Desertification Combating in the Mauritania

Yuan You¹, Jie Zhou*¹ and Yongdong Wang¹

¹National Engineering Technology Research Center for Desert-Oasis Ecological Construction, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, 818 South Beijing Road, Urumqi 830011, Xinjiang, China.

*Corresponding Author E-mail: zhoujie@ms.xjb.ac.cn;

Abstract. The Islamic Republic of Mauritania known as “the desert of the Republic”, is located in the Western Sahara, which accounted for 2/3 land area of it, the remaining belongs to the edge of the desert semi-desert areas. With the purpose of survival, people are forced to deforestation destroyed the grass, excessive land reclamation, pasture overload use, which has formed a “deepening poverty and desertification, exacerbated by desertification poverty” vicious circle. The paper summarizes the present situation of Mauritania on combating desertification, two aspects of causes and problems in desertification from natural factors and human factors were analyzed respectively, characteristics and countermeasures arising in a desertification combating. Desertification has seriously threatened the people’s survival and development, which have become the country’s urgent need to face. The Mauritanian government has taken a series of effective measures on combating desertification, and Mauritania active in communication and collaboration with an international community in desertification, and actively serves as an agency in “the pan-African Great Green Wall” Initiative.

1. Introduction
Desertification is defined as “land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities” [1]. Desertification is a global environmental problem, nearly one quarter of the world land has been turned to desert, and 1.1×10⁸ people in over 100 countries have been faced with the menace of desertification, especially in some African countries were particularly serious. For half a century, the Sahara Desert has expanded 6.5×10⁵ km², is now the Sahara desert in the south of the Sahel (West Africa) region has become the world’s most serious desertification areas. The land is a necessary resource for human survival, and now the world couldn’t keep pace control desert its pace of increase. Therefore, desertification has seriously affected the survival of human and has become a major obstacle to sustainable development in the next century.

The Islamic Republic of Mauritania (referred as “Mauritania”) located in the western Sahara, and the east of Atlantic coast, which between 15°~27°/N, the area is 1.03×10⁶ ha, for which accounts 2/3 of the Sahara, 1/3 of the land also belongs to desert and semi-desert areas, so called “desert of the Republic” [2].

From periods 1913~1916, 1944~1948 and 1968~1973, appeared in the Sahara of North Africa continued drought and dust storms, which is exceptionally serious from 1968~1973, the years of drought swept through the southern edge of the Sahara, resulted in several hundred thousand of deaths,
to become the most tragic ecological disaster. Large numbers of farmers have been left homeless, Mauritania jobless herdsmen proportion of 9%, but in 1965~1988 of 41% [3]. Capital Nouakchott perennial scraping 5~6 East (West) north, on the day scraped away more than 200 m$^3$ of sand. One year had 200~240 days with at least 10 hours with airborne dust, and one in five storms had zero visibility [4]. The most frightening is that dust storms, known as “Hamadan”. When Sandstorms coming only 2~30 m visibility, dust thickness could be 500 m. One of Prime Minister had suffered a sandstorm, who killed by a plane crash. In the local dialect Nouakchott is the “tuyere”, means the strong sandstorm [5].

Mauritania is mostly covered by the Sahara desert, which is very susceptible to desertification damages. Desertification has seriously restricted the people’s survival and development in Mauritania. This study was conducted to analyze the desertification combating in the Mauritania, which could provide guidance and suggestions on desertification combating in Mauritania.

2. Study area
The Mauritania landscape is mostly flat with about 300 m low plateaus and its highest point, the east Rick Clifford at 915 m. The climate of the Northwest is hot and dry, the annual temperature is 30~35℃ and annual precipitation is 100 mm or less. And the southern Senegal River basin as tropical savanna, from May to October is the rainy season, from November to April of the following year is the dry season, which the annual temperature is 30℃ and annual precipitation is 250~650 mm [6].

The forest area of Mauritania is seldom, only in the Senegal River valley region, the national forest area only 4.8×10$^4$ ha, nearly half (2.2×10$^4$ ha) are concentrated in the Senegal River basin. Lack of energy, 50% of Mauritania household cooking timber, especially in rural areas the proportion reached 76% the limited forest resources also face being cut, even the danger of destruction. Currently Mauritanian reforestation 1×10$^3$ ha annually, but the area of forest destroyed each year is that 40 times. Mauritania’s arable land is 5.02×10$^5$ ha and accounts for 0.487% of the land area, of which 1.37×10$^5$ ha is irrigated farmland (account for 0.133% of the land area), 2.2×10$^5$ ha of rain paddy field, flood land 1.39×10$^5$ ha, and Oasis 5.5×10$^3$ ha. Agricultural areas are concentrated south of the Senegal River Basin Gorgol, Guidimaka, Brakna, and Trarza provinces [7].

3. The desertification cause and problems

3.1. The natural factors
Desertification is usually associated with land degradation in rangelands under drought, however, desertification combines many land degradation processes and can be exacerbated by climate change [8]. Periodic drought, sandy surface, low vegetation coverage, terrain topography are the main cause of the occurrence and development of desertification, climate change over the years is one culprit desertification [9].

3.1.1 Average annual maximum temperature. The anomaly variation of average annual maximum temperature of Nouakchott is shown in Figure 1. It could be seen that although the average annual maximum temperature is in a rising trend. The inter-year variation of the same still has a lot of small undulations. There are two obvious periods featuring the trend of temperature rising, i.e. from 1950s to early 1960s and from late 1960s to 1970s. From 1970s to the middle of 1990s, the temperature is always undulating and the temperature anomaly is below 0℃ at the most times. The temperature shows a trend of undulating rising since the middle and late of 1990s and reaches the maximum record at the end of 1990s. The recent variation of temperature still shows a rising trend, but the rate of increase is down slightly.
3.1.2 Average annual minimum temperature. According to the available temperature data, the average annual minimum temperature of Nouakchott shows different trends. From 1950 to 1967, the average annual minimum temperature is an undulated downward phase. The turning point is the year 1968. Since then, the anomaly variation of minimum temperature is in a gradual increase phase. Its variation range is greater than that of the average annual temperature. Therefore, the trend of temperature rising is more obvious than the change trend of average annual maximum temperature (Figure 2). Gradual increase in the average annual minimum temperature began since 1970s and rapid temperature rising appeared in the middle of 1980s. Since mid1990s, the temperature rising was accelerated. The highest average annual minimum temperature had been recorded at the end of 1990s and the early 21st century, which is similar to the average annual maximum temperature. The variation of average annual minimum temperature in recent years has the same characteristic as that of the average annual maximum temperature, i.e. there is an obvious trend of temperature rising, but the rate of increase is down slightly.

3.1.3 Diurnal Temperature Range. Corresponding to the variation of average annual maximum temperature and average annual minimum temperature, the average annual DTR (Diurnal Temperature Range) shows a general downward trend (Figure 3). From an inter-years point of view, there is an obvious increase in DTR of average temperature before the 1960s. Since the early 1960s, the DTR is in a downward trend until the middle and late 1980s. Since the late 1980s, the average annual DTR has been decreasing, but the extent is obviously reduced when compared with that in the earlier stage. Through the analysis on the variations of average annual maximum temperature, average annual minimum temperature, and average annual DTR, it is concluded that: the inter-years variation of average annual maximum temperature and that of average annual minimum temperature are almost the same, i.e. the temperature rising mainly begins from the mid-1980s in the past 62 years and reaches the highest record in late 1990s and is down slightly in recent years; because of the close relation with the variation of average annual maximum temperature and that of average annual minimum temperature, the variation of average annual DTR shows a similar characteristic and is in an upward trend in recent years.
Figure 2. Change of Nouakchott averages annual minimum temperature anomalies. The blue columnar is average annual minimum temperature anomalies. The red line is 3a moving average.

Figure 3. Change of Nouakchott DTR anomalies. The blue columnar is DTR anomalies. The red line is 3a moving average.

Figure 4. Year and Rainy Season Rainfall Change Curve of Nouakchott

3.1.4 Rainfall. Over the past 62 years, the annual rainfall in Nouakchott has shown a decreasing trend with the short rainy periods alternating with the pluvial periods periodically. However, rainfall in adjacent years differed a lot with the biggest gap of 182 mm being observed in 1994 and 1995 (Figure 4). The maximum annual rainfall in history was seen in 1956, recording 266.8 mm, while the minimum of 2.1 mm was observed in 1984, showing a range of 264.7 mm. It rains a lot mainly in July, August and September the rainfall during which accounted for more than 90% of the whole year.
3.1.5 Wind speed. The average wind speed in Nouakchott over the past 52 years of 1960~2011 was 4.7 m/s. Figure 5 shows the results of anomaly analysis and three-year slide anomaly analysis of the average wind speed year by year. The average wind speed in this region varied periodically and could be classified as fast wind speed and slow wind speed. The year of 1980 was a watershed. The wind speed in the region was slow from 1960~1980 during which the average wind speed was 0.55 m/s lower than the average for previous years and 95.2% of the years recorded negative anomalies. The average wind speed was very slow over the five years from 1966~1970 which was 0.82 m/s lower than the average for previous years. However, the period from 1981~2011 experienced strong wind speed and 87.1% of the years recorded positive anomalies. The wind speed during this period was 0.37 m/s higher than the average for previous years. Since 1980s, the average wind speed has risen significantly and it had increased to 4.71 m/s in 1980s from 3.52 m/s in 1960s, an average rise of 33.8%. The fastest wind speed was seen in 2011, 2 m/s higher than the average for previous years.

![Figure 5. The Year Average Wind Speed of Nouakchott in 52 Years](image)

3.2. The human factors

3.2.1 Rapid population growth. Mauritanian population growth from the 1960s 1,000,000 to 2009s 3,069,000, the total population increased by nearly three times. Population explosion and social need, not only increased pressure on land resources utilization but also undermine the rationality of traditional land use [10]. Doubled of the population also contributed to the demand for livestock doubled, made the multiplication of livestock has focused on decreased pasture, grazing the increased load, made the grassland degradation, reduced quality and further speed up the process of desertification. In a sense, human economic activity is excessive Mauritania’s main causes of desertification [11].

3.2.2 Overgrazing. Mauritania is based on livestock agriculture, and animal husbandry in the national economy is only second to the mining industry, account for about 1/5 of GDP, 3/4 of residents in animal husbandry [12]. Local people are uncontrolled livestock, for example, an eastbound departure from the capital, residential areas along the way pastures have undergone various degrees of degradation, and away from the residential area of grassland vegetation coverage and growth are better. Because of the mainly grazing livestock without rules, livestock pastures mainly eat that day can come back in the distance range of activities, thus increase the burden on settlements surrounding pastures. Another factor is the water resource is distributed in serious inequality, which greatly limits the expansion of pastoralists grazing point, and rarely seen grazing separate points in the field. Like this desert, reclamation land suitability is further cultivated into farmland in the rainy season, but these lands were abandoned, and finally, desertification and dune when the dry season comes [13]. Further, exacerbate soil desiccation, the only plant went in the destruction of human and livestock, and gradually evolved into a desert.
3.2.3 Poverty. Poverty in turn exacerbates desertification in Mauritania. Reduction of arable land, locals had to reclaim more land; freshwater shortages, dam up a lot of exploitation of groundwater, which caused the vegetation became scarce and even arid land. Mauritanians struggle against desertification is a poverty fight fundamentally [14].

4. Results and discussion
To combat desertification, Mauritania took some measures to prevent desertification and salinization of land. The country has made such principles and policies as a series of laws and regulations for protecting the environment after they have realized the significance of environmental protection. For example, forbidden deforestation, overload grazing, and large-scale afforestation. To develop water resources, reduce the use of land and sustainable development of intensive agriculture (Table 1). After decades of effort to get some of the desertified areas of governance and ecosystem gradually restored to prevent further desertification [15]. But Mauritania's industrial and forestry system is lagging behind the low degree of utilization of resource development [16]. So far, the country has yet to establish a unified system of clean energy, residents and some industrial energy mainly for timber, resulting in a large number of forest have been cut down, and small afforestation efforts keep up with the speed of deforestation and fire; the population increased, grassland reclamation, grazing and other agricultural, forestry, animal husbandry over-exploitation of resources; scarce water resources, mainly rely on rain-fed agriculture, the poor irrigation and agricultural technology, the low productivity; the poor survival rate of afforestation, reforestation plant species monotonous; strengthen climate aridity, increased poverty; state protection and legal awareness not strong; some agricultural technology has some development, but low penetration, even very primitive backward industrial and agricultural production, hindered the development of the productive forces [17].

Above mentioned fundamental problems, the exacerbating desertification also affects the lives of local people and production, through the modernization of the system need production system, particularly the scientific development of energy, water, agriculture, forestry, animal husbandry systems, rational use of resources to effectively improve the local ecological environment, curbing the further development of desertification [18].

| Time       | Policy name                                                                 |
|------------|----------------------------------------------------------------------------|
| 2018       | National livestock development plan 2018~2025                              |
| 2017       | National environment and sustainable development strategy and action plan  |
|            | for 2017~2021                                                              |
| 2015       | National agricultural development plan 2015~2025                           |
| 2014       | Mauritania’s strategy and action plan for implementing the “Great Green  |
|            | Wall” initiative                                                            |
| 2010       | National biodiversity strategy and action plan horizon irrigation           |
|            | agriculture development policy letter 2011~2020                            |
| 2008       | National action plan for rural women                                       |
| 2006       | National sustainable development strategy                                  |
| 2004       | National adaptation action plan for climate change adaptation              |

5. Conclusion
To control the desertification, the government decided to combat desertification into the whole process of national sustainable development strategies and four action plans are being implemented (1) Nouakchott Greenbelt Project; (2) fixing sand projects; (3) sand encroachment prevention programs and the development of agricultural projects; and (4) development projects oasis of green belt plan. Besides, the focus of the Special Programme for the protection of the capital Nouakchott greenbelt
afforestation project: duration of 4 years (2010–2013) and the project aims to build 16 green areas, 2000 ha of governance mainland dunes, 150 ha along the coastal dunes.

In recent years, the Mauritanian government increased efforts in building on the environment, desertification in some areas have been effectively controlled. The ecological environment is effectively restored. Mauritania with the active involvement of the international community is taking a series of strategic measures, and measures of desertification control [19].

1) Control the population, limits grassland cultivation, and overgrazing. Mauritania increased population pressure and environmental issues, through the promotion and advocacy of birth control, prenatal and postnatal care has begun to develop in the city, slowing population growth, to reduce the cultivation and overgrazing pressure.

2) Introduction to expand the scope of protection screening desert plants and the introduction of economic plants from abroad, improve the survival rate of the ground between the mound planted seedlings.

3) Strengthen water conservancy construction, construction of reservoirs used to expand the development of drip irrigation water-saving technologies, improve agricultural productivity [20].

4) Publicity and raise environmental awareness, build a conservation-oriented society [21].

5) Improve the ability of drought risk management, the establishment of early warning drought risk management platform, increasing inter-regional and inter-country cooperation [22, 23].

In this study, although the analysis is preliminary, the objective involved positive implications for policymaking and management. At present, 11 African countries are jointly to establish a greenbelt across the African continent. The total length of the plan for more than 7100 km wide and 15km, west from Senegal and east to Djibouti, pass through Mauritania, Mali, Burkina Faso, Nigeria, Niger, Chad, Sudan, Ethiopia, and Eritrea 9 countries on combating desertification. Mauritania has been acted as an agency in the “Great Green Wall” Initiative. And plans to build 20 ha botanical gardens in the capital Nouakchott (including 5 ha nurseries), to select adaptable species for the “Green Great Wall” Initiative, and also to improve the living conditions of residents.

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