ANALYSIS OF RURAL HOUSING IN HOT-HUMID AND HOT-ARID REGIONS

Part I . Housing Analysis in the Solomon Islands

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1. INTRODUCTION

In the developing countries, generally speaking, there has been little change in the centuries-old tradition of village layout and construction. Rural planning has been an officially neglected field, mainly because it is not considered by central policy makers as part of the economic development of the country. Rural settlements therefore tend to develop in an uncontrolled fashion, exposed to many environmental hazards, natural and man-made. The problems which rural settlements face are therefore varied and interrelated.

In 1972 the U.N. Conference on Human Environment held in Stockholm noted "The housing and environmental problems of traditional urban areas and rural settlements in developing countries could never be solved by attempts to replace them to the highest desirable standards. The problem is too big and the resources are too small for that sort of approach"¹³⁾.

Earlier in 1968 another report of U.N. Seminar on Rural Housing recommended that "Suitable systems for the construction or improvement of rural housing must be adopted, bearing in mind the national traditions and most appropriate new techniques. It is desirable to use local initiative to the maximum, including societies, groups and leaders already on the spot, in order to obtain participation of people"¹⁴⁾. The above statements emphasize the need for adopting rational rural developments within the scope of local tradition, resources and social organization instead of introducing international or foreign standards. Within such a context, the approach of this study is to categorize the improvement of rural settlements into two classes: First, those improvements which definitely need the assistance of non-native technology and materials, and second, those which may be achieved by locally available skills, materials and the manpower.

Information and analysis techniques for the first type of improvement are easily available to architects and planners in the developed world. The basic principle underlying the second type of improvement is the efficient utilization of natural resources of the country, both human and physical. In order to achieve this, one must be aware of the building tradition of the region, and of its background factors, including house types, life-style, building materials and techniques, as well as prevailing environmental constraints.

This paper is the first report of the series of studies on rural housing. It proposes to assemble such information

Fig. 1 Flow of Research

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for the second type of improvements and evaluate the same in the Solomon Islands, with special emphasis on settlement locations, house types, materials, and construction techniques. The specific aim of this research is to seek rational ways to improve the living environment in the developing world.

To fulfill this aim, case studies have been carried out in two regions with distinct differences in their physical and socio-cultural backgrounds – the Solomon Islands and Syria. As existing research on rural housing problems in these countries is meagre, the major part of the data in this study was obtained from field studies through natural observation, questioning, measuring and photographing.

2. PHYSICAL BACKGROUND OF THE SOLOMON ISLANDS

Located between five and twelve degrees south of the equator, the Solomon Islands form a scattered archipelago stretching approximately 1500 km in a south-easterly direction from Bougainville to the Santa Cruz Islands. The main islands are built up around a volcanic, mountainous backbone as high as 2447 m.

The climate is typical of tropical islands, that is warm and humid with little change throughout the year. Following Atkinson's classification¹⁾ of tropical climate, two climatic areas may be distinguished at about 1200 m above sea level, they are : tropical island climate and tropical upland climate. The sea as a climatic stabilizing mechanism causes the significant difference of these two areas. Sea breezes carry a heavy load of water vapor and cause more rainfall and cooler nights in upland regions.

The trade winds are another climatic factor of the area. During winter in the southern hemisphere the south-easterly winds blow almost continuously with varying intensity. From September through to March, the winds are undependable, unlike the trade winds. Being at the fringes of monsoons, most of the winds during this time come from the west or north-west. The geographic and climatic characteristics of the different regions and the remoteness of some islands play an important role in the evolution of local building traditions.

3. LOCATION OF SETTLEMENTS

During the field survey throughout the Solomon Islands, some 250 settlements were visited. Most of these are of small size with a population of less than 200. The variety of these settlement sites may be categorized and analyzed as follows.

3-1 SMALL AND REMOTE ISLANDS

Being isolated from the major chain of islands, the atolls of Ontong Java, Sikaiana, Rennell and Bellona and some of the Easter Outer Islands are suitable habitation for small groups of people. Most of these islands are of less than three sq. kilometre in area, with a high density of Polynesians. The advantage of such a location was the isolation, which means there was little need for defence against outside world. At the same time the isolation has also led to difficulties in introducing modern communication. The shortage of land and potable water became critical in supporting an increased population.

3-2 OFFSHORE ISLANDS

There are many small offshore islands around the major islands. The islands are of either natural cays or artificial ones constructed on coral blocks in shallow lagoon waters. One of the advantages of such a location was easy defence against the bush people of the main land as well as easy fishing and

Fig. 2 Map of the Solomon Islands

Fig. 3 Location of Settlements

communication by canoes. Another advantage of such a location is the relief from the swamp mosquitoes of the main land. The disadvantage, on the other hand, is a shortage of water which sometimes is carried from the main land. The shortage of land is not as critical as on the remote islands, because the people of the offshore islands have their gardens on the mainland.

3-3 OVER WATER

There are some settlements on stilts over the water, but they are not as numerous as they are in Papua New Guinea. In case of Kia in West Santa Isabel, the whole village was on top of a hill looking down the strategic Austria Sound until the end of the last century. Since the pacification by the protectorate government and the establishment of missionary stations on the coast facing the narrow sound, the people on the hill moved down, but the coastal strip was so narrow that it was necessary to build houses over the water. An advantage of dwellings over the water is that it does not encroach on the land which can be used for other purposes.

3-4 COASTAL STRIP

Many of the settlements throughout the Solomon Islands are located on the coastal strip where communication by sea is easy and convenient for both agriculture and fishing. The advantage of modern sea transportation has helped to develop cash crops in some areas along the coast. This has caused the population of the coastal strip to increase rapidly. Except for the Guadalcanal Plane the coastal plane are very narrow. In many cases coastal people have gardens of taro and sweet potatoes in the hilly bush some distance inland from the coast.

3-5 HILL

Hills, not far from coast, are ideal for gardening of taro and sweet potatoes and it was safer in the past to be away from the coast where they were exposed to sudden attack by seawater people. Nowadays people prefer to live along the coast where modern transportation and facilities such as schools and clinics are easily accessible.

3-6 RIVERSIDE

Because of the steep topography of the major islands, villages on riversides are in danger of floods at times of heavy rainfall. Therefore not many settlements along rivers were observed despite easy access to water. In some villages, located on sandy banks of streams, the houses have been raised on stilts or high stone foundations in order to survive during sudden floods.

3-7 RIDGE

A bird's eye view of the inland area of large islands such as Malaita and Guadalcanal reveals areas of cleared or scrub-over-grown land surrounded by a sea of dense forest growth. In these clearings most of the hill people live and work, only occasionally penetrating the surrounding forest to hunt or to journey to other settlements. The villages are usually located on top of ridges near springs and streams. Garden plots are cleared with bushknives and used only for a year or two, then abandoned in favour of new sites. This regenerates soil fertility by the so called "bush fallow system".

4. HOUSE TYPES

The Solomon Islanders' houses vary from one region to another according to such factors as the

Fig. 4 House Types

location of settlements, the ethnic and cultural differences, and the extent of Western influences. The basic house consists of two separate buildings which fulfill distinctly different functions of sleeping and cooking. A cooking house can be shared by several families but a sleeping house is generally used by one family. The classification of the various types of houses in the Solomon Islands, shown in Fig. 4, is based on differences in floor levels of both sleeping and cooking houses. D.L. Oliver⁹⁾ maintains that the pile dwellings are the result of the Western influences of the British administration, which encouraged natives to build pile dwellings for sanitary reasons. H-31 type, a raised floor sleeping house with a cooking house on the ground, is accepted throughout the Solomon Islands.

A detailed analysis of each house type has been reported at the Kanto District Convention of A.I.J. in July 1977 (15).

Fig. 5

5. PLAN AND USE OF SPACE

A significant aspect of traditional village planning in the Solomon Islands is the absence of Physical boundaries around or between house sites. The reasons for this are three: First, family units are not entirely independent because their social structure is based on large families and clans. Secondly, the village sites are cleared from the bush as a whole and planned for protection from enemies or animals as a single complex. Thirdly, any physical obstacles such as fences, shrubs or walls tend to obstruct air circulation in and around houses.

The interior of the house was traditionally a single space in which individual privacy was hardly possible. Major activities such as cooking, eating and sleeping took place in a single room, and many miscellaneous activities were carried on outside around the house. Consequently, although the land belongs to individuals, the Solomon Islanders' notion of territory expands vaguely into the surrounding

area which is a part of the community sphere. Various types of planning may be analyzed as follows (Fig. 6), with regard to the territory pattern of each household.

Fig. 6 Territory Pattern

T-1 is a type of traditional pagan hamlet where the land was occupied by the chief of the clan without any recognition of individual territory. An independent household is fundamentally a place where family members sleep. It is mainly the women's domain since it is they who are responsible for such activities as cooking. Communal houses such as men's house, canoe sheds and work sheds fall within the men's sphere.

T-2 offers another type of traditional plan. Here several families, most of whom are related, share a cooking-house. Here territorial recognition indicates a mixture of individual and communal use. In this way women have their own place to work and leave the dwelling to be used by men during the day. The area shared by a set of houses and a cooking house is recognized as group territory rather than that of an individual.

T-3 is an example which suggests another type of traditional land use, where the land belongs to a clan but individual territory is vaguely recognized. Whether cooking takes place inside the main dwelling or in a detached houses, each house has an independent threshold or boundary, but the area around each house are more or less communal.

T-4 is similar to T-3 type but the territory of each house is clearly distinguishable. Recent land reform, especially in urban areas, is beginning to ensure such individual control and ownership of land.

T-5 and T-6 indicate new patterns in urban areas planned under the Western concepts. Each house has physical boundaries of shrubs or fences. These types of plans are not welcomed by the local people because it is against their custom of recognizing the open spaces surrounding houses as communal or semi-communal spaces. As the traditional system of collective security is inadequate in an urban community, it has been found necessary to provide security to each household.

Activity patterns in and around houses have been reported at the Kanto District Convention of A.I.J. in July 1977 (op. cit.), and indicated the importance of such semi-enclosed space as verandah. Providing shade and allowing ample breeze, the verandah presents a significant aspect of the Solomon Islanders' house. It is an entrance space as well as space for outdoor living, eating, and working. Verandahs are arranged in several ways as shown in Fig. 7. They are oriented according not only to the prevailing winds and such but also take into account the view from the verandah; usually towards sea, a river, a road or a communal open space.

Fig. 7 Type of Plan

6. CLIMATIC CONSTRAINTS ON TRADITIONAL HOUSES

One of the chief causes of discomfort in the warm and humid Solomon Islands is the subjective feeling of skin wetness which can be alleviated by air flow. Continuous ventilation is therefore very desirable and affects all aspects of building design. Shading of roofs, walls and outdoor living spaces is also an important requirement.

6-1 SHADING

In the Solomon Islanders' traditional houses the screening of sunlight is generally provided by: Horizontal building elements; Vertical building elements; and Vegetation. Horizontal building elements are most effective against a high sun. The simplest form is a roof overhang, a projecting floor-slab or a balcony. The eaves of a thatched roof can shade a large area of wall and verandah. Raised floors also provide shade for afternoon sleep and children's play. Vertical building elements are an effective way to screen against low sun. However, disadvantages are that vertical elements tend to limit the view, and to also prevent effective ventilation. Window shutter panels are commonly used to minimize these disadvantages. Vegetation can serve as a sun-control device. As winds are necessary for achiev-

ing physical comfort, vegetation is planned in such a way that the air-movement at body level is not disturbed. Therefore tall plants with a slender trunk, such as coconut palms, betelnut palms and palmyra palms are preferred for planting around houses.

6-2 TYPE OF VENTILATION

The predominance of high humidity necessitates a correspondingly high air velocity to increase the efficiency of sweat evaporation. Ventilation has been considered in traditional settlements in various ways, including the following.

- Location of some settlements is determined by the prevailing winds, as shown in Fig. 8.
- Buildings are spaced to allow winds to reach every house.
- Surrounding bush is cleared around the settlements to allow air flow through the living zone.
- Orientation of the openings and verandah is determined so as to provide the best possible ventilation.
- Large openings are protected from the penetration of solar radiation and driving rain.

Fig. 8 Plan of Anuta and Tikopia

Fig. 9 Cyclone House

Fig. 10 House in Tikopia

Fig. 11 House in Utupua

Fig. 12 Joint: Studs to Rafters

Fig. 13 Joint: Rafters to Ridge Beam

Fig. 14 Detail of Ridge

Various means of ventilation, observed in traditional houses, may be classified as follows and some of them are used simultaneously.

V-1 TYPE : Opening on the top of end walls, are an effective way to exhaust hot indoor air and smoke. This type was observed in many traditional houses used for cooking.

V-2 TYPE : Slits on the top of side walls allow the movement of air while preventing direct sunlight and maintaining privacy. Almost every traditional house has such slits partly because of the irregular shape of building materials and inaccurate workmanship.

V-3 TYPE : Low openings at ground level are a typical air flow system of the Polynesian houses of the Easter Outer Islands. This permits natural breezes at body level, and maintains privacy.

V-4 TYPE : Shutter-type windows are made of leaf panels like the wall and roof, and hinge out held by wooden sticks. This type of window is finding greater use in the western and central parts of the country. It indicates the influence of Western methods in the use of local materials and techniques.

V-5 TYPE : Screen walls of Gilbertese houses in the Western Solomons are either movable or fixed. One type is composed of mats of coconut leaves which can be held up during the heat of the day. The other type is a series of bamboo studs with slits between them. They allow ventilation all over the living space. The disadvantage of this type is its lack of strength in cyclones. It is one of the reasons why this type is not popular despite its advantage in ventilation.

V-6 TYPE : Slits between flooring material allow an air flow, and thus reducing the indoor temperature. To contain warmth at night, people lay leaf mats on the floor. The slits are created accidentally because of the irregular shape of the split sago trunk.

V-7 TYPE : Open space over partitions permits airflow without sacrificing visual privacy.

6-3 EFFECT OF WIND ON HOUSE FORM AND DETAIL

The most significant influence of winds can be observed in what may termed a "cyclone house" (Fig. 9). This is a kind of emergency shelter for women and children. These shelters are built in villages in northern Malaita and are well protected by forests. The thatched roof is set on the ground so that cyclones can not lift it.

The form of Tikopian houses (Fig. 10) is another example of structure designed to cope with the danger of high winds. To release the destructive effect of strong winds, the low-pitched gable roof of sago palm leaf reaches within 30cm or so of the ground. Openings on side walls allow breezes at lower level to blow across bodies of people.

Plan and shape of Utupuan houses (Fig. 11) also show a considerable influence of the prevailing winds. The oval shape reduce the impact of strong winds.

7. LOCAL BUILDING MATERIALS

Organic materials such as Sago Palm, Pandanus, Bamboo and bush poles constitute the basic construction materials for most of the buildings in the Solomon Islands. They are obviously easy to obtain in the Islands and are equally easy to work with simple tools. Inorganic materials such as stone and coral blocks are also used for the foundations of houses but are never used as major structural materials.

7-1 POTENTIAL OF LOCAL MATERIALS

SAGO PALM (Metroxylum) : Sago palm is the most important building material throughout the Solomon Islands. The core of the trunk is fed to pigs, the split trunk is used as flooring material, leaves are for thatching, and the ribs of the leaves are used for stitching the panels (Fig. 15). People carefully plant Sago palms near their houses and keep some in reserve for natural disasters such as cyclones. The low heat storage capacity of thatching material fulfills the functional requirements

MATERIAL DIAGRAM		STRUCTURE							FINISH & FURNITURE					DURABILITY	
MATERIAL		STILL	FRAME WORK	RAFTER	STUD	JOINT	FLOOR	WALL	PANEL	PANEL	ROOF OF PANEL	STITCH OF PANEL	WINDOW & DOOR	BED BENCH SHELF	
SAGO PALM	Split Trunk				△	⊙	⊙								4-5 years
	Mid Rib														
	Leaf							⊙	⊙						
	Rib of Leaf														
COCONUT PALM	Trunk	⊙													
	Leaf							△							2-3 years
COCONUT	Fiber String					△									
BETEL NUT	Split Trunk						⊙						⊙		
PANDANUS	Leaf							△					⊙		2-3 years
BUSH POLE		⊙	⊙	⊙	⊙										10-15 years
BAMBOO											⊙				
LOIR CANE						⊙						⊙			

⊙

 MOST COMMON

⊙

 COMMON

△

 RARELY USED

⊙ MOST COMMON ○ COMMON △ RARELY USED

Fig. 15 Material Diagram

dictated by local climate. The major disadvantage of thatching is its short life and poor durability. The risk of fire is not critical in the rural context, because of the open spaces between buildings.

BETEL PALM (areca catech) : The Betelnut palm grows as tall as the coconut palm but is smaller in section. The split trunk is mainly used for making furniture such as beds and benches, and for flooring material. It is also used for stilts and piles.

SCREW PINE (pandanus) : Pandanus leaves are rarely used for thatching in the Solomon Islands, for they are not as durable as the Sago palm leaves. People make a form of umbrella structure from Pandanus for protecting from rain. Pandanus leaves, as well as coconut leaves, may be used as a over layer of the Sago leave roof.

BAMBOO (bambusoideae) : It is common to use bamboo joints as containers for water and food. As a building material it is used for scaffolding, rafters and studs but not for major structural elements.

BUSH POLE : Various kinds of bush poles are used as basic structural materials. The section varies from 100 to 300 mm. Major piles and beams are sometimes larger than 300 mm in section.

LOIR CANE : Throughout the Solomon Islands, this is the most popular material for tying all structural and finishing elements. In some islands where loir cane is in short supply, coconut fibre string is used as a substitute. Nails and steel bands are being used increasingly but they have a tendency to deteriorate faster than loir cane in humid conditions.

7-2 DURABILITY OF TRADITIONAL MATERIALS

The main causes of the deterioration of building materials are related to weathering. In hot and humid conditions they are subjected to repeated exposure to rain, sunshine and wind. Consequently thatched leaves have a short lifetime of three to four years depending on the thickness and the inclination of the roof. With continuous maintenance, the overall durability period can be extended twice as long as the usual case. Maintenance can be provided by replacing deteriorated panels with new ones or putting extra layer of leaves over the roof. Termites and rot are other causes of deterioration, and are known to destroy many parts of the frames within a decade. If the footing of piles is improved, the durability of bush pole frames can be extended. As the lifetime of thatching materials is much shorter than that of the frame members, bush poles are not critical to the durability of an entire house.

8. BUILDING TRADITION

In building a new house or making extensive repairs to an old one, it used to be common that a series of work parties, consisting of volunteers of no particular relationship to the house builder would complete the final assembly of the dwelling in one or two short sessions. These days, most of the work is done by a few family members and assistance is given only for the major setting-up work. This change is caused by the introduction of a cash economy and individualism. The time to complete a house, therefore, depends on the size of the house and the number of workers involved. With concentrated assistance, it can amount to less than a week. Other cases take four to five weeks. Most of the work is the men's responsibility, and the women help only with such light jobs as transporting, drying and cutting leaves. The primary role of women is to prepare food while the men are working.

8-1 PREFABRICATION

Construction of the traditional Solomon houses is undertaken in three phases : preparation, setting-up and finishing. As mentioned above, the preparation and finishing phases are carried mainly by family members while the setting-up involves the assistance of relatives and neighbours.

PREPARATION : Work starts with cutting of logs, sago leaves and other materials from the nearby bush, and then proceeds with cutting, splitting, drying, stitching, or weaving of these materials into panels. Prefabrication of these wall and roof panels is most time-consuming and this is one of the reasons why people prefer to use more durable materials such as corrugated iron sheeting involving less work. To produce these panels, Sago leaves are dried for a few days. While half dried, they are folded around a stick and stitched to overlap one other as seen on Fig. 16. These panels are dried and stored under the eaves or below the raised floor. Frame members are also stored after proper cutting

and shaping.

SETTING-UP : One or two days are required to set up the major structural members, with the assistance of neighbours and relatives.

FINISHING : As the thatch panels are pre-fabricated, once the setting-up is done it is easy for a owner-builder to do the rest of the construction. The size and weight of the prefabricated panels is therefore the key to distinguish owners work from collaborative work.

8-2 STRUCTURAL TYPES

The structural systems may be classified into four types of roof supports and three types of floor supports as shown in Fig. 17. The structure of the Solomon Islands house mainly involves the use of timber. The main frame is of bush poles of diameters ranging from 100 to 300 mm, and secondary members are usually more slender bush poles or bamboo. The major vertical members which support roof and floor are set into holes in the ground with coral rocks as a base.

The R1 type has only one major beam which is the ridge, and rafters are supported by horizontal members connecting the top of the wall studs. Examples of this type were observed in the islands of Vanikoro and Utupua. Having wall studs dug into the ground and roof structure well connected to wall frame, the whole frame work is quite resistant against cyclonic winds. The R2 type has two major beams. This type is used for simple shelters such as cooking sheds, canoe sheds or work sheds. The R3 type has three major beams which support rafters and is typical of the type of construction used throughout the Solomon Islands. The R4 type which does away with the long posts supporting the ridge beam shows a Western influence. Recently this type of roof support is in wide use.

The F1 type of floor is the traditional one in which people cover the ground with mats made of coconut leaves. The interior ground level is usually 100 to 500 mm higher than that of the exterior and this practice ensures a clean and dry floor. The F2 type is a raised floor type in which the floor load is taken on separate piles independent of the roof posts. There is another traditional type between the F1 and F2 types, employing a raised floor inside a F1 type house. In this way the same technique which was used traditionally to support the roof beams is applied to support the floor beams. The F3 type is also a raised floor type where the floor and roof loads are supported by the same piles. This system is utilized in most of the new European type houses built by Solomon Islands Government.

9. CONCLUSION

In this study an attempt has been made to document and evaluate the environmental quality of the traditional rural houses in the Solomon Islands. These structures have evolved under the local climate and physical conditions and have successfully met the requirements of human and social needs. However in recent years and especially in urban areas the conditions and requirements of the people have been continuously changing, and any assessment of the habitability and the environmental quality of the traditional house must be viewed in relation to currently prevailing conditions.

In the rural environment however, where nearly 90% of the people live, changes in social conditions and life style are slow. Land is still available in the natural environment and the settlement organization and spatial requirements for dwellings are the same as in the past. There the traditional houses continue to be habitable, appropriate to their user's life-style, and economical to build.

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Fig. 16 Process of thatching

Fig. 17 Structure Type

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