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Fishery Management Assessment Tool for Developing Country (FishMAT)

Hiroaki TERASHIMA[†], Ron ISHITANI[*] and Shinichiro KAKUMA[**]

(IC Net Ltd／*Marino-Forum 21／**Okinawa Deep Seawater Research Center)

E-mail : terashima@icnet.co.jp／ishitani@mf21.or.jp／

kakumsh@pref.okinawa.lg.jp

【abstract】

Fisheries are important means for regular income source for low-income populations in developing countries. Many fishery resources however have been in decline with uncontrolled exploitation. In this circumstance, international cooperation for fishery resource management is therefore indispensable especially in developing countries. One of the first steps for effective cooperation would be to obtain a holistic view of the current status of fishery management in the target country. In this study, we aimed to develop a tool to understand present status of fishery management according to the local and fishery characteristics. The Fishery Management Assessment Tool for Developing Country (FishMAT) was then compiled by revising and combining the resource management tool box and MCS code. After preparing FishMAT, we attempted to apply it in six target countries to estimate the efficacy of it. FishMAT seems useful as quick and easy assessment tool for fishery management in target countries though further study would be needed for its quality improvement.

1. Introduction

In many countries, coastal regions are some of the most populated areas. Also a large share of the world's marine fish harvest is caught or reared in coastal waters (Rosen (2001)). JICA (2010) has defined fishery sector with following four characteristics, viz. 1) fishery resource naturally maintains self-sustaining reproductive capability, 2) fishery resource is mobile and it is difficult to claim possession of it, 3) it is difficult to predict fluctuation of fishery resource state and fish catch amount, and 4) quality of fishery product easily deteriorates at normal temperature. Garcia and Rosenberg (2010) also concluded that the fisheries would be important means for regular income source to

stabilize livelihood for developing countries, especially for their low-income populations. However, in recent years, many fishery resources have been in serious decline with uncontrolled increase of exploitation, especially in developing countries (FAO (2005)). Consequently, it should be indispensable to advance fishery resource management in the developing countries. With these circumstances, Japan has been providing grant aid of fisheries-related facilities and a considerable amount of technical cooperation for promotion and management of the fisheries in the developing countries as a part of the Official Developing Aid (Japanese Fisheries Agency (2014a)). Japanese aid activities regarding fishery sector have ranged over wide area such as fishing technique, resource management, distribution channels, processing, aquaculture, environmental conservation, administration for fisheries, and development of fishing villages (JICA (2010)). However, fishery management measures to prevent overfishing are still insufficient in many regions, especially in many developing countries, where fishery resources, considered as common properties, have been overexploited (e.g. FAO (1996), FAO (1997), Hilborn *et al.* (2003), Hilborn and Hilborn (2012)).

One of issues for effective cooperation on fishery resource management would be to obtain a comprehensive view of the current status of fishery management in the target country in easy and convenient way. In Japan, the concept of resource management tool box has been developed (Fisheries Research Agency (2009), Makino *et al.* (2011), and Makino (2013)). In these studies, they classified important measures of the fishery management in eight categories, and listed beneficial measures to solve the matters in each category. The tool box would facilitate an understanding of the present fishery status of developing countries appropriately. However the categories and measures were specifically drawn up for understanding Japanese status. Therefore, we need to modify the tool box for application in developing countries.

We aimed to develop a tool to understand present status of fishery management according to the local and fishery characteristics; to promote the adequate resource management measures; and to contribute to the healthy development of local fisheries in the developing countries. We then compiled the tool named Fishery Management Assessment Tool for Developing Country (FishMAT) by revising and combining the resource management tool box and MCS code. After preparing FishMAT, we attempted to apply it for understanding the present status of fishery resource management in six target countries.

2. Methods

Fishery Management Assessment Tool for Developing Country (FishMAT)

To understand present statuses and issues of fishery management in developing countries, we drew up FishMAT as Table 1 and 2 by integrating the "Resource Management Toolbox" (Fisheries Research Agency (2009), Makino (2013)) and the "MCS code" (FAO (1994)). The details of FishMAT are as follows.

Table 1 FishMAT: 1/2

Country/Area/fishing :   date of the entry :
Entry Method : joint assessment by consultant and local counterparts   Person of entry : Authors

Categories		Factor	Weight [1]	MCSA Code[2]	Score	Remarks
I) I) Basic information of current situation		1. Information on the number of fishing vessel and local fishers	2	M		
		2. Information on the number of days of fishing operation	1	M		
		3. Information on the catch amount of principal species	2	M		
		4. Information on the distribution amount of principal species	1	M		
		5. Price data on landing and retail site for principal species	1	M		
		6. Information on the facilities of landing site such as number of ice-making machines and storage	1	M		
		7. Information on the domestic consumption of principal species	1	M		
		8. Information of the number of middle-persons in active	1	M		
		9. Information of fisheries cooperatives in active	2	M		
		10. Information of resource management activities in local fishers	3	M		
		Score	15			%
II) Maintenance/ Rehabilitation of the Ecosystem	On Land	1. Regulations on inflow/outflow sediment including sands/soil mining	2	C		
		2. Regulations on sewage and industrial effluent water	1	C		
		3. Regulations on deforestation including mangrove	1	C		
		4. Regulation on waste disposal and control	1	C		
		5. Surveillance system on the practice of the above factors	2	S		
	On water	6. Activities for rehabilitation of environment (Coral reef, mangrove, tidal flat and seaweed bed)	2	A		
		7. Surveillance system for preventing IUU fishing	2	S		
		8. Seed production & release and installation of nursery ground for stock enhancement	2	A		
		9. Conservation activities for rare and endangered species	1	S		
		10. Public awareness on the practice of the above factors	1	A		
		Score	15			%
III) Management of efforts (Input-Control)		1. Fishers / vessel registration system for each fishing type	2	C		
		2. License / permission system for each fishery	1	C		
		3. Surveillance system on the practice of the above factors	2	S		
		4. Zoning of fishing ground by fishing method	2	C		
		5. Surveillance system on the practice of the above factor	2	S		
		6. Regulation on fishing vessel capabilities such as HP, Tonnage, length	1	C		
		7. Restrictions on the fishing method including destructive fishing	2	C		
		8. Surveillance system for destructive fishing	2	S		
		9. Restrictions on the fishing gear or equipment of fishing vessel	1	C		
		10. Restrictions on the fishing period (months in year)	1	C		
		11. Restrictions on the operational time of fishing (time in a day)	1	C		
		12. Restrictions on allowable operational days (days a year)	1	C		
		13. Surveillance system on the practice of the above factor	1	S		
		14. Regulation on fishing ground such as no-fishing zones, marine preserves, MPAs.	3	C		
		15. Surveillance system on the practice of the above factor	3	S		
		Score	25			%
IV) Management of harvests (Output-Control)		1. Systematic mechanisms to understand fish-catch information such as catch amount, size of caught fish.	2	M		
		2. Regulation on catch size of principal fishery species or restrictions on catch by maturation stage or sex of crustaceans.	2	C		
		3. Surveillance system on the practice of the above factor	2	S		
		4. Restrictions on by-catch in industrial fishing	1	C		
		5. Surveillance system on the practice of the above factor	1	S		
		6. Restrictions on upper-limit of catch amount per each fisher	2	C		
		7. Surveillance system on the practice of the above factor	2	S		
		8. Restrictions on upper-limit of catch amount per region or in the nation	1	C		
		9. Surveillance system on the practice of the above factors	1	S		
		10. Regulation or support system on local fishers or fishery cooperative for fish catch recordings	2	M		
		11. Public awareness or fishers' training program regarding above factors	1	A		
		12. Periodical communications between fishers and government regarding above factors	1	A		
		Score	18			%

Table 2 FishMAT: 2/2

Categories		Factor	Weight[1]	MCSA Code[2]	Score	Remarks
V) Business improvement		1. Activities or guidelines for cost saving of fishing operation	1	A		
		2. Activities or guidelines for fish preservation	2	A		
		3. Activities or guidelines for value-adding to fish products	1	A		
		4. Activities or guidelines for alternative income sources	3	A		
		5. Activities for diversion or change of fishing type	1	A		
		6. Activities for cooperative shipping or marketing by local fishers groups or fishery cooperatives	2	A		
		7. Finance support system such as tax reduction or financial compensation for local fishers or fishery cooperatives which assist any resource management scheme	1	A		
		8. Micro-finance scheme for local fishers	2	A		
		9. Activities for the business development service (BDS) for fishery cooperatives and related small and medium-sized enterprises (SMEs)	1	A		
		10. Public awareness activities by administrative institutions regarding above factors	1	A		
		Score	15			%
VI) Post harvest treatment / processing	Onboard	1. Activities for improvement of fish preservation techniques	2	A		
		2. Technical guidance by administrative institutions	1	A		
		3. Fishing vessels equipped with cold storage facilities for fish preservation	1	A		
		4. On-board sanitary standard	1	C		
		5. Surveillance system on the practice of the above factor	1	S		
	After landing	6. Sanitary and quality standard for fishery products	1	C		
		7. Surveillance system on the practice of the above factor	1	S		
		8. Activities for improvement of processing techniques	1	A		
		9. Activities for improvement of fishery products distribution	2	A		
		10. Activities for improvement of fish landing factors	1	A		
		11. Activities for improvement of fish markets	2	A		
		12. Public awareness activities by administrative institutions regarding above factors	1	A		
		Score	15			%
VII) Human and organizational capacity		1. Officers for dissemination and protection in each local area	2	M		
		2. NGOs supporting fishery management activity	2	A		
		3. Periodical communications between central and local fishery authorities	1	M		
		4. Periodical communications between fishery authority and related other authorities such as ministry of environment and coast guard	1	M		
		5. Periodical communications between fishery authority and fisheries cooperatives	2	M		
		6. Periodical communications between private organizations such as fisheries cooperatives and NGOs	2	M		
		7. Education system for the local officers	1	A		
		8. Education system for the staff of research institutes	1	A		
		9. Education system for the local fishers	2	A		
		10. Education system for the middlepersons and processing persons	1	A		
		Score	15			%
VIII) Assessment and analysis capacity		1. Research institutes for fishery science	2	M		
		2. Stock assessment to principal species by local researchers or institutes	2	M		
		3. Studies for ecological and biological characteristics such as spawning ground, period on principal species by local researchers or institutes	2	M		
		4. Studies for oceanography such as current variation, salinity change and ocean temperature anomaly by local researchers or institutes.	1	M		
		5. Studies for biological chemistry on coastal, estuarine and swampy waters by local researchers or institutes	1	M		
		6. Studies for socioeconomics on fishery by local researchers or institutes	2	M		
		7. Studies for processing techniques by local researchers or institutes	1	M		
		8. Studies for fishing equipment and techniques, by local researchers or institutes	1	M		
		9. Periodical communications between the administrative organizations and researchers regarding above factors	1	A		
		10. Dissemination activities for the research results regarding above factors	1	A		
		Score	14			%

Notes: 1) Larger number shows high importance

2) "M": Monitoring, "C": Control, "S": Surveillance, "A": Activity

2-1. Modification of Resource Management Toolbox

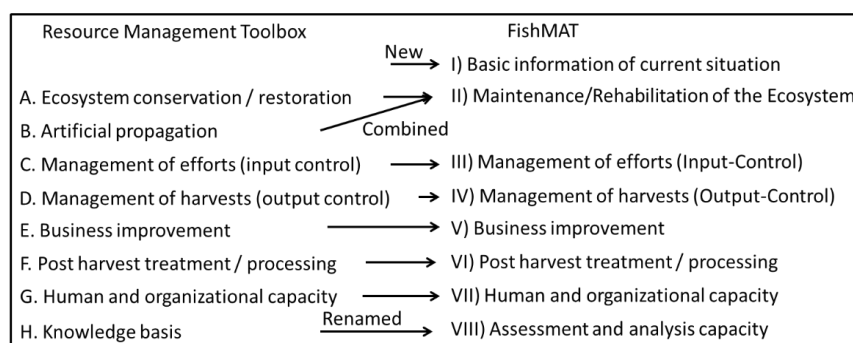FishMAT was based on the Resource Management Toolbox (Fisheries Research

Figure 1 Modification of the categories in FishMAT

Agency (2009) Makino (2013)) developed for Japanese fishery management. This Resource Management Toolbox classifying important measures of the fishery management consists of 8 categories from "A" to "H" as shown in Figure 1. The original toolbox however contains relatively few factors regarding the traditional activities for fishery management, political will of local leaders and politicians, and local fishers' concerns about fishery management. These issues have been important to improve fishery management in developing countries although they are difficult to assess quantitatively. We modified these categories from I) to VIII) to adapt to the current conditions of developing countries as described as Figure 1.

For many developing countries, one of important issues for implementing viable resource management is to understand present status in the country. We appended new category "Basic information to understand current situation". The category B is unfamiliar in the developing countries whereas it has been one of standard means in Japan. We combined the category B with category A and renamed the category as "Maintain/Rehabilitation of the Ecosystem". The category H is for overall advancement of science and technology. It might be practical for developing countries to narrow the scope and renamed it as Assessment and analysis capacity.

2-2. Addition of an item to MCS code

FAO (1994) considers that Monitoring, Control and Surveillance (MCS) performances are crucial for realizing national fishery strategies and capacity building for resource management. It therefore arranged and defined MCS code as M for "Monitoring" of fishing effort characteristics and resource yields, C for "Control" to regulatory conditions with resource exploitation and S for "surveillance" required to maintain compliance on fishing activities. However, these MCS code concepts have been insufficient in many developing countries, where periodic surveillance has not been

realistic due to insufficient human and financial resources. Flewwelling *et al.* (2002) described the participatory control-with-consensus approach that might be suitable for developing countries due to its cost-effectiveness and ability to deal with social, economic, biological and ecological issues. We considered that the information regarding management activities in participatory approach and jointly undertaken by local fishers and administrative institution is also important as well as Monitoring, Control and Surveillance to understand present status of fishery management in developing countries. Local authority usually must take on such management way with local fishers or their communities in order to develop effective and sustainable fisheries management (Kakuma (2003)). Many authors have already noted that the importance to practically understand the these management activities (e.g. Pinkerton (1987), Pomeroy and Rivera-Guieb (2006), Townsend and Shotton (2008), Cohen *et al.* (2008), Ruddle and Satria (2010)). We therefore appended "Management Activities (A)" in participatory approach or co-management activities to the MCS code for developing countries and employed MCSA (Monitoring, Control, Surveillance and management Activity) code to understand the present status more effectively in this study.

2-3. Arrangement and weighting of factors in each category

We aimed at identifying the vulnerable and therefore high priority domains in fishery management by utilizing FishMAT combining eight categories with MCSA code. Factors in each category were selected as basic information for fishery management. These were basically adopted from the Resource Management Toolbox. However factors attributing to the category of "I) Basic information of current situation" were chosen as basic information for resource management. Similarly, for the category of "VIII) Assessment and analysis capacity", activities and facilities for collecting basic information to understand current situation were selected as the factors. Within the "III) Management of efforts (Input-Control)" and "IV) Management of harvests (Output-Control)", we excluded factors regarding TAC and IQ listed in the Resource Management Toolbox since there were few cases in coastal waters of the developing countries. We then checked the presence or absence of each factor in the target country. However, it is difficult to judge the presence or absence of factors due to the fact that target countries have varied conditions depending on target area, target species and fishing method, even within the same country. We decided to count it as "present" when even one case of the factor was recorded in the country to avoid temporal constraint. In addition, each factor was categorized into MCSA code in order to understand practical accomplishment

in each MCSA performance.

Furthermore, due to each factor in the category varying in importance to contribute to the fishery management, we set weighted score on each factor to three ranks (1~3, 3 prime) based on our experience and knowledge obtained through many fishery management projects. We then calculated proportion of weighted code of implementation factors and all factors in each category for multidimensional evaluation of fishery management of target country.

The details of each category for fishery management were shown as follows.

（1） I） Basic information of current situation

In this category, we selected ten factors as necessary information for improvement of fishery management. Within these factors, factor 10 would be the most important one for effective fishery management and we weighed it as 3. Likewise, factors 1, 3 and 9 would be the indispensable information and we weighed them as 2. We weighed the remaining factors as 1. We also categorized all ten factors as the M (Monitoring) in MCSA code.

（2） II） Maintenance/Rehabilitation of the Ecosystem

We divided this category into two sub-categories, viz. On-land and On-water according to Fisheries Research Agency (2009) and Makino (2013) and selected five factors in each sub-category. Within these factors, factor 1, 5, 6, 7 and 8 would be the indispensable for conservation and restoration of coastal ecosystem and we weighed it as 2. We weighed the remaining factor as 1. We also categorize factors 1 to 4 as C (Control), factors 5 and 7 as S (Surveillance), factors 6, 8 and 10 as A (Management Activity) in MCSA code.

（3） III） Management of efforts (Input-Control)

In this category, we selected fifteen factors as necessary information for improvement of fishery management. Since this category was directly connected to resource management, the number of factors in this category was larger than other categories. Within these factors, factor 14 and 15 would be directly related to effective resource management and we weighed it as 3. Likewise, factors 1, 3, 4, 5, 7 and 8 would be the indispensable information and we weighed them as 2. We weighed the remaining factor as 1. We also categorize factors 1, 2, 4, 6, 7, 9, 10, 11, 12 and 14 as C (Control), factors 3, 5, 8, 13 and 15 as S (surveillance) in MCSA code.

（4） IV） Management of harvests (Output-Control)

In this category, we selected twelve factors as necessary information for improvement of fishery management. Since this category was directly connected to resource

management as well as the category III, the number of factors in this category was larger than other categories. Within these factors, 1, 2, 3, 6, 7 and 10 would be the indispensable information and we weighed them as 2. We weighed the remaining factors as 1. We also categorize factors 1 and 10 as M (Monitoring), 2, 4, 6 and 8 as C (Control), 3, 5, 7, 9 as S (surveillance), 11 and 12 as A (Management Activity) in MCSA code respectively.

（5）Ⅴ）Business improvement

This category would be closely related to the standard of living improvement of local fishers and therefore would be essential for sustainable fishery management in developing countries. In this category, we selected ten factors as necessary information for improvement of fishery management. Within these factors, factor 4 would be the most important one for effective fishery management in developing countries and we weighed it as 3. Likewise, factors 2, 6 and 8 would be the indispensable information and we weighed them as 2. We weighed the remaining factors as 1. We also categorized all ten factors as the A (Management Activity) in MCSA code.

（6）Ⅵ）Post harvest treatment / processing

As well as category V, this category would be also important for improvement of livelihood of local fishers and distributor for fishery products. Fisheries Research Agency (2009) and Makino (2013) divided this category into two sub-categories such as "On-board" and "After landing" to make the meanings of the factors in this category clearer. We followed their arrangement and selected twelve factors as necessary information for Improvement of processing and distribution for fish products. Within these factors, factors 1, 9 and 11 would be the indispensable for improvement of the livelihood of local fishers and distributors for fishery products and we weighed them as 2. We weighed the remains as 1. We also categorize factors 4 and 6 as C (Control), 5 and 7 as S (surveillance), 1 to 3 and 8 to 12 as A (Management Activity) in MCSA code respectively.

（7）Ⅶ）Human and organizational capacity

It might be essential for carrying out sustainable fishery management to establish a human resource administration and organization system. In this context, we selected ten factors in this category as necessary information regarding enforcement of human resource and organization system. Within these factors, factors 1, 2, 5, 6 and 9 would be the indispensable information since these factors were important to maintain and expand capacity building and institutional reinforcement and we weighed them as 2. We weighed the remaining factors as 1. We also categorize factors 1 and 3 to 6 as M

(Monitoring), 2 and 7 to 10 as A (Management Activity) in MCSA code respectively.

(8) Ⅷ) Assessment and analysis capacity

This category might be essential for understand the standing stock of fishery resource and environmental status in coastal waters. In this category, we selected ten factors as necessary information for improvement of fishery management. Within these factors, factors 1 to 3 and 6 would be the indispensable information since these factors were closely related to stock assessment and other scientific research. We therefore weighed them as 2. We weighed the remaining factors as 1. We also categorize factors 1 to 8 as M (Monitoring), 9 and 10 as A (Management Activity) in MCSA code respectively.

Table 3 Factors in category and MCSA code

MCSA code / Category	M (Monitoring)	C (Control)	S (Surveillance)	A (Management Activities)	Total in each category
I) Basic information of current situation	I)1(2), I)2(1), I)3(2), I)4(1), I)5(1), I)6(1), I)7(1), I)8(1), I)9(2), I)10(3)				10 (15)
II)Maintenance/Rehabilitation of the Ecosystem		II)1(2), II)2(1), II)3(1), II)4(1)	II)5(2), II)7(2), II)9(1)	II)6(2), II)8(2), II)10(1)	10 (15)
III) Management of efforts (Input-Control)		III)1(2), III)2(1), III)4(2), III)6(1), III)7(2), III)9(1), III)10(1), III)11(1), III)12(1), III)14(3)	III)3(2), III)5(2), III)8(2), III)13(1), III)15(3)		15 (25)
IV) Management of harvests (Output-Control)	IV)1(2), IV)10(2)	IV)2(2), IV)4(1), IV)6(2), IV)8(1)	IV)3(2), V)5(1), IV)7(2), IV)9(1)	IV)11(1), IV)12(1)	12 (18)
V) Business improvement				V)1(1), V)2(2), V)3(1), V)4(3), V)5(1), V)6(2), V)7(1), V)8(2), V)9(1), V)10(1)	10 (15)
VI) Post harvest treatment / processing		V)4(1), V)6(1)	V)5(1), V)7(1),	V)1(2), V)2(1), V)3(1), V)8(1), V)9(2), V)10(1), V)11(2),V)12(1)	12 (15)
VII) Human and organizational capacity	VII)1(2),VII)3(1), VII)4(1),VII)5(2), VII)6(2),			VII)2(2),VII)7(1), VII)8(1),VII)9(2), VII)10(1)	10 (15)
VIII) Assessment and analysis capacity	VIII)1(2),VIII)2(2), VIII)3(2),VIII)4(1), VIII)5(1),VIII)6(2), VIII)7(1), VIII)8(1)			VIII)9(1), VIII)10(1)	10 (14)
Total in each MCSA code	25 (39)	20 (28)	14 (22)	32 (42)	

Notes: 1) Number in bracket shows weight of each factor

2-4. The way to understand present status of target country by FishMAT

Using FishMAT, we calculated the total weight of factors marked in each category and calculated the percentage of each in the total weight of the category. In the same manner, we calculated percentage of total weight of factors marked in each MCSA code. Each percentage calculated was utilized as benchmark for the performance measure of each category. We sorted out factors and the total of these weights in each category and MCSA code as shown in table 3.

2-5. The verification of efficacy of FishMAT

To verify the efficacy of FishMAT, we implemented field survey at Republic of Suriname in South America and Saint Vincent and the Grenadines in the Caribbean region from November 30th to December 6th and December 9th to 18th 2014 respectively. In the survey, we interviewed local officers and fishers and reviewed local sites of coastal villages to understand present status of the local fisheries in both countries. Along with these activities, we had trial session to complete FishMAT with officers in charge for fishery management section of the fishery division or department in each country. As the criteria of selecting interviewees, we selected a number of the officers and section chiefs who have field experience of fishery sector more than 10 years and the leaders of local fishery cooperatives. We then compared the results of FishMAT and the field survey in order to confirm the effectiveness of FishMAT.

2-6. Comparison of current situations of target countries implemented

After the verifications of FishMAT as described above, we compared current situations of the countries estimated by FishMAT with another four countries, which we had baseline data through studies for overseas fishery resources management for "Socialist Republic of Viet Nam" and "Republic of Senegal" (Japanese Fisheries Agency, (2013)) and for "United Republic of Tanzania" and "Republic of Palau" (Japanese Fisheries Agency (2014b)).

3. Results

3-1. Republic of Suriname

The results for Republic of Suriname are shown in Table 4.

In the FishMAT for Republic of Suriname, the percentage of categories V), VI) and VIII) were 33 %, 47 % and 14% respectively, all less than 50 %. The lowest score was in

Table 4 Results for Republic of Suriname in the category and MCSA code

MCSA code / Category	M (Monitoring)	C (Control)	S (Surveillance)	A (Management Activities)	Total (%)
I. Basic information to understand current situation	11 / 15				11 / 15 (73 %)
II. Maintain/Rehabilitation of the Ecosystem		4 / 5	3 / 5	1 / 5	8 / 15 (53 %)
III. Resource management (Input-Control)		12 / 15	2 / 10		14 / 25 (56 %)
IV. Resource management (Output-Control)	2 / 4	3 / 6	3 / 6	2 / 2	10 / 18 (56 %)
V. Improvement of business structure				5 / 15	5 / 15 (33 %)
VI. Improvement of processing and distribution for fish products		1 / 2	1 / 2	5 / 11	7 / 15 (47 %)
VII. Reinforcement of human resource and organizations	8 / 8			2 / 7	10 / 15 (67 %)
VIII. Reinforcement of Capabilities for assessment and analysis	2 / 12			0 / 2	2 / 14 (14 %)
Total(%)	23 / 39 (59 %)	20 / 28 (71 %)	9 / 23 (39 %)	15 / 42 (36 %)	67 / 132 (51 %)

category VIII), indicating that the Republic of Suriname seems to need powerful measures for reinforcement of "capabilities for assessment and analysis (VIII)", followed by "reinforcement of improvement of business structure (V)" and "improvement of processing and distribution for fish products (VI)" for improvement of its effective fishery management from the result of FishMAT. In MCSA code, S (Surveillance) and A (Management Activity) were less than half at 39 % and 36 % respectively. Even in the category showing more than half, the score of S (Surveillance) in category III was 2/10 and the scores of A (Management Activity) in II and VII were 1/5 and 2/7 respectively. Therefore, Surveillance might be a key action for the further reinforcement of category III as well as Management activity for the categories II and VII.

The qualitative information of each category collected in our field survey was shown in Table 5.

In Republic of Suriname, industrial fishery has been developed relatively and various fishery systems and their monitoring schemes have been relatively equipped. However, the Reinforcement of Capabilities for assessment and analysis has been rather poor. It would be exigent to step up analytical facility and capability for fishery and related data. In addition, many artisanal fishers appealed for the improvement of business structure.

It seems that the trial run of microfinance would be an especially important issue. The above-mentioned result almost accords with a result provided in FishMAT.

Table 5 Qualitative information of each category in Republic of Suriname

Category	Suriname
I) Basic information of current situation	Data collectors dispatched from the Department of Fisheries recorded landing amount of fishery product in main landing stations every day. Most of the fishery products have been exported with a customs record and the landing and distribution amounts of fishery products have been comparatively determined by the government entity. Therefore, this category seems to work effectively.
II) Maintenance / Rehabilitation of the Ecosystem	The regulation and law enforcement for earth and sand mining, deforestation and waste disposal have been relatively provided. Control for rare species conservation and its propagation have been implemented. Therefore, this category seems to reach a certain level though of sewage control and resource propagation activities.
III) Management of efforts (Input-Control)	As mentioned above, registration and licensing systems with a focus on industrial fishery have been comparatively provided since large proportion of fishery products have been exported with record and custom control have been undertaken on foreign fishing vessel. In addition, the legislative bill for jurisdiction of the coast guard for control of IUU fishing has been tabled in the parliament. Therefore, this category seems to reach a certain level while record systems for artisanal fishers and small out-board engine boat have not been sufficient.
IV) Management of harvests (Output-Control)	The controls for size limit and fishery amount for high value and exported fish have been securely implemented. Therefore, this category seems to reach a certain level though monitoring systems for coarse fish species by artisanal fishery have not been sufficient.
V) Business improvement	It seems there is not enough to support for business development and a need to establish the system of microfinance. Although developments of guidelines for the administrative improvement of small scale fishery and related activities have been progressing, these are only halfway complete. A trial of microfinancing scheme is now undertaken in agriculture whereas there is no this activity in fishery sector.
VI) Post harvest treatment / processing	In the fishery targeting high value and exported fish, there have been several improvements for storage and quality control. Responding to these activities, many small-scale fishers also have brought blocks of ice for their fishing operation. The Department of fisheries also has been promoting fish processing activities. However, in our interviews with local fishers, many described the requirement for fulfillment of ice making machinery and the beneficial change of distribution system for fishery products. Therefore, the need for several actions in this category seems to be high.
VII) Human and organizational capacity	Local authority's mandates for fishery management or distribution of fishery products have been set up and have been relatively active. Therefore, this category seems to reach a certain level although few training courses for extension workers, artisanal fishers and distributors have been implemented.
VIII) Assessment and analysis capacity	Human and financial resources for scientific research and assessment have been insufficient. There is no research institute for fishery statistics, stock assessment and marine surveys exclusive of the University of Suriname. Consequently, analysis of fishery data collected from local fishing vessels has not been thoroughly implemented.

3-2. Saint Vincent and the Grenadines

The results for Saint Vincent and the Grenadines are shown in Table 6.

In the FishMAT for Saint Vincent and the Grenadines, the percentage of categories IV), V) and VIII) were less than half as 44 %, 40 % and 43 % respectively. Therefore from the result of FishMAT., Saint Vincent and the Grenadines seems to need measures for reinforcement of "reinforcement of improvement of business structure (V)", "capabilities for assessment and analysis (VIII)" and "Resource management (Output-Control) (IV)" to realizer improvement of its effective fishery management. In MCSA code, there was no item less than 50%.

However checking the categories individually, the score of A (Management Activity) in category II was 1/5, scores of C (Control) and S (Surveillance) in category IV were both 2/6, score of A (Management Activity) in category V was 6/15 and score of M (Monitoring) in category VIII was 4/12 respectively. Therefore, management activities may be a key action for the reinforcement of category II and V as well as control and surveillance for the categories IV and monitoring for the category VIII.

The qualitative information of each category collected in our field survey was shown in Table 7.

In the case of Saint Vincent and the Grenadines, the results of FishMAT are almost same as qualitative information collected in our field survey.

Table 6 Results for Saint Vincent and the Grenadines in the category and MCSA code

MCSA code / Category	M	C	S	A	Total (%)
I. Basic information to understand current situation	8 / 15				8 / 15 (53 %)
II. Maintain/Rehabilitation of the Ecosystem		5 / 5	5 / 5	1 / 5	11 / 15 (73 %)
III. Resource management (Input-Control)		9 / 15	5 / 10		14 / 25 (56 %)
IV. Resource management (Output-Control)	2 / 4	2 / 6	2 / 6	2 / 2	8 / 18 (44 %)
V. Improvement of business structure				6 / 15	6 / 15 (40 %)
VI. Improvement of processing and distribution for fish products		2 / 2	1 / 2	9 / 11	12 / 15 (80 %)
VII. Reinforcement of human resource and organizations	8 / 8			6 / 7	14 / 15 (93 %)
VIII. Reinforcement of Capabilities for assessment and analysis	4 / 12			2 / 2	6 / 14 (43 %)
Total(%)	22 / 39 (56 %)	18 / 28 (64 %)	13 / 23 (57 %)	26 / 42 (62 %)	79 / 132 (60 %)

Table 7 Qualitative information of each category in Saint Vincent and the Grenadines

Category	Saint Vincent and the Grenadines
I) Basic information of current situation	The Division of Fisheries allocated data collectors in main landing stations including isolated islands in the Grenadines to collect data on landing amount of fishery product. The basic information on landing and distribution amounts therefore has been comparatively figured out by the government and this category seems to work effectively.
II) Maintenance / Rehabilitation of the Ecosystem	The regulations and law enforcement for earth and sand mining, deforestation and waste disposal have been provided. The conservation for rare species and its propagation have been implemented. With Japanese cooperation, the division of Fisheries deployed artificial reefs for lobster in the marine protected area. Therefore, this category seems to reach an acceptable level.
III) Management of efforts (Input-Control)	In Saint Vincent and the Grenadines, registration and licensing systems for local fishers have been provided. Regulations for the size limit and fishing period for high value species such as lobster and conch have been also enforced. Therefore, this category seems to reach an acceptable level although record systems for coastal fish species such as sardine and horse mackerels have not been sufficient.
IV) Management of harvests (Output-Control)	The controls for size limit and fishery amount for high value and exported fish have been securely implemented. Therefore, this category seems to reach an acceptable level though data collecting for small coastal fish species targeting for self-consumption by artisanal fishery have not been sufficient.
V) Business improvement	The outreaches of alternative income sources and processing activities have been comparatively implemented. However support systems for business development and microfinance have been hardly implemented. The needs of activities regarding this category would be high in Saint Vincent and the Grenadines.
VI) Post harvest treatment / processing	For high value and exported fish, there have been several improvements for storage and quality control. Although some local artisanal fishers wanted maintenances of ice making facilities and access to the fishery markets in our interview, the basic facilities seems to be relatively provided.
VII) Human and organizational capacity	Local authority's mandates for fishery management or distribution of fishery products have been provided and training schemes for extension workers, artisanal fishers and distributors have been implemented with assistances of multilateral development banks and bilateral donors.
VIII) Assessment and analysis capacity	Human and financial resources for scientific research and assessment have been insufficient and these research works have depended heavily on assistance of regional organizations such as Caribbean Region Fisheries Mechanism (CRFM).

3-3. Comparison of current situations of target countries

We compared the results of the FishMAT for two countries viz. Republic of Suriname (hereinafter referred to as Suriname) and Saint Vincent and the Grenadines (hereinafter referred to as SVG) with the other four countries viz. Socialist Republic of

Table 8 Comparison of six countries based on the results of FishMAT

Category / Countries	Suriname	SVG	Tanzania	Palau	Viet-Nam	Senegal
I. Basic information to understand current situation	73%	53%	80%	47%	53%	93%
II. Maintain/Rehabilitation of the Ecosystem	53%	73%	53%	100%	60%	87%
III. Resource management (Input-Control)	56%	56%	68%	56%	64%	68%
IV. Resource management (Output-Control)	56%	44%	61%	39%	44%	72%
V. Improvement of business structure	33%	40%	33%	33%	93%	67%
VI. Improvement of processing and distribution for fish products	47%	80%	20%	13%	100%	80%
VII. Reinforcement of human resource and organizations	67%	93%	47%	60%	60%	67%
VIII. Reinforcement of Capabilities for assessment and analysis	14%	43%	64%	64%	86%	57%

Viet Nam (hereinafter referred to as Viet-Nam), Republic of Senegal (hereinafter referred to as Senegal), United Republic of Tanzania (hereinafter referred to as Tanzania) and Republic of Palau (hereinafter referred to as Palau), collected data in the two studies (Japanese Fishery Agency (2013), Japanese Fishery Agency (2014b)). Results of FishMAT for those four countries were also compared with the qualitative information of each category described in the reports. There were no wide differences between the results of FishMAT and the qualitative information of each target country described in the reports as well as two countries above-mentioned. The results of FishMAT are shown in Table 8.

Within the table, highlighted columns show values less than 50%. These results indicated that the percentages of the categories I, II, III and VII were high in the most countries whereas the percentage of category V ranged from 30 to 40% in four countries out of the six. It therefore suggested that the category of the improvement of business structure might be in need of international assistance in these countries. Regarding categories VI and VIII, some countries exhibited high percentages while some exhibited very low percentages. This suggests that the needs vary according to the situation of each country.

4. Discussion

4-1. A quick and easy tool

To date, there are almost no tools to understand the present status of fishery management comprehensively in developing countries, with quick and easy methods. FishMAT was designed for such a quick and easy tool. The present status obtained from the FishMAT results of six countries corresponds well to the results of fieldworks we implemented in these countries. It therefore might be useful to overview the fishery management status in developing countries. Tietze *et al.* (2006) collected case studies of fishery management in the Caribbean region with comparative studies of Malaysia and the Philippines. They described the status of each country with extensive description in the report. By combining quick and easy FishMAT and these extensive descriptions, we could gain a deeper and more comprehensive understanding of present status of the fishery management in developing countries.

4-2. Collaboration among local staff and outside experts

Since FishMAT was designed to provide quick and easy way to assess the present status of fishery management, even one case on each factor provides the score in the category in our six country case studies. If a similar approach is adopted, a local person who knows detailed local situation would tend to mark high score. For example, he might take up cases performed in a small scale in remote districts or cases performed mainly by foreign donors. On the other hand, a person dispatched from an international organization to study the present status of the fishery management would tend to mark low score because of his or her unfamiliarity with local country situation. Although these tendencies still need to be resolved, one of solutions for increasing accuracy of FishMAT would be collaboration among local staff and outside experts. The local officers in charge who know local situation well can cooperate with outside experts who know general issues on marking FishMAT. When Japanese or other missions use FishMAT, it would be preferable to reach a consensus between the mission side and the local side for each factor.

4-3. A mutual learning tool

Although FishMAT was designed primarily for assessment, it could be used as a mutual learning tool. In the Philippines where thousands of community-based or government-set Marine Protected Areas (MPAs) exist, Marine Protected Area Management Effectiveness Assessment Tool (MEAT) was devised (Philippines CTI NCC (2011)). MEAT was designed mainly for assessment. However, people in the hundreds of communities have learned how to make their MPAs more effective by filling the MEAT

sheets of their MPAs, and observing the sheets of the other site MPAs. The local staff or counterparts of Japanese cooperation projects who are responsible for the fisheries management could thus learn the status of the management in their countries, and develop potential measures to make the management better. If FishMAT is applied for the fisheries in many fishing villages, people in the villages could learn from finding developed at the other sites, like the cases of MEAT in the Philippines.

4-4．Other issues of FishMAT

Since the conditions of fishery management may differ greatly, and the factors and their weights in the eight categories were decided based on our experiences, the factors and weights could be reconfigured depending on the situations and the needs of the target countries.

The numbers of factors among each category and MCSA code are different since the considerable and indispensable factors usually vary in each category and in MCSA code. These divergences however would not deflect from showing present status of the target countries in the result of this study. Nevertheless, since we collected data from only six countries and the effectiveness was evaluated by qualitative verification, the present FishMAT might be considered as a prototype, and we need to raise the reliability by accumulating additional data and revising it appropriately in future.

Similarly, we adopted weighted score on each factor to three ranks due to importance of each factor on FishMAT. These ranks are simple ordinal numbers and do not mean Euclidean distance. For instance, rank 2 is more important than 1, but not necessarily twice as much. Within this study we simply treated the score as numeric measures and calculated the ratio of each category, though some technical aspects of handling the rank might be questioned. The subtle variations in the obtained values therefore may not show relative merit. In the future, we must consider utilizing more statistically robust manners. It would be possible to apply the multi-attribute decision analysis or analytic hierarchy process to cope with this weighting issue.

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