

A THEORY OF NATURE ARCHITECTURE THROUGH INDIGENOUS
KNOWLEDGE: EVALUATION WITH POST-DISASTER BUILDING DESIGN

By

ChungTse Lin

Copyright © ChungTse Lin 2020

A Thesis Submitted to the Faculty of the
COLLEGE OF ARCHITECTURE, PLANNING AND LANDSCAPE ARCHITECTURE

For the Degree of

MASTER OF SCIENCE

ARCHITECTURE

EMERGING BUILDING TECHNOLOGIES

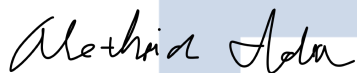
In the Graduate College

THE UNIVERSITY OF ARIZONA

2020

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Master's Committee, we certify that we have read the thesis prepared by ChungTse Lin, titled A Theory of Nature Architecture Through Indigenous Knowledge: Evaluation With Post-Disaster Building Design and recommend that it be accepted as fulfilling the dissertation requirement for the Master's Degree.



Aletheia Ida, PhD

Date: 07/14/2020



Christopher D Trumble

Date: 09/25/2020

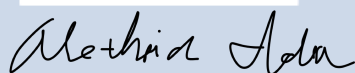


Clare M Robinson, PhD


Date: 07/15/2020

Final approval and acceptance of this thesis is contingent upon the candidate's submission of the final copies of the thesis to the Graduate College.

I hereby certify that I have read this thesis prepared under my direction and recommend that it be accepted as fulfilling the Master's requirement.



Aletheia Ida, PhD
Master's Thesis Committee Chair
Architecture Department

Date: 09/25/2020 

ARIZONA

ACKNOWLEDGEMENT

It has been an amazing journey not only for the Emerging building technologies program with Professor Ida but also for the Master of architecture in the first two years. I want to thank my wife, KuoWei Lee (李國瑋). We share our life, perspective, and knowledge. I cannot finish this flight without you. I also want to thank my professor, Dr. Aletheia Ida, your patient and intellection gave me the courage to seek my dream is something I will never forget. Finally, thank you to all my family members and friend who support me all the way. We are on the way to next adventure.

ChungTse Lin, October 9, 2020, In Alaska

TABLE OF CONTENTS

LIST OF FIGURES	5
ABSTRACT	7
1. CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW	9
1.1. BACKGROUND AND RESEARCH QUESTION	9
1.2. THE THEORIES OF ARCHITECTURE RELATED TO NATURE.....	10
1.2.1. <i>Sustainable Architecture</i>	11
1.2.2. <i>Ecological Building</i>	12
1.2.3. <i>Natural Building</i>	14
1.2.4. <i>Biomimetic Architecture</i>	15
1.3. THREE INDIGENOUS GROUPS IN DISTINCT CLIMATE REGIONS	16
1.3.1. <i>Kavalan People</i>	16
1.3.2. <i>Inuit People</i>	24
1.3.3. <i>Pueblo People</i>	29
2. CHAPTER THREE: RESEARCH.....	33
2.1. THE DEFINITION OF NATURE ARCHITECTURE.....	33
2.2. THE CONNECTION BETWEEN MODERN ARCHITECTURE AND NATURE.....	34
2.2.1. <i>The Relationship by Form</i>	34
2.2.2. <i>The Relationship by Material</i>	40
2.2.3. <i>The Relationship by Condition</i>	46
2.2.4. <i>The Relationship by Space</i>	47
2.3. THE CONNECTION BETWEEN INDIGENOUS DWELLINGS AND NATURE.....	50
2.3.1. <i>The Relationship by Form</i>	51
2.3.2. <i>The Relationship by Material</i>	58
2.3.3. <i>The Relationship by Condition</i>	64
2.3.4. <i>The Relationship by Space</i>	70
2.4. CONCLUSION	76
3. RESEARCH RESULT: NATURE ARCHITECTURE PARAMETERS	77
3.1. EVALUATION WITH POST-DISASTER BUILDING DESIGN.....	79
3.1.1. <i>The Type of Disasters</i>	79
3.1.2. <i>Post-Disaster Building Response</i>	80
3.1.3. <i>Application for Post-Disaster Building</i>	81
3.1.4. <i>Demonstration – Volcano eruption in Yilan</i>	83
3.1.5. <i>Demonstration – War happen in Anchorage</i>	84
3.1.6. <i>Demonstration – Tucson with virus and flood</i>	85
4. CHAPTER FOUR: CONCLUSION AND DISCUSSION	86
REFERENCES	87

LIST OF FIGURES

FIGURE 1. TAIPEI 101 DESIGNED BY CHU-YUAN LEE.....	11
FIGURE 2 PARKROYAL ON PICKERING BY WOHA.....	12
FIGURE 3 FALLINGWATER BY FRANK LLOYD WRIGHT	13
FIGURE 4 CUTE COB COTTAGE PROJECTS	14
FIGURE 5 LA SAGRADA FAMILIA BY ANTONI GAUDÍ.....	15
FIGURE 6 LOCATION OF KAVALAN	16
FIGURE 7 AVERAGE TEMPERATURE OF TAIWAN.....	17
FIGURE 8, KAVALAN WOMEN WITH TRADITIONAL CLOTH	18
FIGURE 9, CENTRAL NEWS AGENCY. KAVALAN OCEAN FESTIVAL	19
FIGURE 10 KAVALAN TIMELINE	20
FIGURE 11 RELATIONSHIP OF INUIT.....	24
FIGURE 12 INUIT LOCATION	25
FIGURE 13 SCULPTURE OF SEDNA BY AISA AUPALUKTUK.....	27
FIGURE 14 PUEBLO LOCATION	29
FIGURE 15 PUEBLO TIMELINE, DIAGRAM BY AUTHOR	31
FIGURE 16 PATRICK DOUGHERTY’S ART WORK IN HONOLULU MUSEUM	34
FIGURE 17 TOD’S STORE IN TOKYO BY TOYO ITO	35
FIGURE 18 KOKAGO INTERIOR AND COLUMN DETAIL.....	36
FIGURE 19 FAÇADE SYSTEM LEARNED FROM HIPPO’S SKIN	36
FIGURE 20 SOUTH FAÇADE OF BURTON BARR CENTRAL LIBRARY AND WILL BRUDER	38
FIGURE 21 NORTH FAÇADE OF BURTON BARR CENTRAL LIBRARY	38
FIGURE 22 SWISS RE BUILDING	39
FIGURE 23 KAMIKATZ PUBLIC HOUSE.....	40
FIGURE 24 EARTHSHIP	41
FIGURE 25 BAMBOO WING.....	43
FIGURE 26 BOSCO VERTICALE.....	45
FIGURE 27 HAUS STRAUB SENIOR FLOOR PLAN	48
FIGURE 28 TOPMOST EXECUTIVE DESK WITH THE SKYLIGHT	49
FIGURE 29 KAVALAN STILT HOUSE IN THE EARLIER PERIOD (LEFT) AND RENEW GROUND HOUSING IN PINGTUNG, TAIWAN.....	52
FIGURE 30 IGLOO	54
FIGURE 31 COMMUNION IGLOO.....	54
FIGURE 32 TERRACED CONSTRUCTION	55
FIGURE 33 PUEBLO BONITO	57
FIGURE 34 KIVAS	57
FIGURE 35 MATERIALS OF KAVALAN DWELLING	59
FIGURE 36 COW DRUGS ON THE EXTERIOR WALL.....	59
FIGURE 37 PROCESS OF IGLOO	60
FIGURE 38 IGLOO SECTION AND MATERIALS.....	61
FIGURE 39 THE FRAMEWORK OF QARMAQ MADE BY WHALE BONES	61
FIGURE 40 STONE MASONRY OF PUEBLO BONITO.....	63
FIGURE 41 STONE MASONRY AND WOOD FRAMES	63
FIGURE 42 ORIENTATIONS OF MAJOR CHACO CANYON BUILDINGS THAT RELATED WITH ASTRONOMY.....	65
FIGURE 43 SECTION OF PUEBLO DWELLING, SHOWING THE DARK ROOM AND HOW HEAT WAVE PASS THOUGH THE BUILDING ..	67
FIGURE 44 CLIFF DWELLING AVOID THE SUMMER HEAT BUT HAVE WINTER SUN.....	71
FIGURE 45 KAVALAN STILT HOUSE	73

FIGURE 46 KAVALAN DWELLING BUILD PROCESS	73
FIGURE 47 KAVALAN DWELLING FLOOR PLAN	74
FIGURE 48 PUEBLO BONITO PLAZAS.....	75
FIGURE 49 NATURE ARCHITECTURE ELEMENTS	77
FIGURE 50 NATURE ARCHITECTURE PARAMETERS	78
FIGURE 51 TYPE OF DISASTERS	79
FIGURE 52 NATURE ARCHITECTURE APPLICATION.....	82
FIGURE 53 DEMONSTRATION – VOLCANO ERUPTION IN YILAN	83
FIGURE 54 WAR HAPPEN IN ANCHORAGE	84
FIGURE 55 TUCSON WITH VIRUS AND FLOOD	85

ABSTRACT

Humans are continuously developing new technologies to transform buildings into comfortable fortresses that are not affected by the outdoor environment. But this modality of environmental control also makes architecture a barrier to the relationship between nature and humans. Although the topic of green architecture or sustainable building is becoming ever more prevalent, the focus tends to primarily be on physical impacts such as energy-reduction and carbon footprint minimization. However, the early and long-standing important relationship between humans and nature is not well considered through these contemporary sustainable architecture practices.

This research seeks to develop a built environment theory, identified as Nature Architecture, that focuses on establishing the relationship between humans and nature. This relationship has the capacity to bring humans back to natural systems and help situate human considerations, reflections, and actions for and with nature in the future. Nature Architecture is a metaphorical bridge connecting people directly with nature, rather than a barrier that isolates humans from nature due to technological developments.

In order to identify human and nature relationships in architecture, this research analyzes the indigenous architecture from three different geographic regions: Arizona, Alaska, and Taiwan. By comparing and contrasting ancient people's dwellings, which were built with early construction techniques, a symbiotic relationship between indigenous people and the balance of nature for thousands of years is identified. Fundamental defining characteristics are elicited from this symbiotic relationship,

including form, material, condition, and space. These foundational aspects are then applied to post-disaster architecture's conceptual design process with three demonstrations that show more connection with nature that improve psychological and physical health for refugees.

1. Chapter One: Introduction and Literature Review

1.1. Background and Research Question

After working in the architecture profession and beginning my career, I returned to academia determined to find my own theory about the relationship of nature and architecture. In my expectation, there's a great way to use technology to create architecture that connects with nature. From Wright's Falling Water to Glenn Murcutt's houses, I believe that environmental sustainability is one of the responsibilities of this generation for architects. My imagination for sustainable architecture is how to make humans connect back to nature by allowing the architecture not only be exclusive to humans, but also inclusive of the natural system. Those forms of architecture may not have some specific shape, appearances from our natural experiences, or the form may self-growth by time passes. But those forms should all have a meaning concept which expresses the desire for integration into nature. I doubt that many sustainable architectures only care about reducing energy consumption or reducing the impact on the environment, because the existence of the architectures itself has actually changed the environment, the habitat of animals and plants in this area has been destroyed because the architecture were built, so even though we reduce 90% of energy consumption, it still not as good as before. Therefore, I do my effort and concerned that the architecture can be integrated into the natural system part of the ecosphere, no matter a part of the architecture can become the habitat for plants and animals, or started produce resources for ecosphere, not only just the fortress to protects human as

before. I want to claim and proved that is more sustainable for our earth, and it will be the philosophy I want to fulfill in my entire life.

1.2. The Theories of Architecture related to Nature

The sustainable issue of architecture has become the standard when the new design processes. This thesis will arrange five types of architecture that use different approaches to make our nature better. This research will use sustainable architecture to collectively those architectural theories related to nature in the research section. However, because sustainable architecture is one of the five types, it will be named as sustainable architecture theory in the research section.

1.2.1. Sustainable Architecture

Sustainable architecture or green architecture is a kind of architectural design method to reduce the impact of buildings on the environment through various methods, including energy and material consumption control, water resources management, traffic assessment, and even indoor air quality.¹ Many countries have formulated different sustainable building regulations to reduce the impact, such as Leadership in Energy and Environmental Design (LEED) or German Sustainable Building Certificate (DGNB). Taking LEED as an example, the building determines the certification obtained by summing up the scores of different categories. Therefore, the building itself may not necessarily look related to nature, such as Taipei 101 (Fig. 1). People must use the scoreboard to understand the sustainability of these buildings.



Figure 1. Taipei 101 designed by Chu-Yuan Lee, (C.Y.Lee & Partners, <https://www.cylee.com/?lang=cn>)

¹ "The U.S. Green Building Council," <https://www.usgbc.org/>.

1.2.2. Ecological Building

Ecological building can be said to be another kind of sustainable architecture. However, in addition to the concept of reducing environmental impact in sustainable architecture, ecological building also focuses on increasing the benefits of the environment.² For example, sustainable architecture discusses how to reduce carbon emissions from buildings, but ecological building considers how to reduce carbon emissions in the atmosphere. Therefore, compared with sustainable architecture, the ecological building is a more active design method. Furthermore, that push ecological buildings must consider becoming part of the cycle of nature to maximize environmental benefits. As a result, most ecological buildings feel more "green" or related to nature for people (Fig. 2).



Figure 2 PARKROYAL on Pickering by WOHA, (WOHA, <https://www.woha.net/>)

² James Steele, *Ecological Architecture : A Critical History* (London: London : Thames & Hudson, 2005).

Organic Architecture

The concept of organic architecture was proposed by architect Frank Lloyd Wright. He believes that the architectural design should promote the balance between the natural environment and the building. Therefore, the building is regarded as an organism integrated with the environment, from furniture space to material appearance (Fig. 3).³ Under the influence of Frank Lloyd Wright, Hans Scharoun, Hugo Häring, Chen-Kuan Lee, and others had developed German organic architecture. They believe that architecture is an organism that has been grown according to people's daily life. It emphasizes that people are relying on the human spirit to grow the architecture, rather than people adapting to the architecture.⁴



Figure 3 Fallingwater by Frank Lloyd Wright, (author)

³ Frank Lloyd Wright, *In the Cause of Architecture, Frank Lloyd Wright : Essays*, ed. Andrew Devane and Frederick Albert Gutheim (New York: New York : Architectural Record, 1975).

⁴ Peter Blundell Jones, "Hugo Häring & the Search for a Responsive Architecture," *AA Files*, no. 13 (1986).

1.2.3. Natural Building

Natural building is a design method that focuses on local materials, hand-made construction, balance, imitating nature, and respect to nature. In other words, people need to choose local or recycled materials and build the building by hand without advanced technology.⁵ Each natural building will look different that represents the personality of the builder (Fig. 4). They believe that human can reconnect and respect nature through handmade process. Therefore, the most important thing about the natural building is not the development of architectural technology, but the return to nature with a simple life. Because of that, people need to either have time or budget to build a natural building.⁶



Figure 4 Cute Cob Cottage Projects, (Cob Cottage Company,
<https://www.cobcottage.com/galleries/cob-cob-cottage-complex-coquille-oregon>)

⁵ I. Evans et al., *The Hand-Sculpted House: A Philosophical and Practical Guide to Building a Cob Cottage* (Chelsea Green Publishing Company, 2002).

⁶ Ibid.

1.2.4. Biomimetic Architecture

Biomimetic architecture, or sometimes may call animal architecture is a philosophy that learning and analyzing from nature and reapply to architecture. People believe that most natural species' evolution provides the best resource for architecture, and those resources can make the building more sustainable and functional.⁷ Unlike natural building, which imitates the form of nature, biomimetic architecture focuses more on the system of nature, such as the nutrient transport or structure system of trees (Fig. 5). The logic or behavior of those systems may redesign as facade structures or other elements in the building. Therefore, biomimetic architecture may sometimes look natural, but most of the time, it only retains the logic of nature.⁸



Figure 5 La Sagrada Familia by Antoni Gaudí, (author)

⁷ Ingo Arndt, *Animal Architecture*, ed. Jürgen Tautz and Ingo Arndt, English-language edition ed. (New York, NY : Abrams, 2013).

⁸ Ilaria Mazzoleni, *Architecture Follows Nature : Biomimetic Principles for Innovative Design*, ed. Shauna Price (Boca Raton : CRC Press, 2013).

1.3. Three Indigenous Groups in Distinct Climate Regions

1.3.1. Kavalan People

Kavalan people are one of the Austronesian-speaking peoples and lived Yilan Plain in the east of Taiwan before 1878 (Fig. 6). They used to be confused and recognized as Ami but have been recognized as one of 16 indigenous groups since 2002.⁹ Kavalan.

Taiwan is an island with 13,974 mi² area in East Asia, another known name in the historical document is Formosa. Taiwan located on the Tropic of Cancer with marine tropical climate.

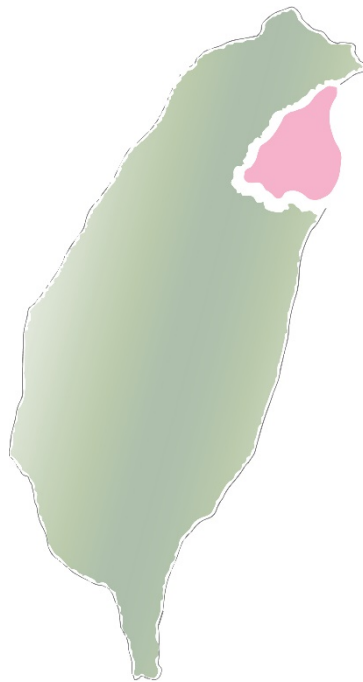


Figure 6 Location of Kavalan, (author)

The whole island separated by Central Mountain Range from North to South; the weather and culture have can be vast differences and hard to connected from west to

⁹ Shu-Hua Chen, *Kavalan*, Traditional Chinese ed. (Lanyang Museum, 2006).

east. Yilan Plain is on the east of Taiwan experiences hot and humid weather during the summer season, and the average humidity is 81.6% year-round. The average high temperature in the summertime is 90F, and the lower average is 77¹⁰ (Fig. 7). During the

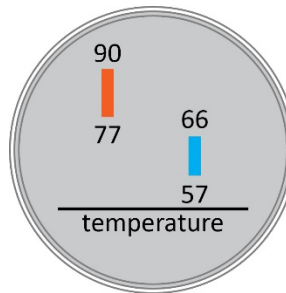


Figure 7 average temperature of Taiwan, (author)

winter season, the northeast monsoon impact Yilan Plain experiences steady rain most of the time, the proportion of rainfall up to 3,000 millimeters per year.

Yilan Plain area faced several natural disasters, including earthquakes, typhoon, and monsoons. The earthquake frequently happened on the whole island. According to the Taiwan Central Weather Bureau Seismological Center¹¹, Taiwan's average of about 26,686 earthquakes each year, of which about 965 times for felt earthquakes. The earthquake with magnitude 6 in Richter scale on average about 18 every ten years, magnitude 7 earthquake on average about 3 every ten years. Typhoon is another common natural disaster and brings a huge impact in Taiwan, especially in the east of Taiwan, usually the first landing place of the typhoon. The east of Taiwan be attacked around 4 typhoons average each year; the wind speed can move up to 51 m/s.¹² The

¹⁰ Taiwan Central Weather Bureau, "Weather," <https://www.cwb.gov.tw/eng/>.

¹¹ Ibid.

¹² Ibid.

typhoon not only brings the strong windstorm but also carries a huge amount of rainfall. Typhoon Herb carried 1748.5 millimeters in 24 hours in 1996. Because of the rainfall from the typhoon in summer and northeast monsoon in winter, at least 0.01 inches (0.25 mm) of precipitation falls on 210 days in an average year in the Yilan Plain area. In comparison, the average rainy days in Seattle each year is 150 days¹³.

The climate forcing ancient people live here need to adapt and respect nature. Kavalan people (Fig. 8) had been lived in Yilan Plain for at least a thousand years. They connected and gave respect to nature through their religion. Kavalan's traditional religion was animism before the Catholic introduced by the western missionary.¹⁴ They believed that each organism, such as animal and rock all have spirit. Each spirit can give



Figure 8, Kavalan women with traditional cloth.

(Mayaw, Paylang. Women of Kavalan. Wikipedia. Wikipedia, The Free Encyclopedia. Accessed May 14, 2020. https://zh.wikipedia.org/wiki/File:Women_of_Kebalan_2015062)

¹³ Weather & Climate, "Average Monthly Rainy Days in Seattle (Washington State)," <https://weather-and-climate.com/average-monthly-Rainy-days,seattle,United-States-of-America>.

¹⁴ "Kavalan People's Culture," <https://www.dmtip.gov.tw/web/page/detail?l1=2&l2=33&l3=400&l4=409>.

different protection and blessings to family members or property. “Sepaw tu lazing” as known as ocean festival (Fig. 9), is one of the significant worship festivals in Kavalan traditional religion, which is a path that Kavalan people pray for a bumper harvest and sailing safety.



Figure 9, Central News Agency. Kavalan Ocean Festival, (Central News Agency. Accessed May 14, 2020. <https://www.msn.com/zh-tw/news/other/%E6%9A%8C%E9%81%95%E8%BF%9190%E5%B9%B4-%E5%AE%9C%E8%98%AD%E5%99%B6%E7%91%AA%E8%98%AD%E6%97%8F%E9%87%8D%E7%8F%BE%E6%B5%B7%E7>)

The traditional festival always leads by mitu*(witch)¹⁵. The mitu is the representor of Goddess in Kavalan mythology, which is the religion center and arbiter in Kavalan society. The traditional Kavalan's social structure is a Matriarchal society. In their mythology, the female represents the rice and creator that feed and raise people, and the male represents lazy and poverty¹⁶. Furthermore, they connected female fertility and the sowing of rice together. This connection makes the framing become a holy duty

¹⁵ Chen, *Kavalan*.

¹⁶ Ibid.

and Exclusive for females, and the males are responding for protection around the field and hunting. The Kavalan society does not have a dominator for the whole community, but each tribe has their chieftain and elders. The chieftain and elders assumed by the older generation in the traditional Kavalan culture, the structure of tribe hierarchic by generation or age, each generation role different duty or department in the tribe.¹⁷

The Kavalan dwellings can be considered in four phases based on the shape and general influences of imported culture (Fig. 10). The first phase is Douth Formosa from 1624-1662, the second phase is Chinese Immigration from 1663-1894, the third phase is Japanese Taiwan from 1895-1945, and the last phase is R.O.C. Taiwan from 1945 until the present. In this thesis, the dwelling analysis of Kavalan will emphasize on the first

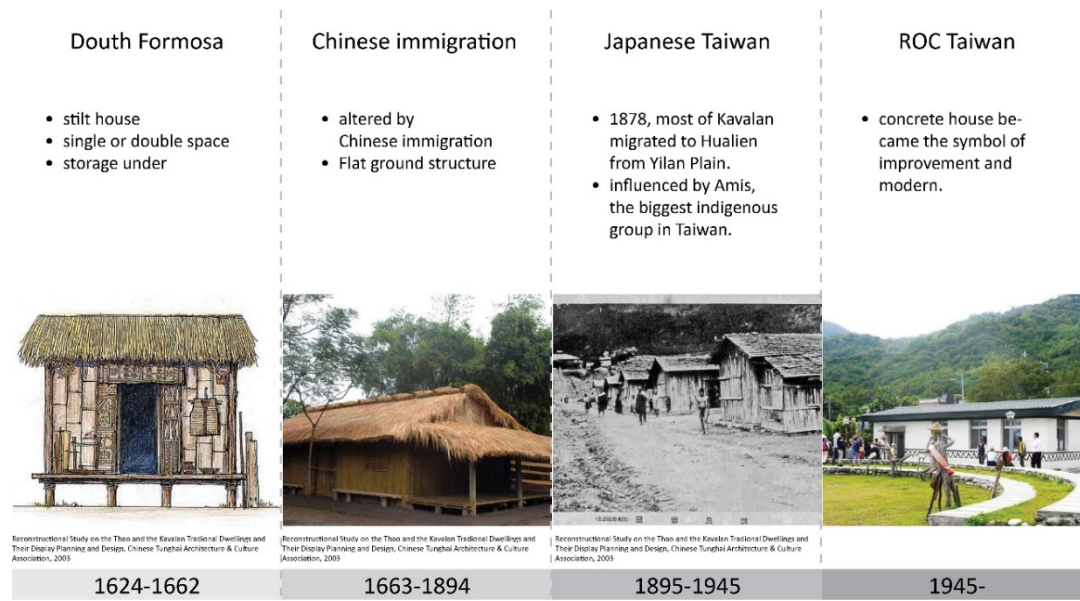


Figure 10 Kavalan timeline, (author)

¹⁷ Ibid.

and second phases, which are more related to Kavalan's original living environment and building materials.¹⁸

Douth Formosa

The Dutch East India Company established the first regime in Formosa, the previous name of Taiwan by Portuguese, to trade with China (Ming Empire) and Japan in 1624. The Dutch started from the south-west of Taiwan and progressively to the whole west of Taiwan in 38 years. Perhaps because of the imitation of the economy and human power, the Dutch did not force indigenous people to change their culture and living style. In addition, the Dutch had been documenting the culture, dwellings, clothes, and the social structure in different indigenous groups. One of the earlier documents that record the shape of indigenous dwellings in Taiwan is by the Dutch missionary, George Candidius. Based on this, I am assuming that the Kavalan dwelling in the Douth Formosa period can be considered the original dwelling they have since the recorded history¹⁹.

Chinese Immigration

After the Dutch defeated by Chinese General Koxinga and forced to leave Taiwan in 1662, The population of Chinese immigration started increased dramatically from around 30,000 to 200,000 in 20 years. More and more Chinese began to explore and occupied the difficult area such as east of Taiwan. That cause indigenous people to force the cultural impact, and lifestyle changed. According to George Leslie Mackay's book can

¹⁸ Huashan Guan, "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design," (Chinese Tunghai Architecture & Culture Association, 2003).

¹⁹ Wikipedia contributors, "Dutch Formosa (Traditional chinese Version)," *Wikipedia, The Free Encyclopedia* . https://en.wikipedia.org/w/index.php?title=Dutch_Formosa&oldid=957331402.

know that Kavalan dwelling had been influenced by Chinese immigration from rise-structure to damp mud floor dwelling. That cause the present Kavalan elder does not recognize the rise-structure dwelling as their traditional building, but the ground one, the Kavalan dwelling rebuilt project in 2011 also presents the style in this phase.²⁰

Japanese Taiwan

The Chinese immigration occupied and force the Kavalan people to move to another area after Karewan Incident in 1878.²¹ As a result, only a few Kavalans stayed in Yilan Plain; most of Kavalan moved to the south and lived close to Ami, the biggest indigenous group in Taiwan, and influenced each other.²² When the Japanese started governed Taiwan island in 1845, they recognize Kavalan as part of the Ami group. The record shows that the Japanese reformed Ami's dwelling with other materials and layout.²³ Based on this, it is highly likely that the Kavalan dwelling had been reformed by the Japanese also. On the other hand, the Kavalan that stay in Yilan Plain after 1878, have been converted into Chinese, did not recognize themselves as Kavalan until later.²⁴

R.O.C. Taiwan

The Government of the Republic of China retreated to Taiwan after lost the Chinese Civil War in 1949. After that, Taiwan has been pushed to a development country

²⁰ "Kingdom of Tungning (Traditional Chinese Version)," *Wikipedia, The Free Encyclopedia* . https://en.wikipedia.org/w/index.php?title=Kingdom_of_Tungning&oldid=957371288.

²¹ It was an incident that the Taiwanese indigenous Kavalan and Sakizaya united against the Qing Dynasty in 1878

²² Chen, *Kavalan*.

²³ Guan, "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design."

²⁴ Chen, *Kavalan*.

nowadays. As the technology improvement and earthquake precaution, the R.O.C. Government started to use concrete as a major material in the building industry. Most of the indigenous people include Kavalan adopt this change and begin to use concrete to build the house or move to the apartment. Nowadays, most of the houses in the Kavalan tribe or village are made of concrete or brick. However, some houses keep the same traditional.

1.3.2. Inuit People

This thesis is focusing on generalized Inuit dwellings as a research sample. Inuit is a group with the indigenous people who have a similar culture in the arctic area. Some articles called them Eskimo, but Inuit is just one of the main Eskimo group, another one is Yupik.²⁵ Eskimo has been a disputed word, and most of the official documents replaced Eskimo with other words, Inuit in Canada and Alaska Native in the USA²⁶. However, the Alaska Native does not include Inuit but Iñupiat. The Inuit are a group that includes Greenland Inuit, indigenous in Canada, and Iñupiat in Alaska. The Alaska Native includes Iñupiat, Yupik, and other indigenous groups in Alaska (Fig. 11).²⁷

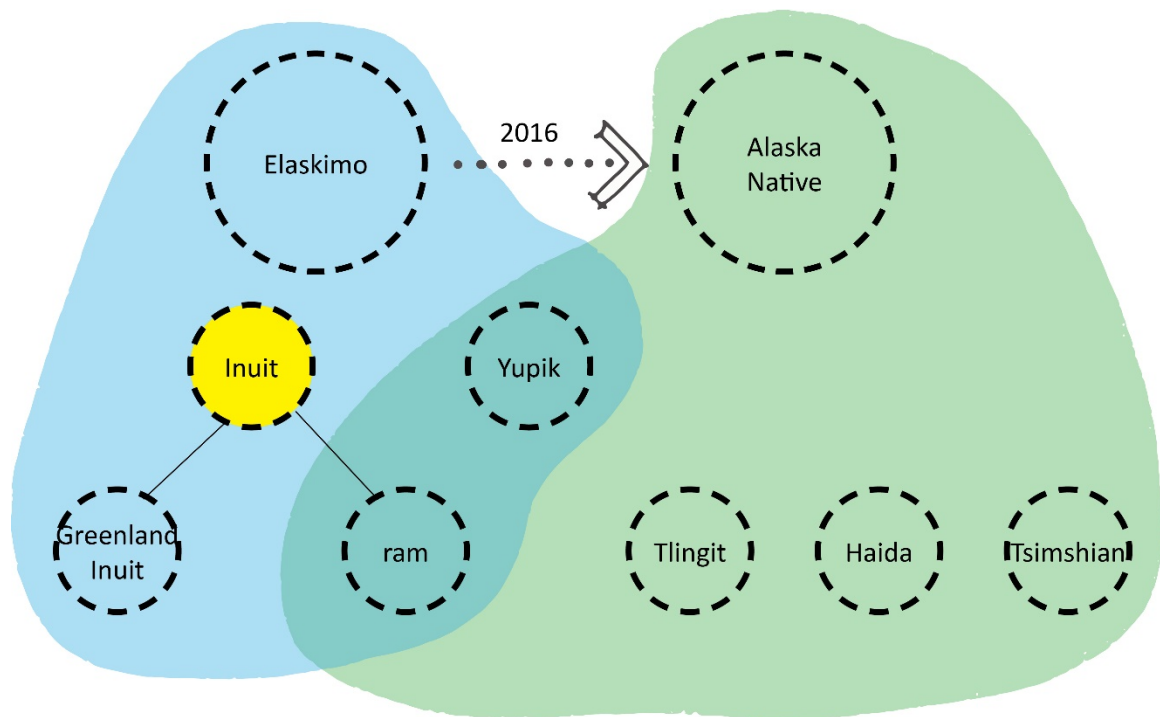


Figure 11 Relationship of Inuit, (author)

²⁵ Russell Tabbert, "The Names Eskimo, Inuit, and Inupiaq/Inupiat," *Names* 37, no. 1 (1989).

²⁶ President Barack Obama signed legislation, HR 4238, that replaced Eskimo with Alaska Native on May 20, 2016.

²⁷ Tabbert, "The Names Eskimo, Inuit, and Inupiaq/Inupiat."

Inuit have been inhabiting around the Arctic area of Alaska, Canada, and Greenland (Fig. 12). The weather in the Arctic area is extremely cold and low humidity. The average temperature in the Arctic area is -30F during the winter. The summer with an average temperature between 39F and 54F, it is as cold as in other places in winter.²⁸ The average humidity is close to 0% in several towns in the Arctic area. The humidity might increase a bit due to the water evaporated into the atmosphere by warm air in the summer. Nevertheless, with really low humidity because the surface temperatures are too low during winter.²⁹

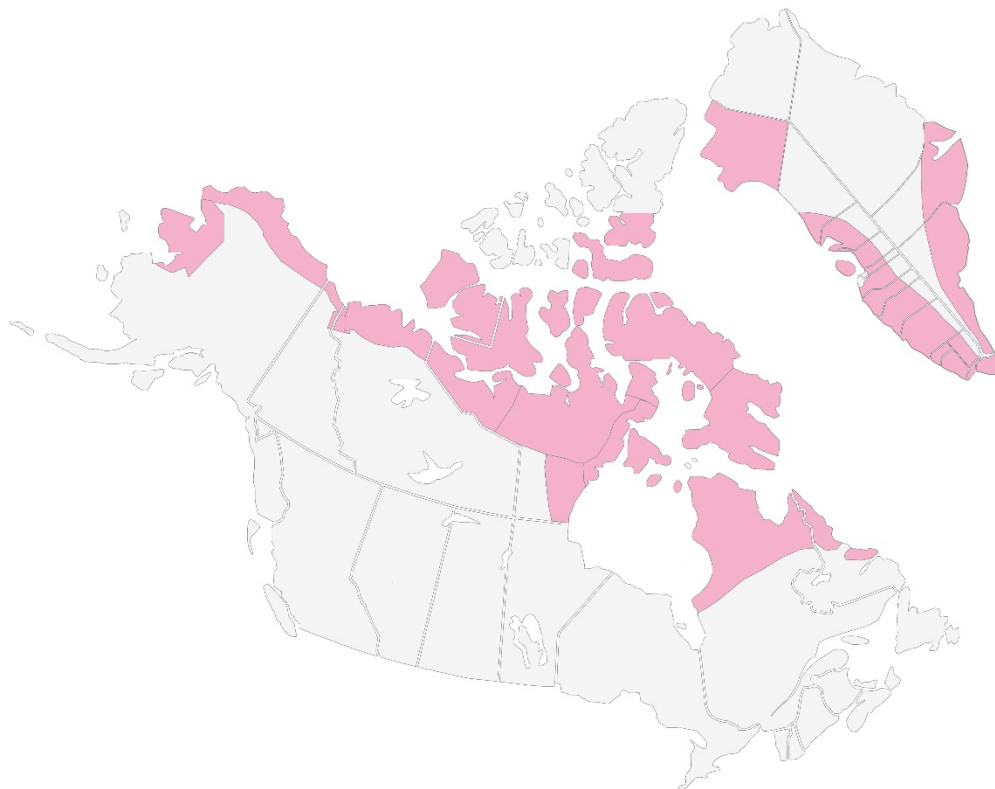


Figure 12 Inuit Location, (author)

²⁸ "Weather Spark," <https://weatherspark.com/>.

²⁹ Ibid.

The major disasters in the Arctic area are blizzard and strong winds. Although the winds usually light in the Arctic area, the speed of strong can up to hurricane strength. These strong winds will blow up the snow on the ground, causing obstruction of sight and increasing the wind chill factor. The earthquake issues in the Arctic area only happens between the North American Plate and Eurasian Plate, which was not the region that Inuit people live. Another phenomenon that happens in the Arctic area is not counting disaster but does cause difficulty to live, polar twilight, and polar day. The average polar twilight is two months from the middle of November to the middle of January in the Arctic area, and the average polar day is about three months from May to July.³⁰

Under this kind of extreme environment in the Arctic area, Inuit must respect nature to survive. Although there is no source of mythology to prove that the form of the dwelling is related to nature, the mythology and Inuit's beliefs explain how they connect to nature. Inuit of animism and shamanism believe there is a spirit of the natural world and these spiritual impact on everything in life.³¹ For example, the displeased spirits will cause bad weather, illnesses, or the lousy hunt. Inuit also believe that if spirits are honored and returned to sea, the spirit will reappear in another body and back to the world. Another belief in Inuit culture is Goddess Sedna (Fig. 13). In Inuit mythology, Sedna controls the ocean's resource and animal, where the source of Inuit

³⁰ Ibid.

³¹ *Amerindian Rebirth - Reincarnation Belief among North American Indians and Inuit*, (Toronto; Buffalo; London: University of Toronto Press, 1994).

food is found. They believe in making her happy that can continually get food from her.³²



Figure 13 Sculpture of Sedna by Aisa Aupaluktuk,
(La Fédération des Coopératives du Nouveau-Québec,
<http://www.virtualmuseum.ca/edu/ViewLoitDa.do?method=preview&lang=EN&id=10191>)

The social structure of the Inuit is based on the family, as known as Eskimo kinship or Inuit kinship, one of six major kinship systems in anthropology. Each Inuit family usually with five to six people³³; people who married will become another family. During the winter hunter, several families might become a hunting group, but separated during the summer. Because of the family core structure, Inuit people do not have leader or command hierarchy like other indigenous groups.³⁴ The experienced hunter might be

³² Ibid.

³³ Molly Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*, ed. Gregory A. Reinhardt (Fairbanks: Fairbanks : University of Alaska Press : University of Alaska Museum, 2003).

³⁴ Peter Nabokov, *Native American Architecture*, ed. Robert Easton (New York: New York : Oxford University Press, 1989).

respected and make some decisions, but disobedience will not get punishment. Besides, because of the limited resource and challenging environment, Inuit shared resources rather than have war between families.³⁵

Inuit are traditionally nomadic people. They migrated by the season and Hunting grounds. In addition to moving to places with resources when the season changes, they also move several times during the season. It can be moved more than six times a year on average.³⁶ Usually, this kind of movement has no specific destination, follow the natural resources and decide. Also, because they are willing to share each other's resources, there is no concept of exclusive hunting ground or territory. Because of the lifestyle of nomadic, their dwellings are easy to assemble and disassemble for reuse. However, as modern values influence the Inuit, most Inuit chose a permanent space to settle down.³⁷

³⁵ *Amerindian Rebirth - Reincarnation Belief among North American Indians and Inuit.*

³⁶ Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period.*

³⁷ Ibid.

1.3.3. Pueblo People

The "Pueblo" in this thesis is mean Ancestral Pueblo, the ancestor of modern Pueblo and lived in four corner regions from 7000 BCE to 1600, may also be called "Anasazi" in some previous research.³⁸ Pueblo can be considered the ancestor of the modern Pueblo and several modern indigenous groups such as Hopi.³⁹ They started from the Colorado Plateau area and moved to the southwest area later of time (Fig. 14). The elevation of Colorado Plateau can go up to 5,000 to 7,000 ft, and the general is

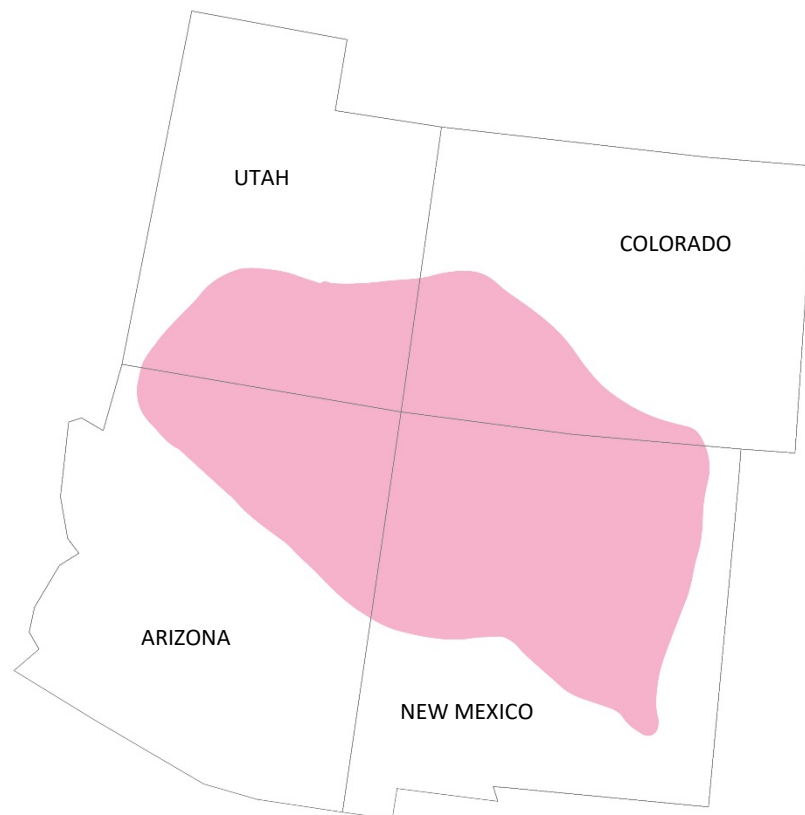


Figure 14 Pueblo Location, (author)

³⁸ *Chaco Revisited - New Research on the Prehistory of Chaco Canyon, New Mexico*, (TUCSON: University of Arizona Press, 2015).

³⁹ Andrew Munro and J. Malville, "Ancestors and the Sun: Astronomy, Architecture and Culture at Chaco Canyon," *International Astronomical Union. Proceedings of the International Astronomical Union* 7, no. S278 (2011).

ranging from 500 to 3,000 ft. Due to the high altitude, the climate is cold in the winter and hot in the summer. The summer also with temperature variation diurnal of up to 98 F in the daytime, but it drops to 50 F at night. The average summer temperature is from 62 F to 92 F, and 20 F to 41 F is the average winter temperature. The humidity in this region is about 1% to 5% depends on elevations and provinces. Furthermore, the average precipitation is about 20 annually.⁴⁰ The natural disasters in this region rarely happen, but those disasters such as wildfire and drought are speculated as one of the reasons that forced Pueblo migration.

Before being influenced by the Christianity of Western missionaries, the religion of Pueblo, like Kavalan and Eskimo, was Animism.⁴¹ Many religious stories discuss the relationship between people and nature. They believe that humans and nature must preserve harmony and respect for each different.⁴² However, another unique feature was that they combine the astronomy into their religion and life. Astronomical observations are essential not only for arranging the functional features of their lives, such as confirming the orientation of the building, but also determining the date and time of religious ceremonies.⁴³

⁴⁰ "Weather Spark."

⁴¹ Donna M. Glowacki, *Religious Transformation in the Late Pre-Hispanic Pueblo World*, vol. 9780816599721 (TUCSON: University of Arizona Press, 2012).

⁴² Ibid.

⁴³ R. Williamson, *Pueblo Ethnoastronomy* (2015).

On Archaeology, The Pueblo is generally considered into six developmental periods. The primary focus of this thesis will be on Pueblo I (750–950) to Pueblo IV (1300–1600), the section after the Pueblo people started building the house on the ground and before influenced by Western culture (Fig. 15).







Ancestral Pueblo (Anasazi)			
Pueblo I	Pueblo II	Pueblo III	Pueblo IV
			
			
Pithouse	Kivas	Cliff dwelling	
750-950	950-1150	1150-1300	1300-1600

Figure 15 Pueblo timeline, Diagram by author, Pueblo I, (Pueblo Indian History for Kids, https://www.crowcanyon.org/EducationProducts/pueblo_history_kids/introduction.asp, Pueblo II, Photograph by author, Pueblo III and IV, Photograph by National Park Service)

Pueblo I (750-950)

During Pueblo I, in addition to living in the underground pithouse, Pueblo also developed the building on the ground.⁴⁴ The houses in this period were usually one-story buildings and started to put astronomical observations in the building system. The entire community contains houses, pithouses, and plaza.⁴⁵

Pueblo II (950–1150)

⁴⁴ Stephen H. Lekson, *The Architecture of Chaco Canyon, New Mexico* (Salt Lake City: Salt Lake City : University of Utah Press, 2007).

⁴⁵ Ibid.

During this period, most people moved from the Mesa Verde region to Chaco Canyon due to the climate condition. They started developing the "Great House" that had larger rooms, more community buildings, and with multiple floors. Those Great Houses connected to the small villages or other Great Houses became the network system.⁴⁶ Furthermore, the pithouse evolved to "Kiva" and had more purpose rather than living only.⁴⁷

Pueblo III (1150–1300)

Pueblo III is also called the "Great Pueblo period".⁴⁸ People moved back to Mesa Verde and built the houses inside the natural cliff. Those cliff dwellings used the cliff as protection and had more floors to contain more people.⁴⁹

Pueblo IV (1300-1600)

During this period, Puebloans abandoned their original settlement and migrated to the south. General speculation is due to climate change or enemy factors. Furthermore, the limitation of stone in the south forced them to start using more adobe brick as material.⁵⁰

⁴⁶ Munro and Malville, "Ancestors and the Sun: Astronomy, Architecture and Culture at Chaco Canyon."

⁴⁷ Lekson, *The Architecture of Chaco Canyon, New Mexico*.

⁴⁸ *Chaco Revisited - New Research on the Prehistory of Chaco Canyon, New Mexico*.

⁴⁹ Ibid.

⁵⁰ Jesse Walter Fewkes, *Mesa Verde : Ancient Architecture : Selections from the Smithsonian Institution, Bureau of American Ethnology, Bulletins 41 and 51 from the Years 1909 and 1911*, Mesa Verde ; Antiquities of the Mesa Verde National Park, Cliff Palace (Albuquerque, NM: Albuquerque, NM : Arvayu Pub., 1999).

2. Chapter Three: Research

2.1. The Definition of Nature Architecture

Nature architecture maybe sounds familiar, but it does not have a clear definition yet. Different architects can have unique perspective on the relationship between nature and architecture. Kengo Kuma thinks nature architecture is the happiness relationship between nature and architecture. This happiness between nature and architecture not about look harmonious or beautiful, but the process of production.⁵¹ Toyo Ito believed that nature architecture is an extension of the relationship between humans and nature; people can feel the natural experience inside the building and get peace and relax.⁵² Some people may argue that sustainable architecture, organic architecture, or other similar concepts can describe the same theory. The difference is, nature architecture is the architectural design methodology that connects human and nature relationship on the premise of being part of nature. Furthermore, nature architecture is not only the conversation between nature and architecture but between nature, architecture, and human.

⁵¹ Kengo Kuma, *Natural Architecture* (自然な建築) (Iwanami Shoten, 2008).

⁵² Toyo Ito, *Architecture from That Day* (あの日からの建築) (Shueisha, 2012).

2.2. The Connection Between Modern Architecture and Nature

Though analyzing those modern architecture theories that related to nature, the relationship between nature and architecture can be classified into two ways, form and material.

2.2.1. The Relationship by Form

Imitating Nature

On the form design, some architects and artists borrowed the form from nature to make people feel reconnect with nature; they used natural materials, assimilate into the landscape, or designed the shape to look like some natural object. For example, Patrick Dougherty design designed a nest-like temporarily building (Fig. 16) in the Honolulu Museum of Art Spalding House in 2003.⁵³ Another approach is using natural shape but



Figure 16 Patrick Dougherty's art work in Honolulu museum,
(DOUGHERTY, PATRICK. Na Hale 'Eo Waiawi. n.d. Photograph. PATRICK DOUGHERTY.
<http://www.stickwork.net/featured.>)

⁵³ Alessandro Rocca, *Natural Architecture* (New York : Milan, Italy: New York : Princeton Architectural Press ; Milan, Italy : 22 Pub., 2007).

not imitating nature. The Tod's building (Fig. 17), for instance, demonstrates Toyo Ito uses the shape of Japanese elm, which be plan along the street, as the structural system



Figure 17 Tod's store in Tokyo by Toyo Ito.

(TOD'S Omotesando Building. Toyo Ito & Associates, Architects. Tokyo, n.d. http://www.toyo-ito.co.jp/WWW/Project_Descript/2000-/2000-p_13/2000-p_13_en.html.)

on the facade, to making people feel around the Japanese elm forest in the architecture.

The other way to "look like nature" is to analyze the behavior or rules of nature and apply it to ecological or biomimetic architecture. One of the examples is the project Kokaga, designed by Hirokazu Suemitsu.⁵⁴ He analyzed the tree circulation system and represented as the building structure and water harvesting system (Fig. 18). He created

⁵⁴ Hirokazu Suemitsu, *Architecture as a Part of Natural Circulation: Suet Book 1* (Taipei: Garden City, 2015).

Computational Analysis

Computational analysis is another method of form design that collects environment and climate data to drive the design direction. The data might include but not limited to wind direction, solar path, rainfall, and even the height of surrounding buildings. The architect uses those data to make the decision such as window opening, building direction, the shape of the exterior, or the material choosing. For example, in the case of the Burton Barr Central Library (1989-1995), Will Bruder used the solar path to set the building direction and windows opening.⁵⁶ In the Burton Barr Central Library, the main lighting opening of the building to the north and south (Fig. 20) to avoid the heat from east and west sunlight in the desert.⁵⁷ Furthermore, the firm also used computer analysis and simulation to configure and determine the length of the volume (Fig. 21) to prevent the morning and afternoon sun from entering the building through a northerly angle on the north windows.⁵⁸ This project has achieved several awards and LEED Silver certification in 2010.

⁵⁶ CAPLA USGBC Student Club tour, *Will Bruder And the Burton Barr Central Library*, 2/24/2019.

⁵⁷ Ibid.

⁵⁸ Ibid.



Figure 20 South façade of Burton Barr Central Library and Will Bruder. (author)



Figure 21 North façade of Burton Barr Central Library. (author)

Computational analysis can also calculate and simulate the wind flow of buildings to reduce energy consumption. The Swiss Re building in London (1997-2004) by Foster (Fig. 22) and Partners, for example, unlike the general straight buildings, the wind direction is biased toward the ground, causing people to feel uncomfortable.⁵⁹ This project uses computational fluid dynamics (CFD) that allows wind to flow smoothly around the high-rise building, thereby minimizing wind loads on the structure and cladding, and providing pedestrian comfort at the bottom of the building.⁶⁰



Figure 22 Swiss Re building. (author)

⁵⁹ Branko Kolarevic and Ali Malkawi, *Performative Architecture : Beyond Instrumentality* (New York : Spon Press, 2005).

⁶⁰ Ibid.

2.2.2. The Relationship by Material

Recycled Material

Materials are an indispensable part of architectural composition, and materials are also one of the methods for modern architecture to reflect on environmental issues. Some materials, such as concrete, are likely to cause environmental pollution during the manufacturing or discarding process. One of the solutions is to use recycled materials.

Hiroshi Nakamura designed a public house in Kamikatz (Fig. 23), and it used the recycled windows from the surrounding villages as the facade of the building. In addition to reducing the use of new materials and pollution of old materials, it also made the facade a part of the village people's memories of history.⁶¹ Furthermore,



Figure 23 Kamikatz Public House.

(Hiroshi Nakamura & NAP. [https://www.nakam.info/en/works/kamikatz-public-house/.](https://www.nakam.info/en/works/kamikatz-public-house/))

⁶¹ Hiroshi Nakamura & NAP, "Kamikatz Public House," [https://www.nakam.info/en/works/kamikatz-public-house/.](https://www.nakam.info/en/works/kamikatz-public-house/)

adaptive reuse in sustainable architecture is also a concept of using recycled materials. The production process of a sustainable building may cause more pollution than the entire building life cycle. Therefore, adaptive reuse can become one of the solutions that decrease materials usage and waste pollution. In addition to the use of materials in construction materials recycling, domestic waste can also be converted into construction materials. Architect Mike Reynolds used various domestic waste such as tires to become the building materials in his natural building, Earthship (Fig. 24). One the project Earthship, Mike Reynolds used tires, glass bottles, aluminum cans, and other domestic waste as building materials and stabilized with rammed and adobe bricks. The tires have significant sorption capacity for organic liquids and vapors, and the glass bottles can replace the glass and reflect different colors inside or outside the building.⁶²



Figure 24 Earthship.

(Arch2O.Com. <https://www.arch2o.com/earthship-homes-michael-reynolds/>.)

⁶² Khushboo Vyas, "Earthship Homes: Michael Reynolds," <https://www.arch2o.com/earthship-homes-michael-reynolds/>.

Sustainable Material

Another material connection that sustainable architecture will consider is the sustainable material. In the discussion of sustainable materials, the life cycle and reproducibility of materials are a significant concern. In addition to considering the impact of materials on the environment, the choice of materials must also consider the cost of the material production process and subsequent disposal. Therefore, the life cycle of materials should be one of seriously considered in sustainable materials. For example, Cross Laminated Timber (CLT) as a sustainable material⁶³ that used in many new sustainable architectures that can avoid the pollution and resource consumption of concrete manufacturing and showed the same structural strength and toughness.

Some people may think that natural materials that can include wood, stone, gravel, or other natural polymers can reduce the environmental impact and consider as sustainable materials. However, some natural materials are difficult to reuse or cause enormous environmental damage after being mined, such as soil and water conservation issues.⁶⁴ Wherefore, alternative natural materials, such as fast-growing bamboo or adobe brick, will be considered in sustainable architecture. One the other hand, the consideration of carbon footprint from shipment in sustainable materials also being the concern. In other words, the materials that ship from the other end of the earth to the site may not consider sustainable material due to the cost of carbon

⁶³ Mohammad Arif Kamal, *Sustainable Building Materials and Materials for Energy Efficiency : Special Topic Volume with Invited Peer Reviewed Papers Only* (Pfaffikon, Switzerland : Trans Tech Publications Ltd, 2015).

⁶⁴ Ibid.

footprint increases. The Vietnamese architect, Vo Trong Nghia, for instance, selects local bamboo in most of his projects as the main building material not only satisfied with the local environment but also reduce the carbon footprint of shipment (Fig. 25).



Figure 25 Bamboo Wing.

(Vo Trong Nghia Architects. Vinhphuc, n.d. <http://votrongnghia.com/projects/bamboo-wing/>.)

Biomaterial

Beside recycled material and sustainable material, the biomaterial is another solution that can improve the relationship between nature and architecture. The biomaterial has the characteristic of sustainability and versatility.⁶⁵ Some of them can be used to dehumidify or deduce the CO² in the atmosphere⁶⁶ that allows activity in architectural design to increase environmental benefits and become part of the ecosystem to change the destruction of the environment actively. The biomaterial not only ecological manner but also provide minimum transportation costs due to can be produced locally. For instance, TIS & Partners, a Japanese design firm, has developed a biomaterial call CO² sand brick⁶⁷ that to replace the concrete. CO² sand brick mainly composed of silicon dioxide, Carbon dioxide, and resin. It has stronger properties than concrete and can reduce the amount of CO² in the air, and because it is convenient to obtain materials, it can be manufactured in most places in the world. Similarly, consider reducing the CO² in the air; some architects use plants as building materials. Bosco Verticale (Fig. 26), an apartment project designed by Italian architect Stefano Boeri, be planting around 800 trees that providing an amount of vegetation equivalent to 30,000

⁶⁵ A. V. Yadav and S. B. Bhise, "Chitosan: A Potential Biomaterial Effective against Typhoid," *Current Science* 87, no. 9 (2004).

⁶⁶ Norihide Imagawa et al., "14030 Eco-Structural Design to Reduce Co₂ by Combining with Co₂ as New Joint (in Japanese)," *Architectural design announcement summary (建築デザイン発表梗概集)* 2011 (2011).

⁶⁷ Ibid.

square meters of woodland and undergrowth on the balconies.⁶⁸ Those trees become the Bio-envelope that will change by the time and adjust the humidity and ultraviolet.



Figure 26 Bosco Verticale. (Stefano Boeri Architetti. Milan, n.d.
<https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/>.)

⁶⁸ Stefano Boeri Architetti, "Stefano Boeri Architetti,"
<https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/>.

2.2.3. The Relationship by Condition

Environmental condition is one of the priority consideration and majority methodology in most of the sustainable architectures. Those environmental conditions can impact the orientation, shape, or material selection. For example, Burton Barr Central Library mentioned in the previous chapter was designed toward north and south and avoid the opening on east and west was because of the local environment.

However, contemporary architecture often sacrifices the appearance of the local environment for the style of the building. That not only affected the local ecology but also need to recreate the environment through landscape design after. Therefore, an architect proposed a design method that respects the original appearance of the local environment. In Hiroshi Nakamura's project, Dancing trees and Singing birds, his team tried to keep the trees as their original place in the site and let the shape of architecture follow the forest position. Besides, the team also used computer simulation to predict the growth of trees and the motion of wind blows to keep the space between architecture and nature.

2.2.4. The Relationship by Space

Spiritual Path

Besides the physical connections between nature and architecture through form and material, there is also the spiritual connections in space and condition. The goal of connections through space provides humans to feel natural. One of the examples is German organic architecture. German organic architecture developed by Hugo Häring who influenced by Frank Wright when he lectured in Germany.⁶⁹ Hugo Häring views architecture as the second skin of the human body, and spaces as human organs arranged in sequence according to different functions. These functional sequences are developed according to the user's lifestyle, and then the building facade grows with these functions. This organic architectural space reflects the natural arrangement and combination, rather than the arrangement of geometric forms.⁷⁰

Chen Kuen Lee, who worked with Hugo Häring, designed many residential works based on this theory, taking his Haus Straub Senior in Knittlingen, Germany, as an example. In this case, the fireplace is used as the core area of the family (Fig. 27). The kitchen, entrance, dining room, and living room form become a continually circular move path around the core area and connect the entire spaces;⁷¹ Those spaces have adjusted the size according to the environment and needs. This organic architecture

⁶⁹ Pei Jyun Ciou Chuan Wen Sun, *C. K. Lee and German Organic Architecture* (李承寬與德國有機建築) (GardenCity, 2008).

⁷⁰ Jones, "Hugo Häring & the Search for a Responsive Architecture."

⁷¹ Chuan Wen Sun, *C. K. Lee and German Organic Architecture* (李承寬與德國有機建築).

seems to have no direct connection with nature through space. However, it is closely related to people's natural development and makes the building echo their spirituality.⁷²

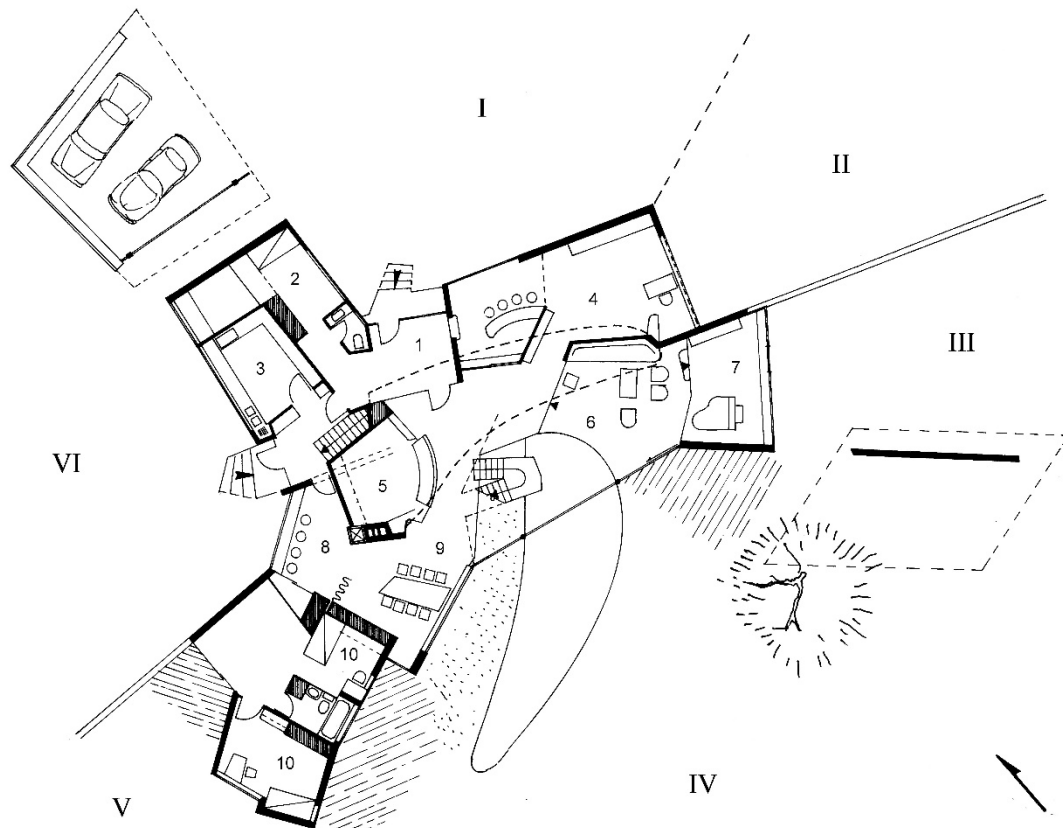


Figure 27 Haus Straub Senior Floor Plan.
(C.K.Lee. C. K. Lee and German Organic Architecture, GardenCity, 2008.)

Natural Experience

On the other hand, the natural feeling can also provide by representing the natural experience in the spaces. The Viipuri Library, designed by Alvar Aalto, designed the knowledge-seeking experience in the library as hiking.⁷³ In the Viipuri library circulation

⁷² Ibid.

⁷³ Sarah Menin, *Nature and Space : Aalto and Le Corbusier*, ed. Flora Samuel (London ; New York: London ; New York : Routledge, 2003).

design, Aalto kept the library collections along the entrance line and rose until the topmost executive desk with the skylight (Fig. 28) that represents the summit and the broad view. Furthermore, the route path can be returned to the first floor from the reading area beside the desk and start over.



Figure 28 Topmost executive desk with the skylight,
(Egor Rogalev, INRUSSIA, <http://inrussia.com/the-vyborg-library/>.)

2.3. The Connection Between Indigenous Dwellings and Nature

Francis Bacon's word, "nature being known, it may be master'd, managed and used in the services of human life." can be described as the relationship between humans and nature in modern society. In modern society, we apply "nature" as a value or label to architecture and sell it as a commodity. Some people are willing to implement sustainable architecture not because they are responsible for nature but can add values to business, or the government will give extra rewards. Under this relationship, humans and nature are in an unequal state in architecture. We continuously try to rule nature, change nature, and overcome the limitations of the natural environment to build various artificial facilities. However, this idea is constantly knocked down when we face natural disasters. Regardless of the direct or indirect causes, human activities are one of the causes of these natural disasters. The relationship between humans and nature should be reconsidered.

The relationship between humans and nature was not the case in the past. Conventional wisdom has it that indigenous people have a more appropriate relationship with nature. Their culture, economy, and spirit are deeply connected nature and developed rich knowledge of nature. When we look back at the indigenous people's religion and nature view, we can find that the indigenous people regard everything as spirit, and they are full of respect for nature. They consider themselves to be equal to other species in nature and believe that everything is given by nature, and they also must dedicate back to nature. Accordingly, they do not feel that they are the master of the world, but a part of the cycle of all things on earth. This relationship also preserved

in the indigenous dwellings. Because there is no support for modern equipment, the indigenous dwellings have developed a close connection not only in physical materials and form but also the spiritual space and condition. On the other hand, the indigenous dwellings growing like the biological genes had been adapting and evaluate with the environment over time. Otherwise, it is impossible to survive on the land without the support of modern equipment.

2.3.1. The Relationship by Form

The obvious connection between indigenous people and nature is through the form. The form of indigenous buildings usually reflected the local climate and social structure. The following compares the three regions of indigenous groups to develop different styles of buildings due to different climates.

Kavalan

The traditional Kavalan building shows north-south rectangular sloping roof stilt house (before around 1622) or ground building (after 1622) (Fig. 29).⁷⁴ Kavalan housing usually begins on one unite of building, including a living area and sleeping area. Some people may add more space to the south or north side for the kitchen or storage if needed. The average size of Kavalan dwelling is 27' x 14', the long side of the building built by four trusses, two for south and north façade, and the other two for the interior separate wall.⁷⁵ The distance of the short side of the building is based on the length of

⁷⁴ Guan, "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design."

⁷⁵ Ibid.

Phyllostachys makinoi Hay, one of the original bamboos in Taiwan, this type of bamboo can grow from 6m(19') to 16m(52'). The sloping roof usually has 30 degrees and not only easily anti-drain water but also reflect the wind direction. The wind direction of Yilan Plain is east wind for most of the time; therefore, the roof slopes in the east-west direction can ensure that the roof follows the windward side without being subject to too much wind pressure. Even Though the summer wind direction changes to the south wind and can make the building dry and cool but consider that most of the typhoons that prevail in summer are east winds or northeast winds. On the other hand, the style of the stilt house also developed by the moist and wet environment in Yilan Plain, but it has been turning to ground housing when the Chinese immigrants move to Yilan.⁷⁶

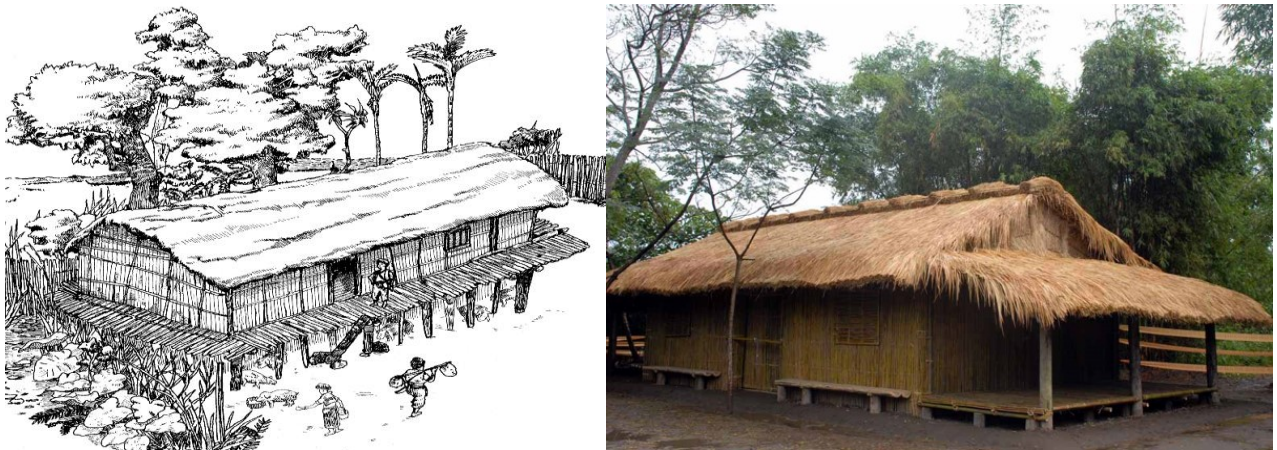


Figure 29 Kavalan Stilt house in the earlier period (left) and renew Ground housing in Pingtung, Taiwan. (A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design, Chinese Tunghai Architecture & Culture Association, 2003)

⁷⁶ Ibid.

Inuit

The traditional dwelling of Inuit people also reflects nature in the arctic region. Inuit's winter hunter house, igloo, presents the dome shape that can conform to the high wind speed snowstorm in the polar circle area compare with the square housing. The igloo was built by snow bricks and followed the particular direction, depending on different groups⁷⁷, and spirally built up. The entrance and exit are through a tunnel normally with 3'-5' high to reduce heat loss, and part of the igloo was be built half of the ground to increase warmth. The dome shape also provides an excellent structural system to ensure that it does not collapse. This structural system is strong enough to allow people to dance on the dome, which means that animals can be passed from above without breaking down. The igloos were also had windows made by ice brick to let the sun or moonlight into the interior. Holly states that "some sun- and moonlight penetrated the snowy dome and shone a bit more brightly through an ice pane over the doorway.....coupled with lamplight and the dome's reflective white interior, meant that seeing indoor was seldom a problem (Fig. 30)."⁷⁸ Besides, those windows should be placed in the same direction of the igloo and ventilation to avoid the snow covering from winds.⁷⁹ Because of the heavy wind and low temperature in the artic area, the polar circle is also different from the general village model. The winter village of Inuit

⁷⁷ According to Molly Lee "in Labrador, men built the principal dome spirally from east to west, or "as the sun goes down". Caribou Eskimos built their domes upward counterclockwise, but left-handed men followed the sun's path (clockwise)."Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*.P.41

⁷⁸ Ibid.

⁷⁹ Nabokov, *Native American Architecture*.

used tunnels to connect each igloo, representing a family, and the size of the hunting group determines the size of the entire village (Fig. 31). A large igloo is usually used as a public space to connect other residential igloos, and the big igloo can be a space for dancing, gathering, food, meeting.⁸⁰

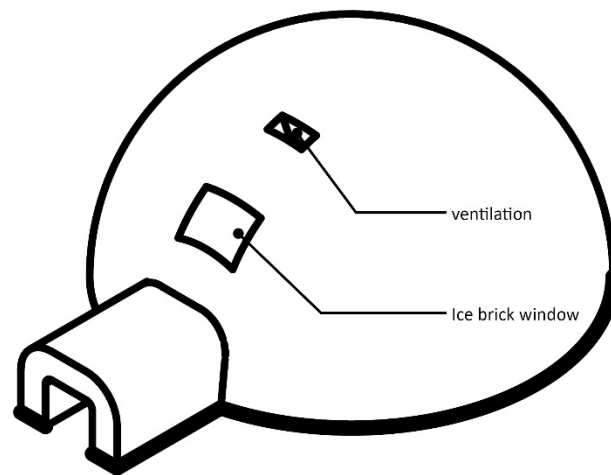


Figure 30 igloo, (author)

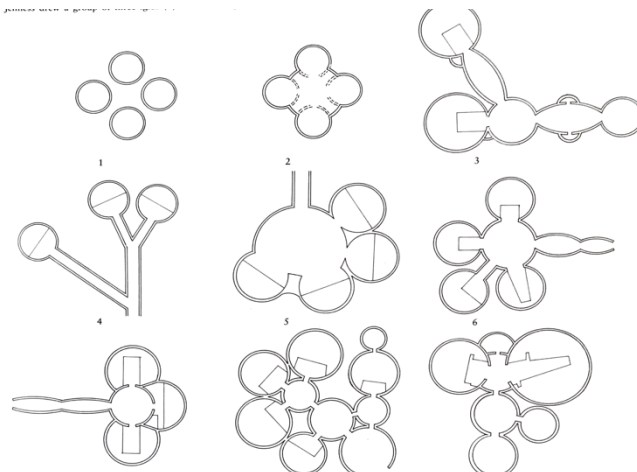


Figure 31 Communion igloo, (Peter Nabokov, Native American Architecture, ed. Robert Easton, New York : Oxford University Press, 1989)

⁸⁰ Ibid.

Pueblo

The form of Pueblo dwelling reflects the dry and heat climate of the Colorado Plateau. Compared with other places, the Colorado Plateau has no special disasters and only has a few wildfire and drought. Therefore, the only thing Pueblo people had to face was the heat. Under this condition, they do not need the sloping roof for water draining and dome to windproof but with the flat roof and developed the terraced construction similar like the modern apartment (Fig. 32). Therefore, unlike Kavalan and Inuit

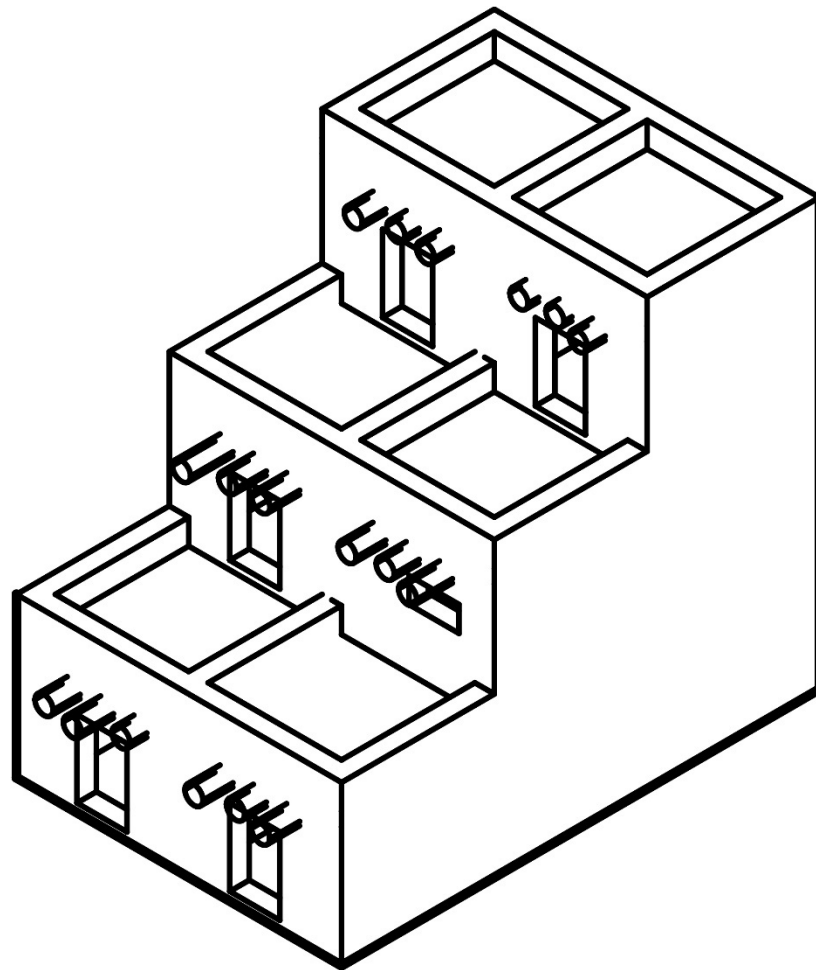


Figure 32 Terraced construction, (author)

dwelling can be viewed from the unit, the Pueblo dwellings were a combination of several units and other functional spaces (Fig. 33).⁸¹ In Chaco Canyon, the Pueblo dwellings can be considered separating to general residential and Great house, surmise for trading, or gathering. G. B. Cornucopia, Park ranger in Chaco Culture National Historical Park, said that the Chaco Canyon maybe was the Ancient Las Vegas, and the Great houses were the entertainment place, people came from the surrounding area to celebrate and trading.⁸² The Great house usually combined the terraced construction, plazas and kivas. The terraced construction was composed by rooms. The rooms can be connected to the front or up to become room suite based on the family or other relationships.⁸³

The terraced constructions were facing the plazas and surrounded it, and there are several kivas scattered in the whole community. Kivas is a space were originally square but gradually turned into a circle (Fig. 34).⁸⁴ The function of modern kivas is Pueblo now are used for male ceremonial associations.⁸⁵ But the function of ancient Kivas was inconclusive, and archaeologists speculated Kivas was for social and ceremonial purposes. The entire Pueblo Great house is a combination of the above. Even though the cliff dwellings during Pueblo III and the adobe construction in Pueblo IV also had

⁸¹ Lekson, *The Architecture of Chaco Canyon, New Mexico*.

⁸² Chaco Culture National Historical Park 4th Astronomy Festival, *Chaco Canyon History*, 9/22 2019.

⁸³ *The Architecture of Chaco Canyon, New Mexico*.

⁸⁴ Ibid.

⁸⁵ *Chaco Revisited - New Research on the Prehistory of Chaco Canyon, New Mexico*.

those elements. Therefore, it is difficult to observe the form of the building itself but must include the entire community.

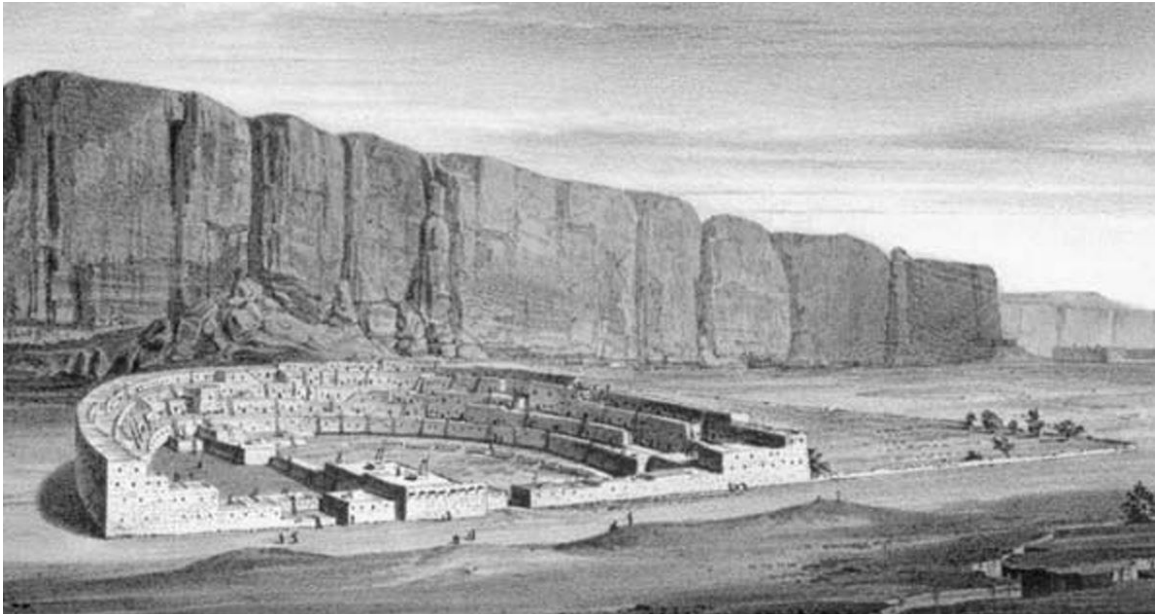


Figure 33 Pueblo Bonito, (William Henry Jackson, The Architecture of Chaco Canyon, University of Utah Press, 2007, P.128)



Figure 34 Kivas, (author)

2.3.2. The Relationship by Material

Another physical connection between nature and the indigenous people was materials. The materials on indigenous buildings without modern technology were obviously natural materials. Besides using the particular materials for construction, some material selection also used to make the housing more comfortable.

Kavalan

The materials that Kavalan buildings used including miscanthus, thatch, cow dung, rattan, and bamboo. Kavalan traditional dwellings selected bamboo as the structure material to build the framework then use rattan to fix. The miscanthus stems were bundled and mix thatch, mud, and water to make the wall and then assemble it with the bamboo framework (Fig. 35). Lastly, Kavalan had used cow dung as the finish material to avoid bug and adjust moisture (Fig. 36).⁸⁶ Some people might pick the driftwood during typhoon season and used that as the main structure or decoration on tribal chief's or elder's home.⁸⁷

⁸⁶ Chao Cheng Pan, "Kavalan Traditional Dwelling," (Youtube2017).

⁸⁷ Chen, *Kavalan*.

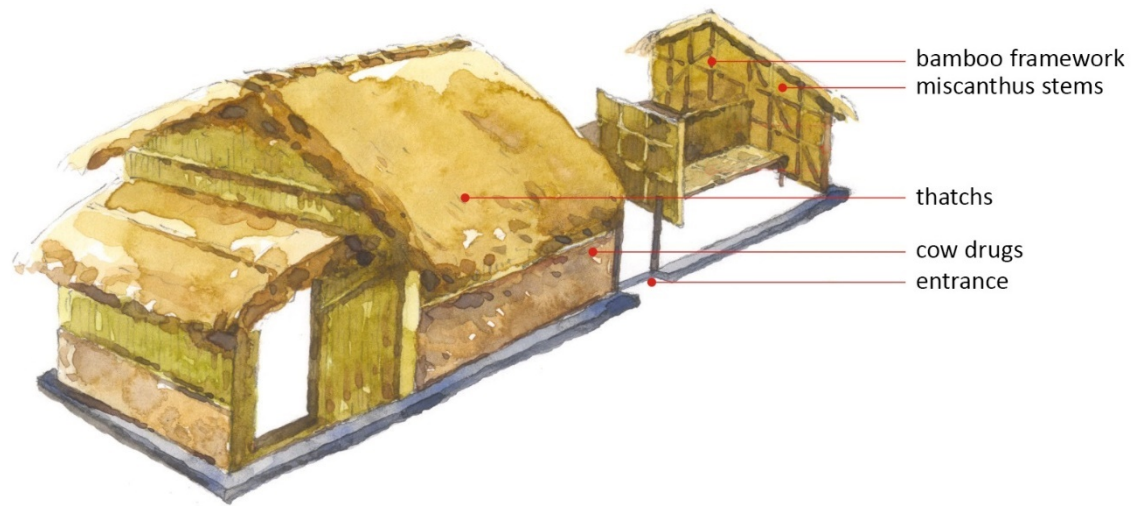


Figure 35 Materials of Kavalan dwelling, (Digital Museum of Taiwan Indigenous Peoples.
<https://www.dmtip.gov.tw/web/page/detail?l1=2&l2=61&l3=28&l4=138>.)



Figure 36 Cow Drugs on the Exterior Wall. (Luo, Xin Zhen. Liberty Time Net.
<https://news.ltn.com.tw/news/local/paper/540419>.)

Inuit

The igloo of the Inuit is arguably the most environmentally friendly material. They used snow, which might sound cold but a good insulating material, to build the house. Igloo's indoor temperature can be increased by the lamp, body heat, the animal skin, and the dome shape. Even if the outdoor temperature reaches -20°F to -50°F , the indoor temperature may still rise to 70°F or even 100°F .⁸⁸ To build an igloo, in addition to the hardness of the snow must be specially selected, special equipment must also be used. The construction process usually requires two men, one to cut the snow brick and the other to place it (Fig. 37).⁸⁹

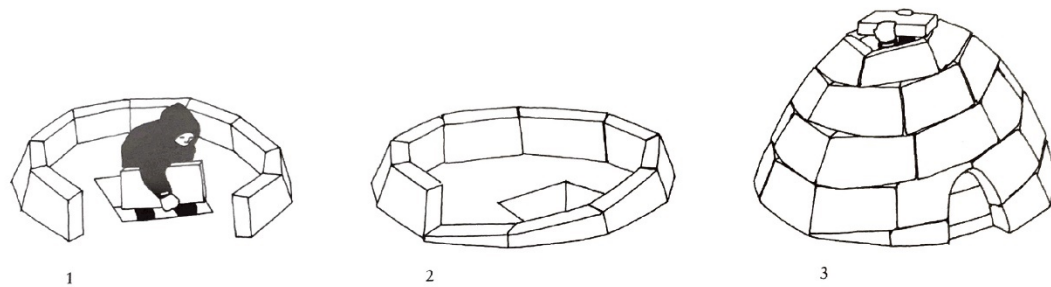


Figure 37 Process of Igloo, (Peter Nabokov, Native American Architecture, ed. Robert Easton, New York : Oxford University Press, 1989)

The whole process may take several hours, and then some Inuit were put animal skin on the interior wall and sleeping platform (about 5' higher from the ground) to keep warmer (Fig. 38). Besides the igloo, the summer tent and transitional dwelling, Qarmaq (Fig. 39), also used natural material. In the summer, Inuit lived in the tent made with

⁸⁸ Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*.

⁸⁹ Ibid.

animal skins and using driftwood as the support. Moreover, in the Qarmaq, whale bones and stone were the consideration of building materials.⁹⁰

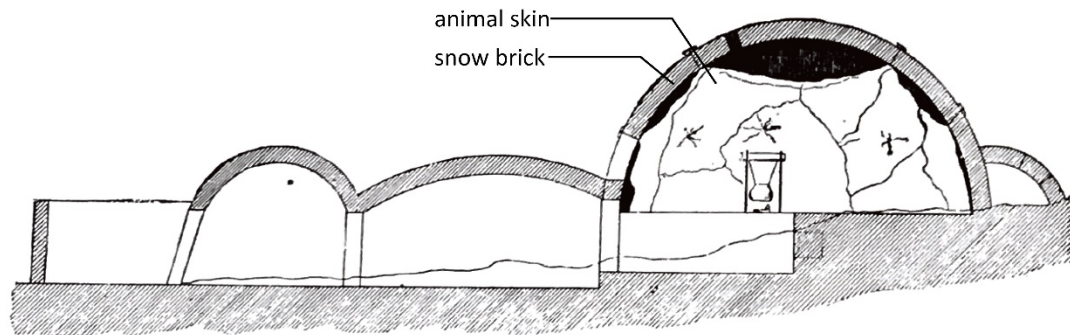


Figure 38 Igloo section and materials, (Peter Nabokov, Native American Architecture, ed. Robert Easton, New York : Oxford University Press, 1989)



Figure 39 The framework of Qarmaq made by whale bones,
(Ansgar Walk, Wikimedia Commons, the free media repository,
https://commons.wikimedia.org/w/index.php?title=File:Qarmaq_1_1997-08-02.jpg&oldid=151781877)

⁹⁰ Ibid.

Pueblo

The pueblo people used stone, adobe brick, and clay as the house infrastructure before Pueblo IV. In the Pueblo Bonito, the major material of great house was stone masonry and wood. The use of stone masonry (Fig. 40) for the construction mainstays and can build up to three floors. The benefits of stone are that it can increase the stability of the building and raises indoor coolness.⁹¹ The use of wood usually was beams or the support for the upper floor deck, and window and door frames. Due to the weather, some wood of beams and window frames still exists now (Fig. 41).

However, after Pueblo people move to New Mexico during Pueblo IV, the stone become difficult to found, so the major material became adobe brick and mud that also affects modern Pueblo dwelling. The adobe usually made pressing the mud mixture, which can be easy to find and process. Adobe has the load-bearing behavior and features of heat insulation that become suitable material in the dry heat area.⁹²

⁹¹ Lekson, *The Architecture of Chaco Canyon, New Mexico*.

⁹² Ibid.



Figure 40 Stone masonry of Pueblo Bonito, (author)



Figure 41 Stone masonry and wood frames, (author)

2.3.3. The Relationship by Condition

On the other hand, the spiritual interaction of the indigenous dwellings and nature can be found from the space and condition. The connection of conditions can consider in three, climate condition, environmental condition, and seasonal(time) condition.

Environmental condition

The first type is the environmental conditions. Indigenous dwellings often find that environmental conditions are used as the foundation for building development. Taking Pueblo people as an example, the master plan of Pueblo Bonito in Chaco Canyon is generated with the solar path, allowing the tangent of the building to follow the path, allowing direct interaction between light, shadow and the building (Fig. 42).⁹³ This connection described the function of recording time and allowed the appearance of the building to change with the environment.

This similar concept can be seen in the Kavalan culture. The Kavalan dwellings were placed to face the east, the direction of the Pacific Ocean, that can get the direct sunlight in the morning and consistent with the operation of nature. Moreover, the east orientation also means respect for the abiogenesis of Kavalan. Although the previous literature does not clarify the connection between culture and building orientation, but the evidence can get from the "Sepaw tu lazing" (ocean festival) and the methodology.⁹⁴ The methodology shows that the first Kavalan people were from East sea and registered

⁹³ Munro and Malville, "Ancestors and the Sun: Astronomy, Architecture and Culture at Chaco Canyon."

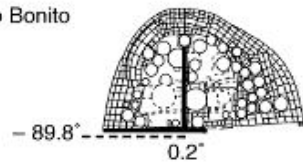
⁹⁴ Chen, *Kavalan*.

on the Yilan Plain, and "Sepaw tu lazing" (ocean festival) is one of the essential festivals in Kavalan culture. According to those reasons, it can argue that the east direction has another culture layer.

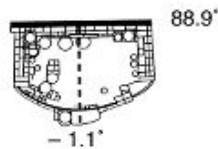
SOLAR ORIENTATIONS

Cardinal : $0^\circ, 90^\circ$ (meridian, equinox)

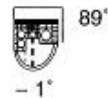
Pueblo Bonito



Pueblo Alto



Tsin Kletzin



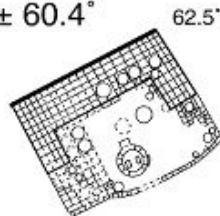
Equinox: $\pm 90^\circ/-85^\circ$ visible

Hungo Pavi



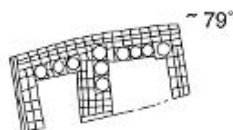
Solstice: $\pm 60.4^\circ$

Aztec



Other

Kin Bineola



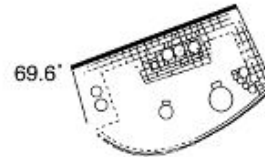
Wijiji



LUNAR ORIENTATIONS

Minor Standstill: $\pm 67.1^\circ$

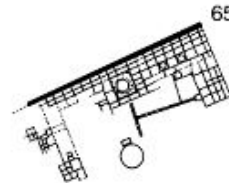
Chetro Ketl



Pueblo Pintado



Salmon Ruin



Pueblo del Arroyo



Kin Kletso



Major Standstill: $\pm 54.3^\circ$

Una Vida



Peñasco Blanco

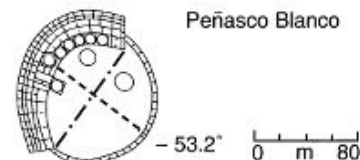


Figure 42 Orientations of major Chaco Canyon buildings that related with astronomy, (The Architecture of Chaco Canyon, University of Utah Press, 2007)

Climate condition

The second one is the connection with climatic conditions. Unlike environmental conditions, the climatic condition is a necessity and survival instinct to adjust the scheme of the building by observing the climate. The necessity is even more visible in the harsh arctic region. When Inuit people built their igloo during wintertime, they need to consider building and entrance orientation to match the climate condition. According to Molly Lee, "To avoid the dangers of snowdrifts the villages were situated out of the prevailing wind on east- or south-facing slopes."⁹⁵ the wrong orientation can damage the whole building. It is the same as the entrance orientation; the entrance of igloos needs to have 90 degrees turn either upwards or sideways to avoid strong blizzard direct into the building. Those solutions highlight the difficulties of the arctic climate.

On the contrary, Pueblo people need to face the temperature that can reach up to 100 degrees in summer. In response to such climatic conditions, Pueblo people created a south-facing stepped massing that can make the heat wave rising naturally through the facade in summer and still get the sun during winter (Fig. 43).⁹⁶ Moreover, the stepped massing also created the dark rooms in the deep of the building. Those dark rooms not only avoid the crops exposed to the direct sun but maybe become the cold space for people during summer. On the other hand, the island climate cause Kavalan people developed rise-structure building to avoid moisture and pests, and some of the Kavalan tribe may also choose to hide in the forest that depends on the mountains. By

⁹⁵ Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*.

⁹⁶ Nabokov, *Native American Architecture*.

inference, the forest has the defensive function and can also be used as a windbreak to weaken the typhoon during summer.⁹⁷

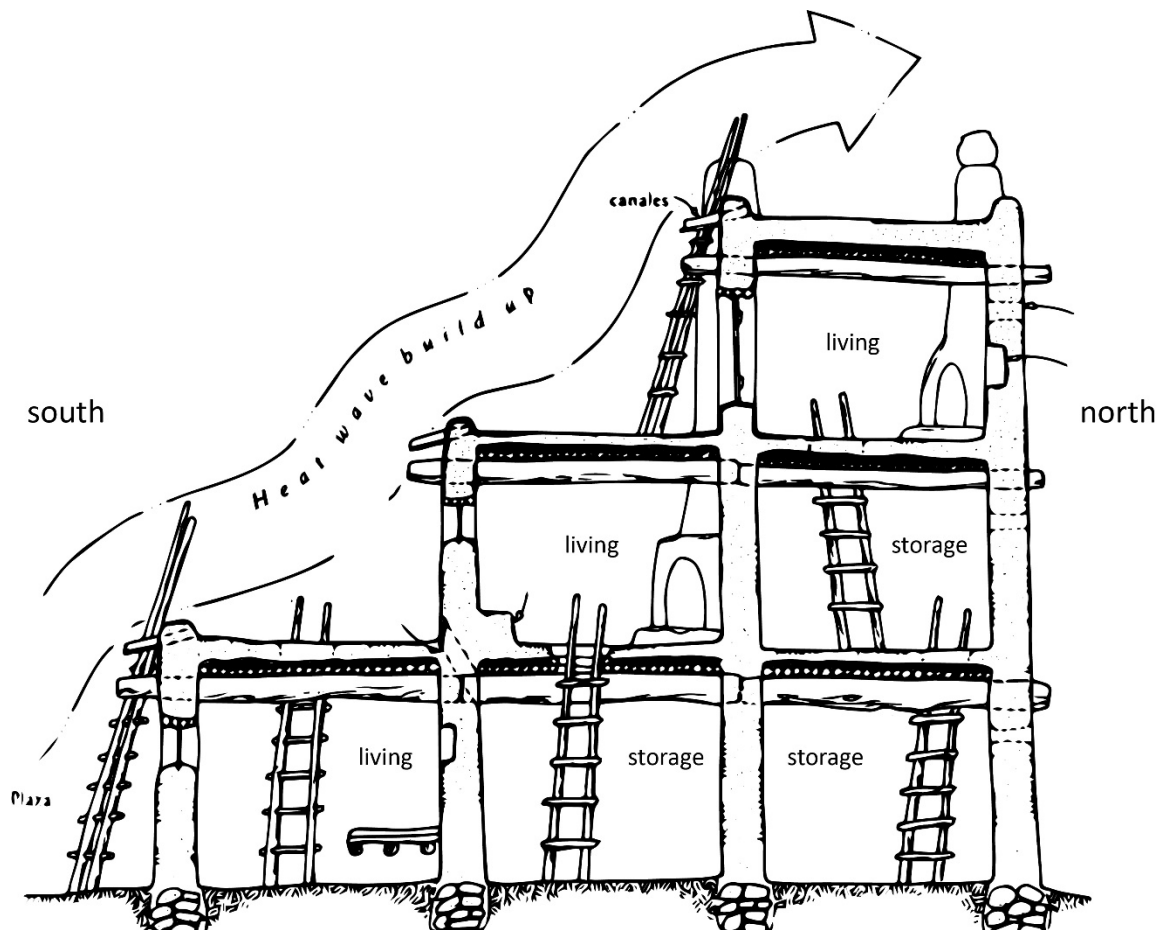


Figure 43 Section of Pueblo dwelling, showing the dark room and how heat wave pass though the building, (Native American Architecture, New York, 1989)

⁹⁷ Guan, "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design."

Seasonal(time) condition

Another connection is to make adjustments based on seasonal conditions. In the era of indigenous life, the building's appearance may need to adjust by the season and time because of the limitation of the technology. Therefore, the mobility and reusability of the building become essential.

The best example is probably the Inuit's dwellings. Consider the season condition wild difference between summer and winter in the arctic region; the Inuit dwelling has three types of adjusting the seasonal condition. During the summer, most Inuit used the tent as their primary building system and became a large village that gathers people from different areas.⁹⁸ The tent can easily transport and have a friendly ventilation system. When the winter is coming, the Inuit separated into small groups and moved to igloos. The igloo size may adjust each time depends on the size of the group and the number of people. As the winter hunter house, the igloo appeared by the time when the snow comes to earth. Conversely, the igloo will back to the earth when the spring is coming.

Between the summer and winter, Inuit people stayed in transitional dwelling call Qarmaq. Molly Lee states, "transitional houses called qarmaq.....once the chill drove them from tents but before snow had formed drifts deep enough for them to make

⁹⁸ Lee, *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*.

snow houses."⁹⁹ Because of frequent migration and changes, the building form may have different appearance every time.

Kavalan people also have the custom of relocating the village. The seasonal condition may be the main reason that forces Kavalan to migrate frequently. The possible inference is the fallow fields. According to Chen "Chinese people believed that the Kavalan did not know how to farm. In fact, they used the method of nomadic farming to recuperate the land."¹⁰⁰ Although Kavalan people may not understand the reason of fallow fields, they respect the phenomenon that nature appears. Therefore, they probably relocated the village when the field becomes barren, and that not only fallow fields but also connect the natural cycle and Kavalan people. Under this condition, both the Kavalan and Inuit dwellings exhibited rapid dismantling, reorganization, and material reuse.

⁹⁹ Ibid.

¹⁰⁰ Chen, *Kavalan*.

2.3.4. The Relationship by Space

In terms of space, the space and layout in indigenous dwellings cannot be compared with modern architecture due to the technology and materials limitedly. However, the development of building space is closely related to nature in the indigenous culture based on the belief of part of nature. Those connections can be divided into three types, borrow space with nature, reserve space for nature, and space extension.

Borrow space with nature

Borrow space with nature is not only a cultural concept but also applies to architectural practices. In Kavalan culture, people believed that the land belongs to the ancestor spirit of nature. Therefore, when planning the new building or village relocation, the ceremony that communicates with ancestor and nature to clear that they are borrowing the land but not robbery is necessary and important.¹⁰¹ On the other hand, Pueblo people borrow the natural space to become the shelter and barrier and merge with their stepped massing naturally. The cliff dwelling start appeared in the Pueblo history during the Pueblo 3 period. Pueblo built their village inside the natural cliff space on the Colorado Plateau. Fewkes record that "stand in a recess protected above by an overhanging cliff. its form is crescentic following that of the cave and extending approximately north and south."¹⁰² The natural cliff provides a defensive

¹⁰¹ Pan, "Kavalan Traditional Dwelling."

¹⁰² Fewkes, *Mesa Verde : Ancient Architecture : Selections from the Smithsonian Institution, Bureau of American Ethnology, Bulletins 41 and 51 from the Years 1909 and 1911.*

feature for Pueblo people from animals or other indigenous groups and the temperature control feature. From the section of Cliff Palace can see the overhanging cliff blocked the summer heat to the village, but the winter sun with a lower angle can shine in (Fig. 44). People living the Cliff Palace can avoid the heat from summer but get the warm in the winter. Ultimately, Pueblo people physically borrow the space from nature as part of their dwelling system, and Kavalan people psychologically recognize that their space is borrowed from nature.



Figure 44 Cliff dwelling avoid the summer heat but have winter sun, (National Park Service, <https://www.nps.gov/meve/index.htm>, Drawing original from Native American Architecture, New York, 1989, Redrawing by author)

Reserve space for nature

Besides, without the ability to resist nature, indigenous people have reserve space for nature. For instance, Kavalan's stilt house may not only design for moisture but also create the space for water. Researchers have long assumed that the stilt house was used to avoid moisture and pests. For instance, one eminent scholar of architecture, Huashan Guan, assumed that in his research report.¹⁰³ Nevertheless, compared with other indigenous dwellings in Taiwan, Amis, as an example, also living in the east of Taiwan with a similar climate condition but did not develop the stilt house system but the general flat building on the ground in their traditional houses.¹⁰⁴ On the other hand, according to the history of climate in the Central Weather Bureau in Taiwan, Yilan Plain regularly have flood issues, the maybe is the main reason that Kavalan developed the stilt house. During the flooding, the stilt house can avoid the water directly into the building (Fig. 45); moreover, the space under the building can become storage or allow the animals to cross by. Stilt houses can also be built in many southeast Asian countries, which also have a huge flooding issue or living close to the river. In short, Kavalan's stilt house not only design for the moisture but also for reserve space for nature. The consideration of Kavalan may not be about sharing space for nature, but the result shows that it achieves a balance between architecture and nature.

¹⁰³ Guan, "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design."

¹⁰⁴ "Digital Museum of Taiwan Indigenous Peoples."

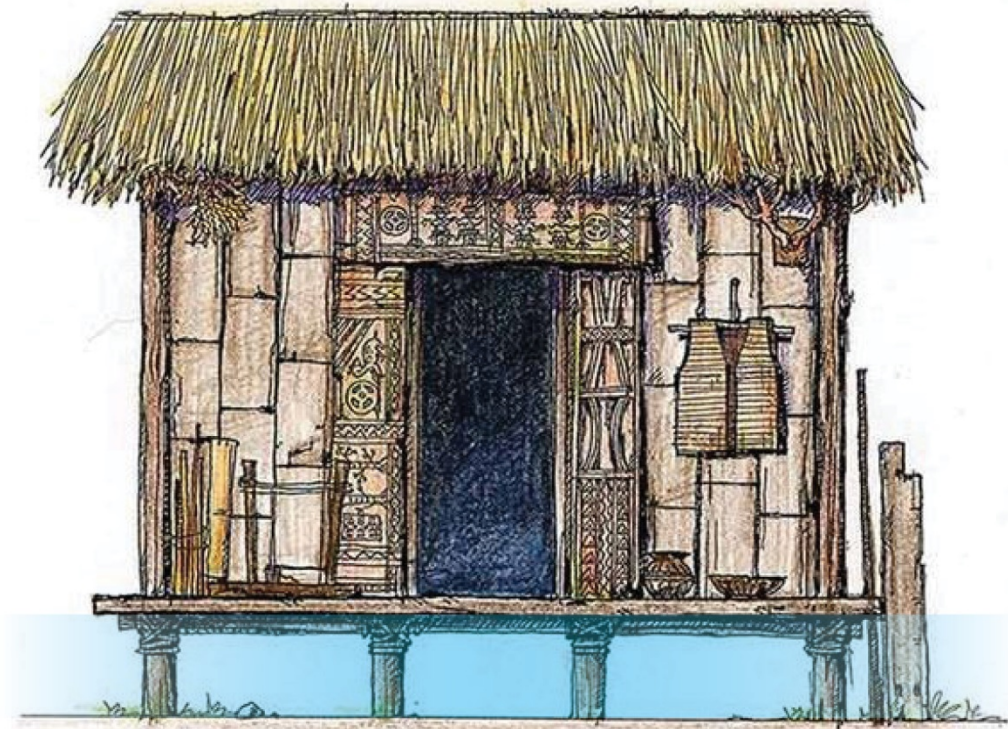


Figure 45 Kavalan stilt house, (A Reconstructional Study on the Thao and the Kavalan Traditional Dwellings and Their Display Planning and Design, Taichung, 2003)

Space extension

The last connection is space extension. Space extension may sound like borrow from nature. However, the difference is that borrowing from nature takes the feature of nature and becomes part of the functional element in the building. However, space extension is to see nature as an additional space of the building (Fig. 46). In traditional Kavalan buildings, nature became the space of the kitchen, toilet, bathroom, and

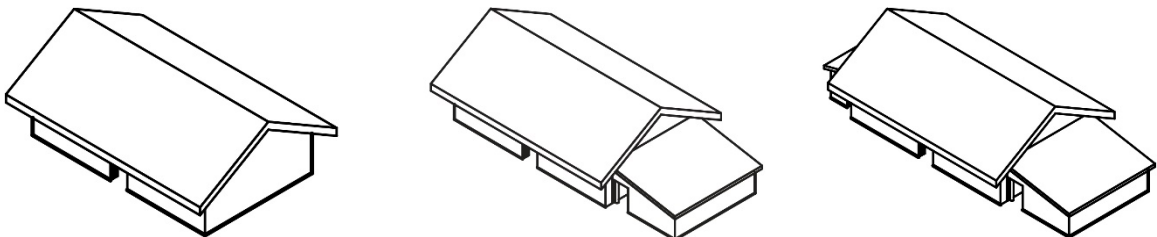


Figure 46 Kavalan dwelling build process, (author)

religion area. From the floor plan of traditional Kavalan dwelling (Fig. 47), the main space for living and sleeping usually were being built at first, and the kitchen and storage became added later when having enough resources. Therefore, Kavalan people usually cooked outside before the kitchen be built. Even though the additional be built, there is no indoor connection between the main structure and additional; people have to go through nature to the kitchen or storage every time. The possible factor is that the architecture technology in that period did not allow them to make additional opening after building built. On the other hand, because of limited space and lack of sewage systems, Kavalan's sanitary and religious space also extends to nature. On the religious part, besides the "palilin", the worship of ancestor, went on in the building, other festivals like "Sepaw tu lazing" hold by the ocean and "Gataban" located on the plaza of the village are all extends to natural space. These spaces increase the connection between nature and humans not only happened on Kavalan but also can found on Pueblo dwellings.

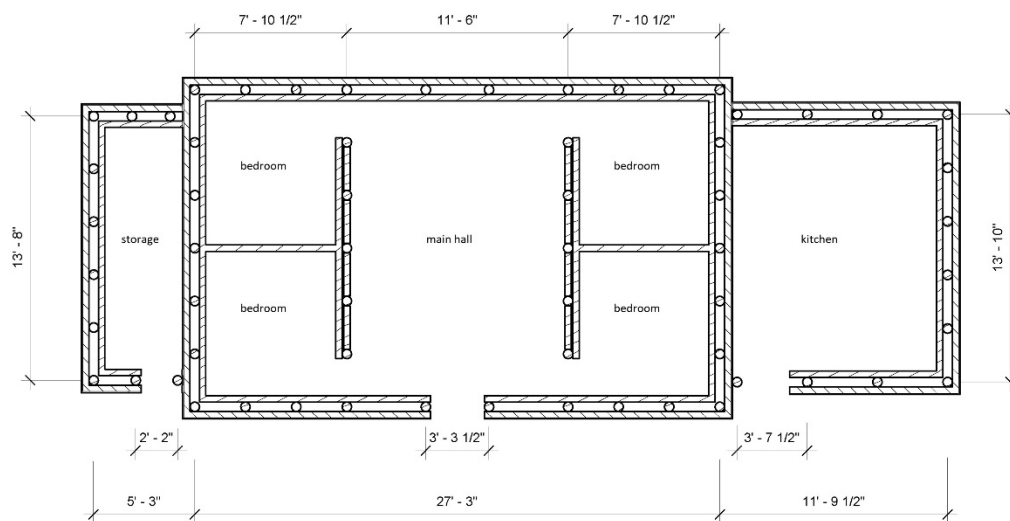


Figure 47 Kavalan dwelling floor plan, (author)

In Pueblo dwellings, Pueblo Bonito, as an example, developed balcony terraces and plazas that extend spaces to nature. The plazas in Pueblo Bonito were enveloped by the Kivas and building around. Even though the function of plazas is unknown, but the speculation might be for quotidian, such as corn husking, or ritual place for ceremonies. Furthermore, the well-know terraced construction of Pueblo was designed by facing the plaza (Fig. 48). Usually, the terraces were created by the plaza-facing massing, with one story massing and two stories massing behind from front to rear. That created a centralized point to the plaza and showed the evidence that Pueblo might use the terrace as a platform or observation for ceremonies and communion. Both the plazas and the terraces show the Pueblo extend the natural space that plays an essential role in their lives rather than relaxes or gardening.

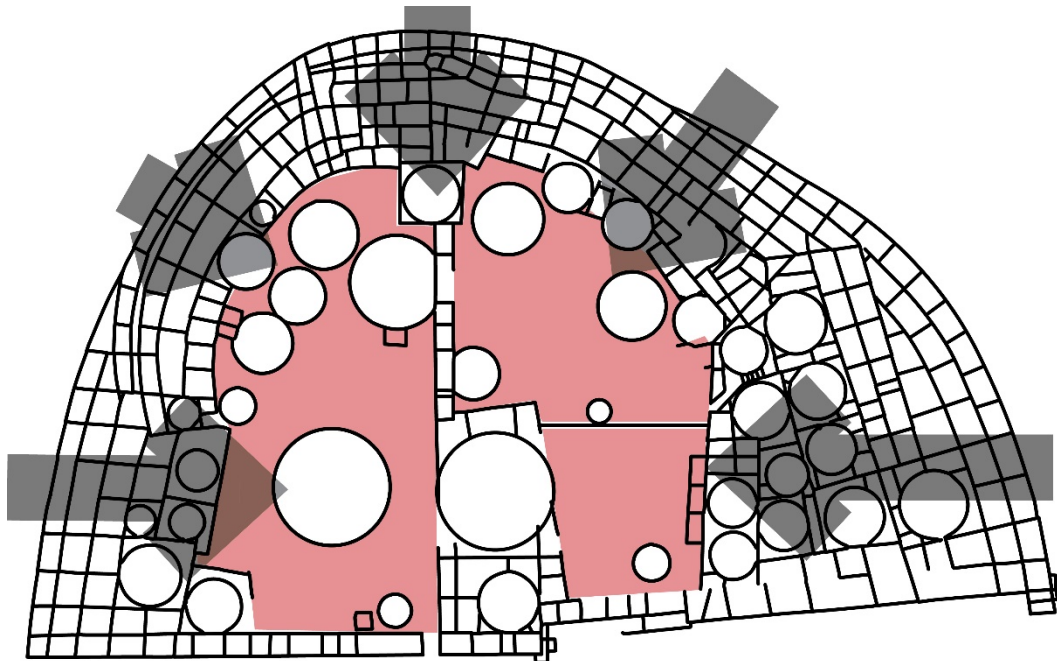


Figure 48 Pueblo Bonito plazas, (author)

2.4. Conclusion

In sum, then, these connections are the way for architects to think about how to narrow the relationship between architecture and nature through the material selection and the facade designed to reduce the environmental impact and pollution from the building. However, most of these buildings lack the relationship between humans and nature. Many times, we will find that even if the building is sustainable, environmentally friendly and energy-efficient, the people who use the building do not feel much difference compare with general buildings. Those built environments that we are living in become a wall that separates humans from the natural environment. In other words, these sustainable architectures strengthen the physical connection between nature and the human world by environmentally strategy. However, they disconnect the spiritual connection between humans and nature. Some people would say that natural buildings advocates reconnect with nature by using our hand to build the building. Isn't this also a spiritual connection? Yes, in a certain way, but we must continue to ask whether this connection is bidirectional, does this connection is based on the human or nature perspective? It is like the couples always use individual thought to establish the relationship but not the needs of the two. Essentially, I am arguing not negatively what modern achieved nowadays, but what we should reconnect humans and nature. Therefore, the purpose of nature architecture is to become a bridge that not only connects the human world with nature physically but also achieves a two-way connection in spirit. These relationships reflect human attitudes towards nature, but the attitudes have been changed since human thought they can conquer nature.

3. Research Result: Nature Architecture Parameters

Base on the analysis from indigenous dwellings and modern architectural theories, we can find that nature, architecture, and humans can be connected physical elements and spiritual elements including material, form, space and condition (Fig. 49).

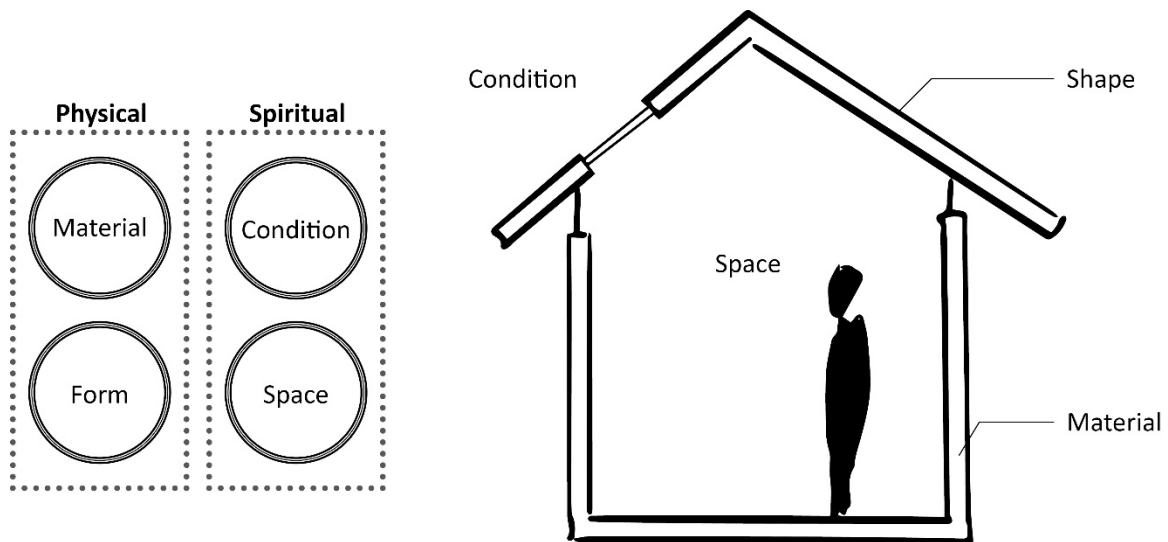


Figure 49 Nature architecture elements, (author)

Physically, whether it is a contemporary architectural concept or an indigenous dwelling, both choose the appropriate approaches to adapt to each local environment and climate. The form design should follow the local climate and environment, and the material selection could come from regional material, recycled material, sustainable material, or biomaterial.

On the other hand, we can explore the spiritual connection, which lacks in modern architecture, from indigenous dwelling. The space design needs to be interactivity. Either use nature features as part of the design and extend the space merge to nature or share the space with nature and consider the space not limited to humans but allows nature to use it. In terms of condition design, the architect can make an interaction

between architecture and natural phenomena that can allow people to have a dialogue with nature. Besides, the appearance of buildings that changes with the season or climate can also make people connect with nature.

Through the above research, the nature architecture parameters can be analyzed from the four elements that including space, form, material, and condition (Fig. 50). These parameters can be added through more analysis and sampling in other indigenous groups, such as the dwelling of Māori in New Zealand. Finally, this study suggests that the new design of nature architecture should satisfy at least one parameter in each element that can be call nature architecture.

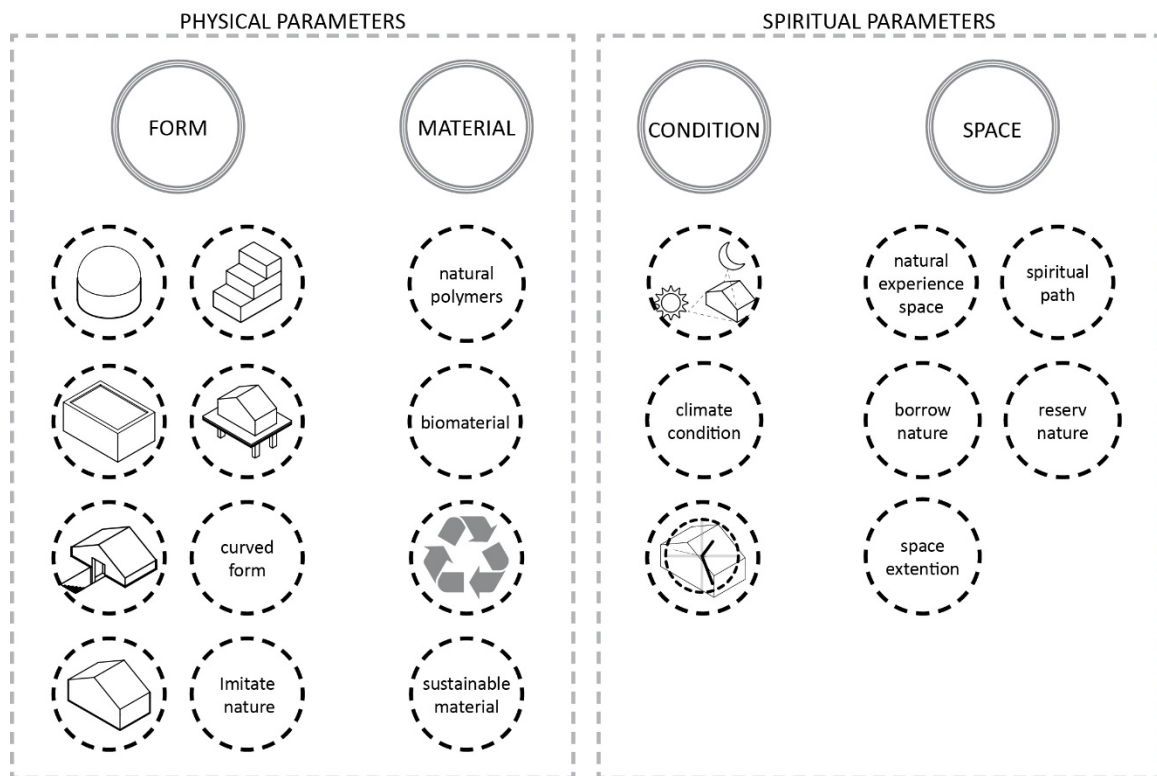


Figure 50 Nature architecture parameters, (author)

3.1. Evaluation with Post-Disaster Building Design

3.1.1. The Type of Disasters

Disaster usually happens suddenly and uncontrollably, and always cause huge damage to human life and economic loss. According to the American Red Cross and the United States Department of Homeland Security (D.H.S.), there are about ten different types of disasters that will cause a comprehensive loss. They can classify natural disasters, including wildfire, flood, earthquake, wind¹⁰⁵, winter storm, and volcanic eruption, and human-caused disasters, which including chemical emergency, pandemic, war, and radiological and nuclear emergency (Fig. 51). Different disasters can cause different issues during the post-disaster period and affect the strategy of post-disaster shelter design.

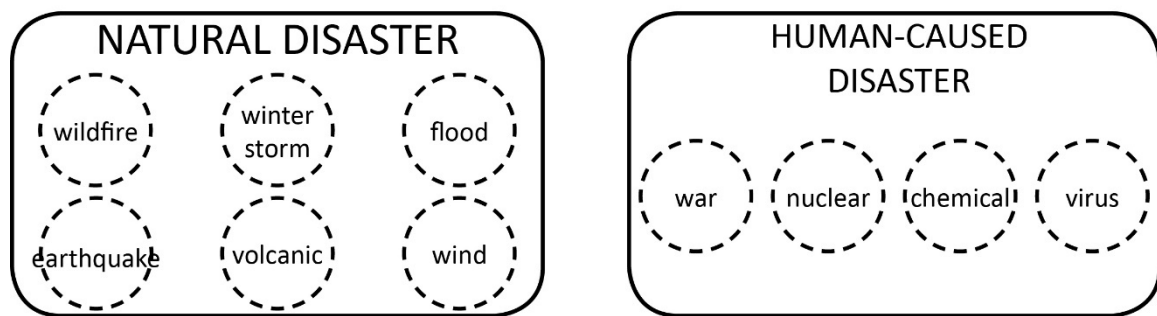


Figure 51 Type of Disasters, (author)

¹⁰⁵ The disaster of wind in this research means tropical storms, which also call hurricane, typhoon, or cyclone depends on regions. The behavior of tornado is different compare with tropical storms. It still can use the nature architecture application but need to specify and clarify the situation after the disaster.

3.1.2. Post-Disaster Building Response

Post-disaster architecture usually refers to a temporary structure to help the victims quickly have a place to shelter. This kind of building that including tents, shipping containers, and manufactured housing can be built faster than standard buildings and can be easily transported to all parts of the world. However, post-disaster architectures have several concerns due to globalizing and universal of the form and materials. First, the price might too high for local organizations in some areas.¹⁰⁶ Secondly, the form and material may not be suitable for the regional environment, culture, and climate,¹⁰⁷ or the unpredictable reconstruction process, and the limitation of space causes psychological problems.¹⁰⁸

Most importantly, post-disaster architecture cannot function as a typical building due to the lack of modern systems, like the electrical system. That causes people cannot ignore natural conditions but still stay comfortable. Victims must face the most authentic natural environment and reconnect to adapt it. Therefore, this research wants Nature architecture application to make post-disaster architecture become the medium of humans reconnects to nature via nature architecture parameters.

¹⁰⁶ Marie Jeannine Aquilino, *Beyond Shelter : Architecture and Human Dignity*, Architecture and Human Dignity (New York: New York : Metropolis Books : Distributed by D.A.P./Distributed Art Publishers, 2011).

¹⁰⁷ Cut Dewi, "Rethinking Architectural Heritage Conservation in Post-Disaster Context," *International Journal of Heritage Studies* 23, no. 6 (2017).

¹⁰⁸ Gloryrose Alcoran Dy and Maria Lovella Parcon Naces, "Rebuilding with a Heart: Architecture Roles in Post-Disaster Psychosocial Interventions," *Journal of Architecture and Urbanism* 40, no. 1 (2016).

3.1.3. Application for Post-Disaster Building

This study wants to evaluate natural architecture through post-disaster architecture. The purpose of choosing the post-disaster architecture is that its condition, such as limitation of modern systems and space, is like indigenous dwellings. Under such circumstances, the natural architecture through indigenous wisdom can be a solution for living comfort and self-recover after the disaster.

Therefore, Nature Architecture Application (Fig. 52) is a set of templates for the design of post-disaster architecture through the parameters of natural architecture. Those parameters like different seasoning for nature architecture, and each nature architecture can have different recipes depends on regional condition. First, we need to select the type of disaster, the happening location, and the culture of the most affected group by the disaster. Then those will connect to the consideration of elements, space, material, form, and condition. Each element has respective parameters that represent approaches of connection between nature and humans. Each element should have at least one parameter be selected to achieve nature architecture. This research designed three demonstrations that under different location and disaster.

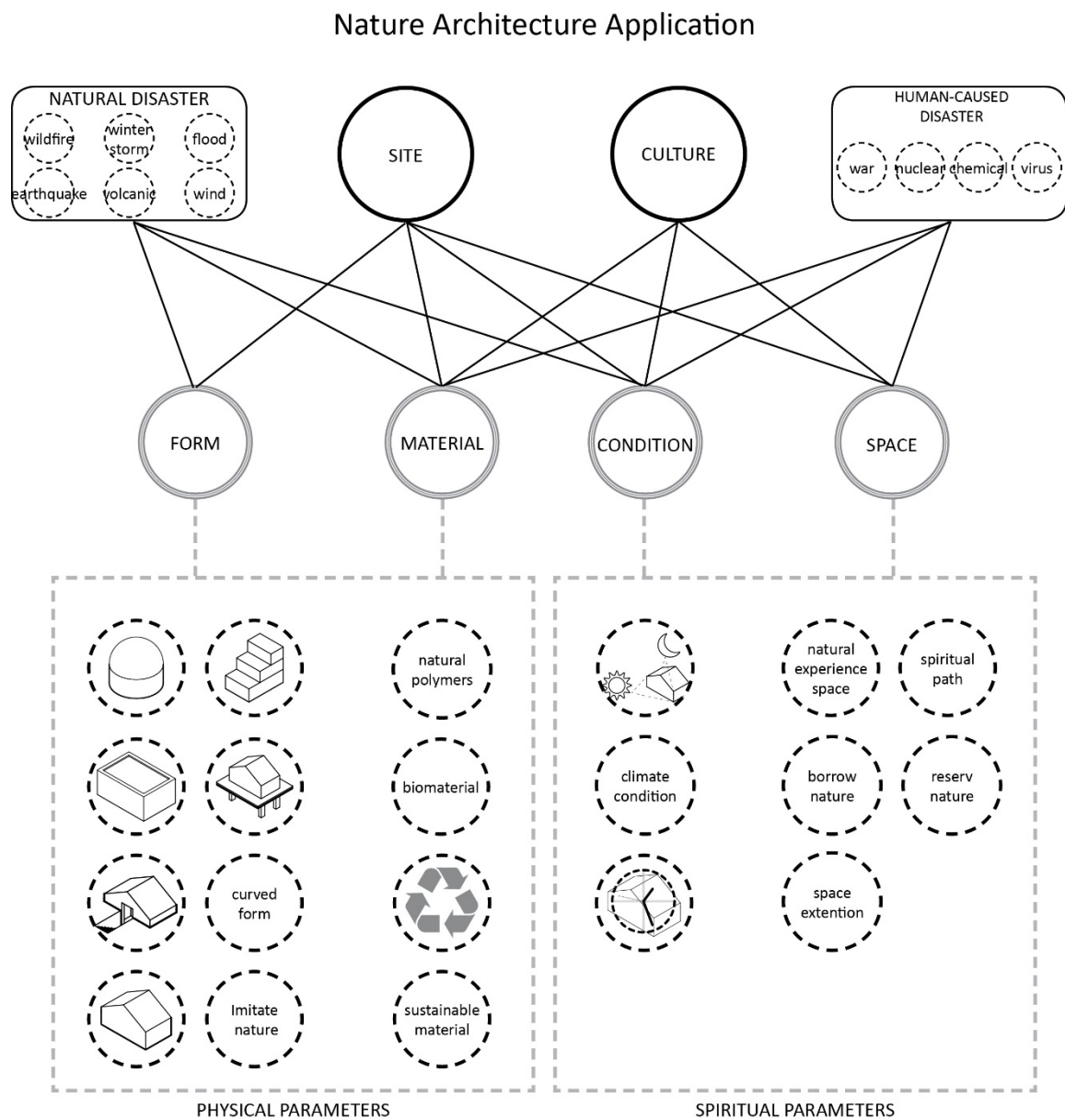


Figure 52 Nature Architecture Application, (author)

3.1.4. Demonstration – Volcano eruption in Yilan

The damage of Volcano includes pyroclastic flows, lahars (debris flow), and carbon dioxide. Therefore, the possible impacts like air pollution and ground damage are the features in the post-disaster situation. To avoid air pollution and ash spread into the building by the strong wind in the Yilan area, the dome shape, borrow nature space, and environmental condition is selected. Besides, due to the high-density population and pyroclastic flows or debris flow may around, multi-floor and nature experiential space in the closed building are the solution. On the other hand, the local material can be pollution by volcano ash; the sustainable and recycled materials can be more suitable. Moreover, the ocean resource of Yilan can also be considered to become biomaterials (Fig. 53).

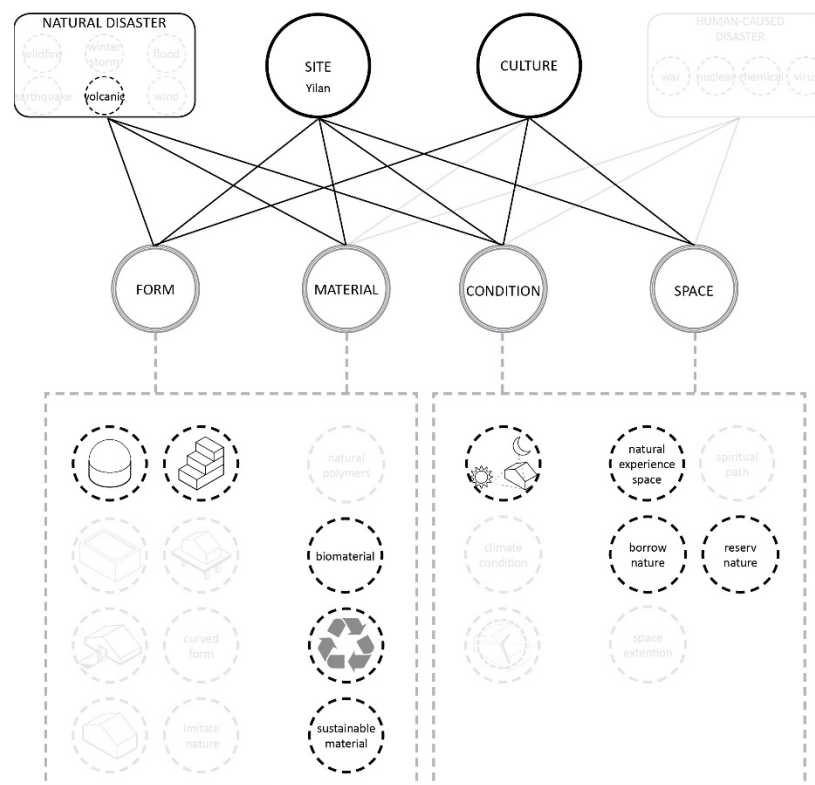


Figure 53 Demonstration – Volcano eruption in Yilan, (author)

3.1.5. Demonstration – War happen in Anchorage

War can cause several sequelae like the building to be destroyed or infrastructure inoperable. But the most significant impact is the end date is usually unpredictable. In other words, the refugee may force to stay in the post-disaster shelter for several months or years. Because of that, the design of post-disaster architecture needs to think as a long-term living way. As a long-term housing, space can have more connection with nature by borrow nature space, space extension, or reserved nature. Also, climate conditions and weather conditions are essential when staying in a place for a longer time. Therefore, the dome shape and curved form probably suitable for Anchorage condition. However, the damage caused by war may limit the resource of local material, sustainable material, recycle material might be the better choice (Fig. 54).

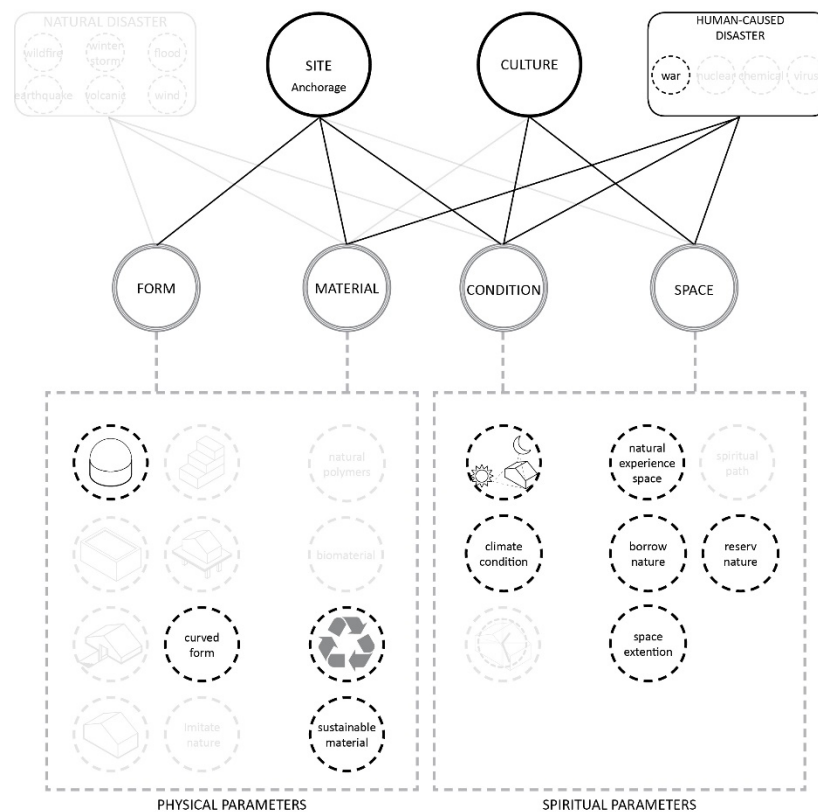


Figure 54 War happen in Anchorage, (author)

3.1.6. Demonstration – Tucson with virus and flood

Sometimes we may face more than one disaster at the same time. This demo shows the hypothesis that people face virus and flood issues in Tucson at the same time. Take COVID-19 as an example; the virus may have high contagious that need the space to be isolated and pollute the building. Therefore, the selection of parameters can consider natural experience space to connect with nature without leave housing. On the other hand, to face the flood issue, reserve the space for water rather than resistance water might be the solution just like what Kavalan did (Fig. 55).

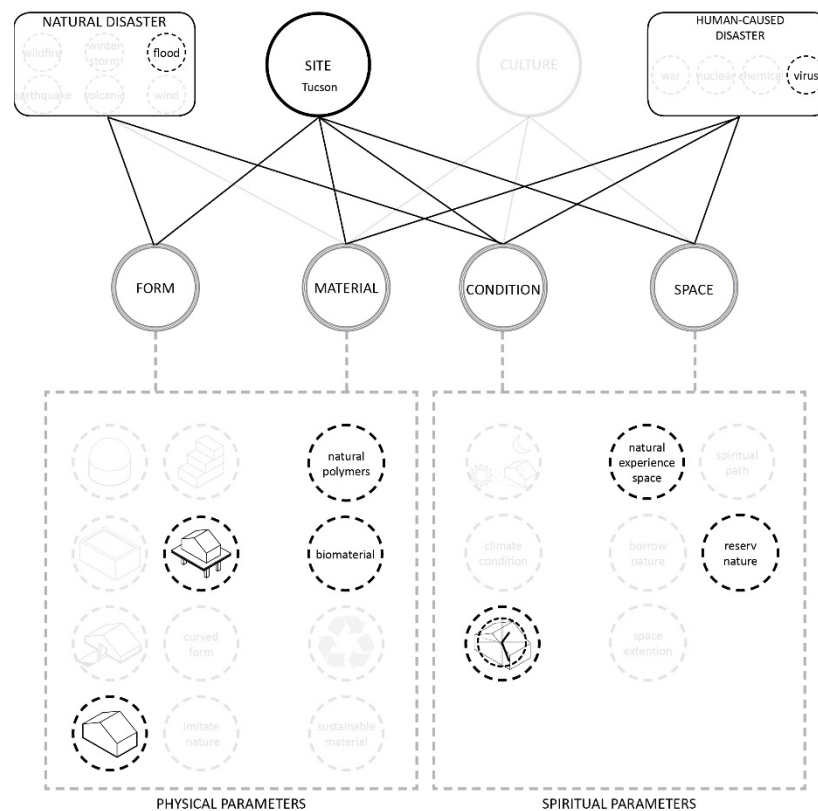


Figure 55 Tucson with virus and flood, (author)

4. Chapter Four: Conclusion and Discussion

In conclusion, nature architecture becomes the solution to reconnect and balance nature and humans, just like our ancestors did. Not only does it keep architecture sustainable, but nature architecture also makes humans feel connected with nature. Nature architecture does not deny other modern architectural theories but complements the shortage of spiritual connection. On this basis, some further topics can be developed:

1. As a result, we can see that the spiritual connection parameters are still less than the physical connection. Therefore, additional studies of the indigenous group like Māori may enrich more possible parameters of Nature architecture.
2. Another important topic is the response of post-disaster architecture to the length of time. Different disasters have different time effects. Sometimes the post-disaster period can up to years but also can be a few days. Parameters can be classified into temporary and permanent, according to the length of time to determine the proportion of parameters used.
3. Another possible research is to use the concept of nature architecture to design other types of buildings. For example, the buildings like hospitals and eldercare facilities with nature architecture concept might speed up recovery or provide spiritual support.

REFERENCES

- Amerindian Rebirth - Reincarnation Belief among North American Indians and Inuit.*
Toronto; Buffalo; London: University of Toronto Press, 1994.
- Aquilino, Marie Jeannine. *Beyond Shelter : Architecture and Human Dignity.* Architecture and Human Dignity. New York: New York : Metropolis Books : Distributed by D.A.P./Distributed Art Publishers, 2011.
- Architetti, Stefano Boeri. "Stefano Boeri Architetti."
<https://www.stefanoboeriarchitetti.net/en/project/vertical-forest/>. (Accessed May 5 2020)
- Arndt, Ingo. *Animal Architecture.* Edited by Jürgen Tautz and Ingo Arndt. English-language edition ed.: New York, NY : Abrams, 2013.
- CAPLA USGBC Student Club tour. *Will Bruder And the Burton Barr Central Library,* 2/24/2019.
- Bureau, Taiwan Central Weather. "Weather." <https://www.cwb.gov.tw/eng/>. (Accessed May 5 2020)
- Chaco Revisited - New Research on the Prehistory of Chaco Canyon, New Mexico.*
TUCSON: University of Arizona Press, 2015.
- Chen, Shu-Hua. *Kavalan.* Traditional Chinese ed.: Lanyang Museum, 2006.
- Chuan Wen Sun, Pei Jyun Ciou. *C. K. Lee and German Organic Architecture (李承寬與德國有機建築).* GardenCity, 2008.
- Climate, Weather &. "Average Monthly Rainy Days in Seattle (Washington State)."
<https://weather-and-climate.com/average-monthly-Rainy-days,seattle,United-States-of-America>. (Accessed 5 May 2020)
- contributors, Wikipedia. "Dutch Formosa (Traditional chinese Version)." *Wikipedia, The Free Encyclopedia* .
https://en.wikipedia.org/w/index.php?title=Dutch_Formosa&oldid=957331402. (Accessed May 5 2020)
- . "Kingdom of Tungning (Traditional Chinese Version)." *Wikipedia, The Free Encyclopedia* .
https://en.wikipedia.org/w/index.php?title=Kingdom_of_Tungning&oldid=957371288. (Accessed May 5 2020)
- Chaco Culture National Historical Park 4th Astronomy Festival. *Chaco Canyon History,* September 22 2019.
- Dewi, Cut. "Rethinking Architectural Heritage Conservation in Post-Disaster Context." *International Journal of Heritage Studies* 23, no. 6 (2017): 587-600.
- Dy, Gloryrose Alcoran, and Maria Lovella Parcon Naces. "Rebuilding with a Heart: Architecture Roles in Post-Disaster Psychosocial Interventions." *Journal of Architecture and Urbanism* 40, no. 1 (2016): 2-7.

- Evans, I., L. Smiley, M.G. Smith, M. Smith, and D. Bednar. *The Hand-Sculpted House: A Philosophical and Practical Guide to Building a Cob Cottage*. Chelsea Green Publishing Company, 2002.
- Fewkes, Jesse Walter. *Mesa Verde : Ancient Architecture : Selections from the Smithsonian Institution, Bureau of American Ethnology, Bulletins 41 and 51 from the Years 1909 and 1911*. Mesa Verde ; Antiquities of the Mesa Verde National Park, Cliff Palace. Albuquerque, NM: Albuquerque, NM : Avanyu Pub., 1999.
- Glowacki, Donna M. *Religious Transformation in the Late Pre-Hispanic Pueblo World*. Vol. 9780816599721: TUCSON: University of Arizona Press, 2012.
- Guan, Huashan. "A Reconstructional Study on the Thao and the Kavalan Tradional Dwellings and Their Display Planning and Design." Chinese Tunghai Architecture & Culture Association, 2003.
- Imagawa, Norihide, Hidetoshi Kawaguchi, Tsutomu Sato, and Shingo Koyama. "14030 Eco-Structural Design to Reduce Co₂ by Combining with Co₂ as New Joint (in Japanese)." *Architectural design announcement summary (建築デザイン発表梗概集)* 2011 (2011/07/20 2011): 60-61.
- Ito, Toyo. *Architecture from That Day (あの日からの建築)*. Shueisha, 2012.
- Jones, Peter Blundell. "Hugo Häring & the Search for a Responsive Architecture." *AA Files*, no. 13 (1986): 30-43.
- Kamal, Mohammad Arif. *Sustainable Building Materials and Materials for Energy Efficiency : Special Topic Volume with Invited Peer Reviewed Papers Only*. Pfaffikon, Switzerland : Trans Tech Publications Ltd, 2015.
- "Kavalan People's Culture."
<https://www.dmtip.gov.tw/web/page/detail?l1=2&l2=33&l3=400&l4=409>.
 (Accessed May 5 2020)
- Kolarevic, Branko, and Ali Malkawi. *Performative Architecture : Beyond Instrumentality*. [in eng]: New York : Spon Press, 2005.
- Kuma, Kengo. *Natural Architecture (自然な建築)*. Iwanami Shoten, 2008.
- Lee, Molly. *Eskimo Architecture : Dwelling and Structure in the Early Historic Period*. Edited by Gregory A. Reinhardt. Fairbanks: Fairbanks : University of Alaska Press : University of Alaska Museum, 2003.
- Lekson, Stephen H. *The Architecture of Chaco Canyon, New Mexico*. Salt Lake City: Salt Lake City : University of Utah Press, 2007.
- Mazzoleni, Ilaria. *Architecture Follows Nature : Biomimetic Principles for Innovative Design*. Edited by Shauna Price. Boca Raton : CRC Press, 2013.
- Menin, Sarah. *Nature and Space : Aalto and Le Corbusier*. Edited by Flora Samuel. London ; New York: London ; New York : Routledge, 2003.
- Munro, Andrew, and J. Malville. "Ancestors and the Sun: Astronomy, Architecture and Culture at Chaco Canyon." *International Astronomical Union. Proceedings of the International Astronomical Union 7*, no. S278 (2011): 255-64.
- Nabokov, Peter. *Native American Architecture*. Edited by Robert Easton. New York: New York : Oxford University Press, 1989.

- NAP, Hiroshi Nakamura &. "Kamikatz Public House."
<https://www.nakam.info/en/works/kamikatz-public-house/>. (Accessed May 5 2020)
- Pan, Chao Cheng. "Kavalan Traditional Dwelling."
<https://www.youtube.com/watch?v=DMF3MFUAF48>. Youtube, 2017. (Accessed May 5 2020)
- Rocca, Alessandro. *Natural Architecture*. New York : Milan, Italy: New York : Princeton Architectural Press ; Milan, Italy : 22 Pub., 2007.
- Steele, James. *Ecological Architecture : A Critical History*. London: London : Thames & Hudson, 2005.
- Suemitsu, Hirokazu. *Architecture as a Part of Natural Circulation: Suep Book 1*. [in Chinese] Taipei: Garden City, 2015.
- Tabbert, Russell. "The Names Eskimo, Inuit, and Inupiaq/Inupiat." *Names* 37, no. 1 (1989): 79-82.
- "The U.S. Green Building Council." <https://www.usgbc.org/>. (Accessed May 5 2020)
- Vyas, Khushboo. "Earthship Homes: Michael Reynolds."
<https://www.arch2o.com/earthship-homes-michael-reynolds/>. (Accessed May 5 2020)
- "Weather Spark." <https://weatherspark.com/>. (Accessed May 5 2020)
- Williamson, R. *Pueblo Ethnoastronomy*. 2015. doi:10.1007/978-1-4614-6141-8_248.
- Wright, Frank Lloyd. *In the Cause of Architecture, Frank Lloyd Wright : Essays*. Edited by Andrew Devane and Frederick Albert Gutheim. New York: New York : Architectural Record, 1975.
- Yadav, A. V., and S. B. Bhise. "Chitosan: A Potential Biomaterial Effective against Typhoid." *Current Science* 87, no. 9 (2004): 1176-78.