Developing an Erosion Rate Map for Myanmar Using USLE, GIS and Remote Sensing

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Introduction

Erosion is the removal of surface material from Earth's crust and the transportation of the eroded materials by natural agents such as water flow or wind. In Myanmar erosion and collapse of river banks is common during the rainy season and riverine communities are frequently forced to relocate as their homes are dangerously close to the disintegrating river banks. In Myanmar, soil erosion measurement and monitoring approaches are increasingly important for land management planning to effectively avoid erosion and soil degradation, but such monitoring is limited by the availability of data and budgetary constraints. Therefore, spatial modeling approaches using GIS and remote sensing techniques play an important role for rapid risk assessments. In this study "Model Builder" tool in ArcGIS was used to develop a model which generates an erosion rate map using USLE. USLE was developed by Wischmeier and Smith (1965) and it is as follows: A = R.K.LS.C.P

Where A is average annual erosion, R is erosivity factor, K is soil erodibility factor, L is slope length, S is slope steepness, C is cover-management factor and P is support practices factor.

Study Area

In this research an erosion rate map was developed for Myanmar. Myanmar is located in southeast Asia and it is one of the most climatically diverse countries. It has a total area of 678,500 km^2 and lies between latitudes 9° and 29°N, and longitudes 92° and 102°E.

Data and Materials

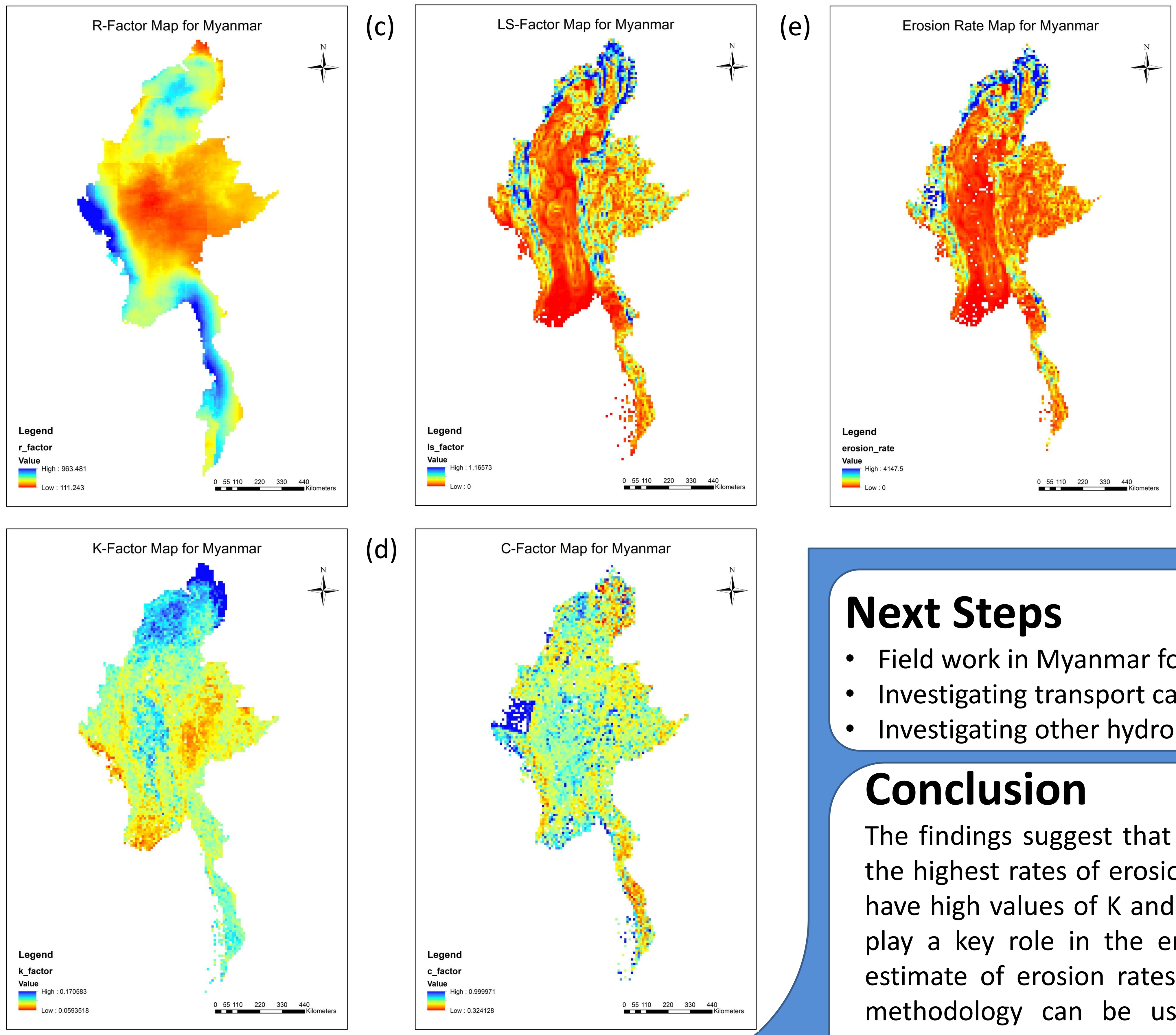
Monthly precipitation data for the year 2015 was downloaded from Global Precipitation Measurement (GPM) for calculation of R factor. Soil maps depicting percentages of sand, clay and silt were obtained from soilgrid website for calculation of K factor. Digital Elevation Model (DEM) was taken from Shuttle Radar Topography Mission (SRTM) for calculation of LS factor and satellite images for the year 2015 from Landsat 8 were used for calculation of C factor. Due to lack of spatial distributed data, the P factor was set to 1.

Results and Discussion

"R"values are in MJ.mm.ha^{-1}hr^{-1}yr^{-1}, "K" values are in tn.ha.hr.ha^{-1}.MJ^{-1}.mm^{-1}, "LS" and "C" values are unitless and the erosion rates are in ton/km^2/year. These results were compared with the results provided by other researchers who have estimated erosion rates for a catchment near Yangon as well as a reservoir in the west of the country. A reasonably good agreement was found between these results.

The generated erosion rate map shows very high values in the north; this is while the values of R-factor in that area are in the range of low to medium. On the other hand, this area is covered by forest and it is presumed that vegetated areas should have low rates of erosion. It seems that USLE does not efficiently take into consideration the effects of precipitation and vegetation cover on soil erosion.

GIS maps were generated for different factors of USLE using ArcMap. R-factor and C-factor were calculated based on the data of the year 2015. P-factor was set to 1 due to lack of data. Figure (a) shows R-factor map, figure (b) shows K-factor map, figure (c) shows LS-factor map, figure (d) shows C-factor map and figure (e) shows the erosion rate map.



Next Steps

- Field work in Myanmar for collection of verification data
- Investigating transport capacity approaches
- Investigating other hydrological and hydrodynamic models

Conclusion

The findings suggest that northern and western parts of the country have the highest rates of erosion. These areas are mostly mountainous and they have high values of K and LS. This means that soil properties and elevation play a key role in the erosion process. This procedure provides a good estimate of erosion rates, but certainly field verification is required. This methodology can be used in regions where the density of weather stations is low. It can be used by policy makers to identify the areas with high risk of erosion and to mitigate the erosion effects.

Methodology

The model developed in this study creates a map for each factor of USLE using the equations given below:

- **R-factor:** $R = 0.1922(Pt)^{1.61}$ where "Pt" is mean annual precipitation (cm) (Renard and Freimund 1994).
- **K-factor:** $K = 2.1 \times 10^{-6} \times M^{1.14} \times (12 - a)$ where $M = (\%Silt + \%very\ fine\ Sand) \times (100 - \%Clay)$ and $a = \%organic\ matter$ (Sotiropoulou, Alexandridis et al. 2011)
- **LS-factor:** $LS = (Flow\ Accumulation \times \frac{Cell\ Size}{22.13})^{0.4} \times (\frac{Sin\beta}{0.0896})^{1.3}$ where Flow Accumulation is the number of cells that contribute to a given cell, Cell Size is the raster resolution and β is the slope angle(Moore and BuRCH 1986)
- **C-factor** : $c = \exp\left(\frac{-2 \times NDVI}{1 - NDVI}\right)$ where $NDVI = \frac{NIR - RED}{NIR + RED}$ (Van der Knijff, Jones et al. 1999)

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