A study of the Possibilities of Sustainable Building in Timber- in the City of Pines

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Abstract

Our generation is about saving the earth, our one and only home. For centuries resources have been used without the consideration of tomorrow. Modernization contributed to today’s environmental issues such as climate change and greenhouse effects. Effects of past deeds have been seen and experienced. We are trying to correct these mistakes and this paper is all about that. Construction industry is a major contributor to these issues and sustainable building is one solution to aid these matters. This paper is about exploring the possibility of sustainable building in timber in Baguio City, Philippines.

Considering the intensive development, rapid population increase and natural conditions, the city like most of the cities in the world is in need of sustainable building. This paper reviews modern green architecture and today’s durable timber construction design particularly suited for the city. There is of course a presentation of timber as sustainable material. To complement these reviews fieldwork in documentation on traditional and current sustainable building in timber of the city was performed.

Discussions with the different Philippine organizations regarding the current use of timber as sustainable material were also completed in this work. While to recognize the current situation in Baguio City enquiry to Department of Environmental and Natural Resources-CAR was necessary. Visit and phone call survey of the availability of Benguet Pine, the most dominant timber, in local suppliers were made as well.

For decades the Luzon Tropical Pine Forest has been exploited for its timber. These forests have not been sustainably managed. Logging (illegal and legal), regular fires and natural calamities are causes of forest destructions. These are the constraints of sustainable building in timber not only in the city but the whole country. There is now an on going forest rejuvenation and log banning. That is why Benguet Pine is not available in the market. Building in timber is expensive and very limited.

The future success of the Department of Environmental and Natural Resources – CAR as well as the international and national NGOs in saving the forest and promoting Sustainable Forest Management will answer the availability of Benguet Pine for local timber production.

The package of green architecture, combination of traditional and modern durable timber construction designs is the beginning of future Sustainable Building in timber in the City of Pines.
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I would like to thank my family and friends for the help and interest in the work. I would also like to give my appreciation to Bengt Hjort for the support as well as the University of Halmstad for providing the opportunity and the knowledge to accomplish the research to begin with.

Baguio City, in gratitude, my forever inspiration.
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1 Introduction

1.1 Background

Green is a very popular word today. We see Green in televisions, magazines, even billboards and newspapers. However, there are only few countries where this popularity is more than just a craze. In The Philippines, only a few enthusiasts and advocates practice Green building. Even worst, sometimes Green is only used as marketing strategy, making products more appealing to potential clients. We are still in the transition phase where building green could be the norm.

Green buildings are modern structures in a way that they are built more than the thought of cost, function, robustness and comfort. These structures are ecofriendly and uses supplies economically, not only during the period when they are in use but from the time these buildings are being designed, produced and even when we decide to reuse or completely demolish them.¹

To decrease the impact of built environment on the people as well as on the environment Green buildings are designed: to use resources such as energy and water economically, to protect the inhabitants well being both in their homes and work, and to lessen waste, contamination and other ecological degradation.²

In other words, sustainable building means that we are building for today as well as for tomorrow. While The Philippines is one of the most vulnerable countries to the negative impacts of climate change it is, unfortunately, in excessive development. Corporate and commercial buildings are being built here and there. The country is continuously building high-rise condominiums in every area property developers can put their hands on. The rise of unsustainable building is also the rise of major problems. There is a risk for an increase in Solid Waste, Coastal Ecosystems Degradation, Energy Abuse, Air Pollution, Water Pollution and Poor Sanitation.


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Engineers, architects, entrepreneurs, real estate owners and the government are the key players to answer this challenge. As the number of Green homes increases in a community the more this dream of sustainable building will become a reality. Big success happens from a small start. Slowly and hopefully surely, the more we build sustainably the more we motivate others and inspire one another. Having Green houses standing in local communities gives statements that this goes beyond a fashion and that this can be done, even better, that this should now be the choice for everyone.

The ultimate achievement is when every country and every city of the world build Green, living in a Sustainable Earth. Alongside victory travelling in places, it must also travel in time. It is therefore not only our responsibility to spread the awareness and understanding to the corners of the world but a privilege to be part of this global advancement.
1.2 Problem

Baguio City, Philippines lies in the mountains of the Cordillera. Imagine a city that is built on the tip of the highest mountains of the country (1,5km above sea level). This is one of the reasons why the climate here is cool even if the Philippines is in the tropical zone. Having the mountainous character, developed areas of the city are constructed on rough and steep terrain. The indigenous people of Baguio City are the Igorots or the Highlanders.

Landslide is a major problem in the city not only because strong storms come in the Philippines but because of the city’s geotechnical conditions. This geological phenomenon has killed a lot of people during the past years and many of the survivors have lost their homes. Some houses even remain buried in mud and rocks.

The city was designed for only 30,000 people but according to National Statistical Coordination Board the population by 2011 was 301,926 and it will remain to grow. It is no wonder because many of students and job seekers migrate here from the highlands and the lowlands. There are also a large number of foreigners now living in the City. Koreans appreciate living here not only because of the pleasant weather but also because of the Korean English Academies.

With the non-stop population increase and effects of natural disasters, there is a need of building homes. But this demand must be supplied through sustainable building. Building green is the builders part to save the city’s environment, future, and its cultural past and heritage. Future houses must be design with Green in mind. With these considerations, it leads us to the question, is Sustainable Building in the City of Pines possible?

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1.3 Aims and Objectives

The aim of this study is to investigate the possibility of building sustainably in timber in Baguio City. What is the tradition and condition of Baguio City in sustainable building in timber? When using timber as sustainable material, what are the green architecture and construction designs? What is the current situation of The Philippines particularly Baguio City in the use of timber as sustainable building material?

1.4 Methodology

The study has been based on the following methods:

1. Literature Review
2. Field study in Baguio City. This was done in order to acquire knowledge about traditions in Baguio City regarding building in timber. This field study comprised:
   a. Documentation of timber structures
   b. Visual observation
   c. Interviews with the representatives of different organizations in The Philippines.
   This was done in order to get information about the present use of timber as sustainable building material.

1.5 Limitations

The study is confined to the possibility of sustainable building in timber in Baguio City, Philippines.

It is limited to the basic green architecture and timber construction design.

It is also limited to the traditions and conditions of sustainable building -timber in the city.

The paper focuses on the current state of the use of timber as sustainable material in the city although situation of The Philippines in general is considered.
2 The Philippines\textsuperscript{4}

The Philippines is located in Southeast Asia. This area is very often visited by calamities like typhoons and earthquakes. There are also numbers of volcanoes that are active in this country.

The country is uniquely beautiful and attractive but it is also exposed to these calamities. It is composed of 7,107 islands which makes it the second largest archipelago, not only in Asia but also in the world. It has a 28,962 km coastline the longest in the world.

The Philippines' land area is 115,739 sq. m. where 60% is mountainous. Other parts are low swamps, coastal plains, volcanoes and rolling hills.

Since the country consists of different topographies Filipinos deal with different natural disturbances. Those that live near the ocean deals with floods, storms and tsunamis for example. While those who live inland like the Cordillerans experience landslide, heavy rainfall as well as forest destruction.

The yearly average of the number of typhoons is twenty. The recorded number during 1986-1990 was 84 and 32 were damaging. The most destructive had a total damage cost of €216.92 M.

A minimum of five earthquakes happens in the country daily but most of them are to weak to be felt. Since 1599, The Philippines had experienced damaging earthquakes, 74 in total. The most damaging happened in Northern Luzon, including Baguio City. It was on July 16, 1990 with a death number of 1,666 and total cost damage of €12.2 M.

\textsuperscript{4} Gertrude Calayag Samson, \textit{From Emergency Shelter Towards Implementation of Disaster Resist and Technologies in the Philippines}, 2005-09

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3 Baguio City

Baguio City is the “Summer Capital of The Philippines” and is located in the Benguet province. Benguet province is in Cordillera Administrative Region (CAR). It is 250kms away from the capital, which is Manila. Baguio is the provincial center for tourism, education, economy, transportation and communication.

The city is located 5,000ft above sea level. Most of the terrain is inclined about 45° which causes landslides during strong typhoons.

Baguio City is also called the “City of Pines” because of the cool and refreshing weather all year long. The temperature is between 15°- 23° with an average of 18° everyday while humidity is about 86%. The chilliest months are Dec-Feb, the recorded lowest is 6.3° (1961) and the highest is 30.4° (1988).

The city has a Dry and Wet season. Wet Season is from May-Oct and Dry is during Nov-April. Because of the geographic location the rainfall in the city is heavier when tropical cyclones occurs. The effects of the nearby ocean also add up to the heavy rainfall.

Rainy season is from June-Sept where the annual rainfall is 4,176mm and the densest is 1085.8mm due to a 24hr rainfall during 2011. Because of the mountainous conditions of the city, orographic lifting happens. This lifting causes formation of rain clouds and fog. This is why strong rains and wind still happen even during summer.

The main direction of the wind is southeast with a speed of 8km/h (Oct-Jan). The city experience cloudy weather most of the time. Fog is also experienced in the afternoons and early mornings, with a cool breeze of Pine-tree-fragrant, an extraordinary occurrence truly awarded by nature to this region.

Figure 2 Baguio City in The Philippines via Google Maps

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5 Philippine Atmospheric, Geophysical and Astronomical Services Administration- Baguio City, Climate of Baguio

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4 Sustainable building in timber-general guidelines

4.1 Sustainable Architecture

4.1.1 House

4.1.1.1 House shape
To build a heavy-duty house, choosing the shape is significant because specific shapes can better withstand the effect of natural calamities such as typhoons and tsunamis. The principle is to choose the most compact shape, this means circle is the safest shape. Square is better than rectangle but circle is still better than square. L shape is to be avoided because this is the least stable. It is better to separate the L-shaped structure into 1 rectangle building and 1 square building. These are vital precautions especially in cities like Baguio City where strong winds befall.\(^6\)

4.1.1.2 House orientation
House orientation is essential to efficiently use the natural resources provided by the surrounding. In Baguio City for example, during summer, east as well as west fronts of the buildings must be protected from solar heating and heat gain so that temperature inside will maintain cool.\(^7\)

4.1.1.3 Natural ventilation\(^8\)
Natural ventilation is also an aim. This can be achieved by allowing the flow of the air trough numbers of openings, like doors and windows. A way to do this is the adaptation of cross ventilation where openings are placed on opposite sides of the structure. Having an open atmosphere is also a charm that houses in Baguio City can take advantage because of its climate.

Since warm air elevates, there must be openings in high parts of the structure. Detached or double roofing also allows better airflow as well as solar protection.

In order to maximize air circulation in windy cities like Baguio, the house should be placed with their longer axes facing the prevailing wind direction. And to further allow air circulation in the whole house, they should be designed with a small depth.

As for the low parts of the house, airflow must also be present. That is why elevating (very common in Baguio City) is practiced through stilts.

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\(^6\) UNEP SBCI, *After the Tsunami: Sustainable building guidelines for South-East Asia*, 2007

\(^7\) UNEP SBCI, *After the Tsunami: Sustainable building guidelines for South-East Asia*, 2007

\(^8\) UNEP SBCI, *After the Tsunami: Sustainable building guidelines for South-East Asia*, 2007
4.1.2 Site layout

In Figure 3-6 different precautions against landslide are presented. These precautions are important when building houses on steep mountains like in Baguio City.

Figure 3 Proper cutting, filling and house locating

Figure 4 Slope height reduction

Figure 5 Recommended location of house on slope

Table of Recommended Slopes for Common Soil Types

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Recommended Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clays and Loams</td>
<td>1:3.65 or 200%</td>
</tr>
<tr>
<td>Silts</td>
<td>1:1.45 or 100%</td>
</tr>
<tr>
<td>Sands</td>
<td>2:1.36 or 50%</td>
</tr>
</tbody>
</table>

Figure 6 A stepped drain for stable down slope of runoff

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4.1.2.1 Vegetation
Simply by using the existing landscape and topography of the location will protect the future buildings. This means, as much as possible, design houses while keeping the prevailing trees and bushes.

Plant vegetation in order to break strong winds. This is a simple mitigation knowledge, which can protect structures from strong storms.

Vegetation also delivers shading that will maintain the cool air of the city. Most importantly vegetation absorbs pollutants. (This will be more discussed in the following chapter, Timber - Sustainable Building material)

Vegetation also of course can provide food and material. Beside these needs it has an aesthetic appeal as well.

4.1.2.2 Building arrangement
Arranging the structures are also important. In areas like Baguio City, where storms and strong winds happens, houses are better arranged in clusters instead of rows. This way wind tunnel effect can be avoided.\(^{14}\)

\(^{13}\) UNEP SBCI, *After the Tsunami: Sustainable building guidelines for South-East Asia*, 2007

\(^{14}\) UNEP SBCI, *After the Tsunami: Sustainable building guidelines for South-East Asia*, 2007

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4.2 Sustainable Structural Design

4.2.1 Roof
Baguio City is an earthquake-prone zone; therefore roof construction must be of light character. It is also obligatory that all components of the roof be fastened appropriately. Also, it is essential that the roof be connected to the columns and walls properly and tightly. In the event that the walls fail during earthquake, the structure that carries the roof must still support the roof without these walls.\textsuperscript{15}

![Figure 7: Example of good jointing practice roof\textsuperscript{16}]

Where heavy wind occurs slope of the roof must also be considered. Wind suction forces must be decreased and this can be done by designing the slope of the roof 30\textdegree, minimum.\textsuperscript{17}

There are four reasons for building pitch roof: Better rain protection, bigger air space, less wind suction and cheaper compare to green roofs.\textsuperscript{18}

![Figure 8: Increasing Vulnerability to Wind Forces of Different Types of Roof\textsuperscript{19}]

\textsuperscript{15} UNEP SBCI, After the Tsunami-Sustainable building guidelines for South-East Asia, 2007
\textsuperscript{17} UNEP SBCI, After the Tsunami-Sustainable building guidelines for South-East Asia, 2007
\textsuperscript{18} Ecotektonika, Interview 2012-02-22
\textsuperscript{19} Gertrude C Samson, Emergency Shelter Towards Implementation of Disaster Resist and Technologies in the Philippines, 2005-09

A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
To further enhance the durability of the roof, roof trusses must be solid yet flexible. For example, connections of timber trusses must be bolted together with metal straps for flexibility but still provide sturdiness against lateral forces.\textsuperscript{20}

As mentioned earlier components of the roof must be fastened properly and this can be achieved in different ways. The following examples are provided.

Gussets should be made of steel or plywood.

\begin{figure}[h]
\centering
\includegraphics[width=0.3\textwidth]{figure9}
\caption{Gusset\textsuperscript{21}}
\end{figure}

In collar ties, timbers should be nailed to the rafters.

\begin{figure}[h]
\centering
\includegraphics[width=0.3\textwidth]{figure10}
\caption{Collar Tie\textsuperscript{22}}
\end{figure}

Metal straps should be placed over the top of the rafters.

\begin{figure}[h]
\centering
\includegraphics[width=0.3\textwidth]{figure11}
\caption{Metal Strap\textsuperscript{23}}
\end{figure}

Since strong wind form under large roof overhangs, construction of more than 18 inches must be avoided. Aside from the destruction of these overhangs, the main structure will also suffer. It is then better to construct verandas and patio separately from the larger building.\textsuperscript{24}

As for the indoor climate, roof insulation and overhanging roof will aid heat gain reduction, which will then result in maintaining the natural cool breeze in the buildings.\textsuperscript{25}

\textsuperscript{21} Gertrudes C. Samson, Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines, 2005
\textsuperscript{22} Gertrudes C. Samson, Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines, 2005
\textsuperscript{23} Gertrudes C. Samson, Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines, 2005
\textsuperscript{24} Gertrudes C. Samson, Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines, 2005

\textsuperscript{25} A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
4.2.2 Walls
Construction of overhangs was already mentioned earlier; besides from shading the building they also protects outer walls. Walls must be reinforced appropriately. Ring beams must also be linked properly to each corner as well as to the reinforcement of the walls and columns\textsuperscript{26} in order for the walls to stay intact even when strong natural forces strike.\textsuperscript{27}

![Figure 12 Example of timber framing with ring beams and wall reinforcement\textsuperscript{28}](image)

![Figure 13 Example of strengthening connection in exterior walling\textsuperscript{29}](image)

4.2.3 Openings
The maximum width of the openings like windows and doors must not be more than 1.20m. The walls must not have an opening that is more than 1/3 of the total width of the wall. And the measurement of the wall between openings must be more than 1m.\textsuperscript{30}

Other disaster preventing measures must also be observed. Doors must open in the outside direction. More than one door is also necessary in the event that the main door is stuck or obstructed.\textsuperscript{31}

\textsuperscript{25} UNEP SBCI, \textit{After the Tsunami-Sustainable building guidelines for South-East Asia}, 2007
\textsuperscript{26} UNEP SBCI, \textit{After the Tsunami-Sustainable building guidelines for South-East Asia}, 2007
\textsuperscript{29} Gertrudes C. Samson, \textit{Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines}, 2005
\textsuperscript{30} UNEP SBCI, \textit{After the Tsunami-Sustainable building guidelines for South-East Asia}, 2007
\textsuperscript{31} UNEP SBCI, \textit{After the Tsunami-Sustainable building guidelines for South-East Asia}, 2007
4.2.4 Floor

It was already mentioned that elevated houses (houses on stilts) allows better airflow. Floors are suggested to be elevated more than 30cm.\textsuperscript{32} Natural airflow will prevent moisture problems especially in materials like timber. Another way to prevent moisture problems in the floor is using light materials, like timber, for the reason that it doesn’t store high temperatures.\textsuperscript{33} Using plywood as flooring material performs as a shear plate that will add to the durability of the floor\textsuperscript{34} as well as the whole house.

All of the floor beams must be firmly attached to the foundation with metal straps for example.\textsuperscript{35}

![Figure 14 Wood Floor and sub-flooring insulation\textsuperscript{36}]

4.2.5 Foundation

Designing foundations must be very particular. Foundation designs depend on the building it will carry and the location. That is why besides the size and the weight of the above structure, other important studies must first be made. These studies include: investigation of the foundation ground, the height of the water table and the possibility of liquefaction.\textsuperscript{37}

\begin{itemize}
\item \textsuperscript{32} UNEP SBCI, \textit{After the Tsunami: Sustainable building guidelines for South-East Asia}, 2007
\item \textsuperscript{33} UNEP SBCI, \textit{After the Tsunami: Sustainable building guidelines for South-East Asia}, 2007
\item \textsuperscript{34} Gertrudes C. Samson, \textit{Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines}, 2005
\item \textsuperscript{35} UNEP SBCI, \textit{After the Tsunami: Sustainable building guidelines for South-East Asia}, 2007
\item \textsuperscript{36} Gertrudes C. Samson, \textit{Emergency Shelter Towards Implementation of Disaster Resistant Technologies in the Philippines}, 2005
\item \textsuperscript{37} Robin Willison, \textit{Handbook on Good Building Design & Construction in the Philippines}, 2008
\end{itemize}
4.2.6 Stabilization

Stabilization is vital to all structures because it resists lateral forces. A way to achieve this, especially in timber-framed structures, is to have cross bracings in walls, roofs and foundations. Diagonal bracings are essential for the sturdiness of the structure. These are classical measures and are still a must-do when designing modern structures.\(^{38}\)


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4.2.7 Joints
To construct a safe timber building is to design it in a coherent manner. Since timber is a light structural material anchorage, e.g. against wind, is of greater importance. The structures of a building must be tied together tightly and securely.

4.2.7.1 Roof-Walls
Roof trusses for example should be designed in way that they are placed on top of the carrying structure like columns. These trusses must be linked to these columns or walls with connectors like metal ties.

![Figure 18 Connection of roof and wall](image)

4.2.7.2 Walls-Foundation
While the roof is connected to the walls correctly the wall must also be linked properly to the foundation. Timber columns must be anchored to foundation of the structure. Using non-corrodible metal like brackets can do this. These brackets must be bolted to the columns and hooked appropriately to the foundation.

![Figure 19 Connection of wall and foundation](image) ![Figure 20 Bracket](image)

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42 Ankush Agarwal, Cyclone Resistant Building Architecture, 2008
43 UNEP SBCI, After the Tsunami: Sustainable building guidelines for South-East Asia, 2007

A study of the Possibilities of Sustainable Building in Timber- in the City of Jines
4.3 Timber – Sustainable Building Material

Where earthquake and other calamities occur, structures made of timber are safer compared to other materials like concrete. Timber can be considered as sustainable building material because even if it's a light material, it is also heavy-duty and renewable. Both production of logs from the forest and manufacturing of timber products and are simple. One of the most important characteristics of timber is that it stores carbon, which is very needed in our time.

4.3.1 Ease of manufacture
Producing timber and other engineered timber products is simple. The process needs a limited amount of resources and energy. Not too many chemicals are used in the production and contamination is also low.

4.3.2 Transport
Timber doesn’t weigh as much as concrete and steel, transport is then easier. Also sawmills are located close to the suppliers. Beside these distances trucks needed for the transport are simply ordinary trucks.

4.3.3 Producing sawn timber
After harvesting, the logs are delivered to the site where it will be stored and then later on sawn. There will be no wasted portion in the logs because most of them become hardwood or softwood and then the rest will be sawdust or chipped.

4.3.4 Refurbishment & recycling
It is also easy to construct, refurbish and recycle timber.

4.3.5 Carbon storage in forests
Through photosynthesis trees absorb CO₂. The absorbed CO₂ stay in the tissues of the trees while producing O₂. Even if the logs are already used as timber, the absorbed CO₂ remain. These timber structures are considered CO₂ keeper.

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50 UNEP SBCI, After the Tsunami-Sustainable building guidelines for South-East Asia, 2007
4.3.6 Timber impacts compared to other materials

In Table 1, timber is compared with some other building materials. The comparison is with regard to sustainability.

<table>
<thead>
<tr>
<th>Material</th>
<th>Fossil Fuel during production (MJ/kg)</th>
<th>Stored CO₂ (kg/m³)</th>
<th>Released Carbon (kg/m³)</th>
<th>Embodied Energy/Stiffness (kJ/MN-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>1.5</td>
<td>250</td>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>Concrete</td>
<td>2</td>
<td>0</td>
<td>120</td>
<td>800</td>
</tr>
<tr>
<td>Steel</td>
<td>35</td>
<td>0</td>
<td>5320</td>
<td>1800</td>
</tr>
<tr>
<td>Aluminum</td>
<td>435</td>
<td>-</td>
<td>-</td>
<td>9200</td>
</tr>
</tbody>
</table>

Table 1: Comparison of the impacts of different materials


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5 Existing timber buildings in Baguio City- some examples

5.1 Introduction

To acquire knowledge of the traditions of Baguio City in sustainable building in timber, documentation of timber buildings were performed. All in all twelve buildings were studied. Of these ten were constructed before 1990. These houses survived the 1990 earthquake, landslides, and hundreds of cyclones that have hit the city for the past years. The remaining two are modern buildings and were documented to acquire knowledge about the present condition of the city in sustainable building in timber. These two houses were constructed after 1990. When data is not given in the table then it was visually impossible to acquire them.

5.2 Old timber buildings

Traditional ways of buildings are results of decades of mistakes and improvements. These practices are then considered realistic and dependable.\textsuperscript{52} Traditional buildings are considered sustainable building not only because of their durability but because these buildings are mostly made out of local materials, labor and skill.

Documentation from the studied buildings is presented in Figures 22-68. Acquired technical information is presented in Table 2 and Table 3

\textsuperscript{52} UNEP SBCI, \textit{After the Tsunami-Sustainable building guidelines for South-East Asia}, 2007
A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
A study of the Possibilities of Sustainable Building in Timber in the City of Pines
### Table 2: Data gathered from five different old houses (2012-03-08 – 2012-03-16)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roof type</strong></td>
<td>-</td>
<td>Trusses</td>
<td>Trusses</td>
<td>Trusses</td>
<td>-</td>
</tr>
<tr>
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</tr>
<tr>
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<td>-</td>
<td>1</td>
<td>2.5</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>Posts dim. (cm)</strong></td>
<td>22x22</td>
<td>22x22</td>
<td>20x20</td>
<td>D=22</td>
<td>55x55</td>
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<tr>
<td><strong>Posts c/c (m)</strong></td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Floor type</strong></td>
<td>Stones</td>
<td>Concrete</td>
<td>Trusses</td>
<td>Stones</td>
<td>-</td>
</tr>
<tr>
<td><strong>Floor dim (cm)</strong></td>
<td>-</td>
<td>-</td>
<td>5x25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Floor c/c (cm)</strong></td>
<td>-</td>
<td>-</td>
<td>48</td>
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<td>-</td>
</tr>
<tr>
<td><strong>Foundation type</strong></td>
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<td>Concrete slab</td>
<td>Concrete pier</td>
<td>Concrete pier</td>
<td>Pier &amp; Beam</td>
</tr>
<tr>
<td><strong>Foundation dimension (cm)</strong></td>
<td>-</td>
<td>-</td>
<td>5x25</td>
<td>30x30</td>
<td>55x55</td>
</tr>
<tr>
<td><strong>Foundation c/c (m)</strong></td>
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<td>3.15</td>
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<tr>
<td><strong>Joint: Roof-Wall</strong></td>
<td>Bolts</td>
<td>Nails</td>
<td>Bolts</td>
<td>Nails &amp; wood</td>
<td>-</td>
</tr>
<tr>
<td><strong>Joint: Floor-Foundation</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Bolts &amp; metal anchor</td>
<td>-</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>-</td>
<td>Bracing</td>
<td>Bracings</td>
<td>-</td>
<td>Bracings</td>
</tr>
<tr>
<td><strong>Figures no.</strong></td>
<td>22-25</td>
<td>26-29</td>
<td>30-35</td>
<td>36-39</td>
<td>40-45</td>
</tr>
</tbody>
</table>

### Table 3: Data gathered from five different old houses (2012-03-08 – 2012-03-16)

<table>
<thead>
<tr>
<th></th>
<th>Milhi Center</th>
<th>Cantinettailly</th>
<th>House of waffles</th>
<th>Himaya</th>
<th>Café Will</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roof type</strong></td>
<td>Trusses</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Roof dim. (cm)</strong></td>
<td>15x9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Roof c/c</strong></td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Posts dim. (cm)</strong></td>
<td>29x29</td>
<td>15x15</td>
<td>15x15</td>
<td>21x21</td>
<td>21x21</td>
</tr>
<tr>
<td><strong>Posts c/c (m)</strong></td>
<td>3</td>
<td>2.5</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Floor type</strong></td>
<td>Stones</td>
<td>-</td>
<td>Concrete</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Floor dim (cm)</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td><strong>Floor c/c (cm)</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Foundation type</strong></td>
<td>Concrete slab</td>
<td>Concrete raised</td>
<td>Concrete slab</td>
<td>Concrete slab</td>
<td>Concrete slab</td>
</tr>
<tr>
<td><strong>Foundation dimension (cm)</strong></td>
<td>-</td>
<td>20x20</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Foundation c/c (m)</strong></td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Joint: Roof-Wall</strong></td>
<td>Metal straps</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Joint: Floor-Foundation</strong></td>
<td>-</td>
<td>Bolts &amp; metal anchor</td>
<td>Bolts &amp; metal anchor</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Stabilization</strong></td>
<td>Bracings</td>
<td>Bracings</td>
<td>Bracings</td>
<td>Bracings</td>
<td>Bracings</td>
</tr>
<tr>
<td><strong>Figure no.</strong></td>
<td>46-51</td>
<td>52-55</td>
<td>56-60</td>
<td>61-64</td>
<td>65-68</td>
</tr>
</tbody>
</table>

A study of the Possibilities of Sustainable Building in Timber - in the City of Pines
5.3 Recent timber structures in the City of Pines

Documentation from the studied buildings is presented in Figures 69-80. Acquired technical information is presented in Table 4.

Figure 69 Roof trusses, 2012-03-08
Figure 70 Metal plate and bolts, 2012-03-08
Figure 71 Posts & beams, 2012-03-08

Figure 72 Entrance, 2012-03-08
Figure 73 Original roof trusses, 2012-03-08
Figure 74 Original bracing, 2012-03-08

Figure 75 Four-floor hotel, 2012-03-08
Figure 76 Ceiling beams, 2012-03-08
Figure 77 Four-floor hotel, 2012-03-08

Figure 78 Posts & beams, 2012-03-08
Figure 79 Hallway to balconies, 2012-03-08
Figure 80 Hotel’s restaurant, 2012-03-08

A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
Table 4: Data gathered from two recent buildings (2012-01-08) and the results in total (new & old structures)

<table>
<thead>
<tr>
<th></th>
<th>Forest House</th>
<th>Manor Hotel &amp; Restaurant</th>
<th>Result</th>
<th>Frequency out of 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof type</td>
<td>Trusses</td>
<td>-</td>
<td>Trusses</td>
<td>5</td>
</tr>
<tr>
<td>Roof dim. (cm)</td>
<td>5x10</td>
<td>-</td>
<td>5x10-9x15</td>
<td>5</td>
</tr>
<tr>
<td>Roof c/c (m)</td>
<td>3-5</td>
<td>-</td>
<td>1-5</td>
<td>5</td>
</tr>
<tr>
<td>Posts dim. (cm)</td>
<td>29x29</td>
<td>66x66</td>
<td>15x15-66x66</td>
<td>12</td>
</tr>
<tr>
<td>Posts c/c (m)</td>
<td>3-5</td>
<td>5-6</td>
<td>2.5-6</td>
<td>12</td>
</tr>
<tr>
<td>Floor type</td>
<td>-</td>
<td>-</td>
<td>Concrete/Stone</td>
<td>4</td>
</tr>
<tr>
<td>Floor dim (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Floor c/c (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Foundation type</td>
<td>-</td>
<td>Concrete slab</td>
<td>Concrete slab</td>
<td>7</td>
</tr>
<tr>
<td>Foundation dimension (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Foundation c/c (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Joint: Roof-Wall</td>
<td>Metal plates &amp; Bolts</td>
<td>-</td>
<td>Bolts</td>
<td>3</td>
</tr>
<tr>
<td>Joint: Floor-Foundation</td>
<td>-</td>
<td>-</td>
<td>Bolts &amp; metal anchors</td>
<td>3</td>
</tr>
<tr>
<td>Stabilization</td>
<td>Bracings</td>
<td>-</td>
<td>Bracings</td>
<td>9</td>
</tr>
<tr>
<td>Figure no.</td>
<td>69-74</td>
<td>75-80</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

5.4 Conclusion

It turns out massive timber construction on concrete slabs and pier foundations were the most common building techniques. Joint technology such as bolts and metal anchors were also used. It is also apparent that bracing for stabilization was a usual practice. Through the data gathered it is evident that knowledge in timber construction was available and functional.

The beautiful old houses that were documented indicate that building sustainably in timber existed. Theses houses survived the 1990 earthquake and many typhoons that have visited the city. These houses have proven their durability because they are still fully functioning and have maintained their classical aesthetic appeal that fits the city. These houses can be used as models when building sustainably in timber.

The recent buildings shows promise that building in timber is still achievable. These buildings, according to the data gathered, are using latest technologies that were not seen in the old houses, building in four floors for example. The recent buildings also have a newer version in style and clearly showed progress but still maintained to suffice the taste of the locals.

A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
6 Use of timber as sustainable building material for housing projects—present situation

6.1 Introduction

To know the current use of timber as sustainable building material in The Philippines, interviews with representatives of different organizations were completed. The reason for choosing the organizations was the idea that they were the country’s enthusiasts and that they were the most probable to have had and will promote sustainable building.

Even though the discussion didn’t go exactly as planned, it was pleasing to listen to the architects and engineers of the country. They were helpful enough to inform the reality of the situation and they willingly shared what kind of work they do for the organization and the organization itself.

6.2 TAO Pilipinas

Verna Sarraga is an architect who has been working with TAO Pilipinas for two years. The interview was done February 21, 2011. Before joining the organization, Verna used to work in a private architectural firm.

TAO Pilipinas is an organization that aims for a sustainable community especially to those that are suffering due to natural catastrophes. It has been functioning for a decade now. They even provide workshops for the communities. Misercor EU and the Asian development bank fund the organisation.

The organisation provides technical assistance to those in need, free of charge. They help communities in activities like resettlements. As of now, they are helping the Navotas Community to relocate to Masagana, Bulacan. The community has to resettle 70 families in total.

With the discussion I had with Verna, she told me that they haven’t done any housing project with timber as the building material because of its cost. They also see that cutting trees help with landslide catastrophes. But they use systems that are easy to teach the community, as they are the ones to build themselves. They use sustainable materials such as compressed earth blocks, micro concrete roof tiles, interlocking compressed earth blocks, coconut fiber-cement board, wood wool cement-bonded board and concrete interlocking blocks.

For the future, the organization is preparing to help communities to build evacuation centers but timber housing is not an option to them.
6.3 Habitat for Humanity

Habitat for Humanity (HH) envisions a world where everybody has a decent place to live in.

The discussion was with Augusto Baltazar an Industrial Engineer and Manager of the organization together with Edgardo Quilates a Civil Engineer and Project management officer of HH in Feb 21.

Augusto Baltazar has been working as an engineer for 50 years but have only have been with HH for three months. Mr Baltazar, with so little time in the organization have already joined with projects that produced 300 houses while Edgardo Quilates has been with the HH since 1999. Mr. Quilates has participated building approximately 4000 houses.

Their concept is that concrete is much stronger than timber especially in countries that are in cyclone prone area. Timber is scarce and it takes time to produce. It is also not environmental to cut trees. Though they admire timber materials such as yakal, nara, opitong and tampong. Timbers such as tangkai, launan are low class then but now these are expensive as well. Commercially available timbers are imported from Indonesia and Thailand.

Building with timber especially with row houses also conflicts with the national building code. Such as that fire retardant coating is only good for three hours. It will also be hard to get permits like from fire department. When I mentioned the availability of sprinklers he said it's not common these things are installed in residential houses.

In The Philippines when you build with timber, it's considered a luxury. As of now there is no way of building with timber.
6.4 Philippine Green Building Council

According to the information on a website the following applies to the Philippine Green Building Council (PHILGBC). "PHILGBC is the largest green building initiative in The Philippines. Its members and partners are working together in promoting environmentally sensitive practices in the way we design, build, and operate buildings. PHILGBC currently undertakes research in the areas of architecture, engineering, market transformation, environmental management and policy development to support the development of systems and tools that promotes green building in industry."\(^{53}\)

The purpose of this discussion is to find out if they have a specific program that promotes timber framing, if not now then in the future.

The dialogue was with Mario Lawrence C. Suelto in February 22, 2012. He is an Architect and the Project Coordinator in the organization.

The council doesn’t have any particular program or project that promotes timber as building material. Due to log banning timber framing especially of hardwood for structural elements is very limited. As of now the council encourages any building materials as long as the sourcing is proper.

6.5 Ecotektonika

According to the information on a website the following applies to the firm. "Ecotektonika is a full service Sustainable Design and Ecologically Sustainable Development Consultant. Services include Architectural Design, LEED, Green Mark, Quezon City Green Building Ordinance and BERDE Consultancy, Energy and Building Simulation Analysis. It has strong working partnerships with Engineers and Commissioning Agents."\(^{54}\)

The discussion with Ecotektonika was with Nestor G. Arabejo an Architect and a Sustainable Design Expert in February 22, 2012.

If to consider using timber, know which timber the native is using. The maturity of the timber must not be more than ten years. And the source of timber products must be within 250km.

Building now with timber as building material is limited because of the log banning and scarcity of the material.

\(^{53}\) PHILGBC, About the PHILGBC, 2011, [http://philgbc.org/about/about-the-philgbc](http://philgbc.org/about/about-the-philgbc) 2012-04-05


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28
7 Availability of timber – present situation

7.1 Sustainable Forest Management

Sustainable Forest Management (SFM) just like Sustainable Building is about providing for today as well as for tomorrow. In order for the forest to continuously supply the building industry of timber the forest must be managed appropriately and be taken care of. The government through laws and technical provisions must implement this management. Sustainable Forest Management is also about guarding and preserving the ecosystem of the forest while in some areas preferring specific cost-effective species or group of specie for an even better production of timber for example.\textsuperscript{55}

Many forest and woodlands of the world especially in tropics and subtropics are not yet managed properly. Many developing countries lack resources such as funding and human. The result is inadequate preparation, implementation and monitoring of forest management plans. Food & Agriculture Organization of the United Nation helps developing countries in dealing with these problems. They for example provide information and policy advices as well as institutional and technical capacity-building activities.

7.2 Sustainable Forest Management in The Philippines

The government owns a large portion of the forest but considerable portions are also owned by private sector, communities, people’s organization and by indigenous people.

In 1987 Community Base Forest Management (CBFM) was established. This means the communities are in charge and responsible in implementing strategies and programs in Sustainable Forest Management (SFM). Organized communities for example will only cut certain number of trees allowed by the government. Department of Environmental and Natural Resources is the government agency for the forest and protected areas. Many international and national NGOs also promote Forest Management and development.

It is difficult to estimate the extent of SFM in The Philippines but in 2005 the CBFM shows promise, 910,000 ha is managed. Area of 76,000 ha of natural forest is sustainably managed in Surigao del Sur.


A study of the Possibilities of Sustainable Building in Timber- in the City of Pines
7.3 Philippine Wood Producers Association

According to the information on a website the following is valid for the organization. "The Philippine Wood Producers Association (PWPA) is the national association of corporations, partnerships and individuals involved in forest management, logging, forest plantation development, manufacture of lumber, veneer and plywood, pulp and paper and other wood products as well as in trading, shipping and sales of these products."

Included in the association’s objectives is to support sustainable forest management both of virgin and plantation forest in order for the association to provide timber needed by the country. This group has 15 members that are functioning in the sustainable manner for 50 years now; unfortunately Baguio City is not included. Despite this though the association is also affected by the recent log banning (will be further discussed). This results to members now importing timber products.

7.4 Timber production in The Philippines

The state is responsible in the administration of the forest of the country. In 1920 the private sector started to be included in exporting timber such as mahogany. According to the Philippine Forestry Statistics (2005) the area under production status in the Philippines in total is 7,809,000 ha.

Timber License Agreement (TLA) was the system for distributing logging rights. It was introduced in 1950. These rights were connected to responsibility of proper logging processes. Only specific species were allowed. There were also meticulous procedures for forest management. Unfortunately these rights were exploited without the responsibility. The Philippine forests were widely deforested during these times. In 1970 for instance 2/3 of the public forest were used to produce timber like mahogany. Even today illegal logging exist in the country and is a foremost issue that hinders the achievement of Sustainable Forest Management.

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7.5 Log banning

The state of The Philippines has recently enforced log banning in the whole country because of deadly floods that occurred.  

Because of improper logging plus unusually heavy rainfall the cities and provinces have been exposed to landslide and flooding.

With this banning there will be no contracts and agreement for timber production in natural forest of the country. Remaining contracts will be respected and utilized. However the government will follow up the production. There will be a task enforcer organization to impose the log banning.

7.6 Luzon Tropical Pine Forest

The forest surrounding Baguio City lies in the Central Cordillera and it is called the Luzon Tropical Pine Forest because the dominant species here is Benguet Pine.

This forest, like most of the forest in the country, has been exploited for years in the past for its trees and minerals. That is why the forest is now in critical and endangered status. As mentioned earlier, logging is a threat to the forest. Both illegal and legal logging is a problem for the whole country.

Regular fires both natural and human conducted are also causes of the forest destructions. Human conducted occurs for growing vegetables and cut flowers.

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7.7 Benguet Pine (P. kesiya)

Benguet Pine, as mentioned earlier, is the dominant specie in the forest of Baguio City. That is also why the city is called "The City of Pines". The scientific name of the specie is Pinus insularis, but more commonly known as P. kesiya.\footnote{Khasi Pine, \url{http://en.wikipedia.org/wiki/Khasi_Pine} 2012-04-04}

7.7.1 Botanic Description\footnote{World Agroforestry Centre, Pinus kesiya, 2009, \url{http://www.worldagroforestry.org/treedb2/AFTPDFS/Pinus_kesiya.pdf} 2012-04-04}

Benguet Pine can be as tall as 45m while the branches can be 15-20m with 100cm in diameter. These trees have thick bark.

7.7.2 Ecology\footnote{World Agroforestry Centre, Pinus kesiya, 2009, \url{http://www.worldagroforestry.org/treedb2/AFTPDFS/Pinus_kesiya.pdf} 2012-04-04}

These trees survive on steep slope and high elevation of the city. Benguet Pine inhabits extensive forest and grassy surroundings. These trees are natives in the area and dominant widely even in just disturbed part due to fire for instance. They grow largely in very seasonal settings.

7.7.3 Biophysical Limits\footnote{World Agroforestry Centre, Pinus kesiya, 2009, \url{http://www.worldagroforestry.org/treedb2/AFTPDFS/Pinus_kesiya.pdf} 2012-04-04}

The following Biophysical Limits apply to Benguet Pine

Altitude: 300-2700m
Mean annual rainfall: 700-1800mm and a pronounced dry season
Mean annual temperature: 17-22°

7.7.4 Timber Product\footnote{World Agroforestry Centre, Pinus kesiya, 2009, \url{http://www.worldagroforestry.org/treedb2/AFTPDFS/Pinus_kesiya.pdf} 2012-04-04}

The average density of Benguet Pine is 560 kg/m cubic with a moister content of 12%. Cutting this species is easy while still producing smooth and tight veneer. The thickness of the cut is also identical under only 50-70°. There is a minimum shrinkage, warping and mostly split-free while dehydrating these products. Patching and filling the imperfections of the product is done to achieve standard quality.

\footnote{World Agroforestry Centre, Pinus kesiya, 2009, \url{http://www.worldagroforestry.org/treedb2/AFTPDFS/Pinus_kesiya.pdf} 2012-04-04}

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7.7.5 Tree Management

Seedlings that are only 4-6 months old may already be planted with a spacing of 1-2m.

These trees are also used to shade coffee plantations and planted with 3x3m spacing. When these trees are already 4m tall, which happen in 5-7 years, plantation of young coffee is done.

Culturing like weeding is needed until the rising pine trees have completely outgrown the surrounding grasses. This is the case about three years after plantation. And weeding must be done four times a year.

7.7.6 Germplasm Management

Benguett Pine seedlings can be kept for several years but the storage must be dry, cold and sealed. 1000 seeds of Benguet Pine only weigh 16-18g.

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67 World Agroforestry Centre, *Pinus kesiya*, 2009, 

68 World Agroforestry Centre, *Pinus kesiya*, 2009, 
7.8 Current situation in Baguio City

7.8.1 Discussion with the DENR-Cordillera

According to the information on the website the following is valid for the department. “The Department of Environment and Natural Resources (DENR) is the primary government agency responsible for the sustainable development of the region’s natural resources and ecosystems. It is the catalyst of sustainable development having at its core, the promotion of human well-being.”

![Figure 81 Placard direction to DENR-CAR](image)

To acquire knowledge about the current situation of the Benguet Pine Forest and Benguet Pine timber production in the area DENR was visited.

The discussion was with Emiliano Casi a Forester for 28 years.

![Figure 82 Placard of DENR Forest Management Service](image)

There is now ongoing forest rejuvenation that could be the reason for the limitation of Benguet Pine timber production as building materials.

In Baguio city about 42,000ha have been replanted where 13,856ha is of regular reforestation with 81% rate of survival. While 16,835ha is of private and community agreement holders and 13,940ha is simply of reforestation contracts.

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70 Darren McPhaffey, *Deforestation and forest management in the Philippine provinces of Benguet and La Union*, 2004

A study of the Possibilities of Sustainable Building in Timber-in the City of Pines
7.8.2 Visit to local Timber Suppliers

Visit to two famous local timber suppliers were done. The first one was Benguet Lumber & Hardware located at 457 Magsaysay Ave., Baguio City. The other is U-Need Lumber address 70A Bonifacio St., Baguio City. Both suppliers did not have Benguet Pine available.

![Figure 83 Piles of timber at Benguet Lumber & Hardware](image)

![Figure 84 U-Need store abel](image)

7.8.3 Phone call inquiry to local Timber Suppliers

A call to Ay General Merchandising was made. According to the supplier Benguet Pine is not available. When asked why, proper answer wasn't really given.

A call to Agualde Construction Supply was made. This supplier doesn't have Benguet Pine available. What they offer are timbers from Tarlac City, which is ca. 125 km away from Baguio City.

A call to Irisan Construction Supplies & Aggregates was made. Benguet Pine is also not available here.

![Figure 85 Piles of timber at Benguet Lumber and Hardware](image)

![Figure 86 Piles of timber at Benguet Lumber and Hardware](image)
8 Result

The TAO Pilipinas and Habitat for Humanity are among the housing organizations in the Philippines that build sustainably. Neither of the enthusiasts has build with timber for the past years and currently has no plans of using timber as their construction material. Both see the restriction is caused by the cost of wood, scarcity as well as the log banning. Another perception is that cutting down trees itself is not environmental.

Philippine Green Building Council, which is the largest green building initiative in the Philippines, as of now doesn’t have any particular program or project that promotes timber as building material. Also, due to log banning, the use of timber framing especially of hardwood for structural element is very limited. The focus of concern for the council is the proper sourcing of the material.

Even a consultant firm that focuses on sustainable designs and ecologically sustainable development, Ecotecktonika, doesn’t design using timber as the main construction materials. The reason is the same; using timber is limited because of the log banning and the scarcity of the material.

Visit to two famous local timber suppliers and phone call inquiries to 3 other suppliers state that Benguet Pine, the most dominant timber species in the area, is not available.

Luzon Tropical Pine Forest, the forest of the area, is in critical and endangered conservation status. Regular fires and logging (illegal and legal) are the reasons for this. This is a nationwide issue. There is now an ongoing reforestation and forest rejuvenation in the area. 42,000 hectares have been planted within the jurisdiction of the city.

Sustainable Forest Management (SFM) is about providing for today as well as for tomorrow. In order for the forest to continuously supply the building industry timber, these forests must be managed appropriately and be taken care of.

It was apparent that massive timber constructions on concrete slab and pier foundations were the most common traditional sustainable building.
9 Conclusion

It has been conceded that building with timber is the most sustainable option. And when building with this material, it is important for the designs to be durable to the local conditions. To know and most especially for Baguio City to have a future possibility of building sustainably in timber, awareness of the current situation as well as the traditions are necessary. Acknowledging the present led to digging the past.

The Luzon Pine Forest or the Benguet Pine Forest has been misused and mistreated for decades. This happened not only in the forests of Baguio City but in most part of the country. There was a time when The Philippines was one of the leading timber exporters in South East Asia but sadly this was exploitation. The agreement between the government and tenure holders wasn’t followed. Even until today, kaingin/illegal logging is still a nation wide issue. Regular fire is also a major contributor to the forest destruction. Besides the unsustainable forest management and regular forest fires, natural calamities likewise aid the deforestation.

These concerns led us to the present situation. These forests are in critical and endangered conservation status. There is an ongoing log banning and reforestation. In Baguio City the focus is forest rejuvenation. The local programs are focused on replantation in the jurisdiction. These are the reasons why even the most dominant timber specie, Benguet Pine is not available at the local suppliers. These are also the reasons why timber is both scarce and of course expensive. That is why building with timber, as the construction material is very limited.

These deforestations happened for decades and even today these issues can’t be easily abolished. It will also take decades for these forests to regain its former glory. Hopefully government agencies, such as DENR as well as the national and international NGOs as FAO will succeed in their programs and missions. This is not unlikely to happen because programs such as CBFM have already showed promising results.

As green trend happens in our time, enthusiasts and also others will build using timber as their material of choice. This will increase the demand in production that will aid foresters to realize the importance of SFM (Sustainable Forest Management) not only for today but also for tomorrow. With the current knowledge of SFM and iron fist implementation hopefully past mistakes will no longer be repeated.

In The Philippines there is a notion that building with concrete is safer than building with timber. The building industries have been accustomed to concrete as their material of choice. The documented old timber houses in the city verify that building with timber can withstand earthquakes and hundreds of typhoons if properly engineered. Current and especially traditional sustainable
building in timber can aid this engineering. And also through the data gathered it is evident that knowledge in timber construction is available and functional.

The literature review and the documentation of existing buildings have shown the importance of proper fastening of elements to each other. If a building is erected with this in mind, the building becomes one huge element that is actually made out of walls, posts, roofs and foundations. When a building is made of timber, bracing is of special importance.

Building with the nature is the architectural strategy to build sustainably. Consideration of the surrounding is the key. To better save energy is to simply use the energy already provided by the nature, such as the sun and wind, and then adapt the designs with these in mind.

Studying the surrounding e.g. soil of the location as mentioned is essential. Available mitigation strategies and technologies must be applied to avoid disasters such as landslide.

The tradition of building with timber is the future. The objective is to increase awareness regarding sustainable building in timber in the city. But most importantly, motivate and encourage the building industries and the local government of Baguio to only build green.

The past has been studied and the present has been evaluated. The present availability of timber and designs evolved from events of the past. Mistakes done must not be repeated and acquired technologies must be applied. With an achieved Sustainable Benguet Pine Forest combined with the green architecture and durable structural designs future Sustainable Building in Timber in the city of Pines is possible.
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