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# Challenges to the Bedouin Traditional Natural Resources Management Systems: The Case of the Bedouin Hadandawa's of Eastern Sudan

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**Abstract**

This research investigates the customary natural resource management system of the Bedouin Hadandawa in Eastern Sudan and identifies the problems it encounters in comparison to the problems encountered by other Bedouin groups in the area. The study is grounded on fieldwork carried out in the research area from January to July 1996. Data were gathered using four questionnaires to survey rural households, with a sample of 300 respondents from Arkaweit, Sinkat, Khor Arabs, Rural Durdaib, and Haya Rural Council. Published sources were also utilized to analyse the problems facing this traditional system. The results point to two critical elements of the Hadandawa's resource management system: the economic system and the social Salif system. The findings reveal that the Hadandawa have maintained this traditional system over time, promoting fair allocation of water resources as well as agricultural holdings and contributing to food security. Yet, this system is failing increasingly to provide for more recent generations, since most families have moved to urban centres and left agriculture and livestock rearing. The greatest challenges to this conventional system are attributed to environmental degradation (70%), conflict (20%), and underdevelopment with state development policies (10%). These combined present a compelling threat to the system's continuity and long-term sustainability. By way of response, the study envisages a vision of coping with these challenges that comprises four interrelated components and their anticipated effects on maintaining the Hadandawa's customary system of resource management.

**Keywords:** Pastoralism, Hadandawa, Resources Management, Challenges, Change.



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## Introduction

A tribe is a group of people who mostly belong to a higher ancestor or a grandfather. Members of the tribe often inhabit a common territory that they consider their home, speak a distinctive dialect, and have a homogeneous culture or at least a common solidarity (Barabantseva 2025). Spatial stability and the emotions of the members of a tribe determine its existence, while tribe solidarity strengthens tribal kinship since each tribe possesses a "land" bounded by emotions that stem from feelings of unity of the tribe (Al-Alawi 2018). The Bedouins communities are tribal ones based on blood kinship, non-urbanized, and diminish eventually to become sedentary communities (Al-Kuwari 2025).

Bedouin societies are based on social and religious systems, being small and isolated groups who live in a social lifestyle facilitated by a coherent kinship system and social behaviour towards the individual and the group (Carland and Buckley 2025). Some of these Bedouin groups like the Borana and the Maasai, for example, raise productive livestock in their homes, while others migrate in search for work elsewhere (Degen and Dana 2024), and among Middle Eastern pastoral nomads some tribes can best be described as "units of subsistence" (Freeman 2025). The unit of subsistence is articulated mainly by networks of institutionalized relationships (Marx 1977). While coexisting with a unit of subsistence, this tribe is not necessarily identical with it in area or population (Hazarika 2025).

Adaptations result in different cultural formulas (Fayek Rizk et al. 2022), which may evolve, change, or decay for diverse reasons. Here, Bedouin are influenced by submission to law and market forces (Abdennour 2024), such as the case of the Sinai Bedouins, due to variations of their spatial stability in terms of proximity and distance from neighbouring cities (Saad 2024), and the Arab nomads of Syrian Desert due to the wars in the Middle East that have pushed them out of homes and cause restrictions on their accustomed cultural traditions (Al-Absi and Hassan 2024). This research aims to describe the traditional system of natural resources management of Bedouin Hadandawa of the Eastern Sudan and to discuss the challenges it encounters within those experienced by other Bedouin communities in Sudan.

## Literature Review

Since time immemorial, Bedouin societies have depended on conventional systems of land, water, and animal management. The systems are based on kinship and customary practice, which enable pastoralists to adjust to the dry climate. Research indicates that such systems of governance facilitate control of land use, avoid conflict, and distribute resources equitably among tribes (Kishore, Pal and Sarkar 2024). In the Hadandawa, social positions like "El Nazir," "Omdas," and "Shuiyukh" serve important roles in land governance and dispute settlement so that natural resources are exploited to the best possible extent (Elhadary and Samat 2011). Nonetheless, environmental variability has rendered such living conditions extremely hard.

Irregular precipitation, increased temperatures, and declining water resources are compelling most pastoralist societies to change. Studies illustrate how such changes have undermined traditional seasonally based grazing regimes, rendering it more difficult for societies to support their livestock (Aubron, Corniaux and Flori 2023; Fonchingong Che and Bang 2024). Hadandawa and other Bedouin communities residing in arid conditions have been compelled to restore land management practices as droughts worsen (Elagib and Mansell 2000). With unreliable water resources, most families have turned to alternative livelihoods,

abandoning traditional pastoralism (Tugjamba, Walkerden and Miller 2023). Land previously set aside for grazing has, in the majority of instances, been turned into extensive commercial agriculture. This has reduced the alternatives for pastoralists to maintain their livestock (Tofu et al. 2025). Government policies have promoted agricultural expansion in Sudan, leaving less land for traditional pastoralism. Numerous families have been compelled to relocate to urban centres in pursuit of employment (Hashimshony-Yaffe, Zhang and Alhuseen 2022). The Hadandawa are not exempt—numerous youth are abandoning herding and seeking wage employment or smallholder farming in pursuit of livelihoods (Gallopin et al. 2021). State land policies have been at the forefront of these changes.

New land legislation and large-scale farming schemes have further complicated the use of traditional grazing grounds by nomadic groups (Elhadary 2010). The application of the 1970 Land Act enabled the government to acquire control over land allocation, frequently at the expense of the local population to accommodate commercial farms (Yagoub et al. 2017). It is the same with other areas as pastoralists struggle with increased problems from land privatization breaking traditional communal systems apart (Behnke et al. 2020). Due to this, there have been heightened tensions between groups, where competition for water and land resources has created more than just random sporadic fights (Brosché 2023). Aside from these economic and environmental challenges, most pastoralist communities suffer from poverty, famine, and poor access to healthcare and education. Research shows that nomadic communities are plagued by high malnutrition rates and lack access to fundamental services (Charnley, Ilan and and Murray 2022). Food shortages in certain areas have now escalated to a crisis in the Beja community, which is made up of the Hadandawa (Soliman and Demissie 2024). Although food relief has been able to address the urgent needs, it has not addressed the root causes hindering economic recovery (Phillips and Mincin 2023). Education is also an issue, as the majority of children in pastoralist communities do not have access to educational facilities, and this hinders them from fitting into contemporary economic requirements (Alredaisy 2023b). This present study adds to existing work by highlighting the unique challenges of the Hadandawa, explaining how they manage to cope with these changes without losing their cultural traditions.

## Fieldwork and Methodology

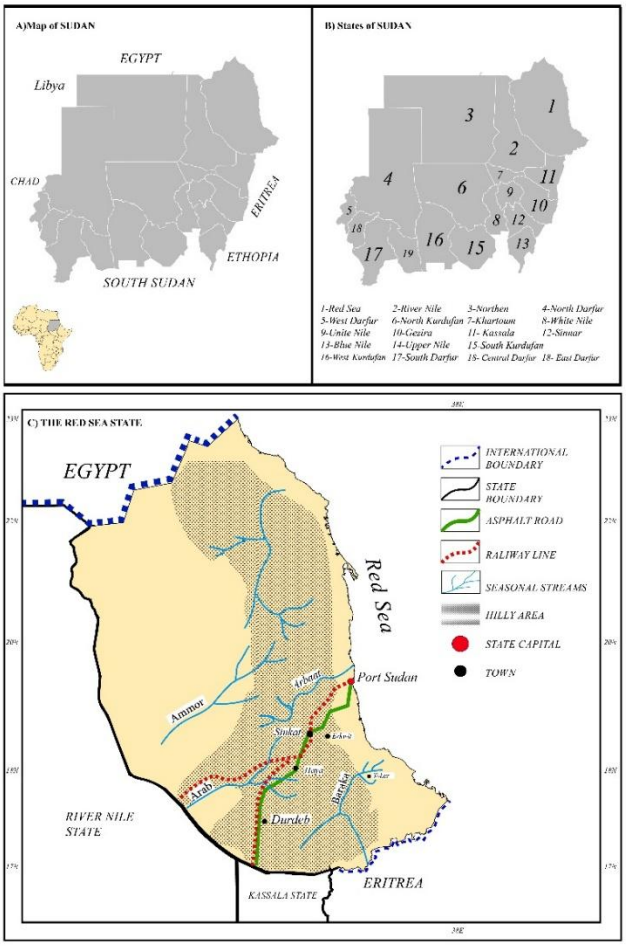
The fieldwork was carried during January and July 1996 in Sinkat Locality which was purposely chosen since the majority (75%) of the Bedouin Hadandawa concentrate. Four questionnaires were designed to survey rural households in areas of Arkaweit, Sinkat, Khor Arabs, Durdaiab, Rural Durdaib, and Haya rural council and were chosen since their reaching were inhabited by highlands Hadandawa who conserve their indigenous culture that satisfy with the objectives of this research. The sample size was 300 individuals chosen randomly and distributed among the selected sites according to size of the population. The limitations of data collection included linking the questionnaire with relief provisioning; mistrust of the respondents with the interviewees, difficulty to choose and access females as respondents, difficulty of transportation, and time-consuming. The illustration shows the challenges of data collection in rural environments, highlighting cultural interactions, environmental conditions, and logistical difficulties faced during the survey process.

## The Physical Habitat of Bedouin Hadandawa

The Red Sea State, with an area of approximately 125000 $Km^2$ in the North-Eastern Sudan, extends between latitudes 17° and 23° N and longitudes 34° and 38° E, neighboured by the Sudanese - Egyptian borders

from the north; the Nile State from the West; Kassala State and the Sudanese - Eritrean borders from the South (Figure 1). The climate is of dry-hot desert type within BWh climatic classification of Köppen (1931), with high temperature, low mean annual rainfall not exceeding 150 mm with high seasonal and annual variability. Soils types are varied and include the saline coastal type, rocky hill tops and steep slopes type, and the sandy alluvial of plains and valleys types (Barbour 1998). The vegetation is of drought resistant species such as *Cenchrus persica*, and *Aristida*, *Acacia tortilis*, *A.*, *Radeldiana*, *A. Etbiaca Salvadorapersica.* The topography and nature of climate of the study area determined type of drainage system and water budget. Infiltration rates are low due to water vulnerability to high evaporation rates and solid rocky surface that result in high loss of water. The estimated total annual discharge is of about 38 million m/3 (Abd el Ati 1996) on very few water courses such as Arab Odrus, Arbaat, Gowb and Langeb.

**Figure 1:** The Location of the Study Area.




## Results

### *The Bedouin Hadandawa's Traditional Natural Resources Management System*

The fieldwork results provided the main characteristics of this traditional system and are detailed in this section.

***The Economic System of the Bedouin Hadandawa***

The livelihood of the Hadandawa depends on traditional subsistence agriculture and animal keeping. Land, similar to other pastoral communities, is considered a highly valuable entity, as it is not just a means of livelihood, but also a source of wealth, identity, social peace (Sghaier et al. 2025). Herds are socially valued by the Hadandawa since they provide work to enable an individual to food sharing during crises, provide cash, milk, meat, leather and wool where milk is the basic ingredient in the Hadandawa food. This could be considered as a part of the history of evolvement of nomadism in Eastern Sudan that conforms to transformation in subsistence strategies and social organization where a greater degree of pastoralism followed by declining mobility and a shift to agropastoralism and this contradicts with evidence from paedogenic carbonates at Sai Island in northern Sudan, which indicated that, environmental changes predated a key shift in local food production from foraging to pastoralism (Adelsberger et al. 2020). Land holdings are determined by discharge seasonality and instability which imposed division of agricultural land among beneficiaries (Kassie 2020). This land is then divided into small parts transverse to water course to enable equal distribution of irrigation water among farmers. Each Hadandawa lineage (*Adat*) is allocated a plot of agricultural land divided among the family member (*Diwab*). Usually each household cultivates 5-7 Feddans (4204 $m^2$) in flat areas of water courses beds, and 2-3 Feddans on hilly areas. All Household members contribute into all agricultural activities to produce *aresorghum* (*Dura or hurob)* and *Lobia* (*Vigna Sinensis*) as the main agricultural crops.

Agriculture is practiced by about 75% of the Bedouin Hadandawa as a secondary activity and by 10% as a primary activity. It is practiced on flat beds of the water courses, around wells, water reservoir "Hafir", and small dams (Krrab) built of sticks to harvest water for irrigation. Generally, downstream catchment areas are more beneficial for agricultural activities compared to highland areas. The human settlements, agricultural and pastoral lands, and wells, are located inside these water courses (Meraiot, Meir and Rosen 2021). Sheep, goats, and camels are kept in Highland while few cattle are kept in the coastal plain, mainly in Toker Delta (Abu-Rabia 2020). The average size of a herd owned by a household ranges between 25-30 heads regardless of an animal type. Animals graze on natural pastures of narrow Red Sea coastal plain, foot of mountains and hills, seasonal water courses, and lands of Toker and Gash deltas (Mudoi 2022). Animal movement within the Hadandawa territory directs towards the Gash Delta and the western plains during summer season and to the Toker Delta during winter to cope with pasture scarcity in the highland and to access agricultural work in Toker and Gash Deltas (Soliman and Demissie 2024). These movements follow the water courses of Baraka, Arab, Amor and Sinkat. These movements changed following the famine of 1984 where long movements to Gedarief and Ed Damar were abandoned after 1984 due to decline in animals. Seasonal migration to Gash and Toker Deltas and towns increased due to degradation of the reproduction systems.

***The Social Salif System of the Bedouin Hadandawa***

The Hadandawa social system and political organization is of a hierarchical structure. It includes respectively, the "El Nazir", "Omdas", and "Shuiyukh". "El Nazir" is the leader of the tribe, while "Omdas" is lineage leaders from the same tribe or leaders of the small tribes within the same "Nazara" area, and "Shuiyukh" are religion men who represent big families. The Hadandawa believes that these leaders should be fair; brave, and competent in solving problems of livelihood affairs. This traditional leadership manages rationally and competently man-environment relationship through hieratical social institutions. The

Highland Hadandawa faced difficulties to adapt with scarce resources in a hilly and mountainous topography. This made them considered "land" a precious basic resource. They developed their adaptation strategies based on "the more resources they gain the more possibilities they find". They have developed the "Salif System" as the main system to manage shear resources and as an as adaptive mechanism of resource for reproduction.

The Salif system emphasized land a common property as termed "*Ohash hashon*"; "*albalad baladon*", and "*Ohash Babon* ". The first and the second terms mean "land is ours", while the term "*Ohash Babon"* means "land is the father". These terms indicate to its importance as a resource base for utilization, inheritance; and it solely confinement to the Hadandawa. These made the Hadandawa knowing their territory at a household, a family (*Diwab*), a lineage (*Adat*), and the tribe (*Gabila*) levels, where "land" is their "father" who allows them all to utilize and defend. The Hadandawa developed the *Asil* and *Amara* systems to organize Land division and utilization among a lineage. The *Asil* allows all to utilize resources for various purposes with absolute ownership of land that could be inherited exclusively by males and excluding of females. *Amara* system is more flexible than the *Asil* as it allows access of others' land by relatives and those who are in need. Hadendowa farmers who suffer from a shortage of irrigation water in years with low rainfall can resort to others to provide them with some irrigation water. This request should not be rejected as it is considered a disgrace in society.

Farmers are not allowed to remove harvest residues from their fields as they are reserved for livestock without restrictions. A farmer whose crops have matured is not allowed to start harvesting until he is sure that his neighbour's crops have matured to ensure that the harvest residues are available for livestock. The ancient sages (Surkenab) determine the harvest date and the date when animals can enter to graze the residues, thus preventing Bedouins from entering the cultivated fields. Failure to comply with this system is considered a violation that exposes them to financial penalties. Where water points and pastures are available, they are open to all Hadendowa lineages. According to the above, cutting green trees is strictly prohibited. In years of low rainfall, only young green branches are allowed to be cut to feed animals, while all lineages are allowed, in the case of dead trees, to use them as firewood, the sale of which is prohibited and restricted only to lineages who own land under the Asil system. Outsiders who live in the same area should request prior permission.

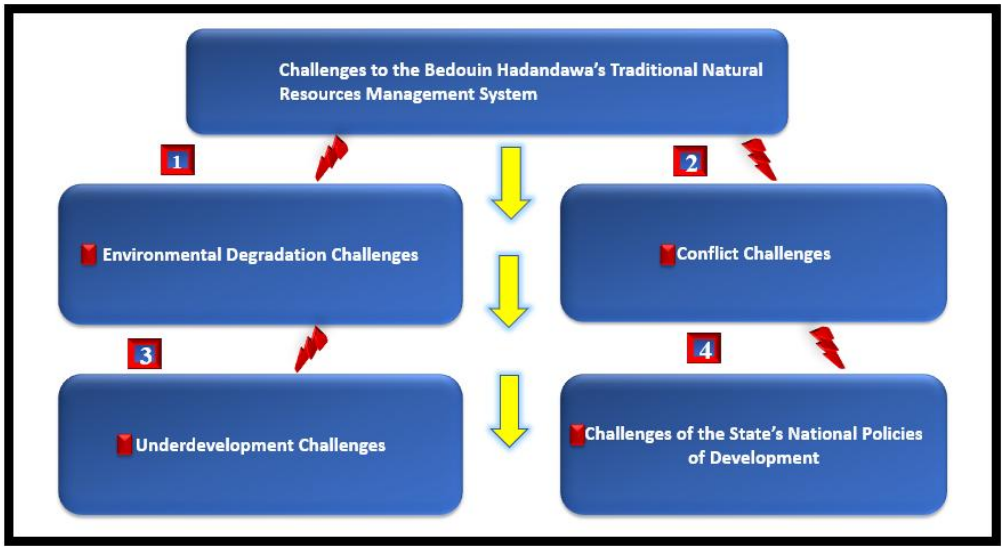
The Salif system manages livestock by "*Yahmut*" and *"Halag"* systems. "*Yahmut*" is a form of property redistribution where the rich help the poor by denoting some of their animals such as the case when a rich gives a poor a milking goat conditionally to return it if stopped producing milk. Here, the rich person has to replace it with another one or entirely donate it to him. In the *"Halag"* system the relatives donate animals to young males who are newly married. Here, the groom goes to relatives and friends to collect what they can donate and then returns home with 10-20 heads of animals which forms a wealth enables him to maintain his newly formed family. The Salif system for social management includes the *"Jalad"* system which is a council for resolving disputes based on *Salif* laws, It comprises of mayors, eldest persons from both disputing sides, wise men (sarkenab), and mayors from neighbouring areas. The "*Jalad"* Council is formed to guarantee the rights of the individuals and is formed immediately after a dispute occurs. The time span between "*Jalad*" meetings are periods prohibit neither party of the disputed has to violate law until issuing of the final decision. In cases of failure of the "*Jalad"* council failed to resolve disputes the case should be referred to the tribe or to the "Nazir" of the Hadendowa. The *"*Salif" system includes the "*Gwadab"* system a form of social work where a donor grants or gifts conditionally to return it whenever

able. The "*Gwadab"* is similar to the sharecropping system when an owner of a land allows a person to exploit his land conditionally on a share of the harvest. "*Gwadab*" also supply herders with food based on productivity of farmers due to that herders care more with animals than with agriculture. Usually, herders are willing to share their land with their relatives since their production does not meet their annual needs.

***Challenges to the Bedouin Hadandawa's Traditional Natural Resources Management System***

The Bedouin Hadandawa natural resources management system is faced by many challenges including underdevelopment, environmental degradation, conflict, and the State's national policies of development. Figure 2 highlights the challenges faced by the Bedouin Hadandawa's, which are detailed in this section.

**Figure 2:** Challenges of the Bedouin Hadandawa's Traditional Natural Resources Management System.




***Environmental Degradation Challenges***

This is the major challenge encountering the Bedouin Hadandawa's system of resources management as confirmed by 70% of the sample of the households' surveyed; this is conforming with the fact that the development of nomadism is mainly referred to ecological factors (Sadr 1988). The Gedarief State, which is one of Eastern Sudan region, underwent highly significant increases in the maximum temperatures, slight gradual increase in variability of annual rainfall and monthly temperature during that period 1961 to 2013, also the Butana region, which is also a part of Eastern Sudan Region, drought during the middle period of 1979-1996 and in some parts close to Ataba area, which is also a part of Eastern Sudan Region (Hošek et al. 2024). These climatic changes could be part of the Holocene environmental change in the northern and central Nile Valley which was leading to changes in aridity and water availability for early occupants of the region (Adelsberger et al. 2020), where desertification and aeolian deflation during the Middle and Late Holocene fostered migration and settlement and the further development of agrarian communities (Du et al. 2025).

***Conflict Challenges***

This is another major challenge to the Hadandawa's systems of natural resources management as was indicated by (20%) of the sample of the households' surveyed, since conflict had preceded the Hadandawa occupation of their present territory and continued during the Turkish- Egyptian (1821-1885), the Mahadism

(1885-1898), and the British rule (1898-1956), and recently in 1986 AD between the Beja and Benia'mer. The issue of marginalization of the Bedouin Hadandawa is old since, historically, the ancient nomadic peoples of north-eastern Africa, who lived under the urban systems of Egypt, Kush, and Aksum, as well as the Greco-Roman and Arab worlds, have generally been neglected in favour of the historical model of the "barbarian" peoples of the northern Sahara, and recently, associated with historical grievances, feelings of exclusion and marginalization, demands for fair sharing of power between different groups, inequitable distribution of economic resources and benefits, underdevelopment, the absence of a genuine democratic process and other governance issues (Davis 2023), that recognized the value of migratory livestock production as to lead to policy changes that support pastoral mobility (Behnke et al. 2020).

***Underdevelopment Challenges***

The Hadandawa Bedouin have depended on their native lifestyle for centuries, controlling natural resources through pastoralism and intimate social relationships. But over the last few decades, it has grown increasingly difficult to live this way of life. Most families cannot get enough pastureland and water for their livestock, which puts their primary source of income and sustenance at risk. As land access becomes more difficult, individuals have fewer choices, and it becomes challenging to continue their traditional means of livelihood. Meanwhile, other livelihood options are still not available, so many households lack alternative means of livelihood. Everyday life is also tough in various ways. Clean water, healthcare, and other essential services are hard to access for most, which makes it more difficult to live a decent life. Malnutrition is increasingly becoming a problem, particularly among children, as food shortages hit most households. When food relief is present, it provides short-term relief but does not address the long-term issue. Most families still remain in a state of uncertainty regarding their next meal, which hinders them from thinking about anything else but survival on a day-to-day basis. Something more sustainable is required—one that assists communities in obtaining consistent access to food and establishing stronger local economies that don't rely on external aid.

Education is also a significant issue. Most children cannot go to school because the schools are too distant, underfinanced, or inaccessible because of financial difficulties. Some children must contribute to their families rather than receive an education, which restricts their future prospects. Without adequate schooling, it is hard for the next generation to create a better future or keep up with the evolving world. Offering improved access to education, including training in practical skills, might lead to new avenues of economic security while still permitting communities to retain their traditions. More and more individuals have turned to outside assistance over time, but this has developed another issue. Although aid is helpful in the short term, it does not assist individuals in becoming independent. Many households get stuck in a cycle where they are unable to sustain themselves completely but also are unable to continue receiving aid. The actual solution is building up the local economies, enhancing the service provision, and providing opportunities through which people can flourish without giving up their traditions. In the future, initiatives must concentrate on achieving a balance—enabling communities to keep pace with challenges in modern times without compromising their way of living and providing them with means to construct a secure and sustainable future.

***The Challenges of the State's National Policies of Development***

The policies in place for the development of these years have totally transformed the approach to land

management and resources for pastoral communities, such as the Bedouin Hadandawa. The former systems that allowed human beings to survive on livestock grazing and cyclical migration were exposed to the increasing pressures today. Among the problems has been the emergence of large agriculture, which transformed the landscape and affected access to grazing land. The more land is converted for agriculture, pastoralists had to change, at times losing access to the land they used before. These events have also had their environmental effects. With land use change, natural vegetation is affected, and water sources initially hosting livestock and farming populations may be depleted. Ground conditions have altered in some areas so that the same amount of farming or pastoral production cannot be achieved. This has led to modifications in traditional practices over time with some having adjusted their way of life to endure the changing conditions. Yet another challenge is the change of land tenure and control.

Where land had traditionally been held and used in common and managed under local tradition, new regulations have introduced alternative regimes that might impinge upon access and control. This has been pushing transformations in how communities organize themselves and tap into resources. In some regions, individuals have been pushed to move in order to seek alternative economic livelihoods or migrate to regions where they occur. These changes have affected livelihoods alongside social and cultural relations. With such constant changes, there is ever more a necessity to look for ways of balancing development with the maintenance of indigenous systems of resource management. Involving local communities in decision-making can assist in formulating strategies that consider both current needs as well as old traditions. With the transitions ongoing and ongoing, it becomes ever more critical that one seeks solutions that ensure economic balance as well as conservation of nature's bounty.

***Keeping on with Challenges to the Hadandawa's Traditional System of Natural Resources Management***

The Hadandawa's indigenous natural resource management system is confronted by several recurring as well as emerging issues such as environmental degradation, economic stress, and land restrictions owing to policy. For its sustainability, an integrated strategy is needed. This study recommends a holistic vision consisting of four major elements, each designed to enhance the Hadandawa community's resilience while protecting their cultural heritage and resource management system as presented in Figure 3.

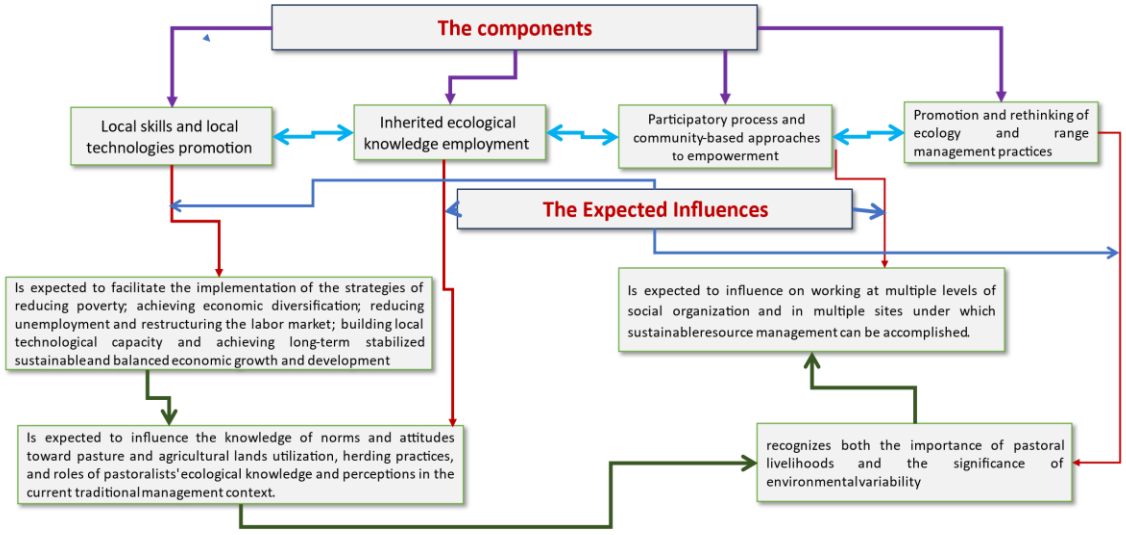
1. Promotion of local skills and local technologies – Intensifying traditional knowledge with improved instruments and methods can enhance the efficiency of resource management. With the incorporation of indigenous practices and sustainable technologies, the community can improve water conservation, pasture management, and agricultural productivity while adjusting to dynamic environmental conditions.

2. Traditional ecological knowledge employment – The Hadandawa possess centuries of ecological knowledge that inform their use of land and water distribution. By officially acknowledging and incorporating these practices into wider environmental policies, their skills in maintaining fragile ecosystems can be perpetuated and passed on to future generations.

3. Empowerment of participatory process and community-based approaches – Effective resource management hinges on inclusive decision-making. Support to the strengthening of local governance mechanisms and mobilizing active participation from communities can make sure that adaptation measures and policies fit the actual needs of the Hadandawa. Empowerment of local leaders, especially under the Salif system, can enhance conflict resolution and negotiations of land use.

4. Ecology and range-management practice reconsideration– With the intensifying threats from climate change and outside economic pressure, there is a necessity to reconsider and change conventional grazing and agriculture practices. Implementing sustainable land-use planning and enhanced range-management practices will enable the integration of livestock needs with environmental preservation to ensure long-term sustainability of the Hadandawa's pastoral system. This integrated vision provides a roadmap for adapting to new challenges while maintaining the core principles of the Hadandawa's resource management system. By combining traditional wisdom with modern sustainability practices, the community can strengthen its ability to thrive in a rapidly changing world.

**Figure 3:** The Proposed Model of Keeping on with Challenges to the Hadandawa's Traditional System of Natural Resources Management.




## Discussion

The challenges to the natural resources management systems of the Bedouin Hadandawa in Eastern Sudan have been faced by other Bedouin groups in Sudan and in their neighbourhood. In the Lower Atbara area of Sudan the external dynamics and processes have long affected and have irreversibly transformed nomadic pastoral livelihood systems (Drysdale 2024), and similarly, the Rashâyda pastoralists from Um Sayâla in Eastern Sudan, have been faced by 1985 A.C. drought which challenged their pastoral production and they have responded to it by their traditionally strong ties to the Gulf States which served them as a buffer, mitigating the negative effects of the crisis (Calkins 2009). They are part of the pastoralists of Eastern Africa who have been under loss of pasture; commoditization of livestock and land; livestock enclosures; drought; warfare; ill-advised development schemes; environmental degradation and overgrazing; a growing gap between rich and poor pastoralists; and the breakdown of traditional coping mechanisms (Schareika, Brown and Moritz 2021).

The land acts issued during colonial and post-colonial periods in Sudan have undermined the rights of traditional communal of pastoral people on land contributed in the deterioration of the traditional sector for

the benefit of the advanced modern agricultural sector (Alredaisy 2023a), particularly as the extent of pastoralism is positively related to GDP and to value added by agriculture is positively related to pastoralist's contribution to GDP. This consequently led to regional disparity of development (Alredaisy 2023a) and to the changing of the nature of local economies and social relations following from integration into large systems has threatened the viability of pastoral herding and led to increasing differentiation within and between local communities (Sorbo 1991). Here, although diversification is a strategy common to all tenants, the poor are obliged to diversify to provide an adequate subsistence, while the more affluent elect to diversify to increase profit (Salem-Murdock 2019), in situation that the whole planning exercise was conducted in the absence of any popular participation or support (El Arifi 1988).

The challenge of climate change to the Bedouin Hadandawa on natural resources management was experienced by other Bedouin communities in Sudan that were challenged by rain depletion during the periods of 1921-1950 and 1956-1985, and by decrease of annual rainfall rate by 15% as was in central Sudan. This has adversely led to the deterioration of about 120 million hectares of land, changes in biological factors; scarcity of tree products; general deterioration in the natural production base and in renewal of natural resources; and the expansion of the desert's environment (Alredaisy 2023b). This has also contributed into desertification and aeolian deflation which fostered migration (Tangi et al. 2023), and to destroy ecological zones and the ecosystems diversity in Central Sudan (Mohamed et al. 2016), and as for example, the over intensive land use by the growing population in villages in the northern part of the White Nile State (Trilsbach 2015), and the *Acacia tortilis* morphology which showed a correlation with the immediate environment (Andersen et al. 2022; Hošek et al. 2024). However, there are adaptation measures to counter environmental degradation in the Sudan-Sahel Zone of West Africa included use of manure, reforestation, soil and water conservation, and protection of fauna and vegetation.

The conflict in Eastern Sudan that was experienced by the Bedouin Hadandawa was experienced by most pastoral communities in Sudan and elsewhere. They could be attributed to high population growth rates, repeated droughts, ecological stresses and climatic changes (Emenike 2024), as well as the limited access to water and competing rights to land, intertribal conflict arises when pastoralists from one tribe enter the territory of another. Also, the increased availability of small arms in the region from past wars increasingly makes ordinary clashes fatal. Governments in the region have responded with heavy-handed coercive disarmament operations (Brosché 2023).

## Conclusion

This study investigated the Bedouin Hadandawa's traditional natural resource management system in Eastern Sudan, emphasizing its strengths, economic organization, and challenges. The results validate that the Hadandawa possess a well-established system based on cultural knowledge, social cooperation, and sustainable use of resources. Their economic system efficiently organizes land ownership, irrigation, and livestock management, while the Salif system is instrumental in controlling resource allocation and community welfare. But this system is increasingly stressed by environmental degradation, land conflicts, economic marginalization, and government policies promoting large-scale agriculture over pastoral livelihood. Climate change has exacerbated droughts and scarcity of resources, adding to threats to their livelihood. The research underlines the importance of a shared vision integrating sustainable development, secure tenure rights, and more effective local governance. Unless proactive intervention is undertaken, the Hadandawa's traditional resource management regime could be undermined by external forces. Future

policy should aim to promote their adaptation strategies while safeguarding their cultural heritage and securing long-term sustainability.

## Study Limitations

The research was based on a sample of 300 people, which, as much as it was helpful, could possibly not reflect the entire Hadandawa community or other Bedouin societies with similar issues. Another restriction is generated from the data-gathering process itself. There were respondents who were reluctant to answer because of distrust, potentially affecting the validity of responses. Association of questionnaires with relief provision may have also affected the response pattern of people, creating a potential response bias. In addition, gender coverage of the survey was restricted because inclusion of female participants was challenging given cultural limitations, which could result in an imperfect representation of household decision-making and resource management activities. In addition, the study relies mostly on qualitative descriptions and lacks comprehensive quantitative environmental information like long-term rainfall trends, levels of soil degradation, or economic effects on pastoral livelihoods. This hinders the possibility of statistically confirming the degree of environmental degradation and its direct effect on the Hadandawa's lifestyle. Finally, although the research compares the difficulties of the Hadandawa with those of other Bedouin communities, it does not include a comparative field study between regions, which would have offered a wider insight into how different Bedouin communities respond to similar threats. Future studies need to fill these gaps to construct a more inclusive understanding of Bedouin pastoral sustainability.

## Future Research Directions

Subsequent studies on the Bedouin Hadandawa's traditional resource management systems should take a longitudinal perspective to examine how these systems have changed over time, especially due to climate change, urban migration, and government policies. Follow-up studies on the same areas covered in the 1996 surveys would enable a valid comparison and demonstrate long-term patterns in land use, herding of animals, and economic adaptation. Moreover, future research should involve a larger sample that encompasses a more representative cross-section of community members, especially women and the younger generations, to determine how changes in lifestyle and aspirations affect resource management. Widening the geographical scope to compare the Hadandawa with other Sudanese Bedouin groups would also assist in determining common challenges and distinctive adaptive strategies.

Quantitative approaches should be integrated alongside qualitative methods to measure environmental degradation more precisely, using satellite imagery, remote sensing, and climate data analysis to track desertification, water scarcity, and vegetation loss over time. This would strengthen the empirical foundation of research on pastoral resilience in arid regions. Furthermore, given the increasing influence of market forces and urbanisation, future research could explore how modern economic pressures are reshaping traditional governance structures, particularly the Salif system. Investigating the role of government policies, development programmes, and international aid in either supporting or undermining pastoral livelihoods would also provide valuable insights for policy recommendations. Finally, interdisciplinary research that bridges anthropology, environmental science, and economics would provide a more holistic understanding of the sustainability of traditional resource management practices in Sudan and other similar pastoralist communities.

## Theoretical and Practical Implications

### *Theoretical Implications*

This study contributes to the broader discourse on pastoralist adaptation, indigenous resource governance, and environmental sustainability. It builds on existing theories of tribal land tenure systems, reinforcing the idea that traditional governance structures, such as the Salif system, play a crucial role in maintaining social and environmental equilibrium. The findings also align with the theory of environmental determinism, which suggests that ecological conditions shape human settlement patterns and resource management. Furthermore, this research highlights the intersection of socio-economic transitions and cultural heritage, supporting theories on rural-urban migration and economic transformation in pastoralist societies. It also adds to the debate on resilience theory, showcasing how traditional ecological knowledge enables pastoralists to survive in harsh environments. However, the study challenges the assumption that traditional resource management systems are inherently sustainable, revealing that external pressures—such as government policies and climate change—can destabilise these systems over time.

### *Practical Implications*

From a pragmatic perspective, the results of this research are of particular interest to policymakers, development agencies, and conservationists. To start with, they highlight the necessity of inclusive land tenure policies that acknowledge traditional pastoral land rights and not mechanised agriculture and big land deals. Incorporating traditional ecological knowledge in contemporary land management practices may prove to reduce desertification and over-exploitation of resources. Further, development programs ought to emphasize participatory strategies involving local Bedouin leaders in decision-making decisions instead of having top-down programs. Closing the education deficit among pastoral communities, especially youth and women, would also be instrumental in supporting economic diversification without entirely forsaking traditional livelihoods. Furthermore, climate adaptation mechanisms should be framed in partnership with local communities, with environmental conservation efforts harmonized with indigenous approaches. Investment in water management technologies, including sustainable irrigation and rainwater harvesting, might assist pastoralists in adapting to worsening drought conditions. Finally, mechanisms for resolving conflict need to be enhanced to resolve land conflicts and inter-tribal strife over access to resources. Regional collaboration among Sudan, Eritrea, and Ethiopia might also promote cross-border grazing arrangements that would minimize competition for limited resources and enhance the livelihood security of nomadic communities. Through an assessment of these theoretical and practical implications, future research and policy can serve to more effectively aid the sustainability of Sudanese Bedouin pastoral systems and those globally.

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