

Reinventing Vernacular Morphology in Modifying Micro Climate in The Sustainability Context

Case Study: Cikeusik Kampong, Kanekes Village (Inner Baduy), Lebak District, Banten Province

Marcus Gartiwa

Universitas langlangbuana

e-mail: mgartiwa@yahoo.com

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ABSTRACT

Morphology refer to physical features such as building form in the context of neighbourhood, cluster of buildings, even in the urban scale. Vernacular architecture refer to local oriented, especially local climate. Indonesia as a tropical climate country, has had a long history of the specific characteristic, as indicated by the term of equatorial tropical. Vernacular morphology has been implemented comprehensively by vernacular community in ordering built environment; especially building and the site which respond to the local climate, which respect to natural environment. Such local wisdom which is known as local genie, has spesific characteristic, such as: architecture without architect, local-orientated, functional, humble, appropriate technology, climate adaptation. Various Sunda Kampung Adat (customary kampong) in West Java and Banten province, have been preserved by vernacular wisdom, which respond to local climate, in providing thermal comfort, such as modifying microclimate in the context of environmental sustainability. Such sustainability is indicated by humble approaches such as technics, and methods. The aim of the research is to get better understanding how vernacular morphology in modifying microclimate, to get human comfort, which respect to environment sustainability. The goal of the study includes : 1) to identify vernacular morphology, 2) to evaluate the micro climate, 3) to evaluate the effectiveness the morphology in modifying microclimate. The methodology of research is quantitative and descriptive, which based on observation and actual measurement. The vernacular morphology has been successly proven by vernacular people, in modifying micro climate to provide thermal comfort for human being. Therefore, there is a recomendation of vernacular morphology wisdom, which can be transformed into contemporary building implementation. Such recomendation mainly respect to environment sustainability.

(9 pt).



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INTRODUCTION

Morphology refer to physical features such as building form in the context of neighbourhood, cluster of buildings. Morphology is the science which study building form, especially building envelope, which is formed by foundation, wall, and roof. In the settlement scale, such as neighbourhood scale, morphology also refer to space which is formed by buildings. The term consist of two words: *morf* which means form, and *logos* which means knowledge, therefore the term means the science which study physical product logically. Vernacular architecture refer to local oriented, especially local climate. Indonesia as a tropical climate country, has had a long history of the specific characteristic, as indicated by the term of equatorial tropical, such as: high radiation, high humidity, high temperature relatively, moderate wind, high precipitation. Vernacular morphology has been implemented comprehensively by vernacular community in ordering built environment to respond the local climate, which respect to natural environment such as: village, kampong(neighbourhood), and building. Such local wisdom which is known as *local genie*, has spesific characteristic, such as: architecture without architect, local-orientated, functional, humble, appropriate technology.

Vernacular architecture such as Indonesian vernacular architecture cannot be separated from locality, especially nature environment, e.g; climate. The result is architecture which uses native-local materials, traditional structural systems, humble. Local characteristic, especially ecology which surrounds the building is main aspect, symbolically and realization, such as: Indigenous society in various areas in Indonesia. Vernacular morphology has been developed by people in settlement scale until building scale, to fulfill human need, to encourage their live, which make architecture has related with human culture [Rapoport, 1969]. Vernacular morphology are nonengineered construction, result of ancient tradition, gradually improved along time as a response to the occupant's needs; which also accepted by their community [Gutierrez, 2004], without supported by theory or building principle, tuned with their climate, environment, respectful with society and environment [Rapoport, 1969]. Vernacular architecture are built to meet specific needs; values, economies and ways of life, cultures [Oliver,1997], therefore Vernacular architecture have sustainable wisdom, such as: 1) environment aspect, built environment which have respectfull consideration to their natural environment, especially climate, 2) social aspect especially human being;human friendly this building is accepted by their society; 3)economic aspect. especially energy usage, energy friendly. Such ecological wisdom is developed from the belief that ecology should play a primary role in the realization of vernacular morphology, mainly building morphology, which can be seen in various Sunda customary villages (*Kampung Adat*) in West Java and Banten . There are 3 aspects of ecology wisdom must be respected, such as ; 1) respect to ecosystem processes, 2) design as a social process, 3) A holistic approach; an interdependency of all things and living objects. Therefore vernacular morphology is very interesting, because it can promote architecture of the future should have paradigms of fostering man's spirit and soul, also buildings which physically last long, and save in energy, utility and disposal costs. Such sustainable concept is how to accomadate human need at present without disturbing the human needs in the future [Steele, 1997].

RESEARCH METHODS

Scope of research is various indigenous villages of Sundanese ethnic, such as : Naga Viilage, Ciptagelar village, Baduy village, and Dukuh village,etc. The methodology which is used is comparative quantitativ- decriptive-analysis.The methodology uses approaches. Such approahes led the indigenus society in ordering built enviroment with climate adaptive wisdom. Research methodology base on observation and actual measurement. First step is : the observation of physical condition of village, kampong, and building, and measurement microclimate of kanekes as case study. Second step is the analyze of morphology of village, kampong, and building, the analyze of microclimate of kanekes, the third step. The third step is discussion of vernacular morphology in modifying microclimate in providing human thermal comfort, finally recommendation such vernacular wisdom in contemporary implementation.



Figure 1 Location of Research
(source: field data)

RESULTS AND DISCUSSION

Vernacular morphology of Sunda *kampung adat* (customary kampong)

The understanding that morphology as wide subject formation in urban or region. Morphology stress mostly in describing form, therefore for giving the meaning of space revealization, which must correlate with space value, e.g: spatial order, spatial relationship, spatial form, spatial

value. Morphology refer to figural quality in the context of spatial form realization, which can be read by pattern, hirarchy, co-relationship each other. Morphology refer to way of indentifying environment characteristic which realization through building form, such as: significant dimension, unique form, and strategic location [DK Ching,1979]. The term of morphology have close relationship with topology and typology, which indicates the differency of spatial characterictic because of location. Tipology as character classification of urban object formation in small scale, which is almost used for define elements form of city, such as : road, green open space, building, etc.Topology corelate to spatial order, which corelate to place. The term refer to the orientation of human activity in certain location. The role of place not just acomodate function activities, but also give certain meaning of place, such as:a) setting of land physically, b) the building compotion and figuration, c) the life of people in certain location. Generally,the architectural aspect include: a) topology aspect such as the orientation of human activity in certain location which based on spatial order and organization, b) morphology aspect such as environment character indentification through building form realization, which figural quality can be read through pattern,hirarchy, and its relationship, c) typology aspect such as the overview to concept and consistensy which people can acknowledge architectural elements. Vernacular morphology in can be seen two scale:1)Settlement : village, kampong, 2)Building.

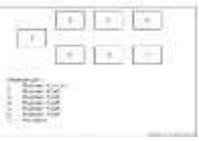
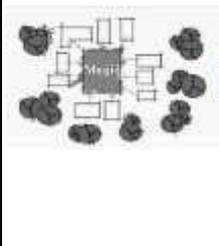
Vernacular morphology in level of settlement propose sustainability implementation,which can be seen in the vernacular habitation styles, which is mainly climate-oriented, such as: 1)The Settlement such as Water management system, harmony between nature and environment, 2)Spatial Specification, Sundanese traditional' houses are very diversified, that it is difficult to determine constants, 3)Life cycle asesment, which is a process to evaluate the environmental burdens associated with a product, to assess the impact of those energy and materials used and releases to the environment, to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product. The settlement is along the drainage basin of river, which shows a human's natural need of water in his life, 4) Representation of tradition-belief, There are two fundamental matter as basic principle of their daily life, such as believe in God, therefore the society respect, take care of the other creation of God, especially the environment, horizontal relation; taking care of good relation between human beings and other living things; plants and animals,5)Sustainability ethics; attitudes toward natural resources and their management.The attitude consists of: Basic philosophy of nature and its management. The indigenous community believes that human being is just one of many living creatures in the universe.

The perception of nature must always be related to the concept of; "*Jagat Leutik, Jagat Gede – Jagat Leutik Sanubari, Jagat Gede Bumi Langit*", which indicate the awareness of the microcosm and macrocosm;the immensity of the natural universe. Therefore natural resource management must be based on self-awareness; their natural resources limitation, the harmonization between people and nature, which implement to their agriculture and forest management. Such morphology can be seen in table 1. Sustainability Wisdom of customary villages (*Kampung Adat*), especially in indonesia is a respresentation of sustainable architecture. Within a given setting, human cultures evolve an adaptive response to their ecology, such as ;climate. Therefore technology is developed as means of fulfilling individual and collective needs. Architectural culture must understand and contribute to the harmonization of ecology and technology, such as:1)Sustainability as a dynamic process; ecology, culture, technology has triangle correlation; ecology indicate the adjustment of human groups to their geographical environment, culture indicate the ideas, beliefs, etc. of a given people in a given period, technology indicate 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 tradition; traditional settlement culture- tradition are developed pararely with the development of the human civilization, 3)Institutional structure of the kampong. Such institution is very important to maintain the tradition, therefore people live under customary law, which are being decided by community leaders of *adat*, 4) Sustainable forest management, which distinguishes three kinds of forest, such as Protected forest (*Leuweung titipan*) which is protected by the community and the forest spirits as the sustainability of the community's livelihoods, as a buffer and also protects the village, open forest which the community uses for its paddy fields and settlement ,5)The sustainable concepts of housing, such as The inhabitant of village vary depend on the complexity of the village, sometimes there is village which has constant number of inhabitant, The

inhabitant of *Kampung adat* believe that their kampong is a heir from their ancestor; therefore they must keep the village always clean and suitable, secure for living. Sustainable housing design concepts, such as: a) The clean area ; the village has a holy place which not everybody can go to this place ;communal house and *Bumi Ageung* (building for their heirloom), b) profan place is place for profane activities, c)dirty place; narrow than other place; is on river branch, also as a border from village to other villages; simple buildings for washing, shower, stable, rice mortars and ponds. Dividing the places on the basis of their activity, as an effort to improve interaction- social sustainability, d) The traditional settlement protect their houses and preserve the ecological environment through the separation of two division, such as :“forest” and “settlement” areas.

Vernacular morphology in level of building applies the principles from the community custom and belief, therefore an important aspect of a sustainable house design is the extent to which the house can accommodate user needs. Well-designed houses minimize environmental impacts and risks, for meeting user needs. The sustainable house morphology must been applied to: 1)Maintaining the land contour as an effort to get sustainability of nature. The strategy which is applied such as podium type as building structure, which allows building exist without change the contour, a mode to maintain land topography. The house is built above these pillars allows them to maintain topography naturally. The uplifted floor of the house from the land allows land conservation, 2)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 sunlight. In this pattern, sunshine with high intensity (settlement of reside at equator tinder area), will give less influence to the room temperature, 3)Building Materials. House design especially materials consider its whole life cycle. Building materials are either made from naturally available sources like ;inorganic materials or from organic raw materials, such as wood. 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,such as Bamboo , wood are used for the floor and wall of the house.

Table 1 Vernacular Morphology of Various *Kampung Adat* Sunda (customary kampong) (source:field data)

vernacular morphology scale	Mahmud-Urban Kampong	Kanekes Village (Inner Baduy)	Kampung Naga	Kampong Pulo
village				
kampong				
building				

The roof is made of wood, bamboo and organic material, *ijuk* as roof; and stone as foundation, 4) House shape, the house shape is crucial to ensuring building can be built sustainable, consider flexible designs that are easy to upgrade and expand. It depend on environmental technical aspect, the shape of the house has an important effect on its stability, also economic aspect, construction cost can be minimized by using simple shapes without numerous and complicated angle, also Social aspect which to ensure a socially, aesthetically and culturally appropriate house design consult with the house residents, regarding which build form and lay out will be suit their needs and fit with their customs, 5) Building structure is using a simple structure, which based on 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 *lower structure*, or foundation, they use *umpak* 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, 6) Building components and construction method, The main building components are thfoundation, supporting frames, floor, walls (with door and window), ceiling and roof. Simple building techniques help to ensure sustainable reconstruction Sustainable construction practices are low cost, practical and environmentally appropriate, such as the availability of building material and skilled workers, Simple, low-cost, robust, and practical solutions, 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, therefore more expensive.7) Mass product is based on community based development. Managing by vernacular community, which is in turn usefull for the need of whole community interest. All member of the community share the knowledge and craftsmanship in construction process. The occupant involves in the construction process. House and kampong are product of community. The result is specific construction, such as building shape, fabrication method, building component, connection details, transportation, finally inventory. Such model of vernacular mass product can be seen in the figure 5, 8) Building especially house can be explored by three component of mass product: 1) Foundation component with specific dimension, 2) Wall component with certain module, fabriacated by local people in small industry scale, 3) Roof component with certain module, fabricated by local people in small industry scale, 4) Each component is fabricated from the nature resource at the first, and the next phase is transportation, finally the erection and connection.

Tabel 2. House’s Material

Element of construction	Material	Source of material	Process of material - fabrication	System of material-fabrication
Roof cover roof frame trusser	Rumbia bamboo wood	<i>Reuma Leuweung -lembur Leuweung Lembur- Leuwung kolot Reuma</i>	Kampung <i>Huma</i> Kampung Kampung	Gotong royong –community Gotong royong –community Gotong royong -community
Column	wood	<i>Leuweung kolot -Reuma</i>	<i>Huma</i>	family
Beam	wood	<i>Leuweung kolot- Reuma</i>	<i>Huma</i>	family
Wall	bamboo	<i>Leuweung lembur</i>	<i>Huma</i>	family
Floor material Floor frame	Bamboo Bamboo- wood	<i>Leuweung lembur -Reuma Leuweung kolot</i>	Kampung <i>Huma</i> Kampung	Gotong royong- community Gotong royong -community
foundation	stone	river	Kampong	Gotong royong -community

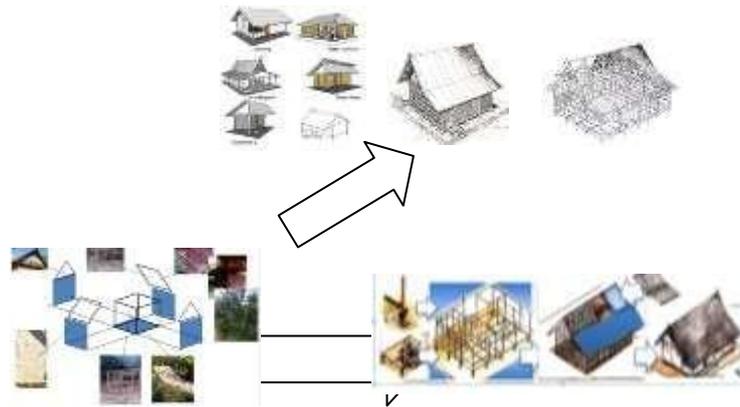


Figure 2 Model of building morphology realization

Micro Climate Condition

Climate is a physical environment condition of atmosphere which characterised the location-geography, which is influenced by ; temperature,, humidity, wind, rainfall, solar radiation, which has close-relationship. Climate can also be defined as average condition of weather on one place of the earth's surface, which happen during a long period. The character of tropic climate of Indonesia as *Equatorial character*, such as :1)The rainy season and the dry season. The difference between the rainy and dry seasons isn't relatively obscure. Precipitation (Rainfall) causing problems at the site, which also can damage the building's body, 2)Sun-radiation, radiation is relatively high, the majority is been reflected, 3)Air temperature, often above the limit of human comfort; most of the area is heat because it receives most sun-radiation, the temperature range is 21⁰ - 27⁰C., 4)Humidity, is known as the RH (relative humidity); give effect thermic discomfort, high humidity with a range ; 55 % - 100 %., 5)The movement of air generally is low, does not support comfort sensation, 6)Low diurnal region, Most of the time the air was cloudy. luminance can reach 7000cd/m², minimum illumination 850cd/m².

Micro climate is a specific climte of site, as a result of micro climate (atmospheric) interaction with physical condition certain place, nature condition or built environment.The general character of Sunda villages micro climate is a reference in indicating the thermal environment include aspects such as: 1) the rainfall is relatively moderate, local rainfall often happen because of mountain topography condition, which is indicated by valley wind and mountain wind. Such aspects give effect to high humidity, especially in rainy season, also in the transition period (dry season to rainy season), 2) Monsoon wind such as west and east monsun wind blow in villege area, but local wind is dominant. The local wind is mountain wind and valley wind. The mountain wind give effect to low temperature and high humidity, 3) The level of radiation is quite high, as effect of monthly percentage's sun-duration, 4) the temperature gap between daytime and night time is rather wide, between the lowest temperature in the night and highest temperature in midday, especially in the dry season and transition period 2 (rainy to dry season).

Vernacular morphology as built environment, in this context as a form of physical human culture, as the output of the process of adaptation to the natural environment, particularly climate, the manifestation such as ; 1) various morphological spatial structuring efforts, e.g: the arrangement of the environmental setting and the cultivation land,2) Building morphological: building enclosure, orientation, mass building, system, technology, building materials.

The condition of village micro climate correlate with soil's material surface characteristic. The usage of soil materials surface influence the environment performance, especially in overcoming problem of climate. Such case is related with albedo; reflection-coefficient, is the diffuse reflectivity or reflecting power of a surface. It is the ratio of reflected radiation from the surface to incident radiatio upon it. Its dimensionless nature which is expressed as a percentage, it is measured on a scale from zero (no reflection) of a perfectly black surface to 1(perfect reflection) of a white

surface. In general, the albedo depends on the directional distribution of incident radiation, except for. Most land areas are in an albedo range of 0.1-0.4. A lot of open spaces in customary kampongs use nature surface, the fabricated material is used at least as possible, as an effort in gaining the environmental friendly kampong (Table 3). Albedo of various customary kampong can be seen in the following table. In general the albedo of the neighbourhood of urban *kampong adat* village <the albedo of *kampong adat* in village areas, especially the real vernacular, such as Kanekes village which has been presevered to be natural environment. The micro climate performance of building has been indicated by: 1) the indoor's span of humidity is below outdoor's humidity (60%-70%) in the daytime, especially in dry season. In the night time, the indoor's humidity span is close to outdoor's humidity span, especially near to morning-time especially in dry season and transition 1 (dry-to rainy season), 2) wind velocity is about 0-1 Beafort scale, with indication physically felt on the face. Such condition is in the span of humidity comfort. Such wind character disturb the human comfort in rainy season and transition season-2 (rainy to dry season) and dry season, 3) radiation level is in the comfort zone, is about 20-27 °C which is indicated by globe temperature. The maximum radiation is in transition 2 (dry season to rainy season), 4) the temperature level is the comfort zone is about 23°C-27°C in the day-time, but not-comfort the night time, there is heating by firestone.

Table 3. Comparison study of albedo in various customary kampong (%)
(source: field data)

Surface	Area	Albedo(%)			
		Mahmud	Kanekes	Naga	Pulo
1	Residential materials	15	25	23	15
2	Terace of residentials cluster	15	-	-	-
3	Hall/yard for furniture cfratmen	15	-	-	-
4	Rice field/park	10-18	10-15	10-15	
5	Tomb of the Kampong founder	9	6-8	6-8	6-8
6	Places for worship: Mosque,	15	20	6-8	-
7	Public MCK	10-17	-	8-12	8-12
8	Small café in local house	9	-	-	-
9	forest	18-20	25-30	20-23	18-20
	Average	17	23	19	18

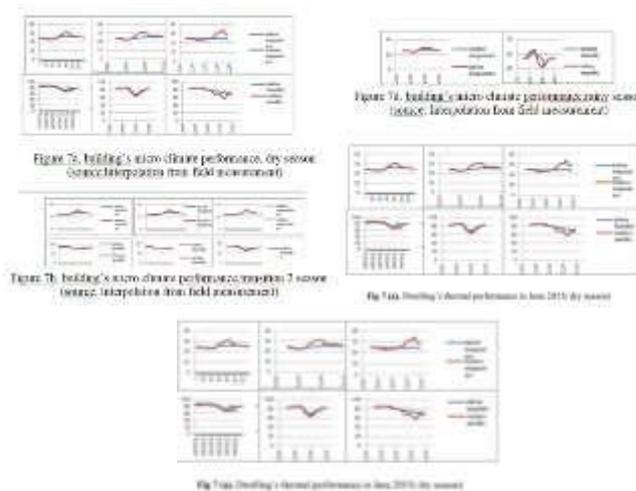


Figure 3 Curve of microclimate building indoor and outdoor (source: field measurement)

RESULT AND DISCUSSION

The potential of wet tropical climate such as Indonesia: 1)The combination of air temperature, humidity and wind speed support human being has activities outside the building. Solar radiation is sufficient, able to provide natural lighting as well, the potential for energy saving lighting, 2)High rainfall, providing clean water supplies for human activities of daily, It is suitable for plants that are sensitive to water shortages. Rain gives a cooling effect / decrease in air temperature, low wind speed, not danger to the structure / building construction,3) almost two third of its area comprises the sea. Dominant wind direction is the east wind and westwind throughout the year, 4)the duration of day not too varies (11-12 hours).



Figure 4 Map of Indonesia macroclimate

The micro climate performance of the kampong and dwelling are indicated by : 1) the ability of kampong's environment in regulating the kampong's micro climate, indicated by the significant gap between macro climate and kampong's micro climate, 2) building envelope's ability in regulating building micro climate, indicated by the difference between building's outdoor and indoor micro climate.

Kampong micro climate performance, consist of: 1) the air temperature between dwellings and the field temperature has been indicated that the dwelling's average temperature is lower than the field's average temperature. In dry-season-daytime, temperature between dwellings is relatively lower than field temperature. In the rainy season-day time, the temperature between dwellings and field temperature is not far, 2) sun radiation between dwellings is lower than the field radiation, because it is influenced by vegetation surrounding and building shading, In general, the performance of kampong's micro climate is influenced by topography of the mountain region, the axis of Cikeusik kampong is south-north which is parallel to mountain-valley wind's direction. The vegetation around the kampong influence shading and thermal environment, especially by the stilt- dwellings configuration which enable wind movement under the dwellings. The open space in the kampong, close-access to river give enhancement of shading. Such aspects influence the cooling effect of the kampong, especially in dry season and transition 2 (rainy to dry season), the stilt dwellings form decrease the humidity and wind velocity in the night, 3) the humidity between dwellings and the field's humidity not to far even in night time and daytime. Such condition is influenced by the air flow which goes under the building, also moves through the space between dwellings, 4) the velocity between buildings is quite lower than the wind which blows in the field. The axis of the building is parallel with wind's north-south direction of mountain-valley wind, therefore creating air flow, which support thermal comfort in kampong.

The vegetation which dominate the village, especially kampong oCikeusik give shading, also specific air flow in the kampong, create air temperature lower, through cooling area around the buildings. Therefore reducing the conductive and infiltration of heat gains, which in turn can be regulated into the comfort level. High temperature and radiation in certain seasons, such as dry season can be overcome by configuration of dense-buildings. High humidity and low temperature in certain seasons, such rainy season, the thermal environment conditioned by heating, which is provided by firestone in the dwellings. In the extreme weather, such as the rainy season, the level humidity is high in night-time, which is sometimes indicated by fog existence. In the dry season generally the temperature is low in night time, but it is quite high in the day time. Vegetation, particularly in the form of shade giving trees and ground cover, should be part of modifying kampong's micro climate in tropical climates, especially in Baduy area. Data relating vegetation and high stilt dwellings show providing shade and reduce sun-radiation, gain with relatively small blockage of wind [Fathy,1986]. High shrubs next to kampong providing shade, reduce the wind velocity which blow through the kampong. Dense plants near the kampong Ground cover by plants around a kampong reduces the reflected solar radiation and the long wave radiation emitted towards the walls from the surrounding areas, thus lowering the heat gain in dry season. Kanekes is a area of large green areas, its village and particularly the outskirts of village are devoid of

important vegetation. No heat islands in most Kanekes area related to an abundance of vegetation and natural areas.

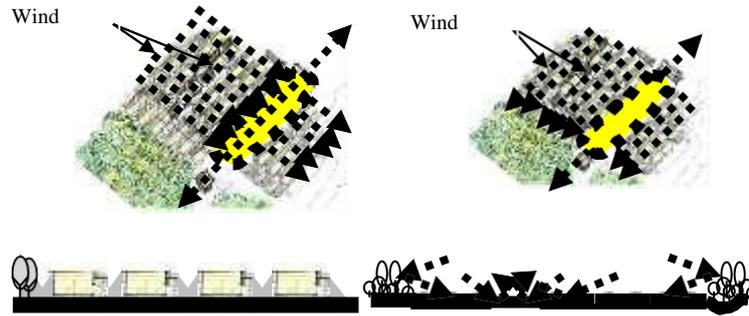


Figure 5 Micorclimate in kampong scale

The detail building micro climate in four seasons is indicated by aspects, such as: 1) in the dry season, the centre part zone's dwellings are easy to be hot because of being close to open space. Northern part easy to be hot than southern part because of valley-wind. in the centre zone, especially eastern part hotter than western part, 2) In rainy season, the differentiation of climate element lower than dry season, such as: humidity, temperature, radiation. Centre part is easy hot, close to open space, northern part easy to be hot than southern part because of valley-wind. Eastern part easy to be hot than western part, because of duration of sun-radiation, 3) transition 1 (dry to rainy season), the differentiation of climate elements of transition 1 is bigger than rainy season. Centre zone easy to hot close to open space, northern part easy to be hot than southern part because of valley's wind. Eastern (centre) part easy to be hot if it's been touched by sun-radiation, eastern part easy to be hot because it's touched by sun radiation relative longer, 4) transition 2 season, the differentiation of climate elements is bigger than rainy season. Centre is easy to be hot because of closeness to the open space, the northern part is easy to be hot than southern part, because of valley's wind. The centre's eastern and eastern part is easy to be hot than western part.

The overall characteristic of micro climate of kampong is indicated by the significant distance between aspects such as: a) day's maximum temperature and night's minimum temperature, b) day's minimum humidity and night's maximum humidity, c) day's maximum radiation and night's minimum radiation, especially in dry season. d) in the rainy season the humidity-level is quite high, especially in the night. The micro climate performance as described above such as differentiation of temperature, humidity, radiation, wind in the night-time less than the day-time.

Energy consumption can be very efficient at both buildings and 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, 2) Environmental green building that still, a lot of large trees, which can serve as wind filter towards the building, 3) soil around buildings and green plants, which can be used for reducing the sunlight reflection/ heat, 4) adequate ventilation in the roof, so the wind can be channeled through the roof space (the space between the ceiling and the roof), 5) the stage floor, because it allows air to circulate under the floor so well that no damp, 6) building eaves to protect sunlight (which carries heat), so sun radiation indirectly on the walls of buildings, 7) walls, doors, windows, jalousie, which can allow air to pass through, Wall light which can prevent radiant heat in the afternoon sun, 8) Colour and roofing material that can reflect or absorb the sun's heat. Energy efficient buildings can be indicated by the existence of sunlight along the year; the dry season and rainy season. Climate adaptive method can be seen from figure 5 and table 4.

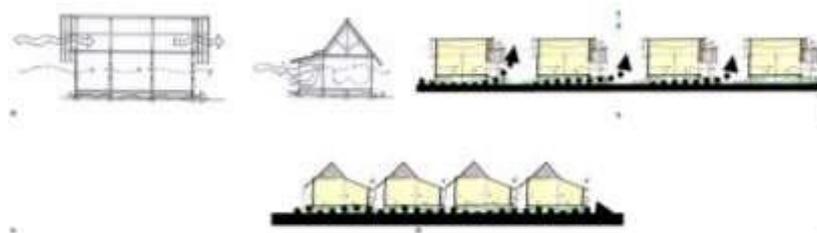


Figure 5 Air movement through space under the building's floor

Table 4 The mode of microclimate modifying in building of Sunda *kampung Adat*

To make air quality (environment, green nature)				
To make air flow/ventil				
To filter sun radiation				
To maintain the land resources, an effort to get sustainability of nature				
Landuse and zoning:				
1. Natural and man made				
2. Nearby the river				
Structural System:	Rigid Frame	Rigid Frame	Rigid Frame	Rigid Frame
Foundation, Wall, Roof	Stone, Fabricated, Bamboo/Blk, Clay	Stone, Natural, Bamboo/Blk, Kayu/Local Plant	Stone, Fabricated, Bamboo/Blk, Clay	Stone, Fabricated, Bamboo/Blk, Clay

Such condition show that: a) protection from sun-radiation, conductancy low, not storage the heat, b) in the night, there is mountain's valley which cold character enter the wall's hole and floor's hole, so the influence the closeness of indoor's and outdoor's thermal environment, c) the diferentiation of temperature, radiation, wind in night-time in rainy season is the least in compare with transition-1, transition-2, dry-season. In the rainy season, the building envelope's perfomance toward humidity is weakest, because of wall's void. Such condition is overcome by floor's natural cover and fire-stone. The diferentiation of temperature, humidity, radiation in day's time in rainy season is the least, in comparison to transition-1, transition-2, and dry season. In the rainy season, the humidity is high, the globe's temperature is quite same with normal temperature.

Building's thermal environment performance indicate the response of dwelling to kampong's thermal environment, which indicate, such as: a) in dry season, especially daytime, there is a gap of element of outdoorindoor, such as temperature, humidity, radiation. The surface temperature close to indoor temperature, which indicate that the indoor has been controlled since the inner surface, b) in rainy season, especially in the day-time, there is no gap between indoor climate-outdoor climate, but especially there is a gap between indoor's wind and outdoor's wind, which indicate that the configuration of building mass and thickness can regulate the wind velocity significantly. Design of small openings, long overhangs and local materials used in tropical vernacular constructions play an important role in optimizing ventilation rate and indoor thermal quality[12]. The form of the vernacular Indonesian houses are considered to be a prime example of environmental design to response the regional climate conditions. It has a low thermal mass, extensive solar shading, and a large number of ventilation openings. The environment condition which produced by these housing types are generally considered to be thermally unsatisfactory, and there has been a recent move towards the development of designs which offer the thermal performance of the vernacular house[1], whilst using modern construction technique and low cost material Indonesia, an archipelago nation in South-East Asia contains more than 13,000 islands is located in the tropical region (8° North and 13° South). Because of its equatorial position, Indonesia is endowed with a tropical climate, aired by the monsoon winds. With a high pluviometry annual average.

Indonesia is then characterized by a hot and humid climate. December, January, and February cover the rainy season in most areas in Indonesia. March, April and May represent the transition from the rainy to the dry. June, July, August represent dry season. Finally, September, October, November represent ther transition from dry season to rainy season. In Indonesia, most of modern societies look vernacular societies as backward and their houses as old fashion. Although some who admire these houses were then just copying them to build similar shapes of buildings in urban areas but for different function other than dwellings. This study was conducted in four seasons: the rainy season, the dry season, transition-1 and transition 2 in 2016/ 2017. In most areas of Indonesia, especially in kanekes area during the rainy season outdoor temperatures are likely to be lower than in the dry season. The crucial condition may occure in the dry season where occupants may feel too warm since the ambient temperatures tend to be higher. This study is to examine whether occupants will feel thermally comfortable in both seasons in vernacular houses. Vernacular houses in one locations, namely Baduy dalam (inner baduy) were taken as samples for the study. In many vernacular buildings, both primitive and

vernacular, some ingenious solutions to the architectural problems of resisting extremes of weather and maintaining a comfortable indoor climate can be seen. Vernacular shelters of tropical region (hot humid climate) are usually lightweight in order to allow rapid cooling down and has larges openings to allow the maximum possible breeze penetration. These openings are fully protected from the sun and from penetration by driving rain. In Indonesia, the existence of a wide variety of vernacular village and house styles as the product of the cultural groupings; the country consists of many islands, many worldviews, languages, ways of life and social culture. Building technology is largely dictated by the nature of available materials. Traditionally one of building components, which epitomizes shelter and which perhaps, dominates all buildings is the roof. The importance of the roof as a major architectural form is underlined by the need to shelter from the hot sun and the rain. The Kanekes builders, for instance, have applied what they term as *payung*, or the umbrella principle to develop roof forms. From the view of general form, we can see the Kanekes village shelter has basic form as stilted construction, which other Java and Bali regions. Their vernacular houses are elevated about only 50-180 cm from exterior surface.



Figure 6a wind flow through the kampong from south to the north



Figure 6a wind flow through the kampong from the east to the west

Detail of dwelling unique character of kampong adat, such as: 1) The *golodog* (veranda) is singled out as a significant Kanekes's building element to attain environmental comfort for the type of climate present in Banten region, Indonesia. The veranda can be shown to be a fairly constant element in the development of the Kanekes house, which is generated from ancient time, as the rural house of Sunda ethnic's house. The Kanekes counterpart may have a narrow bamboo's terrace sitting and neighbourhood gathering, as an extension of the house's front. *Golodog* provides transition from public to private spaces, also protect the house from sun's radiation and rain. *Golodog* integrate the house with the public's way of the kampong. The *golodog* improves thermal comfort of the house in hot and humid climates, dominant in Kanekes and provides shading, usefull space for a number of domestic activities the outdoor climate in hot and humid regions is more pleasant than the indoors. [Givoni, 1998]. Furthermore, basically the house can not accommodate all household activities, many functions have to be carried out outdoors. In this respect, outdoor areas must be protected from sun radiation, therefore the *golodog* was once a regular feature of the house. Most *golodog* are narrow strips as roof extension. These *golodog* act as a really outdoor space for family gatherings and relaxation activities. The length of *golodog* is primarily related to the design of the dwelling. The population recognizes the veranda's importance as a shading element, but selfbuilders in the modern life seldom incorporate such knowledge into the house design, 2) thermal comfort, the design of stilt houses with bamboo-woven creates an enhancement space to obtain adequate air flow to mitigate heat gains in indoor spaces and keep cooling the building envelope. This combination of such passive design gives proper ventilation conditions in houses. Furthermore such investigations have shown that self-built houses, are not provided by furniture, due to their small functional spaces, 3) this condition enhance air flow and access to windows which are not manipulated optimally. A certain natural environmental can also be accessed, where users do not adjust small window openings in favor of their own thermal comfort. Analysis of self-built settlements in the region of Banten province shows that house orientation which is north-south, gives significant influence to thermal comfort, 4) the axis of kampong is also paralel to the direction of mountain wind, which is south-north direction, movement and natural ventilation are main tools to provide the thermal comfort sustainably, which in turn thermal environment in hot humid climate [Garna, 1974]. Adequate ventilation allow fresh outdoor air.

therefore the fresh air is passed over people to increase evaporative cooling on the skin [Lechner, 2001], 5) Cross ventilation also must be provided to achieve comfort thermal environment. Cross ventilation assures the constant flow or movement of the air inside a building [Garna, 1974], house occupant must consider their designs to provide buildings with comfort thermal environment. Different types of climate requires different types of design strategies [6], 6) The thickness of roof material (*kiray*) which is formed by layers of bamboo (*usuk*, *reng*, *kiray*) enable insulation, which can trap/catch cool air into the building and enable stratify, which is supported by overlay roof materials, more roof-layers enable the increase of insulation, which in turn the roof have high-insulation, 7) the space under building which relatively high, enable the infiltration of air-flow. The overhang enable to cool the building structure from sun radiation in the dry season [Pearson, 1994]. Such

condition as form of roof's protection toward building structure's material, especially column and beam. Air flow with velocity of 1,0 m/s will give relief satisfactory for all the time, give decrease the efficiency of skin evaporation, to avoid uncomfotability of skin evaporation. Such that, opening and porosity of wall support the thermal comfort [Mediastika,2002].

CONCLUSION

Vernacular's morphology in modifying microclimate can be seen in various customary kampung, but effectively in Sunda *kampung Adat* which still preserved natural material usage; open space, building materials. The effectiveness can be seen in albedo value, which has lowest value in Sunda Kampung, than urban kampung, especially in social space, which accomodate socio-culture activities, especially the specific character of the kampung. Such implementation can be seen in three levels : 1)village morphology, such as in *Kampung Mahmud*, kanekes village ;which is formed by respecting the environment surrounding, the zoning which respect natural environment, which give quensecuenses of average low-albedo (reflection of sun radiation), such as: green open space, vegetation, the usage natural materials, river, 2)Neighbourhood/kampung morphology: The infrastructure for social space, such as: street, path, and open space between buildings, which influence the low thermal environment, such indicate in Kanekes village 3)Building morphology: maintaining vernacular building: local material, local technology, vernacular envelope as response to tropical climate.

Such condition can be seen in case study of various Sunda Kampung, which can be indicated in the comfort environment in indoor-building/house, also outdoor space, which is supported by natural building materials, also natural surrounding, such as vegetation.

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