Spatial Assessment of Soil Erosion and Aridity in Somalia Using the CORINE Model

ABSTRACT

This study analyzed precipitation patterns, drought conditions, erosivity indices, and arid periods in Somalia using the CORINE model. Utilizing rainfall and temperature data from 50 meteorological stations collected between 2011 and 2019, the study calculated key indices: The Fournier Precipitation Index (35.70%), the Bagnouls-Gaussen Drought Index (61.36), and the erosivity index. The results revealed notable spatial variability in erosivity and aridity across Somalia. Northwestern regions, encompassing 204,978.65 km² (32.14% of the total area), exhibit low erosivity due to reduced rainfall intensity, while southern regions, spanning 252,341.11 km² (39.56%), face high erosivity driven by frequent and intense rainfall events. The study also identified significant arid conditions, with 61.36% of Somalia's land classified as "dry" and 38.64% as "very dry," highlighting widespread water scarcity and vulnerability.These findings underscore Somalia's environmental challenges, including severe soil degradation, reduced agricultural productivity, and the exacerbation of droughts due to climate change. The integration of the Modified Fournier Index and the Bagnouls-Gaussen Index within the CORINE model provides a comprehensive assessment of the country's susceptibility to erosion and aridity. This research offers critical insights for prioritizing areas that require urgent soil conservation and improved land-use management. It also serves as a vital tool for policymakers and international organizations aiming to mitigate the adverse impacts of climate change, enhance agricultural sustainability, and promote ecological resilience in Somalia's diverse landscapes.

Keywords:*Somalia,MFI,BGI,CORINEmodel,Erosivity*

#.1. Introduction

“Soilerosionseverityisafunctionofsoilerodibilityanderosiveagent.Rainfallandrunoffrepresentth emajorsourceofenergyforsoildetachmentandtransportinwatererosionprocesses. Erosivityis defined as the potential ability of rain to causeerosion.It is dependent on the physicalcharacteristics of rainfall, which include raindrop size, drop size distribution, kinetic energy, andvelocity.Therainfallerosivity,similartootherrainfallproperties,iscontrolledbytherainfalldrop size distribution (DSD)” (Ahmed Mohamed Abd Elbasit, 2013). “Because the rainfall DSD isqualitative rainfall information, several indiceshave been suggested toquantify the rainfallerosivity.Soil erosion is due to the interplay between soil erodibility and erosivity” (Kertesz and Gergely,2011). The subject of rainfall erosivity has been studied worldwide, and various properties ofraindrops,suchasintensity,velocity,size,andkineticenergy,areamongthemostfrequentlyusedp arametersto develop erosivity indices.

“Rainfall erosivity is a major driver of sediment and nutrient losses worldwide, which may leavefarmers vulnerable to crop failures and lead to unstable equilibrium states in landscapes. Theexposure of the Earth’s surface to aggressive rainfall is a key factor controlling the water erosionin terrestrial ecosystems and other damaging hydrological events, such as floods and flash floods.The occurrence of hydrological extremes and the associated sediment loss during rainfall eventsare central features in the global climate system because worldwide variations in temperature andprecipitation patterns produce corresponding changes in the development of natural hazards. It isalsoassumedthatextremestormsandrainfall-runoff erosivityarebecoming morefrequentduetoclimatechange”(GianniBellocchi andNazzarenoDiodato 2020).“Erosionisaseriousproblemthroughouttheworldduetoitsadverseeconomicandeco-environmentalimpactssuchaslossesinlandresourcesanddecreaseinlandproductivity,speciallythr ough nutrient rich sediment delivery that leads to eutrophication and reduces overall storagecapacity of reservoirs as well as life span” (Eroglu et al. 2010). “In Africa the situation is dramatic,in the sub-Saharan countries where receive heavy rainfall, water erosion is a serious problem inagricultureandthe environment.Soillossbywatererosionwas mainlyintheNorthwilesoillossdue towinderosionwasprominentinthe north-westcostsofIndianOceanof Somalia”(faoswalim, 2009). The soil of Somalia is generally characterized by well-developed and deeplyweathered material with exception of soil in eroded areas, in recent alluvial and sand dunesdeposits.Accordingto theWRB Somalisoils arewidely differentin termsof parentrock.

CORINE model is an environmental process model (Beck et al. 1993) which integrates existingknowledge about the soil erosion processes in the real world into a set of relationships andequations for quantifying the process and deal with the interaction of two main parametersincluding actual soil erosion risk (EA) and potential soil erosivity (EP). The CORINE model(Coordinationofinformationontheenvironment)hadbeencreatedin1985byEuropeanCom missionprogram(ElzbietaandJenerowicz,2019).CORINEmodelisnotforEuropecontinent only,in Ethiopia(Africa), (Gurebiyaw and al. 2018) have used it for assessing spatialheterogeneityof soil erosion inGumara-MaksegnitWatershed.InSomalia,theriskofsoillossisdeterioratedbyremovaloflandcovervegetation,unsuitablelandusagepracticesandnegativeeffectsofgrowingurbanizationwhichfattestgetting high.Itiswidelyrecognizedthatmostofthese changeshavecome tobythe presentcircumstancesof landdeteriorationinthecountryandinclude:highextentofagriculturalcultivationintotherangelands withoutsuitablelandmanagementactivities,non-legislatedcharcoalproductionforlocalconsumption and for export, uncontrolled and overgrazing of livestock, and individual landownership for urban and agricultural development. Farther more, lack of good land managementpracticesand lackof conservation measuresestablished by formergovernments.

"Soil erosion severity is a function of soil erodibility and erosive agents. Rainfall and runoff represent the major sources of energy for soil detachment and transport in water erosion processes. Erosivity is defined as the potential ability of rain to cause erosion. It is dependent on the physical characteristics of rainfall, which include raindrop size, drop size distribution, kinetic energy, and velocity" (García-Ruiz et al., 2015; Poesen, 2018). "The rainfall erosivity, similar to other rainfall properties, is controlled by the rainfall drop size distribution (DSD)" (Martínez-Murillo et al., 2021). "Because the rainfall DSD is qualitative rainfall information, several indices have been suggested to quantify rainfall erosivity. Soil erosion results from the interplay between soil erodibility and erosivity" (Blanco & Lal, 2008; Panagos et al., 2015).

"Rainfall erosivity is a major driver of sediment and nutrient losses worldwide, which may leave farmers vulnerable to crop failures and lead to unstable equilibrium states in landscapes" (Borrelli et al., 2020; Nearing et al., 2017). "The exposure of the Earth's surface to aggressive rainfall is a key factor controlling water erosion in terrestrial ecosystems and other damaging hydrological events, such as floods and flash floods" (Boardman & Poesen, 2006; Kinnell, 2010). "The occurrence of hydrological extremes and the associated sediment loss during rainfall events are central features in the global climate system because worldwide variations in temperature and precipitation patterns produce corresponding changes in the development of natural hazards" (IPCC, 2019). "It is also assumed that extreme storms and rainfall-runoff erosivity are becoming more frequent due to climate change" (Diodato & Bellocchi, 2020; Zhang et al., 2021).

"Erosion is a serious problem throughout the world due to its adverse economic and eco-environmental impacts, such as losses in land resources and decreases in land productivity, especially through nutrient-rich sediment delivery that leads to eutrophication and reduces the overall storage capacity of reservoirs as well as their lifespan" (Eekhout & de Vente, 2022; Govers et al., 2017). "In Africa, the situation is dramatic, particularly in sub-Saharan countries that receive heavy rainfall, where water erosion is a serious problem in agriculture and the environment" (Sonneveld & Nearing, 2003; Mekonnen et al., 2021). "Soil loss by water erosion is most prominent in the North, while soil loss due to wind erosion is prominent in the north-west coasts of the Indian Ocean in Somalia" (FAO, 2009).

"The soil of Somalia is generally characterized by well-developed and deeply weathered material, with the exception of soil in eroded areas, recent alluvial deposits, and sand dunes" (Tesfai et al., 2016). According to the World Reference Base for Soil Resources (WRB), Somali soils are widely different in terms of parent rock (IUSS Working Group WRB, 2015). The CORINE model is an environmental process model that integrates existing knowledge about soil erosion processes into a set of relationships and equations for quantifying the process, dealing with the interaction of two main parameters: actual soil erosion risk (EA) and potential soil erosivity (EP) (Panagos et al., 2014; Boardman & Poesen, 2006). The CORINE model (Coordination of Information on the Environment) was created in 1985 by a European Commission program (Barreiro-Lostres et al., 2019).

The CORINE model is not only applicable to Europe. For example, in Ethiopia, Gurebiyaw et al. (2018) used it to assess the spatial heterogeneity of soil erosion in the Gumara-Maksegnit Watershed. In Somalia, the risk of soil loss is exacerbated by the removal of land cover vegetation, unsuitable land use practices, and the negative effects of growing urbanization, which are becoming more severe (Asfaha et al., 2018). It is widely recognized that most of these changes have resulted from the current conditions of land deterioration in the country, which include the extensive cultivation of agriculture into rangelands without suitable land management activities, non-legislated charcoal production for local consumption and export, uncontrolled and overgrazing of livestock, and individual land ownership for urban and agricultural development (Kassahun et al., 2008).

"Furthermore, the lack of good land management practices and the absence of conservation measures established by former governments have contributed significantly to soil degradation" (Erenstein et al., 2016). "Since Somalia has been without effective governance for about three decades, the lack of effective land management practices and widespread unsuitable land use are the main consequences of soil degradation" (Ali et al., 2017; Evers & van der Heijden, 2017). "The main objective of this study is to determine an aridity index that best represents different regions in Somalia and to evaluate the erosivity indices using the Modified Fournier Index (MFI), the Bagnouls-Gaussen Index (BGI), and the erosivity index proposed by the CORINE project" (Panagos et al., 2017; Yihenew et al., 2020). Ultimately, this study will help prioritize critical areas that require urgent soil conservation interventions.

Since Somalia had been out of rule about three decades, lack of effective land managementpractices and widespread unsuitable land use are the main consequences of the soil degradation.The main objective of this study is to determine an arid index showing the best representation fordifferentregionsinSomaliaandevaluationismadeoftheerosivityindicesusingtheModifiedFournierIndex(MFI),theBagnoulsGaussenIndex(BGI)andtheerosivityindexproposedbytheCORINE project (1995) methodology. Ultimately, the study will help prioritizing critical areashavinghigh erosivity measures to prevent.

Thus, the objective of this study is to analyze precipitation patterns, drought conditions, erosivity levels, and arid periods in Somalia from 2011 to 2019, using the Fournier Precipitation Index, Bagnouls-Gaussen Drought Index, and erosivity index based on rainfall and temperature data.

#.2. MaterialsandMethodology

#.2.1. StudyArea and Climate

The country is located in East Africa in what is commonly referred to as the Greater Horn ofAfrica. It lies between the latitudes 1° 40' 48” S and 12° 6' N and the longitudes 41° 0' E and 51°22’ 12” E, covering an area of 636,657 Km^2. It shares borders with Djibouti in the northwest,Ethiopia in the west, and Kenya in the southwest. It is also bounded by Gulf of Aden in the northandIndian Ocean in theeast.Somalia's complex political and social dynamics have been shaped by its history of state failure and clan divisions (Loubser, 2014). This has had a significant impact on the experiences and concerns of Somali communities, including those in London, where issues such as identity, belonging, education, employment, and safety are prominent (Ahmed, 2014). The country's strategic location in the Horn of Africa has also made it a point of interest for global powers (Dawson, 1964). Furthermore, the unique ecological and ethological characteristics of Somalia's coast have been the subject of scientific research (Pardi, 1976).

The climate of Somalia varies between desert and semi-humid. It is generally influenced by the north and south Inter-tropical Convergence Zone (ITCZ) with alternate movement of northeast monsoon winds blowing from the Arabian coast, southwest monsoon winds blowing from Africa, and south winds from the Indian Ocean. These monsoon winds provide very erratic rainfall which contributes to four seasons; Gu’, Haga, Deyr and Jilal. (SWALIM, 2009).he impacts of climate change on Somalia is a pressing issue, exacerbated by the country's fragile political and economic stability (Broek, 2022; Mufidah, 2002). The situation is further complicated by a lack of education and awareness about climate change, particularly in underdeveloped nations like Somalia (Wehliye, 2021). To address these challenges, an integrated approach to climate security and peacebuilding is needed, involving national and international actors, as well as the United Nations Peacebuilding Commission (Broek, 2022). This approach should also prioritize education and awareness, with a focus on media and TV as key tools for increasing understanding and engagement (Wehliye, 2021).

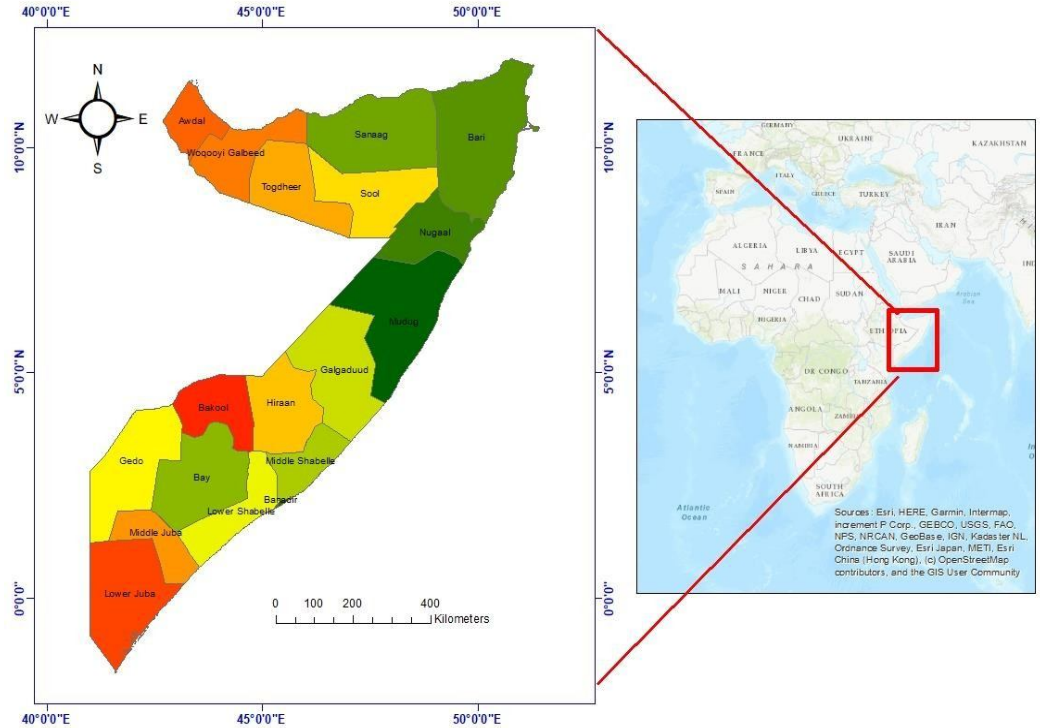

Fig.1.Study areamap

#.2.3. Method

CORINE database was used for multidisciplinary purposes, which served as a main input formappingsoilerosionrisk(PanagosP.etal.2014—219)soilorganiccarbontransitionallandscapesand land use change. The well-known CORINE model is one of the semi qualitative cartographicmethods that can easily be integrated with GIS environment to utilize and process remote sensing(RS) data (Zhu M. 2012).The CORINE model can be employed for determining (soil erosion)SR based on universal soil loss equation (USLE) (Reis M. 2017). CORINE is the one of the mostsuitable for determining erosivity of rainfall. CORINE model provides an alternative frameworkthat could improve upon some of the limitations in previous techniques. For example, it is aqualitative and simple method, easy to apply with GIS, and provides a clear forecast on anobjectivebasis andcost-effectiveapproach(Yuksel etal. 2008;Zhu 2012;Reis etal. 2016).

This model gives simple and suitable formula for conducting potential erosivity and it is easy touse with GIS.CORINE model is widely used various parameters, but in this study we will usetwoparameters:MFIandBGI.Thesoilerosivityfactor(R)isequaltotheproductofkineticenergy(E) of a rainstorm. Raindrops parameters necessary to quantify rainfall erosivity are the size,distributionand terminal velocity of individualraindrops (Gabriels 2006).

#.2.4. Erosivity

Rainfall erosivity is defined as the kinetic energy of the raindrop's impact and the rate associatedrunoff.Todescribetheeffectofrainfallonsheetandrillerosion,themulti-annualrainfall'skineticenergyand intensity must be measured(ESDAC,2019)

R=MFIx BGI

WhereRisthesoilerosivityfactor,MFIistheModifiedFournierIndex(Arnoldus1980)andBGIisthe Bagnouls–Gaussenaridity index (Bagnouls &Gaussen 1952).

The Modified Fournier index which is a good indicator of rainfall aggressiveness represents aration between average monthly rainfall and average annual rainfall (Helena et al. 2018). It isdefinedas:

$$MFI = \sum_{i=1}^{12} \left(\frac{p2i}{n}\right)$$

Table1. FournierİndexClassification

Class	Range	Description
1	<60	Verylow
2	60-90	Low
3	90-120	Moderate
4	120-160	High
5	>160	Veryhigh

Wherepiisthetotalprecipitationinmonth(mm)andpisthetotalmeanannualprecipitation(mm).

Meanwhile,TheBagnoulsGaussenaridityindex(BGAI)istheothercomponentoftheclimatequality index.Itisusedalsotogiveanestimationoftheaveragewateravailableinthesoil.BGIwascalculatedfromtheaveragemonthlytemperatureandprecipitationandclassifiedtofourclassesand defined as:

$$BGI = \sum_{i=1}^{12} (2ti - pi)ki$$

Whereti:isthemeantemperaturefortthemonth iPi:the total precipitation foramonth i

K:represents the proportion of themonth duringwhich 2t-pi>0

Table2. BagnoulsGaussen IndexClassification

Class	Range	Description

1	0	Humid
2	0-50	Moist
3	50-130	Dry
4	>130	Very dry

TheModifiedFournier İndex(MFI)andtheBagnoulsGaussen Index (BGI)arecombinedtogiveerosivity index.

Erosivityindex=MFI*BGI

Table3. Erosivity İndexClassification

Class	Range	Description
1	<4	Low
2	4-8	Moderate
3	>8	High

#.3. Results

#.3.1. ModifiedFournierIndexMFI

In this study, the Modified Fournier Index (MFI) was calculated by equation $MFI = \sum_{i=1}^{12}\left(\frac{p2i}{n}\right)$andfrommonthlyreturn frequenciesofrainfalleventsfor9years.The followingtableshowsadistributionofMFIin various weatherstations.

Table4. DistributionofMFI

Weather station	MFI	Weather station	MFI	Weather station	MFI
BariAlula	90,45	BeletWeyne	153,12	Jamaame	169,49
Baidoa	168,27	Bulo Burto	142,32	Afgooye	101,83
Bandarbeyla	110,60	Bu'aale	128,27	Jenale	62,36
BalliDhiddin	99,83	Jowhar	126,60	Saakow	132,35
Bardaale	137.81	Galkacyo	75,78	Taleex	59,66
Bossaso	4,85	Burtinle	83,40	Xudun	55,25
Dangoroyo	97,8	Galdogob	116,49	Buuhoodle	123,04
Diinsoor	309,35	Jariiban	75,92	Burco	48,43
ElBarde	150,90	Eyl	122,64	Owdweyne	91,11
Hudur	145,57	Garoowe	77,97	Sheikh	83,03
Iskushuban	49,56	Ceerigaabo	98,94	Aburin	0,91
Qardho	80,36	ElAfweyne	108,98	Berbera	96,37
Borama	101,50	Erigabo	83,27	Cadaadley	64,53
Barhere	147,85	Aynabo	92,77	Dararweyne	38,15
Dilla	84,21	Gebiley	96,09	Hargeysa	79,99
Luuq	106,65	LaasAnod	85,98	Dhubbato	78,36
Malolwe	66,82	TogWajaale	87,26		

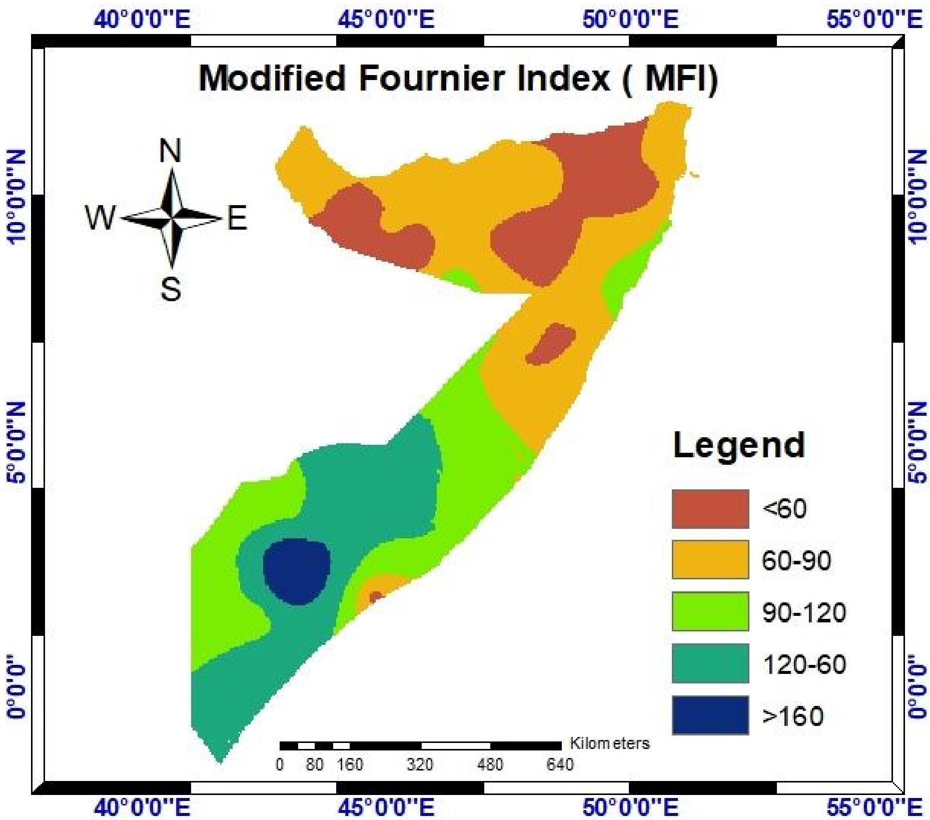

Fig.2. MFIMap

The area classified under the "very low" category, encompassing 87,576.61 km², represents 13.73% of the country's total area. This suggests a relatively limited extent of regions with minimal erosivity, which may be attributed to lower rainfall intensities or frequencies within these locales. Conversely, the "low" category, covering 227,778.63 km² or 35.70% of the national territory, indicates a more substantial portion of the landscape experiencing low erosivity. This could reflect areas receiving moderate rainfall amounts but not with sufficient intensity to result in significant erosion.The "moderate" category, encompassing 148,896.54 km² or 23.34% of the country's area, highlights regions where rainfall patterns may present a balanced risk of erosion, neither negligible nor excessively severe. These areas might be characterized by a mix of rainfall intensities and frequencies conducive to moderate erosive processes.Significantly, the "high" category covers 154,490.42 km², accounting for 24.21% of the country's total area. This considerable proportion underscores the presence of extensive regions prone to higher erosivity, likely due to frequent and intense rainfall events. Such areas necessitate targeted erosion control and land management strategies to mitigate potential soil loss and degradation.

Lastly, the "very high" class, though representing the smallest portion of the country with 19,284.25 km² or 3.02%, signals the critical hotspots of erosivity. These areas, possibly subjected to extreme rainfall events, require urgent and specialized attention to prevent severe erosion impacts, which could have profound implications for soil sustainability, agricultural productivity, and ecological balance.Thefollowing table showsthe classification ofMFI

Table5. ClassificationofMFI

MFI classes	Area(km2)	Area%
Very low	87576,61	13.73%
Low	227778,63	35.70%
Moderate	148896,54	23.34%
High	154490,42	24.21%
Very high	19284,25	3.02%
Total	638521,879	100.00%

#.3.2. BagnoulGaussenAridityIndex(BGI)

The Bagnoul Gaussen drought Index (BGI), calculated from the average annual temperature ofeach station, was used to determine the number of dry and wet months based on precipitation andtemperatureby this formula.

$$BGI = \sum_{i=1}^{12}(2ti - pi)ki$$

According to the Bagnaul Gaussen methodology, a month is classified as dry when the ratiobetweenprecipitationandtemperatureislessthan2.InBGI,2stations(ErigavoandGebiley)wer edetermined between 0 and 50 and the other 48 stations were determined as over 50 and classifiedasvery arid.

It has been observed that the country is dry period for only 3 months, in January, February andMarch.

Table6. BGIClassification

Weatherstations	BGI	Weatherstations	BGI	Weatherstations	BGI
BariAlula	515,79	BeletWeyne	257,19	Jamaame	329,28
Baidoa	155,27	Bulo Burto	225,20	Afgooye	408,52
Bandarbeyla	526,79	Bu'aale	205,42	Jenale	384,11
BalliDhiddin	376,73	Jowhar	164,48	Saakow	259,85
Bardaale	198,24	Galkacyo	408,71	Taleex	438,61
Bossaso	665,46	Burtinle	442,03	Xudun	443,00
Dangoroyo	430,48	Galdogob	439,13	Buuhoodle	331,64
Diinsoor	71,41	Jariiban	588,20	Burco	334,36
ElBarde	349,00	Eyl	370,56	Owdweyne	261,31
Hudur	212,05	Garoowe	427,84	Sheikh	53,94

Iskushuban	478,57	Baran	257,42	Aburin	203,38
Qardho	345,98	ElAfweyne	228,22	Berbera	685,46
Borama	69,33	Erigabo	21,44	Cadaadley	261,32
Barhere	257,02	Aynabo	283,88	Dararweyne	427,92
Dilla	122,50	Gebiley	32,05	Hargeysa	110,52
Luuq	378,07	LaasAnod	310,54	Dhubbato	166,95
Malolwe	252,09	TogWajaale	115,21		

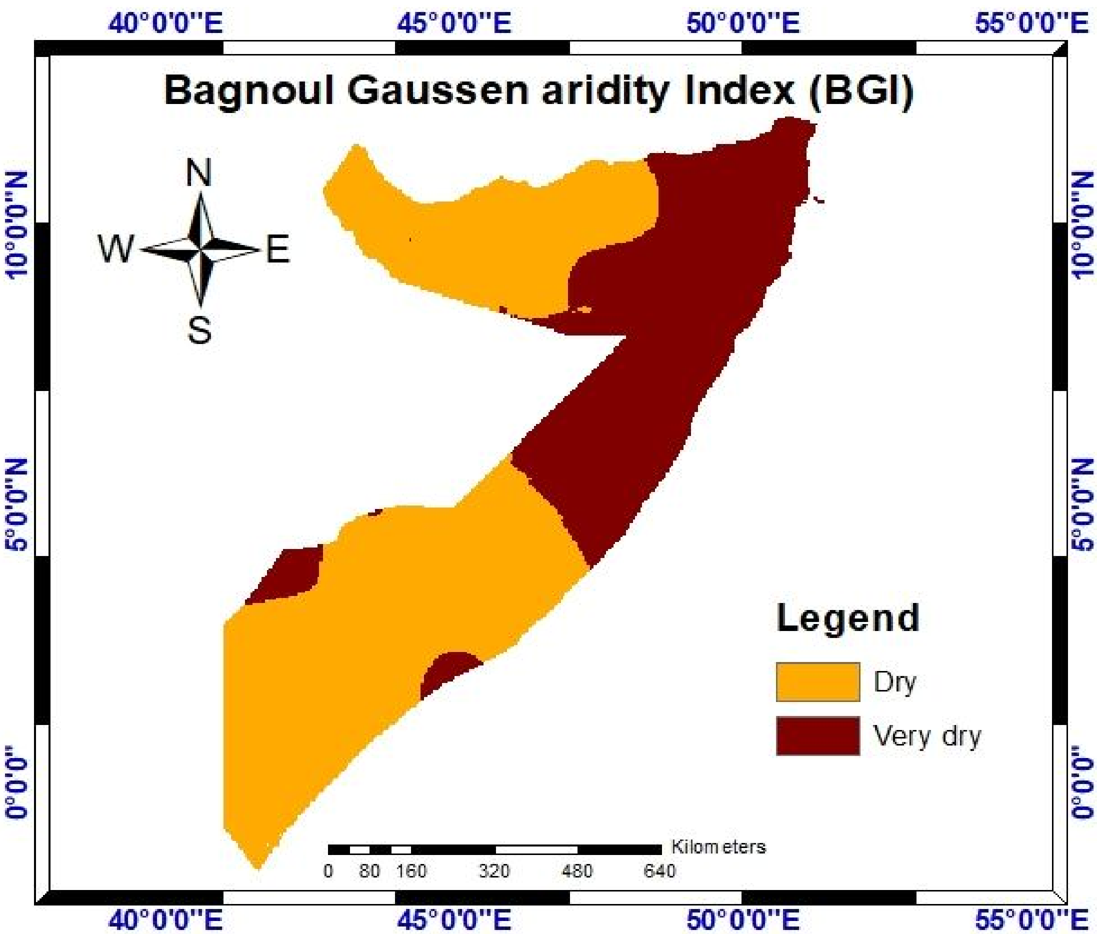

Fig.3. BGIMap

Theresultsof the "dry" class, characterized by less severe drought conditions, encompasses an extensive area of 391,815.88 km². This constitutes 61.36% of the total land area of the country, indicating that a significant portion of the region experiences conditions of moderate aridity. Such areas, while not the most severely affected, still face challenges related to reduced water availability and potential impacts on agriculture and natural ecosystems. The designation of such a large area under the "dry" class underscores the widespread nature of drought conditions, albeit at a less extreme level compared to the "very dry" regions.

On the other hand, the "very dry" class signifies areas subjected to the most severe drought conditions as per the BGI analysis. Covering an area of 246,705.99 km², these regions account for 38.64% of the country's total area. The classification of nearly two-fifths of the country into the "very dry" category highlights the critical zones of extreme aridity, where the risk of adverse ecological and socio-economic impacts is markedly high. These areas are of particular concern, as they are most susceptible to the harshest effects of drought, including significant water scarcity, loss of biodiversity, and challenges to agricultural sustainability

Thefollowingtable showsBGIclassification.

Table7. BGIClassifications

BGIclasses	Aea(km2)	Area%
Dry	391815.8828	61.36%
Verydry	246705.9967	38.64%
Total	638521,879	100.00%

#.3.3. Erosivity

The "low" erosivity class, predominantly situated in the northwestern regions of Somalia, encompasses areas surrounding the Bossaso, Aburin, Dararweyne, Burco, Xudun, and Iskushuban weather stations. This classification is attributed to the lower MFI values in these regions, indicating relatively less intense rainfall events. The area covered by this class is approximately 204,978.65 km², constituting 32.14% of the total study area. The reduced erosivity in these locales suggests a lesser susceptibility to soil degradation processes induced by water erosion, which is pivotal for land use planning and conservation strategies.Conversely, the "moderate" erosivity class is primarily located in central and southwestern Somalia, where the interplay of moderate MFI values and "dry" BGI classifications converge. This zone, covering an area of 180,539.67 km² or 28.30% of the study domain, is characterized by a balanced precipitation regime that does not significantly exacerbate erosion risks. The moderate erosivity levels in these areas underscore a need for cautious land management to prevent potential escalation into higher erosion risks, particularly in agricultural and developing regions.

The "high" erosivity category is distinctly observed in the southern parts of Somalia, where the convergence of very high MFI values and "dry" BGI classifications indicate a heightened risk of soil erosion. This region, spanning 252,341.11 km² or 39.56% of the study area, is subject to more intense and frequent rainfall events, compounded by drought conditions that exacerbate the soil's vulnerability to erosion. The high erosivity in these areas signifies critical zones where immediate and effective erosion control measures are imperative to safeguard soil resources and maintain ecological balance.

Table8. Erosivityclassifications

Erosivityclasses	Area(km^2)	Area%
Low	204978,65	32.14%
Moderate	180539,67	28.30%
High	252341,11	39.56%
Total	638521,879	100.00%

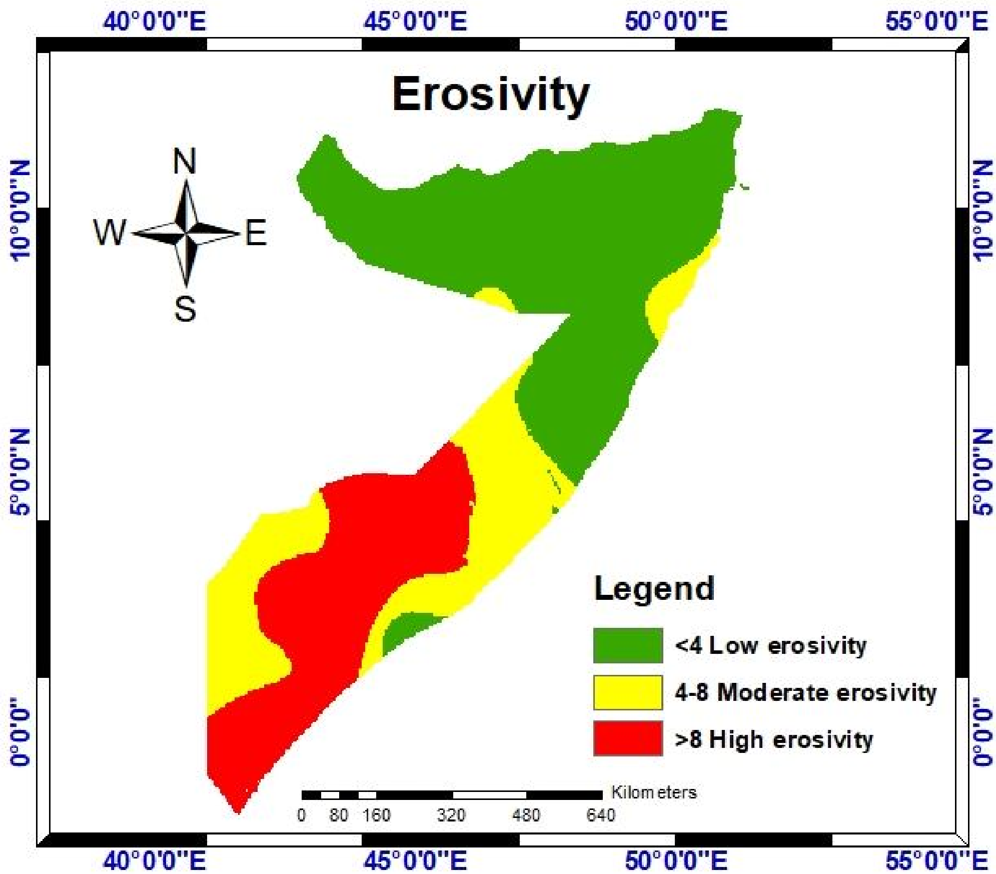

Fig.4. Erosivitymap

#.4. Discussions

Rainfall erosivity is defined as the kinetic energy of the raindrop’s impact and the rate associatedrunoff.Todescribetheeffectofrainfallonsheetandrillerosion,themulti-annualrainfall'skineticenergyandintensitymustbemeasured(ESDAC,2019).Since,Somalia’slandisfacingadversecondition and concerns about the environment are everywhere. Assessing erosivity index in the country is crucial task that needsknowledge and experience. In this study, two parameters of CORINE model was used as to reachthe result of erosivity: modified Fournier index (MFI) and Bagnaul Gaussen index (BGI). TheModified Fournier Index (MFI) was created from monthly and annual rainfall of each weatherstation.TheBagnoulGaussenaridityIndex(BGI)Bagnoulwhichcalculatedfromthemeanannualtemperature of each station, has been used to determine the number of dry and wet months basedonprecipitation and temperature.

Erosivity Index quantifies the effect of rainfall impact and also reflects the amount and rate ofrunofflikelytobeassociatedwithprecipitationevents.Therainfallandairtemperaturedatawerecollectedfrom 2011 -2019 from Meteorological station ofthestudy area.EvaluatingtheresultofMFIandBGIoverlaidshowsthatthereislowerosivityriskinthenorthern part of the country. It includes the Bossaso, Aburin, Dararweyne, Burco, Xudun and Iskushubanweather stations. It is covering the area of 204978, 65km^2, which represents 32.14% of the studyarea. This indicates that Northern part of the country, annual rainfall is low, whereas some areaslike Erigabo and Gebiley are relatively moderate in the MFI. Thiswassupported by studypreviouslyconducted inEast Africancountries include Somalia(Ashebiretal. 2017).Classification of MFI of “moderate” and classification of BGI of “dry” which represent area of180539,67km2,whichrepresents28.30%ofthestudyarearevealedmoderateerosivityindex,that means where annual rainfall is high. Annual rainfall were observed most parts of north andsouthwestern Ethiopia, eastern, northern Tanzania, and some part of eastern Somalia, whichsuggestthat theseareas becomewetter in recent years.(Ashebir et al. 2017).High erosivity of the country was found in the South area which receives high rainfall and moistwindsfromtheIndianOcean.Thestudyindicatedtheannualrainfallofthisareaishighandannualtemperatureisdry.It occupiestheareaof252341,11km2,which representstheareaof39.56%ofthestudy area.The study on the geospatial assessment of aridity and erosivity indices in Northwest Somalia using the Corine model underscores the importance of integrating these indices to identify vulnerable areas, essential for sustainable land management in arid regions (Nur, et al 2024.)

#.5. Conclusion

This study on the spatial assessment of erosivity and arid conditions in Somalia provides essential insights into the region's susceptibility to soil erosion and drought, employing the CORINE model through detailed indices—the Modified Fournier Index (MFI) and the Bagnouls-Gaussen Index (BGI). By analyzing extensive rainfall and temperature data from 50 meteorological stations across Somalia from 2011 to 2019, the study illustrates notable regional differences in erosivity and aridity, uncovering distinct patterns of land vulnerability. In the north, low erosivity suggests a reduced risk of soil degradation, largely due to lower rainfall intensity and frequency. Conversely, central regions exhibit moderate erosivity, indicating a balanced yet significant risk, while the southern regions are classified as high-risk, with intense rainfall events driving more aggressive erosion, which threatens soil sustainability.The aridity analysis identifies two major classes—dry and very dry—covering extensive portions of the country, signaling widespread water scarcity and posing substantial challenges for agriculture and ecosystem resilience. This classification shows that while 61.36% of Somalia's land is moderately dry, the remaining 38.64% experiences extreme arid conditions, which could intensify with climate change. This prolonged dryness affects not only local agriculture but also has broader socio-economic impacts, stressing the urgent need for effective water management and drought mitigation strategies.

The findings emphasize the critical need for targeted soil conservation efforts and sustainable land-use practices, particularly in areas of high erosivity in the south, to prevent severe land degradation. This assessment, offering a comprehensive view of the environmental pressures on Somalia's landscapes, serves as a valuable tool for policymakers and land managers. By pinpointing regions that require urgent intervention, this study supports the development of strategies that can strengthen soil health, enhance agricultural productivity, and improve overall resilience to climatic challenges in Somalia's diverse environmental zones.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

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3.

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