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Geological, Hydrological and Socio-economic Dimensions:

Flying over the landscape often presents a great opportunity for viewing landforms on earth's surface and comprehending the occurrence and the magnitude of geohazards and environmental degradation. In recent years, individuals flying in the skies of Nepal experience not only the majestic and inspiring Himalayas but are also shocked by the countless scars of landslides, especially in the Churia region, as well as bare mountains, massive river-cuttings, and blanket of polluting haze over developed cities such as Kathmandu. One can clearly notice the aftermath of severe landslides, debris-flow, and flooding, and the degradation of Churia region from the sky as the plane descends for landing at the Tribhuvan International Airport in Kathmandu.



Nepal has five physiographic units (i.e., Terai or Indo-Gangetic Plain, the Sub-Himalaya or Siwalik range, the Lesser Himalaya, the Higher/Tethyan Himalaya, and the Tibetan Plateau) from south to north. The Churia region (or area) consists of the Terai and the Siwalik range physiographic units. The Siwalik range or the Churia hills are geologically young and are comprised of rocks and minerals that are structurally weak, have steep slopes, and have high potential for slope failures, landslides, and soil erosion. The Churia region consists of about 26.6% of the total area of Nepal and is the home for nearly 53% of the country's population. Available literature indicates that the population of the Churia region has increased by 31.3% from 1991 to 2001. The Bhabar areas that lie in the foothills of the Chure hills serve as the groundwater recharge zone for the Terai. The valleys in the Churia region such as Trijuga Valley, Chitwan Valley, Dang Valley, and Surkhet Valley are heavily cultivated and consist of some of the major human settlement areas of the nation. The Churia region is the home of many exotic wildlife species including tigers, rhino, crocodile, many different kind of birds, and pythons. The Churia forests consists vegetation of high economic values such as *sal*, *khair*, *simal*, and *sisson*. The Terai belt of the Churia region is the granary of Nepal. Most of the volume of international trade (both import and export) pass through the Churia region. This region hosts major dams, transit routes, industrial cities, and processing and manufacturing industries. The Churia region is culturally very diverse and is the birthplace of Nepalese luminaries such as King Janak, Lord Sita, and Lord Buddha.

The Churia region, unfortunately, is experiencing an unprecedented level of ecological and environmental degradation due to massive deforestation, landslides, debris flow, river-cutting, and flooding in recent decades. Degradation of agricultural lands, property loss, infrastructural damage, and loss of livestock and human life due to landslides, debris-flow and flooding is a major concern. Land degradation due to landslides, debris-flow, river-cutting, flooding, and sediment deposits has become so widespread and pervasive that one can easily anticipate a complete desertification of the upper part of the Churia region in

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the not too distant future. With some exceptions, most Churia rivers that originate from the Chure hills contain water for only a limited duration in a year. These rivers contain an abundance of exposed rocks, pebbles, and gravel in their beds at distances up to several miles from their origin, where they literally appear as "Rock Beds". The pictures below show a Churia river and its tributary near Hetauda. Several similar tributaries were observed a short distance away.



The Churia rivers have enormous power when they are flooded. The Churia rivers originate from the steep slopes of the Churia hills which are very fragile and largely composed of mudstone, gravel, and conglomerates. Soils found in the slopes and the foothills of Chure are very shallow and are underlain by rocks and gravel.

In this thin soil mantle, trees, shrubs, and Chure vegetation thrives. Degraded forest land or land lacking in forest cover exacerbates runoff, soil erosion, and landslides during intense rain events which generally occur in the months of July, August and September. We observed flood water marks 3-4 feet high (from the bed) in one of the Churia rivers. Mr. Sandeshwar Jha at the Ranger Post located at the bank of the Pasaha Khola also mentioned that the flood level at Pasaha Khola reaches 3-3.5 ft high and the flood water is loaded with logs, debris, stones, sand, and wood. Mr. Subha Narayan Prasad Shah, a Forest Guard, who has been working at the Post for the past 18 years recalls heavy flooding of the Pasaha Khola in 2051 B.S. (about 7 ft high) and 2062 B.S. (about 5 ft high). During flooding, the Churia rivers are capable of carrying huge boulders, large trees and stumps, and rocks for considerable distances. Once the flood water is loaded with logs, rocks, boulders, and other debris it becomes even more destructive and capable of massive river-cutting, increased sediment loads, changes in river courses, and destruction of property and infrastructure, and possible loss of human life and livestock.

Further south from the foothills of the Churia (i.e. around the East West Highway), we find Churia rivers depositing debris, rocks and gravel in large amounts, damaging agricultural lands and often sweeping away villages. Pictured below (on left) is the Dhansar Bridge on the East West Highway where a large amount of debris is deposited. The



The middle picture shows the Bakeya River from the East West Highway bridge downstream with a large tract of land under rocks and gravel. Mr. Sudarshan Dangol who has lived on the bank of the Bakeya River for the past 20 years told us that there is flooding every year in the river and he has observed an excessive loss of agricultural land due to river-cutting in the past 20 years. Mr. Sher Bahadur Rai, the caretaker of the Dhansar Bridge, told us that a microbus was swept away killing all five people in 2064 B.S. by the flashflood of the Dhansar Khola. The picture on the right shows the Chandi River in Rautahat with Mr. Hira Lal Shah standing in front of a river bed which once contained 200-300 houses and fertile agricultural land, but is no longer habitable because of flooding (70-80 of the houses of that village were swept away in a single flood event in 2025 B.S.).

Mr. Shah states that "I am seventy years old. There was a village called Khaira Basti. There were 200-300 houses. The 2025 B.S. flood swept away 70-80 houses. Twenty to twenty-five people were killed, there was a lot of livestock loss. In that morning, I went to Chandranigahapur to sell milk to dairy on a dairy vehicle at around 3-4 AM. I returned to this village around 6-7 AM. I crossed the river. I saw the flood coming. I shouted for evacuation. It was the month of Shrawan. There was a rain for about a week. Once I shouted, villagers came out of their houses and fled away. They collected some of their belongings. Since I was from another village, none of my family members were living in that village. I was going there to purchase milk. I saw the Khaira Basti being swept away by the flood. All of the current flood plain is owned by people. It was a good agricultural land. People are not able to reclaim this land. There was a lot of debris, logs, gravels and trees in the flood. That house is the part of the old Khaira Basti."

Sand, gravel, and rock mining from the river beds for building and construction materials are very common activities in the region. Several Crusher Plants were found operating in the region. How rock and gravel extraction activities impact river morphology, river-cutting, flooding and land degradation in the Churia region is one of the major environmental questions requiring research.

Moving further south into the Indo-Gangetic plains (closer to the Indian border), the Chure rivers receive water from groundwater discharge for most of the year. During their flooding, they are loaded with silt and

fine particles which are deposited further downstream. Thus, inundation, silt deposition and land degradation are major problems in this region. The flood of August 2068 B.S. in the Dudhaura River can be taken as an example. According to our local respondents, there was a heavy flooding of the Dudhaura River with a 20-25 ft rise in the water



level at the bridge of Birgunj/Kalaiya road in August, 2011. The flood event occurred as soon as the rain stopped at around 9 AM. There were 200-250 armed forces camped on the bank of the Dudhaura River who had to be evacuated immediately, abandoning the camp, which was completely destroyed.

Based on field observations of some of the Chure rivers between Hetauda, Birgunj, and Chandranigapur areas and the information on Chure degradation previously published in the literature, there is no doubt that the degradation of the Churia region constitutes a national level environmental and ecological crisis for Nepal. The problem of Churia degradation demands immediate attention from all concerned authorities and stakeholders to avoid catastrophic levels of irreversible environmental and ecological devastation. For the development of effective risk reduction and mitigation programs and strategies, it is necessary to understand the geomorphology, hydrology, geology, water balance, forest conditions, socio-economic conditions, and other relevant parameters in relation to landslides, debris flow and inundation in the Churia region. Community capacity-building for risk reduction and mitigation of natural disasters is another important aspect of landscape rehabilitation. To realize these overarching goals, there should be a high level of collaboration among various governmental and nongovernmental agencies, academic institutions, local communities, and other stakeholders for this research and development. Through the implementation of appropriate strategies and measures for disaster risk reduction and mitigation in the Churia region, Nepal can reclaim hundreds of thousands of hectares of degraded land and restore ecosystem services which will not only benefit local communities in the region in their socio-economic uplift and transformation but also will contribute the whole nation in its food security, disaster risk reduction, ecological restoration, and environmental quality.

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