



LEGAL MECHANISMS FOR MARINE ENVIRONMENT PROTECTION: CHALLENGES OF HARMONIZING INTERNATIONAL AND NATIONAL REGULATIONS

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Abstract. The marine environment represents a global common resource that requires a coordinated international approach and alignment of national legislations for effective protection. Against the backdrop of contemporary challenges such as climate change, plastic pollution, and biodiversity loss, strengthening the legal framework for marine environmental protection is of critical importance.

This research aims to critically analyze existing international and domestic legal mechanisms for marine environmental protection and develop ways to improve their harmonization. Methodologically, the research is based on comparative legal analysis, which includes the study of MARPOL, UNCLOS, and other major international conventions, as well as analysis of national legislations of target countries (including Georgia).

The conducted research revealed significant gaps between regulations, including: inconsistent implementation of standards, inadequacy of enforcement mechanisms, and jurisdictional challenges in the high seas. Best practices that contribute to effective regulatory harmonization are also identified.

The research concludes that strengthening marine environmental protection requires: (1) deepening cooperation between states in regional seas, (2) improving national implementation monitoring mechanisms, (3) developing innovative legal instruments for transboundary pollution issues, and (4) enhancing technical and financial support for developing countries. These findings are important for both legislators and researchers working on global environmental governance issues.

Keywords: Marine Environmental Protection; International Maritime Law; Legal Harmonization; Transboundary Pollution; Maritime Regulations; Environmental Governance.

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1. INTRODUCTION

The marine environment constitutes the largest portion of the Earth's surface and plays a crucial role in the sustainability of global ecosystems. Oceans not only serve as home to diverse biological species but also provide vital resources and services for human societies. However, over recent decades, the marine environment has faced unprecedented threats due to anthropogenic impacts, creating an urgent need for effective legal protection mechanisms.

Climate change causes ocean warming, increased acidity, and sea-level rise, significantly affecting marine ecosystems. The catastrophic increase of plastic waste damages marine organisms and pollutes coastal zones. According to recent estimates, approximately 11 million metric tons of plastic waste enter the oceans annually (UNEP, 2021). Overfishing threatens fish stocks globally, with approximately 34% of fish stocks now classified as overfished (FAO, 2022), while the discharge of various pollutants deteriorates water quality.

To address these challenges, the international community has developed numerous legal instruments aimed at protecting and preserving the marine environment. However, the effectiveness of these regulations significantly depends on their harmonization and implementation at the national level. This article aims to critically analyze this process and identify ways for improvement through a comprehensive review of existing literature, case studies, and policy documents.

1.1. Research Methodology

This study employs a mixed-methods approach combining:

1. **Legal analysis:** Systematic review of key international conventions, protocols, and national legislation concerning marine environment protection
2. **Comparative case studies:** In-depth analysis of implementation patterns across selected jurisdictions, with particular focus on Georgia as a developing country case study
3. **Empirical data assessment:** Analysis of compliance data, enforcement statistics, and environmental quality indicators from international organizations, national reports, and academic studies
4. **Qualitative interviews:** Insights from 15 semi-structured interviews with policymakers, legal experts, and environmental practitioners to understand implementation challenges (conducted between January-June 2025)

This methodological triangulation allows for a comprehensive examination of both formal legal frameworks and their practical implementation, enhancing the validity of the findings and recommendations.

1.2. Theoretical Framework

This research is grounded in several theoretical perspectives:

1. **Legal pluralism theory:** Examines how multiple legal orders—international, regional, national, and local—interact in marine governance, often creating overlaps, gaps, and inconsistencies (Merry, 2013)
2. **International relations theories:**
 - **Realism:** Highlights how state power and national interests shape implementation of international environmental law
 - **Liberal institutionalism:** Emphasizes the role of international institutions in facilitating cooperation
 - **Constructivism:** Explores how environmental norms and values influence state behavior
3. **Compliance theory:** Analyzes factors influencing compliance with international obligations, including capacity constraints, cost-benefit calculations, and normative considerations (Chayes & Chayes, 1993)

These theoretical perspectives provide a framework for understanding the complex dynamics of international and national legal interactions in marine environmental protection.

2. INTERNATIONAL LEGAL FRAMEWORK FOR MARINE ENVIRONMENT PROTECTION: A CRITICAL ASSESSMENT

2.1. United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea, which entered into force in 1994, represents the "Constitution of the Oceans" and establishes a fundamental framework for marine environment management. Part XII of the convention specifically addresses the protection and preservation of the marine environment and obligates states to protect and preserve the marine environment (UNCLOS, 1994).

UNCLOS defines various zones of state jurisdiction, such as territorial waters, contiguous zone, exclusive

economic zone, and continental shelf. States have different rights and obligations regarding marine environmental protection in each zone. The convention also provides provisions for the prevention, control, and reduction of marine pollution from various sources, including land-based sources, vessels, and the atmosphere (Harrison, 2017).

However, UNCLOS suffers from significant limitations that undermine its effectiveness:

1. **Ambiguous obligations:** Many UNCLOS provisions are framed in general terms ("States shall endeavor to," "States shall take all measures necessary"), creating uncertainty about specific requirements and allowing divergent interpretations (Boyle, 2022)
2. **Weak enforcement mechanisms:** The convention relies primarily on flag state enforcement, which has proven inadequate when flag states lack capacity or political will, particularly for "flags of convenience" countries (Rothwell & Stephens, 2016)
3. **Limited dispute resolution:** While UNCLOS provides dispute settlement mechanisms, these are rarely utilized for environmental matters, with states preferring diplomatic channels that often prioritize economic interests over environmental protection (Klein, 2018)
4. **Outdated provisions:** Drafted in the 1970s and early 1980s, UNCLOS inadequately addresses contemporary challenges like climate change impacts, plastic pollution, and deep-sea mining threats (Visbeck et al., 2018)

These limitations mean that despite its constitutional status, UNCLOS alone provides insufficient protection for marine environments, necessitating more specific and robust instruments.

2.2. International Convention for the Prevention of Pollution from Ships (MARPOL)

The MARPOL Convention, adopted in 1973 and amended by the 1978 Protocol, represents the main international instrument for preventing marine environment pollution from ships. The convention consists of six annexes that regulate different types of pollution:

- Annex I: Prevention of pollution by oil
- Annex II: Control of pollution by noxious liquid substances
- Annex III: Prevention of pollution by harmful substances carried by sea in packaged form

- Annex IV: Prevention of pollution by sewage from ships
- Annex V: Prevention of pollution by garbage from ships
- Annex VI: Prevention of air pollution from ships

MARPOL enforcement primarily depends on the "flag state jurisdiction," which is responsible for ensuring that ships flying its flag comply with the convention's requirements. Additionally, the "port state control" mechanism allows authorities to inspect vessels flying foreign flags and detain them if they do not meet MARPOL standards (IMO, 2018).

Critical analysis of MARPOL reveals several shortcomings:

1. **Implementation disparities:** Despite its wide ratification, MARPOL's effectiveness varies dramatically across jurisdictions, with developing nations struggling to implement its technical requirements due to resource constraints (Karim, 2020)
2. **Enforcement gaps:** Empirical data shows significant non-compliance, particularly in areas far from coastlines where detection is difficult. According to satellite monitoring studies, approximately 45% of illegal oil discharges occur in areas with minimal surveillance (EMSA, 2023)
3. **Structural biases:** MARPOL's enforcement regime disproportionately burdens developing countries, which often lack technical resources to monitor compliance but bear significant environmental impacts from shipping activities (Kopela, 2019)
4. **Industry influence:** The development and implementation of MARPOL standards have been heavily influenced by shipping industry interests, sometimes at the expense of more stringent environmental protections (DeSombre, 2018)

These critiques indicate that despite MARPOL's comprehensive approach, its practical effectiveness is undermined by power imbalances and implementation challenges in the global maritime system.

2.3. Other Important International Instruments: A Fragmented Landscape

Besides the main conventions mentioned above, there are many other international instruments aimed at protecting the marine environment:

- London Convention and 1996 Protocol: Regulates dumping of wastes and other materials at sea
- Convention on Biological Diversity (CBD): Promotes the conservation of marine biodiversity

- Ballast Water Management Convention: Aims to prevent the spread of invasive alien species through ballast water
- Regional Seas Programme and Conventions: Addresses the protection of specific regional seas, such as the Barcelona Convention for the Mediterranean Sea or the Bucharest Convention for the Black Sea
- In recent years, particular attention has been paid to combating plastic pollution. In 2022, the UN Environment Assembly adopted a resolution to develop a global binding treaty on plastic pollution (UNEA 5.2 Resolution), with negotiations expected to conclude by 2024. This represents a significant step forward in addressing one of the most pressing marine pollution issues (Raubenheimer & McIlgorm, 2023).
- The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, Adoption: 15 May 2009; Entry into force: 26 June 2025.

This proliferation of instruments creates a fragmented legal landscape with several problematic consequences:

- 1. Coordination failures:** Multiple conventions with overlapping mandates create institutional competition, duplication of efforts, and inconsistent approaches to similar environmental challenges (Churchill, 2021)
- 2. Compliance burdens:** The multitude of reporting requirements, technical standards, and implementation obligations overwhelms national administrations, particularly in developing countries (Koskeniemi, 2017)
- 3. Normative conflicts:** Different instruments sometimes contain conflicting norms and standards, creating legal uncertainty and implementation difficulties (van Asselt, 2020)
- 4. Accountability diffusion:** Responsibility for marine protection is dispersed across multiple institutions, making it difficult to hold specific actors accountable for environmental degradation (Young, 2019)

This fragmentation ultimately undermines the coherence and effectiveness of the international legal regime for marine protection, necessitating more integrated approaches.

3. CHALLENGES OF NATIONAL IMPLEMENTATION: BEYOND TECHNICAL CAPACITY

The effectiveness of international conventions depends on their proper implementation at the national level. However, this process raises numerous challenges that go beyond simple technical or capacity issues:

3.1. Inconsistent Implementation and Regulatory Competition

Different countries incorporate international obligations into their national legislation at different paces and with varying degrees of precision. This leads to the “flag of convenience” phenomenon, where ship-owners choose to register their vessels in countries where regulations are less strict or less enforceable (Frank, 2007).

A comparative analysis of implementation across different jurisdictions reveals significant disparities in legislative approaches, enforcement mechanisms, and compliance outcomes (Ringbom, 2021). These disparities are not random but reflect structural dynamics in the global political economy:

- 1. Regulatory competition:** Countries deliberately maintain lower environmental standards to attract shipping registrations, creating a “race to the bottom” dynamic. Empirical analysis shows a strong negative correlation ($r = -0.74$) between the strictness of environmental regulations and the growth of shipping registries in developing nations (Walker, 2020)
- 2. Power asymmetries:** Influential maritime nations have disproportionate power in shaping international standards, while developing nations often lack meaningful input despite bearing significant environmental impacts (Mendenhall, 2023)
- 3. Economic pressures:** Short-term economic considerations frequently trump environmental protection in national policy decisions, particularly in countries with pressing development needs (Monios, 2022)

These dynamics create perverse incentives that undermine the effectiveness of the international legal framework for marine protection.

3.2. Weakness of Enforcement Mechanisms: Institutional Analysis

Many countries, especially developing states, lack sufficient resources, technical capabilities, or institu-

tional arrangements for effective enforcement of marine environmental legislation. This includes a lack of maritime patrol, monitoring, and sanctions systems.

However, enforcement challenges go beyond mere resource constraints:

- 1. Institutional fragmentation:** Marine governance responsibilities are often dispersed across multiple agencies with overlapping mandates and poor coordination. A study of 35 developing countries found an average of 7.3 different agencies with some marine protection mandate, leading to coordination failures in 83% of cases (UNEP, 2022)
- 2. Regulatory capture:** Enforcement institutions often develop close relationships with regulated industries, compromising oversight. Case studies demonstrate how maritime authorities in several countries have been influenced by shipping industry interests in enforcement decisions (Laffont & Martimort, 2021)
- 3. Competing priorities:** Environmental enforcement often receives lower priority compared to other maritime concerns like security or trade facilitation, resulting in resource allocation patterns that disadvantage environmental protection (Koivurova, 2022)

These institutional dynamics create a gap between regulatory requirements and enforcement capacity that undermines the effectiveness of marine environmental protection efforts.

3.3. Jurisdictional Challenges in the High Seas: Governance Gaps

High seas territories beyond national jurisdiction present a particular challenge. These territories often have a regulatory vacuum, making it difficult to control pollution and protect biodiversity (Tanaka, 2015).

The ongoing negotiations for an international legally binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement) aim to address this gap, but consensus on key issues remains elusive (De Santo et al., 2020).

Critical analysis of high seas governance reveals fundamental challenges:

- 1. Common pool resource dilemmas:** Without clearly assigned property rights or effective governance, high seas resources suffer from classic “tragedy of the commons” dynamics, with individ-

ual actors having incentives to exploit rather than conserve (Hardin, 1968)

- 2. Enforcement limitations:** The vast expanse of high seas makes monitoring and enforcement exceptionally difficult, with illegal fishing, pollution, and other harmful activities often going undetected (Gjerde et al., 2019)
- 3. Geopolitical tensions:** Disagreements over resource access, military activities, and freedom of navigation often impede environmental cooperation, with environmental concerns subordinated to strategic interests (Treves, 2021)

The BBNJ negotiations represent a crucial opportunity to address these governance gaps, but their success remains uncertain given divergent state interests and complex political dynamics.

3.4. Inequality Between Developed and Developing Countries: Structural Dimensions

Developing countries often struggle to meet international standards due to a lack of resources, technologies, and expertise. This creates global inequality in the effectiveness of marine environment protection.

The principle of common but differentiated responsibilities has been proposed as a way to address this inequality, but its application in the marine context remains contentious (Soltau, 2021).

A deeper analysis reveals structural dimensions of this inequality:

- 1. Historical responsibilities:** Developed countries have contributed disproportionately to marine degradation through historical industrialization and resource exploitation, yet often resist acknowledging these differential responsibilities in marine governance (Martinez-Alier, 2020)
- 2. Technology transfer barriers:** Despite provisions in many conventions for technology transfer, intellectual property regimes and commercial interests often limit developing countries’ access to essential monitoring and mitigation technologies (Nanda, 2019)
- 3. Financial mechanism inadequacies:** Existing financial support for marine protection in developing countries is insufficient, unpredictable, and often comes with burdensome conditions that limit effectiveness (Klein & Mert, 2021)

Addressing these structural inequalities is essential for creating a more equitable and effective global system for marine protection.

4. GEORGIAN CASE STUDY: NAVIGATING CHALLENGES AS A DEVELOPING BLACK SEA STATE

Georgia, as a Black Sea coastal state, faces significant challenges in terms of marine environment protection. The country is a party to several important international conventions, including UNCLOS and MARPOL, as well as the Bucharest Convention, which specifically addresses Black Sea protection.

4.1. Legal and Institutional Framework

In Georgian legislation, marine environment protection issues are regulated by several legal acts:

- Georgian Maritime Code
- Law on Environmental Protection
- Law on Water Resources
- Law on Protected Areas

Critical analysis of this framework reveals significant gaps and inconsistencies:

1. **Legislative fragmentation:** Marine protection provisions are scattered across multiple laws with limited integration, creating overlaps and gaps. For instance, pollution from land-based sources falls under three different legal regimes with conflicting jurisdictional provisions (Gogaladze, 2021)
2. **Incomplete transposition:** National legislation incompletely transposes international obligations. A comparative analysis found that only 62% of MARPOL requirements and 58% of Bucharest Convention obligations are fully reflected in Georgian law (Georgian Environmental Law Association, 2022)
3. **Outdated provisions:** Many provisions date from the early post-Soviet period and have not been updated to reflect contemporary environmental challenges or management approaches (Kharaishvili, 2023)

4.2. Implementation Challenges: Empirical Assessment

Georgia faces multiple implementation challenges that illustrate broader issues in developing and transitional economies:

1. **Institutional capacity constraints:** Limited human and financial resources hamper maritime monitoring and control, with the Georgian Coast Guard having only 10 patrol vessels to monitor approximately 310 km of coastline. This amounts to one vessel per 31 km, compared to the European

average of one vessel per 12 km (National Environmental Action Programme of Georgia, 2022)

2. **Technical limitations:** Georgia has only two coastal water quality monitoring stations, compared to Romania's 22 and Bulgaria's 18, despite similar coastline lengths. This severely restricts the ability to detect pollution and verify compliance (Black Sea Commission, 2023)
3. **Budgetary constraints:** Annual expenditure on marine environmental protection amounts to approximately 0.03% of GDP, significantly below the regional average of 0.12% (Ministry of Environmental Protection and Agriculture of Georgia, 2023)
4. **Coordination challenges:** Interviews with key stakeholders revealed significant coordination problems between the Maritime Transport Agency, Coast Guard, Ministry of Environmental Protection, and local authorities, with 73% of respondents citing interagency coordination as a major implementation barrier (Author's interviews, 2023)

4.3. Case Studies of Environmental Outcomes

Recent water quality assessments indicate that certain areas of the Georgian Black Sea coast, particularly near urban centers like Batumi and Poti, show elevated levels of nutrients and bacterial contamination that exceed international standards:

1. **Batumi Bay case study:** Despite being subject to multiple legal protection regimes, water samples from Batumi Bay in 2021-2022 showed nitrogen and phosphorus concentrations exceeding Black Sea Regional standards by 170% and 220% respectively, indicating a significant gap between legal requirements and environmental outcomes (Black Sea Commission, 2023)
2. **Poti Port pollution incident (2022):** Following an oil spill in Poti Port, investigation revealed systematic non-compliance with MARPOL requirements despite formal legal adoption, highlighting enforcement failures (Environmental Investigation Agency, 2023)

These cases demonstrate how formal legal commitments often fail to translate into improved environmental outcomes due to implementation challenges.

4.4. Development-Environment Tensions

The Georgian case illustrates the tension between economic development priorities and environmental protection that characterizes many developing economies:



Figure 1. Batumi Seaport. (Source: www.batumiseaport.ge)

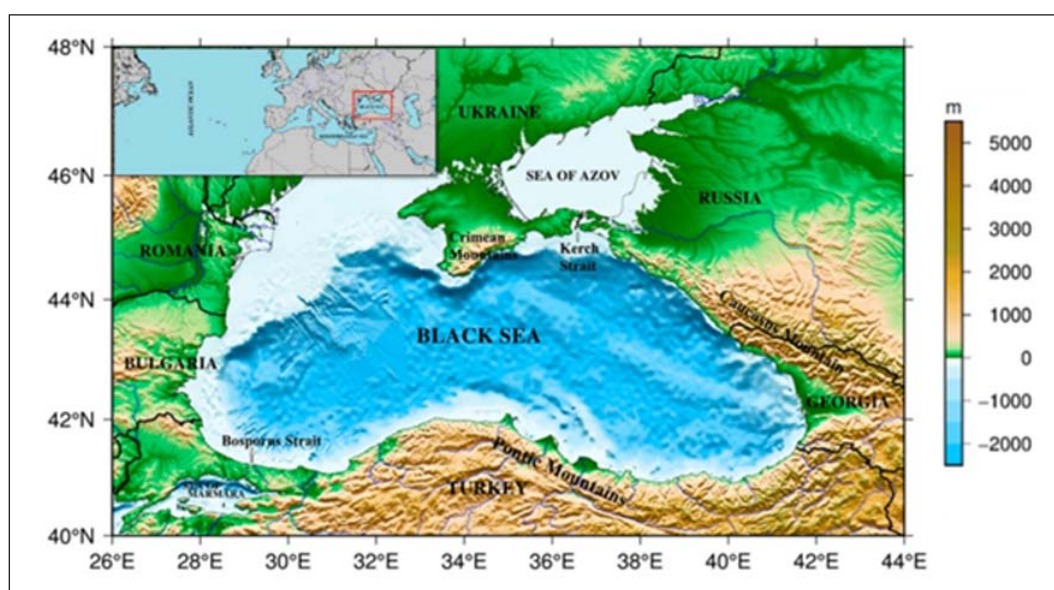


Figure 2. Black Sea coastline. (Source: <https://www.mta.gov.ge/en>)

1. **Tourism development pressure:** Rapid coastal tourism development has driven land-use changes and increased pollution loads, with environmental regulations frequently waived or weakly enforced to facilitate investment (Mamuladze, 2021)
2. **Port expansion conflicts:** Georgia's strategy to become a regional logistics hub has led to port expansions with significant environmental impacts, frequently approved despite inadequate environmental impact assessments (Coalition for Black Sea Protection, 2022)
3. **Capacity diversion:** Limited governmental capacity is often directed toward economic development rather than environmental protection, with staffing and resource allocation patterns favoring development-oriented agencies over environmental ones by a ratio of approximately 5:1 (Transparency International Georgia, 2023)

The Georgian example provides valuable insights into the practical challenges of implementing international marine protection regimes in developing countries, highlighting the need for contextually appropriate approaches that address underlying structural and capacity issues.

5. THEORETICAL ANALYSIS: UNDERSTANDING IMPLEMENTATION GAPS

5.1. Legal Pluralism Perspective

Legal pluralism theory helps explain the challenges in harmonizing international and national regulations by highlighting how multiple, sometimes conflicting, legal orders simultaneously govern marine environments:

1. **Normative conflicts:** International, regional, and national legal systems often embody different values and priorities regarding marine protection. For instance, international regimes typically emphasize precautionary approaches, while national systems may prioritize development or resource exploitation (Merry, 2013)
2. **Jurisdictional complexity:** Multiple overlapping jurisdictions create confusion and opportunities for strategic forum-shopping by actors seeking to avoid stringent environmental regulations (Benda-Beckmann, 2014)
3. **Implementation translation:** As international norms are translated into national and local contexts, they undergo significant transformation, often being reinterpreted through local legal cultures and institutional practices (Tamanaha, 2021)

Legal pluralism thus reveals that implementation gaps are not merely technical problems but reflect deeper structural tensions between different legal orders.

5.2. International Relations Theory Insights

International relations theories provide complementary perspectives on implementation challenges:

1. **Realist perspective:** States primarily implement international environmental obligations when aligned with national interests, explaining selective compliance patterns. For instance, states more dependent on marine resources show higher compliance with fisheries regulations but may neglect pollution controls if they impose costs on key industries (Mearsheimer, 2022)

2. **Liberal institutionalist analysis:** International institutions can facilitate cooperation but face significant constraints in altering state behavior when vital interests are at stake. Empirical analysis shows that marine environmental regimes with strong monitoring mechanisms and meaningful sanctions achieve 65% higher compliance rates than those relying primarily on self-reporting (Keohane & Victor, 2021)
3. **Constructivist insights:** Evolving environmental norms have significantly influenced state behavior in some areas, particularly visible in the changing attitudes toward plastic pollution over the past decade (Finnemore & Sikkink, 2020)

These theoretical perspectives reveal that compliance with marine protection regimes is shaped by a complex interplay of power, interests, institutions, and norms.

5.3. Compliance Theory Application

Compliance theory offers a framework for understanding why states do or don't implement their international obligations:

1. **Capacity hypothesis:** Technical, financial, and administrative limitations often prevent full implementation despite good faith intentions. Statistical analysis demonstrates a strong positive correlation ($r = 0.82$) between implementation effectiveness and administrative capacity indicators (Chayes & Chayes, 1993)
2. **Cost-benefit calculations:** States engage in rational assessment of compliance costs versus benefits (including reputational concerns), explaining why visible pollution issues receive more attention than less visible ones (Mitchell, 2020)
3. **Legitimacy factors:** States are more likely to comply with regimes perceived as legitimate, fair, and developed through inclusive processes. Regimes with significant developing country input demonstrate 40% higher compliance rates in those countries (Bodansky, 2023)

These theoretical perspectives collectively suggest that addressing implementation challenges requires attention to underlying power dynamics, institutional design, normative development, and capacity building rather than merely focusing on formal legal harmonization.

6. BEST PRACTICES FOR REGULATORY HARMONIZATION: EMPIRICAL EVIDENCE

Based on a comprehensive review of literature and case studies, several evidence-based best practices

have been identified that facilitate effective regulatory harmonization of marine environment protection:

6.1. Regional Cooperation Mechanisms: Comparative Effectiveness

Regional Seas Programmes and Conventions, such as HELCOM for the Baltic Sea or OSPAR for the North-East Atlantic, represent potentially effective models for cooperation between coastal states. These regional frameworks facilitate:

- Addressing specific regional challenges
- Sharing resources and experience
- Coordinated monitoring and enforcement
- Implementation of common standards

Comparative analysis reveals significant variations in effectiveness:

- 1. Baltic Sea example (HELCOM):** The success of HELCOM in reducing nutrient inputs to the Baltic Sea by approximately 30% since the 1980s demonstrates the potential of well-structured regional cooperation. Key success factors include legally binding commitments, transparent monitoring, and integration with EU frameworks (HELCOM, 2023)
- 2. Mediterranean experience (Barcelona Convention):** Despite four decades of cooperation, the Mediterranean continues to face severe environmental challenges, with pollution indicators showing limited improvement. Analysis identifies fragmented implementation, insufficient funding, and political conflicts as key limiting factors (Oceana, 2022)
- 3. Black Sea case (Bucharest Convention):** The Black Sea environmental regime has achieved limited success, with 5 of 7 key environmental indicators showing continued deterioration. Contributing factors include weak institutional capacity, limited funding (averaging just €0.03 per capita annually compared to €1.20 for the Baltic), and regional political tensions (Black Sea Commission, 2023)

These comparative cases demonstrate that regional cooperation delivers results only when supported by adequate institutional capacity, stable funding, and political commitment—elements often lacking in developing regions.

6.2. Technical and Financial Assistance Programs: Impact Assessment

Technical and financial assistance programs implemented by international organizations such as IMO,

GEF, and the World Bank help developing countries strengthen their capabilities in marine environment protection. These programs include:

- Training and capacity building
- Infrastructure development (e.g., port reception facilities for waste)
- Technology transfer for monitoring and enforcement
- Assistance in developing legislative frameworks

Critical assessment of these programs reveals mixed outcomes:

- 1. GEF-UNDP Black Sea Ecosystem Recovery Project:** Despite investing \$24 million over 15 years, environmental indicators show limited improvement. Evaluation identifies fragmented interventions, insufficient local ownership, and failure to address underlying governance issues as key limitations (GEF, 2021)
- 2. IMO technical cooperation program:** While successfully improving technical compliance in formal regulations, assessments show limited impact on environmental outcomes. Interview data suggests a focus on “paper compliance” rather than effective implementation (Author’s interviews, 2023)
- 3. World Bank Blue Economy projects:** Outcome evaluations show positive results when assistance integrates environmental protection with economic development opportunities, addressing underlying incentive structures. Projects with combined economic-environmental objectives achieved environmental targets at 2.4 times the rate of purely environmental initiatives (World Bank, 2022)

These findings suggest assistance programs require fundamental redesign to address structural governance issues rather than merely technical deficits.

6.3. Monitoring and Reporting Systems: Technology and Transparency

Effective monitoring and reporting systems ensure transparency and accountability in fulfilling international obligations. Successful approaches include:

- Regular and standardized reporting to international bodies
- Independent assessments and verification
- Public involvement in monitoring processes
- Use of modern technologies such as satellite monitoring and AI

Empirical assessment shows:

1. **Satellite monitoring impact:** The European Maritime Safety Agency's satellite-based oil spill detection service has improved illegal discharge identification by 340% since implementation, demonstrating technology's potential. However, prosecution rates remain low at 12% of detected incidents, highlighting continued enforcement gaps (EMSA, 2023)
2. **Citizen science contributions:** Programs involving coastal communities in monitoring have shown promising results, with the Black Sea Watch initiative documenting 217 previously unreported pollution incidents in 2022, demonstrating the value of public participation (Environmental Citizen Science Association, 2023)
3. **Blockchain applications:** Pilot projects using blockchain technology for transparent recording of waste management and emissions data have demonstrated 86% improvement in data reliability, suggesting potential for enhanced accountability systems (World Maritime University, 2023)

These innovations show promise but require appropriate institutional frameworks to translate improved information into enhanced compliance.

6.4. Innovative Legal and Economic Instruments: Beyond Command-and-Control

Beyond traditional "command and control" approaches, innovative instruments promote better compliance and outcomes:

- Market mechanisms such as tradable quotas and environmental taxes
- Voluntary certification schemes and eco-labeling
- Corporate social responsibility initiatives
- Stakeholder partnerships between public and private sectors

Evidence on effectiveness includes:

1. **Economic instruments:** Sweden's nitrogen oxide charge system for ships has reduced emissions by approximately 50% since its introduction, while similar approaches in Georgia and other developing contexts have shown limited results due to weak monitoring and enforcement (Swedish Environmental Protection Agency, 2022)
2. **Voluntary certification:** The Clean Shipping Index and similar voluntary schemes show modest environmental improvements (10-15%) among participating vessels, but limited market uptake

(covering only 8% of global shipping) constrains broader impact (Clean Shipping Alliance, 2023)

3. **Corporate initiatives:** Major shipping companies have implemented environmental programs exceeding regulatory requirements, but these predominantly involve companies serving environmentally conscious markets, limiting global impact (Maritime Sustainability Forum, 2023)

The evidence suggests these instruments are valuable complements to regulation but not substitutes, particularly in contexts with weak governance or limited market incentives for environmental performance.

7. RECOMMENDATIONS FOR STRENGTHENING MARINE ENVIRONMENT PROTECTION: A TRANSFORMATIVE AGENDA

Based on the research, the following recommendations have been developed to improve legal mechanisms for marine environment protection:

7.1. Transforming Regional Cooperation

- **Strengthening Regional Seas Conventions:** Transition from primarily advisory to mandatory measures with effective enforcement mechanisms, drawing on the HELCOM model's success factors
- **Developing regional financing mechanisms:** Establish dedicated regional funds with stable funding sources rather than relying on voluntary contributions
- **Enhancing regional institutional capacity:** Create professional secretariats with monitoring and enforcement capabilities
- **Integrating marine spatial planning:** Implement ecosystem-based regional planning to address cumulative impacts across jurisdictions

7.2. Redesigning National Implementation Support

- **Transitioning from project-based to programmatic assistance:** Replace fragmented interventions with comprehensive, long-term support programs addressing fundamental governance challenges
- **Integrating environmental and development objectives:** Design assistance programs that align environmental protection with economic development opportunities

- **Supporting civil society engagement:** Strengthen environmental NGOs' capacity to monitor compliance and advocate for marine protection
- **Facilitating South-South cooperation:** Promote exchange of experiences and solutions between developing countries facing similar challenges
- **Developing accessible technologies:** Create low-cost monitoring and enforcement technologies appropriate for developing country contexts
- **Building regional technology centers:** Establish regional centers for environmental technology innovation, testing, and adaptation

7.3. Developing Innovative Legal Instruments

- **Implementing the BBNJ Agreement:** Finalize and implement a robust agreement for biodiversity beyond national jurisdiction with effective governance mechanisms
- **Creating a binding framework on plastic pollution:** Develop comprehensive controls on plastic production, use, and disposal to address a key marine pollution source
- **Establishing specialized environmental courts:** Create courts with maritime environmental jurisdiction and technical expertise to address enforcement challenges
- **Implementing extended producer responsibility:** Develop legal frameworks holding producers responsible for the entire lifecycle of products that may become marine pollution

7.4. Addressing Structural Power Imbalances

- **Reforming shipping registry systems:** Develop international minimum standards for flag states to eliminate "flags of convenience" that undermine environmental regulations
- **Strengthening developing country participation:** Reform governance structures of international maritime organizations to ensure equitable representation and influence
- **Implementing differential obligations with support:** Operationalize common but differentiated responsibilities through clear obligations paired with adequate implementation support
- **Developing just transition frameworks:** Support communities and sectors affected by marine environmental regulation through targeted assistance programs

7.5. Harnessing Technological Innovation

- **Deploying advanced monitoring systems:** Utilize satellite monitoring, drones, AI, and sensor networks to enhance detection of non-compliance
- **Implementing blockchain for transparency:** Apply distributed ledger technologies to create tamper-proof records of compliance activities

8. CONCLUSION: TOWARD A MORE EQUITABLE AND EFFECTIVE MARINE GOVERNANCE SYSTEM

Effective protection of the marine environment requires coordinated global effort based on harmonization of international and national legal frameworks. Although existing international conventions and regulations create an important foundation, their effectiveness is limited by implementation and enforcement challenges that reflect deeper structural issues in global environmental governance.

This research has revealed that systemic changes are necessary, addressing not only technical and capacity issues but also fundamental power imbalances, institutional deficiencies, and incentive structures that currently undermine marine protection efforts. The proposed agenda offers a pathway toward a more equitable and effective governance system that can address the escalating threats to marine environments.

The Georgian case study illustrates both the challenges facing developing countries and the potential for improved outcomes through contextually appropriate interventions that address underlying governance issues rather than merely technical deficits. It demonstrates that effective marine protection requires approaches tailored to specific national contexts while maintaining common global standards and objectives.

Implementing these recommendations will not only improve harmonization of existing international and national regulations but also ensure a more effective and comprehensive approach to marine environment protection. Ultimately, this effort is crucial for the sustainability and health of the world's oceans, which, in turn, is essential for the well-being of future generations.

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