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Transformation of Built Environment in Karnali and Far Western Himalayan Region of Nepal: A Case Study of Settlements of Chandannath and Martadi

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Abstract

The built environment in Nepal has undergone significant changes due to the construction of transport infrastructures, particularly roads, and the establishment of local governments in 2015. The Karnali and Far Western Himalayan Region (KAFHR) in Nepal have unique traditional rural settlements characterized by distinctive settlement patterns, house forms, roof structures, building materials, and spaces. In the upper Karnali region, buildings have flat mud roofs called 'Thada' and are interconnected at the roof level known as 'Bada,' which serves as a public gathering place. In the Far Western region, buildings have sloped roofs covered with slates and are connected through courtyards, narrow passages, and public spaces. The development of road access and the influx of population have transformed these settlements, not only as market centers but also in terms of their patterns and features. The new political and administrative power of municipalities has influenced the self-governance of these settlements. However, they still face significant risks from disasters such as landslides and earthquakes. This paper focuses on analyzing the transformations in two settlements, Chandannath-Jumla and Martadi-Bajura, using a mixed-method approach. The study utilizes secondary data from literature reviews, spatial analysis, and open street maps through a QGIS-based application. Additionally, the knowledge of local citizens is incorporated through key informant interviews, enabling the development of a trajectory of settlement transformation from 2000 to 2020. The analysis identifies various drivers of transformation in socio-cultural, ecological-environmental, economic, and political domains, along with their dynamics. By filling the knowledge gap regarding the transformation process in the KAFHR, this research contributes

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to understanding process of shaping settlement patterns, forms, features, inclusivity, and sustainability in these regions.

Keywords: Built environment, transformation, Himalayan settlements, Karnali and Far Western Himalayan region, Nepal

Introduction

Nepalese Himalayan Region (NHR) encompasses over 35% of the country's total geographical area, while hosting less than 10% of the population (CBS, 2021). Within the NHR, Karnali and Far Western Regions collectively account for 57% of the area and accommodate over 30% of the population (CBS, 2021). Prior to local governance restructuring, Nepal consisted of approximately 35,496 settlements, with only 4,986 settlements located in the Nepalese Himalayan Region, representing around 14% of the total (CBS, 2011). Notably, Karnali and Far Western Himalayan Region (KAFHR) comprise more than 47% of the Himalayan settlements, totaling 2,358 settlements (CBS, 2011).

The transformation of the built environment in the Nepalese Himalayan Region is a relatively recent process, coinciding with the onset of urbanization. Administrative urbanization in the region commenced in 1997 with the declaration of the first two municipalities: Bhimeshwor Municipality in Dolakha District and Khadbari Municipality in Sankhuwasabha District. In 2011, three additional municipalities were established: Bajhang Chainpur Municipality in Bajhang District, Chandannath Municipality in Jumla District, and Taplejung Municipality in Taplejung District. Furthermore, the state restructuring in 2015 designated over 30% of the region as urban through the transformation of local governments into municipalities, primarily driven by political and administrative decisions.

Although the evolution of early human settlements in Nepal is believed to have occurred in the hills and mountains (Chidi, 2009), the lack of historical data on the western mountains makes it challenging to determine the precise timing and spatial extent of early settlements (Pandey, 2017). Limited research has been conducted on Himalayan settlements in Nepal, particularly in Karnali and Far Western Himalayan Region (KAFHR). These remote and sparsely populated rural settlements have received scant attention, resulting in a dearth of data, information, and knowledge regarding their transformation and current state (Chidi, 2009). Several perspectives exist on human settlements in mountainous regions, emphasizing their historical influence on the built environment and their adaptive responses to emerging challenges (Pandey, 2017). However, these dynamics have long been marginalized, with limited recognition of the unique local-level processes and characteristics, as highland studies often adopt a regional approach, overlooking local nuances (Pandey, 2017). This knowledge gap extends to understanding the locational patterns and underlying factors

shaping human settlements (Chidi, 2009).

In light of these circumstances, this paper aims to analyze the settlements in Chandannath and Badimalika Municipality within the Karnali and Far-Western Himalayan Region, respectively. It employs a mixed-method research (MMR) approach, combining secondary data from literature reviews, spatial analysis of settlements extracted from satellite images, and open street maps using a QGIS-based application. Additionally, the study incorporates insights from key informant interviews (KII) and visual documentation through photographs captured by various individuals. By integrating these data sources, the study constructs a trajectory of settlement transformation from 2000 to 2020, presenting a comprehensive built environment transformation map that traces the historical timeline and identifies the drivers contributing to the production of the built environment. The paper commences with a literature analysis of key aspects related to the production of the built environment, followed by an examination of settlement patterns, characterization of transformational forms, and identification of underlying factors driving the transformations.

Materials and Methods

This paper explores and analyzes the trajectory of transformation in settlements within the Karnali and Far Western Himalayan Region (KAFHR), identifies the drivers behind this transformation and also offers policy recommendations for local governments and stakeholders. Basically, it addresses the following two crucial questions:

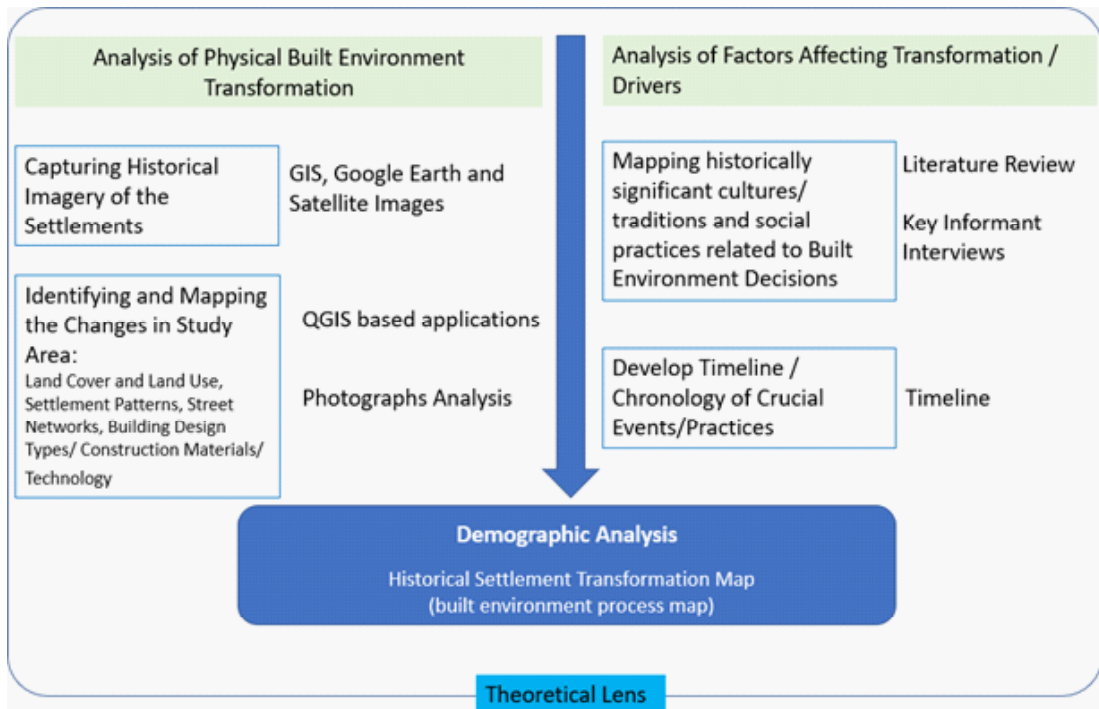
- i. How are rural Himalayan settlements in Karnali and the Far-Western Himalayan Region being transformed in terms of the built environment, including buildings, roads, and land use?
- ii. What are the drivers or factors that have influenced or shaped the transformation process of these settlements over time?

Methodology

It utilizes a mixed-method approach, employing Trajectory-based Qualitative Comparative Analysis (TJ-QCA) (Hürlimann et al., 2022) to analyze the transformation of settlements and their built environments. The analysis incorporates secondary data from literature reviews, spatial analysis using satellite images and Google Earth, and primary data obtained through Key Informant Interviews and photographs. TJ-QCA, traditionally used in clinical and empirical research, enables capturing historical patterns of change and identifying related drivers in the context of built environment transformation.

Figure 1

Research Process



As represented in figure 1, the methodology involves two concurrent processes. The first process focuses on analyzing images and photos related to settlements and built infrastructure, examining changes in location, design, patterns, materials, and related infrastructure over different periods.

The second process involves a comprehensive review of literature combined with insights gathered from Key Informant Interviews, covering socio-cultural practices, environmental events, economic factors, and political milestones related to the built environment. Integrating both processes results in the development of a trajectory of transformations and their drivers across the study period. Historical discourse is critical in understanding the past, which has shaped the present and guides future directions (Moffatt & Kohler, 2008; Adeyemo et al., 2017).

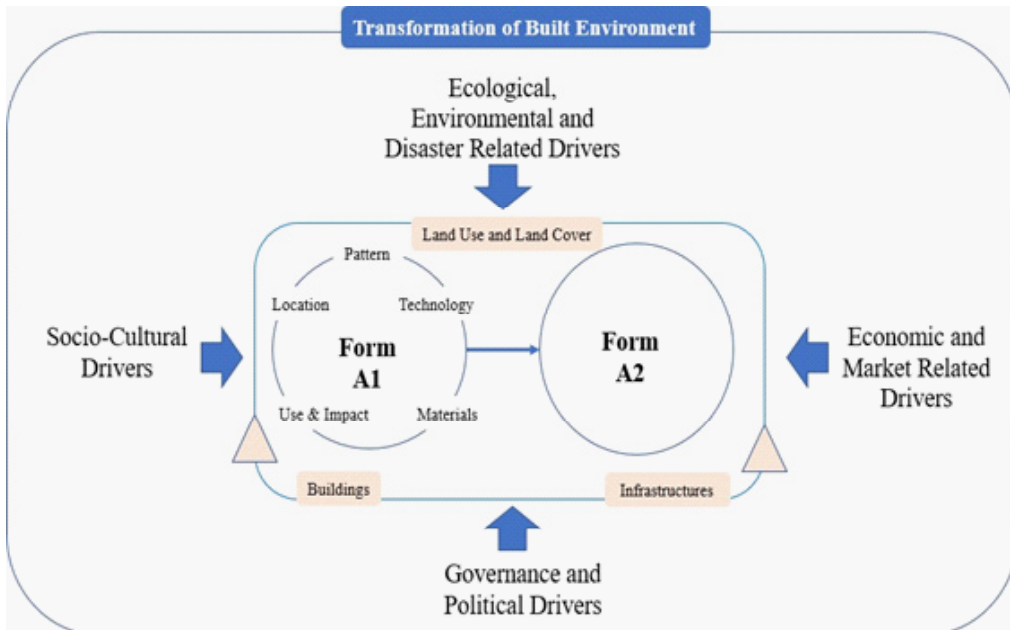
Theoretical Framework

Human settlements encompass physical elements and services sustaining a community, including shelters, infrastructure networks, and other essential facilities (Vancouver Declaration on Human Settlements, 1976; NPC, 2013). The built environment,

as a core component of human settlements, is continuously evolving and influenced by various drivers, such as sociocultural traditions, environmental-ecological conditions, market and economic opportunities, political and governance decisions, and individual choices (Kaklauskas & Gudauskas, 2016). The transformation of the built environment involves changes in location, pattern, construction materials, technology, and use and impact. As presented in the figure 2, the characterization of the transformation is done using five indicators:

Figure 2

Theoretical and Conceptual Framework



Pattern and Form

The pattern indicates the architecture of the settlements in general and mainly the spatial composition of buildings and other infrastructure. These patterns, types, and forms of settlements, especially in the rural context, reflect the culture, traditions, and environmental diversities (NPC, 2013). Shrestha (1980) has identified only two types of patterns i.e., block-type compact and regular compact. However, to broaden the study aspects and include other patterns, the study analyses patterns in three geometrical forms i.e., compact, linear, and dispersed. In terms of rural and urban features of the settlement, the study adopts general classification of Nepalese rural and urban areas i.e., village development committees or rural municipalities as rural, while municipalities, sub-metropolitan, and metropolitan as urban

forms. In addition, the study considers the classification by M. Li. et al (2019) who studied the trajectory of settlements in China. This study classified the forms of settlements as rural form (deep rural, isolated village, sparse village, and dense village), sub-urban (sparsely clustered town, densely clustered town), and urban (large cities) (Li et al., 2019).

Location

The location of settlements is influenced by various factors such as historical factors, accessibility, availability of resources, human preferences, and available technology. Shrestha (1980) has studied nine criteria of the eighteen settlements in Humla, an area belonging to the Himalayan region of Karnali province and concluded that the settlements in these regions are located based on the proximity of three important elements i.e., water, agricultural land, and source of fuel (forest) in order (Shrestha, 1980). Hence, this paper has also used three indicators to analyze the locations from these three aspects and analyze the differences or similarities. The location of settlements has a significant impact on the built environment.

Construction Materials

Construction materials are an important part of built environment transformation. At a core of the built environment, construction materials play an essential role in defining the built environment's vision (Rahla et al., 2021). For a structure to be operational, sustainable, resilient, and possess a desired service life and life cycle cost, all of its essential components must have the required properties. The choice of materials makes not only favorable to the climate, weather, and topography (Thapa, 2019) but also strengthens resilience and sustainability (Rahla et al, 2021). Most importantly, construction materials are also associated with the culture, traditions, and architecture of the settlements. Mid and Far Western Himalayan Settlements of Nepal developed and practiced the Khasa style of architecture which is diffused from its place of origin, Sinja Valley, to the eastern and western hilly region of Nepal (Thapa, 2019). However, with time and increased access to outside markets, and many other factors, the use of construction materials for buildings is changing rapidly.

Construction Technology

Vernacular housing constructions are unique and local technology of construction in local areas is engrossed by the local people, resources, and knowledge (Pal, 2018). Nepal consists of 62% building structures urban area and 38% in rural areas (CBS,

2021). However, 80% of the buildings are constructed using without engineering or poor engineering in construction even in urban areas (Gautam et al., 2016). This depicts the wider presence of vernacular non-engineered dwellings (Pal, 2018). To construct and reconstruct culturally appropriate and assure patrimony, promotion and enhancement of local technology could be effectively utilized in Nepal. The construction technology is not sophisticated and doesn't require specialized high skilled manpower; however, a simple rectangular construction technology with four to six wooden pillars running from foundation to roof is prevalent in the case study area. This simple and symmetric construction is also efficient in terms of balancing the torsional effects during earthquakes. Such appropriate technology is guided by earthquake-resistant features, flood, and damping resilience and to prevent snake attacks. Due to economic constraints, new houses were also observed to be adopting similar construction technology in the study area (Pandey, 1970).

Use of Buildings and Source of Energy

The transformation of the built environment in terms of use is another important dimension as the use of energy is directly linked to local traditions. This aspect influences the wider socio-economic and environmental conditions including health and well-being, inequality and accessibility, resilience, and sustainability. Hence, this analysis primarily focuses on changes in the use of the buildings for different purposes and different sources of energy used by the population.

Study Area

The research focuses on the Karnali and Far Western Himalayan Region (KAFHR), specifically Jumla and Bajura districts. These regions experience rapid rural-urban transformation and face geographical challenges, including limited accessibility and a high risk of natural disasters. The study specifically examines two municipalities, Chandannath Municipality in Jumla and Badimalika Municipality in Bajura, which serve as important market centers despite their remote locations from regional markets. To gain a deeper understanding of these municipalities, the study also investigates two smaller yet densely populated settlements, namely the Chandannath area (previous Chandannath VDC) in Jumla and the Martadi area (previous Martadi VDC) in Bajura. These locations possess unique traditional settlements and built environments and play significant roles within their respective regions.

Results and Discussion

Trajectory of Transformation

Settlement transformation, including changes in the built environment, occurs

gradually and incrementally over time, transitioning from one form to another (Li et al., 2019). This progression of changes, represented by different configurations constitutes a trajectory that captures the qualitative patterns of change on a case-by-case basis (Hürlimann et al., 2022). Trajectory analysis serves as a valuable investigative tool for examining the degree of continuity or discontinuity between settlements (Fletcher, 2020). To conduct such analysis, time series data of various indicators needs to be compared and analyzed, necessitating the determination of suitable periods and intervals.

In this study, the selection of four different periods such as before 2000, 2001–2010, 2011–2015, and 2016–2020 has been taken into account with factors such as the availability of scientifically validated historical data, the significance of different types of changes in settlements and built environment, and the presence of influential drivers of transformation. By adopting varying durations for each period, the study aims to accurately capture the pace of change and its underlying drivers. Once the periods and intervals are established, the analysis focuses on different indicators, with particular attention given to the transformation of buildings and related infrastructures. These areas offer valuable insights into the multifaceted, multisectoral, and complex nature of transformation, as well as the interrelationships that can be discerned through the examination of historical imagery.

The Trajectory of Transformation- Chandannath

Overall Settlement and Built Environment

Before 2000

- (i) Settlement history is scarce, but it is believed to have been established by Saint Chandannath after draining three adjoining lakes (Dana, Yamala, and Lami Raha) (DDC Jumla, 2014).
 - (ii) The existence of the Chandannath temple in 899 A.D. confirms the presence of settlement (DDC Jumla, 2014).
 - (iii) The settlement was in the valley basin near a southern-facing foothill, roads, agricultural fields, the Jugad stream (Khola), and the Tila River (Naraharinath).
 - (iv) Limited household and population data are available, with the total number of households in Jumla recorded as 12,393 in 1981 and 13,547 in 1991 (CBS 1981 & 1991).
 - (v) Photos by Bishop in 1969 and Fairbank in 1971 evident that the settlement is tiny (Photo 2.1 & 2.2).
 - (vi) The settlement was isolated, rural, and lacked connectivity to the National Road Network. However, it served as the zonal headquarters of the Karnali zone from 1962 to 2013 (Chandannath VDC, 2008).
-

During 2001-2010

- (i) Period marked a significant turning point in the transformation of settlement and built environment.
 - (ii) The period began with the destruction of government and public buildings in a 2002 Maoist attack on the district headquarters.
 - (iii) Karnali Highway construction began in 2004 from the Jumla side, with community participation, and was completed in 2007 (Dixit, 2004; Budha, 2007).
 - (iv) Roadside settlements gradually transformed into local markets.
 - (v) The armed conflict in the villages led to an increased influx of population from the peripheries.
 - (vi) The satellite image of 2006 revealed the alignment of the Karnali Highway along the major agricultural area, impacting the overall transformation of the settlement (Shahi, 2008).
 - (vii) Houses and land affected by the highway were compensated with around 120 million rupees from the World Bank (Shahi, 2008) led to construction of new buildings adjoining to road.
 - (viii) No. of households in the Chandannath VDC reached to 1,457 in 2008 (Chandannath VDC, 2008).
-

During 2011-2015

- (i) Witnessed an accelerated transformation of the settlement and built environment in Chandannath.
 - (ii) In 2011, the settlement was declared a Municipality by merging Chandannath and Mahat VDCs, and further expanded in 2014 by merging Talium and Kartikshwami VDCs.
 - (iii) The establishment of Karnali Academy of Health Science as a core academic institution for medical education attracted students from outside of Jumla.
 - (iv) A satellite image taken in 2015 revealed rapid settlement expansion along the newly built highway in the agricultural field on the southern front of the valley. Additionally, four new roads were initiated, two on the agricultural field and two towards the hills.
 - (v) The period concluded with the declaration of Chandannath as a Municipality, representing another significant turning point in the history of settlement transformation.
 - (vi) No. of households in Chandannath VDC increased to 1,830 in 2014 (DDC Jumla, 2014).
-

During 2016-2020

- (i) The settlement witnessed significant growth and expansion during the period, particularly towards the southern end of the agricultural field.
 - (ii) Satellite images from 2016 and 2020 indicate the expansion of the settlement, accompanied by the opening of new road alignments in the plain agricultural area.
 - (iii) Asphalt paving of Jumla airport facilitated regular flights, even in challenging weather conditions.
 - (iv) Several new infrastructures, including a stadium and a bus park, were introduced, contributing to the emergence of a new nucleus of settlement on the eastern side of the agricultural field.
 - (v) The number of households in the entire Chandannath Municipality experienced a drastic increase, rising from 3,996 in 2011 to 5,367 in 2021 (CBS, 2011 & 2021).
-

Pattern and Forms

Before 2000

- (i) The houses in the settlement were aligned along the road, forming a connected and linear pattern (Campbell, 1978).
 - (ii) This form of connected houses, locally known as "Bada," facilitated proximity and interaction among households (Campbell, 1978).
 - (iii) The buildings collectively created a linear pattern along the roads, while the overall settlement had an 'X' shape, with two roads intersecting at the market center (Bishop, 1978).
 - (iv) Photo 2.2 taken by Bishop in 1968 provides visual evidence of this pattern (Bishop, 1978).
-

During 2001-2010

- (i) Traditional patterns of building and settlement continue to be prevalent in the area.
 - (ii) Due to the construction of the Karnali highway, some houses were dismantled and relocated to new areas.
 - (iii) The new locations for these houses were primarily along the roadsides, particularly in proximity to the new alignment of the highway.
 - (iv) This new alignment passes through agricultural land known as "Khet".
 - (v) The dispersed pattern of the new buildings can be observed in Image Collage 1 from the year 2006
-

During 2011-2015

- (i) The construction of new buildings experienced rapid expansion, particularly along newly constructed road segments, notably the Karnali highway (Bijayanagar - Mahatgaun).
 - (ii) Another road alignment was established from the bus park near the jail to connect Kartikshwami on the bank of the Tila River.
 - (iii) These new road alignments resulted in the transformation of the traditional X pattern of buildings into a new isolated and scattered pattern.
-

During 2016-2020

- (i) The construction of new buildings led to the consolidation of settlements around the existing market centers, as depicted in Image Collage 2.
 - (ii) However, the expansion of construction continued towards the southern front of the area, as shown in Photo 1.3 and 1.4.
 - (iii) The photographic images illustrate the construction of multi-story buildings, reaching up to five stories, in the core area, showcasing a shift from the previous two-story buildings (Photo 3.4 & Photo 4.5).
-

Location of Buildings and other Infrastructures

Before 2000

- (i) Buildings were in the valley basin with a slightly raised area near the hill base and Jugad Khola.
 - (ii) They were aligned along both sides of the roads.
 - (iii) Construction was planned to avoid encroaching on valuable agricultural land, particularly the land used for growing Marshi Rice.
 - (iv) During the Rana regime, Marshi Rice was sent to the Royal Families in Kathmandu.
 - (v) The goal was to preserve the agricultural land's productivity and historical significance (Gautam et al., 2022).
-

During 2001-2010

- (i) The construction of the Karnali highway caused displacement of houses in certain areas where the highway replaced the previous road. As a result, the houses were relocated closer to the new highway.
 - (ii) In the Vijayanagar section (Buspark to Mahatgaun), buildings were constructed along the new alignment of the highway.
 - (iii) The construction mainly took place in the agricultural field (Khet) adjacent to the highway (Image Collage 1).
-

During 2011-2015

- (i) The new construction of buildings continued to be in the agricultural field (see the satellite image of 2015). In addition, the buildings were constructed near to stream (Jugad Khola) and Bus Park. (Image Collage 3, the Year 2016).
-

During 2016-2020

- (i) The location for the construction of the building has been rapidly shifting toward the agricultural land along the periphery of the newly opening roads and transport linkages (Photo 1.3 & 1.4). In addition, the old buildings in the core market are being renovated (Photo: 3.2).
-

Construction Technology

Before 2000

- (i) Traditional houses in the area utilized wooden logs as pillars and beams (Campbell, 1978).
 - (ii) Small-sized buildings were prevalent, featuring 18" mud-mortar walls, limited ventilation, and flat mud roofs constructed over wooden beams, flakes, and Thatch lining.
 - (iii) In the 1960s, a few government buildings, including offices and residences, were constructed using local bricks and load-bearing walls (Photo 4.2 & KII Ramananda Acharya).
 - (iv) Non-local individuals, serving as government officials, settled near the Bazaar area, and constructed single-story buildings without animal-raising activities. Other buildings were only two stories tall, with the ground floor dedicated to animal housing (Campbell, 1978; Ramananda Acharya-KII).
-

During 2001-2010

- (i) No significant changes in the construction technology of buildings in the area.
 - (ii) The reconstruction of 18 government buildings destroyed by Maoists opened an opportunity for new construction (Raonline, 2002)
 - (iii) In addition, with the opening of the Karnali highway and the change in government designs (especially for public schools and government offices), the buildings were made of earthquake resistive designs. The use of CGI sheets as roofing material and truss framed structures for sloped roofs were introduced.
 - (iv) Cement tipping on outer walls, primarily for decorative purposes, began to be used by a few local elites and was more prevalent in public buildings (Photo 4.4).
-

During 2011-2015

- (i) Introduction of new construction technology occurred during this period.
 - (ii) According to the 2011 census, among 1,839 buildings surveyed, 3 had RCC pillars, 27 had RCC roofs, 1,735 had CGI sheet roofs, and 75 had cement mortar walls.
 - (iii) Photographic evidence suggests the early stages of a rapid transformation in building construction technology from traditional methods to new techniques involving cement mortar, CGI, and RCC.
 - (iv) The traditional practice of using timber lintels experienced a reduction and replacement with other materials (CBS, 2011).
-

During 2016-2020

- (i) There has been a significant increase in the adoption of RCC (Reinforced Concrete Cement) frame structure for building construction.
 - (ii) Around 90% of the newly constructed houses during this period have utilized RCC frame structure.
 - (iii) Very few percentages of houses have opted for load-bearing walls with CGI roofing.
 - (iv) The trend towards RCC frame structures with stone masonry walls and RCC roofs has become more prominent (Photo 4.7 & 4.8).
-

Construction Materials

Before 2000

- (i) Buildings in the area were predominantly constructed using stone and mud masonry walls, with flat roofs made of mud (Thapa, 2019).
 - (ii) Some government buildings, particularly those associated with the Zonal offices and officials' residences during the Panchayat Regime, were constructed using locally made brick masonry (Photo: Fairbank, 1971). The availability of locally made bricks was made possible by bringing brick-making laborers from Kirtipur to Jumla during the Rana Regime.
 - (iii) However, these brick buildings proved unsuitable for coping with the extreme cold weather in winter, leading to the abandonment of brick usage (Ramananda Acharya - KII).
-

During 2001-2010

- (i) Until 2007, few public buildings used stone cement masonry with CGI sheets.
 - (ii) Construction Materials such as cement and CGI sheets were transported from Nepalgunj or Surkhet by helicopters or airplanes.
 - (iii) The compensation received from Karnali highway promoted use of modern construction materials.
 - (iv) Traditional mud houses transformed into cement-tipped walls and CGI sheet roofs.
 - (v) The opening of Karnali highway facilitated the availability and hence use of modern materials like cement and RCC.
-

During 2011-2015

- (i) Traditional buildings were still prevalent in the municipality. About 99% of households had buildings with mud-mortar foundations (CBS, 2011). About 98% of buildings had mud-bonded walls (CBS, 2011).
 - (ii) About 65% of households had mud roofs (CBS, 2011).
 - (iii) About 31% of houses had CGI roofs (CBS, 2011).
 - (iv) Introduction of modern technology led to changes in building materials from stone, mud, and wood to stone, cement, and CGI sheets.
 - (v) Enforcement of Community forestry restricted the use of timber from the forest (Image Collage 4).
-

During 2016-2020

- (i) Construction materials have shifted towards brick-masonry and RCC (Photo 4.7 & 4.8).
 - (ii) Brick usage as a construction material for walls has regained popularity (Photo 4.7 & 4.8). 22% houses have outer wall with cement bonded brick/stone masonry (CBS, 2021).
 - (iii) Bricks are commonly available and being transported from Nepalgunj and or Surkhet.
 - (iv) Locally made interlock bricks, composed of cement, sand, and local mud, are used in a limited number of buildings, especially low-cost private buildings (Photo 4.9).
 - (v) Around 50 residential buildings are constructed using locally produced interlock bricks (Photo 4.9).
-

Uses of Buildings and Sources of Energy

Before 2000

- (i) Buildings in the area served both residential and agricultural purposes, reflecting the primary occupation of agriculture.
 - (ii) Most houses had a division of floors, with the top floor used for family residence and the ground floor used for housing animals.
 - (iii) Some houses in the main market area also had small retail shops and tea shops on the ground floor.
 - (iv) Data on sanitation facilities is not available, but reports suggest a poor sanitation situation.
 - (v) It is likely that government offices and officials' residences had latrines.
 - (vi) In 1983, a small hydropower plant with a capacity of 200 KW was constructed, providing electricity to Chandannath VDC. Access to electricity has been available to households in the study area since then.
 - (vii) Firewood was the main source of energy for cooking. There were programs promoting improved cooking stoves, but data on the number of households using them is not available (Sulpya, 1997).
-

During 2001-2010

- (i) Area emerged as a major market center, leading to an increase in local business establishments.
- (ii) Existing and new houses are being used as hotels, restaurants, and shops. The trend accelerating after the opening of the Karnali Highway.
- (iii) In 2008, there were a total of 147 small cottage industries, including 18 hotels, operating in the area (DDC Jumla, 2009)
- (iv) Some newly constructed buildings, featuring designs such as CGI Sheet sloped roofs, are being promoted as hotels or guest houses
- (v) Access to sanitation facilities increased to 26.4% in 2009 (DDC Jumla, 2009).
- (vi) Around 25.5% of households used solar energy for electricity (DDC Jumla, 2009).
- (vii) Approximately 78.3% of households had improved cooking stoves (DDC Jumla, 2009). The majority (87.6%) of households used firewood as their primary cooking fuel; while only a small number (9 households) used kerosene (DDC Jumla, 2009).

During 2011-2015

- (i) The use of buildings in the area shifted from small tea shops and hotels to larger hotels and retail businesses. In the main market center high-rise buildings, trade concerns, material suppliers, gyms, computer institutes, and department stores are established.
- (ii) KII revealed that several new business initiatives began during this period (no official data available).
- (iii) In 2014, a significant number of houses in the area had safely managed sanitation/toilet facilities, reaching 94.15% (DDC Jumla, 2014).

During 2016-2020

- (i) During this period, there was a rapid transformation of buildings from small tea shops, hotels, and small businesses to bigger hotels, restaurants, financial institutions, and industries such as the Apple wine industry. There are now more than 45 hotels specifically catering to tourists.
- (ii) Solar, LPG, and Electricity is prioritized as the main source of energy by households. 71% use electricity and 21.4% use solar for light while 33.3% use LPG for cooking (CBS, 2021). Though national grid connection exists, due to frequent maintenance issues, there are significant challenges in accessing electricity consistently throughout the day or even for months.

Image Collage 1:

Overall Settlement Transformation in Chandannath (Satellite Images)

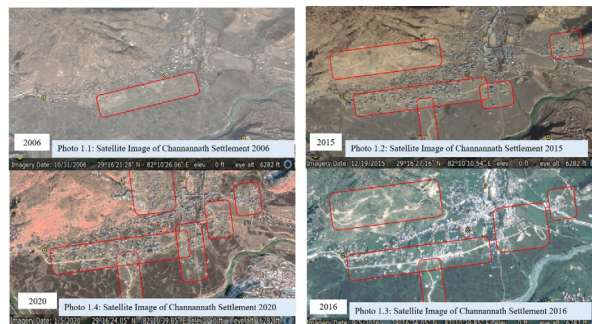


Image Collage 2:

Comparing Settlement Using Photographic Images Between 1970s to 2022 (Chandannath)



Photo 2.1: Main Settlement of Chandannath VDC - Photo Taken by Bishop in 1969 (Bishop, 1978 pp. 541)



Photo 2.2: Extent of Settlement in Chandannath, Jumla – Photo taken by Bishop in 1969 (Bishop, 1978 pp. 537)



Photo 2.3: Main Settlement of Chandannath, Jumla (Soraj Shahi, 2022)



Photo 2.4: Extent of Settlement of Chandannath Area, Jumla (Google Earth Image, 2022)

Image Collage 3: Transformation of Architecture



Photo 3.1: Main Market Area, Chandannath, Jumla (Fairbank, 1971)



Photo 3.2: Main Market Area, Chandannath, Jumla (Koirala, Rabin 2022)



Photo 3.3: Settlement around Main Market, Chandannath, Jumla (Fairbank, 1971)



Photo 3.4: Settlement around Main Market, Chandannath, Jumla (Shahi, Saroj 2022)

Image Collage 4: Building Architecture, Construction Technology and Materials in Chandannath



Photo 4.1: Traditional Stone Masonry made Building (Nepali, Ratan 2022)



Photo 4.2: Stone Masonry Building under construction (Fairbank, 1971)



Photo 4.3: Stone Masonry Building with improvised Door and Windows (Shahi, Saroj 2022)



Photo 4.4: Stone Masonry Building with CGI Sheet Roof (Shahi, Saroj 2022)



Photo 4.5: 5 story RCC Buildings behind the traditional 2 story building (Shahi, Saroj 2022)



Photo 4.6: Private RCC Building and School building on the hillside (highway) (Shahi, Saroj)



Photo 4.7: Private RCC Buildings with brick walls built on paddy field (Shahi, Saroj 2022)



Photo 4.8: Cluster of houses with RCC Frame and Brick Masonry Wall Buildings (Shahi, Saroj 2022)



Photo 4.9: Building made of interlock brick locally made in Jumla (Magar, Amrit 2022)

The Trajectory of Transformation-Martadi

Overall Settlement and Built Environment

Before 2000

- (i) Martadi was situated in the middle of the north-facing hillside slope surrounded by small hills and agricultural fields. It was primarily a paddy field (Martadi VDC, 2013).
 - (ii) The road from Sanfebagar to Martadi was constructed in 1995 to connect Martadi to Dhangadi through Achham and Dadeldhura (Singh, 2016; SMEC et al, 1999).
 - (iii) The settlement of Martadi was small and located remotely from the regional centers of Dipayal and Dhangadi. The entire Bajura district had 12,393 households in 1981 and 17,542 households in 1991 (CBS, 1981; CBS, 1991). The VDC-wise population data is not available, but it can be assumed that the settlement was entirely rural.
-

During 2001-2010

- (i) The period involved preparation for the transition from a rural to an urban nature of the settlement.
 - (ii) The satellite image of 2008 (Image Collage 5) showed the settlement aligned along the lower left corner of the hillside in the northeastern segment, with vacant agricultural areas left for farming and few buildings under construction.
 - (iii) There were no major roads passing through the settlement, only small trails around the outer corners.
 - (iv) The construction of the Shanphebagar-Martadi Road, previously inaugurated, was obstructed during the conflict period and could not be completed, limiting outer access to the settlement.
 - (v) In 2010, Martadi VDC had a total of 1,120 households and a population of 6,829 (Martadi VDC, 2010).
-

During 2011-2015

- (i) The opening of Shangebafar-Martadi road track in 2013/14 marked a turning point for Martadi
 - (ii) The settlement officially declared a municipality in December 2014, combining Martadi VDC with neighboring VDCs.
 - (iii) Settlements expanded towards agricultural land along the new road alignments (Image collage 5)
 - (iv) Only earthen roads exist and no bus or transport services available in VDC (Martadi VDC, 2013).
 - (v) The opening of the road connection between regional markets (Dhangadi) and Martadi led to the initiation of several new constructions including buildings, roads, government offices, hospitals, and bus parks.
-

During 2016-2020

- (i) The settlement has experienced significant growth and expansion toward agricultural land. There is a black topped road until the center of the Municipality (Badimalika Municipality, 2020).
 - (ii) The satellite images of 2017 and 2020 (Image collage 5) show the expansion of the settlement and the opening of new road networks, especially into the agricultural land.
 - (iii) The consolidation of buildings around the old market area and the formation of a new nucleus of settlement can be observed.
 - (iv) After the regular operation of bigger vehicles (Passenger bus) in 2016, the bus park was also constructed in the middle of the settlement (WASH Plan, 2020).
 - (v) The total number of households in the previous Martadi VDC is 1511 (WASH Plan, 2020).
-

Pattern and Forms.

Before 2000

- (i) Very little information is available about the building patterns and forms in Martadi.
- (ii) The houses in Martadi were connected and are called as "Bada" (a suffix used in most settlements).
- (iii) Buildings form linear pattern along the road, while the settlement exhibits a circular pattern (KII).

During 2001-2010

- (i) Lack of official information. KII revealed that traditional buildings remain prevalent throughout.
- (ii) The traditional Bada pattern, characterized by connected houses, shows no significant change during this period (Satellite Image, 2008).

During 2011-2015

- (i) The construction of buildings expanded quickly along newly constructed road segments, particularly in the agricultural lands and hillsides (Image Collage 5, 5.1).
- (ii) The road network expanded across the area, leading to scattered new constructions in the agricultural fields (Image Collage 5, 2014).
- (iii) The transformation resulted in a shift from the old linear pattern of connected buildings new pattern characterized by isolated and scattered buildings (Image Collage 5, 5.3).

During 2016-2020

- (i) The period is marked by a significant expansion of buildings and roads in the built environment.
- (ii) The images 5.3 & 5.4 show the emergence of multiple new settlements in various corners of the area.
- (iii) These new settlements are primarily located in areas where road access has been rapidly increased.

Location of Buildings and other Infrastructures

Before 2000

- (i) Limited information is available for this period.
- (ii) According to KII, the buildings were situated on elevated locations to avoid agricultural land.
- (iii) The choice was also influenced by the lack of irrigation facilities in elevated locations.

During 2001-2010

- (i) Construction of buildings primarily concentrated around the north-eastern corner, with a separation from the agricultural fields below and on the sides.
 - (ii) Other infrastructures besides roads and the school at the center were not visible (Image 5.1)
 - (iii) Crucial is that 53.8% of households were in areas with risk of disasters (Martadi VDC, 2010).
-

During 2011-2015

- (i) The construction of newly built buildings in the settlement was primarily concentrated in the agricultural fields, particularly in the middle of the paddy fields.
 - (ii) The opening of the road alignment in the middle of the agricultural field played a significant role in facilitating the construction of these new buildings.
 - (iii) Satellite image 5.2 shows the expansion of the settlement and the presence of newly constructed buildings in the agricultural field.
-

During 2016-2020

- (i) The construction of buildings has been shifting towards the agricultural land along the periphery of newly opened roads and transport linkages.
 - (ii) The satellite images from 2017 and 2020 (Image 5.3 & 5.4) show the location of the buildings expanding towards the agricultural land.
 - (iii) This shift in location indicates the growing development and expansion of the settlement into previously unused or rural areas.
-

Construction Technology

Before 2000

- (i) Limited information is available about the construction techniques used in Martadi.
 - (ii) The construction technology was simple, with wooden logs used as pillars and beams.
 - (iii) Most buildings in Martadi were two-story structures with sloped roofs made of materials such as slates/tiles or thatch. The ground floor of the buildings was typically used for housing animals.
 - (iv) The size and construction of houses varied based on the economic status of the owner, with some houses constructed using wooden Bardali (KII).
-

During 2001-2010

- (i) There was no significant change in the technology of house construction during the period. However, the introduction of CGI roof led to the use of truss-framed structures for sloped roofs.
 - (ii) Cement tipping on the outer walls for decorative purposes is done by few elites and in public buildings.
-

During 2011-2015

- (i) There was no significant change in construction technology observed during the period.
 - (ii) 93.1% of houses had mud-mortar foundations, 91.9% of houses had walls made of mud-mortar, and 3.6% of houses had walls made of wood (CBS, 2011).
 - (iii) Wooden pillars were commonly used as columns in the construction of houses.
 - (iv) With the opening of the Shanphebagar to Martadi Road, new construction technology was introduced.
-

During 2016-2020

- (i) There has been a significant increase in the adoption of new construction technology.
 - (ii) Around 90% houses constructed during the period used RCC -frame structure.
 - (iii) A small percentage of houses have used load-bearing walls with CGI roofing.
 - (iv) The adoption of RCC frame structures indicates a shift towards new construction methods.
-

Construction Materials

Before 2000

- (i) Buildings constructed during this period predominantly used locally available materials like stone, wood, thatch, and mud.
 - (ii) The roofing material, either slate or thatch, differed based on the owner's economic status.
 - (iii) Construction methods and materials remained traditional, and limited to local area
-

During 2001-2010

- (i) During this period, there were noticeable changes in the use of external materials in building construction, particularly the introduction of CGI sheets for roofing.
 - (ii) The use of cement in construction also became more prevalent during this time.
 - (iii) The majority of houses transitioned from thatch roofs to slate or tile roofs, while a small percentage adopted RCC roofs.
 - (iv) Approximately 28% of households had thatch roofs, 68.1% had tile/slate roofs, 2.2% had CGI sheet roofs, and 1.7% had RCC roofs (Martadi VDC, 2010).
-

During 2011-2015

- (i) The opening of the Sanphebagar-Martadi road marked the start of a significant transformation in construction technology and materials.
 - (ii) According to the 2011 census data, the majority of houses had mud-mortar foundations and walls, comprising 93.1% and 91.9% respectively.
 - (iii) A small percentage of houses, i.e. 3.6%, had walls made of wood.
 - (iv) The use of wooden pillars as columns was widespread in the construction of houses.
-

During 2016-2020

- (i) The construction trend in Martadi has shifted towards the use of RCC (Reinforced Concrete Cement) buildings. About 28% households use CGI sheet and 18% households use RCC roof (CBS, 2021).
 - (ii) The construction of new houses in the area is predominantly done using cement-bonded bricks/stone or RCC materials. By 2021, it increased to 22% (CBS, 2021).
 - (iii) There is a growing preference for cemented buildings, leading to a decline in traditional mud mortar house construction in the bazaar area. Stone/slate roofing decreased to 47% (CBS, 2021).
 - (iv) This shift in construction materials reflects a changing trend in building construction practices in Martadi (Dahal, 2021).
-

Uses of Buildings and Sources of Energy

Before 2000

- (i) Limited information is available.
 - (ii) KII revealed, most of buildings were used for residential purposes by families involved in agriculture.
 - (iii) Very few buildings were designated for government offices and officials' residences, while a handful served as hotels, tea shops, and retail shops.
 - (iv) Due to small hydro project established in 1986 and commissioned in 1990, electricity was available in the Martadi, although specific coverage details are not available (Nepal24Hour, 2014; Adhikari, 2006).
 - (v) Sanitation facilities were limited & available only in government offices, hotels, and houses of the elite
-

During 2001-2010

- (i) Access to Sanphebagar, the urban center, raised the demand of multi-purpose buildings in Martadi (KII).
 - (ii) The concentration of government officials in Martadi during the armed conflict, led to the transformation of private residential houses into hotels, rental accommodations, and larger shops.
 - (iii) Local government's priority and investment in Martadi accelerated the pace of urbanization in the area.
 - (iv) By 2009, 57% of households had access to electricity, while 2% used Solar panels.
 - (v) 97% used firewood as a cooking fuel, and traditional mud stoves were the most common cooking equipment. Only a small number of households (16) used smokeless stoves, and even fewer (11) utilized electric heaters for cooking (Martadi VDC, 2010).
-

During 2011-2015

- (i) The use of buildings in Martadi has shifted from small shops and hotels to larger hotels and various business uses, including retailers, suppliers, and department stores.
 - (ii) % of households with safely managed sanitation facilities has increased to 52.86%, although the settlement lacks proper drainage management.
 - (iii) The roads in the settlement are primarily earthen, and while it is connected to Sanphebagar, there is no bus or transport service available.
 - (iv) 81 households out of a total of 1178 in the VDC have started using imported gas (LPG) for cooking.
 - (v) 5 out of 9 wards in the VDC are categorized as very high or highly vulnerable (Martadi VDC, 2013).
-

During 2016-2020

- (i) The use of buildings has undergone rapid transformation during this period, with the establishment of two new departmental stores and a significant increase in the number of hotels, reaching nearly 160. The number of houses with animal *goth* (shelters) has reduced to 150.
- (ii) Most new constructions are for business purposes, including hotels, shops, suppliers, and offices.
- (iii) There have been significant changes in the sources of energy. More than 20% households use LPG as source of energy for cooking (CBS, 2021). 95.7% households use electricity for light (CBS, 2021).

Image Collage 5: Overall Settlement Transformation Martadi (Satellite Images)

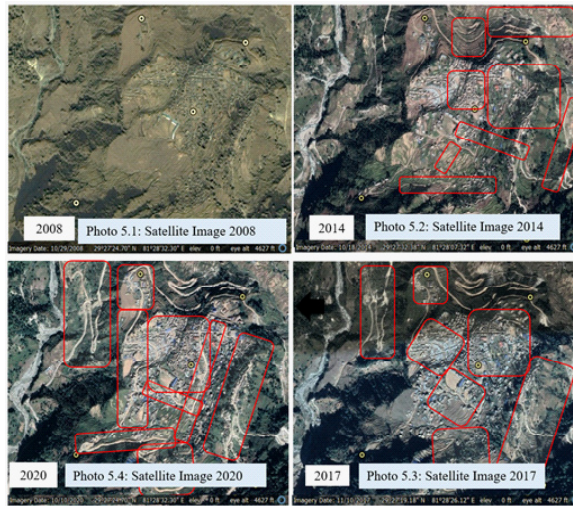
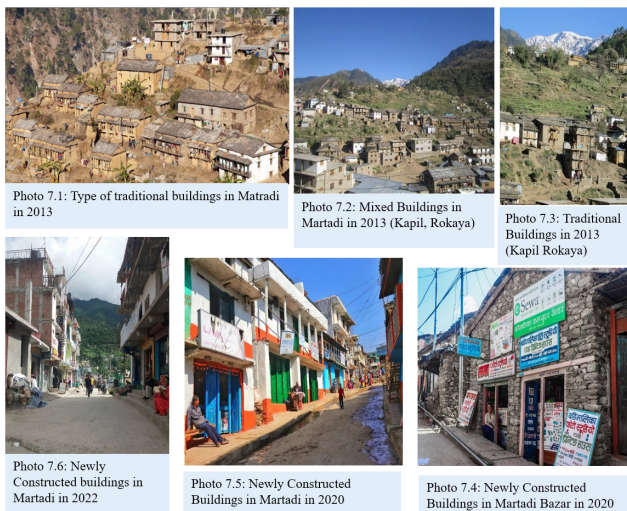


Image Collage 7: Architecture, Construction Technology and Material in Martadi



Drivers of Transformation

Drivers of transformation are the triggering factors that create a conducive environment to change or adapt to the existing built environment. These drivers can be categorized into four major groups

(i) socio-cultural drivers, (ii) environmental, ecological, and disaster-related drivers, (iii) economic and market-related drivers, and (iv) governance and political drivers. Analyzing the different historical drivers of transformation in Chandannath – Jumla and Martadi – Bajura, the key drivers of transformation are summarized in Table 1.

Table 1.

Drivers of Built Environment Transformation

| Category | Driver | Description of driver and relation with transformation |
|----------------------------------|---|---|
| A. Socio-cultural related | a.1. Traditional Khas Culture (Campbell, 1978) | The traditional Khas culture has a settlement pattern of connected houses called “Bado”. The ground floors of two-story houses are used for animals called “Goth”. The roofs of those houses were flat so that they could dry their agricultural products called “Biskun”. In addition, houses were made of locally available materials such as stone, wood, and mud. Although Bajura is also ruled by Jumla, there was a different practice of making sloped roofs which is linked with the amount of rainfall in Martadi being much higher than in Jumla. |
| | a.2. Socio-cultural and political dominance of certain caste/ethnic groups | The political dominance of Thakuri, Chhetri, and Brahmin castes occupied the floodplains of the major rivers and the alluvial fans of secondary and tertiary drainage (Luintel, 2014). This has resulted in the major settlements near to high-value agricultural |

| | | |
|--|--|---|
| | (Bishop, 1978 and Luintel, 2014) | lands being occupied by certain politically influential social groups. |
| | a.3. Land fragmentation into smaller units due to extended family structure (Bishop, 1978 and Campbell, 1978)) | Previously, there were joint families, and all brothers lived together with parents and grandparents limiting the fragmentation of land. The introduction of nuclear and extended families triggered land fragmentation which hampered efficient farming and Agri-production. The production is also not sufficient for their families, resulting in their less interest in keeping these lands for agriculture meaning they are not motivated to use the land for agricultural purposes. |
| | a.4. Practice showing mud to Astrologers or Dhami (God) | Traditionally, there was a practice to show the mud from the land on which buildings were to be constructed. Usually, Dhamis (Traditional Healers) and Jyotis (Astrologers) were used to suggest not to construct buildings on agricultural land. They have three categories of land. Among them, the land that has features suitable for agriculture i.e., access to irrigation, and soft and fertile soil are the worst locations to construct the buildings. In this way, they used to save agricultural land. However, the practice of showing mud is almost extinct and hence impacts the construction of houses on agricultural land. (KII: Ramananda Acharya, Bishnu Prashad Upadhaya) |
| | a.5. Social Status Seen in the number and type of Houses | Not only the size, design, and materials of the house but also locations have always been a matter of social prestige and status. This competition has led to the introduction of new houses with modern designs, and central locations with increased income. |

| | | |
|---|---|---|
| B. Ecological-Environmental and Disaster-related | b.1. Rainfall in the area (Shrestha, 1993) | The average annual rainfall in Jumla is 1343 mm while in Bajura it is 13,433 mm. This has a huge impact on the type of roof of the houses in both districts i.e., flat roofs in Jumla and sloped roofs in Bajura. The settlements in Jumla are in the Rain shadow area and because the winters are extremely cold, roofs were low and flat, and are made of layers of insulating and waterproofing materials such as birch leaves and dried pine needles (Shrestha, 1993). |
| | b.2. Slope of the terrain and Water Availability (Pandey, 2017) | Depending on the slope steepness and amount of water availability, the amount of land available for irrigation is determined. This has significant implications to settlements by i) being close to the source of water, ii) avoiding the agricultural land in construction. |
| | b.3. Traditional Occupations such as agriculture and animal rearing (Pandey, 2017) | When occupations demand different geographic locations i.e., farming in low land and animal rearing in higher altitudes, it is difficult for people to set up their permanent settlements. In such cases, they construct temporary settlements/shelters at both sites. This has been happening in many of the Himalayan settlements. However, with changes in occupations, these temporary settlements are being transformed into permanent ones. |
| | b.4. Land use Change (Tiwari, Tiwari and Joshi, 2018) | Land use changes are now being considered one of the major driving forces in transforming the natural landscape in mountain regions. Especially with increased access to transport services and facilities, previous agricultural land is being converted into a built-up area. |
| | b.5. Climate (Erarslan, 2018) | The climate is a key factor in determining the construction architecture of the built environment. It not only influences the direction and orientation of the building, in terms of material, construction technique, dimensions of the building, splitting rooms, and façade characteristics but also the dimensions and locations of doors and windows, roof, and open-closed spaces. In places like Bajura, which lies in a humid region and where rainfall is abundant, dispersed settlement types including field, vineyard, and garden areas are observed. While places like Jumla, where the climate is dry, cold, and arid, there is a prevalence of compact settlement. |

| | | |
|---------------------------------------|---|---|
| | b.6. Famine / Drought (Bishop, 1978; Kafle, 2015; Pant et al., 2014) | Himalayan regions faced several droughts and famines in history. Jumla faced the highest number of droughts (6 drought years in 30 years) between 1984 – 2009. Bajura has also faced several critical droughts and food insecurity years. When hard work in agriculture is not successful to meet the food security demands, the motive for protecting land for agricultural purposes remains under question. |
| | b.7. Earthquake (Andolfatto, 2020) | Disasters like earthquakes also transform the built environment. Several smaller-scale earthquakes are reported in Karnali and Far-Western Himalayan Region (KAFHR). A destructive earthquake of estimated magnitude 8.2 might have taken place in 1505 and destroyed several ancient settlements. |
| | b.8. Topography (Erarslan, 2018) | Topography is one of the essential factors that determine the settlement type because it has direct or indirect effects on the distribution, population, and economic activities of settlements. |
| | c.1. Improved Transportation | Increased road connectivity through transport infrastructures enhances the exchange of material, information, technology, and |
| C. Economic and Market-related | Infrastructures and Connectivity (Tiwari et al., 2018; Delpino-Chamy, and Pérez Albert, 2022) | knowledge. Many rural areas get external materials at cheaper prices that facilitate the transition and reconstruction of rural settlements. In both the settlements, Chandannath and Martadi, the opening of the roads has a significant role in the transformation of the built environment. |
| | c.2. Publicity, Marketing and Tourism (Tiwari, et al., 2018) | Increased Tourism has a two-way impact on mountain communities. In one way, it increases the income of communities while on the other side, it increases the demand for improved services such as accommodation hotels, restaurants, and transportation services. These both increase in income and demand for improved services transform the built environment. After the opening of the Karnali Highway, the flow of tourists in Jumla has significantly increased in Rara and hence in Jumla (Shahi, 2018). This increased flow of tourists in Jumla has significantly contributed to the construction of new hotels, the improvement of roads, and other services. |

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| | <p>c.3. Nature of livelihoods and economic means of households (Erarslan, 2018).</p> | <p>Himalayan communities primarily depend on mixed-livelihood opportunities that include high-altitude agriculture, animal raising, and seasonal migrations. These all economic and livelihood means demand separate and unique sets of built environments and their use such a temporary settlement. The size of the house reflects the economy-production relationship. Farming families have larger living areas than average houses, as they have space for storage and additional activities. In many cases, both Jumla and Bajura, those families use the ground floor to keep their animals. On the other hand, families who do not have land and depend on small-scale business operations establish their buildings near market centers and operate their businesses on the ground floor.</p> |
| | <p>c.4. Availability of Technology and Architecture</p> | <p>The construction technology and architecture, especially of buildings, in both Jumla and Bajura was vernacular masonry construction which was a continuation of the previous Khas period (Gautam et al., 2018). Later, the government and market influenced construction technology including RCC through different codes especially building codes. The current use of RCC, Brick Masonry, and even interlock brick are market products. The traditional vernacular technology and architecture in new construction are almost non-existent.</p> |
| | <p>c.5 Economic Well-being of People in the Settlement (Delpino-Chamy, and Pérez Albert, 2022)</p> | <p>The economic well-being of the owners influences the common elements such as buildings, yards, and cowsheds selected to express the material environment of rural settlements. The compensation received from the houses and or land use from Karnali highway in Jumla has a significant impact on new building construction including their modern design, architecture, and material. The traditional earth-rock flat buildings were replaced by cement-tipped, CGI sheet-roofed, and RCC buildings.</p> |
| <p>D. Governance and Politics related</p> | <p>d.1. Influence of Political and Administrative Center (Campbell, 1978 and Heraud et al., 2019)</p> | <p>In history, Jumla had political and administrative influence over a big territory. Even during the Panchayat regime, Jumla was the center of the Karnali zone with offices of the Zonal Commissioner (Anchaladhsh), Zonal Court, and the Zonal Hospital located in Chandannath (Campbell, 1978). These officials introduced/revived newly built environment actions such as brick-masonry work in Jumla during the 1960s and 1970s.</p> |
| | <p>d.2. Conflict and Displacement (Muzzini, and Aparicio, 2013)</p> | <p>Nepalese urbanization has taken place amid a conflict-ridden environment (Muzzini, and Aparicio, 2013). More than 3,700 people from Jumla were displaced during the conflict period and</p> |

| | | |
|--|--|--|
| | | the majority of them stayed in district headquarters (NHRC, 2008) creating change in land use and built environment in Chandannath. |
| | d.3. Lack of Policies and their poor Regulation (Muzzini, and Aparicio, 2013) | The growth of the built-up areas in most urban settlements is haphazard and uncontrolled. Unplanned urban development and poor enforcement of regulation have led to rapid and uncontrolled urban sprawl and have contributed to dramatic changes in the urban footprint of the valley. Though both the settlements are recently declared as municipalities, the rapid urbanization and absence of policies to regulate transformed the built environment. |
| | d.4 Government Designs for Schools and other Buildings | Government designs and recommendation for public infrastructures such as school buildings with the use of external materials and modern construction techniques (DUDBC, 1994; and DOE, 2016) has to some extent influenced the local communities to adopt such construction practices. |

Conclusion

The Himalayan Region has been experiencing extensive multi-faced transformation that include changes in sociocultural practices, environmental-ecological conditions, and transport infrastructures. These changes are intertwined with the urbanization process leading to the transformation of built environments. The built environment of Karnali and the Far-western Himalayan Region (KAFHR) has been profoundly shaped by its history up to the KHAS dynasty. However, only limited historical information is available about western Himalayan settlements and their built environment. The information is available only after the 1960s and is limited to the description of people, culture, religion, and to some extent geography and climate. This paper attempted to collect, organize, and analyze that information from the perspective of built environment transformation addressing the gap in built environment transformation knowledge of KAFHR. For this, it developed a trajectory of transformation for both settlements and was used as a tool to identify the drivers of transformation.

This paper illustrates how the built environment in the KAFHR region is shaped by a complex interaction of various drivers that encompass the social-cultural domain, the ecological-environmental domain, the economic and market domain, and political and governance-related domains. These all drivers uniquely interplay with each other and form a context context-specific trajectory of transformations of the built environment. These transformations are not only the result of the social construction by people responding to the opportunities and constraints of their locality (Hölscher and Frantzeskaki, 2021). Although the construction and expansion of

transport infrastructures i.e., especially road access have played the role of the primary trigger, the underlying social, economic, environmental, and disaster conditions also triggered the transformation of the settlements in the study area. The abandonment of the traditional practice of showing mud to Astrologers and *Dhamis* is also related to the adoption of modern education, engineering technology, and knowledge leading to the development of no hesitation to construct buildings in fertile land, which in the past was considered an unsuitable place to construction. The repetitive drought, low agricultural production, and famine in the region discourage the population from farming which means the value of land for agricultural purposes is negligible. When, with the opening of road infrastructure and transport, the availability of food became easier in the market and agriculture became more difficult in the real ground, the local people preferred retail business, tea shops, hotels, and other off-farm work to traditional agriculture.

The opening of the road not only open the linkage to regional markets in terms of food security but also invited the influence of the external market through the new technology of construction, designs of buildings, construction materials, and most importantly demand for improved urban services by tourists. In addition, the concentration of population in the settlements due to both population growth and internal displacement during conflict has exerted induced the transformation of the built environment in the selected locations. The sudden administrative categorization/nomenclature of settlement from rural to urban with the absence of policies and plans to regulate local development including how the urban functions of the settlements should look, opened the window of opportunity to boost up new constructions. These unplanned and unregulated new constructions in the settlements are the latest and significant drivers of transformation.

Limitations

This study has some limitations. Since the study is primarily based on secondary and photographic information within selected settlements, the comprehensive evolution of the transformation and dynamic relationship with other settlements is prioritized.

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