



Environmental Sustainability and the Traditional Tibetan Home

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I. Introduction: *Srivatsa* and Environmentally Sustainable Design

In Tibetan Buddhism, the *srivatsa*, or glorious endless knot, reminds one of the truth of reality. Six right-angled, intertwined strands flow endlessly together, each one connected to the other, each one giving form to the next. So flows reality.

Looking past the illusion of isolation, the endless knot illustrates the interdependence and mutual cooperation that runs the world.¹

No event, no living being has the ability to stand by itself, completely unaffected and unaffacting. All phenomena are intertwined. Every human action, however big or small, impacts the world in some way. The endless knot unveils the truth of reality so often hidden from daily consciousness – every act leaves some type of imprint.

The concept of environmentally sustainable design embodies the lesson of the endless knot. Sustainable design begins with the notion that human civilization is inextricably interwoven with the natural world, and that therefore the survival of human civilization depends on the survival of the natural world. Realizing also that human activities, such as development, often have a significant negative impact on the natural world, environmentally sustainable design seeks to construct buildings that impact the environment as little as possible.² This type of development ensures a healthy environment and guarantees the ability of future generations to meet their own needs.

Environmentally sustainable homes typify conservation principles in every aspect of their design. All parts of the home – from its building materials to its energy and water use – strive to leave the smallest possible footprint on the local and global environment. The ideal home incorporates renewable, indigenous building resources, a passive energy system, water conservation techniques, and avoids the use of waste-producing materials. It strives for minimal disruption to the local landscape.

Environmentally sustainable design is an increasingly important global issue, especially in countries like China, where industrialization and the growing population are putting record strains on the environment. The growth of green design corresponds to advancements in green technology. New building techniques, alternative energy sources, and energy-efficient appliances assist green designers in their quest to build light-impact homes.

Some cultures have known how to build environmentally harmonious homes for centuries, long before the green technology movement began. Native Americans, for instance, have long constructed homes that incorporate themselves perfectly within the local landscape. Studying the indigenous building methods of different cultures can contribute valuable knowledge to the modern green design movement. This paper seeks to examine the environmental sustainability of homes in Hamu Go, a Tibetan village in China, in hopes of creating an information exchange between modern green building methods and eco-friendly building designs already developed by the Tibetans.

Reviewing the environmental sustainability of a home requires knowledge of the home's surrounding environmental conditions and a consideration of the home's building materials, energy and water use, waste production, and site selection.

II. Placing Hamu Go on the Map

Sitting on the tail end of the Himalayan Mountains, northwestern Yunnan encompasses a vertical array of snow-capped peaks, glaciers, snowfields, grasslands, and rivers. The region cradles three of the world's great rivers: the Upper Yangzi,

Mekong, and Salween, and provides habitat for rare creatures such as the black-necked crane, snub-nosed monkey, lesser-panda, and Dian golden monkey.³ Hamu Go lies in the heart of this, in the Hengduan mountain range. It sits about eight kilometers northwest of Zhongdian, the nearest large town.

The Zhongdian area experiences a sunny, cold winter and a cloudy, somewhat rainy summer. The average temperature in January is 4.5°C during the daytime and -6.0°C at night. In August, the temperature rises to 17.2°C in the day and falls to 11.1°C at night.⁴ Home design must take into account these temperature patterns.

Hamu Go is sandwiched between two environmentally sensitive areas. Shrub-covered foothills surround the western edge of the village and quickly rise to 4,400 meter peaks. Du Ji Gorge curves back into these foothills. Several years ago, villagers harvested the pine, fir, and larch trees that grew in the gorge for construction and firewood. After several comments from visitors about the beauty of the gorge, the villagers collectively decided to turn the gorge into a nature reserve in hopes of attracting eco-tourism dollars. A committee within the village currently manages the reserve.⁵

The Napa Hai wetlands hug the eastern side of the village. The area grows into a sizable lake during the rainy summer, then retracts into marshland in the dry season. A community of black-necked cranes resides in the area during the fall, and domesticated yaks and pigs roam the area year-round.⁶ Human development could easily damage these native landscapes, making sustainable design principles all the more relevant to the village.

III. Hamu Go's Homes

Hamu Go is comprised of 39 homes, all built in a local Tibetan style that first appeared in the area about 700-800 years ago.⁷ Employing the same distinctive design and layout, homes in Hamu Go vary only according to size.

Clearly understanding the way Tibetan homes fit into the environment first necessitates a thorough survey of the interior and exterior of the homes. The Tukuda family home serves as an ideal model for such an examination. A typical Hamu Go home, the Tukuda house was constructed 21 years ago.⁸ Looking at the home from the front, it resembles a white rectangle, with the long end of the rectangle facing forward. It sits three stories tall.

The exterior of the home is a whitewashed, rammed earth wall. The wall envelops the home on all sides except the front. Made of local clay, the earth wall is eighty centimeters thick at the bottom, and, for stability purposes, gradually narrows as it rises to the top of the second story.

Construction of the wall takes place layer-by-layer. Builders first place wooden supports vertically in the ground on either side of the future wall, then pack mud between the supports. A new layer is added once the old layer completely dries. Whitewashing the wall takes place last. The paint's primary ingredient is limestone that comes from a site several kilometers from the village, and the earth wall undergoes re-painting annually.⁹ It sits on a one-half meter high stone foundation.

Wood comprises the rest of the home's interior and exterior. Overlapping

wooden shingles make up the slightly pitched roof, and soccer ball-sized rocks on the roof's edge keep the shingles in place. The earth wall and roof receive structural support from a system of twenty wood columns spread symmetrically through the house. Wooden panels lining the earth wall on the interior and placed between the columns add further support and delineate rooms, and wooden planks create the home's floor.

Each story of the home serves a specific purpose. The first story is devoted to livestock, the second contains the family's living quarters, and the third story attic stores hay, barley, and miscellaneous tools. In one large unit, the Tibetan home combines the functions of a traditional American farmhouse and barn.

The ground floor is divided into two open rooms where cows and pigs live. Simple wooden doors provide access to the rooms from the home's front yard, and with no windows, the doors also provide the rooms' only light source. Dirt and hay cover the floor, and, unlike the walls of the second story, the ground story's walls are not lined with wood panels. The family's pigs stay in the larger of the two rooms continuously, and the cows enter the room in the evening after grazing in the fields during the day. The smaller room houses calves and provides storage for hay.

An outdoor wooden staircase leads from the ground floor to a second story porch. The porch extends across the length of the home's front side and serves as an area for hand, face, and hair washing. Various shelves store axes, ropes, hats, and coats, and a clothes line extends across the porch for drying clothes. A wooden door leads into the home's interior entryway room. The room stores *tzampa*, or barley flour, for

feeding the animals, and a large ladder gives access to the third story. Other doors from the second story entryway room lead to the family's living spaces, which include two bedrooms, an altar room, and a living room.

As the largest room in the house, the living room serves as the primary social area. Here, the family cooks, eats, and welcomes guests. At the center of the room stands the sacred column, the biggest and most symbolically important column in the home. The column represents the mother figure, and the family carefully selects which tree to use as the column before construction begins. During an annual two-day festival, local monks visit each home in the village and decorate the column with colorful banners and perform chants around it. The banners remain throughout the year.¹⁰ The column also plays an important role in weddings and other ceremonies as the centerpiece for traditional dances.

In the bottom left corner of the living room sits the hearth – the warmest area of the home, and therefore the area that sees the most social activity. The hearth contains two heating elements. One is a large, four-chambered pot called a *tokka*. A fire under the *tokka* heats the four chambers, two of which hold water for human use, and two of which contain water and food for the livestock. At the other half of the hearth sits a wood-burning stove used for cooking. An opening in the ceiling above the hearth allows smoke to rise to the third floor and escape through the roof. Two low benches are tucked in the corner around the hearth. Women and men sit on designated benches, and here the family eats meals and gathers at night to talk and enjoy the heat of the *tokka*'s fire.

The wall behind the hearth and over the women's sitting area contains a built-in wooden storage cabinet. One end of the cabinet holds a small shrine with pictures of Buddhist deities, seven small goblets of water, and a vase with wood embers that the family tends to twice a day. The rest of the cabinet stores household items like candles, butter, tea, and brass ladles of varying sizes.

Along with the sacred column and hearth, a designated water storage area serves as the third key element of the home's living room. To the right of the sacred column and near the door from the entryway, another built-in, elaborately carved wooden cabinet holds a brass tub that stores cold water. Water pails for collecting water from the village's stream sit near the tub. A small niche below the main cabinet holds firewood for use in the wood stove or *tokka*. Other items in the room include a storage chest for dishes, a TV and DVD player, and an extra bed. The room has a feeling of openness, with few objects relative to the amount of available space.

Two windows and a light bulb near the hearth provide the living room's light. The wood panels that line the earth wall are left bare throughout most of the room. Colorful posters of the Tibetan Buddhist Eight Symbols of Good Fortune hanging near the hearth serve as the only wall decoration.

The home's two bedrooms are approximately the same size and contain similar furnishings, two twin size beds. The parent's bedroom also contains a shelf for extra butter and *tzampa*. Each room has one window and light bulb.

The last room in the home is the altar room. With access from the entryway, the

altar room contains little besides a long, low shelf at the end of the room. Like the smaller shrine in the living room, the altar room shrine contains pictures of deities, water goblets, and a vase for fragrant burned wood.

The home's third story functions as an attic and is comprised only of the space between the second floor ceiling and the home's sloping roof. Dirt covers the floor, and most of the space serves as hay, barley, and radish storage. Shafts of light enter the attic through cracks between the roof's shingles.

In order to examine the sustainability of Hamu Go's homes, four aspects of the home must be considered: building materials, energy use, water efficiency, and waste production.

III. The Building Blocks of Environmentally Sustainable Design

A. Building Materials

The materials used to build a home greatly influence the home's overall eco-friendliness. A new home requires a tremendous amount of resources – most notably, wood. In fact, fifty-five percent of wood cut for non-fuel purposes worldwide goes toward construction.¹¹ The extraction, processing, and transporting of building materials, like lumber, can have potentially devastating effects on the local and global environment. Overlogging in China, for example, was largely to blame for floods in 1998 that killed 2,500 people, displaced millions, and caused billions of dollars in damages. The Chinese government banned commercial logging in seventeen provinces following the floods, but illegal logging – in Yunnan, most

recently – continues.¹² China now imports four times as much wood as it did before the ban, thus pushing the problem of overlogging to Southeast Asian countries.¹³

Besides the loss of habitat and watershed damage caused by logging, the transporting and processing of lumber adds further pressure to the environment. Pollution from lumber mills and logging trucks spreads the ecological cost of logging far beyond the logging site itself. With one-half of the earth's original tree cover already gone, a home's sustainability depends on its use of sustainable building materials.¹⁴

To determine the environmental friendliness of a home's materials, the entire life cycle of the materials must be examined. From the materials' initial availability and harvesting, to its processing and use, and to its final disposal or reuse, every stage of the materials' life affects the environment.

In general, if a material is natural, local, durable, and renewable, it is considered environmentally sustainable. Materials found in nature take little energy to produce, and they give off less indoor pollution than manmade materials. Local materials require less energy for transportation and therefore reduce pollution. Materials that are durable save energy and additional materials that would be needed to maintain and replace broken parts. Finally, renewable materials ensure that a home's construction will not irreversibly deplete resources.¹⁵

As described earlier, Hamu Go's homes use three main materials: wood, rammed earth, and limestone paint. Wood is the material used most in the house, and it also has the greatest potential for negative environmental impact. In Hamu Go, family

members themselves harvest lumber from a forested valley several kilometers to the west of the village. Until a few years ago, families haphazardly cut trees on the hills surrounding the village. Now, many of those hills are completely bare of trees, and a village committee has been created to decide specifically where and when logging should take place. Each family building a new home may only take logs from the designated logging site.¹⁶

Along with the village committee, the local government also regulates logging in Hamu Go. Before a family begins logging, they must apply to the *cun* level government, or village government, for a permit. The family receives a fine if caught logging without the permit, but according to villagers, local officials rarely enforce the permit regulation. The government levies a five yuan (about sixty U.S. cents) tax on each log taken, but, like the permit system, the government seldom monitors the number of trees logged.¹⁷

Men in the family perform most of the logging, and after obtaining a permit, the physical logging process begins with a two-hour hike to the designated lumber area. They select a tree of desired size and cut it down using an axe. While recent research about logging reveals that cutting smaller trees protects a forest's health and allows it to recover faster from logging, Hamu Go residents consider a tree's size only in terms of whether it suits the needs of their new home. Although sustainable logging strategies such as this currently do not exist in Hamu Go, Ngawang Tsultim, WWF Community Leader in Zhongdian, believes environmental education will soon help villagers learn about such ideas.

The processing of the wood, like the actual cutting down of the tree, is done by hand. Using an axe, the villagers shave off the tree's branches and bark, then leave the tree to dry-out. Two yaks transport the prepped log back to the village for construction. The entire process can take up to forty days.

Each new home uses ninety to 100 trees.¹⁸ Throughout the home's lifespan, the wooden walls and columns require little maintenance. Smoke from the hearth preserves the roof and third story wood from rot caused by rain and snow. When a family wants to rebuild their home, they gather a completely new set of logs. The old home's wood is not reused in the new house, but becomes firewood instead.¹⁹

In many respects, the wood used in Hamu Go fits the four characteristics of a sustainable material. The wood obviously comes from a natural source. Using only the sun's energy to grow, the wood's production takes far less energy than the production of a more conventional material, like concrete. The lumber also comes from a local source, the nearby forest. Transportation back to the village requires no input of unsustainable energy, like oil. The strength and energy of humans and yaks alone moves the logs from the forest to the building site. While conventional logging involves invasive, noisy trucks and logging roads that disturb the entire forest, logging around Hamu Go is a quiet process that leaves the remaining forest relatively untouched. The durability of the wood means it holds up well over time and does not require the use of additional wood for maintenance or replacement parts.

Though the wood is natural, local, and durable, it fails in the category of renewability. The villagers do not replant trees after logging and rely instead only on

natural reseeded. While the speed of re-rowth depends on the tree species, many trees in the area take fourteen years to become usable in any way.²⁰ Given that each new home requires ninety to 100 trees, and three to four new homes are built in the village each year, the forest will eventually become too depleted to serve as a healthy, livable ecosystem.²¹

While the problem of overlogging is slowly emerging in the village consciousness, the vast majority of people remain unwilling to seek alternative building materials. Because the family members themselves cut the wood, lumber is cheaper financially than other materials.²² Hamu Go's village-initiated logging plan serves as a good first step toward sustainable logging, but greater scientific knowledge about forest health could further lighten logging's impact on the environment. Most importantly, because each home requires such a large number of trees, a movement toward widely available, eco-friendly materials like bamboo could greatly benefit the overall sustainability of Hamu Go's homes.

The mud used for the earth wall is the second major material used in the home. Builders find the mud by digging directly under the grass surface in an area near the village. Once excavated, the mud goes straight into the wall with no additives. Likewise, the whitewash applied to the wall comes from local limestone. If kept properly whitewashed, the earth wall lasts longer than a traditional brick wall.²³ Natural, local, durable, and renewable – the rammed earth wall and its whitewash fit all the characteristics of sustainable resources.

B. Energy Use

Along with building materials, the amount and type of energy a home uses has a large effect on the surrounding environment. Traditional development uses fossil fuel energy as if it were inexhaustible. The relatively cheap monetary cost of coal, oil, and natural gas covers up the true cost of these fuels to the environment: mining destroys forest cover and grassland, oil spills ruin marine ecosystems and groundwater supplies, and air pollution harms the health of all living species and leads to global warming.²⁴

As the finite supply of fossil fuels diminishes, oil and gas companies go to greater lengths to discover and exploit remaining reserves. Not only does this increase the economic cost of the fuels, but it also burdens highly sensitive environments with invasive exploration and drilling techniques. The combined economic and environmental cost of fossil fuel energy renders it entirely unsustainable.²⁵

Yet, demand for fossil fuel continues to rise around the world. In 2003, China's oil imports rose by thirty percent, and over the last two years, the country's electricity consumption has increased by an amount equal to the entire electricity consumption of Brazil. Some analysts predict that worldwide oil production could peak as soon as 2010; therefore, environmentally sustainable homes must find ways to reduce fossil fuel use.²⁶

Sustainable energy use is accomplished in a home in two ways. First, a home should use building materials and a layout that make little energy input needed. Many materials naturally trap and release the sun's energy, thus keeping a home warm

and cool without additional energy. The home's layout should allow these materials to take advantage of natural energy sources. For example, when combined with proper insulation and draft prevention techniques, positioning windows to capture sunlight in winter can reduce a home's energy needs by ninety-seven percent. Secondly, any additional energy required by the home, for lighting or cooking, should be used as efficiently as possible. Modern light bulbs and kitchen appliances use substantially less energy than older models.²⁷

Hamu Go's homes require energy for heating, cooking, and lighting. The energy for heating and cooking comes from the same source – the hearth fire. The family makes a fire for every meal, and four meals are eaten each day. An average of five logs are burned during each meal. While the fire effectively heats the area around the hearth, the rest of the living room and house remain cold. Fires are not started between meals.

Because the home's heating and cooking systems rely on firewood, a complete lifecycle analysis of the wood is required in order to determine sustainability. Just as they gather the wood used for construction, family members also harvest fuelwood in the hills surrounding the village. Light firewood comes from several different sites, all within a thirty-minute hike from Hamu Go. Women take responsibility for collecting this wood. Most often, they use a small machete-like tool to cut branches from large shrubs. In some sites, people from the village cut the bottom two-thirds of a tree's branches for use as light firewood. The tree survives the cutting and begins to regenerate its branches. The women transport the light wood back to the

village in bundles strapped to their backs.

Heavy firewood comes from the same forested area as construction wood and is cut and transported in the same way. Once the yaks drag the cut tree back to the village, men chop it into small logs using an axe. The government gives each family an annual ration of two truckloads of firewood, but a survey done by Mr. Tsultim found that families usually do not use their full quota.

The home's insulation and ventilation systems play a key role in how efficiently the firewood heats the home. The entryway room serves as a successful barrier between the main front door and the rest of the home. Cold air that might enter through the main door becomes trapped in the entryway, and the entryway creates a pocket to keep the warm air in the living room from escaping to the outside. While the earth wall provides a substantial outer envelope for most of the home, air moves freely between the rooms inside the home. The warmth around the hearth quickly dissipates between the wood panels that separate rooms.

By adding insulation material between interior rooms, the home could take better advantage of the hearth fire. Also, a more compact home layout could give the hearth the ability to heat other rooms. Eliminating the cavernous, unused space in the living room could produce a tighter overall house design. Proper insulation techniques would reduce the family's firewood needs and increase the home's overall comfort level.

While the home must retain heat from the hearth, it must also have a method of ventilating polluted air and smoke. Hamu Go homes employ a natural ventilation

system that takes advantage of the weight difference between hot and cold air. Warm, light air from the fire rises while heavy, cold air from the third story falls to replace it. From there, the hot, polluted air dissipates out the roof. Smoke from the hearth fire also funnels out the living room's two windows.²⁸

Though the simple ventilation system successfully eliminates smoke from the home, it does not do so very efficiently. The natural chimney of air does not perform well in extreme temperatures. During the summer, the temperature outside and in the attic is not cool enough to sink and push the smoke out of the house. The heavy smoke sits in the living room instead of flowing outside. In the winter, the temperature difference is too great, and the hearth's warm air is sucked out before it adequately heats the living room. Cold air rushes in from the third story, eliminating any heat created by the hearth.²⁹

Also, the glassless windows in the living room create a conflict between proper insulation and ventilation. Opening the windows' wooden shutters to release smoke often allows too much cold air to enter, but closing the windows makes the room uncomfortably smoky. The family must choose between letting too much cold air inside or breathing polluted air.

A heat recovery system could help the home eliminate ventilation problems and improve the home's heating ability. Ventilation systems with heat recovery involve an inlet that brings in fresh air and an outlet that releases polluted air. The two airstreams cross over each other and exchange heat. The warm, polluted air from the home heats the cold, fresh air coming into the house. Energy efficiency from this

type of system ranges from sixty to ninety percent, thus also reducing the home's firewood use.³⁰ With a heat recovery ventilation system, the family could install glass windowpanes without the worry that closed windows would inhibit the room's ventilation. Closed windows would benefit the home's insulation efficiency by allowing it to retain heat.

The home also receives heat from solar energy. The earth wall serves as a type of thermal mass. It captures the sun's heat to create a passive solar heating system.³¹ After collecting energy throughout the day, the wall slowly releases it during the night, thus moderating the drastic daytime to nighttime temperature fluctuation common to Hamu Go.³²

While the home's heating system gains some benefit from solar energy, slight alterations in the home's layout could allow it to receive even more energy. During the winter, the sun hangs at a lower, southerly angle in the sky. All homes in Hamu Go face south, but because the earth wall does not extend across the front of the home, the wall cannot capture the sun at its most intense angle. Glass-paned windows also have the potential to warm the home through solar heating. Many homes do not currently have glass windows, and even if they did, the overhanging roof on the south side would block all sunlight from entering. By rotating the home by forty-five or ninety degrees, the earth wall could more effectively heat the home, and unshaded south-facing glass windows would also increase the home's solar energy potential.

More effective insulation and ventilation systems and alterations in the home's layout could cut down on the home's need for firewood and increase the home's

sustainability. Some Tibetan villages have also recently installed solar cookers and bio-gas stoves for cooking.³³ While some of these new appliances do not work effectively at high altitudes, they represent the beginning of a movement away from firewood. According to Mr. Tsultim, Hamu Go villagers will follow the example of local officials – as long as the officials are using firewood for heating and cooking, the villagers will use firewood as well.

Providing light in the home also takes energy. Natural light enters through the home's windows, but the windows are too small to adequately light the home. Moreover, because the windows do not have glass, opening them for lighting purposes is not an option during cold or stormy weather. Each room in the home also has one light bulb, and the electricity for the bulb comes from the local electric grid.

To increase the comfort of the home and to reduce its electric needs, larger windows with glass could be added. Natural lighting could completely eliminate the need for auxiliary lighting during the daytime, and energy-efficient light bulbs could maximize the home's energy use after dark.

Despite the home's use of electricity for lighting, the home mostly avoids the dependence on fossil fuel energy that characterizes most modern development. However, the home's reliance on energy from fuelwood, like its dependence on lumber for construction, puts a strain on the local ecosystem. The Nature Conservancy office in Kunming estimates that seventy-nine percent of people living in northwest Yunnan rely on fuelwood energy, and unless this number decreases, the

region's natural forests will disappear in fifty years.³⁴ By reducing the amount of wood needed for heating through better insulation and ventilation or by redesigning the home to take advantage of solar energy, the home could lessen its impact on the environment.

C. Water Use

From plant photosynthesis to hydroelectric power, water supports life on all levels. This vital resource, however, comes in short supply. Ninety-seven percent of the earth's water is saltwater, and most of the remaining three percent is frozen in glaciers and polar ice caps.³⁵

Due to the uneven distribution of the scant amount of remaining freshwater, many areas face water scarcity problems. Growth in population, industrialization, and consumption are quickly turning water scarcity problems into crises.³⁶ Regions throughout China are currently facing water shortages, and the country's water availability per person is only one-fourth the worldwide average.³⁷

Environmentally sustainable homes must strive to use water efficiently. The home should base its water system around conservation – using little water and re-using as much as possible. For purposes other than consumption or bathing, the system should take advantage of lower-quality water sources, like rainwater run-off or gray water.³⁸

Hamu Go residents collect their water from a small stream diverted from a nearby hillside. The steam flows through town into several concrete holding pools, and

from there family members gather it in buckets.

The water cabinet's large brass tub holds the water before transfer to the *tokka* for heating. Heated water in the *tokka* is used for many household purposes: cooking, drinking, cleaning, washing, and feeding the livestock. The majority of water taken from the stream goes to the family's pigs and dogs. The family fills two chambers of the *tokka* with grated radishes and water, and after the mixture has heated, they feed both chambers to the animals three times a day.

Water for cooking and drinking tea is boiled in a kettle beneath the *tokka*. After meals, the dishes are washed using heated water from the *tokka*. The process does not use soap, and the used dishwater is poured into the livestock chambers of the *tokka*.

The family members also use the *tokka* water to wash their hands and face. This takes place once a day, and feet and hair washing takes place once a week. Since this water contains soap, the family dumps it out on the ground after use.

The average American family of three uses 125 gallons of water per day.³⁹ The Tukuda family, made up of four people, five pigs, and two dogs, uses about six large buckets of water each day, or approximately thirty-three and a half gallons.⁴⁰ Without indoor plumbing – no toilet, shower, or dishwasher – the family uses very little water. All used water that does not contain soap is re-used for the livestock. The family also uses unboiled, untreated water for cleaning, thus saving the energy necessary to produce drinking-quality water.

The Tukuda family, like the other thirty-eight families in Hamu Go, washes their

clothes directly in the village stream. The stream flows into the Napa Hai wetlands that begin across the street from the village and provides habitat for the black-necked crane, a rare and protected species. Untreated and uninhibited, the laundry detergent residue flows into the wetlands area, thus affecting the entire ecosystem. While the family excels at conserving water around the home, their clothes washing process directly releases toxins into the surrounding environment.

D. Waste Production and Disposal

The waste produced by a home inevitably affects the environment. While throwing away trash gives the illusion that waste disappears instantly, the reality is that trash must end up somewhere. Every method of waste disposal entails negative environmental consequences. Landfills pollute groundwater, and trash incinerators release toxins into the air, soil, and water.⁴¹

Because no waste control system can completely eliminate all environmental impacts, the only sustainable solution is to avoid generating waste in the first place. Doing this entails reducing, reusing, and recycling all products and materials. Family members should reduce the number of products they use that will become trash. If such products must be used, they should be reused as many times as possible. If the product cannot be reused, the family should recycle it.⁴²

Hamu Go households produce very little waste. Because the villagers themselves grow and harvest their own food, they rarely bring imported food and its accompanying packaging into the village. No one uses toilet paper or tissue, so its

disposal is not an issue. Leftover food – except for leftover pork – becomes food for livestock.

The family almost unfailingly reuses all packaging brought to the village. The occasional newspaper brought from Zhongdian is reused as wrapper for blocks of butter; egg cartons become drying racks for dishes, and empty chili powder packets are filled with salt and butter for making butter tea on long hikes. No trash trucks come to the village, so the residents must mindfully reuse everything.

The small amount of trash that is not reused – an empty cigarette package, for instance – is burned in the woodstove. Although this produces air toxins, the amount of trash burned is negligible. Of the 135 million tons of domestic waste produced annually in China, the residents of Hamu Go contribute almost nothing.⁴³

V. Conclusions

All aspects of the Hamu Go home system, from its building materials and waste production to its water and energy use, have lessons to offer the modern green architecture movement. However, the home could also learn a great deal from techniques and technologies developed by green builders. The Tibetan rammed earth wall, for instance, offers a valuable piece of local knowledge about how to build a durable, sun-absorbing outer envelope using renewable resources and a simple building technique. Conversely, modern forestry methods and the innovative use of alternative materials and energy represent a chance for Hamu Go residents to learn from new knowledge and increase their homes' environmental sustainability.

Efficient insulation and ventilation systems and modern technologies like solar cookers and energy-efficient light bulbs offer them other ways to reduce their environmental impact.

The Hamu Go community excels at conserving water and reducing and reusing waste. The residents' everyday habits, like reusing dishwater to feed their animals or creatively avoiding the production of trash, could teach communities around the world about how to live lightly.

Unfortunately, a major reason why Hamu Go residents use so little water and produce little waste is because of their relatively low standard of living. For example, with no flush toilets – the largest indoor user of water in the United States – Hamu Go homes obviously require less water than conventional homes.⁴⁴ The villagers' standard of living will almost inevitably improve over time, and while this represents a necessary and positive development, it might also represent a decline in the environmentally sustainable aspects of the Hamu Go home system. Already, new homes under construction in the village are substantially larger than homes built twenty years ago, requiring a greater number of larger trees.

Development does not necessarily have to bring about the destruction of Hamu Go's environmental sustainability, however. Development may herald the influx of new practices and technologies aimed at improving the village's relationship with its surroundings. Indoor plumbing and better heating systems would certainly improve the comfort of the Tibetan home, and they could be installed using eco-friendly methods. Just as predicted by the endless knot, the sharing of home design

techniques creates a connection between the knowledge of Tibetan builders and the knowledge of the green architecture movement.

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