THE INTEGRATED COASTAL ZONE MANAGEMENT BASED ON ECOSYSTEM SERVICES

***NAKAGAMI Ken’ichi, Ritsumeikan University(RU),nakagami@sps.ritsumei.ac.jp***

***OBATA Norio(RU), TAKAO Katsuki(RU), UEHARA Takuro(RU), SAKURAI Ryo(RU),***

***OTA Takahiro Nagasaki University, YOSHIOKA Taisuke(RU),***

***NIU Jia(RU), CHEN Xiaochen(RU),MINEO Keito　Kyoto University***

**Abstract**

**The Japanese term “Satoumi” inspires us to pursue sound coastal zone governance by taking sustainable development into consideration with “Establishment of Sato-umi in the coastal sea”. The popular ICZM (Integrated Coastal Zone Management) shows us the potential approach toward a coastal area with harmonious interaction between human-being and natural environment. Seto Inland Sea which has undergone serious environmental degradation and anthropogenic changes. In order to recover and sustain its unparalleled values, rebuilding a sound environmental policy system from top to bottom is highly required. The ecosystem services and their monetary values are also estimated buy CVM necessary for sustainability assessment, due to their powerful roles in representing human-coastal zone relationship and supporting sustainability of a “Satoumi” system. The sustainability assessment framework for Seto Inland Sea, which consists of Inclusive Wealth, “Satoumi”, and ecosystem service approach was developed.**

*Key words: Satoumi, ICZM, Seto Inland Sea, Ecosystem service, CVM, Sustainability*

Ⅰ.Introduction

Japanese term “Satoumi” refers to coastal zone that has sound bio-productivity and biodiversity through human activities, which is composed of five elements. Three factors support the conservation and revitalization of coastal zone, i.e., material circulation, ecosystem and communication. Another two facilitate the realization of “Satoumi”, i.e., field of activity and executors of activity. Although the concept of “Satoumi” has been advocated for 20 years, the number of fishermen utilizing and conserving coastal zone has always been decreasing, and nowadays it is less than 200 thousand. According to the report published by the Japan Policy Council , there will be a very significant decline in the population of fishing villages[1]. The term “disappearing region” derived from the field of regional economy, while it also has the concept of combat or the stage of exploration. So far, there have been a lot of discussions about how to utilize coastal zone, however, how to realize sustainable management of coastal zone is also necessary. From this perspective, evaluation of the ecosystem services of coastal zone, as well as pursuit of approaches for sound ICZM (integrated Coastal Zone Management), is highly required.

It can be imagined that, if the concept of “Satoumi” can be generalized in Japan, the environmental awareness of fishermen and local citizens inhabiting coastal zone will be largely raised [2]. Therefore, we carried out this study for economic valuation of the ecosystem services of coastal zone, based on which innovative ICZM approaches were discussed. This achievement is considered the first step in our chase for the ideal situation of Japanese coastal zone by 2050[3].

Ⅱ. Review of projects concerning coastal zone exploitation

*Industrial development and consequent pollution in coastal zone*

As processing trade is the core of Japanese industry, convenient and fast shipping of raw materials and end products is of vital importance. Coastal areas fully meet this requirement. According to the National Comprehensive Development Plan formulated in 1962, Seto Inland Area was proposed to be the base for heavy and chemical industries. With the promulgation of the New Law for Construction of Industrial Cities in 1962, 15 areas were appointed as Intensive Industrial Development Areas, including south Okayama Prefecture, Toyo, Oita, and Tokushima. Then with the implementation of the Act of Industrial Development in 1964, 6 more areas were further appointed, including Harima, Bingo, and Shunan area. 1/3 of all the appointed areas are within the territory of Seto Inland. With the large-scale industrialization, land reclamation boomed, which to a large extent changed the landscape of Seto Inland Sea area. At the same time, undesirable phenomena started to occur, such as red tide (eutrophication) due to pollutant discharge, pileup of sludge, scarcity of dissolved oxygen in water, and discovery of teratogenic fish. All these put Seto Inland Sea on the verge of dying. As a countermeasure, the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea was enacted, aiming at cutting down pollutant discharge. As the first step, strict regulation on industrial discharge was introduced, including control on total pollutant discharge from 1979, reduction of phosphorus discharge from 1980, and reduction of nitrogen discharge from 1994. Simultaneously, the improvement of sewer system was carried out. As a result, the coverage rate greatly raised up   
from 24% in 1973 to 63% in 2000.

In terms of the decrease of tidal flats and seaweed beds, it directly led to the loss of habitats and breeding sites for various biota, and consequently the degraded regional biodiversity. As a matter of fact, the area of eelgrass beds shrank by 70% from 1960 to 1990, and the area of tidal flats dropped by 50% from 1898 to 2006 (The Association for the Environmental Conservation of the Seto Inland Sea, 2015).

*Pursuit of the richness of sea*

The Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea enacted in 1973 was recently amended in 2015. Regarding the basic principles for the conservation of Seto Inland Sea, the importance and rational utilization of Seto Inland Sea were once again emphasized. As an area with unparalleled scenic beauty and invaluable fishery resources, Seto Inland Sea should not only be enjoyed by the current generation, but also be passed down to the future generations for their welfare. In order to achieve this goal, we as human-being must exploit Seto Inland Sea in a sustainable way, which maximizes the values of Seto Inland Sea without sacrificing its richness in landscape function, bio-productivity and biodiversity. It is recommended to promote various stakeholders’ activities for the conservation, revitalization and creation of that richness in the coastal zone of Seto Inland Sea. The strategy for the conservation of Seto Inland Sea is apparently different from what it was, as in this amendment we could see the basic viewpoint of keeping the richness of Seto Inland Sea from the perspective of “Satoumi”. This fundamental change points out a new direction that could turn Seto Inland Sea from its current eutrophic state back to sea-alike oligotrophic state.

*Establishing sustainable fishing villages*

In 2012, the fishery production was about 380,000 t, in which 170,000 t came from fishing and the rest came from aquaculture. The fishing and aquaculture productions had their peaks in 1985, and gradually declined thereafter. One of the reasons was the decrease of seagrass beds and tidal flats, as well the subsequent degradation of living environment for fishes. Particularly for the productions of sardine, anchovy, sand eel and clam, dramatic decline was observed. Even fishery production seemed to get better for a while when the sea turned eutrophic, eventually it dropped. Then fishermen started to realize the vital importance of seagrass beds for fishery .Based on a survey in Hinase　Bay area of Okayama Prefecture, in 1940 the eelgrass beds had an area of 590 ha. Nevertheless, it rapidly decreased to 82 ha and then 12 ha, respectively in 1971 and 1985. With the recovery endeavor of relevant stakeholders in the recent decade, it has been improved to 80 ha in 2007, and then 200 ha in 2011 and 250 ha in 2014. This effort shows a promising future of a coastal zone with richness [4]. However, it was reported by Japan Policy Council that population in that area is going to experience a dramatic decrease. For example, from 2010 to 2040, the population of young women (20 – 39 year old) is estimated to decrease by 60.1% in. Then how to continue this effort and maintain the sustainability of the coastal zone becomes a new concern.

Ⅲ. Monetary value of ecosystem services of coastal area

*Monetary value of clean and bountiful coastal area in Hiroshima Bay*

In Seto-Inland-Sea, improvement of water quality has been realized implementing emission control measure based on a special law in order to solve water quality problem due to 1960’s economic growth. However, unideal water quality still continues and dysoxic water body sporadically emerged in highly enclosed sea such as closed-off section of Hiroshima Bay. Water clarity in the part of the Bay becomes lower level than outside of the Bay and oyster production, which Hiroshima Prefecture shows the largest in the country, drastically decreases sometimes. In order to realize clean, diverse, and bountiful bay in this region, both increasing water clarity level in summer and increasing oyster production in winter are required at the same time, controlling inflow of nutrients from the land area. This means both aims are able to be attained without no change of total inflow of nutrients throughout a year. We estimate change of water clarity of a bathing beach, Bay Side Beach Saka situated in the closed-off section of Hiroshima Bay, and change of oyster aquaculture production in the sea facing Saka-cho and Minami-ward of Hiroshima City, based on the emission control scenario described above. We showed estimated values in the Contingent Valuation Method (CVM) scenario, based on chlorophyll a concentration of Hiroshima Bay using an ecosystem process model constructed by marine scientists and also using relational formula between chlorophyll a value and water clarity in Osaka Bay made by the same scientists. Payment method was set as basic sewage bill per month in order to invest expansion of advanced treatment facilities. The improved facilities can cut 50% nutrient emission in summer. The target population of postal questionnaire survey is 1,120 citizens living in Saka-cho, Kaita-cho, Fuchu-cho, Minami-ward and Aki-ward of Hiroshima City, Hiroshima Prefecture. The survey was conducted from September to October in 2015.As a result, Willingness to pay (WTP) estimation using WTP function model became JPY220.90/month/livelihood (median value) and JPY234.52/month/livelihood (mean value) (n=156). Base on the whole livelihoods in the above target area the WTP was estimated at JPY30, 099,392.2/month (median value) and JPY31, 955,226.2/month (mean value).

*Long-term monetary value change of coastal ecosystem*

When we make long-term management plan for coastal area, we can make better decision with ecosystem monetary value. In this section we reveal 20-year-change of monetary value of sea weed bed, tidal flat, and sand beach in Seto-Inland-Sea. To date, there are very few studies estimating monetary value of the same subject with more than 10-year interval. Therefore, it is difficult to estimate future monetary value based on change from the past to the present. We made the same CVM survey with the same scenarios, estimating monetary value of restored sea shore in Himeji City of Hyogo Prefecture, restored sea weed bed in Hiroshima Bay, and natural sea shore in Takehara City of Hiroshima Prefecture, as Tsuge and Washida did in 1998 [5].We asked 7,000 panel members of an internet survey company on December in 2015. In the survey, we used the same CVM scenario as the three above to the greatest extent possible, though we changed several statistics to the current figures. The analyzed samples were about 1,500 residents in 11 prefectures facing Seto Inland Sea. We estimated the monetary values using random utility model only including bid price and constant. WTP to restore the natural sea shore was JPY15, 294/year/livelihood (mean), and JPY12, 371/year/livelihood (median). WTP to restore sea weed bed was JPY15, 689/year/livelihood (mean), and JPY13,343/year/livelihood (median). WTP to restore protect natural seashore was JPY16,088/year/livelihood (mean), and JPY14,441/year/livelihood (median). These values became JPY5,000 to 8,000 higher WTP in terms of median value but JPY3,000 lower price in terms of mean value than those of 18-year-ago. This means WTP in 2015 has few difference between median and mean value and the number of respondents bidding extraordinary high or low price decreased compared to 1998 survey. In addition, the largest WTP was shown for protection of natural sea shore among three scenarios, which is the same as 18 years ago.

There are future issues. We need to do similar surveys in other areas and examine local differences, since there are still few knowledge about estimation of monetary value of Satoumi and its ecosystem services [6]. We need to integrate market value into WTP of oyster production. Finally, in order to apply the estimated monetary value to management policy, it is important to involve stakeholders from survey planning stage and obtain commitment from them.

Ⅳ. Local residents’ willingness to conserve coastal areas

*Local residents and management of coastal areas*

Participation of not only fishermen but also local residents is important in order to sustainably manage natural resources of coastal areas. Local residents are contributing to conservation of coastal zones through various activities including recreation and consumption of fish. Recently, fishermen are decreasing and local communities are facing depopulation with aging of population in Japan. In order to effectively and sustainably manage coastal areas, it is important to understand local residents’ perceptions and behaviors regarding coastal conservation.

*Residents’ sense of place at Shizugawa Bay of Miyagi Prefecture*

Shizugawa Bay of Miyagi Prefecture, the study site, is known as one of famous Satoumi sites. Satoumi is the area where sustainable fishery has been implemented for a long time, and defined as the coastal area where the level of biodiversity and productivity improved through a positive interaction of people and the natural environment [7]. However, most of the fishermen at the study site experienced damage to their ships when the Great East Japan Earthquake occurred in March, 2011. In this study, a web-based survey was conducted to local residents elder than 20 years old living within 100km from Shizugawa Bay from February to March of 2015. Survey was distributed by a research company to get as many samples as possible within the research budget. Samples were adjusted that demographic characteristics such as ratio of gender and age of respondents would represent those of a whole population of the country. A total of 1,746 people responded to the survey. As for the result of the survey, 53% of respondents were male and 47% were female. Fourteen percent of respondents were in the age of 20s, 22% were 30s, 26% were 40s, 20% were 50s and 17% were more than 60 years old. Five percent of respondents were living within 20 km from Shizugawa Bay, 19% were living within 21-40km, 24% were within 41-60km, 28% were within 61-80km, and 25% were living within 81-100km.Thirteen percent of respondents were willing to invest time and efforts to conserve coastal areas while 16% were willing to make a financial sacrifice. Thirteen percent of respondents felt sense of place to the coastal area[8].

This research revealed that about 10% of respondents were either willing to conserve coastal areas or make financial sacrifice, and also felt sense of place to the area implying that residents who have such attitudes and behavioral intentions are limited. Previously, there have been few studies conducted to understand potential targets for participatory conservation activities regarding Satoumi. By understanding what kind of residents have sense of place and willingness to conserve coastal areas, managers could effectively implement promotion of activities and foster residents’ participation.

Ⅴ. Regional sustainability assessment framework for ICZM

*Issues with current sustainability assessment framework*

Four issues with current sustainability framework should be considered in view of its application to regional level and its management implications. Firstly, a region should be considered to be an open system, not closed, in which the region heavily depends on other regions. Secondly, a sustainability assessment criteria or goal to achieve should be articulated. Thirdly, assessment measures should have clear connection to the assessment criteria. Lastly, the assessment should provide detailed and practical implications for ICZM.

*Assessment framework*

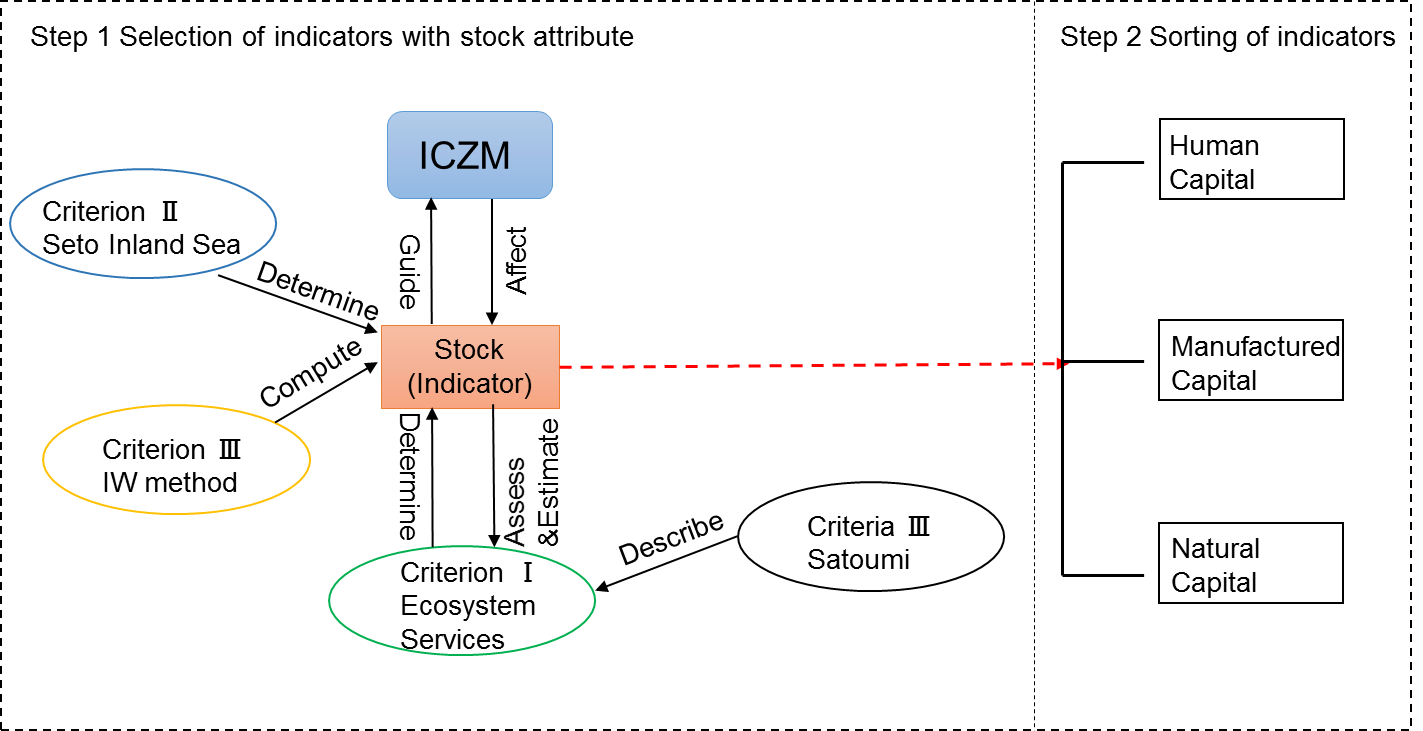
Our assessment framework comprises Inclusive Wealth (IW), Satoumi, and Ecosystem Services Approach (ESA). IW is a sustainability measure firmly grounded in economic theory [9]. Satoumi (a Japanese concept of socioecological production landscapes (SEPLs)) provides a desired state of a coastal zone. ESA is a realm of research which connects ecosystems to their human wellbeing[10]. In this context, ESA translates a desired state of a coastal zone into the list of stocks and shadow prices required for IW computation.　IW measures changes in a present value of social welfare obtained from human, manufactured, and natural capital（Kit,i=1,…,n）over time （(dVt)/dt）. The contribution of each stock to the social welfare is given by their shadow prices （(dVt)/dt） (see Arrow et al. (2003) for the technical and theoretical details).

(dVt)/dt=∑ipit (dKit)/dt+ (∂Vt)/∂t

Kit and pit are the quantity and quality of a stock k at time t respectively. With these measures, decision makers can identify what stock they should improve by how much (dKit) and how well (dpit) in order to improve IW to attain or sustain a desired state of a coastal zone. In contrast to the sustainability path criteria, (dVt)/dt≥0, proposed by Arrow et al. (2003), we should set a specific level of the social welfare, ▁V, and its components. While Arrow et al. (2003) target at a national level which captures the entire social welfare obtained from the nation, our assessment framework targets at regional and partial welfare obtained from the nation. Because of the potential trade-offs between the realization of a desired Satoumi and other social and economic activities, a simple pursuit of the higher V obtained from Satoumi (i.e., (dVt)/dt≥0) does not necessarily mean the maximization of the entire social welfare.

*Example: Seto Inland Sea*

The Seto Inland Sea (SIS) is an enclosed coastal sea in western Japan and is a Satoumi had a long history of human involvement with high ecological productivity maintained. However, because of economic activities in the past half a century, ecosystems such as seagrass beds and mudflats had been destroyed and degraded. In response to these severe situations, laws (e.g., Act on Special Measures concerning the SIS Conservation effective in 1973) and organizations (e.g., Governors and Mayors' Conference on the Environmental Conservation of the SIS in 1971) have been established and the recent amendment of the Act on October 2, 2015 shifted focus to Satoumi for water-pollution prevention. In selecting stocks for IW, there are two points to take into account. Firstly, a stock should be less substitutable and less mobile. Secondly, the selection should be comprehensive in the sense that the list includes crucial stocks for Satoumi.Out test application included oyster farmers, oyster raft areas, mudflats, seagrass beds and Sawara (Japanese Spanish Mackerel). Our results show that the IW declined by 33% over the past 50 years. There are at least two caveats regarding the results. Firstly, there is still room to improve its computation due to data used in the computation. Therefore it is not appropriate to reflect the results to elicit management implications. Particularly, further research on the determinants and better estimates of shadow prices await. Secondly, a consensus-based desired Satoumi (▁V) was not derived because it is beyond our scope. Hence we are not sure if the SIS is not on sustainable development path without ▁V. People may not want to give up the current life by restoring the ecosystems up to the half a century ago.



*Fig.1 Schematic of indicator system establishment*

Ⅵ. Satoumi and ICZM

Studies related to pollution mitigation and prevention seem quite few, which were

probably included in the aforementioned studies about “Satoumi” enforced by Ministry of Environment, which aims forest-river-coast connection based on ICZM. ICZM itself, due to the separation of current legal systems and various administrative agencies, such as coastal administrative agency mainly focuses on disaster prevention and coastal defense, harbor administrative agency mainly cares about the development and operation of port, and Ministry of Agriculture, Forestry and Fisheries always consider how to construct satisfactory places for aquaculture and fishery as their main obligation. Under this background of separation, key issues about the exploitation of the value of coastal zone were often overlooked, which was very undesirable.

*International definition of ICZM*

1. United States

The Coastal Zone Management Act Performance Measurement System (CZMAPMS) was proposed in order to measure national success of the Coastal Zone Management Program. A suite of contextual indicators, from the perspective of social, economic and environments, were identified by the NOAA Office of Ocean and Coastal Resource Management (OCRM) to complement and evaluate the performance of ICZM[11].

② European Union

The SUSTAIN Project was part-funded by the European Regional Development Fund. The aim of the project was to “create a fully implementable policy tool to help coastal authorities and communities throughout Europe to deliver sustainability on Europe’s coast”. The tool will be

applied to all 22 coastal states of the European Union and it is based on a set of easily measurable sustainability indicators[12].The PEGASO Project was constructed for developing ICZM in the Mediterranean and the Black Sea. Its main goal is “to construct a shared Integrated Coastal Zone Management (ICZM) Governance Platform with scientists, users and decision –makers linked with new models of governance”[13].

*Definition of ICZM in different academic society*

1. MEDCOAST

MEDCOAST was first held in the international conference in Turkey in 1993. Up to now,

it works as important academic society, aiming at conserving the coast and marine of Mediterranean and the Black Sea through ICZM. (https://www.medcoast.net/)

1. EMECS

The international EMECS aims at solving the environmental conversation of enclosed sea

in the world, e.g., Seto Inland Sea, Chesapeake Bay (U.S.A.), Baltic Sea (North Europe), Mediterranean Sea (South Europe). It is an organization that “promoting international exchanges on not only coastal but also catchment areas in a wide range of fields such as research, policy, civic activities”. It defines ICZM is “sustainable use and development of coastal resources”. (http://www.emecs.or.jp/s-13/en/)

Ⅶ. Conclusions

ICZM based on ecosystem services helps people to understand the importance and true value of sustainable coastal environment. Seto Inland Sea once faced very severe environmental crisis, especially eutrophication. At that period, the Law Concerning Special Measures for Conservation of the Environment of the Seto Inland Sea came into being in 1973 as an effective countermeasure, which aimed at reduction of discharge load of pollutants. Nevertheless, nowadays the enemy causing environmental degradation seems invisible, and we are not able to come up a solution overnight. It calls for the wisdom and experience that can lead to harmonious development of environment, economy and society, i.e., innovative ideas for achieving a state of sustainability. From now on till 2030, a variety of activities related to SDGs (The Sustainable Development Goals) will set out. Fortunately, in Target 14 we’ve seen that sufficient attention is paid to the conservation and sustainable exploitation of ocean and marine resources[14]. Based on the investigation of ecosystem services, we thus highly expect to see the birth of revolutionary ICZM approaches toward revitalized coastal zone.

Ⅶ.ACKNOWLEDEMENT

This paper is based on the result of the research by The Ministry of the Environment of Japan provides funding for research and development named “S-13 Development of Coastal Management Method to Realize the Sustainable Coastal Sea.” (Head Researcher: Prof. Dr. T. Yanagi) .The authors wish to thanks to The Ministry of the Environment of Japan, EMECS international Center, and Prof. Dr. Tetsuo Yanagi for their support on this research.

Ⅷ.References

[1] Japan Policy Council (2015), “Strategies for Revitalization of rural regions and preventing Depopulation(Stop shoshika Chihou Genki Senryaku)”(In Japanese )

May 8th, 2014

[2] Yanagi, T (2008), “Establishment of Sato-umi in the coastal sea”, *Japan Society of Water Environment*, 21,703p (in Japanese)

[3] Matsuda, O (2013), “A Vital Role of Satoumi in the Implementation of ICM in Japan”Proceedings of the Global Congress on ICM: Lessons Learned to Address New Challenges”, pp241-250, 30 Oct.-03 Nov.2013, Marmaris, Turkey, E.Ozhan (Editor)

[4]Kitagawa Kenji edited,(2007), *Setonaiakai Encyclopedia,*(in Japanese）,

2007,Nannansha Ltd.

[5] Tsuge, T. and Washida, T, (2003), Economic valuation of the Seto Inland Sea by using an Internet CV survey. *Marine Pollution Bulletin*. 47(1-6):230-236.

[6] NAKAGAMI Ken’ichi et al,(1997)“The Relationship between the Fishery Industry and Environmental Evaluation of the Seto Inland Sea”, Edited by T.Okaichi and T.Yanagi*“Sustainable Development in the Seto Inland Sea”* Terra Scientific Publishing Company, Tokyo,

[7] Yanagi.T, (2010), Satoumi Sousei Ron (In Japanese), Kouseishakouseikaku

　 [8] R. Sakurai, T. Ota, T. Uehara, and K. Nakagami (2016) “Factors affecting residents’ behavioral intentions for coastal conservation: Case study at Shizugawa Bay, Miyagi, Japan,” Marine Policy 67, pp. 1-9, May.

[9] Arrow, K. J., Dasgupta, P., & Mäler, K. G. (2003). Evaluating projects and assessing sustainable development in imperfect economies. *Environmental and Resource Economics,* 26(4), 647-685.

[10] Turner et al., (2014), UK National Ecosystem Assessment Follow-on. *Work Package Report 4*: Coastal and marine ecosystem services: principles and practice. UNEP-WCMC, LWEC, UK.

[11] National Oceanic and Atmospheric Administration (NOAA) (2010). Coastal zone management act performance measurement system: contextual indicators manual. U.S. Department of Commerce & National Oceanic and Atmospheric Administration & National Ocean Service & Office of Ocean and Coastal Resource Management.

[12] SUSTAIN, (2012) THE SUSTAIN INDICATOR SET, A set of easily measurable sustainability indicators. INTERREG IVC & European Union

[13] PEGASO, (2008) ,PEGASO Project,2008 http://www.pegasoproject.eu/.

[14]UNDP,(2015),Sustainable Development Goals (SDGs),

<http://www.undp.org/content/undp/en/home/sdgoverview/post-2015-development>

-agenda.html

Footnote

This paper is written by following papers.

[1] Nakagami, K. (2016), “Assessing Sustainability for Satoumi Coastal Governance”, PROCEEDINGS OF THE TWELFTH INTERNATIONAL CONFERENCE ON THE MEDITERRANEAN, COASTAL, ENVIRONMENT (MEDCOAST2015) 23-31

[2] Nakagami K.et al (2016), The Coastal Management Based on the Ecosystem Service (In Japanese ),*Journal of Environmental Conservation Engineering*,Vol.45,No.3