PATTERNS and LAYERING

Japanese Spatial Culture Nature and Architecture

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Patterns in Japan's Vernacular Architecture : Envelope Layers and Ecosystem Integration

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Current overexploitation of earth's regenerative capacity[1] calls for a progressive shift of contemporary architectural design practice, and of environmental benchmarks to evolve from neutral to regenerative (Reed 2007). Strategies for the integration with local ecosystems, which is referred as one of the fundamental basis of future green architecture (Grosskopf, Kibert 2006; Guy, Kibert, Sendzimir 2002), are therefore incorporated in the concept of regenerative architecture, contributing for the renewal of environmental and built systems, emissions' absorption, and restoration of resources and ecological functions.

The adaptation of vernacular architecture to local climate and micro-site conditions is acknowledged by diverse authors, either highlighting its low environmental impacts, through a sustainability assessment perspective[2] (Murakami, Ikaga 2008) (Sakomoto 2005), or either focusing in its co-evolutionary design properties (Frazer: 1995), through a explorative architectural design research perspective. Remarkably, John Frazer observes the attribute of vernacular architecture to share intrinsic evolutionary and symbiotic properties of nature itself, as the capacity to achieve *"a rich biodiversity of interdependent species of plants and animals that are in metabolic balance with their environment"*, through "means of profligate prototyping and the ruthless rejection of flawed experiments" (Frazer 1995: 12).

In Japanese architecture tradition, the concept of multilayered building envelope with its soft boundaries (Kuma 2010), allowing occupancy environmental control; constitute design strategies where the integration of micro-local ecosystems may be identifiable[3]. The intermediate space is referred simultaneously as a inherent condition of traditional Japanese architecture (Kuma 2010), and is being progressively reclaimed as an essential environmental control element to sustainable building design (Matsunawa 2010). However, the reference to a singular Japanese architectural tradition is an abstraction, as it encompasses several different styles and typologies (Isozaki 2006; Nute 1995). Even the adoption of vernacular models to the formulation of *japan-ness* in the beginning of the 20th century (Isozaki 2006), collides with the variables present in the multitude of rural minka styles.

Therefore, it can be asked: which materials, motives, textures and patterns constitute the skin and structure of Japanese vernacular architecture? What boundary patterns are observed in *minka* typologies? "Japanese dwellings are often said to be made of wood and paper; but (...) It is more accurate to say that minka are made of wood, grass, and earth." (Kawashima 1986: 18), in different local arrangements. The existence of local patterns among regional diversity in Japanese vernacular architecture was identified and registered by Wajiro Kon (1888-1973)[4]. In "Nihon no Minka" (1927), Japanese rural house typologies were interpreted *"(...) as material expressions of particular lifestyles, concluding that it was the natural environment which largely defined those patterns of living."* (Nute 1995: 114).

The present research aims to examine the role of intermediate spaces and the usage of different porosity material patterns in building's envelope boundaries, in *minka* architecture, identifying local typologies and its responsiveness to micro-local conditions. It is intended to visualize how these patterns change in space and to clarify how its soft boundaries are subject to local adaptation, and ecosystem integration.

Design elements and envelope boundaries in vernacular architecture of Japan

Passive design solutions, found in vernacular architecture, show evidence of the existence of 3 worldwide typologies of building systems: 1. a cold climate closed system; 2. a hot climate closed system; and 3. a hot and humid climate open system (Kodama 2005). Closed system types are characterized by high thermal inertia and low degree of openings, and open system types by a high degree of openings and low thermal inertia materials. However the application of these archetypal models in local architecture is not rigid, and several regional variations and hybridizations occur.

In vernacular architecture of Korea it is possible to identify the resource to both closed and open systems synthesized in the same housing typology (Kodama 2005: 125). Also in Japan, where climatic conditions share similarities with Korea[5], and where cultural influences from mainland Asia are registered[6], (Nute 2004: 26), closed and open systems coexist, in diverse gradations in vernacular and erudite typologies, resulting in the abundance of transition elements, that characterize Japanese architecture soft boundaries. Transition spaces and boundary layering are not as well exclusive of Asian region, since other examples are observed, as in Mediterranean vernacular architecture' verandas, courtyards, *mashrabyas*, and movable shades.

In Japanese architecture, the transitional boundaries that form the buildings enclosure are synthesized as intermediate spaces and screenings (Kuma 2010). Frequent transition spaces that mediate from interior to exterior space, are constituted by the *genkan* (entrance) and *engawa* (covered hallway space). Among entrance typologies, the *doma* (or earth room), with an earthen floor pavement, is common in vernacular architecture, either serving as *genkan*, or as well cooking and working areas. The *engawa* transitional space is located at lower or similar floor level as the interior areas, paved by different materials as pebbles or wood board flooring. It is enclosed by different mutable gradations: wide open, translucent panels and/or opaque shutters; acting as intermediate thermal insulation and ventilation space. The multiple controllable screening devices add to the building's envelope several layers of different materials and porosity, according to climatic season and weather.

1. Ama-do
(wood shutters)

2. Sudare and Yoshizu
(bamboo and marsh reed shades)

3. Shoji
(paper and wood sliding doors)

4. Goshi
(wood lattice)

5. Yuki amaya
(thatch protection)

6. Wood cladding
(over earth walls)

7. Bamboo cladding
(over earth walls)

8. Plaster and wood structure
(over earth walls)

9. Board wood walls

10. Thatch
walls

11. Thatch roof

12. Shingle roof

13. Tile roof

14. Tile roof

15. Copper plate roof

16. Earth room
(doma, niwa, genkan)

17. Wood flooring

18. Tatami flooring

19. Bamboo flooring

20. Pebbles

21. Groundsill foundations

22. Raised floor
(on wood and stone poles)

23. Leveling Stone Base

24. Stone Retaining wall

25. Intermediate space
(veranda, engawa)

Spread over the islands of Japanese territory, and settled in different local conditions, 9 typologies of *minka* houses (next page Fig 3), depicted in (Kawashima 1986) *minka* survey monography, were analyzed, in order to determine its usage of intermediate spaces and different porosity material patterns. The envelope layers and materials identified in the surveyed *minka* typologies, were organized as the following: *Intermediate spaces; Movable wall elements and screenings* (Ama-do, Sudare and Yoshizu, Shoji, Goshi, Yuki amaya), *Fixed wall elements* (Wood cladding, Bamboo cladding, Plaster and wood structure, Board wood walls, Thatch walls), *Roof materials* (Thatch roof, Shingle roof, Tile roof, Copper plate roof), *Flooring materials* (Earth room, Wood flooring, Tatami flooring, Bamboo flooring), and *Foundation structures* (Groundsill foundation, Raised floor, Leveling stone base, Stone retaining wall) (Fig 2).

Interpretation of material patterns (and ecosystem integration)

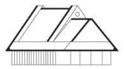
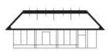
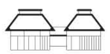
The integration of local ecosystems within architectural design may be described as implementation of synergies towards landscape assistance in thermal comfort processes, water cycle management, waste treatment, environmental amenity, local food production, or enhancement of cultural functions and biodiversity (Grosskopf, Kibert 2006). The adaptation of humanized landscape and natural environment into a cooperation symbiosis within a natural or humanized ecosystem is referred in Japan as *satoyama*, a traditional socio-ecological landscape, associated with vernacular architecture systems.

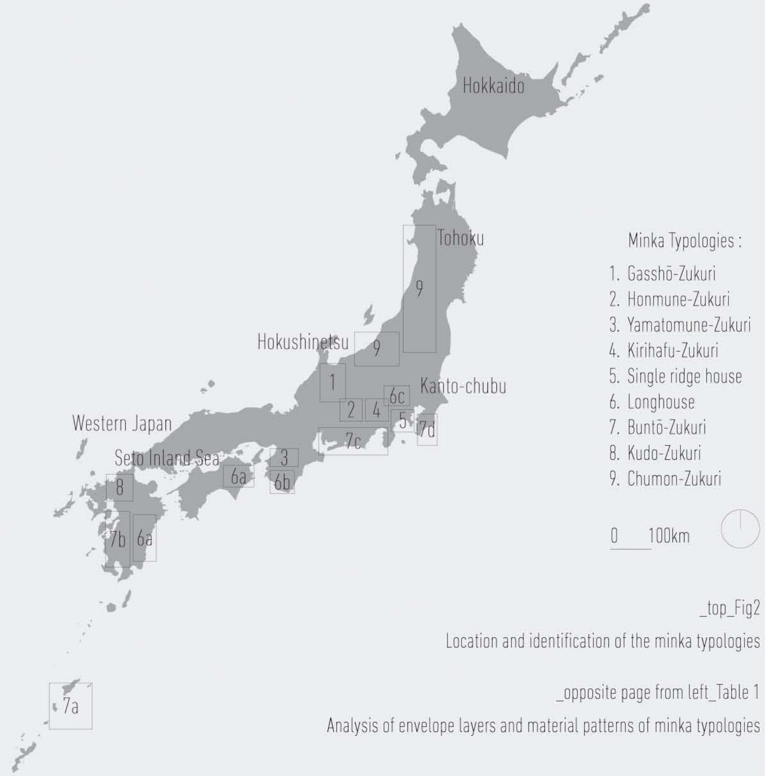
In *satoyama*, the performed social and productive activities[7] provide support for diverse ecological functions, such as biodiversity habitats, water cycle and soil formation. In these socio-ecological structures, advantage use of provisioning, regulating, supporting and cultural ecosystem services is taken without compromising ecological functions balance. It can be assumed that vernacular architectural systems, integrated in *satoyama* landscapes, also share degrees of ecosystem integration. For interpretation of envelope layers and material patterns identified in *minka* typologies, it was attempted to establish patterns of local adaptation, based on regional ecologic[8] and climatic features (Fig 3).

Within vernacular *minka*, local diversity regarding different porosity material patterns in building's envelope boundaries elements may be identified. These patterns often reflect the structure of available resources, materials and textures, both natural and of resulting man made crafts skills and techniques, expressing the results of material stereotomy, as well as indicating about local (natural and cultural) integration. Envelope layers and material patterns of *minka* typologies were classified according to essential environmental exchanges and contact surfaces, as lateral, top and base envelope elements, providing contact with diverse elements such as soil-ground, light, air-wind, and precipitation. In some cases, it was noted the existence of local sub-variants of the same typology, or similar sub-typologies were identified in different areas. The performed analysis results are expressed in Table 1.

_from left_Fig 2

Envelope elements and material patterns in minka typologies

	Site				Lateral Envelope											Top Envelope						Base Envelope								
	Climate		Ecosystem		Intermediate	Movable					Fixed					Shape		Material				Flooring					Foundation			
Minka Typologies	Climate Region I	Climate Region II	Ecosystem Cluster	Inland [I] Coastal[C]	Veranda	Ama-do	Goshi	Shoji	Sudare	Yuki amaya	Wood cladding	Bamboo cladding	Plaster and Wood	Board Wood walls	Thatch walls	Gabled	Hiped	Thactch	Shingle	Tile	Copper plate	Earth Room	[as entrance]	Wood	Tatami	Bamboo	Groundsill	Raised floor	Leveling stone base	Retaining wall
01. gasshō-zukuri 	I, II, III	F	Hoku-shinetsu	I	□ eave extension	■	□	■						■	□	■		■				■ work area and stable	■	■	■		■	■	■	
02. honmune-zukuri 	I, II	G	Kanto-chobu	I	■ side/rear varanda. front porch	□	■	■	■		■		■			■			■	□		■ doma	■	■	■		■		□	
03. yamatomune-zukuri 	IV	J	Western Japan	I, C	■ to formal rooms, and inner courtyard	■	■	■	■		■		■			■		■		■		■ work area	■	■	■		■	■	□	
04. kirihafu-zukuri 	I, II, IV	G H	Kanto-chobu	I	■ balcony to south on 2 floors	■	■	■	■		■		■			■		■		□		■ work area and storage	■	■	■		■	■	■	
05. single ridge 	IV	G H	Kanto-chobu	I, C	■ front porch	■	■	■				■	■				■	■				■ large work area	■	■	■	■	■	■	■	
06. longhouse a 	III, IV, V	J K	Western Japan	I, C	■ front veranda, interior sotohara	■		■						■			■	■			□	■ small work area	□	■	■			■	■	■
06. longhouse b	III, IV	J	Western Japan	I, C	■ front veranda	■		■						■		■			■			■ small work area	□	■	■			■	■	■
06. longhouse c	III, IV	G	Kanto-chobu	I	■ front veranda	■		■						■		■	■	■				■ small work area	□	■	■			■	■	■
07. buntō-zukuri a 	VI	L	[out of clusters]	C	■ open veranda, to rooms, SW	■		□						■			■	■				■ separate cooking area	■	■	■			■	□	
07. buntō-zukuri b	VI, V	J K	Western Japan	I, C	■ between buildings, to SW	■	■	■	■					■			■	■		□		■ separate cooking area	□	■	■			■	■	
07. buntō-zukuri c	VI	H I	Kanto-chobu	I, C	■ front veranda	■	■	■						■			■	■		□		■ large work area	■	■	■			■	■	
07. buntō-zukuri d	VI	G	Kanto-chobu	I, C	■ front, and side veranda	■	■	■			■		■	■			■	■		□		■ large work area	■	■	■		■	■	■	
08. kudo-zukuri 	VI	J	Western Japan	I, C	■ open veranda to rooms esp. SW	■		□			■		■				■	■		□		■ large work area	■	■	■		■	■	□	
09. chumon-zukuri 	II, III, IV	C D F	Tohoku-hokushin	I	□ porch, ante-chamber [chumon]	■	■	■	□	■	■		■		□	■	■	■				■ large work area	■	■	■		■	□	■	



_top_Fig2

Location and identification of the minka typologies

_opposite page from left_Table 1

Analysis of envelope layers and material patterns of minka typologies

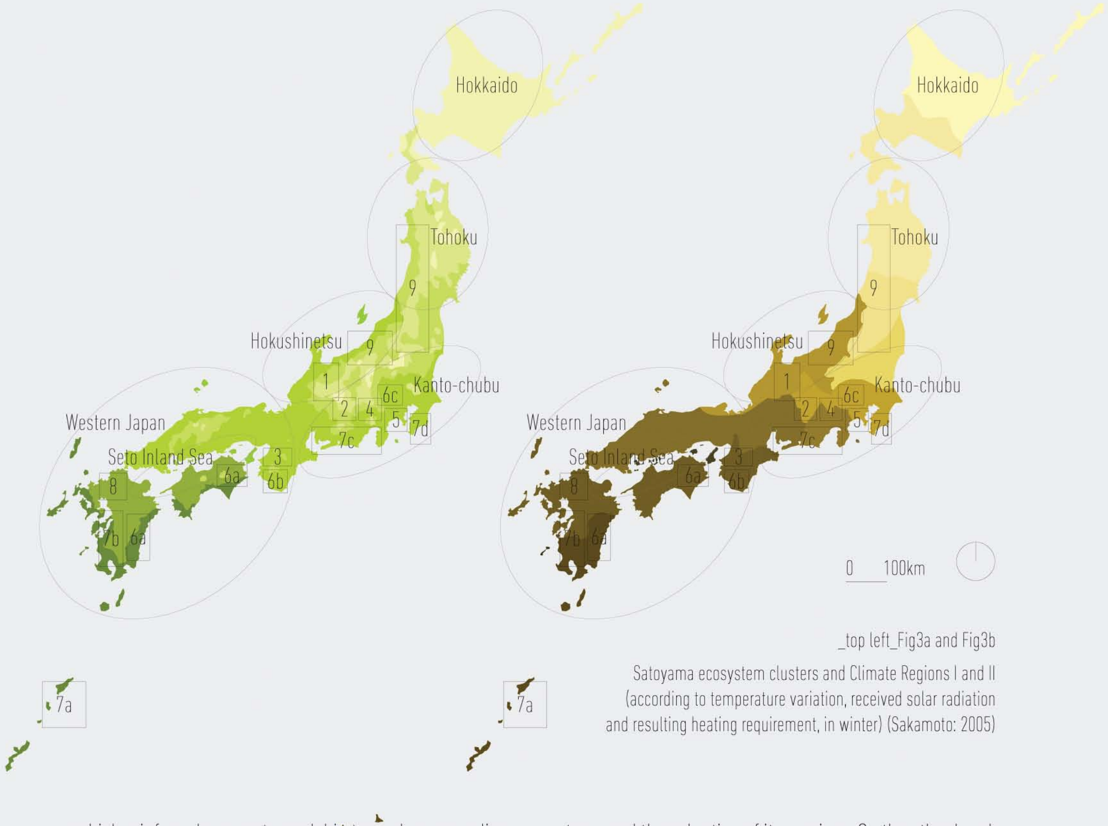
Discussion and Conclusions

In Japanese vernacular dwellings, the existence of material and local patterns and the resource of intermediate spaces arise as important features. Typology shapes present a huge diversity, reflecting different programs and site adaptation, confirming the statement that "as physical expressions of local materials, climate and lifestyles, rural minka in particular were powerful sources of cultural and natural regional identity." (Nute 2004: 25) Functional program and life-styles are more reflected on interior typology, structural shape and circulation than envelope elements, material patterns and intermediate spaces, which act as immediate interface with site specificities, and ecosystem integration. It is observed local diversity in envelope elements and intermediate spaces that reveal site specificities, although several material patterns may be widespread into large regions. Thatch roofs are common on most of the regions, while tile roofs tend to be observed only in southern areas. Similarly, division between inland and coastal areas might be attempted, as well as mountainous and flat areas.

Intermediate or transition spaces are particularly flexible, taking specific different forms and functions, in each typology, from covered alleyways, circulating-perimetral engawas or porches, and verandas. The location, although typically situated to the front of the house complex, presents several variants. On the other hand, although its dimension and function may vary, the presence of an earth entrance room is a feature present in all typologies.

Some material patterns are common to almost all the typologies (as wood and thatch) and others are particularly specific to some typologies (bamboo cladding and flooring, and copper roof). Board wood walls are most commonly observed in mountain areas, where earth walls are more difficultly observed. Although some of these local variants are directly connected with local availability of materials, it not only influences the relation to ecosystem interaction (extraction and maintenance of material reserves) but also the adaptation to indoor comfort requirements, as thatch presents insulation properties and earth walls, humidity absorption.

Some relations that might be established between ecosystem cooperation and envelope material patterns and elements in vernacular architecture of Japan are directly related with the fundamental use of locally sourced natural materials,



_top left_Fig3a and Fig3b

Satoyama ecosystem clusters and Climate Regions I and II (according to temperature variation, received solar radiation and resulting heating requirement, in winter) (Sakamoto: 2005)

which reinforce human stewardship towards surrounding ecosystems and the valuation of its services. On the other hand, the great employment of natural sourced materials signifies increased recyclability and biodegradable disposability at the end of lifecycle, while during occupancy stage, it may also constitute biodiversity refugium and habitat niches.

Thatch roofs and walls allow the growth of grass, to increased insulation in winter, which is periodically cut, in summer. Living materials can also contribute to balance hygrothermal conditions, as they absorb air humidity, contributing to indoor comfort, and air quality, as envelope materials layers tend to present porosity characteristics. In a similar manner, the earth room allows soil permeability over an extended surface, contributing to water cycling.

It was also observed that broader climatic regions[9] are not sufficient per se to form local typology patterns, it is necessary to observe other site and micro-site specificities. While a typology is essentially formed by program, life-style and culture, available local materials, technology processes, and neighboring regional influences, it also encompasses adaptation to local ecosystems attending to specific micro-local features, as topography, hydrology, local biodiversity and landscape arrangements.

Given few surviving examples of *minka* houses, great part of them consisting of reproductions and relocations, not inhabited and removed from traditional life style cycles, attributes an additional difficulty to presently assess temporary seasonal occupancy features, such as movable elements as *sudare*, or exterior fences of diverse kinds, for climatic protection towards wind, snow, and sea airstreams. However, regarding the presence of wall screening and layered elements, variations were observed in variety and amount of covered surface, specially referring to *goshi* and *shoji*[10].

In conclusion, the study of envelope layers and material patterns observed in vernacular architecture may point out future explorative and creative directions, in architectural design. Architecture and planning act as direct drivers[11] on the equilibrium of ecosystems, influencing the vital services provided by these. Its design decisions can potentially influence negative or positive effects. Ecosystem integration design results, based on a given range of site specificity, as in vernacular architecture, are not deterministic but allow degrees of innovative freedom that may create a truly responsive and collaborative architecture with time and place.

Footnotes

1. Presently exceeded in what concerns natural resources, depletion of biodiversity and farming land, and concentrations of pollution and waste. (WWF. (2008). Living Planet Report 2008. World Wildlife Fund (WWF). Available at: www: http://assets.panda.org/downloads/living_planet_report)
2. The assessment of vernacular architecture performance tends however to be analyzed mainly through energy aspects (thermal comfort, energy consumption, embodied energy, etc.) and the balance with micro-local and global environments is assessed predominantly from impacts, and rarely from benefits towards the local or global ecosystem.
3. Moreover, both concepts of fudo (風土) (the reading of the site); and the concept of boundary intermediate spaces, kyokai (境界), grow from a tradition to understand nature and architecture at a site-specific local level.
4. Who conducted in the 1917 the Habukokai minka research.
5. Cold and dry winters and hot and humid summers.
6. Particularly during the Yayoi period.
7. Which take place within layers of natural environment, forestry and cultivated areas, and built systems (Itonaga: 2005: p.68).
8. For ecological characterization, were used the satoyama ecological clusters, representing study areas with geographical, climatic, ecological, social, economic, and political affinities, according to Japan Satoyama Satoumi Assessment (JSSA: 2010).
9. Generically used in energy conservation policies, and sustainable building assessment.
10. The presence of these elements is possibly less related with micro-local specificity and more with the degree of complexity of the typology samples, as it appears larger in more elaborated buildings, and less significant in less wealthy examples.
11. Upon potential impacts as land use change, micro-climate change, invasive species, pollution, over-exploitation or under-use of local resources.
12. Climate Regions I (regional division for housing standards (according to temperature variation, received solar radiation, and resulting heating requirement, in winter), and Climate Region II (regional division for non-residential buildings according to heating supply requirements, in winter, and cooling requirements, in summer) (Sakamoto: 2005).

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