

Paper:

Alternatives for the Marshall Islands to Cope with the Anticipated Sea Level Rise by Climate Change

Mikiyasu Nakayama^{*1,†}, Ryo Fujikura^{*2}, Rie Okuda^{*3}, Mai Fujii^{*4}, Ryuta Takashima^{*5},
Tomoya Murakawa^{*1}, Erika Sakai^{*1}, and Hiroaki Iwama^{*1}

^{*1}Global Infrastructure Fund Research Foundation Japan

Roppongi T-Cube 14F, 3-1-1 Roppongi, Minato-ku, Tokyo 106-0032, Japan

[†]Corresponding author, E-mail: m.nakayama@gif.or.jp

^{*2}Faculty of Sustainability Studies, Hosei University, Tokyo, Japan

^{*3}Graduate School of International Cooperation Studies, Kobe University, Hyogo, Japan

^{*4}The Ocean Policy Research Institute, The Sasakawa Peace Foundation, Tokyo, Japan

^{*5}Department of Industrial Administration, Tokyo University of Science, Chiba, Japan

[Received September 21, 2021; accepted December 21, 2021]

There are four atoll states in the world: The Republic of Kiribati, the Maldives, the Republic of the Marshall Islands (RMI), and Tuvalu. These countries are comprised entirely of low-lying land approximately 2 m above sea level. The Intergovernmental Panel on Climate Change (IPCC) has recognized that atoll countries are highly vulnerable to rising sea levels due to climate change. This study aimed to clarify the relative advantages and disadvantages of possible alternatives compared to the present livelihoods of the Marshallese in their home country. We also attempted to identify the best plausible option, using few sets of possible value judgements over the evaluation criteria. The following four alternatives were examined in this study: (i) migration to the developed world, (ii) migration to other island states, (iii) land reclamation and raising, and (iv) development of floating platforms. To evaluate the performance of the four alternatives, we selected 16 criteria representing the societal conditions that would result from each alternative. The performance of each alternative per criterion was rated from 1 to 5 by a literature survey, interviews with researchers who worked on the livelihood of Marshallese immigrants in the U.S. states of Arkansas, Hawaii, and Oregon, and interviews with people knowledgeable about the behavior of the Marshallese both in their home country and in the United States as immigrants. The “migration to the developed world” alternative proved the best choice, followed by “developing floating platforms,” “land reclamation and raising,” and “migration to other island states.” We also found that “migration to the developed world” offered the most change to immigrants, while the alternative of “land reclamation and raising” resulted in the smallest change. The magnitude of anticipated change should be considered. We employed the Analytic Hierarchy Process (AHP) to experimentally evaluate four alternatives in an integrated manner and about three cases were “all the criteria are equally important,” “social

environment is more important,” and “personal environment is more important.” With AHP, the “migration to the developed world” alternative yielded the highest point for all three cases examined. Notably, climate migrants do not suddenly emerge, because climate change is a slow-onset process. The Marshallese should make wise use of the available lead time to prepare for migration in the future.

Keywords: atoll country, climate change adaptation, Marshall Islands, migration, sea level rise

1. Introduction

1.1. Impact of Climate Change on Atoll Countries

According to the latest special report by the Intergovernmental Panel on Climate Change (IPCC) in 2018, the sea level is estimated to rise from 54 cm to 97 cm with a 1.5°C temperature increase and from 63 cm to 112 cm with a 2.0°C increase from pre-industrial to present-day levels [1]. Since its first assessment report, the IPCC has recognized small islands and atoll countries as being highly vulnerable to sea level rise. There are four sovereign atoll states in the world: The Republic of Kiribati, the Maldives, the Republic of the Marshall Islands (RMI), and Tuvalu. These countries are comprised entirely of low-lying nations [2] with above sea level height of approximately 2 m, which is particularly vulnerable to the anticipated sea level rise [3]. Sea level rise increases the risk of inundation and coastal flooding, erosion exacerbation, and saltwater intrusion into rivers and underground aquifers, causing infrastructural damage. Therefore, climate change poses a major risk to the economic, social, and environmental situation of the region and exacerbates risks to the realization of fundamental human rights, especially for those atoll states [4].



1.2. Present RMI Policy

Except for some commitments to reduce greenhouse gas (GHG) emissions, the RMI government has not presented clear, adaptive policies targeting sea level rise. Hilda Heine, a former president of RMI, who was enthusiastic about environmental issues, once said “My country has shown that if one of the smallest and most isolated nations can do it – so can everyone else, including the big emitters. Making the transition to net zero emissions makes sense for our global economy and our environment, as well as for our people and our planet” [5].

The RMI has already started building seawalls. Heine announced a US\$29 million funding partnership with the World Bank to design and build a new seawall on the densely populated Ebeye Atoll in 2019 [6]. As a separate project, the RMI government allocated \$4.5 million on 78 new seawalls under the national budget for FY2020 [7].

Heine spoke to local journals of the need for land to rise in the future. “Rising our islands is a daunting task but one that must be done.” She stressed that RMI must focus on this new level of adaptation in the age of climate change [8].

Although RMI has thus far focused more on mitigating climate change effects through international efforts rather than implementing national adaptation measures, there have been a few recent adaptation measures.

As a next step, RMI has formulated an interactive, web-based visualization tool that demonstrates the impact of rising sea levels on these communities, to help the atoll nation plan for different sea level scenarios over the next 100 years. Artessa Saldivar-Sali, a resilience engineering specialist with the World Bank, claims that the adaptation pathways highlighted by the visualization platform are already helping the government and its development partners in the short, medium, and long term. She also suggests that under extreme scenarios where sea levels increase by 2 m or more, the only viable option is massive land reclamation with costs in the billions; this is far higher than any current investment in climate adaptation projects. In other words, RMI would be forced to rely on inter-atoll or international migration as an adaptation option [9].

Moreover, at a high-level meeting of the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Glasgow in November 2021, the RMI’s Minister of Health and Welfare stressed the need for a 50/50 split between mitigation and adaptation measures in global financing [10]. This reflects the RMI’s current climate change.

1.3. Policy Selected by Other Atoll Nations

Among the four atoll nations, the Maldives is the only country that took a concrete measure to address sea-level rise. It created Hulhumalé, a new 1.9 km², 1.8 m high artificial island for urban expansion [11]. It is set to house 100,000 people by 2030. Many are expected to be climate

migrants. Currently, it is home to 20,000 residents [12].

The Republic of Kiribati is in a similar situation. The government has promoted “Migration with Dignity,” urging residents with employable skills to consider moving abroad. It bought nearly 6,000 acres of land in Fiji, an island nation more than 1,000 miles away, as a potential destination for migrants. Anote Tong, a former president of Kiribati who pushed through the Fiji purchase, said the purchase was also intended as a cry for attention from the world [13]. Fiji and Kiribati have been working on a planned relocation program, although they have faced challenges in finding land where their citizens can share space with the local population without conflicts [14].

Although Tuvalu has not clearly announced its policy, it has also started discussing possible relocation options in Fiji [14]. Furthermore, Mortreux and Barnett suggest an interesting aspect that may be related to the national policy for sea-level rising: religion plays an important role in shaping people’s responses to climate change in Tuvalu. They mentioned that around half of their interviewees believed that climate change was not an issue of concern because in the Bible, God promised Noah that there would be no further flooding. Moreover, some interviewees indicated that they would never leave the islands even if climate change escalated to a point where the community needed to leave [15].

1.4. Possible Measures to Cope with Anticipated Sea Level Rise

Since atoll countries are currently at high risk of disappearing due to the overall effects of sea level rise, two adapting measures should be considered: migrating to other countries or staying in their countries. Each measure had two possible options. The following four alternatives should thus be examined in this study:

- i. *Migration to developed world.*
- ii. *Migration to other island states.*
- iii. *Land reclamation and raising.*
- iv. *Developing floating platforms.*

It is difficult to answer whether one of these alternatives should be prioritized over others. Still, for example, Adger and Barnett [16] urge for policies and measures that allow people to maintain lives they value in places where they belong, rather than migrating to other places. The UNFCCC attempted to protect people fleeing the direct impacts of climate change, including those forced to leave their homes due to sea level rise. The UNFCCC also recognizes migration and human mobility links by calling for states to respect and promote migrant rights [14]. Biermann and Boas suggested that the way to protect climate migrants must be seen as a global problem and global responsibility [17].

Some coral islands have been reinforced with sea dikes and by raising the land behind them using materials dredged from nearby locations. However, raising islands

through dredging and other engineering efforts is costly, as is the development of floating platforms. Some low-cost community-based adaptation measures, if possible, would be more appropriate for communities with fewer financial resources [18].

1.5. Migration to the Developed World

The citizens of RMI have emigrated to the developed world, specifically the United States, since the 1980s. This was made possible by the Compact of Free Association (COFA), which was concluded between the two countries in 1986 [19]. COFA allows RMI citizens to enter, stay, work, and study in the United States without having a visa or work permit. This study was conducted under the assumption that the COFA will continue.

Most immigrants from RMI live in a few U.S. states, including Hawaii, Arkansas, Oregon, and Washington, where there are job opportunities. In these states, immigrants from the RMI have formed communities. Furthermore, currently, over one-third of the total RMI population has immigrated to and formed communities in the United States; however, some have difficulty earning in household income. In fact, State of Hawaii data show that immigrants through COFA had the lowest household income, averaging less than half of the state average [20].

Moreover, a survey of students in RMI showed that the United States was by far the most popular immigration destination; 60% of the students chose the United States as their top immigration choice, while only 12% chose Fiji. The most popular reason behind the preference for the United States was education, followed by job opportunities, healthcare, and family [21]. In fact, a survey conducted at The University of the South Pacific Marshall Islands Campus showed that 44% of the students at the university were interested in immigrating to the United States. The most common reason was to seek higher education [22].

1.6. Migration to Other Island States

Presently, the most popular destination for Marshallese people is the United States because of the COFA. Therefore, the number of Marshallese people living in the United States has increased by 400% since 2000 [23]. Despite this trend, some Marshallese people may choose places other than the United States as their destination. In this section, we examine the possibility of Marshallese migration to Fiji, with reference to migration from Kiribati in Fiji.

Fiji consists of 333 islands located in the South Pacific Ocean, with beautiful nature and exotic traditional culture [24]. Many offices of regional corporate organizations and international organizations are located in Suva, the capital [25]. Fiji has Fiji National University, the University of Fiji, and the University of the South Pacific. Marshallese immigrants may secure opportunities for higher education in a favorable environment. Yoshioka et al. [22] suggested that Fiji is the second most popular destination for Marshallese students in

USP's RMI seeking higher education. From an education standpoint, it is reasonable to consider Fiji as a possible destination.

However, when Marshallese people settle in Fiji, they may face problems. Maekawa et al. [26] pointed out issues observed among immigrants from Kiribati in Fiji. First, their levels of English skills proved insufficient to settle in Fiji. As English is widely spoken in Fiji, English proficiency significantly affects livelihood after migration. Second, people in Kiribati generally lack information about how to establish a livelihood in Fiji. Thus, they struggle with local customs, cultural differences, and a new environment after relocation. Finally, social capital is important for residing in Fiji. According to a study by Bauer et al. [27], people tend to move to places where members of their community have already settled to take advantage of information or capital from their predecessors. These issues proved instrumental for smooth migration from Kiribati to Fiji and also apply to future Marshallese immigrants migrating to other island states.

1.7. Land Reclamation and Raising

Since the 1990s, the Maldives has been constructing a new artificial island called Hulhumalé as a measure to manage overpopulation in the capital city, Malé. This artificial island construction by land reclamation and raising may be applied to the RMI as a countermeasure against anticipated sea-level rise.

However, the differences in population and economic power between the Maldives and the RMI should be considered when determining if a similar measure is applicable for the RMI. The present population of Hulhumalé is approximately 100,000 [28], and the artificial island is supposed to house 240,000 people. On the contrary, the present population of RMI is around 60,000. At this stage, as many as 30,000 Marshallese have migrated to the United States and it is reasonable to assume that more RMI citizens may soon migrate to the United States. This implies that, even if the RMI chose the alternative of land reclamation and raising, the magnitude (in terms of civil works required) would be much smaller than the case of Hulhumalé development in Maldives.

The major advantage of this alternative is that it may abate the risk of submergence of the country due to sea level rise. People scattered over numerous atolls can be concentrated in one place. This may promote construction of facilities, such as waste treatment plants and sewage treatment systems [29]. It may also improve public infrastructure for healthcare and transportation [30]. A positive impact may also be observed for public safety. The construction of recreational facilities to attract tourists from abroad may lead to new employment opportunities.

However, some disadvantages are foreseeable. First, the project is costly. For those who were self-sufficient in food before relocation, it would be surprising that everything must be purchased with money after resettlement. The number of years within which a new town built via land reclamation and raising may be prone to anticipated sea level rise, is also an open question.

1.8. Developing Floating Platforms

“Mega-Floats,” or very large floating structures (VLFS), are artificial structures built in coastal areas or off-shore. This is increasingly recognized as a solution for anticipated future sea-level rise. For instance, the Deputy Secretary-General of the United Nations, Amina Mohammed, recently commented in a forum on sustainable floating cities at the UN Headquarters in New York that floating cities are “innovative and remarkably interesting” [31]. Various private companies have already started working on floating city concepts. For example, the Seasteading Institute suggests developing floating city projects globally for residential purposes [32]. In 2008, Shimizu Corporation, a construction company in Japan, also proposed a plan to develop a fully self-sufficient off-shore sustainable city called the “Green Float” [33].

Historically, Mega-Floats were used for strategic purposes like storing energy sources, such as liquefied natural gas (LNG) and petroleum [34]. However, facing a significant increase in the global population and subsequent land shortage, floating cities have increasingly gained attention in recent years as possible solutions for the future. In fact, developing floating houses has already been practiced in some countries, such as the Netherlands. With more than half of the Netherlands’s land surface below sea level, people in this country are keen to have the concept of “floating towns.” The proposition includes green houses, shopping centers, and floating residential areas [35]. Facing the threat of sea level rise, therefore, puts us in position to consider and examine how Mega-Floats can help contribute to Marshall Island’s sustainable development.

1.9. International Legal Frameworks

There is no specific international treaty addressing climate-induced migration. In most cases, the definition of a “refugee” in the Refugee Convention does not apply to those displaced by climate change [36]. International human rights law has provided states’ protection obligations beyond the “refugee” category, to include people at risk of “arbitrary deprivation of life, torture, or cruel, inhuman or degrading treatment or punishment.”

These human rights protections, which are called “complementary protections,” are unlikely to sufficiently protect climate-induced migrants [37]. This has led some to call for the establishment of a new treaty for climate migrants [38, 39]. However, in recent years, non-legally binding frameworks such as the Global Compact on Migration have been formulated as practical solutions. There are growing expectations that these frameworks will provide a higher level of human rights protection for climate-driven migrants. In this trend, a new concept of “migration with dignity” has been proposed and is being widely used [40].

1.10. Objectives of the Study

This study aimed to clarify the relative advantages and disadvantages of the above-mentioned four alternatives

vis-à-vis the status quo, namely the present livelihood of the Marshallese living in their home country.

We also attempted to evaluate four alternatives in an integrated manner experimentally, so that the plausible “best option” should be identified in accordance with a few sets of possible value judgements over the criteria for evaluation.

2. Materials and Methods

To evaluate the performance of the four alternatives, we selected 16 criteria (see **Table 1**) representing the societal conditions that would result from each alternative. Wheeler et al. [41] examined the livelihoods of Marshallese immigrants in Hawaii and the Pacific Northwest using eight criteria that were also used in this study. Additionally, eight more criteria, mostly reflecting the relationships among immigrants as well as between immigrants and people in the host community, were employed in this study.

The performance of each alternative per criterion was rated on a Likert-type scale by selecting one of the following estimations: “Significantly improve,” “Improve,” “Neither improve nor degrade,” “Degrade,” and “Significantly degrade.” These estimations were then converted into numbers by giving five points for “Significantly improve,” four points for “Improve,” three points for “Neither improve nor degrade,” two points for “Degrade,” and one point for “Significantly degrade.”

Estimations were made through literature survey, interviews with researchers who worked on the livelihood of Marshallese immigrants in Arkansas, Hawaii, and Oregon of the United States, and interviews with people knowledgeable about the behavior of the Marshallese both in their home country and in the United States as immigrants.

We employed the analytic hierarchy process (AHP) to experimentally evaluate four alternatives in an integrated manner. When faced with a difficult decision, most people consider the factors for evaluating alternatives, assess the benefits of each factor, and make a final decision from a holistic perspective. AHP is a systematic approach for making such natural decisions. The AHP uses a hierarchical structure to evaluate alternatives, and the procedure for evaluating alternatives is as follows: (1) set alternatives, (2) identify factors to be considered when selecting alternatives and establishing their hierarchical structure, (3) evaluate the importance of these factors, (4) obtain a relative score that indicates how much the alternatives value each factor, (5) calculate the overall score for each alternative using the importance factor and relative score, and select the alternative with the highest score [42]. AHP was originally developed by Saaty [43] and is widely used to evaluate alternatives for various scenarios, including ranking available options for a given project.

Table 1. Evaluation of 4 alternatives by 16 criteria.

Criteria	Alternatives			
	<i>Migration to the developed world</i>	<i>Migration to other island states</i>	<i>Land reclamation and raising</i>	<i>Developing floating platforms</i>
Housing	3	2	4	3
Purchasing power	3	3	4	4
Food security	4	3	3	4
Safety	3	3	3	4
Education	5	4	4	4
Social services	5	2	4	4
Health care	5	4	4	4
Employment	3	2	3	4
Participation in local activities	2	2	2	2
Climate	4	3	3	3
Living environment	5	3	4	4
Relationship with neighbors	3	2	2	2
Convenience of shopping	4	4	4	4
Access to amusements	5	4	4	4
Relationship within working place	2	2	3	3
Communications with others (casual issues)	2	2	3	3

3. Results

The four alternatives were evaluated using the above-mentioned 16 criteria, as shown in **Table 1**. The manner in which each alternative was evaluated using a set of criteria is mentioned below.

The feasibility of these alternatives was also examined in the framework of international legal frameworks and possible funding schemes.

The outcome of evaluating four alternatives in an integrated manner, conducted experimentally using AHP, is also shown below.

3.1. Migration to the Developed World

First, housing scored 3 because the increased income will not exceed the increased housing costs in the United States and that the housing situation will not change much. Similarly, purchasing power scored 3 because of the relationship between the rate of increase in income and the price difference between RMI and the United States [20]. Food security was scored 4 by comparing the nutritional state of the people in RMI and the health data of immigrants in the state of Arkansas [44, 45]. The safety score was 3, since RMI and the United States are equally safe. The score for education was 5 due to a large difference in educational opportunities between RMI and the United States. Social services also scored 5, since the United States has social security programs, while RMI does not [46]. Healthcare also received a score of 5 because the healthcare that people can access in the United

States is better than that of RMI. Employment scored 3 because many people who immigrated from RMI to the United States were unable to secure a job [47].

Furthermore, participation in local activities scored 2 because the community of immigrants from RMI did not have the same level of bond and number of people as in RMI. Climate scored 4 because the United States is less impacted by climate change than RMI. The living environment scored 5 because the United States has higher standards for waste collection, electricity, and access to recreation compared to RMI. Relationships with neighbors scored 3 because it has been reported that immigrants from RMI seldom experience trouble with the existing residents in the areas where they settle. Shopping scored 4, since the United States' markets offer more variety than those of RMI. Access to amusements scored 5 because the rate of internet access and number of TV channels are higher in the United States [48]. Relationships in the workplace scored 2 because there are immigrants from RMI that cannot speak English, which makes communication in the workplace more challenging. Lastly, communications with others scored 2 because immigrants who cannot speak English will experience a harder time socializing with their neighbors.

3.2. Migration to Other Island States

In this section, we consider the possibility of Marshallese migration to Fiji, considering the evaluation value consisting of 16 criteria for evaluation. Based on the results, the possibility of Marshallese migration to Fiji is low.

First, the education level in Fiji is lower than that of the United States. The evaluation value for education in Fiji was 4, one point below that of the United States. Education is a major motivation for Marshallese to migrate abroad. Moreover, the United States offers generous scholarships for Marshallese students. Fewer Marshallese students wish to migrate to Fiji than to the United States for the purpose of higher education. Second, the working conditions on Marshall Island may be better than in Fiji for some jobs. Rokoduru [49] suggested that the main factors affecting Fijian migration to RMI are inadequate salary and unfavorable working conditions in Fiji. In particular, skilled workers suffer. Thus, we ranked the evaluation value of employment in Fiji at 2. Third, there are few social networks in Fiji for Marshallese people. IOM [50] estimates that there were just over 14,000 foreign immigrants residing in Fiji in 2019, representing 1.8% of the country's total population. RMI was not included as a major country of origin in 2019. This implies that Marshallese immigrants may not have enough of the social support needed for smooth resettlement. Therefore, we ranked the items related to social networks as 2. Finally, Marshallese immigrants are unable to receive sufficient social services unless they change their citizenship to Fijian. Therefore, we rated social service as 2. According to Maekawa et al. [26], not having Fijian citizenship significantly limits opportunities to receive social services. Maekawa et al. [26] also pointed out that people who want to obtain Fijian citizenship must stay in the country for more than ten years after their arrival. Obtaining citizenship in Fiji is so difficult that migration-minded Marshallese people probably seek opportunities in other countries.

For these reasons, we estimate that the chance of successful migration from RMI to Fiji is low. However, some Marshallese have migrated to Fiji, which implies that some find merit in this decision. If Fiji establishes a new policy to attract immigrants by eliminating existing problems, Fiji may become an attractive destination for future immigrants from RMI.

3.3. Land Reclamation and Raising

The evaluation was conducted with reference to Hulhumalé construction in the Maldives, to evaluate the possible livelihoods if artificial islands were to be built in the RMI.

For the following criteria, improvements are anticipated compared to the status quo. Housing should be improved, especially with regards to housing facilities and public services [30]. Purchasing power must be better for those who were self-sufficient before resettlement. The rate of school enrollment in the Maldives has increased after the construction of Hulhumalé [51]. Public services are expected to improve, as previous studies show that satisfaction with the living environment, including transportation and infrastructure, has increased in the Maldives [30]. The construction of new medical facilities on artificial islands should increase the satisfaction of residents. The housing environment (water supply, drainage,

waste disposal, landscape, etc.) should also be improved with new waste disposal and water tank facilities. The convenience of shopping is also anticipated, as residents will have easy access to commercial facilities. Entertainment should also be enhanced in land built through reclamation and raising.

However, some aspects are expected to deteriorate. Participation in local activities may decrease because migration disrupts the local community. Establishing similarly strong ties after relocation does not immediately sound. Although few residents in Hulhumalé feel that their relationships with their neighbors have weakened, it is expected that the relationships with new neighbors may worsen as people move from single-family houses to apartment complexes.

For some criteria, changes were not anticipated. The survey results show that 67% of the food consumed in the Marshall Islands is purchased from stores [42]. Therefore, it is unlikely that relocation would impact food access. In the Maldives, few data indicate that public safety has improved after the construction of Hulhumalé, and employment opportunities may not change significantly. Although there is a possibility that some residents may have to change their occupations after resettlement. Climate may not change as they continue to stay in the same climate zone. As for interpersonal relationships at workplaces, there should be few changes, because the majority of workers are Marshallese.

3.4. Developing Floating Platforms

To begin, we classified housing as 3 in our results. While proper housing is to be provided, this could mostly depend on the conditions set by developers of the floating islands. Purchasing power should increase when such a major project takes place. We assumed that food security was 4. However, this figure could be as high as 5, because floating cities tend to benefit from their surrounding environments (e.g., marine resources). Considering the current education conditions on Marshall Island, we ranked education as 4. Safety, social services, and health care should be considered as a set, since an increase in one factor positively influences the others. With expectations that public support would increase, we rated these sections as 4 for this reason. According to Shimizu Corporation's Green Float plan, there will be various business opportunities in the floating city. Therefore, we ranked employment at 4.

Participation in local activities and relationships with neighbors were both graded as 2 because of our concern that the existing community might be separated after relocation. Climate was rated as 3, because only minor changes (e.g., wind, sunlight, temperature, etc.) are anticipated in moving to floating platforms. Crucial facilities like sewage, waste disposal, and recycling plants would be constructed on the floating city. For this reason, we determined that living conditions would be 4. Convenience for shopping and access to recreation were classified as 4. Floating cities tend to be compact, and the construction

of recreational areas should be considered. Relationships within workplaces and communication with others were rated as 3, as major changes are expected.

3.5. International Legal Frameworks and Funding Schemes

In recent years, a growing international trend has promoted “Migration with Dignity” for climate-driven migrants both internally and externally; this has included the development of non-legally binding international frameworks. However, there are still many gaps between the ideal and actual domestic laws and host country policies. With the implementation of laws and policies reflecting the “migration with dignity” concept, more people may choose cross-border migration in the future. The other two options, staying in the current location by developing floating platforms or land reclamation and raising, are exclusively domestic policy choices, in which case human rights are subject to the domestic laws of the country.

However, there is no doubt that parties to human rights treaties shall comply with obligations under the treaties; for internal migration, the Guiding Principles on Internal Displacement can be applied. Additionally, considering the Common but Differentiated Responsibility Principle (CBDR), the Paris Agreement under the UNFCCC stipulates the need for capacity building support in developing countries, including SIDS, and requires developed countries to “provide financial resources to assist developing country parties with respect to both mitigation and adaptation (article 9).” International funds have been established to support adaptation efforts in developing countries, especially in the least developed countries and small island countries. These include the Green Climate Fund, Adaptation Fund, Least Developed Countries Fund, and Special Climate Change Fund. Under the UNFCCC regime, the Warsaw International Mechanism (WIM) has been established to share knowledge on loss-and-damage related topics, including slow-onset events (including sea level rise).

The use of these supports may facilitate SIDS governments choosing the third and fourth options. Additionally, although it is not a human rights issue, the legal status of artificial islands or marine structures may come into question under the law of the sea in relation to these options. Experts in the international community have already begun to examine international law issues associated with sea level rise.

3.6. Integrated Evaluation with AHP

For the experimental evaluation with AHP, firstly, a pairwise comparison matrix must be developed for each evaluation criterion (e.g., “social services”). The numbers in a matrix were calculated using the numbers in **Table 1**. If the difference in values between two alternatives (e.g., “migration to the developed world” and “migration to other island states”) was 1, we placed 3 (as a number) to the matrix. If the difference was 2 or 3, we placed 5 and 7, respectively, to the matrix. When one alternative has

Table 2. Pairwise comparison matrix for “social services.”

- I: Migration to the developed world
- II: Migration to other island states
- III: Land reclamation and raising
- IV: Developing floating platforms

	I	II	III	IV
I	1	7	3	3
II	1/7	1	1/5	1/5
III	1/3	5	1	1
IV	1/3	5	1	1

the same value as the others (e.g., “land reclamation and raising” and “developing floating platforms”), a score of 1 was assigned. **Table 2** shows a pairwise comparison matrix for “social services” as an example. Sixteen pairwise comparison matrices were developed for each criterion in this manner.

Second, the relative importance of the criteria for evaluation should be determined. For this purpose, we examined the following three cases:

- Case1: All criteria are equally important.
- Case2: Social environment is more important.
- Case3: Personal environment is more important.

In case 1, because all the criteria had the same importance, all elements in the pairwise comparison matrix of the criteria became 1.

For cases 2 and 3, we classified the criteria into the following four categories:

- Social environment 1: Safety, education, social services, and health care.
- Social environment 2: Employment, participation in local activities, climate, and living environment.
- Personal environment 1: Housing, purchasing power, food security, and relationship with neighbors.
- Personal environment 2: Convenience of shopping, access to recreation, relationship within the workplace, and communication with others (casual issues).

We also assumed that the criteria under social environment 1 were more important than those under social environment 2, and that the criteria under personal environment 1 were more important than those under personal environment 2. To carry out numerical calculation for “case 2” mentioned above, for scores of social environment 1, seven points were given to the criteria under personal environment 2, five points to the criteria under personal environment 1, and three points to social environment 2. Numerical calculations for “case 3” were conducted in the same manner.

Table 3. Experimental integrated evaluation of alternatives.

- I: Migration to the developed world
- II: Migration to other island states
- III: Land reclamation and raising
- IV: Developing floating platforms

	I	II	III	IV
Case 1	0.335	0.143	0.243	0.279
Case 2	0.384	0.139	0.205	0.271
Case 3	0.305	0.138	0.276	0.281

The scores calculated with AHP for each alternative under the three cases are shown in **Table 3**. The alternative “migration to the developed world” yielded the highest score for all three cases, followed by “migration to other island states,” “land reclamation and raising,” and “developing floating platforms.” All cases had the same score ranking for the alternatives. The alternative “migration to other island states” tended to have lower scores than others. In the case where “social environment” was important, the alternative “migration to the developed world” secures a much higher score than other three alternatives. In the case where “personal environment” was most important, scores for the three alternatives of “migration to other island states,” “land reclamation and raising,” and “developing floating platforms” had smaller differences than in the other two cases examined.

4. Discussion

4.1. Possible Impacts to the Mind of Immigrants

According to **Table 1**, by summing up the score of all the criteria for evaluation, the four alternatives yielded (on average) 3.63, 2.81, 3.38, and 3.50, respectively. This implies that “migration to the developed world” was the best choice.

Summing up the difference between “status quo (i.e., three points)” and the points assigned to each criterion, the four alternatives averaged 1.00, 0.69, 0.63, and 0.75 points, respectively. This suggests that “migration to the developed world” offered more changes to migrants. The alternative of “land reclamation and raising” unsurprisingly offered the smallest change to future climate migrants.

Clearly, alternatives should be selected by considering various aspects. The magnitude of the anticipated change caused by each alternative should be given due consideration. Moving abroad for a better livelihood, namely the alternative of “migration to the developed world,” may incur large costs for migrants. A survey of immigrants who have already relocated from RMI to the United States should be included in further study. There is also a legal question of whether the nation of RMI can survive if the land is completely submerged after all residents have moved out of the country.

Although it was not explicitly examined in this study, it should also be considered that in RMI, as well as in other Pacific countries, residents are extremely attached to their land, and land has become an integral part of life [52]. Moreover, land ownership is customary in the RMI [53]. Therefore, for the alternative of “land reclamation and raising” which makes the existing land no longer visible, gaining consensus may be more difficult than the other three options. Additionally, the capacity of the government to plan and implement an alternative should also be considered [54].

4.2. Costs of Alternatives

This study almost disregarded the cost incurred to materialize the suggested alternatives. First, the concept of cost effectiveness may not serve as a criterion for selecting one alternative over another. The nature of “migration to the developed world” is completely different from “land reclamation and raising.” Persuading future climate migrants to choose one alternative over another on the grounds of cost effectiveness may not work.

Moreover, estimating the cost of each alternative in the future, when the emergence of climate migrants becomes imminent, is subject to many uncertainties, most of which are difficult to estimate at this stage.

Construction of Hulhumalé Phase 1 costs US\$32 million to create 1.9 km² of land (excluding cost to build housing) for 60,000 inhabitants [9]. On the other hand, Phase 2 of the project to develop 2.44 km² of land (for 100,000 residents) cost US\$160 million. The “unit cost” of land reclamation and raising is hard to determine even for phased projects in the same country. Thus, the Hulhumalé project may not serve as a guide for estimating the cost of land reclamation and increase in other locations such as RMI.

There is also a difference in the government’s financing capacity between the Maldives and RMI: in 2020, the GDP per capita in the Maldives was \$7,446, while in RMI it was only \$4,073 [55]. Moreover, the government is financially weak: of the total annual budget of \$146 million in 2006, 68% came from the United States, leaving RMI with only \$41 million in revenue, excluding foreign aid [56]. Therefore, even if the government can raise funds and donations for construction, it may not be able to secure funds for continued maintenance.

4.3. Magnitude, Rate and Process

In 2015, we witnessed a “refugee crisis” in Europe. More than 1.25 million people came to the member states of the European Union, leaving their home countries due to war, violence, and persecution [57]. This was regarded as a crisis because of the magnitude, rate, and process. The number of asylum seekers within one year was as high as the population of Mauritius. European countries were not prepared to absorb such a great number of asylum seekers in a short period. This has caused massive confusion in Europe.

Climate migrants, who are obliged to leave their countries because of climate change will never emerge in such a tragic manner. This is because climate change is a slow-onset process, unlike wars. When and where climate migrants emerge is somewhat predictable. At least a decade, probably a few decades, of time is available for the international community to prepare for climate migrants so that they may relocate to their destinations with dignity as humanity, unlike most asylum seekers who reached Europe in 2015.

Nunn and McNamara [54] concluded that relocation is a transformational process. People need to change their lives. Particularly, people need time to adapt when moving to a different place. Moreover, it takes time to identify the changes that will occur after relocation. Therefore, whatever option is chosen, sufficient time should be taken for preparation. The Marshallese should also make wise use of the available lead time, so that they may be well prepared for migration in future.

The nature of climate change as a slow-onset event may lead to decision-making delays. Notably, none of the atoll countries in the Pacific (e.g., Kiribati, RMI and Tuvalu) has made a firm decision about the way they manage anticipated sea level rise by climate change. This is a striking contrast to the Maldives, which decided to address the issue of land reclamation and raising and started building Hulhumalé in the final part of the last century.

This process is also a very important element for rational planning. Provided that either “land reclamation and raising” or “developing floating platforms” be taken, careful planning is needed to determine which people should be moved first from their home to the “new land” When people from a particular region of the country are first relocated to the “new land,” conflicts may arise between them and latecomers from different regions because of differences in culture, religion, ethnicity, etc. An appropriate mixture of people should be identified for a smooth transition from the status quo to the new equilibrium.

5. Conclusion

Among the four alternatives examined, “migration to the developed world” secured the highest score, followed by “developing floating platforms” and “land reclamation and raising.” The two alternatives of “migration to the developed world” and “land reclamation and raising” are more realistic than the other two options because the former has been practiced in migration by the Marshallese to the United States for the last few decades. The latter has happened with the Hulhumalé construction project in the Maldives, although financial issues remain.

Notably, these cases are practiced by those willing to leave their homes voluntarily, not by force. On the other hand, climate migrants are involuntary resettlers. These two groups should not be conflated, so that the needs of the climate migration may be addressed properly.

Only Japanese researchers have conducted this analysis because we needed four sets of researchers who were

familiar with the four alternatives examined in this study. Specifically, the team that focused on “migration to the developed world” conducted an in-depth review of the literature on the lives of RMI migrants to the United States, including interviews with researchers in the United States and Japan, studying Marshallese migration. Another team on the topic of “migration to other island states” examined articles on migration from other Pacific island nations, including the RMI, to Fiji. They also interviewed the researchers with expertise in this issue. Additionally, another team on the topic of “land reclamation and raising” reviewed in detail a study on the case of the Maldives [58]. They also conducted interviews with people familiar with internal migration from Maldives to Hulhumalé. For the development of the floating platform, in addition to the literature review in Japanese and English, the team interviewed people from Japanese construction companies and research institutes involved in the conceptual and detailed design of the floating platform. It was not feasible to obtain a similar number of Marshallese researchers to Japanese researchers to participate in this project in terms of language skills and research capabilities.

Further, the analysis was conducted based on the current international legal framework, including COFA and economic conditions. We would like to point out that if the issue of saving small island states from sea level rise is discussed more seriously in international arenas in the future, and if international laws and economic assistance schemes are changed, the priorities presented here will change and new options may emerge.

Acknowledgements

The authors would like to express their sincere appreciation to the Global Infrastructure Fund Research Foundation Japan (GIF Japan) and the Ocean Policy Research Institute of The Sasakawa Peace Foundation (OPRI-SPF) for their support of this study. We would like to thank all the informants who provided us with valuable input and observations. This study was also supported by JSPS KAKENHI (Grant Numbers 19KK0025 and 21H03711). Lastly, we very much appreciate the assistance provided by Ms. Ayane Komeichi and Ms. Rion Miyauchi, Research Associates of GIF Japan.

References:

- [1] The Intergovernmental Panel on Climate Change (IPCC), “Global Warming of 1.5°C: Impact of 1.5°C of Global Warming on Natural and Human Systems,” https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Chapter3_Low_Res.pdf [accessed August 18, 2021]
- [2] J. Barnett and W. N. Adger, “Climate Danger and Atoll Countries,” *Climate Change*, Vol.61, No.3, pp. 321-337, 2003.
- [3] M. Nakayama, S. Drinkall, and D. Sasaki, “Climate Change, Migration, and Vulnerability: Overview of the Special Issue,” *J. Disaster Res.*, Vol.14, No.9, pp. 1246-1253, 2019.
- [4] Regional Pacific NDC Hub, “Executive Summary Strategy 2030: A Blueprint for NDC Implementation in Pacific Island Countries,” <https://pacificndc.org/sites/default/files/2021-04/Executive%20Summary%20Strategy%202030.pdf> [accessed August 18, 2021]
- [5] Radio New Zealand, “Marshall Islands Aspires to Be Carbon-neutral by 2050,” 2018, <https://www.rnz.co.nz/international/pacific-news/367271/marshall-islands-aspires-to-be-carbon-neutral-by-2050> [accessed August 13, 2021]

- [6] Pasifika Environews, "US\$29 Million Allocated for New Seawall Along Ebeye Oceanside Coastline," 2019, <https://pasifika.news/2019/10/us29-million-allocated-for-new-seawall-along-ebeye-oceanside-coastline/> [accessed August 14, 2021].
- [7] Marshall Islands Journal, "78 New Seawalls Priced at \$4.8m," *Marshall Islands J.*, Vol.50, No.41, 2019.
- [8] G. Johnson, "Let There Be Land," *Marshall Islands J.*, Vol.50, No.8, 2019.
- [9] Marshall Islands Journal, "Watch the seas rise in RMI," *Marshall Islands J.*, Vol 52, No.46, 2021.
- [10] SPREP, "Marshall Islands Tells COP26, Now Is the Time!," 2021, <https://www.scoop.co.nz/stories/WO2111/S00171/marshall-islands-tells-cop26-now-is-the-time.htm> [accessed December 6, 2021]
- [11] S. Brown et al., "Land Rising as a Solution to Sea-Level Rise: An Analysis of Coastal Flooding on an Artificial Island in the Maldives," *J. of Flood Risk Management*, Vol.13, No.S1, e12567, 2020.
- [12] B. K. Sovacool, "Expert Views of Climate Change Adaptation in the Maldives," *Climate Change*, Vol.114, pp. 295-300, 2012.
- [13] M. Ives, "A Remote Pacific Nation, Threatened by Rising Seas," 2016, <https://www.nytimes.com/2016/07/03/world/asia/climate-change-kiribati.html> [accessed August 14, 2021]
- [14] L. Yamamoto and M. Esteban, "Migration as an Adaptation Strategy for Atoll Island States," *Int. Migration*, Vol.55, No.2, pp. 144-158, 2017.
- [15] C. Mortreux and J. Barnett, "Climate Change, Migration and Adaptation in Funafuti, Tuvalu," *Global Environmental Change*, Vol.19, pp. 105-112, 2009.
- [16] N. Adger and J. Barnett, "Compensation for Climate Change Must Meet Needs," *Nature*, No.436, p. 328, 2005.
- [17] F. Biermann and I. Boas, "Protecting Climate Refugees – The Case for a Global Protocol," *Environment Magazine*, Vol.50, No.6, pp. 8-17, 2010.
- [18] M. Esteban et al., "Adaptation to Sea Level Rise on Low Coral Islands: Lesson from Recent Events," *Ocean and Coastal Management*, Vol.168, pp. 35-40, 2019.
- [19] Department of State, United States of America, "Compact of Free Association," 2003, <https://2009-2017.state.gov/documents/organization/173999.pdf> [accessed September 5, 2021]
- [20] Department of Business, Economic Development & Tourism, State of Hawaii, "COFA Migrants in Hawaii," 2020, https://files.hawaii.gov/dbedt/economic/reports/COFA_Migrants_in_Hawaii_Final.pdf [accessed September 5, 2021]
- [21] K. Moriya, "Motivations for Students in the Republic of the Marshall Islands and the Federated States of Micronesia to Emigrate Abroad," *J. Disaster Res.*, Vol.14, No.9, pp. 1293-1296, 2019.
- [22] N. Yoshioka, I. Taafaki, and Y. McKay, "Higher Education and Destination of the Youth in the Republic of the Marshall Islands: Implication for Climate-Induced Migration," *J. Disaster Res.*, Vol.14, No.9, pp. 1287-1292, 2019.
- [23] East-West Center, "Climate, Health, and Migration from the Marshall Islands," 2021, <https://www.eastwestcenter.org/print/36857> [accessed September 5, 2021]
- [24] Asahi Shimbun, "Sekai ichi shiawase ni nareru kuni Fiji (Fiji makes you the happiest of the world)," 2019, <https://www.asahi.com/and/article/20190830/300131953/> (in Japanese) [accessed September 5, 2021]
- [25] Ministry of Foreign Affairs of Japan, "Fiji kyowakoku kihon deta (Basic gata of the Republic of Fiji)," 2021, <https://www.mofa.go.jp/mofaj/area/fiji/data.html> (in Japanese) [accessed September 5, 2021]
- [26] M. Maekawa, P. Singh, D. Charan, N. Yoshioka, and T. Uakeia, "Livelihood Re-Establishment of Emigrants from Kiribati in Fiji," *J. Disaster Res.*, Vol.14, No.9, pp. 1277-1286, 2019.
- [27] T. K. Bauer, G. S. Epstein, and I. N. Gang, "Herd effects or migration networks? The location choice of Mexican immigrants in the U.S.," *IZA Discussion Paper Series*, No.551, 2002.
- [28] The World Bank, Maldives Urban Development and Resilience Project (P163957), "Combined Project Information Documents / Integrated Safeguards Datasheet (PID/ISDS)," 2019, <https://documents1.worldbank.org/curated/en/914371576902602402/pdf/Project-Information-Documents-Integrated-Safeguards-Datasheet-Maldives-Urban-Development-and-Resilience-Project-P163957.pdf> [accessed September 8, 2021]
- [29] Asian Development Bank (ADB), "Proposed Grant and Technical Assistance Grant and Administration of Grant / Republic of Maldives: Greater Malé Environmental Improvement and Waste Management Project," Report and Recommendation of the President to the Board of Directors, Project No.51077-002, 2018, <https://www.adb.org/sites/default/files/project-documents/51077/51077-002-rrp-en.pdf> [accessed September 8, 2021]
- [30] M. A. Mohit and M. Azim, "Residents' Satisfaction with Public Housing in Hulhumalé Area of Malé, Maldives," *Asian J. of Environment-Behaviour Studies (ajE-Bs)*, Vol.3, No.9, pp. 125-135, 2018.
- [31] United Nations, "Sustainable Floating Cities Can Offer Solutions to Climate Change Threats Facing Urban Areas," 2019, <https://www.un.org/press/en/2019/dsgsm1269.doc.htm> [accessed August 30, 2021]
- [32] The Seasteading Institute, "Who we are," 2021, [https://www.seasteading.org/about/?gclid=\\$Cj0KCCQjwg7KJBhDyARIsAHRAXaET4JGkxnuhlu0sDkk-KIFpJAM-GVnpPVU5GFfFOliqWWH8AbwJ6-AaAnlGEALw_wcB](https://www.seasteading.org/about/?gclid=$Cj0KCCQjwg7KJBhDyARIsAHRAXaET4JGkxnuhlu0sDkk-KIFpJAM-GVnpPVU5GFfFOliqWWH8AbwJ6-AaAnlGEALw_wcB) [accessed August 31, 2021]
- [33] Shimizu Corporation, "Kankyo airando Green Float [Environmental Island Green Float]," 2021, <https://www.shimz.co.jp/topics/dream/content03/> (in Japanese) [accessed August 30, 2021]
- [34] A. Kuroyanagi, K. Masuda, A. Kobayashi, T. Ikoma, H. Eto, T. Todoroki, and S. Kobayakawa, "A Study on Mega-Floating Structures for Ocean Space Utilization," *J. of Research Institute of Science and Technology*, Vol.142, pp. 19-28, 2018.
- [35] M. Lamas-Pardo, G. Iglesias, and L. Carral, "A review of very large floating structures (VLFS) for coastal and offshore uses," *Ocean Engineering*, Vol.109, pp. 677-690, 2015.
- [36] J. McAdam, "Climate-Related Displacement of Persons," K. R. Gray, R. Tarasofsky, and C. Carlarne (Eds.), "The Oxford Handbook of Int. Climate Change Law," pp. 519-542, Oxford University Press, 2016.
- [37] K. M. Wyman, "Human Mobility and Climate Change," M. Faure (Ed.), "Elgar Encyclopedia of Environmental Law," pp. 637-648, Edward Elgar, 2016.
- [38] F. Biermann, "Global Governance and Future Climate Refugees," S. Behrman and A. Kent (Eds.), "Climate Refugees: Beyond the Legal Impasse?," pp. 265-277, Routledge, 2018.
- [39] R. McCarney and J. Kent, "Forced Displacement and Climate Change: Time for Global Governance," *Int. J.: Canada's J. of Global Policy Analysis*, Vol.75, No.4, pp. 652-661, 2020.
- [40] S. N. McClain, C. Bruch, E. Daly, J. May, Y. Hamada, M. Maekawa, N. Shiiba, M. Nakayama, and G. Tsiokanou, "Migration with Dignity: A Legal and Policy Framework," *J. Disaster Res.*, Vol.17, No.3, pp. 292-300, 2022.
- [41] B. L. Wheeler, J. Fitzpatrick, K. van der Geest, and M. Burkett, "Marshallese migration: comparative well-being in U.S. destination states," 2020, https://rmi-migration.com/s/marshall-islands-well-being-v10_FINAL.pdf [accessed September 5, 2021]
- [42] K. Suzuki, "Operations Research," Lecture Note, Tohoku University, 2009, <http://www2.econ.tohoku.ac.jp/~ksuzuki/teaching/ch3.pdf> [accessed December 5, 2021]
- [43] T. L. Saaty, "How to make a decision: the analytic hierarchy process," *European J. of Operational Research*, Vol.48, No.1, pp. 9-26, 1990.
- [44] D. E. Willis and K. M. Fitzpatrick, "Adolescent food insecurity: the special case of Marshallese youth in north-west Arkansas, USA," *Public Health Nutrition*, Vol.23, No.3, pp. 544-553, 2019.
- [45] Food and Agriculture Organization of the United Nations (FAO), "Republic of the Marshall Islands Food Security Profile," 2021, <http://www.fao.org/documents/card/en/c/CB3975EN/> [accessed September 8, 2021]
- [46] Department of Statistics, Int. Labour Organization (ILO), "Statistics on social protection," 2021, <https://ilostat.ilo.org/topics/social-protection/> [accessed September 8, 2021]
- [47] William S. Richardson School of Law, University of Hawaii at Manoa, "Marshall Islands Climate and Migration Project," 2020, <https://rmi-migration.com/> [accessed September 8, 2021]
- [48] The World Bank, "Individuals using the Internet (% of population) – Marshall Islands," 2021, [https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=\\$MH](https://data.worldbank.org/indicator/IT.NET.USER.ZS?locations=$MH) [accessed September 8, 2021]
- [49] A. Rokoduru, "Contemporary Migration Within the Pacific Islands: The case of Fijian skilled workers in Kiribati and Marshall Islands," S. Firth (Ed.), "Globalisation and Governance in the Pacific Islands," No.9, ANU Press, 2006
- [50] International Organization for Migration (IOM), "Migration in the Republic of Fiji: A Country Profile 2020," International Organization for Migration (IOM), 2020.
- [51] National Bureau of Statistics, Ministry of National Planning, Housing and Infrastructure, Republic of Maldives, "Statistical Pocketbook of Maldives 2020," 2020, <http://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2020/10/Statistical-Pocketbook-2020.pdf> [accessed September 8, 2021]
- [52] C. Farbotko, "Climate change displacement: Towards ontological security," C. Klöck, and M. Fink (Eds.), "Dealing with climate change on small islands: Towards effective and sustainable adaptation?," pp. 251-265, Göttingen University Press, 2019.

- [53] J. Campbell, "Chapter 4: Climate-Induced Community Relocation in the Pacific: The Meaning and Importance of Land," J. McAdam (Ed.), "Climate Change and Displacement," pp. 57-79, Hart Publishing, 2010.
- [54] P. D. Nunn and K. E. McNamara, "Failing adaptation in island contexts: The growing need for transformational change," C. Klöck, and M. Fink (Eds.), "Dealing with climate change on small islands: Towards effective and sustainable adaptation?," Göttingen University Press, pp. 19-44, 2019.
- [55] The World Bank, "GDP per capita," <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD> [accessed September 10, 2021]
- [56] T. Kurosaki, "Taiheiyō Shokoku Ni Okeru Kokumin Kokka No Keisei To Erito No Henyo (Formation of Nation-States and Transformation of Elites in Pacific Island Countries)," Doctoral Dissertation, Waseda University, 2012 (in Japanese).
- [57] E. Greussing and H. G. Boomgaarden, "Shifting the refugee narrative? An automated frame analysis of Europe's 2015 refugee crisis," J. of Ethnic and Migration Studies, Vol.43, No.11, pp. 1749-1774, 2017.
- [58] A. Sakamoto et al., "Mitigating impacts of climate change induced sea level rise by infrastructure development: Case of the Maldives," J. Disaster Res., Vol.17, No.3, pp. 327-334, 2022.



Name:
Mikiyasu Nakayama

Affiliation:
Global Infrastructure Fund Research Foundation
Japan

Address:
Roppongi T-Cube 14F, 3-1-1 Roppongi, Minato-ku, Tokyo 106-0032, Japan

Brief Career:

1989- Associate Professor, Faculty of Agriculture, Utsunomiya University
1999- Professor, United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology
2004- Professor, Graduate School of Frontier Sciences, The University of Tokyo
2020- Managing Director, Global Infrastructure Fund Research Foundation Japan

Selected Publications:

- M. Nakayama, I. Taafaki, T. Uakeia, J. Seru, Y. McKay, and H. Lajar, "Influence of Religion, Culture and Education on Perception of Climate Change, and its Implications," J. Disaster Res., Vol.14, No.9, pp. 1297-1302, 2019.
- K. Ogino, J. Son, and M. Nakayama, "Effectiveness of hydropower development finance: evidence from Bhutan and Nepal," Int. J. of Water Resources Development, pp. 1-17, 2020.
- S. N. McClain, C. Bruch, M. Nakayama, and M. Laelan, "Migration with Dignity: a case study on the livelihood transition of Marshallese to Springdale, Arkansas," J. of Int. Migration and Integration, Vol.21, No.3, pp. 847-859, 2020.

Academic Societies & Scientific Organizations:

- Japan Society of Hydrology and Water Resources (JSHWR)
- Environmental Peacebuilding Association (EnPAX)



Name:
Ryo Fujikura

Affiliation:
Professor, Faculty of Sustainability Studies, Hosei University

Address:
2-17-1 Fujimi, Chiyoda-ku, Tokyo 102-8160, Japan

Brief Career:

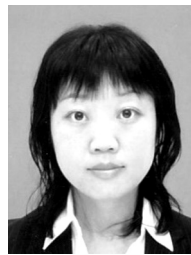
1984-1995 Officer, Environment Agency, Government of Japan
1995-1999 Associate Professor, Institute of Environmental Systems, Kyushu University
1999-2003 Professor, Faculty of Economics, Ritsumeikan University

Selected Publications:

- "Resettlement Policy in Large Development Projects," Routledge, 2015.
- "Climate Change Mitigation and Development Cooperation," Earthscan, 2012.
- "Climate Change Adaptation and International Development," Earthscan, 2010.

Academic Societies & Scientific Organizations:

- Society of Environmental Science, Japan (SES)
- Society for Environmental Economics and Policy Studies (SEEPS)
- Japan Society for International Development (JASID)



Name:
Rie Okuda

Affiliation:
Graduate Student, Graduate School of International Cooperation Studies, Kobe University

Address:
2-1 Rokkodai, Nada, Kobe, Hyogo 657-8501, Japan

Brief Career:

2006- Training Staff, Japan International Cooperation Agency (JICA), Nihonmatsu Training Center (NTC)
2010- English Instructor, Yamaha Music Japan Co., Ltd.
2021- Master of International Studies, Graduate School of International Cooperation Studies, Kobe University

Academic Societies & Scientific Organizations:

- Japan Society for International Development (JASID)
- Japan Society for Oceanic Studies (JSOS)



Name:
Mai Fujii

Affiliation:
Research Fellow, Ocean Policy Research Institute, The Sasakawa Peace Foundation

Address:
1-15-16 Toranomon, Minato-ku, Tokyo 105-8524, Japan

Brief Career:
2011- Advisor/Researcher on International Law, General-Consulate of Japan in Hamburg
2014- Official, Global Environment Bureau, Ministry of the Environment, Government of Japan
2017- Research Fellow, Ocean Policy Research Institute, The Sasakawa Peace Foundation

Selected Publications:
• M. Fujii and E. Higuchi, "The Civil Liability Regime for Ship-Source Oil Pollution and Sharing the Costs : In the wake of The WAKASHIO Accident in Mauritius," Ocean Policy Studies, No.15, pp. 61-78, 2021 (in Japanese).
• M. Fujii, M. Maekawa, and E. Higuchi, "Comparative Analysis on International Trends and Implementations of Three Major Countries towards the Sustainable Development Goal 14: Japan, France and U.S.A.," J. of Japan Society of Ocean Policy, No.8, pp. 49-70, 2018 (in Japanese).

Academic Societies & Scientific Organizations:
• International Law Association, Japan Branch
• Japan Society of Ocean Policy (JSOP)
• Japan Association for Environmental Law and Policy



Name:
Ryuta Takashima

Affiliation:
Department of Industrial Administration, Faculty of Science and Technology, Tokyo University of Science

Address:
2641 Yamazaki, Noda, Chiba 278-8510, Japan

Brief Career:
2007- Assistant Professor, Graduate School of Engineering, The University of Tokyo
2012- Associate Professor, Faculty of Social Systems Science, Chiba Institute of Technology
2020- Professor, Faculty of Science and Technology, Tokyo University of Science

Selected Publications:
• Y. Chen, M. Tanaka, and R. Takashima, "Energy Expenditure Incidence in the Presence of Prosumers: Can a Fixed Charge Lead us to the Promised Land?," IEEE Trans. on Power Systems, Forthcoming.
• Y. Chen, D. Zhang, and R. Takashima, "Carbon Emission Forensic in the Energy Sector: Is It Worth the Effort?," Energy Policy, Vol.128, pp. 868-878, 2019.
• M. Goto, K. Nishide, and R. Takashima, "Leaders, Followers, and Equity Risk Premium in Booms and Busts," J. of Banking & Finance, Vol.81, pp. 207-220, 2017.

Academic Societies & Scientific Organizations:
• Institute for Operations Research and the Management Sciences (INFORMS)
• International Association for Energy Economics (IAEE)
• Institute of Electrical and Electronics Engineers (IEEE)



Name:
Tomoya Murakawa

Affiliation:
Visiting Fellow, Global Infrastructure Fund Research Foundation Japan

Address:
Roppongi T-Cube 14F, 3-1-1 Roppongi, Minato-ku, Tokyo 106-0032, Japan

Brief Career:
2020- Pomona College



Name:
Erika Sakai

Affiliation:
Global Infrastructure Fund Research Foundation Japan
Graduate Student, Graduate School of Economics, Kyoto University

Address:
Roppongi T-Cube 14F, 3-1-1 Roppongi, Minato-ku, Tokyo 106-0032, Japan
Yoshida-honmachi, Sakyo-ku, Kyoto, Kyoto 606-8501, Japan

Brief Career:
2021 Received B.A. in Faculty of Economics from Sophia University
2021- M.A., Graduate School of Economics, Kyoto University



Name:
Hiroaki Iwama

Affiliation:
Global Infrastructure Fund Research Foundation Japan
Department of Economics, The School of Oriental and African Studies (SOAS), University of London

Address:
Roppongi T-Cube 14F, 3-1-1 Roppongi, Minato-ku, Tokyo 106-0032, Japan
10 Thornhaugh St., Russell Square, London WC1H 0XG, UK

Brief Career:
2019 Received Bachelor of Social Science in Environment and Development from Ritsumeikan Asia Pacific University
2020 Received M.Sc. Environmental Assessment and Management from University of East Anglia
2021- M.Sc. Economics and Environment, SOAS, University of London
Academic Societies & Scientific Organizations:
• Institute of Environmental Management and Assessment (IEMA), Graduate Member