Historic Towns in Transition - Documentation and Restoration of the Earthen Palaces in Upper Mustang

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Abstract

Background:

The Tashi Gephel Palace, Lo Manthang Palace was built in the 15th Century in the capital of the Kingdom of Lo, Upper Mustang. century. (Selter, 2007). The five-storey palace was a royal residence however, in recent years it has been in deteriorating state. Damage in Centuries-old heritage building was further promoted by the 25th April 2015 Gorkha earthquake, which destroyed several cultural and heritage sites in Nepal. Earthen structures are vulnerable in earthquakes especially when the construction techniques do not adhere to basic structural principles. Additionally, vulnerability of such structures is accelerated by the effect of climate change.

This paper investigates the transformation of residential neighbourhoods in the historic town of Upper Mustang, facing conflicting needs for development and heritage conservation after the devastating earthquake. The urge is to understand how the unique neighbourhoods that are supposed to be flagships for conservation are responding to changing needs and aspirations of society. The motive of this research is to reflect the practices on heritage conservation and its linkage with the local communities. The paper also highlights the major challenges in restoration works and focuses on the socio-cultural impacts that can be brought by the reconstruction drive. Field observation, documentation, semi-structured interviews and life histories including comparison of technical details in restoration works were used for this research. Transformations in the settlement pertaining to changing lifestyle and climate is visible. Vulnerability of heritage structures is increasing due to loss of traditional construction knowledge. A methodologic approach - transdisciplinary Participatory Action Research (PAR) is practised during the documentation and restoration of the earthen palaces in Upper Mustang. This has given optimistic feedback in the interest to safeguard their tangible properties and preserve the practice of traditional rammed earth techniques.

Key Words: Heritage, Transformation, Rammed Earth, Restoration, Traditional Structure

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1. Introduction

Lo Monthang is the capital of the former kingdom of Lho in Mustang district, in the Trans-Himalayas bordering on Tibet. In this ancient town, the royal palace, monasteries and the town wall are mostly rammed earth (ghyang), whereas the normal residences are mostly sun-dried bricks (pamb). Tashi Gephel, the royal palace, which had already fallen into disrepair, suffered significant damage due to the 2015 earthquake.

The Upper Mustang Region has undergone transformation, in few decades. The opening of Upper Mustang to tourism and construction of National strategic road has progressively taken it towards modernisation. (Lavie & Marshall, 2017) The opportunity increased trade and cultural exchange with the outer world along with the change in livelihood and lifestyle. Monastries and Palaces reflect the economic and cultural prime of the region in the 15th and 16th Centuries. In terms of cultural history, the palaces of the kings of Mustang in the region constitute an important architectural group and are impressive examples of 15th-century architecture.

This paper aims to deliberate on the documentation and restoration activities in the palaces of upper Mustang – Tashi Gephel Palace in Lo Monthang and palaces in Ghemi, Thingkar, Dhagmar and Charang. Himal Asia Foundation organized it in association with Deutsches Archäologisches Institute, DAI, and Gerda Henkel Foundation during April 2018, September 2018, and April 2019. One of the goals is to show to the locals that the advantages of rammed earth still stand and it makes sense both environmentally and economically. The paper shows how local people, decision-makers, and practitioners from Nepal and abroad have come together to preserve the monuments, highlights the challenges and provides recommendations for complete restoration.

2. Methodology

The paper is based on the documentation work carried out in the Lomanthang Palace. The findings from the field visit, interaction with the key personnel and studies from previous research papers are presented in the paper. Architectural measurement of the Lomanthang
Palace, rigorous interview with the caretakers of the palace, visual observation of the palace and research work is presented here. Field observation, documentation, semi-structured interviews and life histories including comparison of technical details in restoration works were used for this research. A methodologic approach - transdisciplinary Participatory Action Research (PAR) has been practised during the documentation and restoration of the earthen palaces in Upper Mustang. Also, locals participating in reconstruction and renovation work were interviewed.

3. Kingdom of Mustang

The Upper Mustang, earlier Kingdom of Lo, is a remote and isolated region of the Nepalese Himalayas. It was a restricted demilitarized area until 1992, which makes it one of the most preserved regions in the world. Life in the Upper Mustang revolves around tourism, animal husbandry, and trade. From ancient times, a route linking India with Tibet has passed through this area, facilitating trade and religious/cultural exchange. The area of Mustang comprises under four settlement clusters –

1. Thak Satsae Area (contains 13 villages)
2. Paanch Gaun Area (contains 5 villages)
3. Barah Gaun Area (contains 12 villages)
4. Lo Tsho Dhyun Area (contains 19 villages)

Upper Mustang is the most unique area, and is worth being designated a Cultural Landscape. The settlements are widely spread, with Buddhist monasteries, century-old fortresses called Dzong, and palaces along with the adobe dwellings and the caves in the cliffs. Many of these monasteries, with rich cultural and religious history, were probably one of the best preserved anywhere. However, the earthquakes and its aftershocks have left some of these sites in dilapidated condition.

Lo’s region falls in trans- Himalayan salt trade route, but after Chinese Invasion of Tibet, northern borders were closed and declared restricted area in 1950s. First foreigners were allowed in 1992, (Selter, 2007) which opened the Upper Mustang Region thus creating interest among different scholars, researchers for further study and research on the area. The area is still a mystery for many. The study on Lomanthang is few with most limited to socio cultural aspect of the place. Various research and restoration work has been conducted in Study on Lomanthang Palace has not been conducted Jhongs and Gompas of Lomanthang but no such activity has been conducted in Lomanthang Palace. Previous restoration works were done with the knowledge and expertise but the detailed drawings have not been drawn so far. In the present context, drastic climate change and the weakening structure had threatened the vulnerability of unique heritage. Therefore, the Gyalchung (Former Raja) Jigme Singhe Palwar Bista has given the authority to enter their property premise for carrying out the archive and the documentation tasks.
4. Construction Technology in Mustang.

As per Nepal’s Ancient Monument Preservation Act 1956 & The Nara Document on Authenticity and many other international charters, heritage reconstruction demands the use of traditional materials. However, supply of good quality traditional construction materials like seasoned timber, traditional bricks whose dimensions are as in mid-sixteenth century & stones is a major issue (Dawadi 2018).

In Upper Mustang, the majority of the existing dwellings and palaces are vernacular, constructed from local earth, stone and poplar. In the lower half of upper Mustang, rammed earth is more popular. Whereas in the northern part, brick is more commonly used in normal dwellings and rammed earth has been used in bigger and older structures like monasteries, palaces and walls.

Rammed earth had not been used for some time in Lo Monthang. All new constructions and repairs were done in brick. Making and laying bricks is much easier and cheaper than rammed earth. Although more time consuming, rammed earth can be much stronger than brick. There are only a couple of people in Lo Monthang with traditional knowledge of rammed earth. A workshop was conducted to mix the best practices of traditional and modern rammed earth. The locals found the use of 18mm plywood and metal tie rods much easier than traditional formwork of planks and wood and rope ties. The traditional practice of moistening the soil overnight and tamping in layers of up to two inches to help pulverize it was much appreciated. Incorporation of vertical wooden pole in the corner and wood elements tying two blocks was also practiced.
5. Transition in Lo Monthang

In recent years’ settlement has expanded beyond the historic earthen walls of Lo Monthang. In the 1960s, police post and government school were built outside of wall. Traditionally, people were bound to live inside the walled town and only Garpa people lived outside the wall, by the riverside. Family properties were not divided in Lopas community as they mostly practiced fraternal polyandry and population density remained relatively stable for centuries. (Selter). These days, the polyandric system is not practiced and population is increasing rapidly, increasing demand for space. Therefore, people have now moved out to fulfil the demand. Furthermore, growth of tourism has led to new construction of lodges, shops and restaurants. To ease mobility openings have been made in the wall in several places, causing structural problems.

Traditionally buildings were made from locally available materials such as mud, stone and timber. These structures harmonised with the surrounding. Courtyard house design kept them warm inside and compact settlement protected them from harsh winds. With the construction of road and increase in tourism use of new building techniques and construction material is prevalent nowadays. With the completion of Kaligandaki corridor Beni -Jomsom -Korala road this is going to get worse. Among the goods mostly transported by the trucks, include cement,
and timber. (Pokharel, 2002). With modern values and materials creeping in, traditional values and practices, including construction are slowly being shelved. With the introduction of new materials, cement and wooden buildings replace whitewashed mud bricks and identity of Mustang is changing. (Wegner, 2020)

5.1 Impact of Earthquake.

According to the Department of Archaeology (DOA), almost 753 historical, cultural, and religious monuments shattered either partially but significantly or entirely by the earthquakes and the aftershocks from all over Nepal. (UNISDR, 2015). Lo Monthang was not spared either. Structures had already been weakened due to moisture ingress in the foundation and inadequate drainage on the roofs. The basement walls in several places of the palace were already crumbling due to moisture and cracks had appeared in upper walls, which was further aggravated by the earthquake. For many years, the Raja had been requested by different organisations to get his Durbar Palace restored. However, he always gave preference to the temples and Chorten of Lo, as he argued, “They belong to the Lopa people and need to be taken care of first”. Besides, out of 153 Households in Lo, 10 of them have sustained serious damages; many others suffer from cracks and are unstable.

5.2 Impact of Climate change

Lo Monthang area is arid as it is located in the leeward side of the Annapurna range. The mean minimum monthly air temperature falls to −2.7ºC in winter, while the maximum monthly air temperature reaches 23.1ºC in summer (National Trust for Conservation (NTNC), 2008). In recent years, there has been an increase in the amount, intensity, and frequency of rainfall. In July 2011, 44 mm of rainfall was recorded in Jomsom. This surpassed the average rainfall recorded in this region, which is 23 mm. (Koirala & Shrestha, 2018). The Trans Himalaya region is facing the effects of climate change. Increase in rainy days, decrease in winter rainfall, an increase of erratic rainfall events, intense summer flooding, increase in the frequency and intensity of violent winds, and increase in both summer and winter temperature are the implications of climate change. These effects have challenged ecosystem-based livelihoods and the Trans Himalayan communities are forced to change their traditional practices. (Pandey,
2016). With many people moving down to cities, the mud roofs are not renewed annually or inadequately maintained. This eventually leads to leakage of roofs and rain water and snow-melt flowing down and eroding the walls instead of properly being drained out using wooden gutters. Higher frequency and intensity of rain due to climate change has only aggravated this problem.

### 5.3 Impact of Modern intervention

Foreign visitors have been allowed to enter the kingdom of Mustang since 1991, but access to Upper Mustang and Lo Monthang requires a special permit (Woodpress, 2007). New construction has many been fuelled by growth in tourism.

Traditional earthen construction technique requires special skill and large human resource. Most youths today are working in cities and pursuing higher education. People now do most construction work from lower hills, who are not skilled in traditional practices. With improved road linkages and availability of material from Pokhara and other cities, people prefer new construction techniques, as it is convenient and time-efficient. People believe that cement and stone are stronger than mud and require less maintenance. Which may be true, but it is yet to see how cement performs in this harsh environment. It is already evident that thermally mud is superior to cement. Already, mixed use of material being -- concrete pillars with infill walls of traditional mud bricks. Cement and rebar becoming more easily available, coupled with lack of standardization and lack of trained architects and engineers in earthen construction has contributed to the difficulty of promoting traditional techniques with modern additions.

### 6. Territory of Upper Mustang

Building survey and research have played an important role in the educational, research, and restoration practice of heritage monuments and sites. The Tashi Gephel Palace is being documented by the adaptation of the building research method based on a true-to-form survey.

The main icon and largest structure of Lo Monthang, the 5-storeyed medieval 15th century-old Tashi Gephel Palace is a dzong fortress, the first building to be constructed in the town. The huge structure of the Palace is in the middle of the town, towering over surrounding houses. It has traditional rammed earth walls, which has now faced structural damages, with huge horizontal and vertical cracks. Inside the building, wooden beams are jutting out of the ceiling, and the whole roof needs a complete renovation.

The building measures 45 meters (150 ft) east-west and 30 metres (100) north-south, with sloping stone buttresses averaging 3 meters (9.8 ft) thick, and 5 meters (16 ft) thick at the base, and with strong foundations to help proof it against earthquakes. Five stories of buildings, containing over 130 rooms, shrines, and statues.

Tashi Gephel, was built at the time of the founding of the town. The palace was referred to as a castle, Gyalkhab, rather than a palace, Phodrang, emphasizing the fortified style of the building with only one entrance and all windows placed high up in the walls. The palace is a massive 5-storeyed building with a single entrance on the East, opening up to the only public square in Lo Monthang. The entrance has a 4-storeyed timber gallery with cornices and carved
Tibetan-style columns on the two lowest floors. The two upper floors now have a simple wooden frame infill, but originally these must have been more decorated. They have been rebuilt during the second half of the 20th century. The southernmost part of the palace collapsed in the early 21st century and was rebuilt recently. Additionally, the wings of the palace are still used as living quarters for the royal family, although they have been equipped with new larger windows on the top floors.

Figure 10: Tashi Gephel Palace, (Pic. dated 2017 Nov)

Lo Monthang is the ancient capital of the former kingdom of Mustang. The Palace of Tashi Gephel or Lo Monthang is famous for its 6-metre high-rammed earth wall, surrounding the densely inhabited place and the three magnificent Buddhist monasteries named Choden Monastery (18th C), Jhampa Lhakhang and Thubchen Lhakhang (15th C) inside the walled region, they are the Gompas. The Gompas have a collective archive and library of astounding statues, mural paintings, as well as great collections of ancient texts and manuscripts inside the constructions.

An assessment of the affected palaces documentation and some restoration and reconstruction work to make the structures alive for its identity is an utmost step that is needed at the instance. The Palace has been restored in different phases partly using different techniques. Original structural elements have been altered using local knowledge and resources. We found the assessed structures of Tashi Gephel Palace which we were doing the documentation are in very vulnerable conditions as the cracks in the walls and unbalance slab floors show the structure is affected very badly. During the documentation and assessment of the palace, several vulnerable areas were identified -- namely the roof and the plinth level on the north-west.

6.1 Lo Monthang Palace at present

The Lo Monthang Palace along with its well preserved traditional urban structure is an architectural monument of great significance. Lo Monthang was founded in 1441, and as early as 1436, the king had left his palace in Tsarang to move to the fortress north of Lo Monthang to oversee the establishment of the new city Lo Monthang. The construction of the palace is dated together with the founding of the city to the year 1441.
The palace is the only building still used today by the royal family -- only small sections. The Five-storey palace is the largest of the palaces in Mustang and, with its two main floors, which open to the upper floor with large windows, has the most representative façade. The structure is staggered back three times, so that in the northeast a narrow access to the square results, which visually expanded by the back grading. The entrance façade is particularly emphasized in the middle by the entrance area, which has several galleries. The two upper main floors are clearly visible with their large windows on the main facade. They are grouped around three two-storey farms. Since the palace was inhabited most of the time, in general, damages in the rooms had been immediately repaired in the past. But after the earthquake and heavy rainfalls since a couple of years now in summer, the restoration and repair of some of the rooms was and is in need of professional support. With battered thick walls, flat roof with short parapets and a facade with minimum openings for doors or windows, the mud architecture of Upper Mustang blends well with the landscape. Occasionally brightened by the colours symmetrically dispersed small window, the general architectural impression the buildings make is one of austere inward looking severity. The interior is mysterious with its limited lighting and painted decor on walls and columns with artistically carved capitals.

6.2 Past and Present usage of Palace Building

During the documentation work regarding the history, the authentic information regarding the Tashi Gephel Palace was gathered from the trustworthy source -- Pema Nodrup (General Commander of the former King and Palace), Lakpa Nodrup (Caretaker of the Palace) and Gyalchung (Former Raja) Jigme Singhe Palwar Bista. As per the information, the 5-storeyedmud dwelling was constructed taking the concern of dzong as a fortress and gradually transformed into a living area with the village settlement around. A recent dendrochronology
study on a timber post gave a result of 60. The basement, which is mostly double in height was used for storage of hay, potatoes and farm equipment, and for cows and horses. The Ground floor and First floor was used for the sleeping purpose for the workers of the palace. Now, these floors are used as the storage for the Palace, and sometime during the festival season, the rooms are used by the monks, lamas, visitors, and relatives. The second floor was used for sleeping and storage purposes for the royal family only in the past.

The third floor and the uppermost level was used for the living purpose for the Royal family, the priest room, and as prayer/altar rooms. Space is still being occupied as the living space, hence not much more transformation and changes in the floor can be seen.

Over many years, certain portions were rebuilt and progressively more sections were abandoned due to deterioration. Now only a small portion is in active use. However, the King himself is very much optimistic about his property, and is promoting its use a living museum. The Palace building in future should be self-sustaining in terms of financing and energy usage as far as possible, structurally sound and liveable for sustainability of the building.
7. Importance of Documentation in Heritage Buildings and Challenges

The task of documentation is highly important as it reveals the historical usage of the rooms and therefore assists in restoration.

Documentation of heritage structures and reconstruction of heritage buildings is a complex undertaking. It requires in-depth study, consultation, high quality documentation and planning before a reconstruction work starts (Banskota 2018). The reconstruction at many instances is difficult due to lack of proper inventory - previous historical records, data, images and architectural drawings, there needs to be meticulous examination and verification. (Banskota 2018). Kai Weise, an architect and an active advocate of disaster risk management of cultural heritage sites says, “The restoration of such cultural heritages is not something to be rushed. Although there was a three-year deadlock due to various political reasons, the silver lining was that there was an ample time to research.”

**Lack of skilled human resource:** In heritage reconstruction there is a shortage of skilled artisans, craftsman & labourers. There are limited people with quality, precision and knowledge about traditional crafts and construction. The traditional system of knowledge transfer that used to happen from an artisan to his child is diminishing. Thus, vocational schools which produces competent artisan skilled in traditional crafts and construction technology is felt necessary (Deupala 2019). Moreover, skilled structural engineers who can enhance seismic strength of traditional building using traditional materials is of high demand.

**High Vulnerability:** If once a building, constructed in rammed earth-technique, sustains major structural damage, mostly the whole house needs to be rebuilt depending on the cracks in the walls. It is a very costly task.

Digital monument records are necessary for protecting the heritage site of the Lo Monthang Palace with its surroundings. These data archives – themselves a part of cultural heritage – are the pre-requisite for research-based activities regarding the preservation of the respective heritage sites. This will be also possible to help to develop national records of sites and monuments in Nepal on an international scale.

8. Structural overview of Lo Monthang Palace (Tashi Gephel Palace)

It is highly likely that several modifications were made to the original structures over the centuries and it is almost impossible to trace them all; some of the recent interventions are obvious. These include repairs to walls, extension and partition of rooms, addition of larger windows, etc. Most of these interventions are concentrated on the upper two floors which are also the floors primarily used for dwelling by the royal family.
The building has two floors: basement and first floor used as storage, and upper three floors used for living purposes. The walls are rammed earth. The floors have been constructed with mud flooring over wooden planks on top of wooden joists spanning between the walls.

The building measures approximately 45 metres east-west and 30 metres north-south and stands 7.5 metres high above the plinth and 5 metres underground with an average floor height of 2.5 metres. The building plan is zigzag shaped towards the north-eastern and south-western portions.

9. **Findings of Rapid Visual Assessment**

The walls have suffered heavy damage below the plinth due to moisture seepage, especially on the northern portion of the building. The locals have temporarily protected these portions by stacking stones around the damaged portions to protect the walls from accumulated snow in the winter. The locals have reported a general trend of increasing rainfall intensity in the area, which could exacerbate the problem in the future.

The north-western walls of the basement floors have been, on the other hand, suffered erosion on the inner side of the wall, inside the building, due to build-up of snow on the outside. Major portions of the walls (almost 2 metres out of the 5 metres) were found to have already eroded.

![Figure 14: Healing the cracks with lime, sand and mud mortar](image1)

![Figure 15: Ongoing Rapid restoration work in case to safeguard from quick rainfall and snowfall](image2)

The south-eastern portion of the building collapsed during the 2015 earthquake and is currently being restored using the traditional rammed earth technique. Some changes to the original...
Several changes to the structure were made prior to 2015 as well. These include removal of structural walls and replacing with wooden posts and joists, introduction of new walls to partition existing rooms and addition of new rooms. None of the changes were made giving due consideration to the structural implications. The adverse effects that some of these changes have had on the structure are clearly visible.

Several structural cracks were visible on the walls, reportedly from the 2015 earthquake, especially at the corners and at the junction between old and new walls. Most of these damages could have been minimized if the corners and the junctions between old and new walls had been stitched together, preferably with wooden members.

The damage was particularly visible on the roof with wooden beams jutting out of the ceiling. No mechanism for shear keys (chukul) to connect the beams with the walls was observed in the building which is a common sight in other traditional buildings in Nepal, especially in the Kathmandu Valley.

The windows on the upper floors were found to be particularly large and could have led to the higher concentration of damages on these floors.

10. Observation - Participants’ reflections and Participatory Discussions

From the workshops conducted so far in the restoration of Lo Monthang Palace, several questions were raised regarding the applicability of building with such technique - that building with rammed earth might need more time during the maintenance phases, something that will be translated to extra cost. But the long term benefits cannot be compared to the long-term running costs and the environmental impacts of our conventional techniques. Which are more expensive to construct and to run in addition result in numerous environmental and health hazards. Their concerns are understood as it is always a major problem that no any proprietor are eager to pay attention for the maintenance running cost rather than for the initial costs.

Also the issues raised were the concern of the compressive strength of the structure after maintenances standing from more than 600 years of time. Plus, water absorption and weather erosion of the earthen walls, including details for visual inspection. That is in addition to the structural stability of the walls. These concerns show a need for and importance of developing
tests to improve reliability. Together with performance requirements and tolerances which should be explicitly defined prior to the construction phase.

One important discussion topic was concerning the national building code which were not potentially clear on this part of the region - that should be a guide on soil suitability and moisture content, and sets out requirements for formwork, methods of construction, testing and curing of rammed earth. Also detailed information on material testing is very important. In addition, the code should be designed and written in conjunction with all other appropriate building standards. Many countries like Germany, Spain, USA and Zimbabwe have already robust codes and standards. If the consisting soils are examined and their strengths are determined, then disciplinary codes can be regulated and also combined experiences presenting the current state-of-the-art in rammed earth construction around the world can be synchronized. The culture of construction and climate around may differ from the conditions of other developed nations as this part of the country is still rural and more overly restoration and maintenance is the prime issues than developing a new rammed earth structure, but safeguarding these heritages can still be important basis for the development of national standards and guidelines.

The discussion also highlighted the material and production parameters and how they have a considerable effect on the quality of rammed earth walls. As optimizing material handling and production can be decisive for the acceptability of the end product.

Maintenance issues from the Lo Monthang Palace was discussed as being burdensome compared to conventional building methods as absence of regular maintenance can be more damaging in earthen structures than in other building types. Heavy snow, hailstorm and regular rainfall is a major agent of decay in rammed earth buildings. Maintenance should mainly be for protecting rammed earth from water deterioration.

Concerning the high value of rammed earth, it was discussed that thick walls which provide high thermal mass could be a common design solution. Through the absorption and release of moisture it regulates the relative air humidity naturally and maintains comfortable surface temperature. Some questions and concerns were on openings, which could be formed easily in various ways, including the openings, timber lintels, and the use of wooden bracing in certain height of mud gyang construction in rammed wall. When it comes to economics generally building with rammed earth should not be expensive especially when compared to cement-concrete techniques using industrialized building material.

Ecological objectives and criteria for the construction material and the use of sustainable resources were also of a concern while doing the restoration work in Lo Monthang Palace. The Lo Monthang Palace could be fully recyclable after useful lifetime with low energy production and with nearly zero emissions in the whole building life cycle phases which is more justifiable for the nature by the humans from over 600 years of age, we have not adulterated for the name of living. The conclusion of this practice tried to discover that there is a need for low-cost, affordable, energy efficient buildings with minimal carbon and ecological foot-prints. Building with rammed earth revealed to be a feasible solution.
The Rammed earth construction technology and restoration process after dealing with Lo Monthang Palace, can be stated that this method of construction is never a threat but there are several challenges starting from building standards and legislation till the craftsmanship and implementation. This transdisciplinary approach facilitates taking action steps to move forward towards an action plan.

The participants formed team for tangible documentation, Intangible record, building simulation for energy efficiency measurements, structural analyse, material investigation and testing, stakeholders meeting and workshop and a technical writing team. That will continue further but for the time being- ended with technical recommendations, a documentation archive of the palaces to the gyalbo (the king), structural analysed technical report and conventional report for references to the locales for maintenance. Then this technical recommendation could be a draft for a guidelines or standard for earth construction technology for the future archive.

11. Recommendations
The damage resulting from the 2015 earthquake is largely concentrated at a few locations and large parts of the building are still habitable. As such, a phase-wise repair of the damage seems to be the best suited approach for the restoration of the building.

A detailed structural assessment of the building should be carried out at the earliest including all the structural changes in order to determine the weak spots and design appropriate strengthening measures before carrying out the restoration works. Several parts of the roof, which are severely damaged, will need to be dismantled and reconstructed. The plinth of the building shall be protected on all sides with stone masonry after repairing the eroded portion of the walls.

An appropriate mechanism shall be devised to prevent the accumulation of snow on the northern portion of the building in order to prevent further damage to basement walls in that portion of the building. The repair and restoration works shall incorporate traditional materials and techniques as far as possible.

12. Conclusion
The specific research tasks described above could represent a basic research area in the complicated adobe rammed earth structure for the enhancement of Tibetan history of architecture and exhibit a pattern. Documentation of heritage buildings is a challenging job and documentation of vulnerable buildings are even more challenging. Proper documentation guides the further restoration work and reduces the duplications. A well-planned document on the heritage restoration is recommended based on documents available before any restoration task to be commenced.

As we are moving towards an era of increasing environmental awareness and with several energy and environmental challenges. The current situation drives responsible researchers and professionals to explore ecological yet economical construction methods. The transdisciplinary and participatory contribution while preserving Lo Monthang Palace furthermore tried to bridge academic research with professional practices together, along Ngos and public authorities. The outcome concluded that adoping and adapting earth construction techniques
should be one of our first natural choices for future building practice. Rammed earth is an optimized construction method with guaranteed product properties for the country which is trying to self-sustain. Despite all the revealed challenges so far, the demand for earth-based buildings products and services is still developing both on the private and commercial building or construction level in this area along the threat and challenges of industrialization and concrete construction. The market is still very new even it started from very long past time, however there is a big potential to support the local economy and create job opportunities especially in this part of region as major economic boom of Upper Mustang is by the sector of tourism that reflects their interest in unique mud settlement architecture. The tourism sector is bringing money and sustaining the city till and has the potential to transform in the future, if the culture of shelter reflecting rammed earth technology that can save energy consumption in the building sector and at the same time can offer low cost and self-help housing are activated and motivated further.

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References

Non-Published Sources


Maie kitamura, La Cite Fortifiee de Lo Manthang, Mustang, Nord du Nepal; Le mur d'enceinte, structure et symbolique d'un site unique dans le monde de culture Tibetaine, Memoire, Ecole d'architecture de Belleville, Paris, 2006.


Publications


Heide, Suzanne von der, After the Earthquakes: Damaged Ancient Heritage Sites in Mustang - Challenges for Renovation, Restoration and Reconstruction.


Peissel, Michel, Mustang, A lost Tibetan Kingdom, London, 1968


