

Lumber Demand and Supply in Ryukyu Islands

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Introduction

Ryukyu Islands are located at the most south part of Japan. In this paper, Ryukyu Islands mean Okinawa prefecture, namely the islands located south of Okinawa main island. Ryukyu Islands consist of many islands, 41 of them are populated as of April 1, 1990. Total area is 2,264 km². The largest island is Okinawa main island (1,185 km²), which is the largest island in Japan except Japan main land (Honshu, Hokkaido, Kyushu and Shikoku) and Etorofu-tou and Kunashiri-tou (both are now occupied by Russia). In Ryukyu Islands, Iriomote-jima (284 km²) and Miyako-jima (159 km²) are largest next to Okinawa main island. The other islands are smaller than 100 km². The total population is 1,241,000 persons in 1991. The population density is 548 persons/km², and is larger than that of all of Japan (326 persons/km²). This density is 11th largest in 47 prefectures.

This study area has several characteristics in Japan. In addition to the geographical characteristics that this area consists of a lot of islands, the following points have to be considered. The temperature of Ryukyu Islands is in subtropical zone with Amami Islands in Kagoshima prefecture, and this is one of the important characteristics of this area. Since the end of the previous war, Ryukyu Islands and Amami Islands had been governed by U.S.A. Amami Islands were restored to Japan in 1953. On the other hand, Ryukyu Islands were restored on May 15, 1972. This study area had been governed by U.S.A. for 27 years. Since the return to Japan, 20 years have passed. During these 20 years, Japan Government has made many public investments in this area, aiming at the reduction in the economic range between Japan main land and Ryukyu Islands. These investments have influenced all the economic fields in this area.

In this paper, the lumber demand and supply in Ryukyu Islands mainly for these 20 years is going to be clarified. The characteristics of this paper are the comparing to Japan main land and the discussion from the view point of the island economies. Shinohara^{14–17)} has published several reports on demand and supply of forest products in this area. Asato²⁾ pointed out the abstract of forest policy in Okinawa prefecture. The source of the most of the statistical data used in this paper is Okinawa Prefectural Government^{10,11)} and Ryukyu Government^{12,13)}.

The structure of this paper is as follows. In the next chapter dealing with the lumber demand, several characteristics on lumer demand are pointed out. As this area is an exceptional one in Japan from the above reasons, the results are quite contrasting to the case of Japan main land. Next, the supply of lumber is shown briefly. The further research including the change of forest resources is left to another paper to be published. In the last chapter, the lumber demand-supply relationship of this area is discussed especially from the view point of the island economies.

Lumber Demand

1. Trend of lumber demand

Table 1 shows the demand and supply of timber in Ryukyu Islands since 1968. During the period 1972–1989, the total of lumber demand has been decreasing. Around 1972, the total demand was approximately over 400,000 m³, but recently 200,000–250,000 m³. On the other hand, the total lumber demand in Japan at the same period is almost horizontal, counting around 100 million m³. Thus, the weight of the occupied Ryukyu Islands has decreased in Japan.

The main field of lumber usage in Ryukyu Islands is building construction and engineering public works. Although there have been no statistical data on the field on lumber demand, the share of building construction seems to be almost 80% (this figure is estimated by a building material company in Okinawa main island).

Since 1980, the import of log from south-sea countries for plywood has been almost constant,

Table 1. Demand and supply of timber in Ryukyu Islands

(1,000 m³)

Year	Total	Import				Japan main land	Domestic				Rate of Ryukyu Islands (%)
		Total	For lumber	For plywood	Lumber* ¹		Ryukyu Islands				
							Total	For lumber	For chips	Others* ²	
1968	349	189	—	—	—	109	51	17	34	—	14.6
1969	424	262	—	—	—	104	58	38	20	—	13.7
1970	476	271	—	—	—	159	46	32	14	—	9.7
1971	831	432	—	—	—	358	41	26	14	—	4.9
1972	405	315	—	—	—	56	34	20	15	—	8.4
1973	395	343	—	—	—	44	8	5	3	—	2.1
1974	364	319	—	—	—	36	9	5	4	—	2.4
1975	322	273	—	—	—	36	13	9	4	—	4.0
1976	368	299	158	141	—	56	13	9	5	—	3.6
1977	366	299	152	147	—	51	17	8	9	—	4.6
1978	353	291	143	148	—	52	10	7	3	—	2.8
1979	435	358	213	145	—	61	17	8	8	—	3.9
1980	338	259	147	100	13	60	19	7	12	—	5.7
1981	306	223	129	89	5	51	32	14	18	—	10.5
1982	304	230	109	111	10	59	16	4	12	—	5.1
1983	312	217	95	105	17	78	17	4	13	—	5.4
1984	288	190	61	114	15	77	21	6	12	3	7.2
1985	310	206	67	110	29	72	32	6	18	8	10.3
1986	227	152	24	103	25	55	21	5	11	5	9.0
1987	233	173	22	112	40	41	19	5	8	6	8.1
1988	249	184	25	113	47	43	22	6	10	6	9.0
1989	242	174	18	107	50	41	27	5	15	6	11.0

Source: Okinawa Prefectural Government, "Forestry in Okinawa", 1978ed., 1979ed. and 1989–1991 eds.

*1 Quantity of lumber is converted into log.

*2 Log for charcoal and Shiitake-mushroom.

the quantity is 100,000–110,000 m³ annually. As the total lumber demand has been decreasing during these periods, the share of log for plywood has been increasing, and recently it reaches to 40–50%.

The quantity of lumber demand per population is around 0.20 m³ in 1991. On the other hand, as the lumber demand and the population in Japan are 116 million m³ and 123 million persons respectively, the lumber demand per population is 0.94 m³. The figure of Ryukyu Islands is only one to five as that of all of Japan.

2. Construction movement and lumber demand

(1) Trend of construction

The most important field of lumber demand is construction activities. Table 2 shows the building construction started in floor area basis and classified by structure in Ryukyu Islands since 1959. Several characteristics are pointed out from this table.

First, the construction activities have been increasing for making a trend through the whole researching periods. As going into details, during the period 1962–1973, the building construction started has been increasing almost 8 times. This increasing-rate is quite surprising. The floor area has been over 2 million m² in 1973. This 1973's record has not been renewed by 1990. Considering the case of 1973 as an exception, during the period 1974–1983, the floor area has been almost horizontal, being around 2 million m². Since 1984, the floor area has begun to increase again. Comparing this movement to the construction activities of Japan, this recent increase is characteristic to Ryukyu Islands. Recently, enlargement of building and rebuilding are increasing in Ryukyu Islands. This is also the tendency in Japan main land. One of the main reasons is the increase of children of 10–15 years old. One more room is required for them. In 1990, Okinawa prefecture is first in the natural increase-rate of population, that is 0.87%. As the social decrease-rate is also high (0.40%), the net increase-rate of population is 0.47%. This increase of population seems to be a basic reason for the increase of housing construction started. Furthermore, the role of public investments has to be referred. This point is going to be explained in the following paragraph.

Table 2. Building construction by structure

(Floor area: 1,000 m²)

Year	Total	Wooden	Non-wooden				
			Steelframe & reinforced concrete	Reinforced concrete	Steelframe	Block concrete	Others
1960	381	213	—	159	6	—	3
1965	579	102	15	335	24	86	18
1970	1,200	36	92	872	71	106	23
1975	2,067	27	134	1,538	231	78	60
1980	1,716	11	94	1,453	109	46	2
1985	2,674	16	273	2,077	223	68	18
1990	2,843	37	397	1,911	403	79	16

Source: Ryukyu Government, "Ryukyu statistical yearbook", (1960). Okinawa Development Agency, "Forests and forestry of non-national forests in Okinawa prefecture", (1965, 1970). Ministry of Construction, "Annual statistics of construction", (1975–1990).

Next, the structure of building construction has changed drastically since the previous war. The rate of wooden building construction has been decreasing. Fig. 1 shows the changes of building construction activities from the view point of the building structure. At the beginning of the 1950's, over 80% of building construction was made of wood. So, almost all of the stocks of building were wooden according to the result of the extraordinary national census taken in Dec. 1, 1955 (Note 1). In the second half of the 1950's, the rate has decreased rapidly to 55–60%. In the 1960's, the rate has decreased to less than 5% (Note 2). According to an estimation by prefectural government officer, almost all the materials for wooden housing are constructed using pre-cut lumber in sawmill because of the lack of carpenters, and almost all the logs and the lumbers for wooden housing are imported from Japan main land and from foreign countries. In 1990, the rate of wooden construction is only 1.3%. The decrease of the rate of wooden building construction such as this has been observed also in Japan main land, but such rapid changes as these are quite characteristic in comparison with the Japan main land (Note 3). In 1990, the building construction by reinforced concrete shares 67.2%, by steel frame is 14.2%, by steel-frame & reinforced concrete is 14.0%. During these several years, the latter two categories have been increasing. The share of wooden building construction has been less than 2% since 1971. In 1981, the rate shows the minimum value, namely 0.5%. Since 1981, the floor area of wooden building construction has been increasing, as shown in Table 2. The wooden building construction started⁶⁾ assorted by use is shown in Table 3. The increase in exclusive use for dwelling has contributed to a recent raising of wooden-rate. The wooden building construction started during

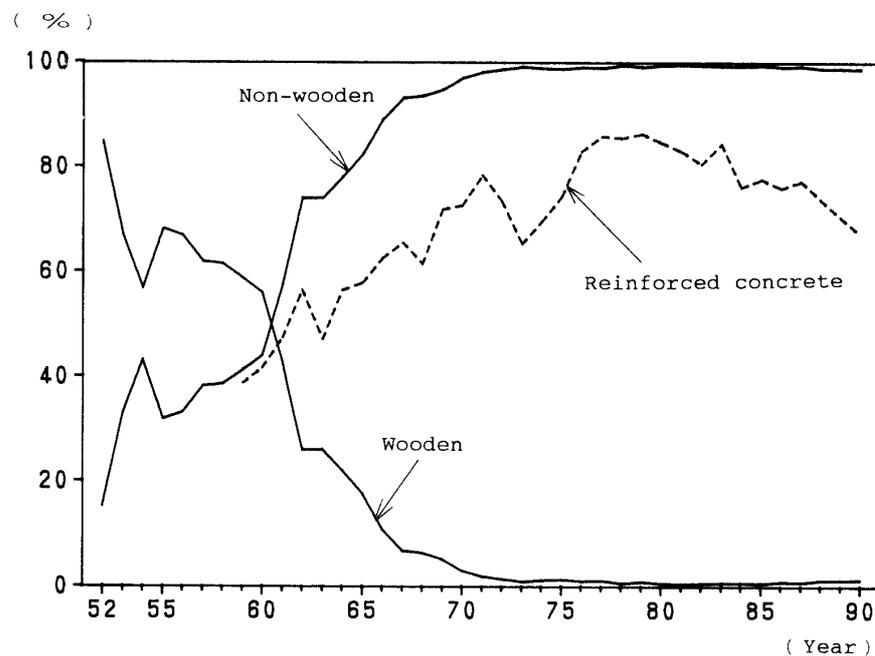


Fig. 1. The change of structure of building construction.

Source: Okinawa Prefectural Government, "Construction administration in Okinawa (business report)", p. 110–113, 1984, (1952–1958). Ryukyu Government, "Ryukyu statistical yearbook", (1959–1964). Okinawa Development Agency, "Forests and forestry of non-national forests in Okinawa prefecture", (1965–1972). Ministry of Construction, "Annual statistics of construction", (1973–1990).

Note: The data before 1958 is number of construction confirmation including notice of plan. As the data after 1959 is building construction started, figures do not follow those before then.

Table 3. Wooden construction started by use
(Floor area: 1,000 m²/year)

Use	1973-75 average	1980-82 average	1988-90 average
Exclusive use for dwelling	9,307	3,706	17,607
Combined use for dwelling and business	1,064	710	2,035
Agriculture, forestry and fishery	5,374	2,320	5,948
Mining and manufacturing	1,888	1,188	895
Commerce	211	158	168
Public utilities	4,930	2,296	2,130
Service	1,482	430	2,898
Public service and education	115	211	479
Others	0	0	46
Total	24,370	11,020	32,207

Source: Ministry of Construction, "Annual statistics of construction".

the period 1988-1990 is almost 3 times as much as that of 1980-1982.

However, as the level of building construction as a whole is quite low, the lumber demand did not show the increase irrespective of increase of wooden building construction. According to a housing company in Okinawa main island, the reinforced concrete house uses lumber from 5.5 m³ to 6 m³ in this area. In 1991, the construction number is 8,490 in Ryukyu Islands. Assuming that the structure of all building construction started is reinforced concrete, using lumber 6 m³ respectively, the required lumber quantity may be about 50,000 m³. This value is almost 20% of all lumber demand and almost half of all demand, excepting for plywood and chip. Wooden building construction started shares only 1% in floor area basis. In 1991, the number of construction is 303 (3.6%). According to the same company's estimation, the lumber usage is from 18 m³ to 20 m³ in case of the complete wooden house. Assuming that all these wooden building constructions use 20 m³ respectively, the total demand is only 6,000 m³, which shares only 2% of lumber demand in Ryukyu Islands.

In Japan, the construction activity is the most important factor that determines the lumber demand, so it is usually adopted as the explanatory variable for the econometric analysis on timber demand-supply relationship (Yukutake²¹), Mori⁷), Matsushita⁵). However, this type of equation is not applicable in Ryukyu Islands (Note 4). Because, the rate of wooden building construction is too small.

(2) Wooden building construction and lumber demand

The main structure of building construction is reinforced concrete. Almost all the people including officers of local government and housing company estimate that this trend will continue in the future in Ryukyu Islands. Under these circumstances, the field of lumber usage in building construction seems to be not so large. However, recently, there are two new movements in which lumber is used.

Firstly, 2×4 housings have been constructed recently. Ryukyu Islands are located in subtropical climatic zone, and everywhere the islands are suitable for marine resort. These 2×4 housings are constructed for villa residence, teahouse and so on. And almost all of these housings are for business purpose. The log for this usage is imported from North America as a whole. A housing company in Okinawa main island has predicted that this 2×4 demand in Okinawa main

island will be almost double the recent level.

Next is the introduction of the combined structures of wooden one and reinforced concrete. This new type of house uses lumber from 10 m³ to 12 m³. This figure is between the reinforced concrete house and all the wooden one. As already referred, the main structures of building construction in Ryukyu Islands are non-wooden, but a survey concluded that half of people want to live in wooden buildings. It seems that attachment for wood still remains in people in this area. Reinforced concrete building has several weak points, which are caused by high air-tightness. Air-conditioner is necessary for the reduction of room temperature. Furthermore, keeping from getting moldy is necessary.

A housing company¹⁹⁾ in Okinawa main island has challenged the improvement of the residential performances of reinforced concrete housing. The result is the combined structure called "Okinawa-type combined structure house"¹⁹⁾. Briefly speaking, this structure is that the main structural pillars and beams are made of reinforced concrete and the other secondary parts are made of woods. Thus, resistance properties for the typhoon and the earthquake are guaranteed. A new air-cycle system called "passive cooling" is used for the improvement of residential performances.

3. Public works

Ryukyu Islands had once been governed by U.S.A. and were restored to Japan in 1972. National Government has made administrative investments for Ryukyu Islands for these 20 years. As there is almost no big industry in Ryukyu Islands, public investments have an important role from the view point of local economies. Table 4 shows the administrative investments by Japan Government and Okinawa Prefectural Government. In fiscal year of 1988, 400 billion yen was invested by administration. Gross prefectural domestic product in Okinawa prefecture is 2,408 billion yen in fiscal year of 1988. The ratio of administrative investments to gross prefectural domestic product is 16.6% in Okinawa prefecture and 8.3% in Japan. The importance of public investments is shown by using another index. Administrative investments per population (Basic Resident Registers) are 327,000 yen in Okinawa, and are 260,000 yen in Japan. Generally, this ratio tends to get high value in the comparatively depopulated prefectures. Okinawa is the

Table 4. Administrative investment (fiscal year 1988)

		(billion yen)	
		Japan	Okinawa
Total		31,679	400
By purpose	Livelihood	14,568	188
	Industry	6,248	103
	Agriculture, forestry and fishery	3,158	60
	Conservation of national land	2,921	20
	Others	4,785	29
By burden share	National Government	10,300	220
	Prefectural Government	9,686	89
	Cities, towns and villages	11,693	92

Source: Management and Coordination Agency, Statistics Bureau, "Japan statistical year-book", No. 41, p. 478, 1991.

seventh prefecture in the order of high population density. Administrative investments by area are 1,768,000 yen/ha in Okinawa prefecture, and are 839,000 yen/ha in Japan. Generally, urban area gets large value because of the high population density. As referred, the population density of Okinawa prefecture is high.

Another characteristic of administrative investments in Okinawa prefecture is that the ratio of national government is high. Okinawa Development Agency has played an important role. Table 5 shows the budget of public works by Okinawa Development Agency (Uchiyama²⁰). During the period 1972–1988, total amount of 2,292 billion yen has been invested. The important point for lumber demand, the main investment field is the engineering works in various fields. Generally in Japan, the main part of the promotion efforts is focused at the public works related to the living circumstances of the islanders or primary industries (Nakajima⁸). These works use the lumber and log. Sheet-pile made of Ryukyu-matsu (*Pinus luchuensis*) and support-log made of broad leaved trees are important for local forestry and wood-based industries in Okinawa main island. Especially, in case of support-log, the production-preferential-usage policy of Okinawa Prefectural Government guarantees a certain level of demand (Note 5).

Table 5. Total budget of public works by Okinawa Development Agency (1972–1988)
(billion yen)

Investment field	Budget*	%
Forest protection and river improvement	135	5.9
Road improvement	898	39.2
Port, fishing port and airport improvement	411	17.9
Agricultural infrastructure	266	11.6
Forest road, industrial water, etc.	47	2.0
Public housing construction	117	5.1
Drainage, environment, sanitation, etc.	416	18.2
Research, etc.	1	0.1
Total	2,292	100.0

Source: Uchiyama (1990), Table 12 (p. 77) and Table 14 (p. 81).

* Total of original budget of every year.

Lumber Supply

Supply area of lumber and log to Ryukyu Islands is divided into foreign countries, Japan main land and Ryukyu Islands. The supply quantity assorted by area is shown in Table 1. Rate of Ryukyu Islands was less than 5% during the period 1973–1979. Recently this rate has risen up to around 10%. Recovery of log production for chip contributes to the increase of this rate. Okinawa prefecture is one of the prefectures showing the least self-supporting rate on lumber and log. However, rate of foreign log and lumber is 71.9% in 1989, this rate is almost the same as in case of Japan, namely 73.1%. This area is not always specific in this statistics.

The rate of import from Japan main land is 16.9%. This figure has decreased after Ryukyu Islands were restored to Japan. As the supplying area to Ryukyu Islands by port of Japan main land, Kagoshima Port (Kagoshima city, Kagoshima prefecture), Aburatsu Port (Nichinan city, Miyazaki prefecture) and Hakata Port (Fukuoka city, Fukuoka prefecture) have been important

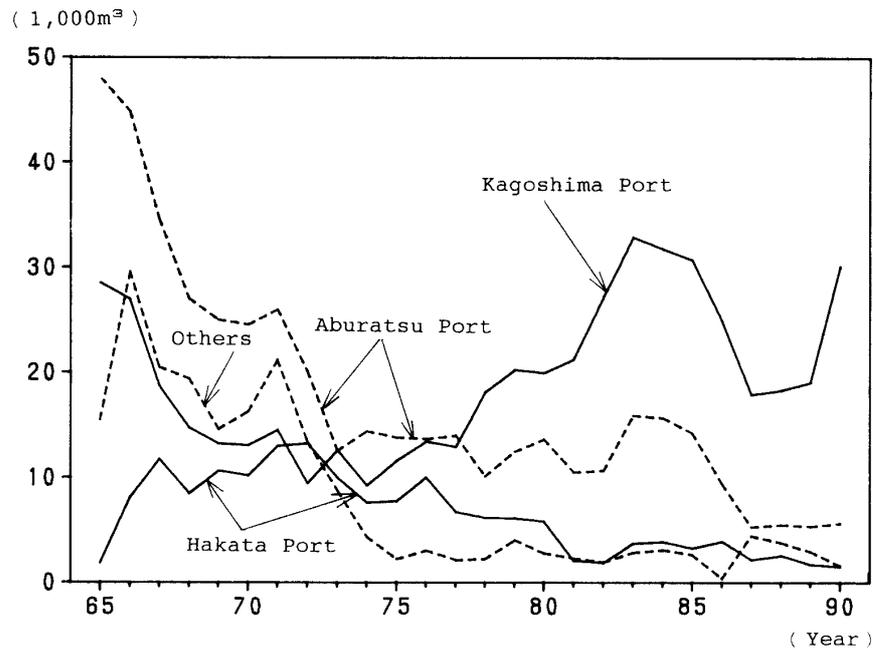


Fig. 2. Import quantity from Japan main land by port.

Source: Okinawa Prefecture Lumber Association.

Note: Aburatsu Port is located in Nichinan city, Miyazaki prefecture. Hakata Port is located in Fukuoka city, Fukuoka prefecture. Kagoshima Port is located in Kagoshima city, Kagoshima prefecture.

for these 20 years (Fig. 2). The weight of Kagoshima Port is getting larger more and more (Note 6). The sawmills that supply lumber to Ryukyu Islands are located mainly in Miyazaki prefecture. According to the lumber demand and supply statistics of 1990 by Ministry of Agriculture, Forestry and Fisheries, the sawmills located in Miyazaki prefecture shipped 43,000 m³. Adding this figure to the shipment from the sawmills located in Ryukyu Islands (23,000 m³), it reaches 91.9% of total import of lumber in Ryukyu Islands (74,000 m³). The species of import from Japan main land is Japanese cedar (*Cryptomeria japonica*). As shown in Table 1, the import quantity from Japan main land has been smaller than the quantity of lumber import from foreign countries since 1988. The decreasing of competition power of wood-based industries in Japan main land is also clear in Ryukyu Islands.

Imported commodities on forest products from foreign countries are log for plywood, log for lumber and lumber itself. Log for plywood is imported from south-east Asian countries, the quantity is almost 100,000 m³ for these 10 years. There are 3 factories that produce plywood in Okinawa main island as of 1988. Log for lumber and lumber are imported from North America. Import of log for lumber has decreased rapidly, on the other hand, lumber import has increased. According to the decrease of log import, the number of sawmill has also decreased as shown in Table 6. The number of sawmill in 1982, 1983 and 1984 are 41, 33 and 28 respectively. For these 2 years, almost one third of sawmills were stopped. This is one of the reasons why the import of lumber from North America began around 1980, as of Table 1.

The rate of the log produced in Ryukyu Islands is recently only 10%. Log for chip is main in this production, and log for lumber shares less than 20%. This is the characteristics of the forestry in this study area. Table 7 shows the abstract of log supply in Ryukyu Islands. The average volume per hectare is very low, namely less than 100 m³/ha. In Ryukyu Islands, as all forest area

Table 6. The number and employee of sawmill

Year	Number of sawmill	Number of employees	Log consumption (1,000 m ³)
1976	52	526	198
1977	50	572	179
1978	47	640	177
1979	45	577	190
1980	46	476	167
1981	43	419	141
1982	41	421	127
1983	33	414	105
1984	28	358	99
1985	23	247	62
1986	23	263	44
1987	19	195	37
1988	19	242	38

Source: Okinawa Prefectural Government, "Forestry in Okinawa", 1990 ed.

Note: Excluding the factory that produces plywood, laminated wood and chip.

Table 7. Cutting volume

Fiscal Year	Ryukyu Islands		North part of Okinawa main island	
	Cutting area [b] (ha)	Volume per ha (m ³ /ha)	Cutting area [a] (ha)	Share [a]/[b] (%)
1972	165	62	137	83
1976	199	93	179	90
1980	487	112	270	55
1984	283	78	200	71
1988	393	69	271	69

Source: Okinawa Prefectural Government, "Okinawa statistical yearbook".

(forest planning basis) is 73,874 ha and the total volume is 6,500,000 m³ in 1990, the average volume per hectare is still 88.0 m³/ha (Note 7). Because of this low volume, log supplied from this area is almost used for chip. The main supply area is the north part of Okinawa main island, and the recent share of this area is around 70%. Kunigami-Village Forest Cooperative played an important role in supply of log and lumber in this north area¹⁷⁾.

Discussion

Ryukyu Islands are located in subtropical climatic zone. From this view point, this study area is specific in Japan. More important for this research, this prefecture consists of many islands. Generally speaking, islands have several common characteristics¹⁾ (Note 8). In this chapter, the characteristics of lumber demand and supply in Ryukyu Islands are discussed from the view point of the island economies. As discussed in the chapter of the lumber demand, almost all of the buildings are now constructed by non-wooden materials. However, this change has occurred for

these 30 years. What causes this rapid change?

Firstly, Ryukyu Islands are on the cruising course of typhoon⁹⁾ (Note 9). Wooden housing at that time was weak for typhoon, especially in case of temporary dwellings constructed just after the previous war. It seems that there was not enough log in this area at that time. Kikuma⁴⁾ pointed out that import of log (*Japanese cedar*) from Japan main land was permitted after 1952. In addition to this weak point, the problem of the termite-damage is also important. Of course, there are species that has resistance against a termite-damage, for example, Inumaki (*Podocarpus macrophylla*), but this is limited in resource stock. This species requires a long growth period. It seems that most people in Ryukyu Islands will image wooden building as negative, namely, weak, poor and so on. They say that the wooden building was actually weak to the typhoon at that time. Kagoshima prefecture is also under the same condition from the view point of the typhoon and the termite, but the wooden-rate of building construction started maintains still 37.7% (floor area basis) or 68.6% (building number basis) in 1989. It seems that the effect of the same factor is different so much, because of the geographical specific conditions as island. One of the reasons of a rapid change in building structure is the influence from the U.S. Force remaining in Okinawa main island. When the wooden building were destroyed by the typhoon, they said that there was almost no damage to the housing in U.S. military base.

Next, the cost of construction seems to be also important⁹⁾. Generally, the cost of wooden building construction in Ryukyu Islands is higher than that in Japan main land. As already shown, the average volume per hectare is low, namely, there are only few resources that can be used as the lumber for housing construction. For these 40 years, the living standard of people in Ryukyu Islands has become higher clearly, and they can never use the same log and lumber that was used before or just after the previous war. So, as shown in Table 1, almost all of the logs and lumbers have to be imported from outside islands. In this sense, the market condition is alike to the urban area in Japan main land. Price means retail price in this area. Generally speaking, the wholesale price in island area has a tendency to get higher because of the addition of transportation cost. However, as imported lumber has a share to a degree, it seems that the price level is not always high as compared to Japan main land. Of course, in the islands except Okinawa main island, the price will become higher. On the other hand, in case of the cost of reinforced concrete, the cost is not so high as in Japan main land. According to Yonemoto (1987), average housing construction cost per 3.3 m² (equal 1 tsubo) is 350,000 yen for wooden and 500,000 yen for reinforced concrete. According to another source, the difference between the wooden house and reinforced concrete one is around 20%. In consideration of the possibility of damage by the typhoon and the termite, if the difference between the both costs is at this level, it seems that many people will select the reinforced concrete. In case of "Okinawa-type combined structure house", it costs 300,000 yen per 3.3 m², this price is almost the same or a little lower as compared with the wooden one.

As the result of the spread of non-wooden building, recently, the carpenter that can build a wooden building is few. Most of the carpenters are those who can work efficiently for non-wooden buildings. In case of Japan main land, if there are no carpenters in an area, the carpenters living in another area can move to the area to build. Housing sent directly from the place where built is a trial made by several towns or villages in Japan main land. However, Ryukyu Islands are far from Japan main land, and the climatic condition is different so much from Japan main land, and the market scale is not large. The biggest city in Ryukyu Islands is Naha city, and the population is about 310,000 persons in 1991, that of the next city is about 110,000

persons. As already shown, Miyazaki prefecture is the largest supply area for Ryukyu Islands in Japan main land. Since about 5 or 6 years ago, a joint meeting between the officers, lumber associations, lumber companies and so on in Miyazaki prefecture and those in Okinawa prefecture has been held annually. A company of Miyazaki prefecture has constructed wooden housing for advertisement in Okinawa main island. In this meeting, an attendant from Miyazaki prefecture said that 'recently wooden housing weathers through a strong wind of around 40 m/sec because of the development of wooden building technology'. The necessity of the research on the housing fitted to Ryukyu Islands was pointed out in this meeting. As of the carpenter, only the necessity of training of engineers is referred. As the result of disappearance of carpenters that can deal with the wooden building, the recovering seems to be difficult. This is also one of the reason why the non-wooden building has spread widely and keeps on high share. A building material company in Okinawa main island has systematized all the lumber units for reinforced concrete housing, and sales the units in the form of the package. It seems that the shortage of carpenters has made a new commodity. As the islands except Okinawa main island is so small for a market, the challenges and the results in Okinawa main island are important for the housing companies that would like to use lumber. In this sense, this study area may be advanced in Japan. Labour-shortage in physical works is one of the important economic problems in Japan. Ryukyu Islands have to solve also this problem within islands.

As the lumber demand is decreasing and the demand for log produced from Ryukyu Islands is almost nothing today, it seems that the pressure for forest resources is almost negligible from the view point of log production for housing construction. As shown in Table 1, log production for chip is continuing. Most of them are produced from the various kinds of development. Generally, as space is limited in island, forests are easily to be changed into a cultivated land, meadows, pastures, roads, residential land and so on. In case of Ryukyu Islands, as this area was governed by U.S.A. after the previous war, in addition to the fact that this area consists of many islands, many public investments have been made. This tendency is nearly constant until today, and will continue at least in near future. As there is no big industry except service sector, construction work is one of the main industry in Ryukyu Islands. After restored to Japan, tourism is also important. These sectors are main pressure to forest resources now in Ryukyu Islands. As of this land-use problem, a further research is necessary. In some islands except Okinawa main island, the land-use pattern was drastically changed during these 20 years. As is omitted on the forest resource conditions in Ryukyu Islands on account of space consideration, it is clear that all the housing could not be constructed by using only log supplied from this area. In this sense, the limitation of forest resources for housing construction had been clear since pre-war days. Ryukyu Islands have been prevented from the complete degradation of forest resources by importing logs from Japan main land and foreign countries. The relationship between the introducing log from outside of the islands and the change of forest resources in the islands is an interesting research topic in this area.

Summary

In this paper, the lumber demand and supply in Ryukyu Islands for these 20 years are discussed. It is clarified that Ryukyu Islands have several characteristics comparing to Japan main land. The main results are as follows:

1. The demand field is almost limited to housing construction and engineering works.

2. The demand of lumber and log tends to decrease gradually. The quantity of demand per population is almost one fifth as that of all of Japan.

3. The wooden-rate of building construction is very low, namely around 1% in floor area basis. Recently, a new movement that increases this rate began in Okinawa main island. However, it seems to be unchangeable that non-wooden building construction will have superiority in future.

4. In Ryukyu Islands, the administrative investments are important for the local economies. Various types of developmental undertaking have been introduced by Okinawa Development Agency and Okinawa Prefectural Government. Lumber demand for these public works is also important.

5. Lumber and log are mainly supplied from Japan main land and foreign countries. Lumber and log for lumber are imported from North America, log for plywood is imported from south-sea countries and lumber and log are imported from Japan main land, especially Kyushu.

6. Supply from Ryukyu Islands is only around 10%. This rate has been almost constant during these 10 years. Log for chip is main, and is supplied from the north part of Okinawa main island. It tends to be produced as the result of the various developmental works.

7. Number of sawmill and employee is decreasing. The decreasing of lumber demand is main reason. In addition, the lumber import from North America is increasing in substitution of the decrease of log import from this area.

As Ryukyu Islands consist of many islands, various movements in social economic fields have been reflected on lumber demand and supply. In addition, the administrative investments have played an important role in this area.

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Notes

- 1) On December 1, 1955, the usual household number of housing (except boarding house and so on) is 120,664 in Ryukyu Islands. 119,830 of them are wooden (99.3%). Wooden housing with a tiled roof is 48,932 (40.6%), with a thatched roof is 37,690 (31.2%) and with a zinc roof is 29,912 (24.8%).
- 2) By classification category in construction statistics, wooden housing includes combined structure of wooden and reinforced concrete. According to a building-materials company in Okinawa main island, recently, the number of all wooden housings is only around 5 a year, the total market value is around 100 million yen. In Ryukyu Islands, the structure of almost all of the housings is non-wooden, but only a few people persist still on housing construction by all wooden structure.
- 3) The rate of wooden housing for all housings in Japan has been decreasing as follows: 76.7% (1965), 69.8% (1970), 66.9% (1975), 59.2% (1980), 47.9% (1985), 42.6% (1990).
- 4) By using ordinary least squares method, the relationship between the lumber demand and the building construction started in Ryukyu Islands is estimated as in the following equation: $Y=345.4-1.152 X$.

Here, Y means the lumber demand, X means the building construction started (wooden). The sign of coefficient of X is minus. The coefficient of determination is only 0.014.

- 5) Kunigami-Village Forest Cooperative produce the support-log made of broad leaved trees in Okinawa main island. However this production is unprofitable for the sawmill managed by this forest cooperative.
- 6) In 1990, the weight of each port is as follows: Kagoshima Port (77.0%), Aburatsu Port (14.6%), Hakata Port (4.1%) and the other ports (4.3%). In 1970, the share of each port was as follows: Aburatsu Port (38.2%), Kagoshima Port (20.4%), Hakata Port (15.9%), Yatsushiro Port (Yatsushiro city, Kumamoto prefecture) (15.9%), Hosojima Port (Hyuuga city, Miyazaki prefecture) (5.2%) and the other ports (4.4%). Most of ports are located in Kyushu.
- 7) In 1988, in case of non-national forests, the average volume is 80 m³/ha for man-made forests, and is 109 m³/ha for natural forests. In 1990, in case of national forests, it is 85 m³/ha for man-made forests, and is 134 m³/ha for natural forests.
- 8) Kakazu³⁾ summarized the characteristics of island economies as in the following 9 points: 1) limitation of resources, 2) limitation of market, 3) monoculture economy, 4) trade deficit, 5) diseconomies of scale, 6) high transportation cost, 7) high migration, 8) high dependence on public sector, 9) history of colony.
- 9) Suzuki¹⁸⁾ showed the following examples as the main damages in Ryukyu Islands by the typhoon after the previous war. 18th typhoon in 1966 was biggest one. The maximum wind speed of 61 m/sec and the maximum instantaneous wind speed of 85 m/sec were recorded and great damages have been given especially in Miyako-jima. 18th typhoon in 1959 brought a flood damage. Total rainfall was 558 mm. 15th typhoon in 1951, the damage by a tidal wave occurred. Suzuki¹⁸⁾ pointed out that as Ryukyu Islands is located near the turning point of typhoon, the destructive powers of the typhoon visiting to Ryukyu Islands is very big.

References

- 1) Alison, L. H.: Overview, sustainable development and environmental management of small island, in Beller, W, d'Ayala, P. and Hein, P. (eds.), *Sustainable development and environmental management of small islands*, 3–14, United Nations Educational, Scientific and Cultural Organization, Paris (1990)
- 2) Asato, I.: The characters and some problems of the forest policy in Okinawa Pref., *Forest Economy*, **44**(10), 25–32 (1991) (in Japanese)
- 3) Kakazu, H.: Island Economies, 12–17, Hirugisha, Naha (1986) (in Japanese)
- 4) Kikuma, M.: Studies on the locality of wooden construction carpenters and housing (II) Case of Okinawa Prefecture, *Trans. Mtg. Jpn. For. Soc.*, **102**, 75–77 (1991) (in Japanese)
- 5) Matsushita, K. and Handa, R.: The fluctuation of lumber price, *Bull. Kyoto Univ. Forests*, **55**, 80–106 (1983) (in Japanese with English Summary)
- 6) Ministry of Construction: Annual statistics of construction, 1974–1990 every year ed., Tokyo (in Japanese)
- 7) Mori, Y.: Timber market in Japan, an econometric analysis, *Mem. Coll. Agric. Kyoto Univ.*, **139**, 179–191 (1991)
- 8) Nakajima, T. and Machida, M.: Islands in Japan, in Beller, W, d'Ayala, P. and Hein, P. (eds.), *Sustainable development and environmental management of small islands*, 273–282, United Nations Educational, Scientific and Cultural Organization, Paris (1990)
- 9) Okinawa Development Agency: Forests and forestry of non-national forests in Okinawa Prefecture, 44–57, Naha (1978) (in Japanese)
- 10) Okinawa Prefectural Government: Okinawa Prefecture statistical yearbook, 1971–1990 every year ed., Naha (in Japanese)
- 11) Okinawa Prefectural Government: Forestry in Okinawa, 1989ed., 1990ed., Naha (in Japanese)
- 12) Ryukyu Government: Ryukyu statistical yearbook, 1956–1966 every year ed., Naha (in Japanese)
- 13) Ryukyu Government: Okinawa statistical yearbook, 1967–1969 every year ed., Naha (in Japanese)
- 14) Shinohara, T.: Forestry and forest policy in Okinawa in a subtropical area, *Rinkeikyo-geppou*, **264**, 2–15 (1983) (in Japanese)
- 15) Shinohara, T.: The characteristics of the distribution system of log produced in a subtropical area,

- Rinkeikyo-geppou*, **289**, 23–35 (1985) (in Japanese)
- 16) Shinohara, T.: Lumber situation in Okinawa in a subtropical area, *Lumber Industry*, **44**(4), 35–39 (1989) (in Japanese)
 - 17) Shinohara, T.: Studies on the promotion of forestry and the part of forestry cooperatives in the islands, *Sci. Bull. Coll. Agric. Univ. Ryukyus*, **38**, 61–75 (1991) (in Japanese with English Summary)
 - 18) Suzuki, M.: Okinawa,—typhoon and housing—, in Sumida, M. (ed.), *Local characteristic of modern housing*, 355–374, Keisoushobou, Tokyo (1983) (in Japanese)
 - 19) System Kenzai Kougyou Inc.: My house, Tokoharu-series, Okinawa-cool, propaganda pamphlet, Naha (in Japanese)
 - 20) Uchiyama, A.: Problems on Okinawa development finance, in Sugino, K. and Iwata, K. (eds.), *Recent Okinawa economies*, 73–85 (1990) (in Japanese)
 - 21) Yukutake, K.: Simulation analysis of demand/supply relationship of forest products, *The Current State of Japanese Forestry*, **6**, 23–38 (1989)