

Vernacularism's Climatic Adaptation of Sustainability's Culture

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Case Study: Sundanese Kampung Adat In West Java, Indonesia

Abstract: Fulfillment of human need is the goal of vernacular architecture, which has been developed to be close relationship with human culture. Such wisdom as *genie loci* which has been implemented in non-engineered construction, which has great response to; 1) the occupants's need, b) the physical environment, c) ecological-oriented. Various Sundanese *Kampung Adat* (indigenous kampongs) in West Java, Indonesia has implemented the wisdom in promoting architecture paradigms, such as ; 1) buildings which physically last long, little maintenance, and save in energy, 2) the way architecture and environment in fostering man's spirit. Its realization is climatic adaptation within the sustainability's culture. The aim of the research is an evaluation of vernacularism's climatic adaptation, such as: 1) to analyse climatic adaptive technology, 2) to develop the potential of climatic adaptive technology, which can be seen in: 1) house Shape, 2) building method, 3) building components, 4) building materials. The methodology of research is qualitative descriptive, which based on observation. The useful of the research is to get better understanding of vernacular wisdom in overcoming climate problems.

Keywords: Vernacularism's Climatic, Adaptation, Sustainability's culture

I. INTRODUCTION

Vernacular architecture such as Indonesian vernacular architecture cannot be separated from locality, especially nature environment, such as; climate. The result is architecture which uses native-local materials, traditional structural systems, humble, but great wisdom. Environment's characteristic, especially ecology which surrounds the building is the main aspect; symbolically, ethic and realization. Indigenous society which is indentic to vernacular culture in Indonesia, living in ecological wisdom which is implemented in engineering of ecosystem, as representation of sustainability's culture. Vernacular architecture has developed to fulfill human need, to encourage their live which promotes architecture has related with human culture [12]. The characteristics, includes; a) nonengineered construction, b) result of ancient tradition, gradually improved along time in response to the occupant's needs; which also accepted by their community, c) the owner is an active participant of the building process, d) without supported by theory or building principle, tuned with their climate, environment, respectful with society and environment, open-ended with site [6]. Therefore vernacular architecture are built to meet specific needs; values, economies and ways of life, cultures [9]. Vernacular housing have sustainable concepts which involve three aspects, such as : 1) environment aspect, especially natural resources; this building is built with some consideration to their environment; climate, 2) social aspect especially human being; human friendly this building is accepted by their society; 3) economic aspect, especially energy usage; energy friendly. Study of such ecological wisdom is the main description, which developed from the believe that ecology, such as climate should play a primary role in the realization, judgment about built environment, which case study is indigenous villages (*Kampung Adat*) of Sundanese ethnic in West Java, Indonesia. Design must have three principles, namely : 1) ought to give respect to ecosystem processes, 2) design as a social process, 3) A holistic approach; an interdependency of all things and living objects.

II. SCOPE AND METHODOLOGY OF RESEARCH

Scope of research is various *kampung adat* (indigenous villages) of Sundanese ethnic, West java, Indonesia, such as : Naga Village, Ciptagelar village, Baduy village, Baduy Village. The methodology which is used is qualitative decriptive-analysis. The methodology uses three approaches, such as : 1) sustainability's culture, 2) identification of climatology character, 3) adaptive climate ethic, 4) sustainable house design. Such approaches led the indigenus society in ordering built enviroment with climatic adaptive wisdom.

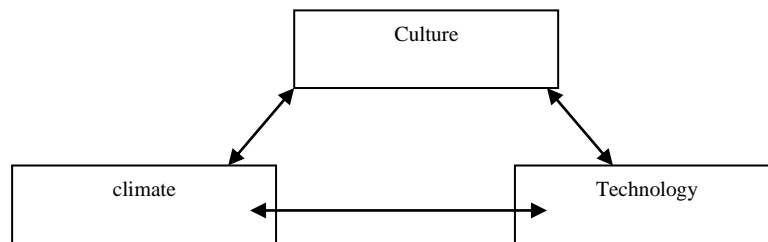
III. DISCUSSION

3.1. Sustainability's culture

The essence of ecology ; adaptive climatic wisdom of indigenous villages (*Kampung Adat*) of West Java is sustainable architecture. Within a given setting, human cultures evolve an adaptive response to their climatic. The cultures develop technologies as means of fulfilling individual and collective needs and desire, as a responds to the climate. Climate (ecology), culture and technology evolve and adapt; climate adaptive

architecture requires architectural culture to understand and contribute to the harmonization of climate (ecology) and technology, such as:

1. Conciousness of dynamic of sustainability; ecology, culture, technology. a) ecology : the study of the relationship and adjustment of human groups to their geographical environment, b) Culture : the ideas, beliefs, customs, skills, arts, etc. of a given people in a given period;civilization, c)Technology : applied sciences, etc; the terms used in a science, art, etc.; technical terminology; a method, process, etc ; the system by which a society provides its members with those things needed or desired. Sustainability involves the interaction between climate and technology; relies on culturally appropriate attitudes and behavior, legacy for future generations to come (diagram 1).



Diagram

2. Interdepdency of sustainability aspects
3. The tradition as the main role of sustainability, Principle on tradional settlement culture- tradition are developed pararely with the development of the human civilization. These is very clearly seen from the way of life; developed in groups of community, which contributed the people in developing cultures, traditions and rituals (*adat istiadat*).
4. Institutional Structure of the kampong people under Customary Law, all traditional offices within the village customary institutional structure are responsible to the highest leader(*Sesepuh*).The position highest leader is very important to indigenouse village, to maintain the tradition, which, are elected by the indigenouse members of that village. As community leaders, the *Kokolot Lembur* participate in *adat* meetings.

3.2. Identification of Climatology character

Architecture as the built environment, in this case as a form of physical vernacular settlements of human culture; the output of the process of adaptation to the natural environment, particularly climate, such as ; various morphological spatial structuring efforts, structuring kampong/village, building morphological. Climate (*klima*, Greek); region with the condition, temperature, humidity, wind, sunlight particular; integration of various physical parameters of atmospheric environment, which is a characteristic of a particular geographic region. Climate elements; temperature and solar radiation, precipitation, humidity, air pressure, wind. Climate Control; factors that affect the climate elements are : radiation, land and water, high and low pressure cells, future air, mountains, ocean currents, *cyclonic* storm. Sun -Declination; major factor climate differences. Tropical (Greek; " *tropikos* "). Tropical climate : climate which occurred in the area of the earth at latitude ; 23.50 North - South latitude 23,50 ; nearly 50% of the earth's surface, more than 17,000 islands.



Figure1.Indonesia'smap

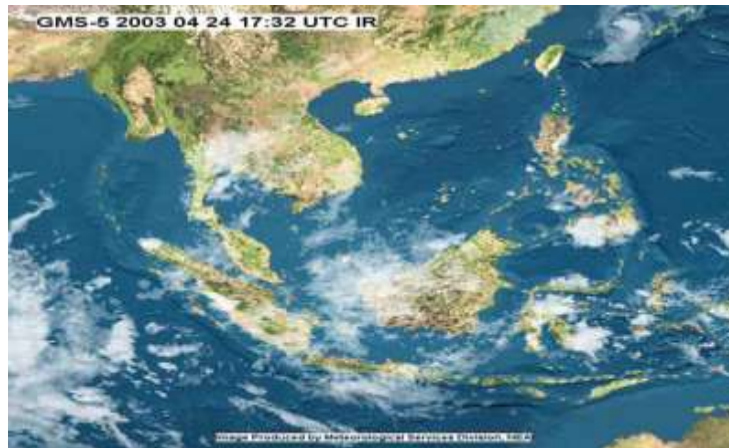


figure 2. Indonesia climate's map

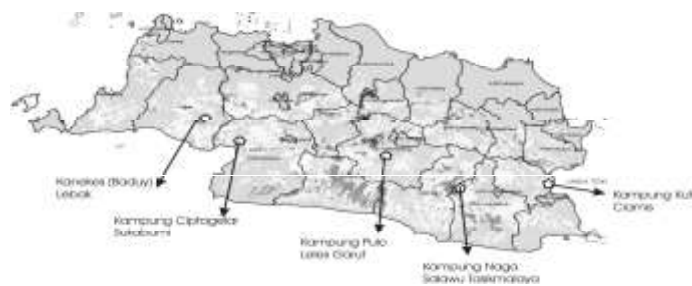


Figure 3. Location Of Sundanese Kampung Adat in West Java and Banten Province

The character of tropic climate, such as : 1)

The rainy season and the dry season. Rainy season from December-February, the dry season in July-August. Difference between the rainy and dry season are relatively obscure, 2) precipitation, causing problems at the site and can damage the building's body. Precipitation occurs during the rainy season relatively large , therefore tropical climate is divided into two: wet and dry. Rainfall during the year is relatively high in wet tropical, such as in Indonesia, annual rainfall ; 2000-5000 mm/year, 3) radiation relatively high, the majority reflected , partly transmitted by clouds. 43 % of solar radiation reflected back, 57 % is absorbed, 4) air temperature, often above the limit of human comfort, average temperature; day; 30.5 °C, evening ; 25 °C, the temperature range is 21⁰ - 27 °C. Daytime range 27-32⁰ C, 5) humidity level is known as the RH (relative humidity) -high humidity, which average humidity is around 75 % , with a range ; 55 % - 100 % , give effect thermic discomfort, 6)the movement of air generally low wind speeds, does not support comfort sensation. Air movement which occurs on the surface of the soil in contrast to the movement of air at high altitudes (above ground level), 7) low diurnal region , Most of the time the air was cloudy , 8)glare and sky conditions ; Almost all year round cloudy sky conditions.

Potential of wet tropical climate: a)the combination of air temperature, humidity and wind speed are there, do not complicate the human being in the outdoor space (outside the building), b)The combination of solar radiation, air temperature, rainfall, humidity and wind speed were there, able to grow vegetation quickly, c)solar radiation is sufficient, able to provide natural lighting as well, the potential for energy saving lighting, d)high rainfall, providing clean water supplies for human activities of daily, e) rain gives a cooling effect / decrease in air temperature, low wind speed, not danger to the structure / building construction, f)Indonesian climate character :Between 6 ° 08 'N ~ 11o 15 ' latitude and 94o 45'BT ~ 141o 05 'E, tropical regions with high temperatures and humidity, Intertropic convergence zone (ITCZ).

3.3. Adaptive Climate Ethic

Adaptive climate ethic is seen in the vernacular habitation styles, such style is mainly climate oriented, such as : 1) the climate adaptive principle on settlement, 2) principles of spatial specification. These two principles has formed the ethic of indigenous community in developing their habitation styles.

The Sustainability principle can be seen through this circumstances, such as : water management system, harmony between nature and environment, building construction systems and building materials. The traditional settlement protect their houses and preserve the ecological environment through the separation of “forest” and “settlement” areas. All built environment activities must be under control of the kampong chief/priest, hence the development of the settlement area can be done only with permit from him., therefore it can control the people activity in protecting the environment, such as: a) choose the location for the settlement on the valey or slope of a hill, b)to secure the flow of water from the mountain to the villages, c) In certain cases, to give security from enemies and animals d) to protect their settlements from water pollution and ground erosion.

It is possible for us to conclude that *Sundanese* vernacular houses are very diversified, that it is difficult to determine constants. The houses generally is built of wood on posts with differences in floor levels, saddle backed roofs, and decorated gable-ends and gable-finials. The inhabitants of village vary depend on the complexity of the village, sometimes there is village which has constant number of inhabitant such as ; Baduy village, Ciptagelar village. The other has decrease population, such as kampong Naga; the Inhabitants are 326 people or 102 families (2001), 110 houses with decrease in 5 years approximately 25 person. The decrease reason is caused by limited housing areas, young family move to the village's outside, and economy. They believe that kampong is a heir from their ancestor; therefore they must keep the village clean and suitable for living. Three elements of land use planning : a) house, b) water supply, c) field for horticultur or agriculture, pound for fishery. Zoning is difereiated by sacre's gradation, such as: a) the clean area ; the village has a holy place that not everybody can go to this place ; a place for housing, granary, communal house and *Bumi Ageung* (museum for their heirloom), b) dirty place is place that narrow than other place; simple buildings for washing, shower , stable, rice mortars and ponds.

The tradition on Kampung is life cycle assessment, which is : a) a process to evaluate the environmental burdens associated with a product; b) to assess the impact of those energy and materials used and releases to the environment; c) to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing, extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling, and final disposal.

The settlement is along the drainage basin of river, which shows a human's natural need of water in his life. Kampong is surrounded by forest and huma, rice field. People never change totally the existing condition of the land in developing their *kampongs*. They always try to keep land being origin, such as natural land contour as the implementation of their belief, which recognize nature as representation of God existence. Basic principle of their daily life are : 1) vertical relation;believe in God which guides the society to take care the environment, 2) horizontal relation; taking care of good relation between human beings and other living things. These two fundamental values are implemented in various strategies in arranging their settlement such as : 1)Maintaining the land contour as an effort to get balanced condition with nature and environmental sustainability, The strategy applied in implementing podium type as building structure, 2) Dividing the places on the basis of their activity, as an effort to improve interaction; and toward social sustainability; cleanest area for Mow area is an area for food-stuff suply, a mixture between clean and dirty areas for settlement area, dirty area for farmland/*huma* is a working area, and maintaining the specific arrangement of the neighborhood which derived from their heritage custom, zone system of the settlement: prohibited forest zone, house of *puun* zone, zone of bale, zone for citizen's houses, and zone of *saung lisung*, 3) The way of living of the society specisifically is based on their religion teachings and custom, such as : avoid using inorganic materials, as an effort toward environmental sustainability, differentiating relaxing time and working time in daily life activity; an effort toward healthy sustainability, refusing or descreasing the external culture.

Adaptive climatic ethic also implemneted in natural resources and their management, which consists of :

1. Basic philosophy of nature and its management, the indigenous community believes that humans are only one of many living creatures in the universe. Perceptions of nature must always be related to the concept is “*Jagat Leutik, Jagat Gede – Jagat Leutik Sanubari, Jagat Gede Bumi Langit*”: awareness of the microcosm and macrocosm –consciousness and the immensity of the natural universe; natural resource management must be based on self-awareness, which is reflected in managing their natural resources. The community place great emphasis on the balance between people and nature, which apply this philosophy to their agriculture and forest management. Therefore, the people do not view their forests as production forests, but they keep forests as; a) protecting water sources; b) balancing climate; c) habitats for animals; d) conservation. They believe that the current generation has only borrowed the natural resources from future generations and must therefore manage them in a fair and sustainable way.
2. Sustainability and the natural resource management practices. Sustainable concept is how to accomadate human need at present without disturbing the human needs in the future. Sustainable concept consists 3 criterias that has to fulfill, which are: 1) economic aspects, 2) environment aspects, 3) social aspects. The

sustainable concepts is related to design concepts of housing, which resulting sustainable house design concepts

3. Land is zoned according to its function. This zoning influences the way people manage their natural resources; a) irrigated rice (paddy), Rice is planted for subsistence, not as a cash crop. One crop of local rice varieties is planted per year on communal land and on individual plots, b) upland plots, these are rain-fed not irrigated. Local upland rice varieties are intercropped with beans, pumpkins, cucumber and maize. This land is used rotationally, c) open forest (*Leuweung bukaan/garapan*) : vegetable gardens, agroforestry, tree species to supply timber and other local needs, d) fish production, the people create fish ponds in parts of the valley floor close to streams or springs. Fish is much in demand for rituals throughout the year, so nearly some kampong adat's community members have fishponds, e) fruit trees, which are grown any where around the village, on the margins of paddy fields or upland plots. The community also uses non-timber forest products such as rattan; honey for local consumption and for sale; mushrooms; and roots, tubers and other parts of many other medicinal plants from the forest, mainly for use within the community. The people's sustainable forest management system distinguishes between three kinds of forest, such as :1) protected forest (*Leuweung titipan*), This forest is protected by the community and the forest spirits. This zone is preserved to ensure the sustainability of the community's livelihoods, 2) closed forest, this forest functions as a buffer and also protects the village. Community members may only harvest non-timber forest products. In cases of extreme need, the community may decide to clear parts of this forest for the benefit of the whole people, 3) open forest ; the community uses for its paddyfield, rotational agriculture, agroforestry, housing, roads, mosques, cemeteries, livestock and other needs.

3.4. Sustainable House Design

An important aspect of a sustainable house design is the extent to which the house can accommodate user needs, climate conditions and local natural hazards. Well-designed houses minimize environmental impacts and risks, while meeting user needs. Key sustainable house design are: 1) the solution that are environmentally sustainable and energy efficient, 2) use house designs that are resistant to natural hazard, such as earthquakes and floods, 3) consider its whole life cycle (construction, maintenance, reuse, demolition, and recycling phases), 4) consider flexible designs that are easy to upgrade and expand, 5) use designs and materials that allow for easy recycling, 6) Simple, low-cost, robust, and practical solutions, 6) ensure easy maintenance through the use of modest and basic house styles. In many cases, maintenance and later renovation turn out to be technically complicated and, therefore, more expensive. Materials and tools needed to work the materials should also be locally available, 7) ensure cost-effectiveness in all construction activities, 8) incorporate the users need and cultural requirements.

Those keys sustainable house design above must be applied to: 1) house Shape, the shape of house is crucial to ensuring that it is built sustainable. Certain house shape can better minimize or withstand the impact of earthquakes, flood, and climate conditions. It depend on : environmental technical aspect which the shape of the house has an important effect on its stability, economic aspect which construction cost can be minimized by using simple shapes without numerous and complicated angle, Social aspect which to ensure a socially, aesthetically and culturally appropriate house design consult, 2) building method, sustainable construction practices are low cost, practical and environmentally appropriate, such as the availability of building material and skilled workers, 3) building components, the main building components are the foundation, supporting frames, floor, walls (with door and window), ceiling and roof. Simple building techniques help to ensure sustainable reconstruction, 4) building materials, building materials are either made from naturally available sources like inorganic materials or from organic raw materials. The appropriateness of a particular building material can never be generalized. Whether a specific building material is sustainable or not, depends on the local context.

The implementation of sustainability in arranging the house, society applies the principles from their custom and trust, such as:

- a. Podium form as house architecture; a mode to maintain land topography. The topography of the land forms a steep contour. Their settlement area is located nearby river. That is why society choose podium system as their housing form. The house is built above these pillars allows them to maintain maximum land topography. The uplifted floor of the house from the land allows a big land conservation.
- b. House orientation is in accordance with settlement imaginary tinder, north – south direction. The entrance of the house is in the north side. This orientation gives an advantage to the inside part of the building in case of the illumination. In this pattern, sunshine with high intensity (settlement of reside at equator tinder area), will give less influence to the room temperature.
- c. Local material as building material, as a relationship with environment. According to the principle, people have to take care of horizontal relation with other living things and environment. The strategy to fulfill this requirement is to use of local materials as their housing construction material; Bamboo , wood are used for

the floor and wall of the house. While the roof is made of wood, bamboo and organic material, which are taken from environment around them; an efficiency in expense and energy. The wall is made of bamboo; to get fresh air into the building; so that the room is always dry and fresh.

- d. Building structure is using a simple structure, to develop their local knowledge. Building structure system is the structure constructed with logs and pillars. Generally the building structure can be divided into upper structure and lower structure. Upper structure consisting of roof and frame of the building. Building construction of sundanese house uses lanching system (for wood construction material) and tying (for wood and bamboo construction materials). They do not use (nail; axis) as mode of the joint, because their trust prohibits the use of materials from outside culture. For the undercarriage structure, or foundation, they use umpak (foundation) system. Umpak is made of stone because it has enough surface level off; as pillar/column fulcrums of their building. Column put down off hand above umpak. Stones multiplied as umpak are only put down off, hand above land, not to be planted.

3.4.1. Structural Systems Of The House System of structure consist of:

- 1) Sub-structure System: a) Floor sub-system, the floor of sundanese vernacular house is lift up; 0.3m-1.3 m above the ground. The space between floor and ground was used to be a buffalo stall and now is used as woods storage. Front room floor is 30 cm lower than floor in back room, b) The floor made from bamboo plates (palupuh). Palupuh is placed on cleaned and refined bamboo-lath. These bamboo-lathes is placed on an intact circular wood bar (darurung) that functioned to restrain palupuh. Darurung is supported by wood beam called pananggeuy. Pananggeuy also functioned to connect columns to make them stand stiffly. The joint system of pananggeuy is pupurus system (pen and notch system) with an inforcement of wood, c) Foundation sub-system, Foundation of vernacular house (tatapakan) is made from stone that has flat surface with diameter 30 cm. Each column of this house is place without any joint on tatapakan, they can still stand firmly.
- 2) Middle System: a) Column sub-system, Sundanese vernacular house has sixteen main column (tihang) which has dimension 19 x 19 cm. These tihangs made from solid teak wood, b) Wall sub-system, wall of vernacular house was made from boards of teakwood and bamboo braid with sasag motif. Now, some parts of wall is changed with woods. The installation system of wood wall is pupurus system and bamboo braid is installed by attaching it on house structure, c) Door and window sub-system, vernacular house has only one door as main entrance that has dimension 1.00 1.60 m. The door has twin door-leaves. The house also has interior door that connects front room and back room. This interior door dimension is 0.80 x 1.80 m with two doorleaves. One of the door leaves has width 60 cm that opened into back room. Two windows located in front room interior wall. The dimension of those windows is 50 x 73 cm. The windows also equipped with jalousie and window leaf. The jalousie is made from five 3.5 cm-thicked woods. Each woods separated by 4 cm spaces. There are three windows on the back exterior wall with dimension 25 x 50 cm. Like the interior windows, the exterior windows also have jalousie and window-leaf. The jalousie made from four 3.5 cm-thicked woods and the window is opened into the house. The installation of window leaf is pupurus system. On the up corner of door/window there are cylindrical wood (\varnothing app. 7 cm) inserted onto paneer beam and floor beam (pananggeuy) that functioned as hinge. The material of door and window are solid teakwood.
- 3) Upper system: a) Roof sub-system, The shape of vernacular house's roof is julang ngapak (the term came from the shape that similar to the shape of bird that open its wings). Originally, the roof is made by shingle-wood; now the roof is made by terracotta-tile. The supporting parts of roof (roof rafter and batten) originally made from teakwood; now it is made from twig of wood (usuk) and bamboo lath (ereng). These new materials is provide in local building material store, b) Easel sub-system, The easel of Kampung Panjalin vernacular house can be seen from inside the house because it does not have ceiling. The ease and its main supporting beam (pamikul) made from teakwood. The joint system used in easel construction is pupurus system with an inforcement of wood peg and ijuk rope bond. Now, many of wood pegs replaced with nails.
- 4) The main materials : the main material which used in West Java vernacular house are wood and bamboo. The common materials used are teakwood and laban wood as a column; johar wood as supporting beam; kepuh wood as roof-rafter; tali bamboo as wall, roof-rafter, and darurung; surat bamboo as ereng, cemped and palupuh; splited bamboo as roof-rafter; bamboo braid as wall and ceiling; ijuk as roof; and stone as fondation (tatapakan). Lightweight structures, elastic, and used lightweight structure, elastic, and daktil indicated by the use of materials from wood and bamboo. Material as well as to cover the roof of the fibers, thatch, and bamboo. Wood is used for poles, roof-frame, frame walls, and floor beams. Bamboo is used for battens, rafters on the roof-rafters, frame ceilings, walls (in the form of woven bamboo), in the framework of the floor joists, roof coverings, as well as bamboo matting on the floor and ceiling. Form the framework of the building is a box, which is interconnected between one part and another (mutual support). This is a

typical indigenous knowledge in the *Sundanese* vernacular buildings. This shape makes the building stiff because there is an order system. Stiffness of the frame shape is not only determined by the columns, ring beams and floor beams, but also by frame walls and ceilings order to be a part of the box frame. Between columns than bound by ring beams and floor joists are also bound by the framework of walls and beams frame the ceiling. Shape of the roof on this building is gable (*suhunan jolopong*) and *julang ngapak*, is unique-formed roof, which material can be obtained from the surrounding environment. There was also a building that uses a portion of the roof of bamboo (split bamboo).

Vernacular buildings ; a building that was built in a joint effort by the community. The material used is available from the forest around the village, for example, bamboo is used for battens, rafters, and even some gording. Walls of the building are also using bamboo matting made by homeowners and assisted by several neighbors. Form the framework of the building is a box, which is interconnected between one part and another (mutual support). This is a typical indigenous knowledge in the vernacular buildings. This shape makes the building stiff because a thorough order system. Stiffness of the frame shape is not only determined by the columns, ring beams and floor beams, but also by frame walls and ceilings order to be a part of the box frame. Between columns than bound by ring beams and floor joists are also bound by the framework of walls and beams frame the ceiling (Figure 5 and Figure 6).

Shape of the roof on this building is gable (*suhunan jolopong*) and towering ngapak, is roofed or thatched lid that can be obtained from the surrounding environment. There was also a building that uses a portion of the roof of bamboo (split bamboo) and fibers. Connection system is a system used pegs (*paseuk*) and bound-systems. Vernacular buildings in West Java is a building that was built in a joint effort by the community . The material used is a material obtained from the forests around the village, for example, is used for battens , rafters , and even some gording . Walls of the building are also using bamboo matting made by homeowners and assisted by several neighbors. Roofing materials using fibers, thatch and bamboo are found in the forest are also made by the community. Kinship excellent properties of the society because the society is a society that is still one offspring, who have a very strong kinship lines. While the knowledge gained to establish hereditary and even those people do not understand the purpose of the connection system and the benefits of the material used. They do so because it is traditional (through trial and error and passed down from generation to generation) , and then using those materials to building strong. Vernacular buildings in the West Java as described in the previous chapter is a lightweight structure that uses wood as the frame structure (columns , beams , roof frame easel , etc.) , as well as the framework of the walls and the ceiling frame . Mass shape is a rectangular building, there are corner - corner column and at the center field wall that extends (the distance between the columns \pm 2.50 m). Each column bound by the floor beams , ring beams to put it together. Any bracing beam or score for the rigidity of connection between the columns and the beams. Between columns is also integrated with the framework of the wall (where the stick or bamboo plank walls) where it adds to the overall rigidity of the framework building . The walls of the room divider (partition) the shape or structure is very organized and always associated with the column. So in addition to the bond between the beams and columns on the perimeter wall area of the building there is also a bond in the building, the lower and upper beam that connects the partition wall between the columns. so, spin structure is very solid and rigid, forming a coherent whole, which can anticipate and earthquake loads can also be referred to as a box structure

Roof frame building that stood on top of each column is a solid relationship, pivoted using bamboo pegs. Relationships like this are very stiff but still able to move, if there was an earthquake (flexible). connection between rafters with columns and beams are very stiff and solid ring to form a single unit. In one building there is usually a 4 roof-trussers, 2 trussers on either side of the outside and 2 trussers are in the middle of the building. Fourth trusses are unified with each other with bamboo as linked. This bamboo can in advertently serve as a winds- bonding , which can unify the four roof truss into a single unit. Though the actual function of it to hang two bamboo crops (rice , maize , cassava , etc.). Building occupants to be able to save the crops in the roof had to use the stairs going up to the ceiling structure. Ceiling building consisting of a wooden frame , bamboo and bamboo should hold the load of people and objects yields . Ceiling frame is made strong enough (with the same dimensions of the timber roof truss). Ceiling mounting frame is attached to a horizontal rod roof truss, the relationship is with a pen between his logs and nailed (solid relationships and stiff). With the framework of the ceiling between the building frame, ceiling, and roof trusses, all linked into one unified system of solid structure and rigid, and resistant to earthquake. Connections between components or building elements that have contributed notably to the overall stiffness of the building resistant to earthquakes, important to form unity of building structure. Building rigid relatively and resistant to earthquake shaking, supported by foundation system. The foundation used for building - is the foundation stone base. Column placed on a stone building that is relatively flat upper surface and a top surface area greater than the cross section of the column. Foundation like this when an earthquake happens , the column will move freely and shifted from its original position. With the movement of the entire column of the foundation and solid structure , then the whole building just to switch positions , there is no damage to the building in the event of an earthquake . The foundation is

extolled as highly suitable for buildings in earthquake areas. Walls of the building in the form of woven bamboo or plank attached to the frame wall. Framework is also used as a wall against the wall, also as door and window frames. The composition and dimensions of the framework walls inadvertently attached with frame building, it will strengthen the overall building structure, especially against earthquake. Connections between components using pen and pegs. Light-materials for the main structure and roof covering, ie; wood, bamboo, and palm fiber. The material can be supported by structure system, so it does not collapse during an earthquake (flexible), as elastic material. The material comes from the surrounding environment which is easily obtained, it has been used by trial and error.

Vernacular building always adapt to the natural conditions in the surrounding areas (use of building materials), the ability of the people in the building (owned building technology), as well as responsive to the natural environment (earthquakes, floods, etc.). Vernacular buildings in the West Java and Banten province frequent earthquakes capable resist to climate problem. According to the results of studies conducted, it can be stated that local knowledge (indigenous knowledge) vernacular buildings in West Java climate response which indicated by: 1) the structure of the building consists of columns, floor beams, ring beams, etc, arranged in a configuration of the main frame structure, plus order to attach seklaigus wall merges with the main structure, as well as the framework of the ceiling and roof of the horses that also contributed to the overall stiffness. This causes the overall configuration of the building into box structure. The box structure is one of the elastic structure, ductile to earthquakes, 2) building a foundation stone base was very appropriate for buildings that have a building frame is solid and rigid, in the event of an earthquake the building remains intact only shifted his position, 3) interconnection structural components of buildings using pen and peg system has the advantage in the event of an earthquake is still tied between component despite a wobble caused by the earthquake, 4) the entire primary structure of the material is the use of wood, including the lightweight building structure having elastic properties and clay.

Purposing of tropical building designs that are environmentally friendly, energy-saving in the local wisdom deepened, in the case of such studies is to compare between various *sundanese* vernacular architecture. Some principles that support the principle of sustainable architectural thinking and energy efficient. Lighting during the day at occupancy in the village obtained from natural light during the day by opening the windows, doors, openings in walls, gaps that exist in the wall (wall board, bamboo walls, etc.). Because the two buildings in the village does not require illumination level of lighting in the room is quite large (± 250 Lux in the space can be used to write and read the article), so the natural light in and does not require illumination level of lighting in a small space, the lighting is sufficient. Air flow in the building obtained through window openings, doors, holes or cracks in the walls. Incoming air in a room that does not have an air - high temperature (heat), because it is first run through a cool environment, shady (lots of trees). Ventilation in buildings without the use of traditional energy (electricity) to run well and comfortable.

The natural environment is a contributing factor that minimal energy consumption in both the villages, the environment shady trees and green grass so that the air becomes cool, controlled wind speed, solar radiation into heat dapatmenyebabkan air temperature can be minimized by a shady environment, shade, and forth. Energy consumption can be very efficient at both buildings in the village because it has: 1) Space in buildings, especially houses traditionally used more for rest or sleep, cook, and eat, for other activities, such as the visit, talk writing something, and others performed on the outdoor patio / porch. Occupancy patterns of activity like this does not require large energies for the lighting ventilation, and so on, 2) Environmental green building that still, a lot of large trees, which can serve as filter or barrier wind flow towards the building, 2) soil around buildings overgrown, other green plants, which can be used for reducing the reflection of heat generated by solar radiation directly into the ground, 3) adequate ventilation in the roof, so the wind can be channeled through the roof space (the space between, the ceiling and the roof), 4) the stage floor, because it allows air to circulate under the floor so well that no damp, and so on, 5) building eaves to protect sunlight (which carries heat), so sun radiation indirectly on the walls of buildings, 6) walls, doors, windows, jalousie, which can allow air to pass through, 7) Wall light which can prevent radiant heat in the afternoon sun, 8) Color and roofing material that can reflect or absorb the sun's heat. Thus basically residential Indonesian vernacular design is a good example as energy efficient buildings, because very concerned humid tropical climatic conditions, including sun is high enough in the dry season and high rainfall during the rainy season, as well as the moist winds which are relatively high speed, and is also suitable for the area through which the line of volcanology, an easy-going earthquake, which should be emulated by the design of multistory buildings.

3.4.2. Climatic Adaptive Mode; Breath Building Envelope

Adaptive climate mode of Sundanese vernacular architecture in West Java and Banten, Indonesia is very important to study, especially in managing energy consumption effeciently for human-comfort with simple method. Residential thermal comfort or convenience according to Egan (1985) obtained for the following matters: 1) Environmental building is still green and many large trees, so it can hold and filter the air or wind

toward the building, 2) Ventilation in the roof of the building through gaps in woven bamboo, 3) the stage floor in this building as high as ± 60 cm from ground level, and is open to all sides to allow air to flow freely and eliminate moisture under the floor, 4) leaves (overhang) building quite a width of approximately 1 m plus the front porch to more than 2 m. With the eaves like this then the walls of the building are not directly exposed to the hot sun, so as a room divider walls keep it cool, and it does not heat the room, 5) The walls are light, made of woven bamboo can absorb and prevent the heat from the afternoon sun radiation, 6) The walls, doors, and windows allow air to pass through.

Walls made of woven bamboo can be passed to the air. The windows are always open and only covered bamboo lattice, so that air can freely enter the room, so that the temperature inside the room is not hot, 7) roofing material in the form of fibers is very advantageous to absorb heat, so the heat does not get incoming solar radiation into space in the building, 8) Highly efficient use of energy, showing the wisdom of the local culture, 9) Vernacular buildings do not require additional energy to reach a level of comfort in residential buildings, lighting, ventilation, and so on. Energy required for lighting only lights at night in the form of kerosene or electric energy, 10) Thermal comfort in the room with the air control is achieved either through the opening of the door, window, wall gap, lower the room temperature due to wearing wide eaves, so that the wall is not directly exposed to the hot sun. Controlled roof space (not hot) because there is a roof vent. Stage floor that can control the humidity in the air under the floor, the building environment with many trees serves to control wind toward the building. Green grass can reduce the effect of heat reflection from the surface of the soil that can enter the building. Roofing material usage of fibers that can absorb solar radiation. Setting and its presence in the building without the need for energy, so that the building is very efficient in energy consumption for residents living sustainability. There are table which figure out various climate-adaptive mode in various Sundanese *Kampung Adat* (indigenous kampong) in rural and urban (Bandung, and Jakarta). There are similarities, as well as differences in energy consumption efforts, especially in: the arrangement of the built environment, material / material walls, floors and roofs, openings in the walls, roof vents, floor elevation (construction stage). This can be seen in the table 1 and figure 4.

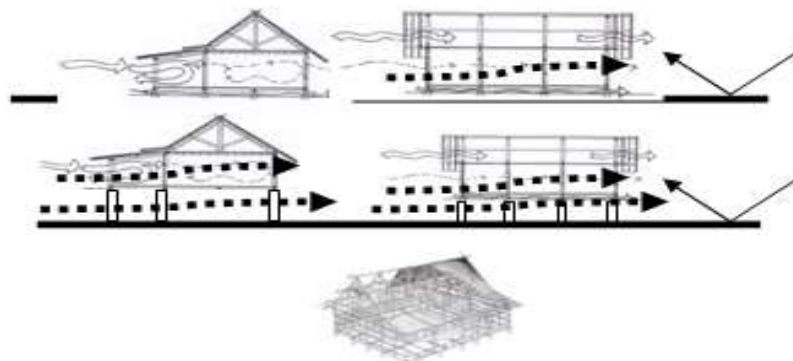












Figure 4. Climatic adaptive mode

	Ciptagelar	Mahmud	Kanekes	Naga	Puloj
green architecture within natural material					
Cross ventilation through Opening, door and window					
Cross ventilation through space under building					
Cross ventilation through porous wall					

Roof of natural material to diffuse sun radiation					
Cross ventilation through wall under roof					
Green-open space within the kampong to filter sun radiation, to adsorp the abundant of rain-water					

IV. CONCLUSION

Various Indigenous Kampong in West java and Banten Province Kampong still preserved local wisdom, especially climate adaptive implementation, such as : Kampong's environment scale , and building scale. Indigenous urban kampong, such as Kampung adat in west java, Indonesia, is the late development of indigenous kampong in rural area. It is still preserve such vernacular wisdom, such as ; Kampong Norm(Adat) manage the kampong to be harmonize with ecology, such as the existing farmland. The natural condition such as : natural open space, organic material as buiding materials.

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