

RESOURCE SECURITY STRATEGIES AND PREFERENCES FOR DEEP OCEAN MINING FROM A COMMUNITY SURVEY IN JAPAN

Abstract

Japan is among the leading countries pursuing deep sea mining (DSM) – both in “The Area” and in its domestic waters. One of the key drivers for this is the dearth of national mineral resources and the government’s desire to secure supplies of metals for its economy. While Japan has been undertaking research and development on the technological and environmental aspects of DSM, it has largely neglected the engagement of the community. This paper presents the results of a survey about DSM and the preferences of society in Japan for alternative sources of minerals. Key results are that for Japanese respondents: (i) understanding of DSM is still low, (ii) they tend to prefer development of DSM domestically rather than overseas, (iii) they prefer recycling or development of substitutes rather than DSM, (iv) people care about the impact on other industries which already use the ocean (fishing, tourism) but are split on whether minor impacts should prevent DSM occurring. This is a preliminary survey and the issue requires further examination with more detailed surveys and sophisticated techniques, importantly there is a need to supply participants with the most recent scientific understanding of DSM and its environmental impacts relative to other industries and other resource supply methods. In terms of marine policy, it is clear that there is a need to engage in significant stakeholder consultation to ensure a social license to operate, including concrete scenarios and plans for local benefit and mitigation of local impacts.

Keywords: stakeholder engagement; seabed mining; resource security;

1. Introduction

Minerals are essential inputs for the development of societies. Moreover, minerals – and particularly metals – are becoming more and more important for a variety of new technologies and infrastructure vital to modern economies, such as clean energy, and there are subsequent concerns that global resources may not be sufficient to meet future demand (McLellan *et al.*, 2016; Watari *et al.*, 2018), although the likelihood of supply risk is a contested issue (Teske *et al.*, 2016). On the back of such concerns, there has been a global drive to seek out new conventional resources or alternative unconventional resources of key minerals in order to secure supplies. This trend has been particularly apparent for countries that rely heavily on imports of metals and mineral ores or concentrates, due to a lack of domestic deposits, such as Japan. Deep sea mining (DSM) or seabed mining is one of the most widely discussed options, with a large potential resource in international waters as well as in territorial waters of some nations (Hein *et al.*, 2013). Other alternative sources of metal include recycling, further exploration or the exploitation of deeper, lower grade or more complex terrestrial ores (Prior *et al.*, 2012). Each of these alternatives has implications for the environmental impacts of metal provision, as well as direct and indirect effects on local communities and the economy, and there is not necessarily a clear-cut ideal supply route across all facets of concern (Motoori, B. C. McLellan and Tezuka, 2018).

This study focuses on the case study of DSM in Japan, due to the nation’s high dependence on imported resources, the long focus on DSM promotion, and its large ocean area. There are notable gaps in the understanding of social

acceptance of DSM, particularly in Japan, as highlighted below, which is the motivation for this study that uses a survey of Japanese public to clarify some of the important opinions, which may help future policy development.

1.1. Japan and Deep sea mining

The focus of this study is on Japan, due to its strong focus on DSM as well as its challenges with providing both energy and minerals needed in its economy (Motoori *et al.*, 2019). Japan has a long history both in its pursuit of resource security, as well as in DSM, with strategies for both being established at least as far back as the 1980's (Ting and Seaman, 2013). Initially, much of this resource security strategy was focused on investment in the development of mines in other countries (particularly developing countries), signing long-term supply contracts and stockpiling rare or strategic minerals (Ting and Seaman, 2013; Wilson, 2014). Previous research estimated that "resource entitlements" of Japanese companies investing in overseas mines can provide between 5.8 years (Silver) to 36.2 years (Lead) of some strategic target metals of DSM (Hatayama and Tahara, 2015). But such entitlements are still vulnerable to short-term supply chain disruptions (due to, for example, natural disasters or labor disputes), or at worst re-nationalisation of assets causing restrictions of supply that was previously considered secure. While it has more recently ventured into free trade agreements as a method of securing supply (Wilson, 2012), on top of these strategies, Japan reaffirmed its interest in DSM in its Basic Act on Ocean Policy in 2007 and Basic Plan on Ocean Policy (Government of Japan, 2013). A useful outline of Japan's history and approaches in DSM development is described elsewhere (Okamoto *et al.*, 2018).

Japan has been involved in the research, exploration and development of deep ocean mining deposits and technology for more than 4 decades through the Deep Ocean Resources Development Corporation (DORD, 2019). As DSM has been seeing a resurgence of interest in recent years, due to a variety of converging factors including spiking prices of metals and costs of extraction (on land), concerns over potential scarcity (physical, economic or political), progress in technology and the potential commencement of mining by Nautilus Minerals in Papua New Guinea (PNG) (Nautilus Minerals, 2013), Japan has increased its investment in the sector and continues to test technology towards commercialization (Thompson *et al.*, 2018). At the same time, there is growing impetus and pressure on the International Seabed Authority (ISA), which is the body in charge of exploration and extraction in international waters, and national governments to clarify the environmental and other requirements for companies who wish to undertake mining and exploration, both to give more certainty to industrial players, and to assure those opposed that adequate safeguards are in place.

The Japanese government has placed particular focus on seabed minerals, due largely to its scarcity of domestic economic terrestrial resources, and the consequent reliance on imported raw materials to support its industry (Motoori, B. C. McLellan and Tezuka, 2018). It is notable that the government has emphasized ocean extraction of methane hydrate as well as metals (used in energy technologies) within its Strategic Energy Plan (GOJ, 2018), highlighting the importance of metals within clean energy technologies, and the similar considerations of resource and energy security for Japan. Japan has one of the largest exclusive economic zones (EEZ) in the world, in significant contrast to its relatively limited land mass. Within its EEZ, Japan currently has a focus on Seafloor Massive Sulphides (SMS) deposits in the Okinawa Trough and the Izu-Bonin areas (JOGMEC, 2013), in addition to methane hydrate exploration around the country, rare earth rich muds (Takaya *et al.*, 2018) and exploration for manganese nodules in the international Area (GOJ, 2018).

The Okinawa Trough is located relatively close (~100km) to the Okinawan islands. Okinawa is located in the south-west of Japan, a significant distance from the most Southern of the main 4 Japanese islands (Kyushu), and is well-known as a tourist destination within Japan, having picturesque coral reefs and beaches. It is sometimes likened to the Hawai'i of Japan, relying heavily on tourism for its economy (Tada, 2015). Okinawa has a distinct culture and language from mainland Japanese which, in addition to its warm climate and ocean attractions, make it a popular destination for mainland Japanese. It is also home to a number of United States military bases, which have been the cause of significant controversies over the years, taking up a significant land area, causing social conflicts due to military personnel involvement in crime and aircraft accidents (Inoue, 2004; Mikanagi, 2004; Kagotani and Yanai,

2012). At the same time, the US bases have been considered an important part of Japan's national security (O'Shea, 2018). The Ryukyu island chain which includes Okinawa, also has at its far fringes the Senkaku/Diaoyu Islands that are contested by China and Japan (Machida, 2020) and may have both territorial and resource (fisheries and oil and gas) claims (Sato, 2019)(Liao, 2008). Thus, Okinawa is well known for a variety of reasons in mainland Japan. This combination of potential DSM and its conflict with existing economic activities and perceived value make it an interesting case study for the current study.

1.2. Social impacts, engagement and the ocean

While the technological, geological and environmental aspects of deep ocean mining have received a large amount of attention, as demonstrated by the bulk of the literature, the social acceptance and community impacts have not been widely examined¹. Specifically for this study there has been little or no evidence of social acceptance studies in the Japanese context in DSM.

Beyond the context of DSM, there have been suggestions to integrate social impact assessment (SIA) into approaches such as Integrated Coastal Zone Management (ICZM) (Vanclay, 2012). In Japan, some of the challenges of SIA in coastal regions have been highlighted for the case of CCS (Mabon, Kita and Xue, 2017) in which the authors discussed the need for SIA to make visible the complex relations between society and the ocean, focus on non-economic values and specifically understand the difference of "new" developments as opposed to continuing activities. There are likely to be learnings from subsea CCS and other coastal stakeholder engagements that can be applied to DSM, although a significant difference with DSM is that in many cases the mining activity will be well-beyond the horizon, so no activity will be visible to coastal communities – and in some cases ore may even be directly exported without local processing or support facilities.

There are minimal examples of studies on social acceptance of deep sea mining or perspectives from other countries, notably Australia (Boughen *et al.*, 2010)(Parr *et al.*, 2009; Mason *et al.*, 2010) and Pacific island states (Roche and Bice, 2013), and it has also been identified that public participation is a potential weakness in the law regarding international deep sea minerals exploitation (Lallier and Maes, 2016). Part of this lack of social engagement has likely been due to the lack of urgency for most countries, as the prospect for deep sea mining appears to be still quite distant in both time and space. The areas which have seen most engagement have been the focus of shorter-term mining prospects (e.g. PNG, pacific nations), particularly in the case of Nautilus Minerals' Solwara I project (Smith, 2010, 2011; Nautilus Minerals, 2013) which had been nearing actualization (before being stalled by ongoing financial issues), where the attainment of environmental and other permits requires some level of stakeholder engagement. A recent review of EIA processes for DSM in the international seabed area, or "The Area", which is "the seabed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction" (International Seabed Authority, 2021) has further emphasized the need for stakeholder consultation and the current underestimation of this in DSM application processes (Durden *et al.*, 2018) despite argument by some stakeholders that such consultation may be more optional than critical as was highlighted by other authors who argue that it may in fact be a legal obligation of the ISA (Willaert, 2020).

There is therefore a gap in knowledge relating to the perspectives of community stakeholders in Japan regarding this resource issue which has significant political support and may have environmental, social and economic implications for the nation if it is actualised. For countries such as Japan, the security of resource supplies is of vital importance for ongoing economic prosperity, but the negative sustainable development implications of the resource inputs are a potential vulnerability that could restrict new resource supplies such as DSM. If stakeholder opinion is against the exploitation of DSM, whether due to actual or perceived negative aspects, this can potentially eliminate this supply route, or present an ongoing risk.

¹ A useful overview of each of these aspects was undertaken by others (Koschinsky *et al.*, 2018).

1.3. Research Aim

On the basis of the points described above, the aim of the present study was to understand the perspective of Japanese towards deep ocean mining, and the drivers behind these perspectives, and to analyse the implication of these results to current and future deep sea mining policy. The study was a first-pass examination, specifically exploring perspectives with regards to the Okinawa Trough, as it is one area that has been widely explored for minerals, and it is considered a potentially controversial site due to its environmental characteristics and relative proximity to land. At the same time, the study seeks to evaluate the preference for alternative resource security strategies to understand the priority that should be placed on DSM within the policy sphere.

2. Methodology

The study utilised an internet-based survey of 681 respondents, with approximately half of the respondents from Okinawa (329) prefecture and the other half from across Japan (352). The survey was undertaken in Japanese during the period 25-28 March, 2016. Respondents covered an age range from 17 to 84, with the largest group of respondents (over all prefectures) in their 30's, distribution of respondents by age and gender is shown in Table 1. Median ages were 42 yrs in Okinawa and 45 yrs in the rest of Japan group, which were very similar to the population median ages (42.1 yrs and 46.4 yrs) in the 2015 census (Government of Japan, 2015).

< **Table 1** here >

Respondents were asked a series of questions regarding the following themes: (1) familiarity with Okinawa; and economic sectors important to Okinawa at present and in the future; (2) their familiarity with mining and the deep ocean environment; (3) acceptability and priority for deep sea mining in comparison to other industries and the environment; (4) how the benefits of deep sea mining should be distributed; (5) deep sea mining as a source of minerals for domestic industry as compared with importing, recycling and other strategies. Themes 3, 4 and 5 are the key focus from the perspective of this research, and are discussed in detail in the results.

With regards to the research aim, theme 3 was expected to give insight into whether deep sea mining would be acceptable if it were to impact on the existing uses of the ocean, thus indicating if there was a latent concern that threats to these alternative uses could occur, which in turn may cause a barrier to community acceptance of DSM. Theme 4 was relevant to understand where the various stages of DSM and processing of the subsequent ore would be acceptable, and to whom the benefits should flow. Theme 5 was then a higher-level strategic consideration of whether DSM would be the rational preference for Japan to provide its required resources, based on immediate alternatives and on the anticipated environmental and cross-industry impacts.

Survey responses have been analysed as two parallel groups (Okinawa and non-Okinawa) for comparative purposes, as well as overall results being used for certain questions where the difference in the groups is not statistically significant or where the location of respondents is not considered to be an important research variable.

3. Results

The results of analysis of the responses are provided in the following sections for the key themes.

3.1. Background and future vision for Okinawa and its economy

By way of understanding the expressed familiarity with the specific case study region, respondents were asked how familiar they were with Okinawa in regards to a number of categories, and with mining and the deep ocean. In the categories of: environment, industry, culture and politics/history; more than 66% of local Okinawans expressed that they had a familiarity at least from reading about it in the news, through to studying it or being an expert in the field. On the other hand, at best 48% (politics/history) to at worst 71% (industry) of non-Okinawans reported that they have no knowledge or have only "heard about" the topics. The politics and history of Okinawa have often been in the news, due to various controversies around US military bases in particular, as mentioned earlier.

The respondents were further asked what sector of the economy they considered to be most important for Okinawa now and in the future (percentage of respondents shown in <Table 2>). The responses were compared with the Japanese government statistics (Statistics of Japan, 2020) for employment and gross prefectural domestic product (GPDP) (<Table 3>). Across both groups, the largest sector in terms of importance was considered to be the tourism sector, both now and in the future, though in both cases it was considered that the sector would decline in importance somewhat. It should be noted that Tourism is not reported as an official sector in the overall Japanese statistics, but would include elements of a number of official sectors including non-specified services and industries, and in other statistics segments are reported in “trade” (Kakazu, 2018). In this case, the most important differences were that non-Okinawans thought that fishing was much more important than Okinawans, which reflects a potential better understanding of Okinawa by locals. Moreover, Okinawans considered that education, research and welfare sectors would be more important in the future, whereas non-Okinawans did not rate these as important. Perhaps most relevantly, it was well-known that the mining sector was not important currently in Okinawa, and it was not expected to play a large part in the economy in the future.

<Table 2 here>

<Table 3 here>

3.2. Understanding of mining

Regarding the basic level of understanding of mining (both on and off shore) some further questions were asked. As shown in <Table 4>, of the sample, most respondents expressed very little knowledge about mining on land, but more had some knowledge about deep ocean mining (although still minimal). There was slightly more familiarity with deep ocean mining from Okinawans than for the rest of Japan, which is as expected given that Okinawa is an area of particular interest for DSM.

<Table 4 here>

3.3. Alternate uses of the ocean

One of the primary concerns expected to be expressed, in particular from Okinawan locals, was over the potential for impacts on existing or priority uses of the ocean. The opinion of respondents with respect to the impact of DOM on fishing and tourism in particular were sought in this case, as these were notable uses of the ocean, particularly tourism in the case of Okinawa. As shown in <Table 3>, the fisheries sector is not among the most significant sectors for employment or GPDP, whereas tourism-related sectors of accommodation and various service sectors are highly important. Around 10% of non-Okinawan participants though, thought the fisheries sector was the most important sector for Okinawa now and in the future (<Table 2>), while most Okinawans recognized this as less important.

The participants were later asked whether they believed that DSM would have any impact on the ocean environment or the tourism industry (<Figure 1>). While around 12-15% of respondents replied that they didn't know or couldn't select a response, and 16-23% of respondents believed the impact would be “neutral”, the majority of respondents considered that there would be somewhat of an impact or a definite impact. The expectation of a negative impact on the ocean environment was overall stronger than the expectation of an impact on tourism.

<Figure 1 here>

Respondents were further asked whether they believed that the fisheries sector or DSM would have a higher impact on the environment. <Figure 2> shows that most respondents expect DSM to have a higher impact.

<Figure 2 here>

When asked whether DSM should be allowed under conditions that impact on the existing economic sectors, approximately two-thirds of respondents indicated that if DSM impacts on either fishing or tourism it should not be allowed. This was consistent across both groups. When cross-correlating these responses, it was shown that those who believed that fishing had the same or greater impact than DSM were typically more supportive of DSM being undertaken even if it has an impact on fishing (<Figure 3). On the other hand, for those who expected DSM to have greater impacts than fishing, the majority said that DSM should not be undertaken if it impacts on fishing (<Figure 4), as would be expected as confirmation of their expectations, but even those who expected fishing to be higher impact than DSM prioritized fishing in the case of a demonstrated impact on the sector from DSM (notably for the non-Okinawan group).

<Figure 3 here>

<Figure 4 here>

With regards to tourism, which is seen as a much more important sector, the respondents generally anticipated at least some impact on the sector from DSM (<Table 5). While there was no significant trend in the ratio of responses in the Okinawan group (there were generally more negative responses if an impact on tourism would occur), the non-Okinawan group responses were more against DSM with a stronger expected impact on tourism.

<Table 5 here>

3.4. Distribution of impacts and benefits

An ongoing concern with all extractive industries, the balance of local benefit and local impact for those most immediately affected by mining, compared with the regional or national benefit, is an important consideration. The location of impacts of DSM, notably with regards to the potential environmental impacts and cross-sectoral impacts on industries such as fishing and tourism, are highly relevant to stakeholder acceptance of an operation and its “social license to operate”. The present study was also interested in examining whether Japanese would be willing to have the negative impacts located in Okinawa, or whether they considered that other parts of Japan or other parts of the world would be more appropriate. Also, the economic benefits from mining, which could potentially be undertaken by non-Japanese companies, was interesting to examine as a balance to these negative impacts.

Firstly, with regards to the potential for DSM in various areas outside of Okinawa, the respondents were largely neutral, but the Okinawan group was overall more supportive of DSM in Japan’s EEZ than in other parts of the world, and slightly more supportive than the non-Okinawan group (<Figure 5).

<Figure 5 here>

Mining is not the only process needed to obtain useful metals from deep ocean ores. <Table 6 shows the responses with regards to where the various components required to support a DSM industry should be located. In general, there was more support for supply chain elements to be constructed in Okinawa from local Okinawans. Of the mentioned supply chain elements, there was less support for mineral processing facilities to be constructed or expanded in Okinawa, and more support for these to be elsewhere in Japan.

<Table 6 here>

As shown in <Table 7, both respondent groups considered that Okinawans should be the greatest recipients of the financial benefits of any DSM in Okinawa, with other Japanese citizens and the companies involved being the next-biggest recipients. Less than one third of respondents allocated any of the benefits to “anyone” and on average the percentage allocated was low.

<Table 7 here>

Specifically, given that many foreign companies are involved globally in efforts to mine the deep ocean, the respondents were asked whether non-Japanese companies were acceptable to undertake DSM in Okinawa. The responses in <Figure 6 indicate an overall preference for local, Japanese companies to undertake any DSM if it was to be undertaken in Okinawa. It was further identified (as shown in <Figure 7), that the respondents would prefer that most of the benefits of any potential DSM should be kept within Japan. 39% of non-Okinawans and 30% of Okinawans believed that all of the benefits (physical and financial) should be kept within Japan, but 39% and 35% respectively were supportive of jobs and employment incentives being taken by foreigners. The Okinawan group was overall more willing to accept the benefits flowing to foreign countries.

<Figure 6 here>

<Figure 7 here>

3.5. Deep ocean mining, terrestrial mining or other forms of resource security?

The relative importance of the environmental impact of terrestrial and deep-ocean mining as a factor in whether they would support DSM was tested using a series of questions. 32% of respondents maintained that DSM should not be undertaken regardless of whether it was more or less environmentally harmful than terrestrial mining. 19% of respondents believed the opposite - that DSM should be undertaken regardless of the comparative environmental impacts. 49% of respondents indicated that they would only support DSM if the impacts were lower than terrestrial mining. These results were mirrored in both groups (Okinawa and non-Okinawa). Due to the similarity of results, the two groups were combined for evaluation of this issue.

As shown in <Figure 8, opinion was slightly skewed towards DSM being expected to have a higher impact than terrestrial mining, but most respondents considered the impact likely to be similar.

<Figure 8 here>

In cross-correlation of whether they expected DSM to have a higher or lower impact than terrestrial mining with their preference for whether DSM should go ahead given a proven higher or lower impact, the responses are shown in <Table 8. Of those who gave a specific answer on the expected impact, it is clear that if the impact of DSM is proven to be higher, then it should not be undertaken (78.7% of responses), whereas if the impact is shown to be lower, the majority (70.7%) would accept DSM. In the group of respondents indicating that DSM should be

undertaken regardless of impacts, the main reasons given were that there would be economic benefits and that Japan's industry and economy required resources.

<Table 8 here>

As anticipated, respondents supportive of DSM regardless of the level of impact relative to land-based mining raised economic and resource security issues as important considerations outside of environmental concerns. These are real issues for a country like Japan that has minimal domestic resources of minerals (particularly). Therefore additional questions were used to evaluate the support for some of the main resource supply options – DSM, imports from overseas, recycling, reduction of the amount of material used, and R&D on alternative materials. The results of a multiple option question showed (<Figure 9) that recycling was the most preferred option, followed by research to find substitute materials, then DSM, while importing was the least preferred. DSM was significantly more preferred in Okinawa than in the rest of Japan.

<Figure 9 here>

The respondents were further asked to prioritise the alternatives (at least one selection was required), overall the trend shown in <Figure 9 is repeated in <Figure 10. On first preferences, recycling was slightly less preferred in Okinawa, while DSM (as the 3rd overall preference in Okinawa) was supported by a higher percentage of Okinawans than the second option (R&D) in areas other than Okinawa.

<Figure 10 here>

4. Discussion

One important challenge in the context of stakeholder engagement in Japan on mining generally, as well as the specific case of DSM, is the lack of familiarity with the sector, due to the relative absence of the industry domestically. The most prominent mines were closed between the 1960's and 1990's due to accidents and declining economic competitiveness, and only a few mines remain in operation. There have been historic issues with mining, such as Ashio Copper Mine that caused an environmental disaster in the late 19th century whereby effluent from the mine polluted water and land, damaged agriculture, and killed fish (HOSHINO, 1982; Huang *et al.*, 2018). Other pollution such as Itai-itai disease (due to cadmium poisoning), affected local people and industry around mines and smelters (Matsuo, 2003; Nogawa *et al.*, 2004; Suwazono *et al.*, 2019). These mining-related pollution issues are taught in schools, and such a legacy may influence stakeholders' opinions on mining generally. Deep ocean mining is an even more unfamiliar technology, dealing with an unfamiliar and hidden environment. This makes it difficult to draw out definitive preferences from general community stakeholders, particularly with only a small amount of background information provided. However, on the basis of the results presented above, it is possible to make some broad conclusions regarding the key themes that were the focus of this research:

1. acceptability and priority for deep sea mining in comparison to other industries and the environment;
2. how the benefits of deep sea mining should be distributed; and,
3. deep sea mining as a source of minerals for domestic industry as compared with importing, recycling and other strategies.

Each of these points is elaborated on in the subsequent sections.

4.1. Acceptability and Priority of Ocean Usage

With regards to the point of acceptability, this section draws on the results presented in section 3.3 primarily. Deep sea mining was generally considered to be unacceptable if it would impact on the existing industries – tourism and fishing (<Figure 4). This was strengthened in the case of fishing when respondents believed that DSM would indeed have more negative impact than fishing. However, there were still around 20-35% of the respondents who believed that DSM should be undertaken even though they believed that DSM had a greater impact than fishing and if it was proved that there would be an impact on fisheries (<Figure 3). This sub-set of respondents may anticipate greater economic and resource security benefits from DSM than from fishing, or see resource supply risks as a greater threat than potential decline in fishing output. In the case of tourism, which is considered to be highly important for Okinawa (and is in reality a very important economic sector), the stronger the expected impact of DSM on the sector, the less likely for there to be support for undertaking DSM (<Table 5) although the trend was more pronounced for those outside of Okinawa. This again reflects the importance of tourism as a sector. In current plans the site of mining is expected to be quite distant from the main islands and beaches of Okinawa, and given the depth of the mining it would be expected that direct impacts on the aspects that attract tourists to the area would be minimal. However, from the perspective of the proponents of deep sea mining, it would be important to ensure the mitigation of impacts on this sector and to communicate this effectively to the community, as they see this as an important sector of the economy both now and in the future.

One significant previous study into “social licence to operate” (SLO) in the Blue Economy found that the focus of stakeholders involved in the resource extraction sector of marine development considered issues such as the tangible economic, biodiversity, environmental pollution impacts and the intangible impacts associated with conflict between users as being some of the most relevant issues for obtaining this SLO (Voyer and van Leeuwen, 2019). It was also interesting that they did not see the local communities as being as relevant as other users / sectors and national/international level non-governmental organisations (NGOs), which could be supported by the respondents’ preference in the current study that other sectors should not be negatively impacted. On the other hand, in the case of New Zealand, it was indicated that the rejection of offshore iron ore mining was at least in part due to the lack of engagement with local and indigenous communities (Ellis *et al.*, 2017). In order to develop DSM in the Okinawa Trough, it would be anticipated that a strong case would need to be made to the local tourism and fishing sectors that any impacts would be minimal.

4.2. Distribution of benefits of DSM

Regarding the benefits of DSM and their distribution (reflecting the results of section 3.4), it was clear that most respondents would prefer that the economic and material benefits be retained locally in Japan, with the majority flowing to those most likely to be directly impacted (in Okinawa). This is fairly common in most extractive industries – for example, a study in Australia (Mason *et al.*, 2014) examining attitudes towards mining, indicated that the expectation of society was that the mining industry should:

“(1) Minimise environmental impacts, (2) support and look after local communities, (3) keep Australia’s economy strong (4) provide employment for Australians and look after workers, (5) leave something for future generations of Australians, and (6) maintain Australia’s international standing.”

Points 2, 3 and 4 reflect a similar opinion to the respondents in Japan. Other jurisdictions with potential DSM, such as New Zealand (Ellis *et al.*, 2017) and the Cook Islands (Wakefield and Myers, 2018) have indicated the need for consideration of both short and long term socio-economic benefits, and many stakeholders consider that if DSM resources are to be extracted, that there should be national and local benefit (Pettersen and Tawake, 2019). Transparency and equity in the distribution of revenues has also been highlighted as important for DSM and the Pacific Community (Ovesen *et al.*, 2018). While these are unsurprising as requirements for resource extraction, clarifying the methods and recipients for distribution of benefit is potentially complicated by the lack of clear claims to historical ownership or usage. Sovereign Wealth Funds are recommended as a method of distributing DSM

resource revenues (Ovesen *et al.*, 2018), but there would still be a need to clarify the extent to which Okinawans should benefit as opposed to Japanese in general. Particularly given Okinawa's history of occupation, by Japanese then the US, the extraction of resources for the benefit of non-Okinawans could potentially exacerbate or reignite resentment.

While Okinawa was the focus of this study due to recent pilot-scale mining and exploration projects, the non-Okinawan group was slightly more supportive of DSM in international waters than in the rest of Japan or other countries, but was most supportive of DSM in Okinawa (<Figure 5). On the other hand, Okinawans were most supportive of DSM in Okinawa or another part of Japan. These two tendencies would seem to indicate a more positive view of local production from those most likely to be in the area of influence of the new activity, in the sense that they found it most preferable to undertake DSM in Okinawa, but if not in Okinawa, then preferably somewhere else in Japan. This is more of a yes-in-my-backyard (YIMBY) (Williams, 2013) consideration of the opportunity prospective in resource extraction. Whereas there was a less positive view for those situated more remotely and less likely to be directly impacted - in Okinawa it may be acceptable, but otherwise it would be better to be outside Japan entirely. This not-in-my-backyard (NIMBY) attitude was somewhat reflected in the responses as to where the various parts of the supply chain could be built or expanded, though at a more local level (<Table 6). While DSM is likely (at least in early stages) to provide only a small amount of ore for processing – and therefore require minimal expansion of existing facilities or construction of new processing facilities – this would be another challenge to ensuring stakeholder support for the supply chain elements needed to ensure domestic mineral supply. In the Cook Islands case, it was indicated that some of the most relevant stakeholder groups would prefer that DSM happen in international waters, rather than in the Cook Islands EEZ (Pettersen and Tawake, 2019), but that if it were to happen in the EEZ, it should be under strict environmental controls. A previous evaluation has indicated that the actual benefit to the people of the nations undertaking DSM would not necessarily be guaranteed to be positive, dependent in part on the geological characteristics of the ore (metal content), the technology and the price of metals in the period of extraction (Wakefield and Myers, 2018). While the techno-economic evaluation of any given mineral extraction project would typically involve these types of estimates, the extension of this to demonstrate benefit to the community with a reasonable level of confidence is difficult given the uncertainty around a new industry.

In both the ultimate shaping of policy and regulatory frameworks for DSM, and decision-making on the final approval, it would be anticipated that the balance of local versus national benefit, and potentially even international benefits such as reduced emissions from metal production or the benefits of clean energy technology produced using metals from DSM would be brought into discussions. Such considerations would inevitably need to trade-off the local and global environmental implications of DSM (Motoori, B. McLellan and Tezuka, 2018) with the economic benefit.

4.3. DSM or alternative resourcing strategies

On the issue of whether DSM would be the most appropriate source of resources to maintain Japan's resource security, respondents had a clear preference for recycling over other forms of securing resources, while importing from other countries was the least preferable. There may be many background reasons for these responses, but it may be that recycling is a familiar environmental and resource-recovery practice in Japan (although most people would not be familiar with the process after collection of recyclables, it is common to have mandated municipal recycling) and there is a recognition that dependence on external sources of resources is a vulnerability to the economy, as indicated by the response to energy security threats from the oil shocks of the 1970's through to the more recent problems associated with nuclear shutdown (McLellan *et al.*, 2013). Notably in recent years there have been restrictions of rare earth exports by China (Barteková and Kemp, 2016), which have had relatively wide media exposure, thus potentially heightening awareness of the resource supply risk. In support of recycling may also be the well-known concept of "mottainai" – an expression meaning basically "what a waste", and expressing regret at a waste or loss of resources – that is also broadly known and socially-learned in Japan (Fujii, 2006).

The development of alternative substitute materials was considered the second most preferred option, again potentially reflective of a culture that promotes innovation in technology. DSM was a higher preference than reduction in use of materials, but this may also reflect an inadequate description and understanding by participants of material intensity.

It is important to note that the respondents were not given information on the current or likely potential of any of these techniques in providing or promoting resource security. It is apparent that recycling on its own cannot supply sufficient material in an economy that exports significant volumes of manufactured products and does not mine its own minerals (Motoori, B. McLellan and Tezuka, 2018). At the same time, the currently proposed Japan-based DSM mines are not able to provide more than a very small proportion of domestic mineral requirements. In either of these cases, either a dramatic reduction in material intensity over time, or a significant policy development to re-import end-of-life products potentially via some form of lease arrangement, would be required to increase mineral self-sufficiency over time. More likely, the large part of mineral requirements would continue to be imported as ore, concentrate and primary metal. At the scale of any single deep sea mine, it may be sufficient to consider local impacts and benefits (social, economic and environmental) in order to gain SLO, but if the current known reserves of metal available from DSM in the Okinawa Trough were put into perspective (up to only a few percent of current demand), respondents may reconsider support. Though this has not been specifically tested in this study, it would be an interesting and important issue for future study towards informed decision making. Moreover, if considered in the context of the international efforts on DSM, although it is possible that there is an enormous amount of available resource (Hein *et al.*, 2013) the cumulative impact of expanding the industry should also be considered.

4.4. Challenges and limitations

The current survey has a number of obvious limitations with regards to getting a detailed picture of the specific concerns of the community. Primarily, the number of questions and the use of multiple choice style questions rather than open, qualitative questions made it impossible to extract the specific underlying drivers for each individual in each issue of concern. The intention of the survey was as a first step in understanding some high level preferences rather than as a detailed evaluation. To get a deeper understanding it would be necessary to engage in interviews or other deliberative processes. This is particularly notable given the lack of certainty about DSM. Even the scientific consensus on many of the issues examined is still unclear – for example, the local environmental impacts of DSM have been widely examined but the circumstances and planning of an individual mining operation would be needed to clarify the extent of those impacts. Indeed, provision of sufficient information to ensure informed decisions was highlighted as one of the potential lessons that could be learnt for DSM from the Antarctic mineral resource convention (Kirkham, Gjerde and Wilson, 2020). Lifecycle assessments have been partially undertaken for DSM with respect to terrestrial mining (McLellan, 2015), but again the particular metal and the specific mining techniques need to be further investigated – particularly because there are no deep ocean mines in operation. Other aspects – particularly the importance of the environmental and health considerations – also need further investigation.

5. Conclusions

This study used a survey of Okinawans and residents of other parts of Japan to investigate the community preference for DSM. The major conclusions were that there was around 30-40% support for DSM under positive assumptions, whereas if there were expected impacts on fisheries or tourism sectors, then the support was lower. Respondents preferred that most of the benefits of mining flow to Okinawans and then to the remainder of the Japanese population, rather than flow offshore. With regards to minerals supply, they considered that recycling and innovation to find alternative technologies or materials were preferable options to DSM, but importing was highly undesirable. The conflicts and trade-offs between environmental, socio-economic and resource security issues were partially examined, but the survey indicates that more extensive examination of these issues is required. More sophisticated survey techniques would be useful to further this investigation, as well as in-depth interviews supplemented with institutional stakeholder surveys.

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FIGURE 11: RESPONSES TO “WOULD DEEP OCEAN MINING HAVE AN IMPACT ON TOURISM OR THE ENVIRONMENT?”

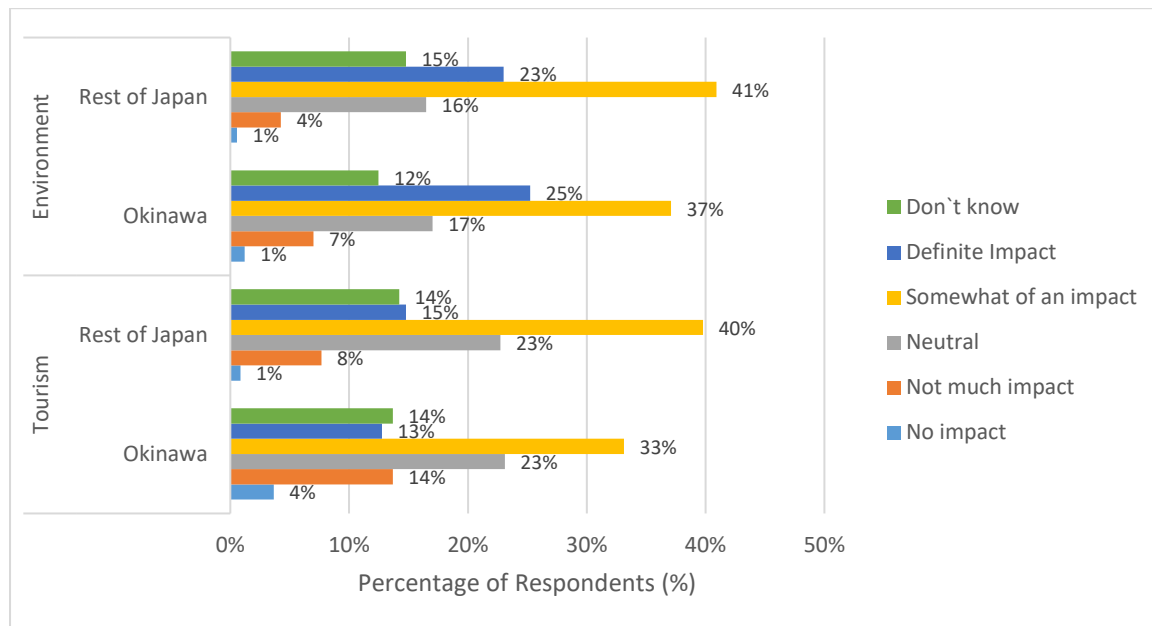


FIGURE 12: RESPONSES TO “WHICH INDUSTRY WOULD HAVE THE HIGHER ENVIRONMENTAL IMPACT?”

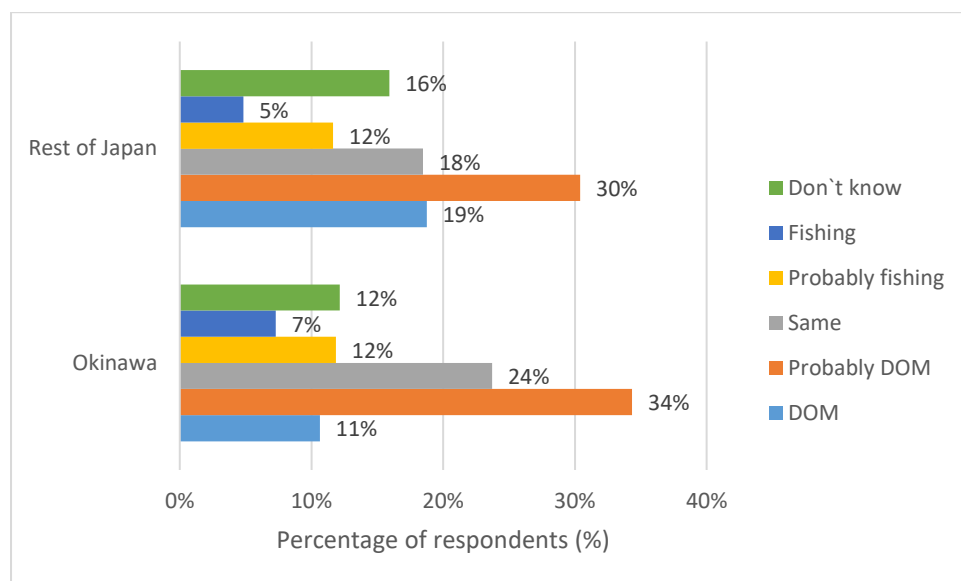


FIGURE 13: PERCENTAGE OF RESPONDENTS WHO BELIEVED THAT DOM SHOULD BE UNDERTAKEN EVEN IF IT HAS AN IMPACT ON FISHING OFF THOSE ANSWERING AT EACH LEVEL OF EXPECTED IMPACT

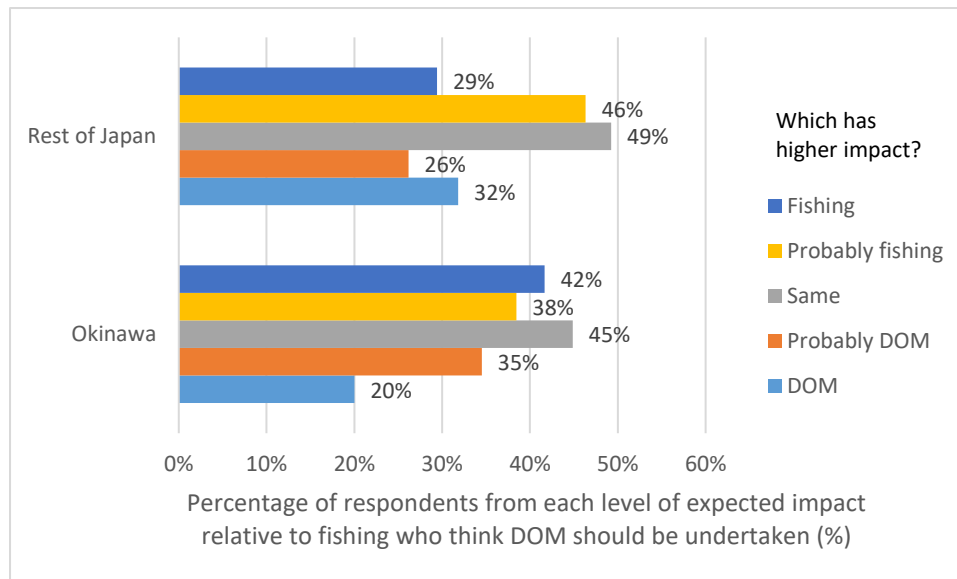


FIGURE 14: PERCENTAGE OF RESPONDENTS WHO BELIEVED THAT DOM SHOULD NOT BE UNDERTAKEN IF IT HAS AN IMPACT ON FISHING OFF THOSE ANSWERING AT EACH LEVEL OF EXPECTED IMPACT

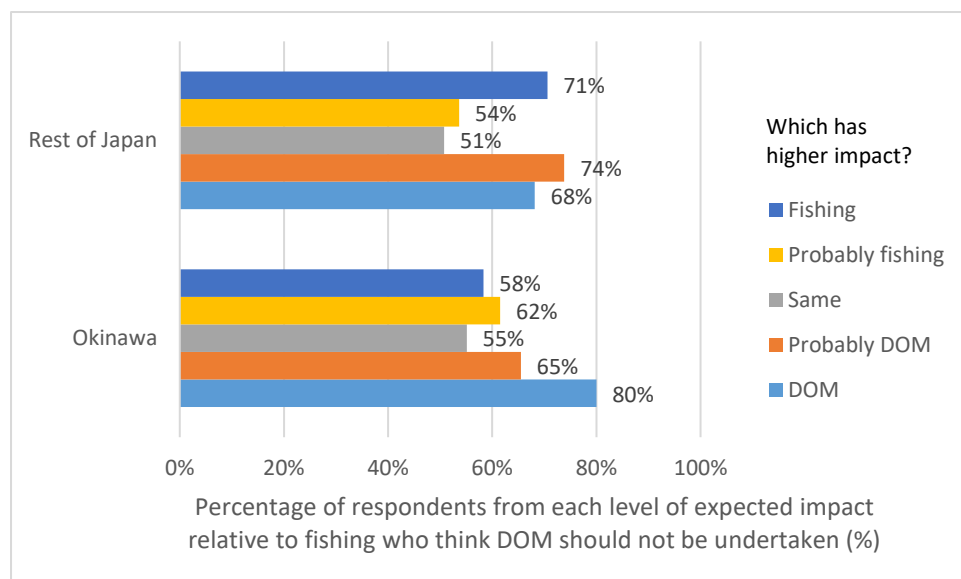


FIGURE 15: RESPONSES REGARDING THE PREFERENCE FOR DEEP OCEAN MINING IN ALTERNATIVE LOCATIONS

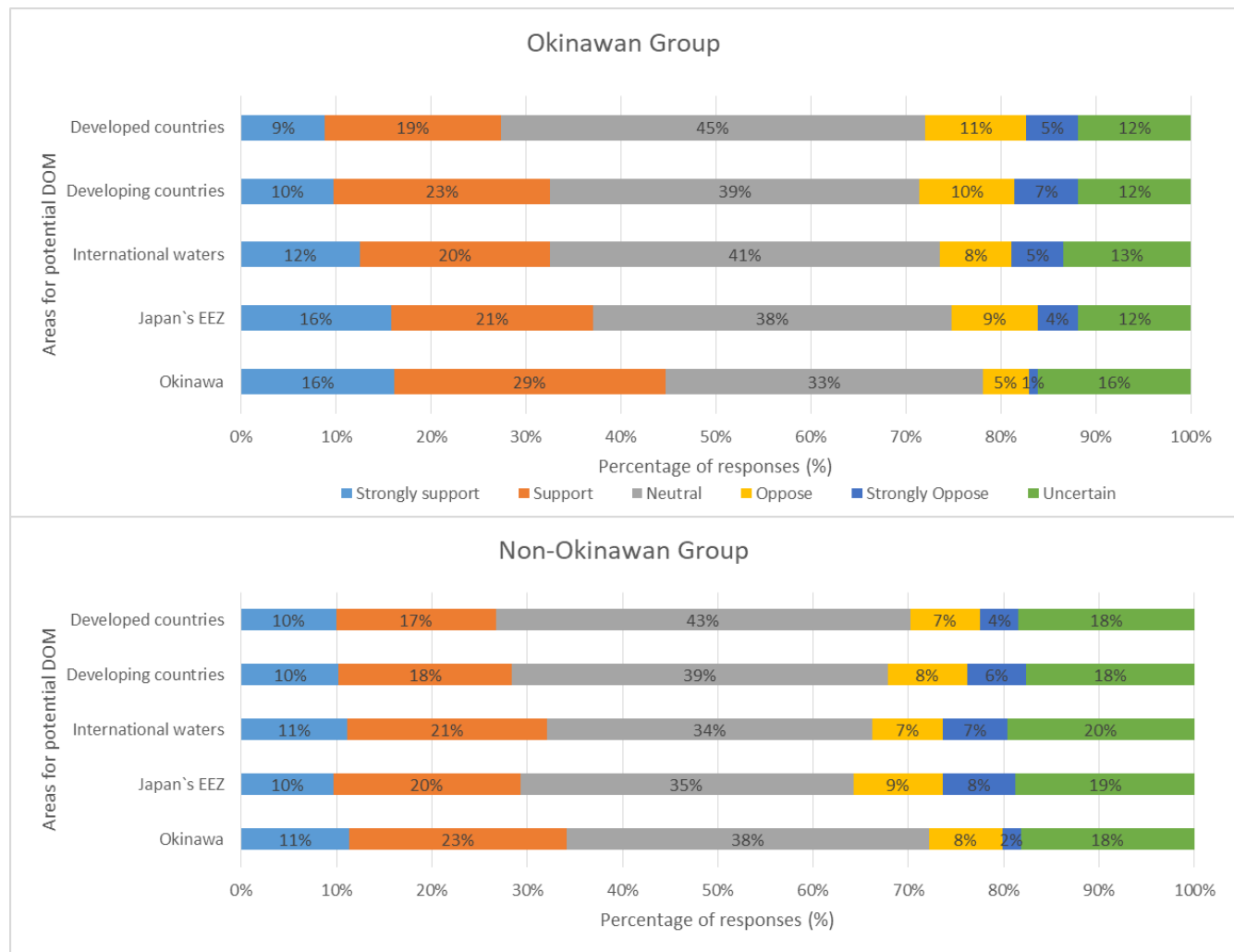


FIGURE 16: RESPONSES ON WHETHER IT WOULD IT BE ACCEPTABLE FOR FOREIGN COMPANIES TO UNDERTAKE DOM IN OKINAWA

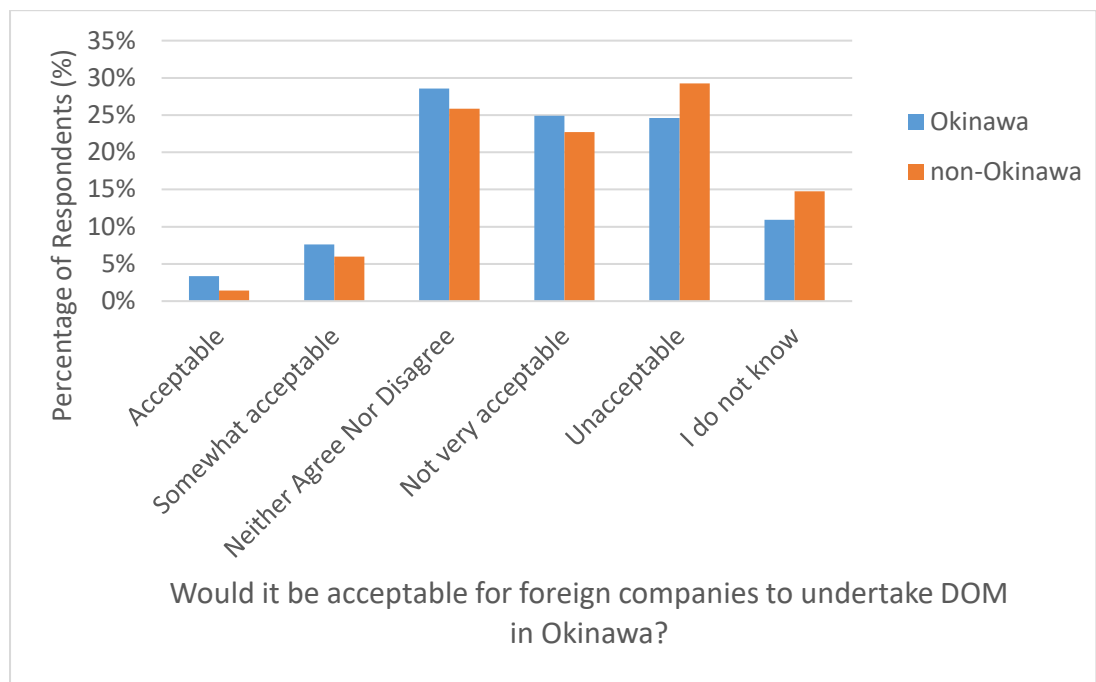


FIGURE 17: RESPONSES TO WHICH PRODUCTS OR BENEFITS COULD BE ALLOWED TO BE EXPORTED OR FLOW OUTSIDE JAPAN

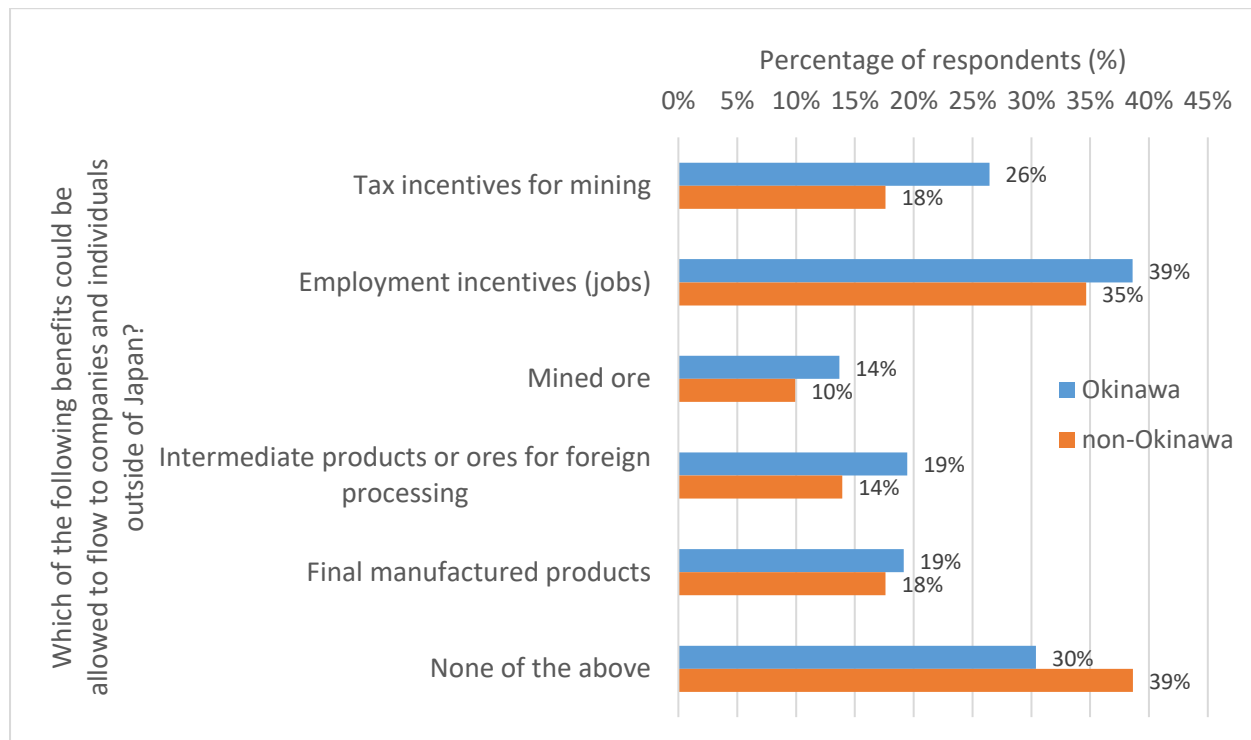


FIGURE 18: RESPONSES TO WHETHER DOM OR LAND-BASED MINING HAS THE HIGHER IMPACT (TOTAL SAMPLE)

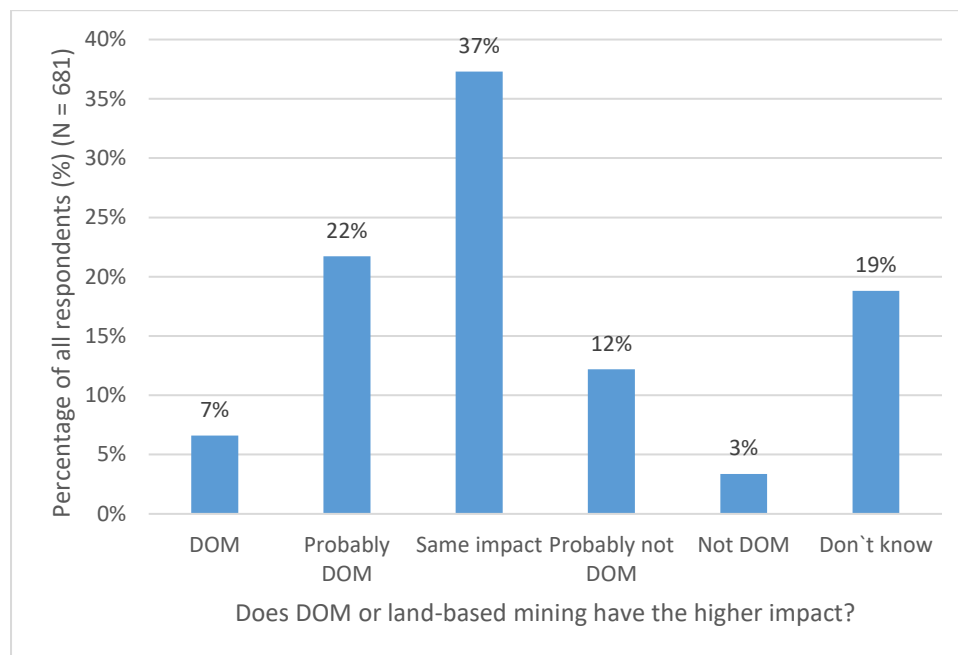


FIGURE 19: RESPONSES REGARDING PREFERRED SOURCES OF MINERALS FOR JAPAN

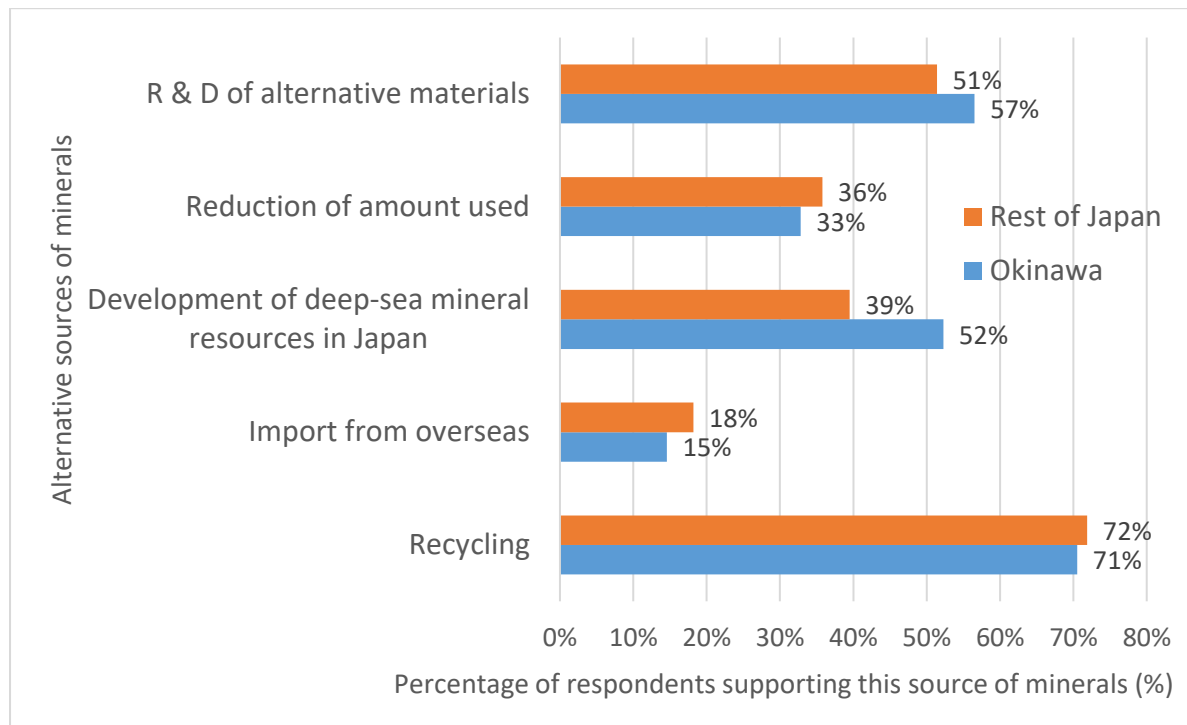


FIGURE 20: PREFERENCES FOR ALTERNATIVE SOURCES OF MINERAL SUPPLY FOR JAPAN

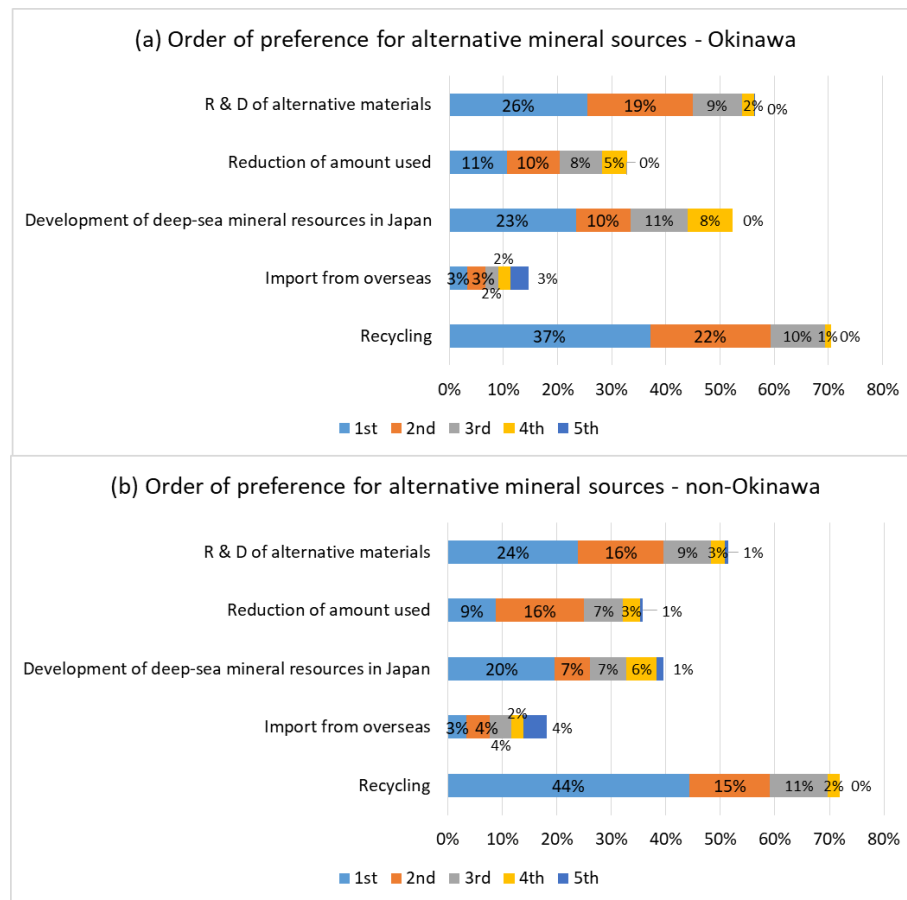


Table 1 Distribution of respondents by age band, gender and area

Age band (yrs)	Okinawa		Rest of Japan	
	Female	Male	Female	Male
15-29	34	30	32	35
30-39	35	39	37	37
40-49	33	35	35	31
50-59	32	34	33	43
60-84	24	33	35	34

TABLE 2: THE MOST IMPORTANT SECTOR FOR OKINAWA (NOW AND FUTURE) ACCORDING TO RESPONDENTS, BROKEN DOWN BY RESIDENCE

Sector	Okinawa		Rest of Japan	
	Now	Future	Now	Future
<i>Fisheries</i>	2%	2%	12%	10%
Agriculture · Forestry	4%	5%	1%	1%
Construction industry	2%	0%	0%	0%
Manufacturing industry	2%	2%	1%	2%
Information and communication industry	2%	4%	1%	3%
Transportation industry · Postal service	1%	1%	0%	1%
Wholesale / Retail	0%	0%	1%	0%
Academic research · professional · technical service	2%	5%	1%	3%
<i>Mining</i>	0%	0%	0%	0%
<i>Accommodation · Food service</i>	8%	8%	11%	10%
<i>Lifestyle related services / entertainment industry</i>	1%	1%	1%	2%
<i>Tourism</i>	64%	48%	65%	54%
Education and learning support industry	5%	9%	1%	1%
Medical / welfare	4%	9%	1%	6%
Service industry (not classified elsewhere)	2%	2%	2%	3%
Public service	2%	2%	2%	3%

TABLE 3: EMPLOYMENT AND GROSS PREFECTURAL DOMESTIC PRODUCT (GDP) FOR OKINAWA (Statistics of Japan, 2020)

Sector	Employment (% of employed persons)			GDP (sector as % of total)		
	2010	2015	Change	2010	2015	Change
Agriculture and forestry	4.5%	4.1%	-0.4%	1.6%	1.1%	-0.6%
<i>Fisheries</i>	0.5%	0.4%	0.0%	0.2%	0.2%	0.1%
<i>Mining and quarrying of stone and gravel</i>	0.04%	0.0%	0.0%	0.1%	0.1%	0.0%
Construction	9.2%	8.9%	-0.3%	8.3%	9.4%	1.1%
Manufacturing	4.8%	4.9%	0.1%	4.6%	5.0%	0.4%
Electricity, gas, heat supply and water	0.5%	0.5%	0.0%	3.4%	3.9%	0.5%
Information and communications	2.0%	2.2%	0.3%	4.9%	5.0%	0.1%
Transport and postal activities	4.9%	4.3%	-0.6%	5.7%	6.8%	1.1%
Wholesale and retail trade	14.9%	13.9%	-1.0%	10.1%	9.5%	-0.6%
Finance and insurance	1.9%	1.9%	-0.1%	4.2%	3.8%	-0.4%
Real estate and goods rental and leasing	1.9%	2.1%	0.2%	11.8%	10.8%	-1.0%
Scientific research, professional and technical services	2.8%	2.9%	0.1%	8.3%	9.3%	1.0%
<i>Accommodations, eating and drinking services</i>	8.1%	7.8%	-0.3%	4.3%	4.4%	0.1%
<i>Living-related and personal services and amusement</i>	4.1%	3.8%	-0.2%			
Education, learning support	5.2%	5.4%	0.2%	5.6%	5.5%	-0.1%
Medical, health care and welfare	12.1%	13.9%	1.8%	10.3%	10.3%	0.0%
<i>Compound services</i>	0.7%	0.9%	0.3%			
<i>Services, n.e.c.</i>	7.9%	8.2%	0.3%	6.1%	5.7%	-0.3%
Government, except elsewhere classified	5.4%	5.7%	0.3%	10.5%	9.4%	-1.2%
Industries unable to classify	8.7%	8.2%	-0.5%			

TABLE 4: FAMILIARITY OF THE RESPONDENTS WITH MINING

	Terrestrial Mining		Deep Ocean Mining	
	Okinawa	Non-Okinawa	Okinawa	Non-Okinawa
I do not know at all	73%	82%	44%	57%
I have heard about it	15%	12%	29%	28%
I know what it is like from news reports	10%	5%	22%	14%
I have studied a bit, so I know it to a certain extent	2%	0%	5%	1%
I am familiar with it because I work in it or am an expert	0%	1%	0%	0%

TABLE 5: RESPONSES REGARDING THE EXPECTED IMPACT ON TOURISM AND THE ACCEPTABILITY OF DOM

Expected impact of DOM on Tourism	If DOM impacts on Tourism, should it be done?							
	Okinawa				Non-Okinawa			
	Yes	No	Row Total	Ratio Yes/No	Yes	No	Row Total	Ratio Yes/No
No impact	1%	2%	4%	0.5	1%	0%	1%	2.0
Not much impact	8%	5%	14%	1.5	4%	3%	7%	1.4
Neutral	9%	14%	23%	0.7	12%	11%	22%	1.1
Somewhat of an impact	11%	22%	33%	0.5	17%	23%	40%	0.7
Definite Impact	5%	8%	13%	0.6	2%	12%	15%	0.2
Don't know	2%	11%	14%	0.2	4%	11%	15%	0.4
	36%	64%		0.6	40%	60%		0.7

TABLE 6: APPROPRIATE PLACES FOR SUPPLY CHAIN COMPONENTS FOR EXPLOITATION OF DOM ORE

	Would you support the following supply chain components for DOM in the following areas? (by groups – Okinawa or Rest-of-Japan, ROJ)							
Supply chain components	Okinawa		The area you live in		Other places in Japan		None of these places	
	Okinawa	ROJ	Okinawa	ROJ	Okinawa	ROJ	Okinawa	ROJ
Construction of a new mineral processing facilities	62%	49%	9%	10%	25%	25%	16%	31%
Expansion of existing mineral processing facilities	55%	46%	9%	10%	33%	29%	18%	32%
Construction of new accommodation facilities for mining workers	67%	58%	9%	10%	23%	22%	14%	26%
Construction of a new port for mining	64%	55%	8%	9%	25%	22%	16%	28%
Existing port expansion	65%	56%	9%	12%	26%	24%	16%	28%

TABLE 7: WHO SHOULD OBTAIN THE FINANCIAL BENEFIT OF DOM IN OKINAWA?

Recipients of financial benefit	Average percentage of financial benefits (%) (by respondent group)	
	Okinawans	Rest of Japan
Residents of Okinawa Prefecture	50.9	48.5
Japanese citizens other than Okinawans	20.4	21.0
Non-Okinawan and foreign companies and individuals who developed the mine	22.3	19.5
Anyone	6.5	11.0

TABLE 8: CROSS-CORRELATION OF PREFERENCES ON TERRESTRIAL OR DOM VERSUS EXPECTED IMPACT (“DON`T KNOW” RESPONSES REMOVED)

Which has the higher impact, DOM or land-based mining?	If DOM has a lower impact than land-based mining, should we do DOM?				If DOM has a higher impact than land-based mining, should we do DOM?			
	Yes	No	Yes	No	Yes	No	Yes	No
DOM	29	16	5.2%	2.9%	8	37	1.4%	6.7%
Probably DOM	106	42	19.2%	7.6%	27	121	4.9%	21.9%
Same impact	177	77	32.0%	13.9%	56	198	10.1%	35.8%
Probably land-based mining	61	22	11.0%	4.0%	21	62	3.8%	11.2%
Land-based mining	18	5	3.3%	0.9%	6	17	1.1%	3.1%
(N=533)	391	162	70.7%	29.3%	118	435	21.3%	78.7%