REMOTE SENSING ANALYSIS OF QUATERNARY DEFORMATION USING RIVER NETWORKS IN HINDUKUSH REGION

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1. INTRODUCTION

Konar-Tirch Mir faults system in eastern hindukush and southern Pamir region extends across the eastern border of north-eastern Afghanistan into north-western Pakistan and is highly rugged terrain and is bounded by principal active zones. [1]. This area is experiencing frequent earthquakes due to ongoing subduction of Indian plate beneath Eurasian plate, the most recent earthquake in this region is 6.2 Mb on January 03, 2009 and many more before this and related aftershocks suggest that the area is tectonically active. The stream profile analysis and box counting techniques were employed on drainage network extracted from the digital elevation models from Advanced Spaceborne Thermal Emission and reflection Radiometer ASTER/TERRA and Shuttle Radar Topographic Mission (SRTM) data to calculate the geomorphic indices and fractal dimension [2, 3]. The discontinuous drainage patterns, displaced fluvial terraces, spatially variable distribution geomorphic parameters and a local correlation of lineaments with the stream network agrees with the ongoing neotectonic activity in this region. The objective of this study is to generate several GIS (Geographic Information system) based maps for better understanding and interpretation. Remote sensing and ground truthing further allow us to validate these results to pinpoint the deformed areas more specifically.

2. STUDY AREA

The Konar-Tirch Mir fault system is associated with the Main Mantle thrust of the Himalayan system and south Pamir fault system across Pakistan and Afghanistan border. The modern fault movements, deformation, and earthquakes in this region are driven by the collision between the northward moving Indian Plate beneath Eurasian Plate. The patterns of probable and possible Quaternary faults generally show that much of the modern tectonic activity is related to transfer of plate boundary deformation across this region. The left lateral, strike-slip Chaman fault in this region has the highest slip rate of any fault in the country; to the north, this slip is distributed onto several fault systems [4]. This region is characterized by the uplift rates of greater than 1-4mm/year with high tectonic activity

3. METHODS APPLIED

The digital elevation model (DEM) of spatial resolution of 15 meter from ASTER stereo pairs was generated for Chitral-Konar river system and also SRTM data was used for the drainage extraction. We used D8 algorithm on each pixel location and used a least cost path algorithm to calculate various flow directions. The network consists of extracted streams with elevation and area as function of spatial location. The drainage basin is assumed to be under steady state condition and is analyzed by using stream profile analysis with power law of scaling relation and fractal dimension was calculated by using box counting method. The estimation of fractal dimensions allows us to measure the degree of complexity by evaluating how a dimension measurement increases or decreases at different scales with respect to the vulnerability of the surface deformation (surface roughness). The objective is to quantify the influence of neotectonic activity on the drainage system by measuring the reduction of complexity as the deformation intensity increases. The spatial distribution of geomorphic indices i.e. concavity and steepness indices were prepared using the results from each individual stream profile. We used steepness index map to prepare a relative uplift rate map of the area. The drainage network and lineaments were extracted from DEM using different image processing techniques. Rose diagrams have been prepared for both drainage network and lineaments to see is there any correlation between them or not [5, 6, 8, 9].

3. RESULTS AND CONCLUSION

The integration of previously published geologic maps, fieldwork and stream profile analysis of the area shows correlative results. The disconnected and rugged drainage patterns shows that it is the part of a complex tectonic setting. The uplift map shows more uplift rates on the northwest side of the river than on the southeast side. The ASTER DEM has good resolution to cover small offsets of streams due to tectonic movement. Along the Konar fault, old landforms, shutter ridges, and active stream channels all indicate a left lateral sense of movement on this fault. We recognized sinistral offsets in young deposits of active alluvial fans, which is evidence of recent surface faulting. Northeastward along the Konar fault, the range-front morphology, shutter ridges, and southeast-facing fault scarps all indicate a progressively greater component of thrust faulting. This study can be improved further by using more high resolution data like. The anomalous and heterogeneous behaviour of drainage pattern, seismicity and fractal dimension values of the region prove the active nature of the region. It is also observed that the correlation between streams channels and lineaments is positive and river systems are influenced by the faultys.

4. REFERENCES

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