Osaka Human Sciences, **4**, 61-83
March 2018

FORCES IN THE DEVELOPMENT OF REMOTE ISLANDS IN JAPAN: A CASE STUDY OF LOCAL ENERGY ENTERPRISES IN TSUSHIMA ISLAND

Yuko Matsumura*, Emako Miyoshi*

Abstract

Japan, one of the most famous islander nations in the world, has promoted the development of its remote islands for over 60 years after the Second World War. The target islands and projects for fostering development have been steadily expanded. However, the country is facing serious socio-economic challenges such as aging and recession, resulting in less available funding for preferential treatment to remote islands. Thus, the framework for boosting island development should be reconsidered, and this paper argues that changing the systems of energy supply is a key step in this direction.

First, the history and the main characteristics of the development initiatives on remote islands in Japan are analyzed. The first project to support remote island development was to improve transportation and port and airport facilities, and to supplement the gap in fossil fuel prices between remote islands and the mainland through public funds. The living environments on the remote island regions were gradually and continuously improved with lifelines such as sanitary water systems and electricity networks. These support structure resulted in a huge amount of subsidies being invested in building and maintaining ports and airports, and in fuel cost assistance, which enabled easy access to the mainland but also prolonged the dependence on the mainland.

In addition, the research focuses on subsidy projects to support high fuel costs and energy development in remote islands. After 63 years of the launching of the law for development promotion of the remote islands, the gap in fossil fuel prices has not been reduced. Based on the research results of local energy enterprises on Tsushima Island, initiatives for locally produced energy are superior to the old energy system that consumes imported fuels. The new energy system that provides local energy suppliers is: 1) more economically manageable, 2) easier to coordinate with municipal strategies, 3) and faster for responding to emergencies such as an unpredicted breakdown or natural disaster.

This article is the English translation of the original one “Bulletin of Graduate school of Human Sciences, Osaka University 43 P. 23–P. 4”

* Graduate School of Human Sciences, Osaka University, 1-2, Yamadaoka, Suita, Osaka 565-0871, Japan

Finally, remote islands have established urban infrastructure such as well paved roads and advanced internet network services. Despite the vast investment, fuel cost is still a severe issue for communities on remote islands. According to the result of the examination of field research on Tsushima Island, the need for locally produced energy has firmly risen in order to build an independent energy system and social structure. As possible solutions, several new energy technologies are going to be introduced on several islands in other countries, in the form of offshore wind turbines, tidal power generation, hybrid ships and electric boats. These technologies enhance the harnessing of the local *oceanity*, that is, the remote islands' marine environment and access to natural resources. This approach should help lessen island dependence on the mainland as well as local mimicry of nationally endorsed technologies and social policies.

Key words: Remote Islands Development Act, energy self-sufficiency, renewable energy, local enterprises

1. Introduction

In April 2016, legislation by nonpartisan House members in the House of Councilors was enacted and promulgated as the Act on Special Measures Concerning Occupied Remote Islands on National Borders Retention and Regional Society of Specific Occupied Remote Islands on National Borders Maintenance (hereafter referred to as "Occupied Remote Islands on National Borders Act") (Shirakawa, 2016). For sixty-odd years or so, calls for remote island reconstruction were made during the postwar reconstruction period, regional reconstruction policies in the framework of "remote islands" have continuously been implemented. While the Remote Islands Development Act enacted in 1953 as a 10-year temporary legislation was revised and renewed for the 6th time in 2013, the target islets still continue to increase in number. In view of the perspective of development studies with respect to this condition[1)], presumably nobody will raise any objections to the improvement of development standards. However, a question has been raised, due to anxieties with respect to the decline of urban and rural areas in Japan's progressively aging society with fewer children, whether the policy in the framework of "islets" is really appropriate or not. In other words, there is an apprehension that the remote island reconstruction policy was excessively prepared without sufficient verification of how the remote islands' conditions would be after the implementation of the remote island reconstruction policy. In order to implement genuinely sustainable regional development, a remote island reconstruction project

[1)] With respect to development studies on developing countries, Kitajima (1998) stated that development after the basic goals were achieved with respect to food, clothing and shelter, development shifts towards a more industrial form, and goals switch to improving levels of welfare.

tailored to the particularity of the islet area must be established. Namely, we reached the conclusion that it is necessary to restructure the project and review the historical background of remote island reconstruction as well as the positioning of island reconstruction as of then in island research.

This paper researches the issues and outlook of remote island reconstruction, while focusing on sustainability and the energy system in remote island areas. More specifically, analysis will be performed from the perspective of the following projects: the bay area development project and transportation cost assistance project, which have been consistently deemed as assistance target projects and a prospective energy development project in the future since the Remote Islands Development Act was enacted. The structure of this paper is as follows. To start, it will reconfirm the definition of islands, the difference between islets research and remote island research, and the positioning of remote island reconstruction from the viewpoint of islets in regional studies. Next, it will review the effects of the ongoing remote island reconstruction project in the remote island area, particularly with respect to the transportation cost assistance project, and take a brief look at energy development research. Then, it will extract issues appertaining to energy production conducted by the region in remote islands based on results of a site survey conducted in Tsushima City, Nagasaki by the authors themselves. Furthermore, it will analyze development practices pertaining to the biodiesel fuel manufacturing project and the wind power generation project regionally implemented in Tsushima City, followed by reconsideration of the special characteristics of remote islands. Finally, it will summarize the abovementioned discussions, reflect on the core concept of remote island reconstruction, and consider future developments in remote island reconstruction in terms of impact on regional sustainment and social systems.

2. Definition of a remote island and remote island reconstruction

Before analyzing remote island reconstruction, we will summarize the discussions in previous research regarding the definition of "island" and "islet." Firstly, the dictionary *Kojien* defines islet as "islands in a broad sense." The Japan Coast Guard defines "island" as follows (Figure 1):

1. The perimeter is 0.1 km or longer.
2. Regarding islands which are connected to the mainland in some way, if the island is connected by a narrow structure such as a bridge or a seawall, the land is considered as an island. Land that is connected by a much broader structure and has become a part of the mainland is excluded.
3. Excludes dumping site

Figure 1. Definition of island
(Excerpt from "The Status of the Coast Guard," Japan Coast Guard, 1987)

Inatomi (1997) compiled the definitions of an island from former researchers using the terms "islet," "island," and "remote island." For example, the definition set forth by Omura (1959) is "an islet is a land that is relatively small in area completely surrounded by a hydrosphere." Miyamoto (1970)'s definition is: "an island must be identified by natural objective conditions, and understood in the sequential and orderly relationship of Mainland to hydrosphere to island. Remote islands are also islands which are secondarily connected to the mainland." Moreover, Kawachi (1968) defined islands as land where "all sides of a remote island are enclosed by ocean and maintains a degree of regional independency while being a world fated to be economically subordinate in some way to the mainland. An island is a topographical concept, and a remote island is a concept in relation with the mainland, where the capital stock is. The remote island is subordinate to the mainland; they are isolated from each other by the ocean."

What can be inferred from these researchers' definitions are the following two primary points. The first is the difference between an islet and a remote island. The second is the difficulty in evaluating remote islands with respect to objective concepts; in particular, underdevelopment (being undeveloped). More precisely, islet areas can be summarized with: 1. topographical positioning, 2. research dealing with island as human geography, 3. islands as part of regional research. On the other hand, remote islands can be summarized as "underdeveloped" areas deemed to need support, and defined (by the Remote Islands Development Act) as an area possessing characteristics of "compactness," "remoteness," and "oceanicity."

Now, we will start our analysis on the background and current conditions of the remote island reconstruction policy, using remote islands as a policy term. In 1950, in order to restore a devastated post-war Japan, the development policy known as the Comprehensive National Land Development Act was enacted; however, upon the selection for special regions designated as assistance-demanding areas in this Act, not many remote island areas were certified as such (Suzuki, 2012). This being said, the standard of living on the remote island areas at this time was low. People were living in poverty, and the qualities of education, medical environment, and lifeline facilities were clearly lower compared to the mainland (Miyamoto, 1970). After it was deemed that these conditions were due to a status of underdevelopment, and the Remote Islands Development Act was established in order to eliminate said underdevelopment of the remote islands. As stated at the beginning of this paper, the Remote Islands Development Act has been updated since it was enacted in 1953 as a 10-year temporary legislation. Despite this, target areas are still being deliberated upon by a committee discussion without clearly defining remote islands and without restricting targets to specific areas within the Remote Islands Development Act[2)]. For instance, when tracing back the definition of remote islands used in committee deliberation processes, statements were made such as "the original plan meant to encompass

2) The target areas for the Remote Islands Development Act are set forth in Article 2 as a process in which "Ministers of three ministries (MLIT, MIC, MAFF) conduct hearings at National Land Development Council, (omitted) to designate the entire or partial region as a remote island development measure implementing region."

Sadogashima-island (Niigata), Okinoshima-island (Shimane), Tsushima-island, Iki-island and the Goto Islands (Nagasaki), Koshikishima-island (Kagoshima), the Nansei Islands, the Izu Islands and the Ogasawara Islands (Tokyo), but—(omitted)—the Amakusa Islands (Kumamoto) and Mishima-island (Yamaguchi) are very remote as well," or "there is no method to make determinations with respect to time or distance yet. Determinations should be made according to the social norm." This suggests that concrete definition of terms was put off, and only cases were deliberated on an individual basis (Suzuki, 2006). Thus, after the 6th revision of the Act, it is difficult to say that the target areas selected under the Remote Islands Development Act were selected according to objective standards.

With respect to reconstruction policies for remote islands, they are not limited to the Remote Islands Development Act. In 2016, the Occupied Remote Islands on National Borders Act was issued, and this Act will be enforced in 2017 as a 10-year temporary legislation (Shirakawa, 2016). As the backdrop for this legislation, there was a discussion over the necessity to maintain remote island areas as well as to retain the society of said island area, which stands on an international boundary. Measures against coral poaching near the Ogasawara Islands as well as Chinese fleets' advancement into territorial water near the Senkaku Islands were addressed as the primary national issues of concern[3]. This can mean that the current remote island research and islet research advancements are being more emphasized nowadays for their use in political considerations or diplomatic purposes, such as national defense, than the purpose of development or improvement of the islands' and islet's standards of living. From a different angle, when looking at methods of remote island reconstruction so far, there is a history of investment and development being conducted which focus on the implementation of social infrastructure development for the purpose of correcting inequalities in standards of living in consideration of remote island areas whose development has been delayed[4] (Suzuki, 2012, Maehata, 2013). Therefore, regional development driven by the remote island reconstruction made it possible to use regional resources that had not been previously utilized due to lack of technologies or facilities. For example, Miyamoto (1970) made a statement regarding conditions before enacting the Remote Islands Development Act as such: "because they did not own good boats, fishing

[3] A year before the Occupied Remote Islands on National Borders Act was established, "the Remote Island on National Borders Retention and Reconstruction Special Measure Bill" was drafted by House members, but was repealed. When reading a clause in an Article regarding the target for support in this law, contradictions between objectives of the bill, specific clauses, and specific budget purposes can be found. This means that despite the lack of descriptions on defense expenditures, there were specific notions in this section with respect to the support amount ratio for development of streets, ports and harbors. On the other hand, the new Occupied Remote Islands on National Borders Act emphasized retention of permanent residents on such remote islands, and had a robust support system particularly focused on regional society maintenance.

[4] The actual budget for the Remote Islands Development Act so far was: 2.748 trillion JPY for ports and harbors, fishing ports, and airports (47.0% of total), 790.4 billion JPY for road maintenance (approximately 18% of total), 568.2 billion JPY for flood control and forestry conservation (13% of total), and 490.3 billion JPY for matters related to agriculture (11.1% of total). The ratio that accounts for maintaining road and ports were very large, with 65% of expenses.

resources were dominated by fishing boats from the mainland, and businesses on islands were apt to be controlled by merchants on the mainland." Kawachi (1968)'s analysis was that "residents' life environments shifted from a lifestyle of self-supply in the remote island area to a lifestyle which was dependent on the mainland. Some island residents started to grow 'awareness of remote islanders as subordinate land to the mainland,' as well as 'independently created a mental structure of remote islands as dependent on the mainland'" (Kawachi, 1968, Sato, 2007). In other words, an influx of technologies and facilities to islands through support activities reinforced capitalization and mainland dependency through the amplification of ports and harbor facilities, such as fishing ports and airports, as well as streets. As can be seen from the above, the pros and cons of the Remote Islands Development Act had been referred to in preceding research, and one can infer that promoting island reconstruction is not always necessarily the best course of action, and that there is a necessity for the purpose and scope of reconstruction projects to be reviewed.

However, at administrative locations, reviews on remote island reconstruction policy had not been conducted sufficiently. When the Remote Islands Development Act approaches its term of extension or revision, the heads of local government situated at their remote islands demand more preferential treatment as the members directly involved in remote island reconstruction by holding rallies (Remote island office, 2012), etc. In the Japan Diet as well, remote island construction supporters are the majority[5]. Among researchers, evaluations regarding the outcome of remote island reconstruction differ. Sato (2006) pointed out with respect to islet areas that there is a higher facility density per population compared to that of the mainland, and that an islet area's remoteness makes its environment easy to live in, while Maehata (2013) pointed out that the amelioration of inequality in remote island areas is not yet sufficient. As a whole, evaluation of remote island reconstruction differs from individual to individual[6].

On the plus side, upon the 5th renewal of the Remote Islands Development Act in 2003, development policies with respect to development assistance which were biased in favor of tangible projects such as the development of abovementioned ports and harbors were modified. An island's resources, as well as an island's traditional use of resources, lives, and culture, started to gained attention, and when people recognized that what was needed was a unique development of islands without aiming only towards capitalistic development that was conscious of the mainland, and especially urban areas. In order to promote strategic island planning on each

[5] The vote in the plenary session at the House of Representatives for the Occupied Remote Islands on National Borders Act ended up with 227 in favor, 1 in objection out of a total vote amount of 228.

[6] Particularly with respect to the Okinawa and Amami area, there are many pieces of preceding research that discuss spontaneous developments of areas (Minamura, 2003, Nishikawa et al., 2010, Aoki, 2012). This is probably due to reconstruction law being applied to Amami and Okinawa, etc. after they were returned to Japan. Their great distance from the mainland and their historical and cultural relationship with the Asian continent might be another reason, as well as their special economic structures due to U.S. military bases, etc. All of the research claims that reconstruction of Amami and Okinawa is insufficient.

individual island, "creating valued differences"—which refers to the development through differentiation from other areas by taking advantage of various conditions (geographical, resource-wise, nature-wise) efficiently and actively—was required (refer to the description in the 1993 revisions). It can also be said, however, that the objectives, targets for support, and target projects for support in the Remote Islands Development Act became abstracted and unclear. While developments tailored to each island with respect to its specific uniqueness has cropped up in the over-10 years since the revision in 2003, said developments are limited to those that were featured in media as examples of success, such as Ama town in Shimane prefecture. The trend is still solidly inclined towards the islands deepening mainland dependency and being absorbed into the mainland. From the perspective of the islanders, interaction and information exchange with the mainland have become more frequent through recent improvement of information and communication technologies, in addition to the development projects based on the Remote Islands Development Act. As a result, islanders have become conscious of their island's underdevelopment with respect to the criteria of "convenience" in comparison to that of urban areas, and have been exposed to more opportunities in experiencing evaluation from outsiders. Therefore, we believe that it is necessary to immediately re-evaluate an islet's characteristics and to consider ways to differentiate each island in terms of positioning with respect to remote island reconstruction.

Remote island areas are not the only parties that face issues of regional reconstruction, etc. Here, we will compare current conditions of underdevelopment of the following two parties: the "current condition of remote islands"[7] in terms of Nagasaki prefecture's remote island reconstruction plan and the "current condition of mountain villages" based on statistical data of mountain villages within the target reconstruction area in terms of the 1965 Mountain Village Reconstruction Act. The common trends in both the "current condition of remote islands" and the "current condition of mountain villages" are decreases/ageing in population, the lessening working force, developments/conditions of streets, and the condition of educational/medical facilities. An issue unique to remote island regions is the issue of transportation costs. In other words, analysis says that although businesses aside from transportation costs are common issues for both regions, the characteristics of remote islands make the situation more severe. Regarding the creation of infrastructure systems including ports and harbor development, sea routes, transport, and energy, they have been heavily supported since before the Remote Islands Development Act. In other words, access, transportation/transportation costs, and infrastructure structuring at remote islands have always been important measures for island reconstruction[8].

---

[7] The reconstruction plan for Nagasaki, the prefecture which holds the largest number of islets, announced and added material which indicated underdevelopment and characteristics of islets at the end of the remote island's reconstruction plan.

[8] According to Sato (2006)'s analysis, the subsidy rate from the country and prefecture with respect to remote island reconstruction-related projects varies depending on the project. The rate for heavily focused-on projects such as roads and ports/harbors development is close to 90%, while that of resident welfare related projects is under 50%.

The next chapter will further discuss transportation/fuel support projects on remote islands as well as the energy development movement.

3. Energy support policy and a movement towards development on remote islands

As described in the previous chapter, it can be said that development-oriented support projects centered on infrastructure, such as port and harbor development, are main items in the reconstruction of islands in Japan. Due to improved access from outside of the islands, the structure of the island's economic and social dependency on the mainland became even more robust. What was brought to light by this change was the growing transportation costs of living on islands; this can be attributed to the fact that products from the mainland including food as well as necessities, and even items such as lights, kitchen works, and transportation within the island proliferated in the islands. With respect to the impact that marine transportation has on a remote island's industries, Akamatsu (2008) explains that islanders who are running industries on remote islands suffer from doubled or more than tripled cost structures. For instance, the marine product processing industry must bear the marine transportation costs for procuring essential materials for processing from the mainland, as well as the costs for when they ultimately ship the products to the mainland. Manufacturers on remote islands are faced with the dilemma of weakened price competitiveness if marine transportation costs are added to product prices—a cost that is unnecessary to mainland products—and lowered profitability if transportation costs are included in expenses instead of passed on to product prices. This chapter will organize energy development support implemented on remote island areas in Japan, and refine those issues.

When a statement regarding the use and application of renewable energy was added in 2013 to the Revised Remote Islands Development Act, Maehata (2014) took the opportunity to summarize energy-related support to Japanese islets and their current development conditions as follows. What were analyzed first were the primarily implemented power introduction projects and distribution cost support projects. For islands, energy is something 1. sent from a long distance, 2. inevitably high in cost, and 3. unstable, fragile, and highly dependent in terms of energy provision. In the current energy system, which depends on fossil fuel, the self-support ratio of energy will decrease on remote islands where there is no fossil fuel production. Furthermore, fossil oil imported from oil producing countries must be transported to remote islands by way of the mainland. Unprofitability generated by dependency on parties outside of the island becomes greater than the mainland by the amount proportionate to the distance from the mainland[9].

[9] The Goto-Islands in Nagasaki is an exception and does not fall into this structure, due to a crude oil transshipment station located adjacent to the Goto-Islands.

Table 1. Primary support projects for marine routes/fuels, etc. targeting remote islands

Year	Contents	Businesses targeted by the subsidy
1952	Act on Maintenance and Improvement of Traffic Routes for Remote Islands	Project related to maintaining marine routes and lowering prices Subsidy for ports and harbor development project, and passage fare to remote islands
1953	Remote Islands Development Act	
2011	Subsidy project for retention and maintenance of public transportation in the region (subsidies for remote island route operation fee etc., etc.)	Subsidy for an estimated amount of loss for sole, unprofitable routes. Subsidy for lowered amount of traffic (bus) fare in islands
2012	Gasoline distribution cost support project for remote islands	Subsidy for discounted amount of gasoline sold at stores. Subsidy related to publicity of projects and inquiries. Subsidizing repair fees and expenses for equipment of gas stations in remote islands
2014	Supplemental project related to oil product distribution rationalization/stable supply support project for remote islands	Supplemental support for expenses related to consortiums in regions

(Created by the authors based on the MLIT website)

In addition to the reason above, due to the advancement of infrastructure development on remote island areas, lowering transportation costs have been considered the most serious and crucial issue for today's support projects for remote island areas. Thus, the country and prefectures have both conducted occasional support projects, etc. which include marine route assistance/transport of fuel (Table 1).

For example, in 2009, a supplemental project was started to promote the lowering of fuel costs for remote islands areas, known as the "gasoline distribution cost support project for remote islands." This is a supplemental project aiming to substantially lower gasoline retail prices on remote islands, which are relatively higher than the mainland prices. Specifically speaking, in this system, when a gasoline retailer within a targeted remote island area offers a discounted price, the country subsidizes the discounted amount. Remote islands are categorized with respect to their means of transport, such as use of gasoline or other fuels, and the amount of subsidy is determined accordingly (Figure 2).

In spite of the effort through such systems, sufficient effects of this project have yet to be observed. As a result of comparisons between gasoline, light oil, and kerosene prices in remote islands and the mainland in 2003, 2006, 2009, and 2012 under the remote island reconstruction plan conducted by Nagasaki prefecture, it became apparent that there was a difference of over 20 JPY in average prices between the mainland and the remote island area in 2009 and 2012. This suggests that the gaps in fuel prices hadn't been eliminated even after the commencement of the supplementary "Gasoline distribution cost support project for remote islands" in 2009 for remote islands (2012 Remote island reconstruction plan by Nagasaki). Since the issue of high

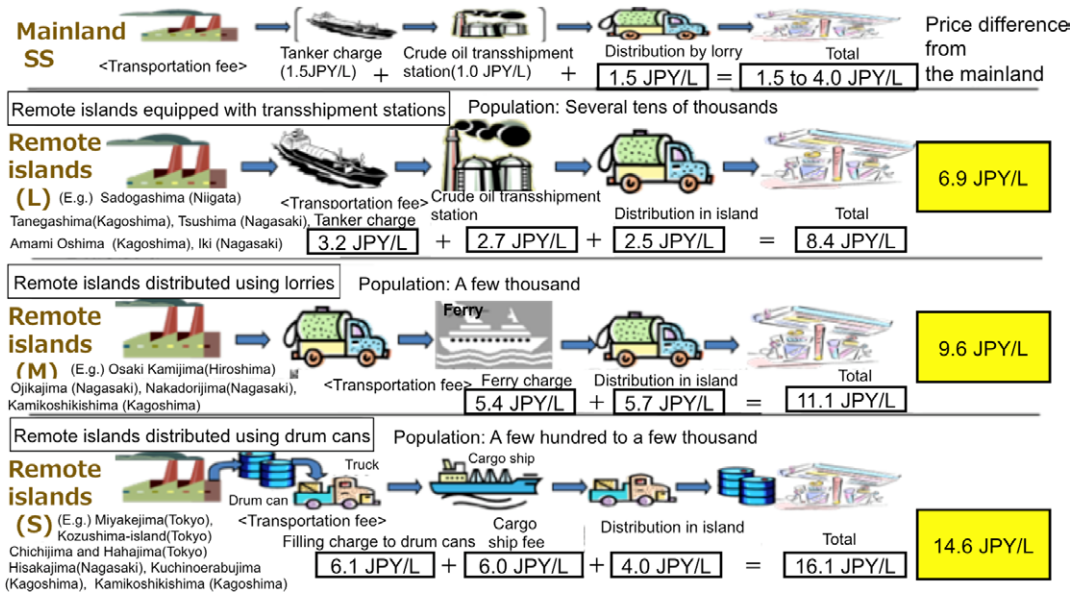

FIGURE 2. Difference in subsidy for islands under the Gasoline distribution cost support project for remote islands
(Created by the first author, Excerpt and from Agency of Natural Resources and Energy 2016)

cost structures for fuel and other energies in remote island areas, despite its seriousness, has not been fundamentally resolved, a need for countermeasures reared its head.

As a response to this need, items pertaining to renewable energy were set forth at the time of revision of the Remote Islands Development Act in 2013, and it recommendations were made to take measures against the issue of fuel high costs in the remote island reconstruction plans as well (created by prefectures). According to Maehata's analysis (2014), when referencing prefectural remote island reconstruction plans, of the 254 islands neighboring the mainland (targeted by the Remote Islands Development Act), 156 of them stipulate items on renewable energy, and many of the goals set can be, similarly to those of the mainland, categorized as disaster measures, industrialization, environmental measures, area resource utilization, etc. However, when it comes to evaluations noted above, there is no detailed analysis of them for each local site, and actual case revision were also not made though renewable energy figures are detailed on the prefectural remote island reconstruction plan. To address this issue, we have been conducting surveys on renewable energy development movements on remote island areas since 2011, and this paper will analyze the current conditions and issues based on our research results while presenting cases regarding Tsushima City, Nagasaki, and exploring the significance of self-supplying energy on remote islands. More specifically, we will study the various efforts aiming towards self-supplying energy while factoring in the residents' point of views as well as evaluations with respect to the efforts' involvement in these residents' sphere of living, and based on the issues that arose, future prospects will be examined.

4. Efforts towards energy independency in Tsushima City, Nagasaki

This chapter will analyze the advantages and issues pertaining to energy development on remote island areas and future prospects particularly based on the performances of biomass fuel, its use projects, and wind power generation projects9. Overall, the need to be energy independent is high because remote islands have a high cost structure for energy, and in particular, fuel. This can be inferred because projects such as those involved in renewable energy which are regarded as relatively low in cost efficiency on the mainland is considered more economical in remote island areas in comparison with conventional fuel expenses. Here, several cases will be presented by discussing energy after categorizing it into categories of fuel (transportation), fuel (use of heat), and electric power. Moreover, we will examine, in the case of Tsushima City in Nagasaki, the process through which enterprises on remote island areas conduct energy development and how it is currently operating, as well as the roles which each project play in the area's reconstruction.

4-1. Outlook of Tsushima City, Nagasaki

Tsushima consists of a narrow island spanning approximately 82 km (north–south) and 18 km (east–west), with 100 islets and 6 inhabited islands (Figure 3). Tsushima Island, without its territorial islands, is the third largest island in Japan excluding Hokkaido, Honshu, Shikoku,

Figure 3. Location of Tsushima City
(created by the first author; excerpt from the Geographical Survey Institute's website)

Kyushu, the Okinawa mainland, and the Northern Territories. The northern section of the Manzeki bridge is known as Kamijima, and the southern part is known as Shimojima. The highest altitude is 649 meters, and its perimeter is over 800 km. In 2004, 6 towns were merged to form Tsushima City, which contains 125 communities. Tsushima City's population is approximately 33 thousand, and it is a part of Nagasaki prefecture. With respect to its primary industry, though agriculture is not a thriving industry given its steep and mountainous topography, its fishery and forestry industries are flourishing. In recent years, over 200 thousand Korean tourists have visited there annually, making for a gradually-boosting tourism industry targeting Korean tourists.

4-2. Efforts towards energy independency in Tsushima City

Tsushima City developed a new vision for energy known as the biomass town scheme, as part of the city's energy development plan in 2006. The city actively accepted several verification experiments, and is aggressively tackling energy conversion. In the next section, we will examine the survey results[10] on specific efforts in individual areas.

a. Fuel (bio-diesel fuel business utilizing cooking oil waste)

Since 2006, enterprises in Tsushima City have produced bio-diesel fuel utilizing cooking oil waste. The enterprise that started this business used to be engaged in the business of waste disposal. When they started considering expansion of their business, bio-diesel fuel production from previously unutilized waste cooking oil in the island came to mind[11]. They independently conducted research and development of their own facilities, etc., and succeeded in the production of bio-diesel fuel using chemical reactions. On the island, companies in forestry and contractors use many large vehicles. As already stated, fuels (gasoline, light oil, and kerosene) are expensive. This diesel fuel, made by the enterprise in Tsushima, is less expensive than commercial diesel fuel by 10 JPY; this has resulted in them being flooded with inquiries. It has been 8 years since their new business started, and their business is expanding favorably with increasing suppliers of the waste oil.

The enterprise explained their profitability as follows:

"While the current light oil price is 167 JPY per liter, bio-diesel fuel is 30 JPY cheaper and costs generally 135 JPY per liter. Since the beginning of this business in 2006, the amount of waste cooking oil collection has tended to increase, and the buy-in system with 1 JPY per liter has been established, so we are planning to stretch our area of collection to cover the island.

[10] We conducted continuous surveys starting on August of 2011 regarding energy policies by Tsushima City, and also conducted follow-up surveys regarding changes over the years of energy policies and operational conditions of projects. Years and months of visitation were August 2011, January 2012, March and August 2013, throughout the year 2014, February 2015, and August 2016.

[11] According to the outcome of our interview conducted on August of 2011.

FIGURE 4. School lunch distribution truck using diesel fuel made from waste cooking oil. (Photo by the first author in 2011)

Most of our current oil collection is done at food-related industries, restaurants, and school lunch centers. Because there is a huge demand for biomass diesel oil, we hope to collect more oil and to maximize our productivity of bio-diesel in Tsushima from now on. Currently, school lunch distribution trucks (figure 4) and garbage collection agencies are using this bio-diesel, but with the current light oil price remaining high, I hear that some construction companies are considering use of the bio-fuel for their vehicles as well."

In the answer above, a future issue was found regarding a limit in business expansion. In order to expand the biomass diesel business, securing more waste oil is necessary; however, oil collection from restaurants on the island have already reached a limit, and expanding this business is facing difficulties as of now. The enterprise is examining the possibility of reusing glycerol, which is a by-product of the diesel fuel refining process. They are also focusing their attention to the large amount of garbage that drift to the beaches, and examining ways in which waste plastic can be converted into fuel.

As has been clarified by the discussion so far, bio-diesel fuel production in Tsushima City was originally developed as one enterprise's efforts, and their wisdom made it possible to produce less expensive fuel. To top it off, a win-win profitable scheme has been established between the producer and the consumers. Regarding outward shipments from the island, they also reduced energy use for transporting cooking oil wastes which used to be considered as waste products out of the island, because of remote islands being characterized by being surrounded by the ocean. In the future, because collecting resources from other areas to expand business will require sea/air transportation fees, this diesel fuel production system can only be considered a profitable scheme that operates solely on islands. The system producing fuel from waste in the island plays an important role in improving a profitable scheme between producers and consumers, in reducing use of fossil fuels originating outside of the island, and in preserving the natural environment on the islands.

b. Fuel (use for heat)

Next, we will examine the woodchip manufacturing business. In Tsushima City, there are 3 hot springs which are provided by Tsushima City as well as independent administrative institutions. However, the water used is not water from hot water springs, but water that is pumped up from deep underground wellsprings and heated using boilers. This is provided to people as "hot springs." The temperature of the water from the wellspring that is pumped up from deep underground is low. Hot spring services cannot be provided unless the water is heated by boilers. Because of this, those three hot spring facilities used fuel oil boilers throughout the year, and the cost for the oil burdened the financial condition of the city as well as independent administrative institutions. In order to resolve this issue, Tsushima City has utilized woodchips for public hot spring facilities since 2006.

The woodchip business was a pioneer in Tsushima's biomass business. The characteristics of the woodchip boiler business in Tsushima can be organized and analyzed as follows. Firstly, Tsushima is a remote island in which transportation fees are costly. Fossil fuels were at once approximately 20 JPY more expensive per liter than the mainland (as of 2006, at the time of introduction). For the raw material of woodchips, shredded pieces of wood trimmed in the process of thinning (unused biomass) or derelict crooked timber from thinning which were unused and supposed to become waste are used. This is how cutting and other miscellaneous fees are cut down, but hefty charges for transportation fees aside from logging are the same for both fuels outside of the island and woodchips. To resolve this situation, Tsushima City built two woodchip production factories (Figure 5) situated within the range of 5 km from the hot springs which use woodchips for boiling water. The operation of the woodchip factories are taken care of by social welfare institutes, which provide workplaces for people with disabilities. This helps to lower labor costs, as well as two other advantages such as job creation for the socially disadvantaged and less expensive woodchip production. Thanks to its creativity,

FIGURE 5. Woodchip processing factory (left) and the woodchips produced (photo by the first author, 2011)

TABLE 2. Comparison of combustion efficiency between common woodchips and fossil fuel.

	Unit price	Heating power per unit	Price per amount of heat (1000 kcal)
Chip (raw)	9.9 JPY/raw kg	1890 kcal	5.24 JPY
A Fuel Oil	68.8 JPY/L	9345 kcal	7.36 JPY
Kerosene	84 JPY/L	8771 kcal	9.58 JPY

Created by the authors, data from the Ministry of Agriculture, Forestry and Fisheries of Japan (2010)[12)]

TABLE 3. Comparison of combustion efficiency between Tsushima's woodchips and fossil fuel

	Unit price	Heating power per unit	Price per amount of heat (1000 kcal)
Chip (50% moisture)	15 JPY/m^3	2700 kcal	5.56 JPY
A Fuel Oil	87 JPY/L	9345 kcal	9.30 JPY

Created by the authors, data from the Ministry of Agriculture, Forestry and Fisheries of Japan (2010)

Tsushima City is able to produce less expensive woodchips compared to other areas (Table 2, Table 3).

Tsushima City's future goal with respect to wood biomass is to expand the business while maintaining this production type. However, the potential quantity of unused wood resources is limited. Increasing the amount of timber thinning from woods would increase cost and make it difficult to gain profits. Maintaining a cautious stance towards business expansion is thought to be necessary. In a meantime, reviewing the island's demand from the perspective of thermal demand may potentially increase opportunities for use. Today, the number of people involved in forestry is decreasing and the industry is falling into decline. Wood biomass is a business that can potentially help Tsushima's vital industries of forestry to revitalize and aid job creation. With respect to forest management, this business is environmentally friendly and is most likely to be able to coexist with the natural environment.

c. Electric Power business (wind power generation business)

Lastly, we will address the power generation business. The following are survey results on the power generation business in Tsushima. In general, electric power on remote islands is supplied through cables or diesel power generation in independent power systems. For remote islands near the mainland, overhead cables or underwater cables are used to distribute power. Since Tsushima City is on a large-scale remote island, power is generated by diesel power generators using fuel oil transported from the mainland, and is supplied through an independent power system.

As of August 2016, Tsushima City has one wind power plant in operation (Figure 6). In the reconstruction plan set forth in 2013, there is information on the defunct wind power plant in old

[12)] With respect to heating power per unit of each type of fuel, figures used were those from Tsushima City (2006), which is used in Table 3 for the purpose of comparison with Table 3.

FIGURE 6. Old Tsushima City wind power plant (left) and the new Tsushima wind power plant (right) in Tsushima City (Photo by the first author, 2012 (left), 2016 (right))

TABLE 4. Comparison table of Tsushima City's old and new wind power plants (Created by the authors)

Tsushima City wind power plant (old)	Tsushima wind power plant (new)
Started operation in April 2003	Started operation in April 2015
Rated output: 1,200 kW	Rated output: 1,500 kW
(600 kW/unit × 2)	(1,800 kW × 1)
Operated by Tsushima City	Operated by an enterprise in Tsushima City

Tsushima City (Kamiagata town), which was established in 2003. The currently operating wind power plant as of August 2016 is on the same location as the one established in 2003, but the windmill itself and the operating enterprise is different (Table 4).

In the next section, we will take a look at the history of wind power business in Tsushima City. The Tsushima City (Kamiagata town) wind power plant began operation in April of 2003. After the plant's commencement and until 2007, the plant's operation rate had been kept very high, and its generation cost had been held down. However, after 2008, its profitability plunged due to frequent malfunctions and elongated non-operational periods. Frequent failures at wind power facilities around the 5 years or so mark is common knowledge in current years, but was not well known when Tsushima City introduced wind power generation in 2003. The old wind power facility became inoperable due to failures inside the wind power generation equipment from 2011 and onwards. The fiscal expenditure associated with repairing the equipment was estimated at as much as 100 million JPY[13]. Because Tsushima City had not been able to recover the plant's

[13] This is a result of being outside of the warranty period set in the contract for its construction. If this failure happened for a wind power facility contracted and built around 2010, there would not have been a problem because the warranty period for a regular wind power facility is set at 10 years.

initial investment cost, after discussion, the city decided not to repair it. In 2014, Tsushima City decided to sell the wind power plant, and made a public offer to enterprises for its operation. A construction enterprise (Enterprise H) in the island made a successful bid and bought the plant at a public auction for 1,000 JPY, which was the minimum buyout price. Enterprise H demolished the old windmill, leveled the land, and started building a new windmill whose operations started in April of 2015. Ninety percent of Enterprise H's capitals is owned by local construction enterprises, and 10% is owned by an enterprise in Tokyo engaged in power generation using natural energy (hereinafter, called Enterprise I). Management of the facility in Tsushima is conducted by Enterprise H's employees, but design, control, operation, and maintenance of the power generation equipment is conducted by Enterprise I.

Here, we will explain the causes behind the malfunction of the old windmill. The failures were caused mainly by parts wear, which was attributed to lightning strikes and complex seasonal winds. On top of this, the windmill's proximity to the ocean may have resulted in greater damage by salt to the windmill than those in other areas. In other words, the damage is thought to have been influenced by the remote islands' characteristics of being surrounded by ocean and severe natural conditions. With respect to wind power generation, the initial investments made to it were enormous, and factoring in the fact that windmills have a standard life expectancy, it is necessary to extend operation periods as long as possible by evading failures and fixing faults immediately as they are found. In the case of the old Tsushima City wind power plant, due to the island's severe natural environment, more advanced maintenance technology for it might have been required compared to other areas. Furthermore, the outsourced business operations hindered swift system adjustment/maintenance on site and is considered to be one factor that shifted their profitability for the worse.

As for the new Tsushima wind power plant, its capital is owned by local Enterprise H, while actual maintenance is performed by Enterprise I, whose employees are permanently stationed in Tokyo. There is hope that the two enterprises, H and I, will conduct sustainable operations through cooperation into the future. Furthermore, the representative of Enterprise H employs electric cars as its company cars. Due to decreasing population, there is a concern that electricity demand will also shrink in scale. Enterprise H is also interested in creating demand for electricity on the island, and has installed two recharging stations for electric cars on the island. Since electricity is a highly versatile form of energy, switching the fuel used in transport on the island to electricity in the future will enable demand for electricity to grow and increase the application amount of renewable energy, etc. Collaboration between enterprises H and I with the municipalities' urban planning, etc. may help progress the introduction of renewable energy in Tsushima City.

4-3. Issues and outlook from implementations in Tsushima City

Through the examples of undertakings conducted by regional enterprises in Tsushima City discussed in the preceding section, it has been brought to light that there are many advantages behind the fuel production business and the electricity business in remote island areas. Furthermore, it became apparent that people are effectively trying to utilize their limited resources while paying close attention to resource circulation, and tackling the remote island's characteristics of being surrounded by the ocean in the local enterprises' efforts on the island. Traditionally, use and application of energy on remote islands have been aided by many support projects. However, this survey revealed the possibility that the system bolstered by these projects shifted towards more heavy utilization of the island's resources, and invigorates industries within islands, lowers environmental burdens, sustainably carries out the energy business by having local enterprises conduct various operations.

Generally speaking, in the case of renewable energy power source development, many development bodies are involved regardless of whether this development is occurring on a remote island or not. We can raise three different cases as examples: 1) undertakings are conducted either by the electric power company in charge of provision/distribution of power or an enterprise outside of the area, 2) undertakings are conducted by the local government, or 3) undertakings are conducted by a local enterprise. The pros and cons of each development body, summarized, are as follows.

1) In the case where an electric power company takes the lead for development

If an electric power company conducts the undertakings, it is possible for the electric power company, with his high level of technical expertise, to take responsibility and go through with undertakings. On the other hand, since the electric power company will be responsible for stable provision of power for the area, they have a tendency to be cautious in their considerations in development with respect to the unstableness and variability of renewable energy power.

2) In the case where the local government takes the lead for development

If the local government conducts the undertakings, the government can proceed with energy development along with social infrastructure and urban planning, in order to realize the energy system model that the government has envisioned. On the other hand, they do not have any know-how regarding the power generation business, so they tend to outsource everyday operations to companies in other areas, which might cause delayed responses in event of a failure as well as other incidents (Like the case of the old Tsushima City wind power plant).

3) In the case where a local enterprise takes the lead for development.

If a local enterprise conducts the undertakings, there are issues with respect to fundraising. This tends to result in implementations of technology on a smaller scale. On the other hand, they would have the fastest response to troubles and failures, and be able to cooperate with municipal energy visions, etc. more readily.

When considering the most important arguments in this paper, which are the characteristics

of the remote islands and the sustainability of regions and technologies, it seems most vital to choose option 3), a local enterprise taking the lead for development. The reasons are as follows. Firstly, as can be seen from the case of the old Tsushima City wind power plant, prompt reaction to malfunctions is key in using and applying renewable energy. Any enterprises outside of the area (in particular those from the mainland for remote island areas) are far away from the site, and require marine traffic to transport materials if the island is an isolated remote island. This means that addressing issues such as malfunctions cannot be conducted swiftly. Secondly, the severe marine environment frequently results in damage from salt and storm surges. The more advanced the technology becomes, the higher probability there is of failure due to operations requiring more advanced technology; this can lead to lowered energy production efficiency within the island. Generally speaking, in remote islands with a small-scale independent power system, large-scale investment is not necessary. Therefore, on remote island areas characterized by being surrounded by the ocean, the advantages with respect to an outside or mainland enterprise to operate the plant become even smaller. For this specific point, local enterprises are not only able to play an important role in energy independence for the remote islands, but are also best suited to take the lead for development.

With respect to tasks for the future, it is necessary to advance developments of energy that does not require transport, such as the development of a system which combines power generation done completely within the island, such as power generation using renewable energy, with energy consumption on the island. In the process of advancement, it is necessary to have a perspective that makes good use of each island's unique characteristics. Good examples of these developments include the geothermal power generation business on Hachijojima-Island, the floating wind turbine business in Goto City, the ocean thermal energy conversion business on Kumejima-Island, and so on. In recent years, some new and unique efforts in remote islands, including the marine current power generation, wave power generation, and electric fishing boats[14], have been put into effect. Many technologies which are under development are currently in the verification phase, and some of them may be in the practical application phase within several decades. Popularization of these technologies can be an option for remote islands, where, as mentioned above, the cost structure of energy procurement is relatively higher when compared to that of the mainland. This is where regional enterprises come into play, when the technology shifts from the verification test phase to becoming a sustainable energy system. After the verification period, it is absolutely necessary to expend effort over a long period time to make operation of these technologies sustainable under severe natural conditions.

Other countries have made an attempt at shifts in energy even with respect to marine transportation. Samso Island is operating boats run by hybrid engines as well as boats that run on natural gas, and they have a plan to eventually use biogas for fuel to operate these boats[14].

[14] According to the outcome of our site interview conducted in Samso Island, on November 22, 2016

The current problem facing remote island areas is their incapability for self-investment due to their exhausted economy. In short, they are under difficult conditions for responding to current needs, spreading new technologies, and putting a comprehensive system shift into action. In terms of transport, many attempts have been made in recent years. Despite these efforts, it is still necessary to create an in-island energy market in addition to support with respect to off-island oriented fuels, much like Samso Island.

5. Closing remarks

This paper has analyzed the background and current situation of the Remote Islands Development Act, and demonstrated that the largest issue facing remote island reconstruction is consistently the cost of transport energy. On the whole, the transport energy business has been considered an issue since remote island reconstruction was first called for in Japan, but has not reached a resolution even 63 years after the Remote Islands Development Act was made public. Tracing back to the beginning of the establishment of the Remote Islands Development Act, the first catch phrase that was cried out was "bring light and water to remote islands," which implied a call for the development of infrastructure. The Remote Islands Development Act was promoted under the banner of "correction of inequality" with respect to interaction between the mainland and the islands, through both tangible and intangible interactions between the two areas through clear investments in public projects, bay area development, and transportation cost assistance projects. This boosted the transport costs for islanders in their daily lives, and expanded the remote island reconstruction projects. We were able to figure out that support project in the field of energy, which specialized in cost support, was not encouraging the area's independence, but rather the reinforcing the mainland-dependent structure. Meanwhile, efforts towards self-supplying of energy within islands have been progressing steadily, and by indicating the efforts made towards energy development by local enterprises in Tsushima City, we have found that local enterprises' businesses are crucial with respect to self-supplying of energy.

Based on the case analysis in the previous chapter, an island enterprise's efforts in the energy business might have advantages such as: 1) industry promotion by local enterprises, 2) increase in consumers' benefit by providing less expensive fuel, 3) use circulation promotion of local resources, and 4) contribution to energy system construction without depending on support. On the other hand, despite various verification research and introduction businesses for renewable energy being conducted, most of the capital is owned by companies on the mainland or the electric power companies, and few island enterprises have tackled these endeavors. As examined in this paper, while paying special attention to the important characteristic of remote islands being surrounded by the ocean, technological development support to adjust to severe natural conditions as well as the creation of a new system that can replace marine/air transportation cost support is thought to be necessary in order for remote islands to become independent. In this

regard, it is true that there may be cases where more advanced technology and capital power will be required. Furthermore, management of energy systems on remote islands will require much more care and attention to detail than systems in other areas due to the islands' characteristics of being surrounded by ocean. However, as described in the previous chapter, on independent remote islands in the open sea such as Tsushima, it is not necessarily large scale and advanced technologies that are necessary; rather, simple and dispersed technologies which can be managed by the region can make detailed operations possible. Such simple and dispersed technologies must be operated via business efforts or by technologies of the regional enterprises in such a way that fits the remote island's characteristic of being surrounded by the ocean. Realizing this structure would result in remote islands having energy independency.

Miyamoto (1970), a contributor to remote island reconstruction, explained the mindset regarding remote island reconstruction as follows:

> *"When it comes to remote island reconstruction, islanders who live on remote islands in Japan must observe their island objectively. Additionally, they must consider support from the perspective of what is needed."*

In the history of remote island development, although development plans which made use of the uniqueness of each island were analyzed in the remote island development plan, the perspective of regarding remote islands as targets for support remained unchanged. The fundamental correction of the transportation cost structure generally stopped at supporting projects, and the pathway to development towards becoming self-supporting does not yet exist. This might be a result of emphasis being placed on making the standard of living on islands equal to that of the mainland when reviews were conducting on what types of support were necessary in remote island development, while the perspective of the remote islands' diversity in natural resource and their coexistence with nature was missing. This paper uncovered that effort by private corporations on remote island areas contributes to the remote islands' sustainability in terms of economy, society, and environment. Thus, when it comes to remote island development, the experience points of not only the islands' enterprises, but also the islanders who have faced the power of the ocean should be utilized. We want to point out that even in terms of development of new energy technologies that would solve the problem of transport costs, if these developments are conducted by companies and electricity companies on the mainland, the power structure would not change from the "island resources were exploited by companies outside of the island" structure that was in effect before the Remote Islands Development Act was enacted.

Remote islands in Japan are a microcosm of Japan. Despite being exposed to severe natural conditions among Japanese regional communities, they remain as resilient areas that have been able to maintain their communities. In a society that faces unprecedented social issues such as declining birthrates in an aging population, exhausting of resources, and global warming,

self-sustainable development of remote islands are expected to reveal the potential of regional development that does not depend on national support. Taking a serious view of sustainability would place emphasis on unique regional perspectives instead of the framework of public support, and it would also make regions which are not restricted to remote island areas not only more inclined to differentiate themselves from urban cities, but also to take action for themselves to make decisions with respect to how development should progress.

In conclusion, we would like to present the following three analyses which were not covered in this paper as future research: 1) analysis on industrial support to local enterprises on remote islands, 2) analysis on examples of energy structure and development of remote islands near the mainland, 3) analysis on examples of self-supplying energy in islets of other countries. In future research, we will conduct further investigation regarding efforts being made on each remote island, followed by classification and accumulation of comprehensive research outcomes. By uncovering issues on energy development on remote islands, we are looking to contribute to their self-development.

Acknowledgement

The authors appreciate those who cooperated with this research. Especially the city officers of Tsushima city and other engineers and employees of energy companies offered rich including information financial information and processes of setting up the projects.

References

Aoki, Y. (2012). Economic and Social Developments of Okinawa Prefecture After the May 1972 Return to Japan (4) [in Japanese]. *Bukkyo University Journal of social studies* 54, pp. 117–135.

Abiru, K. (2012). Kaiyou tousyokoku Nihon wos asaeru ritoushinkou no arikata [in Japanese]. *Shisei* 61, pp. 10–12.

Agency for Natural Resources and Energy, METI. Gasoline distribution cost support project for remote islands [in Japanese]. [Webpage], Available at http://www.meti.go.jp/main/yosan/yosan_fy2016/pr/e/e_enecho_nenryou_34.pdf, Accessed September 25, 2016.

Akamatsu, T. (2008). Kaijyoyusou to Ritou no Sangyo-Ritouchiiki no Kouri, services—gyo no Jittai wo chushin ni [in Japanese]. *Shima*, 215, pp. 112–119.

Inatomi, T. (1992). Nani wo Motomete Ritou he Totsugunoka—Toshi ni sumu wakai jyosei no Ritou ni taisuru Ishikito Oshima mura ni Totsuida Jyosei tachi no Ishiki ni taisuru Hikaku Kenkyu [in Japanese]. Kitakyusyu University Department of Literature, Accessed on 20, July, 2016 available at http://www.apa-apa.net/~jinrui/soturon/paper/inatomi.pdf

Japan Ritou Center (2004). *Ritou Shinkou handbook* [in Japanese], Kokutsu Insatsu kyoku.

Kawachi, K. (1968). *Utsuriyuku Shimajima*. Syoubunsha.

Kitajima, S. (1998). *Kaihatsu to Tiikihendou—Kaihatsu to Naihatsutekihatten no soukoku*. Toushindo.

Maehata, A. (2013). *Okinawa Tousyo no Kakyoka to Syakaihenyou: Tousyo Community no Gendaiteki Henshitsu*. [in Japanese] Otyanomizusyobou.

Maehata, A. (2013). Kokunai Tousyo ni Okeru Saiseikanou energy no Kaihatsu Doukou [in Japanese]. *Saiseikanou Energy wo meguru Syosou*, National Diet Library Japan.

MAFF (2010),"Whitepaper of Shinrin Ringyo in 2010",

MILT. Remote Islands Development Act. [in Japanese] [Webpage], MILT, Available at http://www.mlit.go.jp/crd/chirit/pdf/law/tokekomiban200618.pdf, Accessed July 25, 2013.

Minamura, T. (2003). *Sengo Amami Keizai Syokai ron Kaihatsuto Jiritsu no Dilemma* [in Japanese]. Nihon Keizai Hryouronsya.

Miyamoto, T. (1969). *Nihon no Ritou Dai ichi syu* [in Japanese]. Miraisya.

Miyamoto, T. (1969). *Nihon no Ritou Dai Ni syu* [in Japanese]. Miraisya.

Nishikawa, J., Matsushima, Y., Motohama, H. (2010). *Tousyo Okinawano Naihatsutekihatten Economy, Society, Culture* [in Japanese]. Fujiwara Syoten.

Oshima, H. (1959). *Shima no chiri—Tousho Chirigaku Jyosetsu* [in Japanese]. Daimeidou.

Remote Islands Office (2012). Ritoushinkouhou Kaisei Entyou Jitsugen Kekki Taikai Kaisai, *Shima* 57(4), pp. 14–19.

Sato, Y. (2006). The original and the aim of the Remote Island Development Act: The Designation of the areas for islands development [in Japanese]. *Bulletin of Faculty of Contemporary Social Studies Nagasaki Wesleyan University* 4(1), pp. 61–67.

Sato, Y. (2007). Chapter6 Ritou shinkou karamita Ritoutiiki no Jiritsu [in Japanese]. Nishikawa, Yoshida, *Chikishinkou no seidokouchiku nikansuru yobikousatsu tyousa kenkyuu houkokusyo*", Institute of Developing Economies.

Shirakawa, H. (2016). Tokushu 1 Yujin kokkyou ritoushinkouhou seitei [in Japanese]. Japan Ritou Center, *Shima* 62(1), pp. 22–23.

Tsushima City (2006). *Mokushitsu Biomas no Netsuriyou oyobi haisyokuyu no BDF jigyou nikakaru syousai houkokusyo* [in Japanese]. Tsushima City.

Yamaguchi, H. (2009). *Ritou no Genkyo to Kadai* [in Japanese]. National Diet Library Japan, Tyousa to Jouhou, 635.