Makran, a watershed in building sea-based economy (PressTV, 2024)

Results

An analysis of major development policy documents concerning the Makran coastal region—including the Strategic Plan for Makran Development, the Regional Coastal Development Document, spatial planning reports for Hormozgan and Sistan & Baluchestan provinces, and environmental assessments by the Iranian Parliament Research Center—reveals a dominant orientation toward rapid economic growth. This growth-centric approach prioritizes infrastructure expansion, industrialization, and investment attraction, particularly in energy, trade, and port development. While such objectives may be justified economically, they demonstrate a significant conceptual and operational disconnect from ecological constraints and local environmental capacities.

The Strategic Makran Plan, for instance, envisions the region as a future industrial and commercial hub, yet fails to incorporate robust environmental assessments or acknowledge the region's ecological limits. There is no substantive reference to the carrying capacity of natural resources or the long-term impacts of widespread land-use changes. This is especially problematic

when viewed through the lens of the Planetary Boundaries framework, which defines safe operating limits for key Earth system processes, such as climate regulation, biosphere integrity, and freshwater use. Notably, the Makran documents lack independent evaluations of environmental stress, particularly in relation to groundwater depletion, coastal vegetation loss, and industrial pollution.

Provincial spatial plans do mention some natural and cultural assets of the region, but mostly in broad terms, without establishing mechanisms for environmental monitoring or evaluating ecological trade-offs—such as between industrial expansion and wetland conservation. This oversight risks pushing the region beyond critical ecological thresholds, potentially triggering irreversible degradation.

Regarding socio-ecological resilience, the documents largely lack institutional frameworks for empowering local communities, fostering livelihood diversity, or integrating national strategies with indigenous knowledge and local governance. The prevailing planning model remains centralized and top-down, with minimal stakeholder participation. The concept of resilience—understood as the capacity to adapt, transform, and learn in the face of systemic shocks such as climate change or market volatility—is not operationalized in any meaningful way.

Although some Environmental Impact Assessments (EIAs) have been conducted, they are often limited in scope and fail to propose integrated or actionable mitigation strategies. References to threats such as coral reef degradation, bird migration disruptions, and mangrove deforestation remain descriptive, with no concrete conservation or restoration plans. This weakens both ecological resilience and the adaptive capacity of dependent local populations.

Overall, the findings indicate a pronounced gap between economic objectives and ecological realities. Development strategies that overlook the environmental fragility and socio-cultural specificity of the Makran region pose serious risks to long-term sustainability. The absence of a resilience-oriented, ecologically grounded development vision highlights the need for a paradigm shift in regional planning. Adopting frameworks like the Planetary Boundaries as a central tool for environmental evaluation and policy integration is essential for ensuring sustainable and adaptive governance in Makran.

Tables 1 and 2 present a summary of the alignment between Makran development documents and the nine planetary boundaries, as well as a comparative assessment of environmental and governance considerations across strategic plans.

- **Analysis of Development Documents of the Makran Region within the Framework of Planetary Boundaries**

- **Climate Change Boundary**

Climate change, as one of the greatest environmental challenges of the present era, exerts extensive impacts on coastal areas, particularly the Makran region. Rising temperatures, sea-level rise, and alterations in precipitation patterns are among the significant consequences of this phenomenon that can disrupt the balance of coastal ecosystems and lead to the loss of natural habitats (IPCC, 2022).

Review of Makran's development documents indicates that although climate change is generally acknowledged, there is a lack of concrete approaches and specific policies aimed at mitigating its effects. For instance, the documents scarcely address the importance of reducing greenhouse gas emissions, developing renewable energy, or improving energy efficiency. Moreover, adaptation programs, such as constructing coastal protective structures or optimizing water resource management, are sparse and fragmented. This demonstrates a neglect of one of the critical planetary boundaries, which could weaken the resilience of the region.

- **Land Use Change Boundary**

In recent years, the Makran coast has experienced increased development activities, including port construction, urban expansion, and tourism development. These have imposed significant pressures on natural ecosystems and particularly threaten mangrove forests, wetlands, and important habitats (Ghanavati et al., 2021).

Development documents frequently mention the necessity of preserving these ecosystems; however, they lack specific strategies and robust monitoring mechanisms to prevent unsustainable land use changes. For example, the absence of a precise system for environmental impact monitoring and assessment in many development projects has resulted in irreparable damage to nature. Furthermore, development without coordination among responsible agencies has caused conflicts between environmental and economic goals, which can reduce the resilience of the overall social-ecological system.

- **Biodiversity Boundary**

The Makran region is one of Iran's rich marine and coastal habitats with high species diversity as one of its features. Biodiversity conservation, as one of the planetary boundaries, is vital for maintaining ecosystem balances (Ghanavati et al., 2021; Steffen et al., 2015).

Despite the importance of this issue, development documents seldom refer to long-term and comprehensive conservation programs. The lack of up-to-date scientific data and continuous monitoring of biodiversity in the region is a serious obstacle to implementing protective policies.

Additionally, pressures from human activities such as overfishing, pollution, and land use changes represent serious threats to species that need to be more seriously addressed in development documents.

- **Chemical Pollution Boundary**

Pollution arising from industry, agriculture, urban activities, and maritime transportation in the Makran region poses a major threat to water quality and the health of marine ecosystems (Mehdinia et al., 2021).

In development documents, pollution is recognized as a challenge, but comprehensive and systematic solutions for its reduction and control are not adequately presented. The lack of continuous monitoring and insufficient legal frameworks for pollution management are weaknesses that must be addressed in revising development documents.

- **Freshwater Resources Boundary**

Sustainable management of freshwater resources in the Makran coasts is highly important, as these resources are limited but crucial for human life, agriculture, and ecosystems (Ali et al., 2019).

Existing documents mainly focus on water supply for economic development and pay less attention to optimal management, consumption reduction, and quality protection of water resources. This unilateral approach can lead to groundwater depletion, water salinization, and destruction of habitats dependent on freshwater.

Analysis of the development documents of the Makran region shows that despite some relative attention to certain environmental issues, a comprehensive and systematic approach based on the planetary boundaries framework is absent. This gap has resulted in human pressures on ecosystems and natural resources exceeding their tolerance, reducing the resilience of the social-ecological system. To achieve sustainable development and maintain resilience in Makran, it is necessary to revise development documents and adopt a scientific, multidimensional approach based on planetary boundary indicators. This measure can ensure economic development within a sustainable and balanced framework alongside environmental protection.

Table 1. Assessment of the Alignment of Makran Development Documents with the Nine Planetary Boundaries

Planetary Boundary	Observations from Makran Development Documents	Analysis and Key Notes
Climate Change	General references to climate change (notably in Document 1415) (Supreme Council for Spatial Planning, 2020), but lack of detailed plans for adaptation, emission reduction, renewable energy, or climate resilience. The Hormozgan University master plan emphasizes the need for resilience to natural hazards.	The approach is still impact-oriented rather than addressing root causes (Rockström et al., 2009; Steffen et al., 2015). There is a clear lack of scenario analysis and long-term planning.

Land Use Change	Strong emphasis on port development, industrial zones, new towns, and tourism (Ministry of Interior, Iran, 2016). No clear land use management program.	Development-oriented documents may increase pressure on natural resources (Steffen et al., 2015). Landscape ecology principles and regional environmental impact assessments are needed.
Biodiversity Loss	References to mangrove forests and species diversity (Supreme Council for Spatial Planning, 2020), but no concrete policies for conservation. Document 1415 only mentions “environmental value” without specifying protective actions or monitoring.	Biodiversity—a critical planetary boundary—is insufficiently addressed (Rockström et al., 2024; Steffen et al., 2015). There is a lack of biodiversity monitoring systems, local community-based conservation, and ecosystem restoration programs.
Biogeochemical Flows (N & P)	No direct references to agricultural pollution, nitrogen, or phosphorus. Agriculture is underdeveloped, but industrial expansion may affect nutrient cycles (Ministry of Interior, Iran, 2016).	There is an information gap (Rockström et al., 2024). With industrial and population growth, nutrient cycle alterations are likely.
Freshwater Use	Mentions of water scarcity and inter-basin transfers in some documents (Supreme Council for Spatial Planning, 2020). Hormozgan University plan discusses desalination and soil salinization. Document 1415 makes vague reference to sustainable water supply.	Lack of an integrated water resource management system (Steffen et al., 2015). No evaluation of environmental impacts of desalination or alternatives like rainwater harvesting and reuse.
Chemical Pollution	General mentions of water and soil pollution, but no specific pollutants named (Ministry of Interior, Iran, 2016). Focus on industrial and maritime development without strict environmental safeguards.	Absence of a comprehensive policy for industrial waste control, environmental risk management, and early warning systems (Rockström et al., 2009).
Ocean Acidification	No explicit reference to this issue in the documents.	Despite maritime expansion, this boundary is ignored (Rockström et al., 2024). Should be included in marine assessments.
Atmospheric Aerosol Loading	Document 1394 mentions dust from neighboring countries (Supreme Council for Spatial Planning, 2019), but regional aerosol loading is not considered a developmental factor.	With expansion of mining, transportation, and urban growth, air quality and human health impacts should be monitored (Steffen et al., 2015).

Table 2. Comparative Analysis of Major Development Documents for the Makran Coastal Region in Light of Environmental Considerations and Resilient Governance

Document Title	Main Objectives	Environmental Considerations	Alignment with Planetary Boundaries	Social and Resilience Aspects	Key Weaknesses
Strategic Development Plan for Makran Coasts (Supreme Council for Spatial Planning, 2020)	Economic growth, positioning Makran as an energy and trade hub	General references to the environment, no operational plans	Planetary boundaries entirely overlooked; lacks ecological threshold assessment	No local participation; top-down governance approach	Unsustainable development model, weak environmental annex

Territorial Spatial Plans of Hormozgan and Sistan-Baluchestan Provinces (Management and Planning Organization of Hormozgan Province, 2018; Management and Planning Organization of Sistan and Baluchestan Province, 2018).	Optimal use of local capacities, balanced regional development, infrastructure enhancement	Mentions of water and vegetation; limited impact assessment	No reference to critical planetary boundaries; lacks carrying capacity analysis	Vague references to regional equity; resilience not detailed	Generic language, lack of enforcement tools, no ecological monitoring
Reports from the Center for Strategic Studies of the Presidency (Center for Strategic Studies of the Presidency, 2023a; Center for Strategic Studies of the Presidency, 2023b).	National security, regional advancement, poverty reduction	Fragmented references to ecological vulnerability	Lacks analytical framework based on planetary boundaries	Social participation remains symbolic; lacks operational models	Weak integration with other documents; overly security-focused
Development Programs of Chabahar and Jask Free Zones (Chabahar Free Zone Organization, 2023a; Iranian Oil Terminals Company, 2023; Supreme Council of Free and Special Economic Zones, 2022).	Investment attraction, trade expansion, employment creation	No comprehensive environmental impact analysis	Ignores natural capacities and ecological limitations	Social resilience not addressed; potential cultural erosion	Fragmented growth drivers, absence of environmental balance

Table 2 reveals a systematic gap across all reviewed development documents between developmental objectives and ecological and social considerations. Almost none of these documents explicitly incorporate the "planetary boundaries" framework into policymaking. Furthermore, genuine participation of local communities and strategies for strengthening the resilience of social systems against environmental crises are largely absent. Table 2 reveals a systematic gap across all reviewed development documents between developmental objectives and ecological and social considerations. Almost none of these documents explicitly incorporate the "planetary boundaries" framework into policymaking. Furthermore, genuine participation of local

communities and strategies for strengthening the resilience of social systems against environmental crises are largely absent.

Discussion

The review and analysis of development documents related to the Makran coastal region indicate that although this area has been defined as a strategic hub in Iran's macroeconomic, security, and geopolitical policies, theoretical and operational frameworks of sustainable development and ecological constraints have not been seriously incorporated into the design and implementation of these plans. Documents such as the Strategic Development Plan for the Makran Coast, the spatial planning documents of Hormozgan and Sistan-Baluchestan provinces, development reports by the Center for Strategic Studies of the Presidency, and programs of the Chabahar and Jask Free Zones follow a fragmented, sectoral approach primarily focused on physical growth and infrastructure investment without offering a thorough assessment of the ecological and social carrying capacities of the region.

According to the planetary boundaries framework (Rockström et al., 2009; Steffen et al., 2015), any development must occur within the safe operating space of the biosphere, observing the critical thresholds of Earth's life-supporting processes. Analysis of the Makran development documents shows no environmental assessment has been conducted with respect to these boundaries, particularly in cases such as coastal land-use change, water resource exploitation, pollution, and biodiversity loss. Specifically, industrial development plans for Jask and Chabahar (Chabahar Free Zone Organization, 2023a; Chabahar Free Zone Organization, 2023b; Hormozgan Investment Services Center, 2023; Iranian Oil Terminals Company, 2023; Ministry of Roads and Urban Development, 2022; Supreme Council of Free and Special Economic Zones, 2022) only include superficial environmental appendices, lacking comprehensive assessments of cumulative impacts on the sensitive coastal ecosystems. By contrast, experiences from countries such as the Netherlands, Australia, and Sweden illustrate how ecological and ecosystem-based limitations are integrated into development decision-making and supported by systematic assessments (Pope et al., 2004; Runhaar et al., 2014).

From another angle, the social-ecological resilience framework (Biggs et al., 2015; Walker & Meyers, 2004) emphasizes that regional systems must possess the capacity to absorb, adapt, and transform in the face of ecological disruptions and social shocks. However, Makran development plans generally lack a resilience-based approach. Local communities are portrayed merely as passive recipients of economic benefits, not as active development agents. As a result, traditional livelihood patterns, the role of women, localization of technologies, and livelihood resilience in the face of climate change have been neglected. In contrast, FAO reports (FAO. (n.d.-a); FAO. (n.d.-b)) indicate that in countries such as Indonesia, Senegal, and the Philippines, enhancing community

resilience through environmental education, access to data, and participation in regional decision-making has significantly reduced vulnerability and promoted long-term sustainability.

Institutional shortcomings are also evident in the reviewed documents. In the absence of interdisciplinary and coordinating institutions, policymaking suffers from functional conflicts and structural redundancies. The lack of synergy among military, economic, environmental, and civil institutions has resulted in decisions being driven by security and political logic rather than ecological and livelihood needs. For instance, in Jask port development plans, there is no effective mechanism for public oversight, environmental data dissemination, or institutional accountability.

Conclusion

Despite the strategic importance and substantial environmental and economic potential of the Makran region, the analysis of development documents reveals a significant gap between current developmental goals and the requirements of sustainable social-ecological systems. Continuing with a development model that emphasizes rapid economic and infrastructural growth without clearly acknowledging ecological and social constraints can lead to irreversible degradation of natural resources, erosion of social capital, and increased regional vulnerability to climate and economic threats. Therefore, the coherent integration of emerging conceptual frameworks such as planetary boundaries and social-ecological resilience into decision-making and policymaking processes must become a foundational priority for future planning. This cross-sectoral and inclusive approach will enable the realization of a balanced, sustainable, and resilient form of development in the Makran region.

Recommendations for Sustainable and Resilient Development in Makran:

- Integrate planetary boundaries into regional planning and policymaking by designing and deploying continuous, high-precision monitoring systems to track ecosystem health and prevent the transgression of critical thresholds.
- Strengthen institutional frameworks and coordination mechanisms among environmental, economic, and social sectors to reduce conflicts and enhance decision-making efficiency.
- Foster active and meaningful participation of local communities, not only through environmental education but also by empowering them to play key roles in resource management and project evaluation.
- Revise environmental and social impact assessment methodologies to comprehensively address the cumulative and long-term effects of multiple projects.
- Develop transparent, data-driven systems that widely share environmental, economic, and social data, thereby improving public access, institutional accountability, and policy effectiveness.

- Support applied, interdisciplinary research especially in the interface of environmental science, social studies, and development planning to generate locally relevant knowledge and inform evidence-based policies.
- Design and implement flexible policies and adaptive management strategies that can respond effectively to climate variability and economic shocks, thereby reinforcing social-ecological resilience in the region.

Implementing such comprehensive and integrated approaches will not only ensure balanced and sustainable economic development in the Makran coast, but will also safeguard natural and social capital, and enhance regional resilience in the face of future crises paving the way for environmental justice and sustainable prosperity in this strategically vital region.

The overall analysis confirms that insufficient attention to ecological limits and social capacities poses a serious threat to the sustainability of the Makran coastal region. Integrating the planetary boundaries and social-ecological resilience frameworks, strengthening institutions, and fostering genuine community engagement are essential steps toward achieving sustainable and resilient development.

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CRedit authorship contribution statement

All authors contributed equally to the conceptualization of the article and writing of the original and subsequent drafts.

Conflict of interest

The authors declare no conflict of interest.

Ethical considerations

The authors avoided data fabrication, falsification, and plagiarism, and any form of misconduct.

Data availability statement

The data analyzed in this study are available from the corresponding documents and reports cited in the manuscript.

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