GIS Applications

Complex Engineering Problem 1

Submitted by

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Aim

The aim of this Complex Engineering Problem is to determine the Multi Hazard Vulnerability and Risk Assessment of the area Muzaffarabad.

Introduction

Muzaffarabad, located in Azad Kashmir, is a region prone to various natural and man-made hazards, making it essential to undertake Multi-Hazard Vulnerability Risk Assessments (MHVRAs). These assessments aim to evaluate and analyze the vulnerabilities and risks associated with multiple hazards in the area, providing valuable insights for disaster management and resilience-building efforts.
MHVRAs in Muzaffarabad involve a comprehensive analysis of hazards such as fire forest, floods, landslides, and human-induced risks like civil unrest and infrastructure accidents. By understanding the potential impact and likelihood of these hazards, decision-makers can develop effective strategies to mitigate risks, enhance preparedness, and promote the resilience of the local community.
The assessment process includes identifying and characterizing the various hazards prevalent in the region, drawing on historical data, scientific studies, and local knowledge. This step provides a foundation for understanding the nature, severity, and spatial distribution of each hazard.

Solution

The solution entails using the Earth Engine (EE) platform and the geemap package, which makes working with Earth Engine in Python simpler. Users can set the ROI using a district name, start and end dates for data gathering, and a folder to store the downloaded image in the code snippet. The Landsat image collection is filtered by ROI and time period, and a composite image is constructed from the Landsat data. After clipping the composite image to the ROI, the desired bands are picked for visualisation. Finally, the clipped image is saved to Google Drive via the batch export capabilities of Earth Engine.

Requirements

I. Arcmap
II. Landuse and LandCover
III. Dem Data
IV. Waterways Data
V. Roads Data
VI. Slope
VII. NDVI calculation
VIII. Satellite Imagery
IX. Rainfall Data
X. Elevation

Method

1.Landslide:

Muzaffarabad district is located in an area with steep slopes and unstable geological formations, making it prone to landslides. The district has experienced numerous landslides in the past, leading to loss of life and property damage.

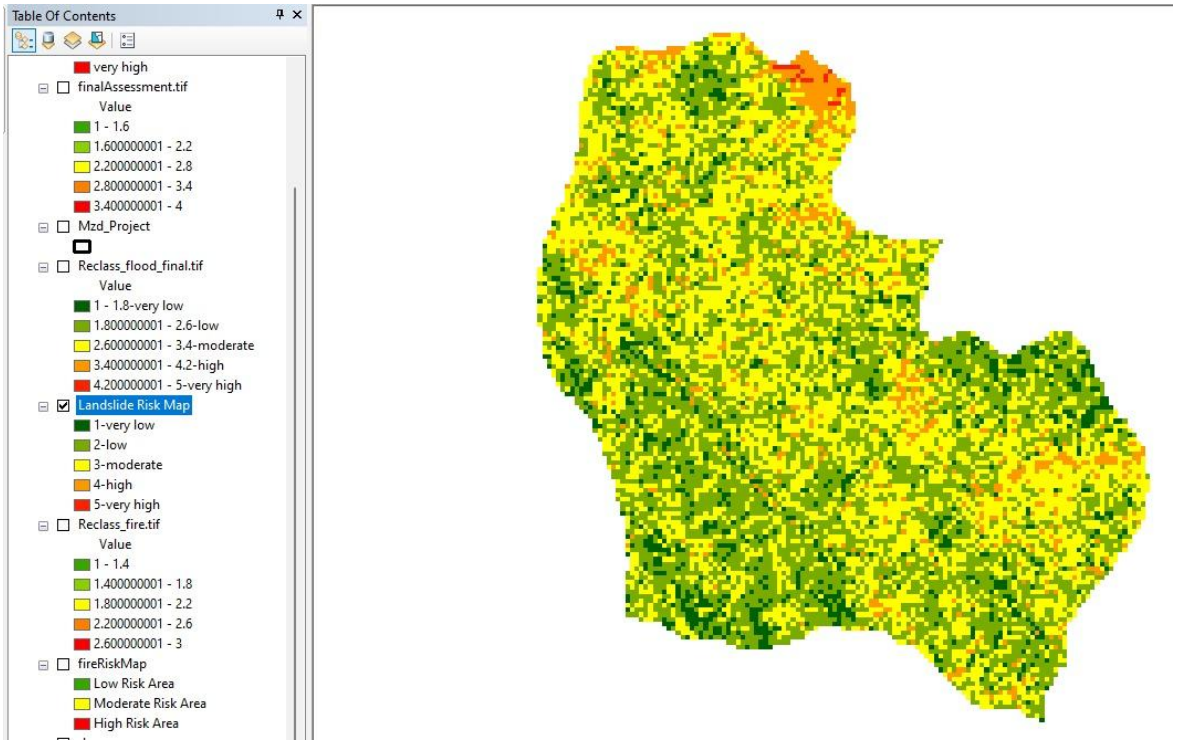
Here are the following steps that are included in the methodology of landslide:

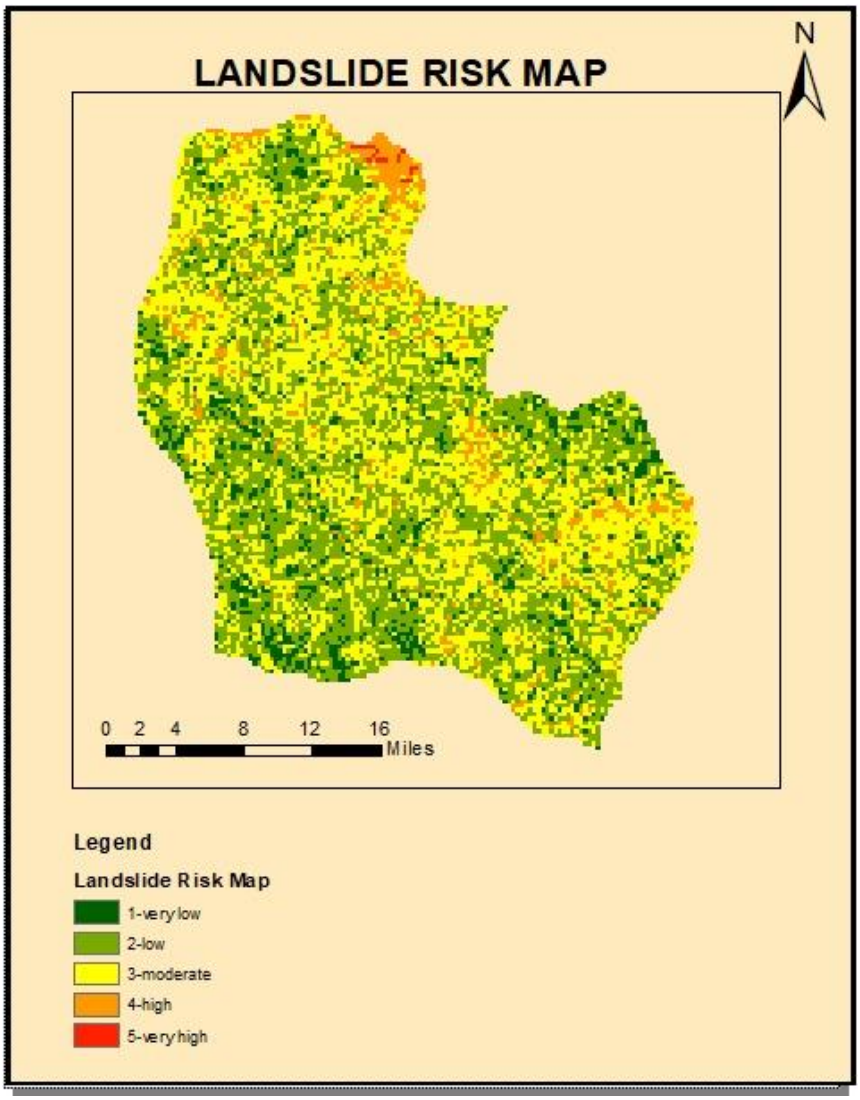
1.Take the data of roads to see the extent of roads in the area of Muzaffarabad.
2.Clip the DEM of the area of the Muzaffarabad by the clipping tool of the ARCMAP.
3.Then find the raster out of the DEM.
4.Find the Slope and then reclassify it (using reclassify tool)
5.Find the flow direction from the DEM of Muzaffarabad.
6.From flow accumulation,find the flow direction in the area of Muzaffarabad.(High flow of accumulation means high risk of landslide.)
7.Use the raster calculator and set that if flow of accumulation is greater than 500 show 1 which means high risk else show 0 which means low risk.
8.Then check the stream link.
9.Check the Stream order.
10.Find the Euclidean distance from stream to feature.(Spatial Analyst tool)
11.Reclassify the Euclidean distance.
12.Find the Euclidean Distance of roads.
13.Reclassify it too.(Because near road has higher chances of landslide)
14.Calculate the NDVI using NIR and RED band and using the formula

NDVI = (B5-B4/B5+B4)

15.Low value of NDVI means less vegetation and have high chances of landslide while high values means high vegetation and low risk of landslide.
16.Reclassify the NDVI.
17.At the end find the Euclidean Distance using
.Reclassify NDVI
.Stream(Euclidean Distance)
.Road (Euclidean Distance)
.Slope

OUTPUT IMAGE OF LANDSLIDE:





2.Flood:

Muzaffarabad district is also prone to flooding due to heavy rainfall and its location on the banks of the Kabul River. The district has experienced several devastating floods in the past, resulting in the loss of life and extensive damage to infrastructure and crops.

Here are the following steps that are included in the methodology of landslide:

1.The Parameters required for the flood assessment are LandUse and LandCover(LULC),Drainage Density,Road,River,Rainfall,Elevation,Slope.

2.We set the Parameters from the values of 0-5 as low to high risk.

3.First of all find the Drainage Density of the area of Muzaffarabad.

4.using DEM find the fill that leads to find the Flow Direction.

5.From Flow Direction,we find the flow Accumulation which leads to the Basin Raster.

6.set the flow accumulation as if the value is greater than 5000 it is highly prone for the flood else it is less prone area.

7.Find the raster to polyline(Streamline.shp).

8.From here find the linear density(line-density).

9.Then Find the Watershed of the area which leads to find the delineation .

10.Calculate the field density(Density in line density).

11.The other important factor that leads to the flood is the rainfall.

12.First of all downland the data of rainfall from the cru.data.

13.Then extract the data using(make NetCDF raster layer tool)

14.Export the data.

15.Change the data framework to the WGS 1984 UTM Zone 43N)

16.Then take the pro layer.tif

17.From this prepare annual rainfall map.

18.Add 109 to 120 bounds.

19.Add Composite band tools using the (prelayer.2020.tif)

20.Add statistics and point to raster.

21.Find the IDW.

22.Next parameter is the slope.

23.From DEM find the slope which gives Aspect that leads to the hilshade and Contour.

24.Then the next parameter is LULC.

25.Download data from ESRI living atlas.

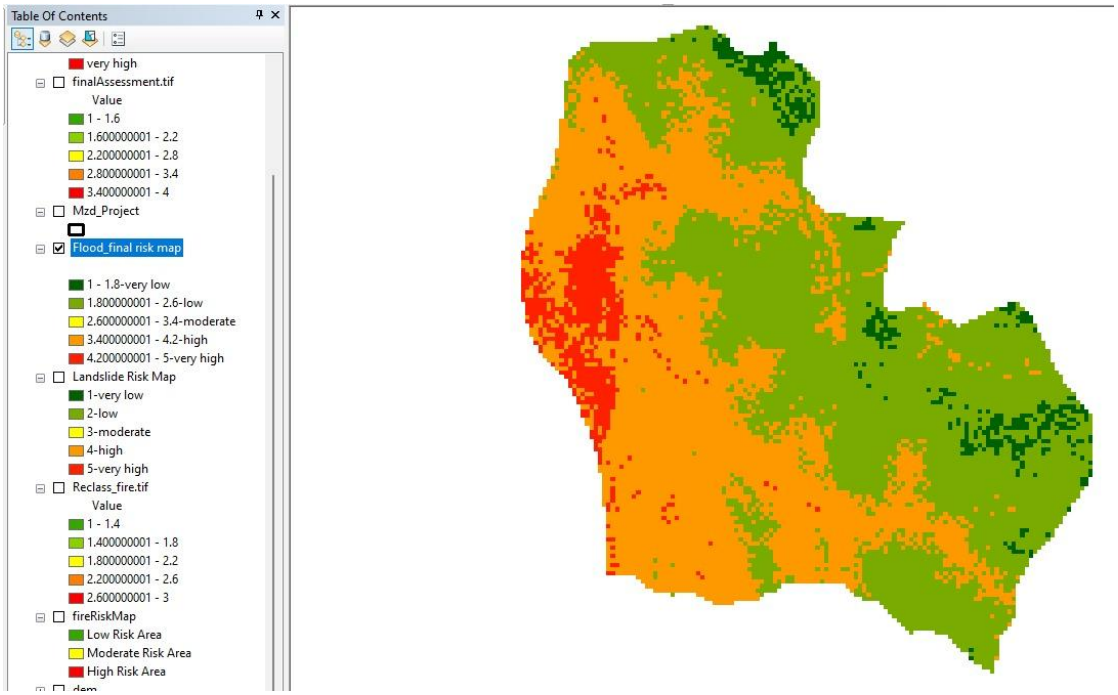
26.Extract data by clipping in tif file.

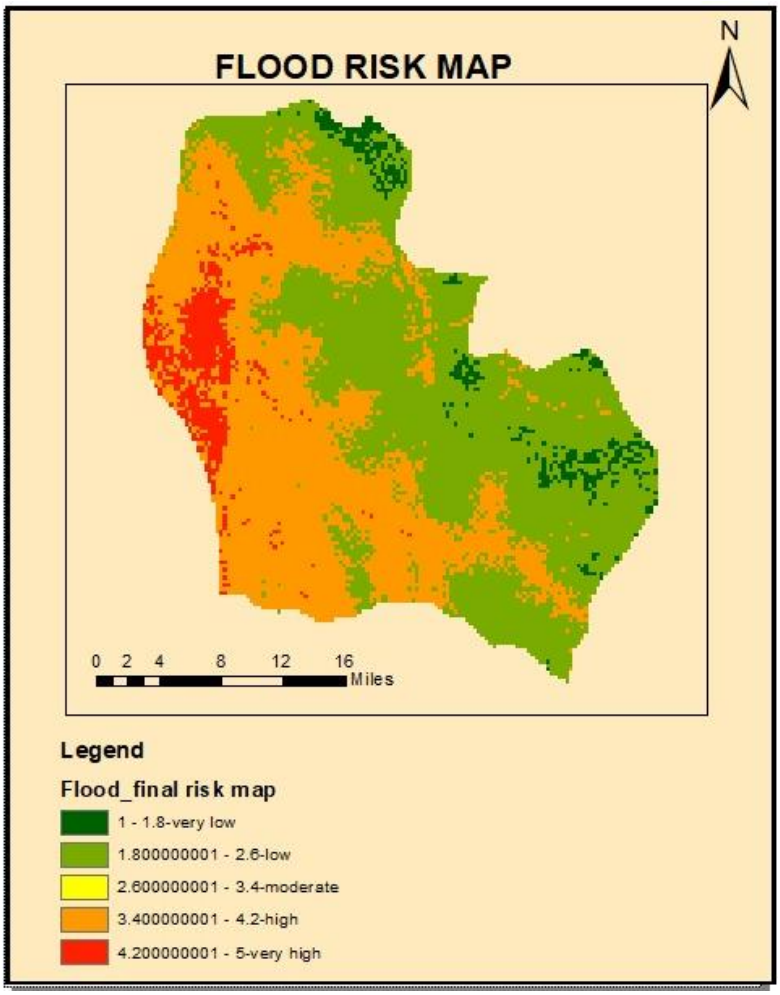
27.Take the data of roads and rivers from geofabrik.

28.After setting and getting of the data,first of reclassify all the parameters using the reclassify tool.

29.And at the end find the weighted overlay of the flood.

OUTPUT IMAGE OF Flood:





3.FireForest:

Due to large amount of forest and heat it is considered as the prone area for the fire forest.Man-Made

activites also leading cause of this hazard in the area of Muzaffarabad.

Here are the following steps that are important in the methodology of FireForest:

1.The parameters required for the assessment of FireForest in the are slope,Elevation,Aspect and Landslide.

2.For this ,we have made three categories of high (H=3) Moderate (M=2) and Low (L=1).

3.First reclassify the slope,Landuse and Landcover ,Elevation and aspect into three classes of high,medium and low according the respected values.

4.In this way, we reclassify our parameters and then reclassify it from the values 5-12 and assign as the

L=(5,6)=1

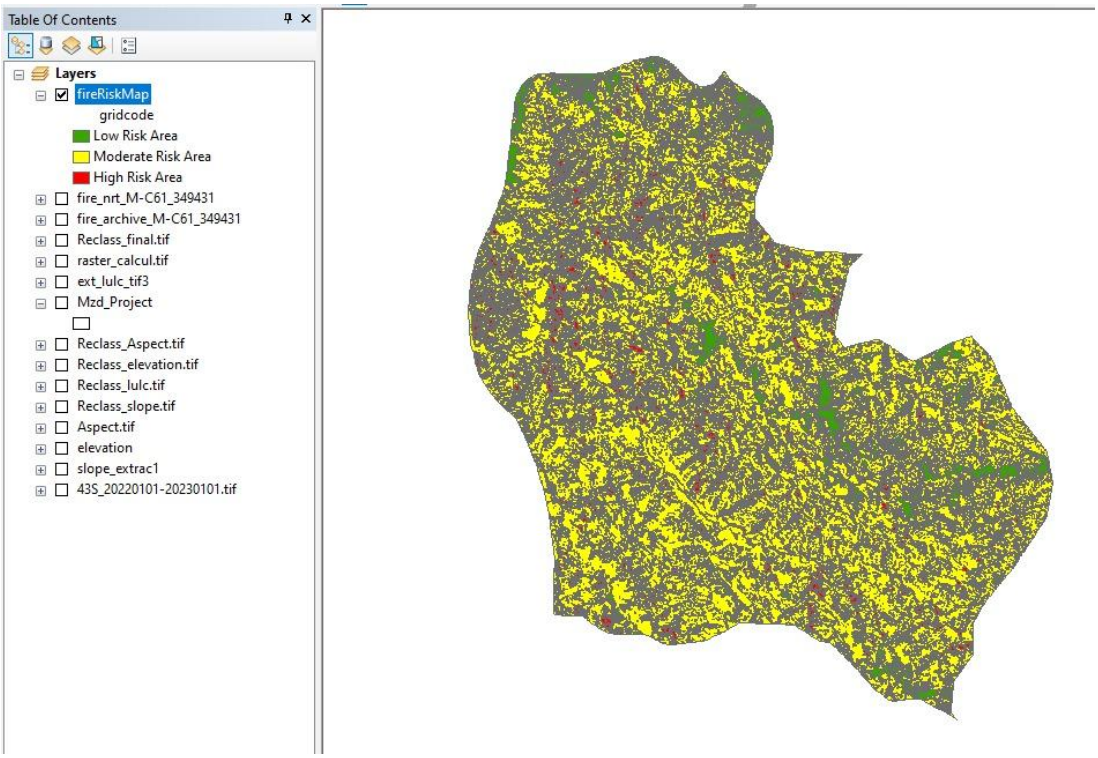
M=(7,8,9)=2

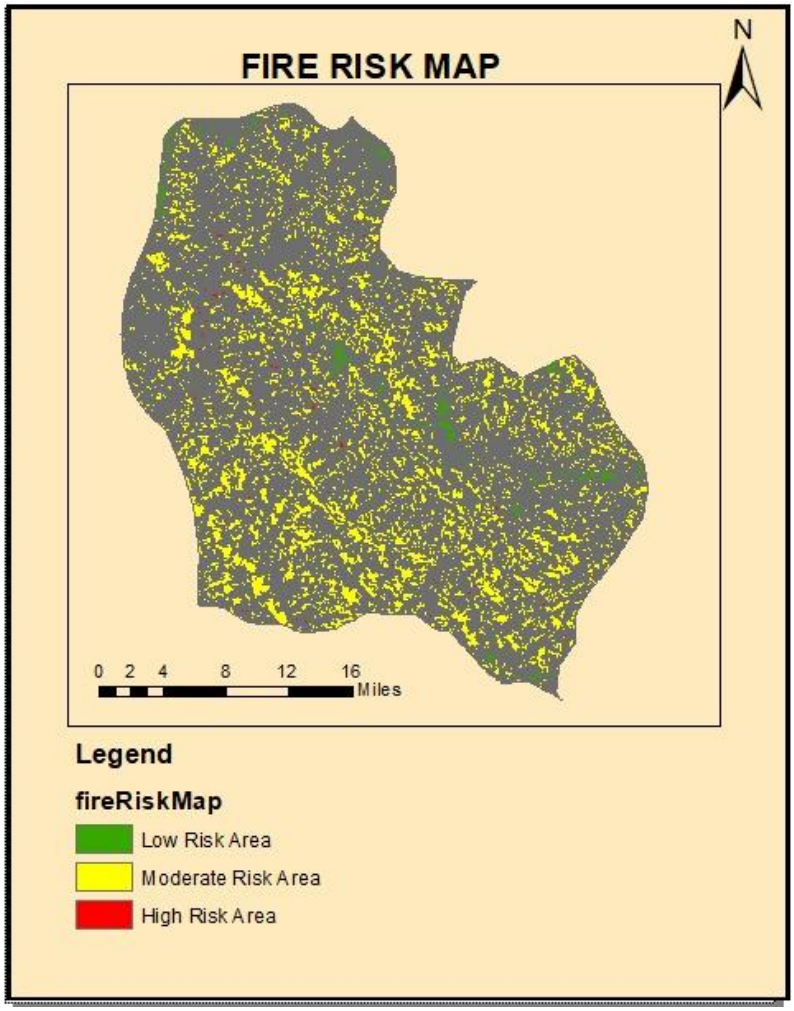
H=(10,11,12)=3 as final reclassify.

5.Then use the map algebra and add sum of reclassified slope,elevation,landuse and landcover ,aspect and do the reclassification again .

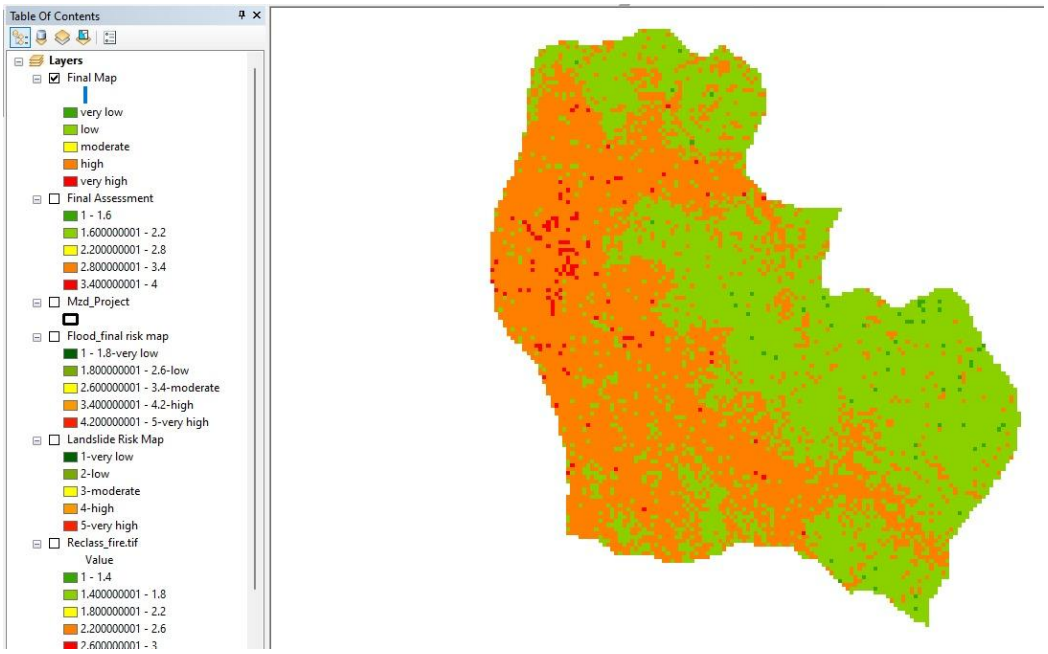
6.At the end find the weighted overlay of it.

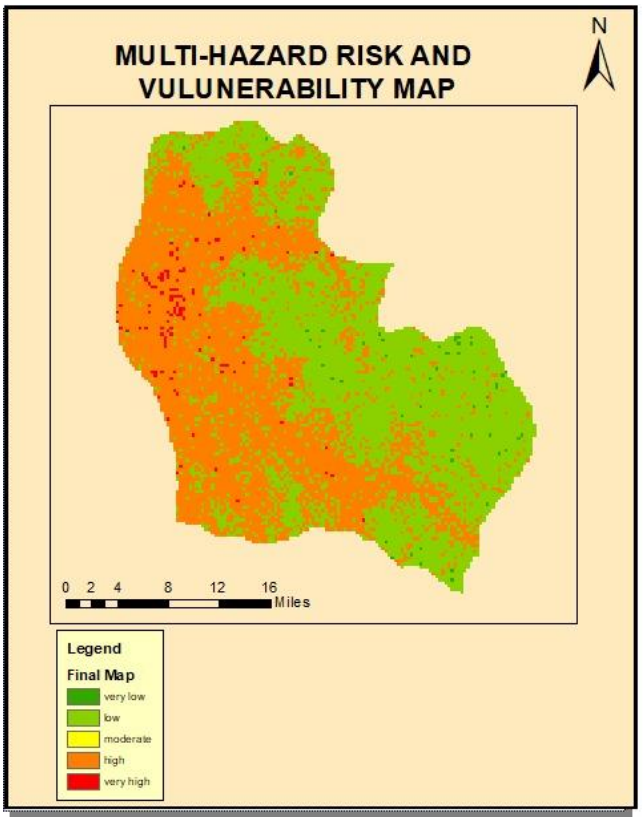
OUTPUT IMAGE OF Fireforest:




FIRE RISK MAP
N
0 2 4 8 12 16
Miles
Legend
fireRiskMap
Low Risk Area
Moderate Risk Area
High Risk Area

Final Output image:





Conclusion

In conclusion, Multi-Hazard Vulnerability Risk Assessments (MHVRAs) in Muzaffarabad provide valuable insights into the vulnerabilities and risks associated with various hazards in the region. These assessments enable decision-makers to make informed choices and develop effective strategies for disaster management, risk reduction, and resilience-building. By identifying the nature, severity, and spatial distribution of hazards, along with understanding the factors that make communities and infrastructure susceptible, MHVRAs contribute to the development of targeted mitigation measures and preparedness activities. The findings of MHVRAs inform the creation of comprehensive disaster

management plans and emergency response strategies, ensuring that Muzaffarabad can effectively respond to and recover from hazardous events. Ultimately, the implementation of MHVRAs plays a crucial role in enhancing the resilience of Muzaffarabad's community, reducing the impacts of hazards, and fostering a safer and more secure environment for its residents.