

forestation techniques, *Sanrin Shinpi* (山林真秘), Sai On emphasizes the importance of close embracing mountains (*ho:go*) for growing good timber and suggests tree planting to compensate for the low topography in the surroundings (Purves et al. 2009).

In a typical Feng Shui village, the natural forest behind the village and planted forest belt at the front have been preserved and rich biodiversity is found in such forests (Chen 2008; Chen et al. 2008a). Sacred forests preserved by the local people, although in fragmented patches and only in small areas, were also reported in and outside Asia (Zhuang and Gorlett 1997; Ramanujam et al. 2003; Upadhaya et al. 2003; Mgumia and Oba 2003). With economic development and rapid urbanization, forests are disappearing. Even the culturally conserved forests are vanishing as a result of commercial agriculture (Chandrakanth et al. 2004).

House-embracing Fukugi trees have been prevalent in the islands of Okinawa Prefecture (Shigematsu 1979). The oldest trees might have been planted around 300 years ago (Chen and Nakama 2010). A Feng Shui village landscape featuring tree lines is worthy of further study as a sustainable and ecological landscape.

House-embracing Fukugi trees might have been recommended by the then Kingdom of Ryukyu. Fukugi trees are a slow growing species that have played an important role in farmers' lives as windbreaks, firewood, and even green fertilizer. In terms of the features of Fukugi trees, please refer to previous research (Shigematsu 1979; Chen et al. 2008b).

House-embracing Fukugi trees were functionally laid out with denser forests on the northern side of the houses and on the sides facing the sea (Chen et al. 2005; Chen et al. 2006; Chen et al. 2008b; Ando and Ono 2008).

Forests planted hundreds of years ago for cultural purposes are disappearing due to economic and social changes. Such green Feng Shui village landscapes have been vanishing over past decades as the result of local people rebuilding their houses in concrete (Shigematsu 1979). Immediately following World War II, when the island was badly short of timber, local people cut down mature trees to build houses. War-caused fires during WWII also contributed to the disappearance of Fukugi tree lines inside villages.

Regardless of this steady decline, there exist several well preserved Fukugi tree landscapes in Bise, Imadomari, and Inamine in the northern part of mainland Okinawa, and on the small isolated islands of Tonaki and Aguni.

A case study in Bise village found that tree density in the coastal line and northern side of village was higher than the tree lines inside the village (Chen et al. 2006; Anto and Ono 2008). The authors studied the current layout and density of house-embracing Fukugi trees (Chen et al. 2008a; Chen and Nakama 2010) and the vegetation composition in the village *ho:go* and the preserved natural forest behind the village (Chen et al. 2008b). In previous studies, all Fukugi trees surrounding several houses in Tonaki, Bise and Aguni Island were surveyed. Fukugi woodlands were higher in density and smaller in Tonaki and Bise than in Aguni (Chen and Nakama 2010).

Being limited in extant historical records, it is a mystery for historians exactly when and by whom such Feng Shui villages were built, and how the village was developed and laid out in Okinawa. In this study, all houses at several locations in Bise and Imadomari in mainland Okinawa, and at Tonaki Island and Aguni Island were surveyed, focusing on the distribution of the remnant large trees in the hope of unveiling the history of the village's establishment through the use of these large trees. By measuring

all the large Fukugi trees inside the villages, the spatial distribution of Fukugi trees will be assessed with the aim of recovering how natural and cultural factors relate to the distribution.

Previous case studies of Bise (Chen et al. 2006; Ando and Ono 2008), Tonaki (Chen et al. 2005) and Aguni (Chen and Nakama 2010) discuss the density of Fukugi trees surrounding houses. In this study, large trees were surveyed and included several survey sites.

METHOD AND SURVEY SITES

The old Fukugi trees inside Feng Shui villages surveyed were measured to understand the development process of village houses. All Fukugi trees whose DBH's (Diameter at Breast Height) were larger than 25 cm were measured. The heights of old trees were also measured. The estimated tree age was calculated based on the formula [Age (year) = DBH (cm) ÷ 2 × 8] by Hirata (2006). At present, Hirata's formula is the only one available to estimate the age of Fukugi trees. Hirata Formula is the only one available at present; however, it has some limitations. First, it was calculated based on the two cut stumps in the southern part of Okinawa Island. Second, other factors such as local site, climatic conditions and competition from other trees besides tree age also affect the annual ring width. Thus, the tree age values calculated from this formula to be used in this paper are approximations, not exact ones. To account for the possible deviation between estimated tree age and the real tree age, a class of 50 years of estimated tree ages is used for the analysis in this paper.

All surveyed house-embracing Fukugi trees were further categorized into four groups (≥250 years; 200–249 years; 150–199 years; 100–149 years), based on their estimated ages. A map was reproduced with reference to a residential map published by Zenrin, which is a large company that mainly produces and sells residential maps in Japan. The map was used to present the distribution of Fukugi trees older than 100 years. The four groups of surveyed trees were mapped by house and presented in different colors.

All large trees were measured in Bise, Tonaki Island, Aguni Island, and Imadomari in Nakijin Village. There is only one hamlet in Bise, Tonaki Island, and Imadomari. Imadomari is the result of a merging of the two previous hamlets of Nakijin and Oyatomari. Historically, these two hamlets have merged and separated several times. Since Nakijin and Oyatomari were separated only by a main street, Imadomari is considered as one hamlet in this study from the perspective of the village landscape. There are currently three hamlets on Aguni Island: East, West and Hama. East and West are two adjoining hamlets and were not separated until 1872 (Aguni Son Shi 1984), thus, they are also considered as one village landscape. East and West were named Yae, also called *agi* (meaning "inland") in contrast to *hama* (meaning "seashore"). Thus, large trees in the survey sites were grouped into Bise, Tonaki, Imadomari, Yae (East & West), and Hama. Yae, although an old name, will be used in the following text for the convenience of data analysis.

Residences in Tonaki Island are clustered together in the small narrow sandy plain between two high hills in the north and south, respectively. Tonaki had a population of 502 in 2003. Bise village is an arc-like protruding area on the tip of the Motobu Peninsula facing the ocean to the west. The population was 572 in 2006. Aguni is triangular, with a total area of 7.64 km². Ryukyu limestone, which is coral limestone formed during the Pleistocene era, extends mainly through the central

part and the southern end of the island, forming terraces. The two clustered hamlets of East and West villages are located in the center of the island, with the hamlet of Hama near the coast. As of November 2007, the village had a population of 874. Imadomari, covered with sandy soil, is located in the westernmost part of Nakijin Village facing the ocean to the north. Large ports were also located east and west of the hamlet.



Figure 2. Photos of Fukugi trees in the surveyed sites. 2a) A rebuilt, traditional timber house embraced by Fukugi woods (Tonaki Island).

RESULTS AND DISCUSSION

Distribution of Large Fukugi Trees

All house-embracing Fukugi trees older than 100 years were measured. It was found that Yae had the highest number of large trees, totaling about 2,500, while Hama, also on Aguni Island,



Figure 2b. House-embracing Fukugi trees line the village road covered by white sand (Tonaki Island).



Figure 2c. The old narrow road with the overlapping tree branches at the top (Bise village).



Figure 2d. A huge tree (DBH: 643 cm; TH: 10 m) by a vacant house (Aguni Island).



Figure 2e. A huge tree line with the traditional stone fence of coral reef, which were moved inside for the spreading roads. The stone fence was around 1m away from the tree line.

had the fewest, totaling about 500 trees (Table 1). Yae has more Fukugi trees in excess of 100 years old than the other three survey sites, and five times as many as in Hama. About 333 houses in Yae were found to have Fukugi trees older than 100 years, but only 85 houses in Hama. According to statistical data from Aguni Village (Anguni Village Stat 2009), in March 2003, the number of registered households and the population were 302 and 615, respectively, in Yae, and 131 and 298 in Hama. The fact that the surveyed house number is larger than the registered household number in Yae suggests many houses lay vacant. The field surveys also found that Fukugi trees have been better preserved in proximity to vacant houses which were always the older houses and used for family rituals, particularly on Aguni Island. Vacant houses also include abandoned houses whose owners have moved out, leaving the premises without manage-

ment. In many cases, old houses fell down but the grounds are still used as farm land. Only the still-standing Fukugi trees indicate that a family once lived there. The inhabitants left the house but the trees remain untouched around the premises. In contrast, people moved to more convenient places (e.g., Hama), and replaced old style thatch-roof houses with concrete houses.

Table 1 shows that Bise, Imadomari, and Yae have a larger number of large trees in excess of 200 years old than the other two sites, Tonaki and Hama. The former three sites have a similar number of Fukugi trees older than 200 years, totaling about 100. In contrast, Hama and Tonaki only have about 10 remaining trees older than 200 years.

The oldest trees were approximately 300, 268, 294, 296, and 281 years in Bise, Tonaki, Imadomari, Yae, and Hama, respectively (Table 1). The biggest trees found in Bise and Imadomari in the north of Okinawa were larger than those on small isolated islands. This suggests that Fukugi trees might have been promoted in an earlier age in mainland Okinawa.

The mean tree heights of old Fukugi trees were 994, 842, 900, 723, and 713 cm in Bise, Tonaki, Imadomari, Yae, and Hama, respectively (Table 1). The fact that Fukugi trees in Bise, Imadomari, and Yae were found to be bigger and taller can be attributed to the local inhabitants' consciousness of the cultural importance of tree conservation. A survey in Bise village by Nakama and Koki (2002) found that about 94% of the surveyed villagers wanted to preserve house-embracing Fukugi trees. More than 70% of the surveyed villagers had high regard for Fukugi trees since they protect the houses from typhoons; provide them with shade, and make up a pleasant landscape.

The oldest trees were in the southern part of Bise, in the south-east of Imadomari, and in Yae, Aguni Island. The biggest trees were in the eastern part of Tonaki Island, which is the narrower part of the flat area between two high mountains. Hama is much nearer to the ocean than Yae in Aguni (Chen and Nakama 2010).

According to the renowned statesman and also a Feng Shui master, Sai On, close surroundings are needed to achieve the

Table 1. The Number of remnant Fukugi trees in selected villages.

	Area of Village Houses (m ²) ^z	Number of Remnant Fukugi Trees						Estimated age of biggest tree	Mean tree height (cm)
		Total	≥300 yrs	250–299 yrs	200–249 yrs	150–199 yrs	100–149 yrs		
Bise	191,143	1,075	1	17	89	360	609	300	994 ^y
Tonaki	134,723	964	0	2	9	111	842	268	842 ^y
Imadomari	263,378	1,293	0	15	85	307	886	294	900
Yae (East & West)	384,254	2,561	0	16	82	486	1,977	296	723
Hama	137,602	541	0	3	6	65	467	281	713

^zThe areas of all village houses is a rough value, calculated based on the residential map published by ZENRIN. The area only includes the houses that were assumed to have been built approximately 100 years ago.

^y Mean tree heights in Bise and Tonaki was derived from the survey data from 2005–2008.

Table 2. Distribution of Fukugi trees around the house courtyard.

	Surveyed house number	Total number of Fukugi ≥ 25 cm (dbh)	Fukugi in the east ^z		Fukugi in the west		Fukugi in the south		Fukugi in the north	
			Tree Number	% ^y	Tree Number	%	Tree Number	%	Tree Number	%
Bise ^x	99	1075	-	-	-	-	-	-	-	-
Tonaki	165	918	276	30.1	157	17.1	174	19.0	311	33.9
Imadomari	155	1293	299	23.1	323	25.0	278	21.5	393	30.4
Yae (East & West)	333	2561	714	27.9	294	11.5	357	13.9	1148	44.8
Hama	85	541	184	34.0	59	10.9	85	15.7	213	39.4

^z The trees were classified according to their location relative to the house courtyard.

^y Refers to the proportion of trees found in one direction in relation to the total surveyed Fukugi trees inside the village.

^x Bise was surveyed with the help of students in the lab in the summer of 2008. The tree stand by the side was not recorded.

harmony of Yin and Yang (Purves et al. 2009). Typical house-embracing Fukugi trees should be positioned in the four directions of the courtyard to create proper protection. However, with the felling of Fukugi trees, such a typical shape is difficult to find inside villages. When the orientation of the remaining trees were averaged, it was found that the greatest number of large Fukugi trees stand to the north of the house, followed by the eastern side, and then southern side (Table 2). The western side has the smallest number of large Fukugi trees. This is in accordance with the fact that monsoonal winds from the north and typhoons from the eastern side are the greatest threat to property. The survey results confirmed assumptions that Fukugi tree layout is strongly correlated with wind direction. Local people have purposely kept the large trees untouched in the northern and the eastern sides of the courtyard.

Huge Trees and the Hamlet Landscape Layout

Fukugi tree distribution by tree age is shown in Figure 3. It is clear that Fukugi trees older than 100 years are prevalent in Bise, Tonaki, Imadomari, and Yae, while there are few in Hama. From Figure 3, shows a tendency for huge trees older than 200 years to cluster around important sites in the hamlet, e.g., *asyagi*, *hasagi* or *haisyo*. The *Hasagi*, also called *kami-asagi*, is a small building in a sacred place, where guardian deities were summoned for the holding of ceremonies and rituals (Nakamatsu 1977). The *Kami-asagi* used to be a small building with a low thatched roof supported by four pillars without walls or a floor. At present, most of the *kami-asagis* have been rebuilt with concrete or tiled roofs.

Asagiya: is the local name for *asagi* in Bise village. Figure 3a shows Fukugi trees older than 200 years were clustered around houses surrounding the *asagiya*. The *Asagiya*: is at the center of Bise village, with the oldest houses around it. In the area in the north of the *asagiya*, Fukugi trees were younger, generally not older than 150 years. The distribution of large Fukugi trees here suggests the houses surrounding the *asagiya*: are the core area of Bise, and that the village developed from its southern part to the northern part.

Hasaginkwa: and Fupuhasagi are two *kami-asagis* belonging to Imadomari and Oyatomari in Imadomari, respectively (HCCN 2007). It was found that houses around these two *kami-asagis* have more Fukugi trees in excess of 200-years-old than other areas. A broad road of about 250 m between the two *kami-asagis* is called *baba* (馬場), which was an open space used for horse training, horse racing, and tug-of-war. This place is now where the Harvest Festival is held every year.

In Tonaki Island, large Fukugi trees older than 200 years are clustered in the eastern part of the island, while Fukugi trees in the western part are younger (Figure 3b). Four *haisyos* out of a total of five inside the village are located in the eastern part. From Figure 3b, one will find the Fukugi trees older than 200 years were clustered in the eastern part of the village. It is obvious that houses in the current residential site were built in the eastern part in earlier years and later in the western part of the village.

Tomari Hara is thought to be the earliest settlement of Aguni village, where people moved from a mountainous area in the west to the current flat area (Aguni Son Shi 1984). It is difficult to pinpoint the exact location of Tomari Hara. Its boundary was drawn by a local villager named Tsuyoshi Komine. The *Ufuya*: (大屋) and *ni:ya* (根屋) are located in this area. *Ufuya*: is the male deity of the village and its habitat is a sacred place.



Figure 3. Distribution of old house-embracing Fukugi trees older than 100 years inside selected villages. The grayscale legend is pertinent to Figures 3a-3e. 3a) Bise village. The darkened star indicates the location of *Kami-asagi*.

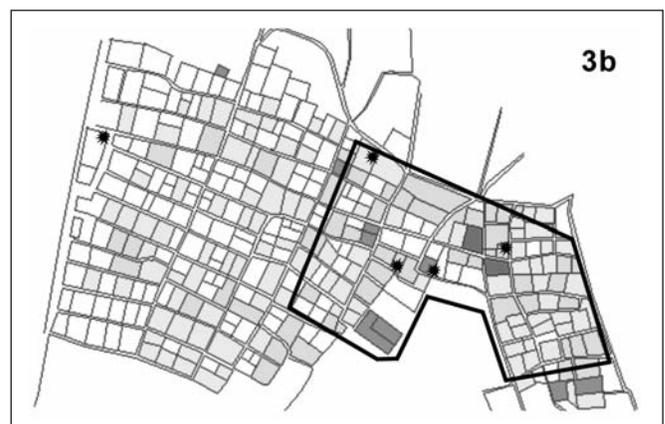


Figure 3b. Tonaki. The darkened stars indicate locations of *haisyo*, the place where individuals pray to the gods.

In mainland Okinawa and its surrounding islands, the house of the earliest family that settled in a hamlet was called *ni:ya*, which became the center of hamlet rituals. Figure 3d shows rees older than 200 years are clustered around Tomari Hara.

The biggest Fukugi trees were found to be around the old houses at the foot of the high land behind Hama hamlet, although the number of large Fukugi trees is much fewer than in other survey sites.

As mentioned earlier in this study, the oldest parts of the hamlets in the survey sites are also the location of most of the large Fukugi trees older than 200 years. Not exclusively, it must be said, since large trees can be found in places other than core areas. In particular in Imadomari and Yae in Aguni Island, large trees older than 200 years were found scattered here and there in the village. Fukugi trees around 300 years were also found in Bise (Figure 3a). The present village landscape, with large Fukugi trees older than 200 years and orderly road layout, might have been planned and built during the Sai On period from 1737 to 1750. The age of some trees suggests that some houses might have moved to the current residential area with Fukugi trees planted as windbreaks to protect the houses before the Sai On period.

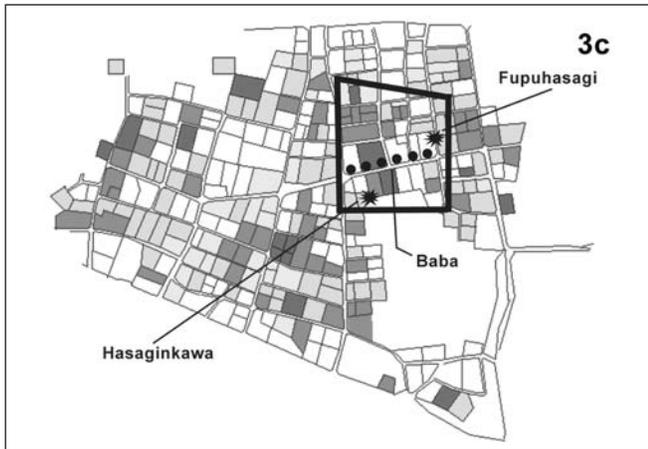


Figure 3c. Imadomari. The dotted path indicates the location of Baba. It was an open space used for horse training, horse racing, and playing tug-of-war. Now it is where the Harvest Festival is held every year.

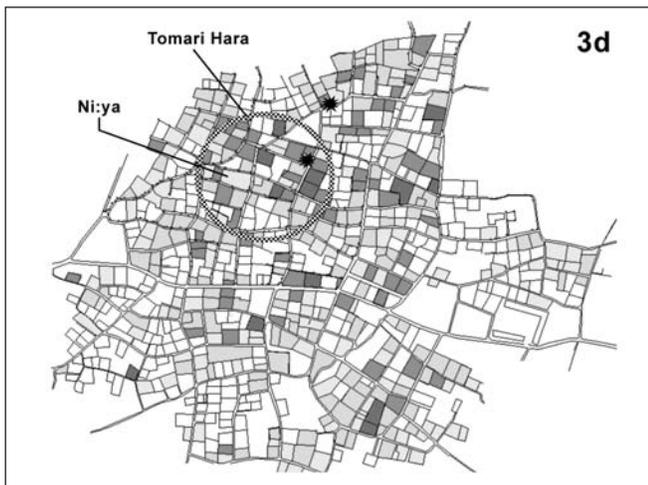


Figure 3d. Yae (East & West). The area inside the patterned circle is Tomari Hara, which is supposed to be the location of the earliest habitation in the current village site (Aguni Son Shi 1984).

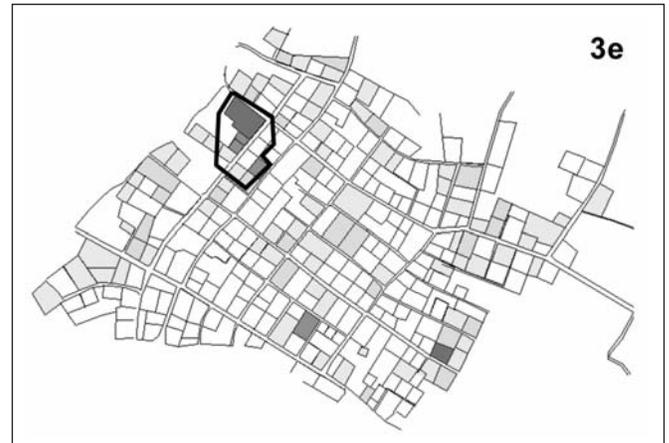


Figure 3e. Hama. The area inside the dark line is thought to have been the older parts of the hamlet.

CONCLUSIONS

A Feng Shui village landscape, assumed to have been planned or reformed during the modern Ryukyuan Period, features Fukugi house-embracing trees and an orderly road layout. Fukugi trees are well preserved on Okinawa Island and its nearby isolated islands. However, it is still a mystery to historians when and how these Fukugi trees were planted. In order to clarify the development process of the house-embracing Fukugi trees, all Fukugi trees that were assumed to be older than 100 years in Bise, Tonaki, Imadomari, and Aguni Island were measured. The surveyed hamlets were located on the fringe of Okinawa Island and its nearby smaller islands. Exposure to the sea might be one factor accounting for the preservation of Fukugi trees.

Fukugi trees older than 100 years were prevalent in all surveyed hamlets. Trees older than 200 years, however, were more common in Bise and Imadomari, and at Yae in Aguni Island than in Tonaki and Hama, Aguni Island. The spread of older trees in the former three villages was wider than in the latter two villages, suggesting the former three might have been settled at the current sites earlier than the latter two. The mean heights of large Fukugi trees were taller in Bise and Imadomari than in Tonaki and Aguni Island. A higher value placed on Fukugi trees by local people might be one important factor for having a better preservation of Fukugi trees.

The spatial distribution of old Fukugi trees in a Feng Shui village in Okinawa also suggests that strong wind has been the primary factor for such a layout. The oldest trees standing around the older part of the settlement were farther from the ocean than the younger trees.

Kami-asagi in northern Okinawa Island and *haisyo* on its nearby isolated islands were thought to be the hamlet center, with the houses around it forming the earliest settlement area. The present study found that large Fukugi trees older than 200 years are clustered in the core area around the *kami-asagi* or *haisyo* in the village. Fukugi trees in the northern part of Bise and the western part of Tonaki were younger than those in the core area near the *kami-asagi*, or *haisyo*. Thus, a traditional village in Okinawa was laid out with a structure related to the local religion and sacred rites at its center.

The oldest tree of around 300 years might have been planted prior to the period from 1737 to 1750, when Sai On was a *Sanshikan*, during which Fukugi trees were planned and rec-

ommended. Fukugi trees were planted as windbreaks around houses before the Sai On period, however, with the current house-embracing Fukugi tree landscape coming into being during the Sai On period and based on the Feng Shui concept.

Feng Shui village landscapes with numerous large Fukugi trees which were planned hundreds of years ago is a cultural landscape which should be reevaluated, preserved, and utilized as a green tourist resource in a contemporary context.

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Bixia Chen (corresponding author)
School of Economics
Fujian Normal University

JSPS Postdoctoral Fellow
Faculty of Agriculture
University of the Ryukyus
Senbaru, Nishihara Town
Nakagami Gun, Okinawa 903-0213
Japan

bixia.chen@gmail.com

Yuei Nakama
Professor
Department of Subtropical Agricultural Science
Faculty of Agriculture
University of the Ryukyus

Résumé. L'aménagement paysager d'un village Feng Shui implique l'emploi d'alignement d'arbres composés de Fukugi (*Garcinia subelliptica*) qui entourent chacune des maisons ainsi que de part et d'autres de routes organisées de manière relaxante. Ce type d'aménagement paysager végétal, qui a été conçu ou organisé durant la période moderne du Ryukyuan il y a environ 300 ans, a été très bien conservé sur l'île d'Okinawa au Japon ainsi que sur les autres îles isolées à proximité. Le mystère demeure cependant toujours pour les historiens à propos de savoir quand et comment ces Fukugis ont été plantés. Afin de clarifier le processus de développement des Fukugis entourant les maisons, tous les Fukugis dont on assumait qu'ils étaient âgés de plus de 100 ans ont été mesurés sur les îles de Bise, Tonaki, Imadomari et Aguni. On a découvert que les immenses Fukugis de plus de 200 ans se regroupaient autour de la place centrale du kami-asagi ou haisyo à l'intérieur du village. Le kami-asagi et le haisyo sont des places sacrées où les dieux gardiens sont appelés lors de la tenue des cérémonies et des rituels. Les plus vieux arbres ont approximativement 300, 268, 294, 296 et 281 ans respectivement à Bise, Tonaki, Imadomari, Yae (Est et Ouest) et Hama dans l'île Aguni. Ces vieux arbres pourraient avoir été plantés antérieurement à la période comprise entre 1737 et 1750 lorsque Sai On était un membre du Sanshikan au cours de laquelle l'emploi des Fukugis était recommandé. Alors que les fukugis pourraient avoir été plantés en tant que brise-vent autour des maisons avant la période du Sai On, l'aménagement paysager actuel avec des fukugis entourant les maisons est devenu réalité durant la période du Sai On en se basant sur les concepts du feng shui.

Zusammenfassung. Eine Feng shui Dorflandschaft ist gekennzeichnet durch Fukugi-Baumreihen, die jedes Haus umgeben und die ordentlichen Straßen säumen. Solche Landschaften, welche vermutlich in der neuen Ryukyuan Periode vor ca. 300 Jahren geplant oder reformiert wurden, sind auf der Insel Okinawa und den benachbarten Inseln gut erhalten. Aber es ist für die Historiker immer noch ein Geheimnis, wann und wie diese Fukugi-Bäume gepflanzt wurden. Um den Entwicklungsprozess dieser hausumgebenden Fukugi-Bäume zu klären, wurden alle Bäume auf den Inseln Bise, Tonaki, Imadomari und Aguni, die wesentlich älter als 100 Jahre sind, gemessen. Es wurde festgestellt, daß sich große Fukugi

-Bäume, die älter als 200 Jahre waren, um das Zentrum kami-asagi oder haisyo im Dorf gruppieren. Sowohl kami-asagi und haisyo sind heilige Plätze, wo Schutzgötter versammelt sind und Zeremonien und Rituale abgehalten werden. Die ältesten Bäume waren schätzungsweise 300, 294, 296 und 281 Jahre alt und standen auf Bise, Tonaki, Imadomari Yae (Ost und West) und Hama auf der Insel Aguni. Diese alten Bäume könnten vor der Periode von 1737 – 1750 gepflanzt worden sein, als Sai On ein Mitglied der Sanshikan war, während der Fukugi-Bäume gepflanzt und empfohlen wurden. Während die Fukugi-Bäume vor der Sai On Periode möglicherweise als Windschutz um die Häuser gepflanzt wurden, sind die gegenwärtigen hausumgebenden Fukugi-Baumlandschaften in der Sai On Periode auf der Basis von Feng shui Konzepten angelegt worden.

Resumen. Un paisaje Feng Shui caracteriza las líneas de árboles Fukugi (*Garcinia subelliptica*) alrededor de cada casa y metódicamente fuera de las carreteras. Como tal un paisaje verde, planeado y reformado durante el período moderno Ryukyuan alrededor de 300 años, está bien preservado en Okinawa Island, Japón, y sus islas vecinas aisladas. Pero es aún un misterio para los historiadores cuándo y cómo estos árboles Fukugi fueron plantados. Con el fin de clarificar el proceso de desarrollo de las casas asociadas a estos árboles, todos fueron asumidos en 100 años de edad en las islas Bise, Tonaki, Imadomari, y Aeguni. Se encontró que los árboles más viejos fueron de 200 años, agrupados alrededor del área núcleo kami-asagi o haisyo dentro de la villa. Los dos lugares, kami-asagi y haisyo, son espacios sagrados donde los dioses guardianes fueron convocados en ceremonias y rituales. Los árboles más viejos son aproximadamente de 300, 268, 294, 296 y 281 años en Bise, Tonaki, Imadomari, Yae (East & West), y Hama en Aguni Island, respectivamente. Estos viejos árboles pudieron haber sido plantados antes del período de 1737 a 1750, cuando Sai On era miembro del Sanshikan, durante el cual los árboles Fukugi fueron planeados y recomendados. Mientras que los árboles Fukugi pudieron haber sido plantados como rompevientos alrededor de las casas antes del período Sai On, sin embargo, las casas en la actualidad se cree que los árboles vienen siendo durante el período Sai On con base en los conceptos Feng Shui.