Legal Innovations for Desert Governance in Saudi Arabia: From Formal UNCCD Compliance to Enforceable Ecological Governance

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Abstract. Desertification has been among the gravest governance issues to the environment especially in the Rub al Khali desert and the neighboring desert lands in Saudi Arabia. The question in this research is to what extent Saudi Arabia has already implemented its duties as laid down in the United Nations Convention to Combat Desertification (UNCCD) into concrete domestic rules governing deserts, and what laws would need to be changed to shift the normative correspondence to actual ecological performance. The research is methodologically oriented to the doctrinal and law-and-policy approach, which involves the analysis of the treaty, the discussion of the Saudi environmental laws and executive regulations, and a specific comparative commentary on the anti-desertification system in China. According to the research, Saudi Arabia has made significant formal alignment with the UNCCD by implementing the Vision 2030, the Saudi Green Initiative, expansion of the protected areas, ecological restoration goals, and the institutional nature of the Ministry of Environment, Water and Agriculture (MEWA) and the National Center of Vegetation Cover Development and Desertification Combat (NCVC). But formal conformity is but a partway measure of efficiency. The existing framework still has three structural vulnerabilities namely lack of integration of implementation among the agencies, lack of local implementation and monitoring and inadequate regional legal coordination of transboundary drylands. A comparison to China shows that over time monitoring, and adaptability of implementation, and greater involvement of subnational is valuable, and also shows the weaknesses of imported hyper-arid locations as well. The research then ends with a legal reform agenda to include the statutory monitoring responsibilities, delegation of enforcement responsibilities, a GCC desertification protocol, land-restoration reporting responsibilities, and controlled siting of renewable-energy in non-arable desert areas. Governance of Saudi desert can thus be perceived not as a failed implementation experience, but as an unfulfilled journey of the treaty adherence to the rule-of-law ecological governance.

Keywords: *Desertification; Saudi Arabia; UNCCD; Rub' al Khali; Vision 2030; Environmental Law; Land Degradation Neutrality; GCC cooperation*

ملخص

يُعدّ التصحر من أخطر قضايا الحوكمة البيئية، لا سيما في صحراء الربع الخالي والأراضي الصحراوية المجاورة لها في المملكة العربية السعودية. يتناول هذا المقال مدى التزام المملكة العربية السعودية بواجباتها المنصوص عليها في اتفاقية الأمم المتحدة لمكافحة التصحر (UNCCD) وتحويلها إلى قوانين محلية ملموسة تُنظّم شؤون الصحاري، وما هي القوانين التي يجب تعديلها لتحقيق التوافق بين المعايير والواقع البيئي. يتبنى المقال منهجياً النهج العقائدي والقانوني-السياسي، والذي يشمل تحليل المعاهدة، ومناقشة القوانين البيئية السعودية واللوائح التنفيذية، بالإضافة إلى دراسة مقارنة لنظام مكافحة التصحر في الصين. ووفقاً للمقال، فقد حققت المملكة العربية السعودية توافقاً رسمياً هاماً مع اتفاقية الأمم المتحدة لمكافحة التصحر من خلال تنفيذ رؤية 2030، والمبادرة الخضراء السعودية، وتوسيع المناطق المحمية، وأهداف إعادة التأهيل البيئي، والطابع المؤسسي لوزارة البيئة والمياه والزراعة والمركز الوطني لتنمية الغطاء النباتي ومكافحة التصحر. إلا أن هذا التوافق الرسمي لا يُمثّل سوى جزء من الكفاءة. لا يزال الإطار الحالي يعاني من ثلاث نقاط ضعف هيكلية، وهي: غياب التكامل في التنفيذ بين الوكالات، ونقص التنفيذ والرصد على المستوى المحلي، وعدم كفاية التنسيق القانوني الإقليمي للأراضي الجافة العابرة للحدود. تُظهر المقارنة مع الصين أن الرصد بمرور الوقت، وقابلية التنفيذ للتكيف، وزيادة مشاركة الجهات دون الوطنية، أمورٌ قيّمة، كما تُظهر أيضًا نقاط ضعف المواقع شديدة الجفاف المستوردة. وتختتم المقالة ببرنامج إصلاح قانوني يشمل مسؤوليات الرصد القانونية، وتفويض مسؤوليات الإنفاذ، وبروتوكول مجلس التعاون الخليجي لمكافحة التصحر، ومسؤوليات الإبلاغ عن استصلاح الأراضي، والتحديد الدقيق لمواقع الطاقة المتجددة في المناطق الصحراوية غير الصالحة للزراعة. وبذلك، يمكن النظر إلى إدارة الصحراء السعودية لا على أنها تجربة تنفيذ فاشلة، بل على أنها مسيرة لم تكتمل بعد في سبيل الالتزام بالمعاهدة والحوكمة البيئية القائمة على سيادة القانون.

الكلمات المفتاحية: التصحر؛ المملكة العربية السعودية؛ اتفاقية الأمم المتحدة لمكافحة التصحر؛ الربع الخالي؛ رؤية 2030؛ القانون البيئي؛ حياد تدهور الأراضي؛ التعاون الخليجي

1. Introduction

Desertification is not just a biophysical phenomenon in Saudi Arabia, but is a governance issue, a legal design problem, and progressively a development-planning issue. The magnitude of arid in the Kingdom and the strains created by overgrazing, groundwater erosion, urbanization, industrialization, and the weakness of its ecosystems puts land degradation at the core of modern environmental policy. This dilemma is particularly evident in and around the Rub al Khali which due to its ecological susceptibility, territorial magnitude and transboundary nature become one of the most legally prominent desert landscapes in the Arabian Peninsula. Land degradation is not a new problem that has been addressed by international law through the concerted efforts of states. The normative expectation that states must follow preventative, engaging and sustainable dryland management practices was established by the Stockholm Declaration, Rio instruments and subsequently the UNCCD. The UNCCD is now the sole binding agreement that is dedicated to desertification, land degradation, and drought in drylands. However, its structure is institutionally unique: it does not involve coercive implementation as much as national action programmes, reporting procedures, cooperation, scientific exchange and a recurring compliance review. That is why the success of the UNCCD in any country-level context is highly determined by the way, in which the treaty obligations are converted into national legal power, institutional implementation, and performance metrics. The case of Saudi Arabia is of special significance. At the one level, the Kingdom has emerged as a more prominent participant in the desertification governance on the international front. Its hosting of COP16, its own environmental commitments in its Vision 2030 and the Saudi Green Initiative, as well as its investment in restoration, protected areas and biodiversity recovery all indicate that its policy is aligned with the goals of UNCCD to a significant extent. At another level, though, there are still significant questions regarding the thoroughness of the legal implementation. Formal commitment is not always part of creating binding commitments at the national level, nor does the investment itself guarantee sustainable ecological results. The main question is thus not whether Saudi Arabia is pursuing anti-desertification objectives overall, but whether it has managed to pursue a sufficiently-integrated legal framework that can achieve long-term land-restoration results that are in line with the UNCCD (Abdelraouf, & Nagasawa, 2023). This paper discusses this question by posing the following: how far has Saudi Arabia transposed its UNCCD commitments into enforceable domestic desert management, specifically with regard to the Rub al Khali and the adjacent drylands? This is followed by two subsidiary questions. To start with, what are the major legal and institutional strengths and weaknesses of the current regime? Secondly, what are the reforms that will transform Saudi desert governance to be more efficient, quantifiable and coordinated regionally? The research has three assertions. First, Saudi Arabia was able to make significant normative convergence with the UNCCD by way of legislation, executive regulations, ecological institutions, restoration programmes and strategic environmental planning within the framework of Vision 2030. Secondly, such alignment is still partial as there is still a lack of implementation due to over-centralized authority, disproportionate enforcement capability, limited statutory monitoring responsibilities, and poor integration of desert governance with land-use planning and cross-border coordination. Third, enhancing the judicial practicality of the anti-desertification system in Saudi Arabia could be done by a more expressive rule-of-law regime consisting of surveillance, delegated enforcement, protected-area regulations, renewable-energy land-use regulations, and a Gulf-level legal system of collective dryland management.

Research Question

The main research question of this study is:

- To what extent has Saudi Arabia translated its obligations under the United Nations Convention to Combat Desertification (UNCCD) into enforceable domestic legal frameworks governing desert ecosystems, particularly in the Rub al Khali and surrounding drylands?

Sub-questions:

- What are the key legal and institutional strengths of Saudi Arabia’s current desert governance framework?
- What structural weaknesses hinder effective implementation and ecological performance?
- What legal and policy reforms are required to enhance enforceability, monitoring, and regional coordination in desert governance?

Research Objectives

This study aims to:

1. Assess the level of alignment between Saudi Arabia's domestic environmental laws and the obligations of the UNCCD.
2. Analyze the effectiveness of current legal, institutional, and policy frameworks in addressing desertification.
3. Identify gaps and structural weaknesses in implementation, including issues of enforcement, monitoring, and inter-agency coordination.
4. Propose a legal reform agenda to strengthen ecological governance, including monitoring mechanisms, delegated enforcement, and regional cooperation frameworks (e.g., GCC-level coordination).
5.

Importance of the Study

This research is significant for several reasons:

- **Environmental Importance:** Desertification poses a major threat to ecological sustainability, biodiversity, and land productivity in Saudi Arabia, especially in sensitive regions like the Rub al Khali.
- **Legal Contribution:** The study bridges the gap between **international environmental law (UNCCD)** and **domestic legal enforceability**, highlighting how treaty commitments can be operationalized.
- **Policy Relevance:** It supports national strategies such as **Vision 2030** and the **Saudi Green Initiative** by evaluating their legal foundations and implementation effectiveness.
- **Academic Value:** The research contributes to the field of environmental governance by reframing desertification as a **rule-of-law and institutional design issue**, not merely an environmental concern.
- **Regional Significance:** By proposing a **GCC-level desertification framework**, the study addresses the transboundary nature of desert ecosystems and promotes regional cooperation.

Limitations of the Study

Despite its contributions, the study has several limitations:

- **Doctrinal Scope:** The research relies primarily on legal and policy analysis rather than empirical field data, which may limit assessment of on-ground ecological outcomes.
- **Data Availability:** Limited access to detailed governmental data on enforcement practices, monitoring systems, and ecological performance may affect depth of analysis.
- **Geographical Focus:** The study focuses mainly on Saudi Arabia, particularly the Rub al Khali region, which may not fully represent all desert governance challenges across the wider Middle East.
- **Evolving Policies:** Environmental laws and initiatives (e.g., under Vision 2030) are continuously developing, so findings may require future updates.

2. Methodology and Contribution

The approach employed in this research is a doctrinal and law-and-policy approach. The doctrinal aspect looks at the legal framework of the UNCCD, the international instruments relating to the environment, Saudi Arabia Environmental Law, executive regulations concerning vegetation cover and protected area, and institutional requirements regarding desertification regulation. The law-and-policy dimension measures the connection of those legal norms with the national strategies, such as Vision 2030, restoration initiatives, biodiversity programmers, and decarbonization planning of the future. A limited comparative reflection, and not a comprehensive comparative-law study, based on the anti-desertification system in China is also used in the research as a reference point. China is chosen due to the fact that it provides one of the most famous cases of massive desertification control that can be represented by legislation, long-term planning, ecological engineering, and monitoring systems. This is not meant to import the Chinese model directly to Saudi Arabia. The comparison is applied instead to find the methods of governance that can be informed by the reform-oriented strategies but can be based on the local and specific context of Saudi Arabia, namely adaptive implementation, local incentives, and mechanisms of monitoring. The research has three contributions to the literature. First, it reformulates Saudi desertification not merely as an environmental issue, but as the issue of the domestic legal enforceability through an international treaty framework. Second, it relates Saudi desert governance to the larger arguments on the rule of law in the environment, demonstrating that what is really important in its implementation is not merely policy aspirations but the presence of identifiable obligations, institutional responsibility, and capacity to monitor. Third, it suggests a realistic reform agenda that is based on the Saudi specs as opposed to the abstract demands of more cooperation or more sustainability.

3. The UNCCD as a Framework of Managed Compliance

UNCCD has a special status in the international environmental law. The UNCCD is based on a managed compliance model, unlike treaties that are organized according to hard sanctions or centralized enforcement. States have a duty to develop policies, design and revise action programmes, collaborate in scientists and technical fields, share information and report progress. The architecture signifies the complexity of desertification as well as the sovereignty-sensitive aspect of land-use governance. Leverage of climate pressures, ecological features, local activities, and long-term economic decisions produce desertification. Consequently, the treaty is not as much worried about punitive enforcement as it is about capacity-building on the domestic level and maintaining an iterative implementation. There are strengths associated with that model. It enables national adjustment to the local ecological conditions, promotes scientific sharing, and supports varied legal and institutional systems. It also goes further to relate desertification to the wider sustainable-development agenda by linking land recovery, drought-resilience, biodiversity and livelihoods. But there are weaknesses that are generated by the same design as well. National reporting systems with effective monitoring can only make reporting effective. Action programmes of national action differ in quality and legality. Local enforcement is not necessarily created through scientific cooperation. And since the treaty does not contain any coercive instruments of compliance, ambitious states and recalcitrant states are frequently distinguished or rather than by the design of the treaty, by the quality of domestic governance. This is important in the case of Saudi Arabia. The point of contention is not whether the UNCCD needs to be acted in a formal sense; it does. The harder matter is whether Saudi domestic legislation transformed treaty alignment into institutional responsibilities which are sufficiently clear, delegated, measurable in indicators and reviewed. The success of the UNCCD within the Saudi framework should thus be considered through national execution: who can do what and to what standard, how is progress to be evaluated and is policy aspirations translated into land-governance results.

4. Saudi Arabia's Domestic Legal and Institutional Architecture

A visible domestic architecture of anti-desertification administration has been built in Saudi Arabia in the last ten years. At the legislation level, the Environmental Law and the framework which is used to implement it have created a general law that provides environmental protection, conservation, and regulation. In the executive tier, the vegetation regulations on development and desertification control give stronger connections with the governance of the drylands. At an institutional level, MEWA and NCVC are the central players in an extended administrative environment that incorporates wildlife, protected-area and national strategy agencies. This architecture is a true development. The state today has a comprehensive legal language in regard to vegetation protection, land restoration, ecological management, and environmental responsibility than used to be the case. The NCVC has gained a lot of significance due to the fact that it functions along the line of restoring policy, vegetation management and real desertification management on the ground. The expansion of the protected areas, rehabilitation programmes, and restoration metrics, have also provided Saudi Arabia with a more favorable profile of implementation under the UNCCD than would otherwise be the case with

declaratory implementation. However, the structure also has a number of legal weaknesses. To begin with, there is diffused authority. The governance of anti-desertification relies on the environmental law, vegetation laws, the protected-area laws, the wildlife protection laws, land-use planning, water planning, and climate planning. These spheres cannot exist independently, but they are not necessarily combined under a single legal system. The net effect is such an implementation environment where there is overlapping of responsibilities in a formal sense with operational fragmentation. Secondly, there are numerous commitments which are strategic as opposed to justifiably specific. Politically and environmentally ambitious, Vision 2030 and the Saudi Green Initiative are not enough to establish legal obligations, remedies, and surveying standards that are precise enough. In order to have publishable legal analysis, the line between the policy ambition and enforceable legal obligation cannot be crossed. Saudi Arabia possesses large portions of former; it still needs to institutionalize the latter more Saudi. Thirdly, enforcement is not yet a developed practice in locality. There are already in place laws and regulations which can be used to supervise and punish, particularly within the protected areas and controlled environmental zones, but desertification as a cumulative and diffuse harm in itself may include overgrazing, off road use, ground water pressures, loss of vegetation and progressive land degradation. They are more difficult to control with an orthodox top-down imposition of these pressures. They need governance that is intensive in monitoring; localized involvement and sustainable collaboration among agencies and municipalities (Browne, S. 2023).

5. Formal Alignment with the UNCCD: Where Saudi Arabia Has Progressed

Any strict evaluation should start with the fact that Saudi Arabia has achieved serious steps towards the formal alignment with the UNCCD.

5.1 Strategic environmental integration

Strategic integration is the first field of development. Desertification is no longer perceived as an outskirt rural issue. It has now been placed in a broader national agenda which connects ecological restoration, biodiversity, climate adaptation, renewable energy and sustainable development. That change is important in legal terms since it increases the likelihood of desert governance being supported on a long-term basis instead of a shot-in-the-dark one (Kalfagianni, A.,.et all, 2022)

5.2 Ecological restoration and land rehabilitation

The second aspect of development is the area of restoration and rehabilitation. The Kingdom has now gone a step further in promoting afforestation and vegetation-cover projects, land-restoration programmes, and even ecological rehabilitation has been incorporated into national planning language. No matter how one should always look carefully at the restoration statistics, the administrative shift towards the quantifiable goals is in itself substantial. The logic behind the UNCCD lies in the fact that the national systems have the capacity to establish the indicators, report on the progress as well as make necessary policy changes over time. Saudi Arabia seems to be becoming more than willing to work under that logic (MEWA., 2016).

5.3 Protected areas and biodiversity recovery

Thirdly, the expansion of the protected areas is now among the most powerful practical law enforcement instruments of the Saudi framework. Protected areas do not constitute the ultimate solution to the problem of desertification but they establish geographically delimited zones within which the ecological management, biodiversity restoration and regulation of activities can be more effectively implemented. The acknowledgment of the Uruq Bani Ma'arid as well as similar conservation efforts promotes the legal presence of desert ecosystems that used to be perceived more of a distant rather than administrative phenomenon.

5.4 Institutional specialization

Fourthly, Saudi Arabia has established increased institutional specialization as compared to most of the treaty parties in similar dryland settings. A center that is directly dedicated to the vegetation cover and anti-desertification policy is a worthwhile governance asset. It permits administrative focus of experience and can be a superior long-term planner compared to a diffuse ministry-only model. These processes make it possible to make a qualified conclusion that Saudi Arabia has not only signed the UNCCD rhetorically. It has developed a substantive although yet to be fully achieved domestic governance framework that embodies treaty goals in legislative, institutional and national strategy.

6. Why Formal Alignment Is Not Yet Full Effectiveness

It is not the lack of the commitment but the disjuncture between commitment and enforceable ecological governance. There are three structural limitations that explain why.

6.1 Fragmented implementation across sectors

The management of desertification is heavily intersectoral. It has an impact on water policy, conservation areas, agriculture, infrastructure, conservation, urban development, energy planning, and social health. Saudi Arabia is in the process of integrating such sectors on a strategic level, though not, through operational mechanisms of law. The absence of cross-sectoral statutory coordination can result in the pressures of an environmental gain in one area counterbalancing the pressures of a gain in the other area. An initiative that is aimed at the restoration, such as that, can co-exist with land-use patterns that enhance degradation in other places. Better framework would involve compulsory coordination roles, joint spatial planning of sensitive drylands and jointed reporting of the agencies whose actions contribute to the outcome of land degradation (Secretariat, O. 2000).

6.2 Monitoring and accountability deficits

The second weakness is monitoring. UNCCD model relies on the national measurement. The absence of vigorous monitoring makes restorative claims hard to authenticate, enforcement hard to react to, and learning the policy hard to superficial. In Saudi Arabia, data collection and reporting has been enhanced, however, the existing framework can be refined with more specific legal requirements related to land-restoration indicators, environmental baseline mapping, periodic reporting to the society, and external review processes. This is not a technical concern. Monitoring in terms of rule-of-law in the environment is the gap between proclaimed policy and responsible government. A state can possess grand aims, committed organizations and significant investments, yet when the progress cannot be measured, compared and audited it remains susceptible to an overstatement and institutional drift.

6.3 Limited localization of desert governance

The third weakness is low localization. The benefits of centralized governance in a very diverse dryland setting are more apparent: it is possible to gather finances, align national priorities, and prevent the uneven standards. Nonetheless, ecological responsiveness declines due to over- centralization as well. Local land-use pattern, local ecological knowledge and local compliance incentives are some of the common manifestations of desertification. A system of law that is largely centralized in planning can overly exploit municipalities, community players, reserve managers and locally invested monitoring systems. Saudi Arabia thus has an archetypal implementation issue, national ambition is high, yet local ecological governance structures are not quite as well developed as the central strategy discourse (Komoto, K. et all, 2015)

7. The Rub' al Khali as a Legal Governance Problem

The Rub al Khali is frequently brought out as a figurative landscape: expansive, distant and hostile. Lawwise, though, it is to be taken as a border of governance. It is important in four aspects. To begin with, it is not eco-friendly. An arid ecosystem does not lack population solely because of the fact that they are sparsely populated. They are fragile hence ecological disturbance may have long time impacts and may not be reversed easily. Secondly, it is transboundary. The Empty Quarter goes beyond the territory of Saudi into other states. This provides desertification in the region with cross-border aspect, which can be applied in cooperation and exchange of information and the general international-law principle that states must avoid causing environmental damage to the other countries. Third, it is strategically valued in terms of land-use. The fact that the Rub' al Khali might not be suitable to any conventional form of agriculture or thick settlement does not mean that it cannot be legally considered when exploring development planning. Quite to the contrary, its solar and wind traits open up the prospect of a wise controlled development of renewable energy sources in appropriately chosen non-sensitive regions. Such a possibility necessitates a legal innovation since renewable-energy placement in deserts will and will represent either an ecological assistance to a sustainable transition or a novel ecological unrest, depending on the quality of planning. Fourthly, the area depicts boundaries of pure symbolic environments. Any argument that the Empty Quarter can merely be greenified on a large scale needs to be countered with the reality of water shortage, soil parameters, ecological integrity and sustainability of maintenance requirements. Hyper-arid landscapes need varied administrative, as opposed to generic restoration discourses (Dronin, N. ,2023).

8. Comparative Reflection: What Saudi Arabia Can and Cannot Learn from

China is also applicable as it shows how a more institutionalized response to land degradation can be established with the aid of legislation, long-term planning as well as adaptive implementation. The Chinese model integrates the central direction with quantifiable programmes, implementation on a long horizon and there is increased application of the subnational delivery mechanisms. It has also provided some lessons both good and bad concerning ecological engineering, the quality of afforestation, incentive systems, and the necessity to align interventions with local ecological characteristics. There are three lessons that can be of particular use to Saudi Arabia. To start with, the anti-desertification law should be effective by ensuring that monitoring forms part of the program design as opposed to considering it as an additional measure. The experience of China highlights the importance of longitudinal evaluation, dynamic rectification, and permanent analysis of whether the restoration measures can really ameliorate the land conditions. Second, the local implementation is important. As long as central commitments are connected with subnational actors, pilot zones, and the incentives of the immediate participants of land management, they acquire the practical force. To take advantage of this understanding, Saudi Arabia does not have to imitate the Chinese form of administration. It will be able to modify it with the empowerment of municipalities, reserve administrations, and regionally-specific restoration bodies under the national control. Thirdly, it depends on ecological fit. The practice of afforestation on a large scale in China has demonstrated that it does not necessarily achieve its objectives. The result of poor species selection, local poor fit and numerical over to planting targets may lead to poor results. This caution is very much applicable in Saudi Arabia where the hyper-arid climate drastically reduces the extent to which restoration is practically possible in certain regions. The comparison, on the other hand, also has its boundaries. The size, climatic variations and the administrative hierarchy of China, land governance practices and rural policy tools is very different as compared to those of Saudi Arabia. That is not the lesson, though, but a methodological one: Saudi Arabia ought to learn the logic of governance of adaptive, monitored, and territorially differentiated desert policy, not the externality of the programme of still another nation (World Health Organization, 2020).

9. A Legal Reform Agenda for Publishable Desert Governance Analysis

In case Saudi Arabia needs to shift compliance to enforceable ecological governance, reform must concentrate on legal design as opposed to rhetorical extension of the environmental ambition. There are five particularly important reforms.

9.1 Statutory monitoring and reporting duties

The Saudi law must include a clear statement that wildland should periodically report on the indicators of desertification, the success of restoration, the changes in vegetation-cover areas, and the risks of degradation in ecologically sensitive areas. Such responsibilities cannot be present just in strategic documents or in the administrative practice. They need to be pegged on regulations or delegated instruments, which have specified timeframes, accountable authorities, and reporting responsibilities to the general population. This would enhance accountability within the country and enhance the evidentiary basis of UNCCD reporting (Suo, & 2021).

9.2 Delegated enforcement powers and integrated dryland zoning

NCVC and associated bodies would enjoy more erudite devolved powers on ecologically sensitive drylands such as power to integrate with the municipalities to control the activities degrading nature and initiate enforcement measures in identified desert-threatening zones. There should be a framework of dryland-zoning that separates the areas of protection, restoration, renewable-energy and multi-use with specific standards on each.

9.3 A GCC protocol on desertification and shared drylands

Since the desertification in the Arabian Peninsula has regional aspect, Saudi Arabia ought to advance a Gulf level protocol or structure agreement on desertification collaboration. The instrument would help in dealing with everyday indicators, scientific exchange, monitoring of land-degradation, dust and drought coordination as well as ecological management of transboundary drylands. The usefulness of such a protocol would be to establish a regional legal platform, which would instantiate the cooperation logic already found in the UNCCD.

9.4 Renewable-energy siting rules for non-arable desert zones

The Rub' al Khali and various desert areas could present a high potential of renewable-energy but that potential needs to be legally tamed. Saudi Arabia ought to embrace siting policies which involve placement of solar and wind projects in desert regions being preceded by environmental evaluation, biodiversity checks, cumulative-impact evaluation, and

post-solar and wind monitoring requirements. Well planned, development of renewable energy sources can alleviate expansion pressure into land with farming potential or capable of being reclaimed by other means besides agriculture. It may lead to new types of fragmentation and habitat stress due to poor design (Olawuyi, D. S. 2024)

9.5 Community participation and environmental justice

Participation has also been a long-standing theme of the UNCCD but participatory governance is not frequently explored in dryland policymaking. Saudi Arabia does not need to import adversarial models of governance to be stronger participants. It may instead be regularized participation of local stakeholders, localities, reserve-neighboring communities, environmental volunteers, and regionally based monitoring players. This is especially vital when the livelihoods, movement pattern, grazing, or access to the ecological resources are at stake due to desertification. The participation does not have a normatively appealing nature but enhances the quality of compliance and local legitimacy (Agerton, M. et all, 2023).

10. Environmental Rule of Law and the Future of Saudi Desert Governance

The general lesson of the Saudi case is that the law of desertification should be evaluated in terms of environmental rule law. Within that prism, the measure of success does not solely revolve around the amount of money spent, whether or not it is involved in treaties, or whether or not it takes on commitments, but whether there are effective standards, delegation of authority, transparency in reporting, scrutinizable implementation, and ecological feasibility. The significant milestone already passed by Saudi Arabia. The government of the desert is no longer a subject of non-legal and non-policy discussion. It is currently intertwined with national planning, international environmental relations, conservation practice and new transitional plans. It is an authentic development. But ecological governance on rule-of-law must be based on a second transition: ambition to institutional precision. This difference is particularly significant when it comes to the publishability of scholarship on the topic. Climate leadership language should not be confused with legal effectiveness because of academic analysis. It must also not fall on the other end of the Continuous improvement ladder that ignores the present efforts merely because they are not strictly enforced. The mid-range version is closer to the truth Saudi Arabia is developing a serious anti-desertification system, but it is in the process of doing so. Its advantages are in political determination, specialization of institutions and developing infrastructure of restoration. It has weaknesses in design of enforcement, intensity of monitoring, local enforcement and local legal integration (Cao, S. 2021).

Previous Studies

In a study of Diallo, H. A. (2008). United Nations convention to Combat desertification (UNCCD).

The only agreement that unites the environment, development, and sustainable land management is the UNCCD (the Convention) which is legally binding. The Convention particularly takes care of arid, semi-arid, and dry sub-humid regions, referred to as drylands, where some of the most susceptible ecosystems and societies can be located. Canada has been a leader in the negotiations, which are under discussion as a part of the UNCCD conference of the parties, since it has rejoined in 2017, providing to the negotiations several important results, such as adoption of the Gender Action Plan and Roadmap of the Convention, and introduction of the Gender Caucus. The Convention aims at sustainable land management, improving the living conditions of the people in the affected regions, and reducing the effects of drought. Placing the UNCCD in practice is contributing towards realizing a land degradation-neutral world, which is in line with the 2030 Agenda of Sustainable Development. In Africa, Asia, Latin America and Caribbean, Northern Mediterranean and Central and Eastern Europe, the affected parties develop strategies to deal with land degradation/drought and coordinate at regional and sub-regional levels. Parties in developed countries have been partnering with the affected countries (especially the developing countries) in the provision of financial support and sharing of knowledge, transferring of technology, and developing capacity. The Conference of the Parties and subsidiary bodies are serviced by a permanent Secretariat in Bonn, Germany. This involves holding of official meetings, facilitation of reporting, and general implementation of the Convention. The UNCCD Global Mechanism endeavors to mobilize and direct financial resources (in the form of grants, loans and other forms of funding) to Parties to the Convention in the developing countries that have been affected in order to enhance the goals of the Convention. The UNCCD can play a significant role in terms of the implementation of the Sustainable Development Goals (SDGs), especially SDG 15 Life on land. By applying the Convention, Parties strive to establish a future without or with a minimum and reversing desertification/land degradation and reverse the consequences of drought in the affected regions. Moreover, Parties aim at attaining land degradation neutrality; a position where the quantity of land resources and quality of the land resource required to sustain

ecosystem functions and services to promote food security does not decrease or decline but rather remains constant or improves. This Convention means a lot to Canada considering the degrading environmental, social and economic effects of desertification, land degradation and drought in the country and even overseas. Being a developed country party to the Convention, Canada is believed to be affected by the dryland areas which are found in Western Canada. In order to make sure that the work of the UNCCD is grounded in the latest knowledge of the scientific field, Canada offers its scientific and technical expertise devoted to sustainable land management, soil health, drought monitoring, land restoration, and landscape resilience. Canada also contributes to the achievement of the objectives of the Convention by developing nations especially through global environmental facility, Land Degradation Neutrality Fund and through institutional support given to the UNCCD in order to further integrate gender equality in the implementation of the Convention. In May of 2022, Canada participated in the Fifteenth Session of the Conference of the Parties (COP15) of the UNCCD in Abidjan, Côte d'Ivoire. Canadian delegation had an active participation in COP15 in order to have the Convention Gender Action Plan and gender mainstreaming continued to be supported. Canada will also maintain its collaboration with its international partners, not only under the UNCCD but also in other areas to ensure that it is strongly involved in the critical areas of the Convention work especially those related to gender equity. The UNCCD national reporting process is a regular review of every four years that evaluates the progress achieved in the implementation of an 20182030 Strategic Framework. UNCCD has also taken part in following up the implementation of the Sustainable Development Goal 2030 Agenda on Sustainable Development as the custodian agency in the Sustainable Development Goal indicator 15.3.1 which is proportion of land that is degraded over total land area. More than 80 countries have already set their targets and 129 countries have committed to making voluntary targets in order to attain land degradation neutrality. Drought action plans have already been developed by 60 countries with others six countries in the process of developing the same. The Global Environment Facility has funded at least 190 projects and programs as at 2006 with over 1 billion dollars resources to promote the sustainable use of land to fulfill national and regional development priorities (including over 80 million hectares of land under sustainable land management and benefiting more than 80 million smallholders). Land Degradation Neutrality Fund has six investments underway (on a total 85.5 million) in Peru, Colombia, Sierra Leone, Ghana, Nicaragua, Kenya, Laos, and Bhutan (van der Esch, S, et all, 2023)

In a study of Young, O. R. (2011)., One of the topics which have attracted a lot of interest in the scientific community in the past three decades involves international environmental regimes particularly regimes that have been expressed through multilateral environmental agreements. Nonetheless, it has significant disagreements of the issue of the efficiency of these systems of governance or the extent to which they have been effective in addressing the issues that brought about their development. The research is a critical review of literature on this topic. It derives and generalizes the knowledge on the efficacy of environmental regimes as a sequence of general and particular propositions. It determines potential issues to be discussed during the next stage of the research in this area. Also, it remarks on the research strategies that can be used to follow this line of analysis. The overall findings are that, international environmental regimes do and can make a difference, but often it is in combination with a number of other variables, and that a combination strategy of a number of tools used can be helpful in enhancing our understanding of determinants to success.

In a study of Ahmed, Z., (2024), Desertification endangers land integrity, social stability and sustainable economic development of the world. In the period between 1982 and 2015, 6 percent of the global drylands had been desertified due to the unsustainable land use in the world, which had been worsened by anthropogenic climate change. Even though the United Nations Convention to Combat Desertification (UNCCD) had undertaken a number of global and regional projects to ensure active control over desertification, it was unable to meet its land restoration targets. Thus, this paper critically looks at the factors leading to desertification in major proportions, reasons why the fight against desertification struggle is being hindered and the solutions that can be effectively used to control this menace. The key limitations that hindered the desertification control efforts are poor policy and awareness on desertification, institutional gaps, social and cultural, limited access to credit, modern technologies, lack of standardization and inconsistent estimates on the extent of desertification. Nevertheless, a number of essential measures can be taken to solve the problem of desertification on the global level. Making this to be more comprehensive should include the local communities but land managers, government officials and development planners. The scientific knowledge should be combined with local and indigenous knowledge to achieve a better harvest in lieu of desertification. The sustainable land management practices might improve the productivity of the soil and the use of advanced technology (remote sensing, digital maps, machine learning applications and data mining) might assist in standardizing the processes and evaluating the level of desertification correctly. Bio-cementing and biocrust formation are some of the methods used to stabilize the soil against wind and water erosion. By transforming the degraded places into green spaces, nearly 10 million green jobs would be generated and green economy would be developed in the developing world. Lastly, to meet the aspirant land restoration

targets and sustainable development goals (SDGs), there is an urgent need to conduct a thorough research on desertification, through good and modern scientific knowledge by investing in research institutes and preparing the next generation of researchers.

In a study of Kay, M., et all, (2022). Meeting the evolving food habits and rising demand of food puts extra strain in the water, land and soil resources of the world. Nevertheless, agriculture is holding enormous promise to mitigate these strains and make various contributions to the world aims. Sustainable agricultural practices will result in water saving, soil conservation, sustainable land management, natural resources conservation, ecosystem and climatic change benefits. This is only possible with accurate information and a significant shift in the management of these resources. It also involves augmenting the efforts in the external natural resources management field in order to maximize synergies and trade-offs. The SOLAW 2021 objective aims to create awareness of the state of land and water resources, emphasizing the dangers and informing about the opportunities and challenges associated with it, as well as the crucial role of the right policies, organizations and investments. The recent evaluation, forecasts and possibilities of the international community reveal the ongoing and accelerating loss of land and water resources, biodiversity, the degradation and pollution related to it and the shortage of the main natural resources. The SOLAW 2021 identifies the key risk and trend associated with land and water and offers the ways of managing competition between the users and creating various benefits to people and the environment. It was based on the DPSIR framework to determine the Drivers, Pressures, Status, Impact and Responses. SOLAW 2021 offers a review of the body of knowledge and offers a set of responses and actions to inform decision-makers in the public, the private, and the civil sector to transform the state of degradation and vulnerability to be sustainable and resilient.

In accordance with Basham, E. W.,et all. (2023). Tropical forests are home to the greatest terrestrial biodiversity as well as among the most complex ecosystems on earth and a good part of it is above ground. Despite the vertical dimension as a key feature of the ecology of forest communities, there is scant agreement on prominence, evenness and consistency of stratification of the community at the ground to canopy levels. This is the compilation of the outcomes of 62 studies throughout the tropics to synthesize as well as evaluate the general trends in vertical stratification of abundance and richness in vertebrates, the most examined taxonomic group in which no previous compilation of results has been made. The literature review provided adequate information on bats, small mammals, birds and amphibians. We demonstrate that there is a difference in the stratification of abundance and richness both within and across all the taxa that are taken into consideration. The stratification of bat richness was not consistent in studies, but the abundance of bats was biased in favour of canopy. Both the abundance stratification and richness of birds were not fixed, and there was a lack of an overall pattern. Quite on the contrary, there were uniform trends toward decline in abundance and richness of both amphibians and small mammals toward the canopy. Descriptively, we describe research trends in drivers of stratification as mentioned or examined in literature that depict local habitat structure and food distribution/foraging as the most frequently assigned drivers. Additionally, we examine how macroecological variables affect stratification patterns and the latitude and elevation turn out to be important predictors of bird stratification in that specific case. The major variations among taxa are probably as a result of taxon-specific interactions with the local drivers including vertical habitat structure, food distribution, and vertical climate gradients, which can differ significantly across macroecological gradients including elevation and biogeographic realm. This paper presents the multidimensionality of the animal community organization in tropical forest ecosystems, and illustrates the canopy as an element of a vital niche of vertebrates in tropical ecosystems, further establishing that the tropical vertebrate communities are inherently vulnerable to forest loss and canopy disruptions. We acknowledge that the analyses were limited by the variability in study designs and methods that resulted in the abundance and richness measures taking different values in different setups of vertical strata. We consequently recommend implementation of best practices to report data and point out the great effort needed to close research gaps in terms of regions that are under-sampled, taxa and environments (Garcia, & Cortês, 2023).

12. Analysis

The above literature points out that there are some major dimensions of desertification governance and sustainable land management. To begin with is the study done by Hamadou A. Diallo whereby it is shown that the international framework that the United Nations Convention to Combat Desertification has established is the most extensive legally binding international consensus covering the issue of desertification and sustainable land management. The Convention sets up the system of cooperative governance whereby the countries embrace national strategies, share knowledge, and provide the affected regions with financial and technical assistance. In the research, there is also the focus on the

significance of global cooperation, the financial systems like the Land Degradation Neutrality Fund, and the regular reporting systems to assess the achievement.

Second, Oran R. Young has created a more comprehensive theoretical perspective of international environmental regimes. In his analysis, he has stated that multilateral environmental agreements can have an impact on environmental performance, but their performance largely depends on domesticization and capability of the institutions. This implies that the effectiveness of international environmental agreements like UNCCD cannot be assessed in terms of international commitments only; no, it is the implementation of international commitments as translated into the national policy and enforcement mechanisms in the countries that determine the success of this agreement.

Third, Zafar Ahmed study points out that the problem of desertification in the world is increasing and that degradation of land is caused by a combination of factors such as unsustainable land use, climate change, poor policy frameworks, and lack of technological resources. According to Ahmed, institutional gaps and poor coordination among the stakeholders has contributed to the failure of achieving global land restoration targets. Alternatives to the problem are also identified in the study, and these are sustainable land management, technological monitoring instruments like remote sensing, and increased involvement of local communities.

Further, the Food and Agriculture Organization of the United Nations report highlights the close connection between land degradation and water management as well as, agricultural sustainability. This view proposes that land resource protection must be through multifaceted management approaches that put into consideration the environmental, economic, and social aspects at the same time. Sustainable agricultural systems are capable of decreasing the strain of land and water resources and maintaining the stability of the ecosystem.

Lastly, the study by Emily W. Basham and colleagues is based on ecological structures and ecological biodiversity in natural ecosystems. Despite the fact that the research studied the tropical forest settings, it illustrates a general ecological concept: the ecological systems are very intricate and susceptible to disruption. The paper puts into perspective the effect of habitat structure and ecological relationships on the distribution of biodiversity, and it is important to safeguard the integrity of the ecosystem to ensure environmental resilience. On the whole, the discussion of the existing literature indicates that managing desertification should be based on a complex approach that encompasses the international legal framework, the implementation of national policies, scientific monitoring, and ecological conservation.

13. Discussion

The former research studies covered in this study give valuable insights on the governance, ecological and socio-economic aspects of desertification. Combined, these studies indicate that desertification is a complex phenomenon that demands centralized action on the international, national and local level. The literature identifies the significance of legal frameworks, institutional capacity, sustainable land management practices and scientific monitoring systems in dealing with land degradation effectively.

The paper by Hamadou A. Diallo gives an in-depth insight into the institutional design and mandate of the United Nations Convention to Combat Desertification. The Convention provides an international system that supports the action of countries to fight desertification and support sustainable management of land. In this framework, the role of national action plans, international cooperation and financial mechanisms to support land restoration initiatives are emphasized. The literature therefore indicates that the effectiveness of global desertification governance relies so much on the ability of the national governments to turn international commitments into effective environmental policies and implementation strategies.

In the same way, Oran R. Young theoretical approach helps realize the working of international environmental regimes in reality. Young suggests that environmental pacts can hardly be effective by relying on legal mandates alone but rather it requires the interplay among international standards, local policy frameworks and enforcement mechanisms. This point of view contributes to the idea of why certain nations are more effective than others in executing environmental agreements. It as well brings out the imperative of effective governance arrangements and regular surveillance to hold international undertakings to have quantifiable environmental results.

The fact that Zafar Ahmed found is yet another addition to the value of governance and policy coordination in dealing with desertification. Ahmed outlines some key reasons as to why the global desertification control measures do not work including poor policy frameworks, lack of institutionalisation, and poorly informed society. Such results go hand in hand

with the general literature on environmental governance that highlights the fact that the environmental problems like land degradation cannot be resolved solely using technical solutions. In their place, they need combined solutions that are based on the synthesis of scientific knowledge, policy-making, and involvement of communities.

Besides this, the study by Food and Agriculture Organization of the United Nations indicates the close association between land degradation, water scarcity and agricultural activities. This study shows that the sustainable management of natural resources is an important element towards minimizing the pressure on the environment and ensuring the stability of ecosystems. Through enhancing sustainable farming methods, soil conservation and better water management, the nations will minimize chances of land degradation and at the same time improve food security and economic growth.

The ecological viewpoint offered by Emily W. Basham and others offers more enlightenment the complex nature of the environmental systems. Their work on the patterns of biodiversity in the Amazon rainforest explains biodiversity by the various layers of ecological communities and the impacts that perturbations may have on the distribution of species and the ecological balance. Even though the study is conducted in the tropical forest and not in the dry land, it is still very informative in the conceptual learning that environmental systems are very interdependent and sensitive to disruption. It is also necessary to protect the structure and biodiversity of the ecosystem to ensure the long-term environmental resilience.

Taken together, the above studies underline the value of coherent environmental governance that brings together the international cooperation, national policy implementation and scientific research. The phenomenon of desertification cannot be solved by isolated policy actions but it needs a concerted effort in the agriculture sector, water management, environmental conservation, and economic development. This combined strategy is in line with the overall goals of global sustainability efforts, such as the Sustainable Development Goals, especially those that can be found in land protection, climate resilience, and ecosystem conservation.

Also, the literature recommends that desertification management should be equitable in terms of environmental protection and the socio-economic development. The practices of sustainable land management are known not only to protect the ecosystems, but also to support livelihood, enhance food security, and climate resilience. Policy measures to address desertification would therefore have to be holistic in environment, economics, and social aspects to ensure the long-term sustainability.

The results of the above research indicate that desertification is not a one-sided challenge in the sphere of the environment, but also a challenge of governance that presupposes collaboration at a range of levels. The global system created by the United Nations Convention to Combat Desertification gives a valuable arena in terms of international collaborations. The success of such agreements, however, in realization by the national governments, as Oran R. Young points out can be greatly influenced by the capacity of the national governments to follow such commitments by good policies and institutional frameworks.

Another issue that the research puts forth is that of dealing with the root causes of land degradation. Zafar Ahmed cites population pressure, unsustainable land use as well as climate change as being the factors that contribute to desertification. Such drivers are especially pertinent in the arid and semi-arid areas where the environmental systems are already weak. In the absence of effective regulatory measures and sound land use management, the threat of a degraded ecosystem has been growing. The other significant issue that is discussed in the literature is the use of technology and scientific knowledge to monitor the process of desertification. Military equipment, satellite photos, and machine learning technologies are the tools that can be developed to enhance land degradation assessments considerably. Such tools will enable the policymakers to track the environmental changes more efficiently and develop specific interventions.

Moreover, sustainable agriculture and management of water resources are found to be important elements in dealing with land degradation. Research findings by the Food and Agriculture Organization of the United Nations highlight that better land management systems are useful in improving the soil fertility, erosion and resilience of the ecosystem. These practices should be integrated in the national environmental policies to help in attaining sustainable development objectives. This information on ecology given by Emily W. Basham also supports the need to preserve the ecological systems. Even though she does her research on tropical forests, the larger implication is that environmental systems rely on complicated exchanges among species and environments. Disrupture of these systems may have ripple effects on the ecosystem and this is another reason why ecological governance must be handled carefully.

14. Recommendations

According to the analysis and discussion of the past researches, some suggestions may be put forward to enhance desertification governance and sustainable land management. To improve upon this, governments are first encouraged to reinforce entrench the application of international environmental agreements like the United Nations Convention to Combat Desertification by transforming the treaty obligations into national legislations, policies and institutional obligations.

Second, the nation's ought to invest in advanced surveillance technologies, such as satellite surveillance, geographic information systems, and artificial intelligence. The technologies are capable of enhancing the precision of the desertification assessment and enable policymakers to respond better to changes in the environment.

Third, agricultural policies should be encouraged to promote sustainable land management practices, which entail conservation of soils, effective utilization of water and restoration of ecosystems. This strategy is able to lessen environmental degradation and agricultural productivity is not compromised.

Fourth, international bodies and governments ought to fund research and capacity-building initiatives that would help in increasing scientific knowledge on desertification processes. The process of innovative solutions can be developed as a result of investments in research institutions and educational activities on environmental issues. The involvement of the local communities in the desertification management should be increased. Community involvement and local knowledge can enhance the efficiency of the environmental policies and make sure that the practices of land management are not forced to fit a universal model.

11. Conclusion

The issue of desertification is one of the biggest environmental predicaments that have been experienced by most parts of the world especially in arid and semi-arid ecosystems. The analysis of the existing research confirms that therapy of this problem should be holistic and the cooperation of the countries in the international arena, national policies, scientific control, and sustainable use of the land should be involved. The United Nations Convention to Combat Desertification offers a very important structure of action all over the world, yet it is determined whether it works or not by the efforts and the ability of the respective countries to adopt the perspectives. The works of researchers like Oran R. Young and Zafar Ahmed underline the fact that institutional strength, policy coordination and technological innovation are key to successful environmental governance. Meanwhile, research on ecological systems also highlights the need to preserve the integrity of ecosystems and biodiversity to remain stable in the environment. An increase in community involvement, better monitoring and sustainable land management practices will go a long way in ensuring that the level of land degradation is decreased and that the ecosystems will be more resilient. To sum up, desertification and forestation cannot be addressed without multipolar actions on various sector levels and government levels. Through the reinforcement of environmental policy, scientific research investments and the promotion of sustainable land use behaviour, states will be a step nearer with land degradation neutrality and the long-term sustainability of drylands ecosystems.

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