

## **Disaster Risk Profile analysis for better decision on climate financing Instrument in Mauritania**

### **Abstract**

Climate change impact increasingly led to humanitarian assistance increase and needed. To better address climate change impacts mitigation, a suitable financing instrument is essential to facilitate government, humanitarian, and other stakeholders finance mobilization. However, few studies are done on disaster risk profiling to guide decision makers in their choice. Disaster risk profile analysis has been conducted in Mauritania to facilitate financial resources mobilization and climate finance instrument choice by identifying Historical drought and flood events. To do so, published papers; and some international institution website dealing with climate hazard events such as Reliefweb, Hazard/risk, climate information services, Relief Web; CRED- EM-DAT; World Bank Climate Knowledge Portal, World Bank- UNDRR -ThinkHazard, WFP ARC/GeoNode/VAM/DataViz addressing Mauritania country have been assimilated for evidence accumulation and synthesis and presented in a database. Furthermore, national statistics and national reports on hazards have been also being reviewed. Before starting the reading exercise, a reading/analytical framework has been elaborated. Thirteen (13) drought events have been occurred between 1965 to 2020; in Mauritania and the most exposed regions of drought are Brakna, Gorgol and Assaba. While from year 1984 to 2020; fifteen (15) flood events have been occurred in Mauritania and the most regions impacts are Tangant, Trarza and Inchiri. Time return period of identified hazards has been estimated and compared to identify the suitable climate disaster risk financing instrument for flood and for drought. Drought events are less frequent than flood events, however, drought event affect more population than flood. Also, the yearly response cost for drought event is US D million 192.984 with an average US 204.37 cost per affected population. For the flood event the yearly response cost is US D 1 428 707 With USD 90.45 per affected population. Macro-insurance and CAT bonds are more suitable and recommended to better address drought events while Anticipatory action and government contingency fund are more suitable to better address flood events in Mauritania.

**Key words:** Anticipatory Action, climate risk financing, Climate Insurance, climate resilience drought and flood.

### **1. Introduction**

Climate change is becoming more and more a major development challenge for humanity. Atmospheric carbon dioxide (CO<sub>2</sub>) rising is cited as the main factor and cause of global warming and is attributed, in large part, to human activities (Lindzen, 2009; Neya *et al.* 2020). To address these global challenges, United Nations Framework Convention on Climate Change (UNFCCC) has been created since 1993 by international community in order to find an

inclusive and holistic solution involving worldwide countries. Therefore, UNFCCC recommended his countries members to develop and implement local policies in order to cope with climate change impacts and to contribute to reduce Greenhouse's emission to stabilize temperature increasing at 2°C, through their national adaption plan (NAP) and their Nationally Determined Contribution (NDC) in application of Kyoto Protocol 2007, Paris Agreement 2015, Sendai Framework 2015 and Katowice climate package 2018. Despite, Africa, neglected contribution to global greenhouses gases, still the most vulnerable Continent to the adverse effects of climate change. Climate change pose challenges to African countries on-going efforts to combat poverty, food insecurity and sustainably manage natural resources because Standards of living remain low. Droughts and floods have increased in frequency and intensity over the last two decades and adversely impacted food and water security, energy generation and livelihoods. In application to international community advices, African Countries through Organization of African Unity (OAU) adopted the Agenda 2063 in 2013 during through the 50th Anniversary Solemn Declaration during the commemoration of the Fiftieth Anniversary of the Organization. The main vision of AU Agenda 2063 is "to build an integrated, prosperous and peaceful Africa, driven and managed by its own citizens and representing a dynamic in the international arena" in order to tackle collectively the main impact of climate change. Mauritania which is part of Africa union, and member of UNFCCC since 1994 and ratified Kyoto protocol in 2007 developed and implemented his first adaptation plan in 2004, the second in 2015 and it first NDC in 2015 and the second NDC in 2021 in order to implement AU Agenda 2063 and to contribute to international effort to overcome climate change effect and to build Mauritanian resilience's through the adoption of social protection policies in application of Sandai framework. To mainstreaming climate change in its development policies, Mauritanian Government adopted a strategic framework against Poverty II (CSLP2, 2011–2015); for the first time, climate change was addressed as a priority issue in the Poverty Reduction Strategy Paper (PRSP). Its substitute, the SCAPP (Accelerated and Shared Growth Strategy) 2016-2030, intends to reinforce climate change considerations, Sandai framework and their mainstreaming into sectorial strategies and policies; Also some other planning dealing with climate change have been developed such as (i) the National Environment Action Plan II (PANE, 2011–2016); (ii) the National Strategy for Rural Development (SDSR, 2013–2025); (iii) the Strategy for Agriculture and Food Security (SASA, 2012–2015) and (iv) the National strategy for sustainable access to water and sanitation to 2030 (GCF 2017). In addition to those policies Mauritanian government adopted some specific legislation addressing drought and to reinforce Sandai framework implementation such (i) Decree 042-2002 reorganizing the national framework for consultation on food security; (ii) Decree 2002-042/PM establishing the National Fund for Humanitarian Action and (iii) Order no. 0693-2005 establishing the organization and operations of the Sectorial Technical Committee (food security). and addressing disaster risk management such (i) Decree 2002-17 on the organization of emergency relief; (ii) Order no. 0431 setting the rules of organization and operations of the Permanent Unit for the Coordination and Monitoring of Emergency situations; (iii) Joint Order n°. 430 MIPT/CSA setting the rules for the organization and operation of regional emergency units ; (iv) Joint Order no. 430 MIPT/CSA setting the severity thresholds of

emergency situations and (v) Decree 80-087 of 2 May 1987 on the general regulations of the Civil Protection and the implementation of the ORSEC Plan; (ARC 2020). However, the suitable climate disaster risk financing instrument is essential to mitigate efficiently the climate impact

## **1. Method**

### **1.1. Country Overview**

#### **1.2.1 Geography**

Mauritania is located on the coast of the West African Sahel and has a total land mass of 1.03 million km<sup>2</sup>. Mauritania is located between latitudes N 27° 20' and N 14° 45' and longitudes W 5° and W 17°. The country is divided by three ecological zones, such as: (i) Saharan zone over most of the territory in the north, (ii) coastal zone in the west on the Atlantic strip, and (iii) Sahelian zone in the extreme south. Mauritania is the eleventh largest country in Africa. More than 2/3 of its territory is desert and less than 0.5% is suitable for agriculture. A transition country between the Sahara and the Sahel, it is bordered to the west by the Atlantic Ocean, to the north by the Western Sahara and Algeria (MEDD 2021). The climate is generally dry climate typified by low and irregular rainfall varying from 450 mm in the far south to 50 mm in northern two-thirds of the country (ARC 2014).

#### **1.2.2. Population and Demographics**

The population is estimated to exceed 4.7 million in 2020, given an annual demographic growth rate of 2.8 % (World Bank 2019). Since large areas of the country are part of the Sahara region, the majority of the inhabitants live in the coastal cities of Nouakchott and Nouadhibou and in the Senegal River Valley, which has a more moderate Sahelian climate. The population is predominantly young, with 57.1% under the age of 20 years, and a significant proportion of households headed by women, estimated at one-third (32%) of heads of household. The country is expected to have more urban inhabitants, with over 50% of the population living in urban areas (PIK 2021).

#### **1.2.3. Economic and Social Prosperity**

The country's economy is dominated by the services sector, contributing 45.8 % to the country's GDP in 2019, followed by the industrial sector with 25.3 % and the agricultural sector with 18.7 % (World Bank 2019; PIK 2021) with real GDP per capita of 1 756 USD and an annual GDP growth rate of 3.1 %, (World Bank 2019; PIK 2021). Mineral products (e.g. iron and copper ore), shellfish products and frozen fish are Mauritania's key exports, with fruits and malt being the main agricultural exports (OEC 2018; ; PIK 2021) . In 2018, over 90 % of fruits were exported to France and malt was exclusively exported to Mozambique (OEC 2018; PIK 2021). The poverty rate fell from 42% in 2008 to 31% in 2014 with an annual reduction rate of

1.8 at the national level; 2.5 in rural areas and 0.7 in urban areas (MEDD 2021; WFP 2021). The poverty rate in rural areas is close to 60%, with 30% of the population living in extreme poverty. Mauritania is classified as a Least Developed Country (LDC), with a low Human Development Index (HDI) of only 0.433, ranking 136th of 169 countries (GCF 2017, World Bank 2019).

#### **1.2.4. Food and nutrition security**

Mauritania is exposed to recurrent cycles of drought, resulting in the degradation of natural resources, and structurally affecting productive capacity, resilience, and food security of the populations. Because in Mauritania the main crops cropped are rice, Maize sorghum and the main animal breed are Camels in the driest areas; Goats where shrubs and trees dominate; Sheep on mountain pastures that are too rugged for cattle and Cattle in areas where open savanna provides decent grass cover and adequate water small stock or shoats (sheep and/or goats) provide the “small change” for everyday transactions, while larger stock may be sold to cover larger one-off expenditures (e.g., school fees, social obligations) (FEWS NET 2018). For instance, in 2020, total cereal production has been estimated at 480,000 tons against an estimated cereal need of 1,060,000 tons, with net deficit of 58,000 tons to be covered by imports (FAO 2021). According to the March 2021 “Cadre Harmonisé” analysis, about 196 000 people are estimated to be food insecure and need food assistance and is projected to increase to 484,150 people during the peak of the lean season. One in five children is chronically malnourished, estimated to cost the country US \$759 million in annual economic loss and 9.8% of young children suffer from acute malnutrition (WFP 2021).

#### **1.2.5. Livelihood strategies used by the vulnerable populations**

Mauritania is extremely faced to adverse weather events resulting from climate change and Small-holder farmers and herders are heavily dependent on seasonal rainfall. Smallholder farmers in Mauritania are increasingly challenged by the uncertainty and variability of weather that climate change causes (Sultan 2013; Traore *et al.*, 2013) and the main crops cropped are maize, millet, sorghum and rice (FAO 2020). The main species breed are cattle Goad, Sheep and Camels which are both vulnerable to climate change. Since crops are predominantly rain fed, crop yields depend on water availability from precipitation and are prone to drought. Moreover, the length and intensity of the rainy season is becoming increasingly unpredictable and making smallholders farmers production system worse (FAO 2016). To cope with climate effect the following coping system have been developed and implemented by vulnerable population accordingly:

##### **1.2.5.1. Pastoral migration**

Agro-pastoralist households in Mauritania often use short-term migration as a livelihood adaptation strategy, but women are less likely than men to travel for short periods. According to NUPI; 2021 Pastoral migration seems to be an important adaptation strategy in Mauritania and the Sahel region, requiring climate sensitive policy responses that consider the needs of

pastoralists and farmers alike particularly in areas experiencing increasing in-migration and intensive resource use. However, despite women assume household leadership but lack the access to services and alternative livelihood strategies available to men, making them doubly exposed to climate change, food insecurity and malnutrition (NUPI 2021). In addition to pastoralists effort to cope with climate effect Mauritanian government and its partners such as WFP, ARC another trying to develop policy frameworks for responding to changing migration and mobility patterns, to support climate mitigation and adaptation strategies that reinforce the resilience of farming and herding communities and prevent violent conflict.

#### **1.2.5.2. Climate Smart Agriculture Practices**

The most Climate Smart Agriculture (CSA) developed in Mauritania are : (i) introduction of new cropping systems;(ii) increasing the use of improved varieties that are adapted to local conditions, (iii) using new agricultural technologies (soil and water conservation), (iv) diversifying agricultural production, (iv) improving access to credit for agricultural activities; and securing water for agriculture through the building and maintenance of wells, (v) digging of canals to irrigate more land and cleaning of canals that have been filled with sand, and (vi) constructing new irrigation schemes based on water (PANA 2007; GFDRR 2011) and (vii) strengthening early warning systems to help farmers make use of agro-meteorological information. According to Ministry of Rural development 2011 the use of irrigation facilities remains limited despite Mauritania's considerable irrigation potential of approximately 135000 ha, only 0.030 % of that potential is irrigated.

#### **1.2.5.3. Domestic energy promotion**

To cope with energy issue, improved stoves, replacing charcoal with gas for cooking, improving coal production efficiency, and regulating charcoal markets are promoted (PANA 2007; GFDRR 2011)

#### **1.2.5.4. Support to food-insecure vulnerable households**

In addition to local strategies developed by vulnerable people to cope with climate effect and build their resilience; some partners such as WFP and other international NGO provide support to support them to cope with food insecurity through the development or rehabilitation of productive, natural or social assets, the intensification and diversification of livelihood activities and improved access to markets, using an integrated, gender equitable and participatory community approaches and with food assistance (WFP 2021). Also, investments in research and extension services to enhance the capacity and delivery of information to the agricultural sector, with particular reference to climate change and the implementation of adaptation options have been developed by the government and his technical and financial partners. Thus, leading to gaining a better understanding of production and harvest market implications for key staples such as maize, millet, sorghum and livestock as well as trials for high-yielding varieties; implement integrated soil fertility management practices to rehabilitate degraded land and preserve soil fertility.

## **2.2. Historical drought events identification**

For Drought event identification, published papers; and some international institution website dealing with climate events such as OCHA through Hazard/risk, climate information services, Relief Web; CRED- EM-DAT; World Bank Climate Knowledge Portal, World Bank- UNDRR -ThinkHazard, WFP ARC/GeoNode/VAM/DataViz addressing Mauritania country have been assimilated for evidence accumulation and synthesis and presented in a database. Furthermore, national statistics and national reports on hazards have been also being reviewed. Before starting the reading exercise, a reading/analytical framework has been elaborated. The analytical framework provides a means to incorporate key information pertaining to the drought Risk Profile such as drought year drought manifestation weather is meteorological, agricultural or hydrological, drought frequency, drought covered area or zone, Socio-economic impacts and Response cost if applicable.

In addition to a literature review, rainfall data per given drought event year were performed for better understanding of drought event have been analysis in order to sustain the information's recorded through literature review using country rainfall data if they available or using recent advances in open data, remote sensing and geospatial cloud-based processing solutions such as Google Earth Engine (GEE) that provides a number of benefits for the processing of high resolution, temporal big climatic, environmental and demographic spatial data.

For impact modeling purpose, Africa RiskView model was also used to model the impacts of drought, and the outputs are presented in terms of annual averages rather than absolute modeled estimates to compare with found results. Thematic maps are also presented showing the impacts of the specific drought at administrative level such as province, district, county, and department, as applicable. Also, a stocktaking of key data and information derived from national agriculture statistics have been carried out as a means to highlight the impacts of drought on agriculture production over time in order to sustain the information's found with Africa RiskView.

For risk metric purposes, Average Annual Population (AAP) affected and Average Annual Losses (AAL) for Mauritanian have been estimated and presented in graphic format for comparative purposes using Africa RiskView model. To highlight gender, population affected has been disagreed by gender (male/female).

Country technical experts of Mauritania in different sectors within the government, UN, academia, non-state actors, among others have been involved to collate and harmonize information's and data. Finally, country Technical Working Groups has been involved to validate the DRP.

### **2.3. Historical Flood events identification**

For Flood event identification, published papers; and some international institution website dealing with climate events such as OCHA, Hazard/risk, climate information services, Relief Web; CRED- EM-DAT; World Bank Climate Knowledge Portal, World Bank- UNDRR - ThinkHazard, WFP ARC/GeoNode/VAM/DataViz addressing Mauritania country have been assimilated for evidence accumulation and synthesis and presented in a database. Furthermore,

national statistics and national reports on climate hazards have been also being reviewed. Before starting the reading exercise, a reading/analytical framework has been elaborated. The analytical framework provides a means to incorporate key information pertaining to the flood Risk Profile such as flood year and in the subsequent columns, information such as flood manifestation weather is river flood, flash flood or urban flood, flood frequency, flood covered area or zone.

In addition to literature review, rainfall data per given flood event year were performed for better understanding of flood event have been analysis in order to sustain the information's recorded through literature review using country rainfall data if they are available or using recent advances in open data, remote sensing and geospatial cloud-based processing solutions such as Google Earth Engine (GEE) that provides a number of benefits for the processing of high resolution, temporal big climatic, environmental and demographic spatial data.

For flood hazard impact and risk metric assessment purpose, the damages and losses value method has been used using local price value and if there is lack of information about those value similar value used from other countries have been applied in order to estimate the damage or losses value. For instance, number of populations affected, injury, deaths, livelihood affected (loses of animal, crops area per type of crop), habitat losses caused by flood have been recorded and estimate their monetary value.

Country technical experts of Mauritania in different sectors within the government, UN, academia, non-state actors, among others have been involved to collate and harmonize information and data. Finally, countries Technical Working Groups have been involved to validate the DRP.

#### **2.4. Climate disaster Risk financing Instrument choice**

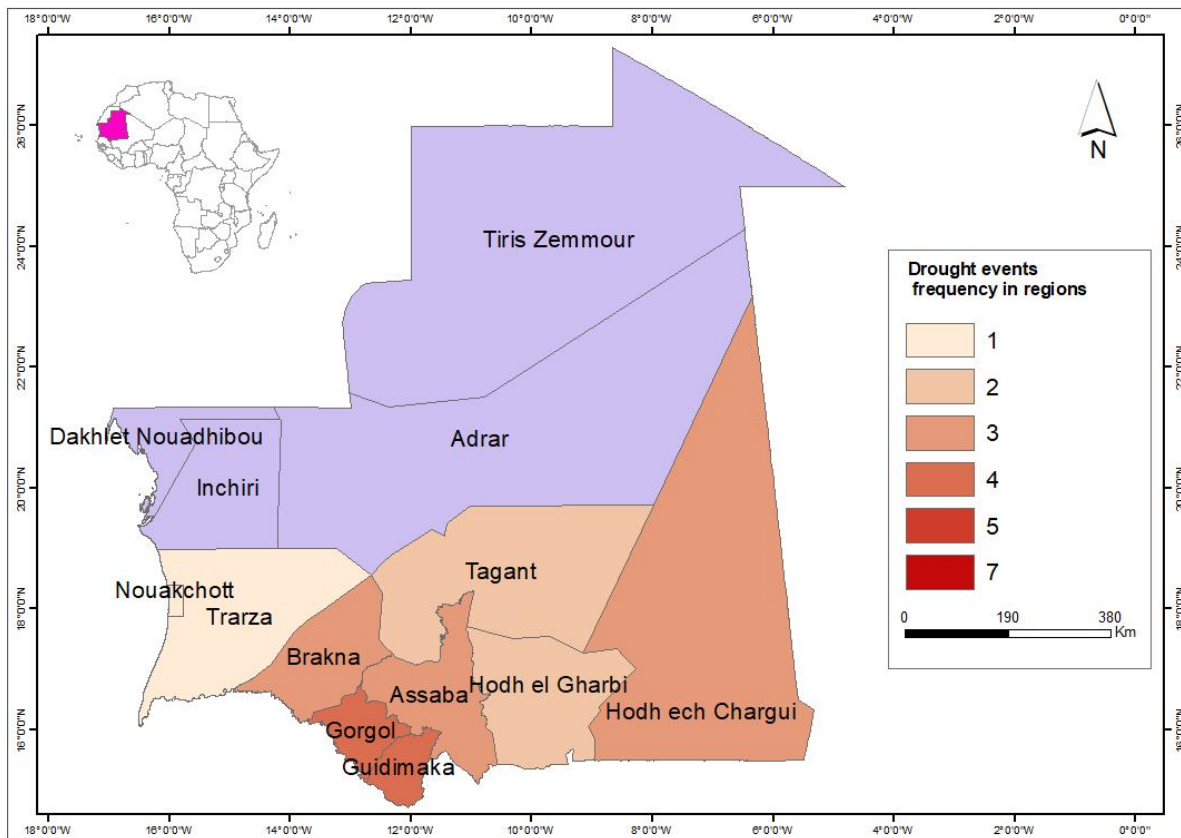
For suitable climate disaster risk financing instrument chois the time return of each has been estimated and compared. Also, the population affected per hazard has been estimated and compared. The hazard which had time return less than two years and less affected population will fil within Anticipatory Action and contingency plan. Those hazard with time returns greater than three years and high affected population suited to macro-insurance mechanism.

### **3.RESULTS AND DISCUSSION**

#### **3.1 : Drought Hazard**

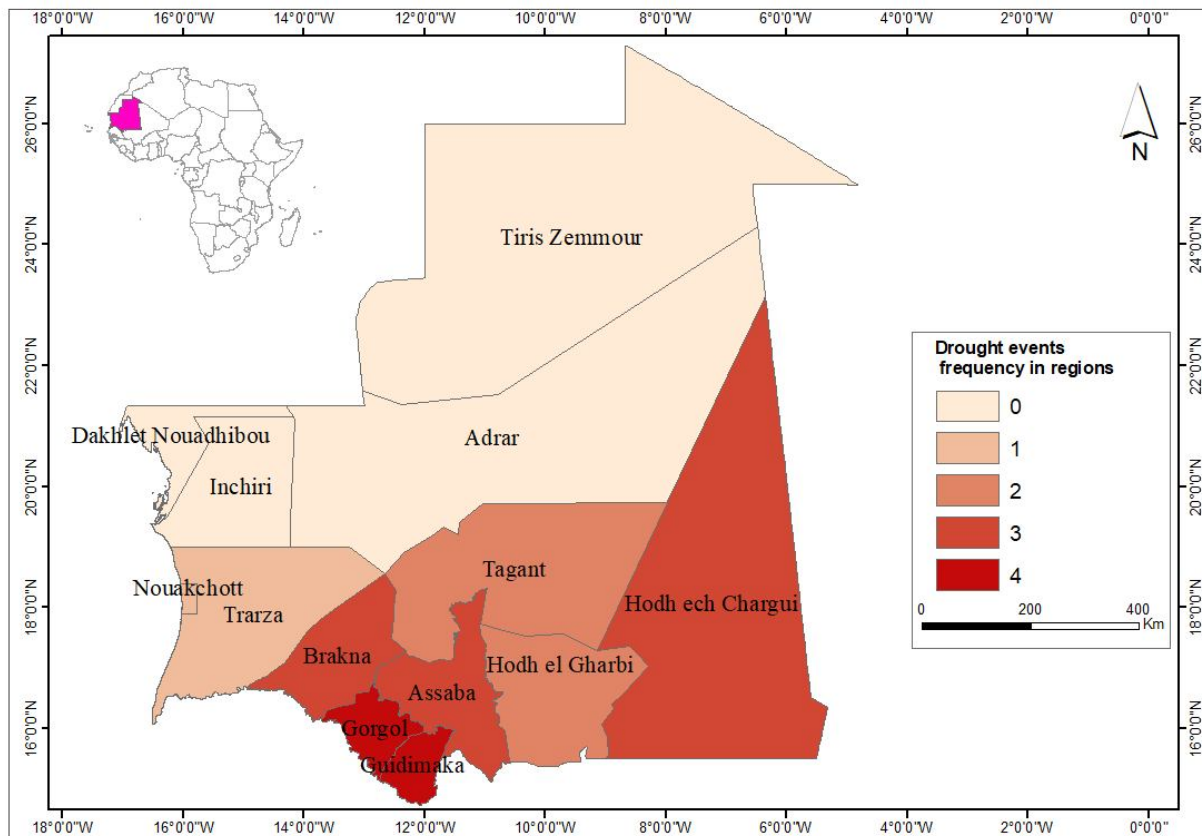
##### **3.1.1 Drought Hazard Exposure**

Drought hazard event analysis shown that from year 1965 t0 2020; 13 drought event have been occurred in Mauritania and the most exposed regions of drought are Brakna , Gorgol and Assaba with respectively 7 drought event over 13 (Figure 1) and the main drought event are meteorological and agricultural drought (Early Warning System).



**Figure 1:** Number of Drought event per region from 1965 to 2020 in Mauritania

Also Mauritania drought occurred event analysis reveal that the time of return of drought event is around 4 years. It means that, each four (4) year Mauritania is exposed to drought event or for each decade yearly Mauritania is exposed to 4 drought **events**. However, the last decade year's drought event analysis in Mauritania from 2010 to 2020 revealed 5 drought events meaning that for each two years drought event has occurred and the most exposed regions are still Gorgol and Guidimakha regions (**Figure 2**)



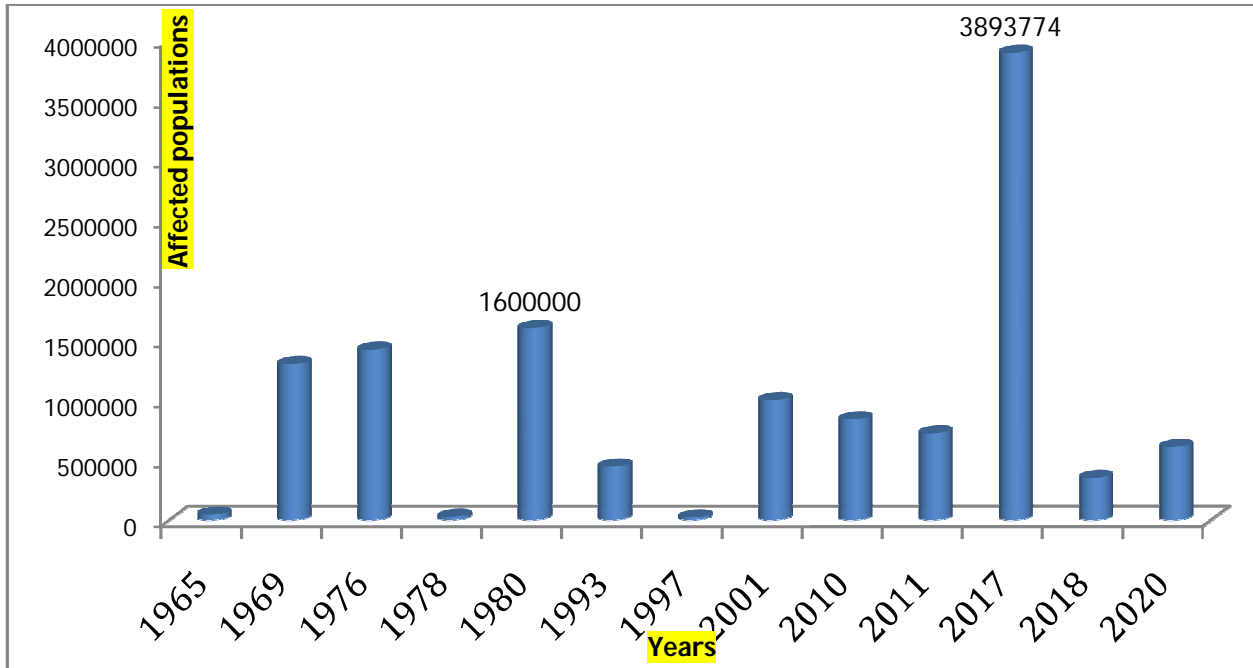
**Figure 2:** Number of Drought event per region from 2010 to 2020 in Mauritania

### 3.1.2 Mauritania Vulnerability to Drought Hazard

The time of return of drought event has estimated about 4 years is less than 10 years returned time making the Mauritania more vulnerable to drought event (Figure 2) That will be affect food production system and making Mauritania more vulnerable to food insecurity given that most of the active population is smallholders farmers, herders and their farming system are rain fed predominant. According to GFDRR 2020 drought events are expected to occur on average every 5 years and will be more frequent and less than that due to the effect of climate change.

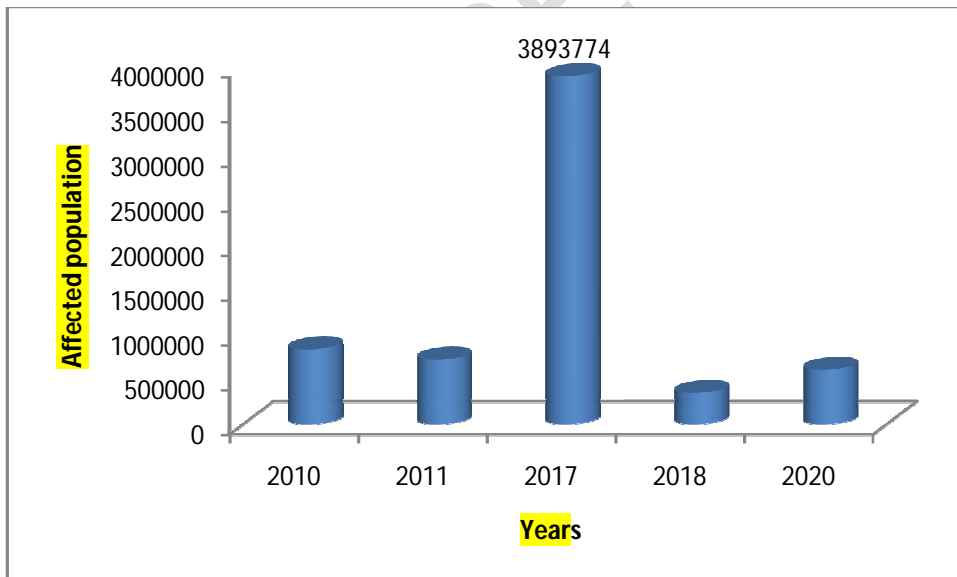
### 3.1.3. Historical affected Population

From 1965 to 2020 thirteen (13) drought year events have been recorded and affected around total population of 12.27 million with an average of 944266 inhabitants per drought event (Figure 3).



**Figure 3:** Affected population of Drought events from 1965 to 2020 in Mauritania

From 2010 to 2020 five (5) droughts event have been recorded and affected around 6 414 554 people in total with an average of 1 282 910 per drought year event (Figure 4). However the 2017 drought event affected more than 3.8 million peoples.

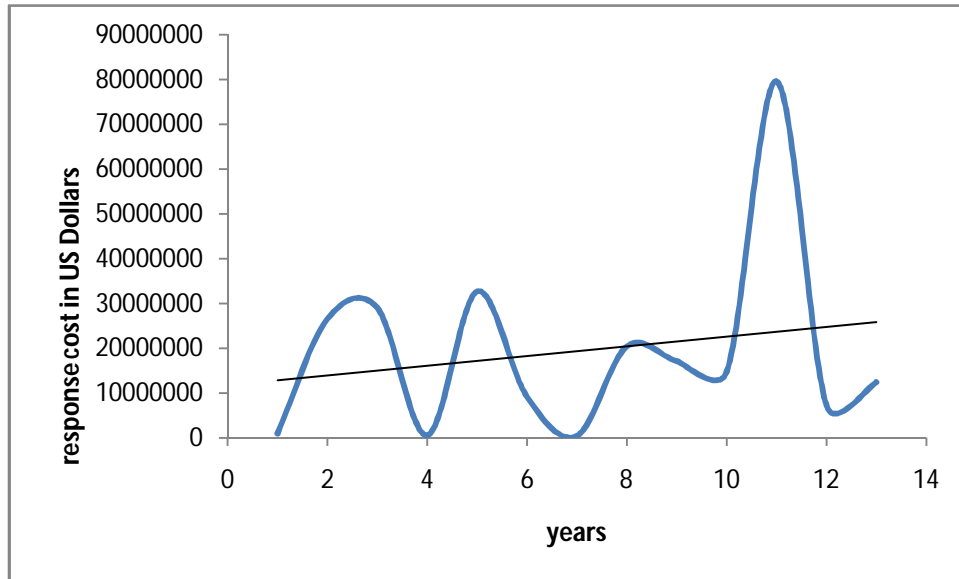


**Figure 4:** Affected population of Drought events from 2010 to 2020 in Mauritania

### 3.1.4. Risk Matrix/ and Modeled cost of drought impact

According to Mauritania country meter consulted in 20/12/2021 the population is composed by 50.3% of men and 49.7% women so mathematically 3226521 men and 3188033 women were

affected. This analysis mean that Mauritania should be prepared yearly to assisted 1 282 910 peoples that will be exposed to food insecurity. According to Mauritania government the yearly need in Cereal per inhabitant has been estimated to 214 and in 2016 and cereal price has been estimated by FAO 2021 at 45. MRO/kg/ USD 0.13) given the cost of response per drought event presented by Figure 5.



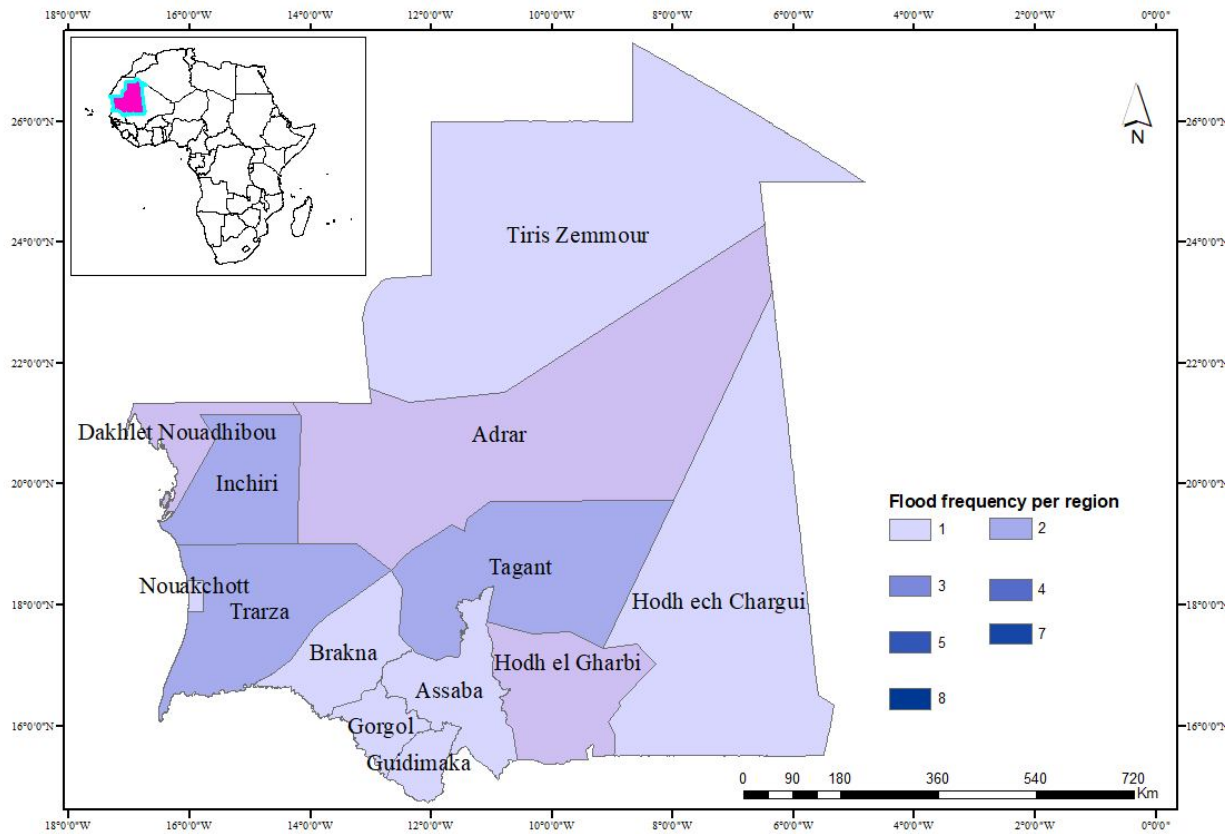
**Figure 5:** Cost response per drought event cereal acquisition without logistic cost

The risk Matrix analysis reveal a yearly response cost of US million 192.984 so an average US 204.37 cost per affected population. That mean Mauritania government will spend each year more than US million 192.984 yearly to assist affected population by drought event when tacking account, the other cost such as logistic cost, staff cost and stored cost.

### 3.2. Flood Hazard

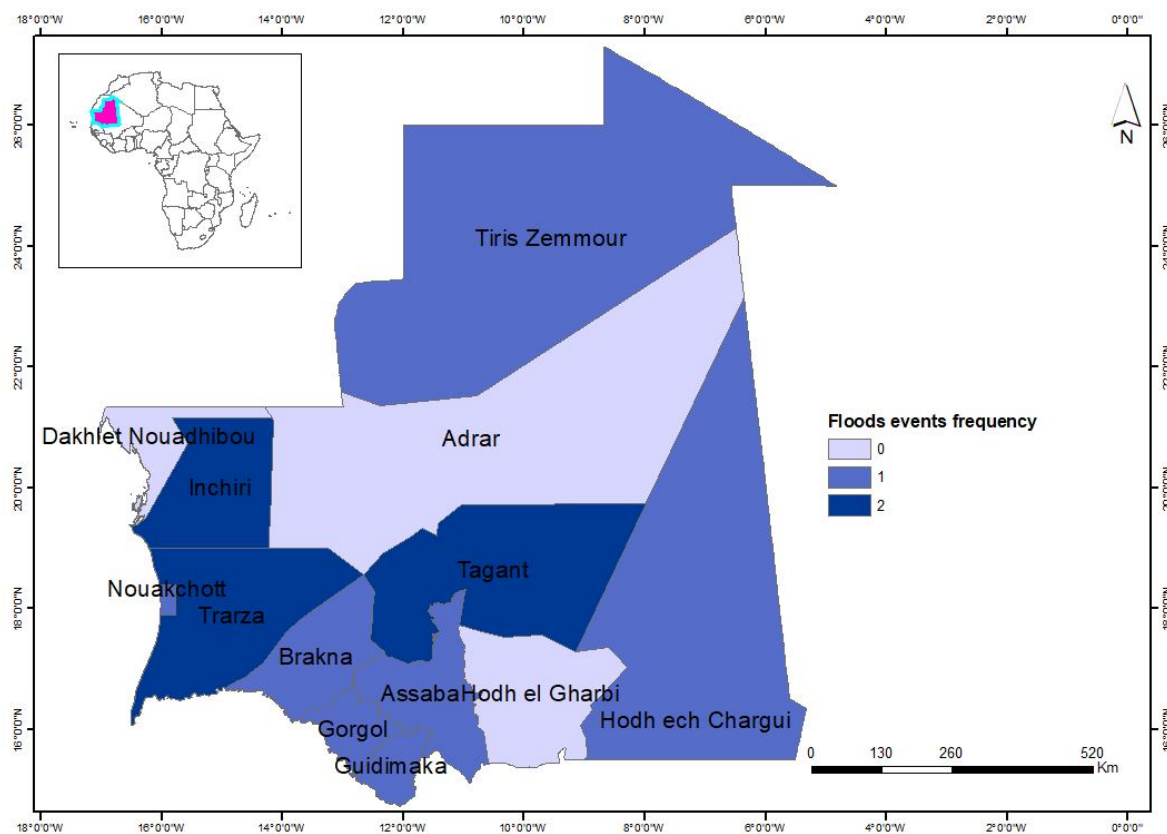
#### 3.2.1 Exposure

Flood hazard event analysis shown that from year 1984 to 2020; fifteen 15 floods year event have been occurred in Mauritania and the most exposed regions for flood are Gorgol, Trarza Brakna and Assaba (Figure 6)



**Figure 6:** Number of flood event per region from 1984 to 2020 in Mauritania

Also, Mauritania Flood occurred event analysis reveal that the time of return of flood yearly event is around 2.5 years. It means that, each two (2) year Mauritania is exposed to flooding event or for each decade Mauritania is exposed to 2 flooding yearly event. However, the most exposed region are Gogol and Trarza , with 53% ; 46% to be affected by occurred flood event. However, the last decade year's flood event analysis in Mauritania from 2010 to 2020 revealed 4 floods events meaning that for each two years flood event has occurred and the most exposed regions are Tangant, Trarza and Inchiri with 55 % respectively to be affected by occurred flood (Figure 7).



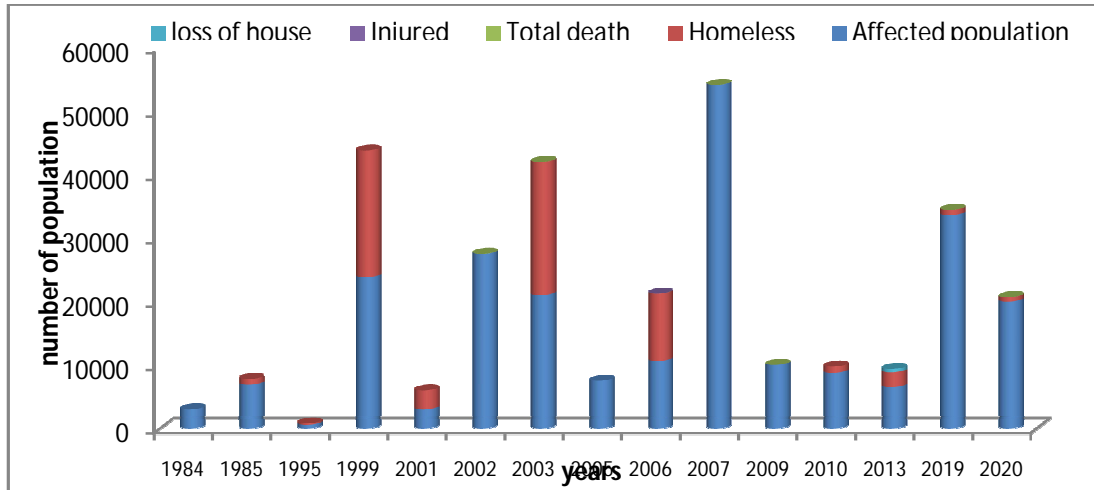
**Figure 7:** Number of flood event per Region from 2010 to 2020 in Mauritania

### 3.2.2. Vulnerability

The time of return/frequency of flood event estimated about 2 years is less than 10 years returned time making the Mauritania more vulnerable to flood event. That will affect more people and making their livelihood more vulnerable given that most of the active populations are smallholders' farmers and herders. According to GFDRR 2020 floods events are expected to occur at least once in the next 10 years and will be more frequent due to the effect of climate change.

### 3.2.3. Historical affected population and type of impacts

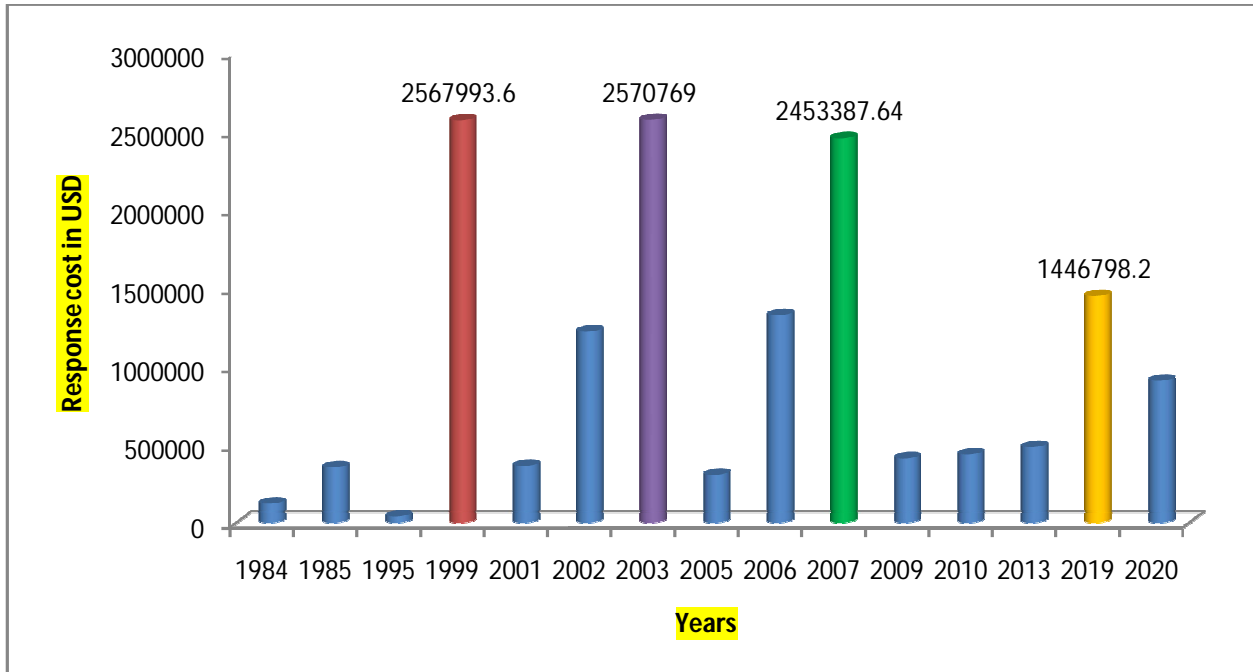
From 1984 to 2020 flood events in Mauritania caused an average yearly 15794 affected populations with 4237 homeless and 5 deaths (Figure 8). While the most flood events with higher impacts are the flooding from year 2007-year 2019 and 2002 with 54120; 33600 and 27500 affected population respectively (Figure 8).



**Figure 8:** Affected population and type of damage occurred from 1984 to 2020 by flood event in Mauritania

### 3.2.4. Risk Matrix and modeled cost of drought impact

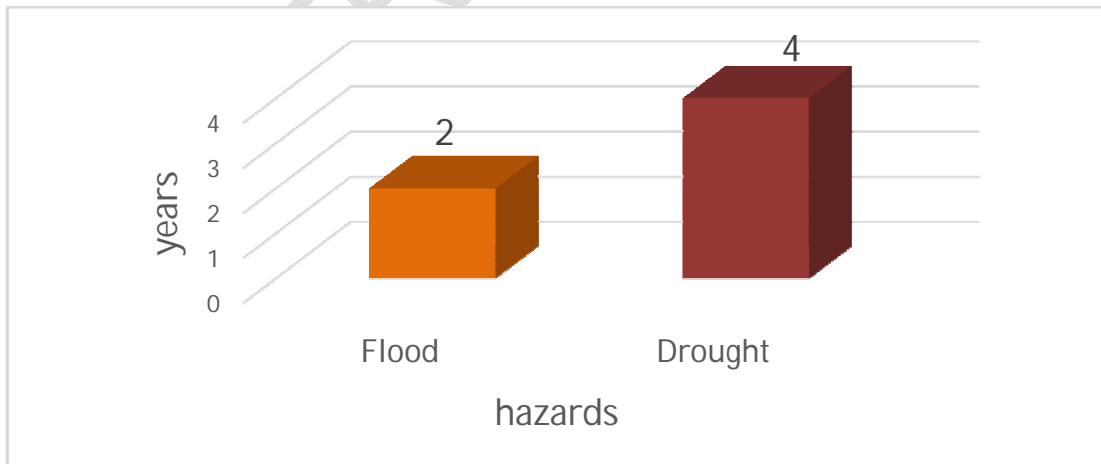
The total yearly average affected populations by flood are 15794 and the total yearly average homeless are 4237. According to Mauritania country meter consulted in 18/2/2021 the population is composed of 50.3 % of men and 49.7 % of women so mathematically 7944 men and 7850 women were affected, and 2131 men and 2106 women are homeless. This mean that Mauritania should be prepared yearly to assisted 15794 peoples that will be exposed to food insecurity and 4237 homeless to be assisted with shelters. According to Mauritania government the yearly need in Cereal per inhabitant is estimated to 214 kg in 2016 and cereal price per kg has been estimated by FAO 2020 at 45 MRO / USD 0.13 given the cost of response per flood event including the other damages cost (animal , deaths, shelters crop area loss) (Figure 9).



**Figure 9:** Estimated cost in US dollars of each flood year event from 1984 to 2020 in Mauritania

### 3.3. Average time returns per hazard

The average time return analysis saw that flood event occurred each two and drought each four year (Figure 10). When an event occurred more frequently with low population affected the disaster risk financing instrument recommended the anticipatory action in order, to anticipate that other mechanism. So, flood events are more suitable to anticipatory action and the droughts events are more suitable to insurance mechanism because, it difficult to insure an event that will be occurred each year



**Figure 10:** average time return period of flood and drought in Mauritania

#### **4.CONCLUSIONS**

In Mauritania from year 1965 to 2020; 13 drought events have been occurred in Mauritania and the most exposed regions of drought are Brakna, Gorgol and Assaba. While from year 1984 to 2020; fifteen flood events have been occurred in Mauritania and the most exposed regions for flood are Gorgol, Trarza Brakna and Assaba. Time return for drought has been estimated to 4 years while the time return of flood has been estimated to about 2 years. Meaning that flood events are more frequent in Mauritania than drought. The most flood events with higher population impacted are the flooding from year 2007-2019 and 2002 with 54120; 33600 and 27500 affected population respectively. While the most drought events with higher populations impacted are drought occurred in 2017 with 3.9 million affected population and 1980 year with 1.6 million affected population. Drought events are less frequent than flood events, however, drought events affect more population than flood. Also, the yearly response cost for drought event is US D million 192.984 with an average US 204.37 cost per affected population. For the flood event the yearly response cost is US D 1 428 707 With USD 90.45 per affected population. Drought response cost is greater than flood cost response in Mauritania. Given that drought occurs every four years and flood occurs every two years, it can be stated that Macro-insurance and CAT bonds are more suitable for drought and Anticipatory action is more suitable for flood in Mauritania. That means Mauritania Government will spend each year more than US D million 194. to assist affected population by drought and flood events when taking account, the other costs such as logistic cost, staff cost and stored cost.

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