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研究課題名（和文）気候変動における漁業や漁村社会の適応力向上対策づくり

研究課題名（英文）Building adaptive policy in fisheries and fisher communities in face of climate change challenges

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研究成果の概要（和文）：地域環境に特化した気候変動適応策には、社会文化的な背景を考慮することが不可欠である。漁業における女性、性と気候変動というテーマは未発達の研究分野であるため、海女漁を事例に、小規模漁業コミュニティーにおける適応策を探索した。2012～15年まで現地調査を行った結果、３つの適応能力（限られた空間における資源の有限性の認識、海を体感することで得られるフィードバック能力、「海女」という性的・文化的なアイデンティティーの所有）を確認した。多くの適応能力は、「漁業者の生態学的知識(FEK)」と関連している。FEKは過小評価されがちだが、政策議論に組み込めば、総体的なアプローチによる資源管理を促すだろう。

研究成果の概要（英文）：Effective climate change adaptation policy will need to be place-and context-specific, and builds on social-cultural contexts. Exploring potential adaptation policies for small-scale fishing communities through a study of ama divers is an aim of this report. 3 adaptive capacity potentials that could contribute to policy for small-scale fishers include: space-defined perceptions of resource availability, proximity to and level of connection with the ocean, and gender and cultural identity as leverages in resource management. Much of the adaptation potentials are linked to the unique sets of fisher ecological knowledge (FEK) the ama divers possess and could complement scientific knowledge towards holistic adaptive policy.

研究分野：環境創成学

キーワード：海女さん　入り会い　適応策　気候変動　漁業権　適応力

１．研究開始当初の背景

Scientific evidence of global warming is unequivocal: a failure to take action will result in aggregate costs for future generations. Adverse impacts on oceans will reduce food security and affect people's lives. Small-scale fishing communities are highly vulnerable to adverse climate change impacts. Governments urgently need to build the capacity of these fishing communities by developing new policies to close existing gaps. Inaction is projected to increase vulnerability. The cost of inaction will be far greater than socio-economic and environmental costs of taking action. Increased global environmental challenges have highlighted the need to apply a locally-relevant, holistic approach to reverse the negative trends of resource degradation connected to adverse climate change impacts and biodiversity loss. Such an approach should focus on and build from human societies' relationships with nature.

Over the past century, average sea surface temperature for Japan has increased by +1.07, roughly double the global average rise of +.51. This study focuses on the Japan Sea region, the area with the largest increase.

２．研究の目的

This project investigates the *ama* by applying two complementary fields of research: Fisher Ecological Knowledge and women in fisheries. Fisher Ecological Knowledge (FEK) asserts that knowledge sets of fishers, particularly those involved in artisanal and small-scale coastal fisheries, is an accumulatively developed knowledge, based on experience, observation and often involves multigenerational cultural transmission. FEK constitutes knowledge sets that complement scientific knowledge. Furthermore, it has been shown to can improve decision-making when integrated into the policy lifecycle. Finally, it provides practical information that may be used in resource management.

The study of women in fisheries is an evolving area of research that highlights the important role of gender in climate change. In particular, it emphasizes the distinctive yet widely overlooked contributions of women to resource management and environmental-related policy. Several factors help explain the absence of women in fishery policy and related research. These include national policy agendas that tend to focus on large-scale, often male-dominated capture fisheries. Such agendas marginalize the small-scale fisheries in which women are more active, which results in under-representation of small-scale fisheries in fisheries catch. Further, there is little desegregation of fisheries data in food production and resource management-related policy. All of this contributes to limited gender-specific data on fishing activities and missing numbers for women.

The broad objective of this report is to explore potential adaptation policies for small-scale fishing communities through the study of the environmental and climate change-related observations and experiences of female *ama* divers in Ishikawa prefecture. It addresses questions around resource use, management, adaptation activities and policy. The research aims of this research project are as follows: i) explore environmental and fishery policy and managerial tools (i.e. fishing practices, stock replenishment activities, self-imposed voluntary no-take zoning) that will increase flexibility, adaptability and resilience in the face of climate change; ii) gain new perspectives on gender relevance and cultural identity when considering resource management approaches and integrative policy potentials; and iii) consider inter-linkages of culture, nature views, environmental awareness and resource management practices with climate change adaptation policies and biodiversity management policies in small-scale fisheries.

３．研究の方法

This research employs an ethnographic approach to explore the FEK of *ama* divers belonging to the Amamachi Fisher Association in Wajima, Ishikawa prefecture. Informal scoping was begun in June 2008 for research related to fisher ecological knowledge (FEK) of small-scale fishers in Japan and climate change-related policy potentials in Noto peninsula. Formal discussions were initiated in the summer of 2011 to obtain prior informed consent. Discussions included research rationale and aims with community leaders in Wajima. Permission was granted by the Amamachi Fisher Association leader in spring 2012. Despite leadership changes, the Amamachi Fisher Association and JF Wajima Fisher Cooperative provided critical continued support that enabled interviews of 167 *ama* divers at least once, and 30 *ama* divers seasonally between the summer of 2012 and 2015.

Utilizing snowballing techniques, formal interviewing commenced on Hegura Island during the summer harvesting season of 2012. Interviews began with simple background questions, advancing to a 6-page questionnaire. The questionnaire asked about harvesting seasons, fishing gear, harvesting grounds, resource management practices, and seasonal observations of the marine environment. Structured interviews were conducted in the summer of 2012 on Hegura Island. However, due to limited results, a modified interview approach was applied from 2013 to employ semi-structured interviews and triangulation. Semi-structured interviews were

better suited to the communication styles/norms and culture of the *ama* divers, thereby providing more accurate insight into their perceptions, ocean views and knowledge sets. Knowledge sets are built through oral transmission, experiential learning and/or observation. The less structured approach allowed for flexibility in the place, mode, atmosphere and rhythm of interviews. Interviews were conducted throughout the four seasons and multiple venues. Locations were highly varied: on the boat en route to fishing grounds, in the ocean observing the *ama* divers as they dove for 4hours/day in the summer season, at port, on porches, sharing tea, or in other places and times that provided a more relaxed atmosphere for the *ama* divers.

More informal semi-structured interviews allowed interviewees time to reflect on their answers and to share experiences and insights. This compared favorably to the formal written questionnaire, since written answers consisting of a single sentence, word or blank tended to result in a no answer/don't know response. The results of interviews were translated into English and used as the basis of this qualitative study. Any mistakes in reporting are thus the sole responsibility of this researcher.

４．研究成果

Field Site Study: Ama FEK, resource management and perceptions of a changing ocean.

The remote islands of Hegura, Nanatsujima, and Yomeguri lie off the coast of Noto Peninsula. Since 1649, these islands have been the designated harvesting grounds of *ama* divers of Amamachi, Wajima City. The area is the northernmost habitat for the hermatypic stony coral colony. Its location at the intersection of warm and cold ocean currents contributes to the climatic and marine biodiversity of the area and makes it culturally and ecologically unique.

Ama divers then and now: technological innovation, socio-economic changes and trade-off discussions about ecological costs and benefits.

The human use of nature can be compared with the way people adopt and apply technological innovation. Short-term socio-economic benefits are often prioritized over longer-term environmental degradation costs. For the *ama* divers, technological innovation of fishing boats, engines, gear and fishing port development in post-WWII years resulted in changes both to their harvesting activities and to male-female relationships in the diver community. Other technological changes in both land and see transportation, along with boat engine technology and the introduction of wetsuits have also imposed both spatial and temporal influences on harvesting activities and seasonal migration traditions.

The introduction of the wetsuit had significant impact. For example, the wetsuit has enabled year- round harvesting activities. From November to December, sea cucumber is harvested in the rented fishing grounds of coastal waters around Wajima. When sea conditions permit, *iwanori* seaweed is harvested on the rocky shores of Nanatsujima and Hegura Island from January to March. From April to June, *ama* drive 2 hours from Wajima to Kanazawa port to harvest rock oyster and *wakame* seaweed. Some elders migrate early to Hegura Island to harvest seaweed in May and June. And from July to the end of September, all *ama* divers harvest abalone, turban shell and *mozuku* seaweed in the traditional harvesting grounds of Hegura, Nanatsujima and Yomeguri Islands.

Technology relating to harvesting activities has not been adopted indiscriminately. Instead, it has followed trade-off discussions. Debates over eye gear and the potential costs of increased visibility leading to overharvesting have been debated as far back as the 1880s. Similar debates were conducted in the 1960s about wetsuit adoption and resource depletion potentials. These discussions have been by elderly *ama* in late their 70s and 80s. In one case, a 3-year-long debate in the early 1970s over whether or not to adopt scuba technology ended in a collective rejection. Potential risks to resource sustainability and cultural identity were given as reasons by a broad range of interviewees, ranging from a 17 year old deciding on whether or not to become an *ama*, to an 82 year old pondering the number of years her body might hold up in the future. In fact, all 167 *ama* interviewed said they had rejected scuba technology. Many commented that adopting scuba technology would risk over-harvesting and jeopardize their identity as professional free divers who rely on natural physical abilities in order to hand-harvest marine resources.

Ama diver FEK as the foundations of adaptive capacity: carrying on the traditions of resource management.

Self-initiative in resource management activities is key to dynamic adaptation capacities. The *ama* community has a long history of community-based management in which women and men work together as one collective community. Voluntary no-take zones on Hegura Island have been implemented since the 19th century and continue today. Punitive incentives such as fines appear to be less effective than fear of ostracism. Designated as a national park in 1968 and currently uninhabited, Nanatsujima no longer has NTZs. Over 50% of *ama* divers interviewed believe that NTZs need to be re-introduced to Nanatsujima. Many have voiced

concern about potential illegal harvesting at night time by non-*ama* divers using scuba technology in the Nanatsujima waters. On Hegura Island, rotation of NTZs has been based on community discussions. However, some assert the need to design scientifically-sound NTZs due to the ocean changing in ways not well understood using existing knowledge sets.

Seedling release activities have been carried out in parallel with NTZ implementation. Numbers recorded for these activities differ between Fisheries Division of the Ishikawa prefectural government, the JF Wajima and the Amamachi Fisher Association. Despite questions around the data, there is no question that this activity has been underway for a century. The current challenge lies in increased seedling costs due to socio-economic changes. Although monies for seedling purchase are in part paid for by *ama* diver annual harvesting fees, they rely on financial subsidies by the government to purchase. Scientists have been consulted by male community representatives on seedling size, the timing of release and success rates. This has led to increasing the size of turban shell seedlings and shifting from autumn to spring release.

Ocean views and shifting baseline syndrome: ama diver observations and experience-based perceptions of the marine environment.
Observations by *ama* divers provide important data about ecosystem changes. All those interviewed unanimously cited changes in the ocean. Interviewees all reported rising ocean temperature in the summer months to a greater degree than seen during the winter. Timelines and details of perceived changes differed among *ama*, particularly between age groups, reflecting what Pauly described as shifting baseline syndrome. Elder *ama*, such as those above age 60, talked of the layers of temperature differences at different depths disappearing and with that changes in marine life. Younger *ama* below 35 years of age reported noticing warming of the ocean over the past 5-6 years, but had limited confidence and reported fewer details.

Rising temperature observations are linked to changes in seaweed and the perception that this has had an impact on declining abalone stocks. All interviewees commented on declining *kajime* seaweed, often referred to by *ama* divers as 'the cradle of abalone.' *Ama* above 60 years of age reported that some 30 years ago, *kajime* seaweed grew like a thick deep forest, giving shelter and nutrients to abalone. Today, however, the ocean has lost the vivid greens of healthy seaweed beds and has now given way to a white-desert like seascape populated by seaweeds. As with rising temperatures, the perceived changes in seaweed are stronger among *ama* above 60 years and also among *ama* divers in their 40s and 50s. Divers in these categories are known for their skill in diving up to 25 meters for abalone. Younger and/or more inexperienced divers said they believed in such changes, but added in interviews that much of their knowledge and perceptions stems from reports by older more experienced *ama* divers rather than from personal observation.

Wetsuit data was also used to gauge changing temperatures. To cross-check perceptions about rising temperatures in the summer and fewer changes in the winter months, *ama* divers were asked about wetsuit thickness. Questions focused on the thickness of the first wetsuit purchased, when they bought it, and the thickness of their current wetsuit. Data had to be weighed carefully, since *ama*'s individual body mass index results in varying wetsuit thicknesses selected to suit their BMI and personal preferences for buoyancy and warmth when diving. 10 *ama* interviewed said that summer diving over the last 2-3 years has become so warm that they have given up wearing wetsuit pants in favor of thinner nylon sport tights. Another 5 *ama* divers said that they have moved to thinner wetsuits, from 5 mm to 2mm. Winter wetsuit thickness of 7mm for many has remained unchanged. An increase in wave heights and strong currents impeding harvesting activities was also noted by all interviewed who harvest and/or fish with their husbands in the winter months.

Using science to assess ecosystem-based management approaches in the face of climate change.
In recent years, community awareness of degrading seaweed beds and concern over how this may be causing a decline in abalone and turban shell stocks has led to discussions with scientists and government officials. Although chiefly preliminary in nature, government-funded steps toward seaweed bed rehabilitation have begun, first in the coastal waters of Wajima, last year at Nanatsujima Island, and will soon start in Hegura Island waters as well. Some elder *ama* interviewed voiced concern over government and scientific support being too late to reverse the degradation in the ocean. By contrast, younger *ama*, particularly those in their 40s, believe there is hope for change.

IPCC AR5 identified that managing future challenges of climate change and building resilience will be dependent on adaptation that is (a) place-and context-specific; (b) that builds on societal values and risk perceptions; and (c) that is cognizant of diverse circumstances, interests and social-cultural contexts. These dependencies may either benefit or hinder the decision-making processes. This report posits that understanding local communities, identifying their existing knowledge sets, such as *ama* diver FEK, as a

means of assessing adaptive capacity potentials and limitations could contribute to more effective management and lead to more integrative, holistic approaches to adaptation policy.

*Adaptive capacity potentials viewed through the lens of ama divers***.** The following are 3 adaptive capacity potentials identified in this study which could contribute to policy discussions:

1) *Space-defined perceptions of resource availability*: Resource use and management behaviors are often driven by resource availability perceptions. Fisheries, particularly large-scale commercial capture fisheries, is an example of perception driven resource over-use and mismanagement. 90% of *ama* divers interviewed view marine resources as limited, and availability as defined by the space/area of their hereditary fishing grounds.
2) *Proximity to and level of connection with the ocean*: When harvesting, *ama* divers are in constant physical contact with the ocean, directly experiencing and observing the marine environment. This allows them to absorb information and can build up FEK on marine ecosystems, the resources they harvest, and the interconnectedness of marine life in ways that sets them apart from the majority of fishers whose observation are limited to above the sea surface. Such data could be useful to scientists and resource managers in monitoring and ecosystem-based management
3) *Gender and cultural identity as levers in resource management*: Trade-off discussions exploring short- and long-term socio-economic benefits are a crosscurrent of technological adoption debates. When asked why scuba technology was rejected in the 1970s and still prohibited within fishing grounds, all *ama* interviewed cited cultural identity and gender as important determinants. A key question is how this experience could be up-scaled and mainstreamed to a form of community-based management that facilitates trade-off discussions prior to the adoption of new technologies. These in turn could potentially contribute to sustainable resource use and biodiversity conservation. Additionally, 70% of interviewees cited their hereditary cultural responsibility to carry on the traditions of their ancestors, and to ensure that the ecological health and sustainability of fishing grounds were passed on to the next generation of women.

Adaptation activities: ama diver perceptions. Although adaptation is often regarded as context-specific, evidence from FAO on fisheries and climate change has identified 17 common adaptation activities that can be applied in most fisheries (Shelton, 2014). *Ama* diver interviewees confirmed applying 11 out of the 17 identified by FAO. As described below, 4 of the 11 discussed were perceived as activities in place and effective, 3 were perceived as activities with limited efficacy, and the remaining 4 were considered non-existent though necessary, but beyond the capacities of the community to initiate.

Effective/functional adaptation activities

1) *Learning from the past:* 90% of those interviewed believe that to some degree much can be learned from the past. The remaining 10% were younger *ama* divers, those below mid-30s, whose inexperience perhaps led to a non-committed answer of 'not sure'. Among those above 70 years of age, concerns expressed about marine based knowledge sets passed down from the past. Lack of confidence in the relevance and therefore reliability of marine based knowledge sets related to marine environment of their fishing grounds.
2) Reduce external stressors on natural systems: Trade-off discussions are frequently conducted around adopting new technologies and deciding now to avoid destructive fishing practices. Land-based run-off such as household sewerage are also discussed. However, there seems to be a higher degree of awareness and concern related to human activities within the marine environment that may act as external stressors.
3) Identify and protect valuable areas: Linked to past knowledge transmission, eco-mapping based interviews elicited that activities such as no-take zones (NTZ), monitoring and seedling release have been conducted since the late-19th century. These show continuous, long-running concerns with increased uncertainty about the changing marine environment, the need for scientific guidance on ecological-relevance, and the efficacy of seedling release and NTZ designation.
4) Identification of useful information: *Ama* divers do not work autonomously, independent of men. They are partners. Male-female relations and commitment to the collective whole are strong, contributing to social capital. Collection of information to ensure continued viability of community is of great importance. Men are more active in the public sphere than women and thus have access to more information.

Adaptation activities with limited efficacy

1) Promote disaster risk management: There is concern over the impact of 'hard options' such as seawalls, believed to potentially change ocean currents and degrade harvesting grounds.
2) Recognition of opportunities: Though

abalone is the marine product that defines them and their cultural identity, *ama* divers exhibit an ability to exploit different marine species, in part facilitated by adoption of wetsuit technology. For example, this allows *ama* to harvest all year round, including sea cucumber in winter months and rock oyster in spring. It allows value-added activities such as providing salted fresh *wakame* seaweed to meet consumer demands and exhibits ability to explore new opportunities.

3) Monitoring: 80% of *ama* divers interviewed talked of monitoring needs beyond their capacity, the gaps between their FEK and what scientists may/may now know and the need to integrate scientific knowledge sets with theirs. Interaction and feedback are limited. Many *ama* interviewed believe this is linked to limited financial and human resources of local research stations and also that local government officials do not often see their role as facilitator of interacttions between *ama* divers and scientists.

Non-existent adaptation activities/in need of

1) Capacity building: 50% of *ama* interviewed believe capacities to understand climate change impacts on their harvesting grounds (the science behind their observations) are needed and that multi-stakeholder partnerships are critical for climate change adaptation planning; and
2) International trade: Decreasing prices of marine products compounded by inability to compete with cheaper aquaculture marine products from overseas has led to discussions regarding eco-labelling to create value-added products that are globally competitive and maintain diving traditions in a sustainable way.
3) Policy and management considerations: *Ama* divers have a long tradition of seasonal migration and thus may have the capacity to adapt to projected poleward shifts in marine species. However, concern voiced among some *ama* divers that changes in all fisheries may result in socio-economic changes for many fisher communities, meaning that comprehensive policies that address the socio-economic impacts from changing fisheries will be needed.
4) Mainstreaming: Many *ama* divers interviewed see fisheries as marginalized from mainstream policy in Japan and often on the fringe of food policy and environmental discussions. Integrating small-scale fisheries into climate change adaptation and food security policies at both the local and national level is seen as the key to reducing vulnerabilities and enhancing socio-economic, cultural and environmental viability of their and other fisher communities in the face of climate change.

５．主な発表論文等

〔雑誌論文〕（計 1 件）

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６．研究組織

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