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기후변화시대 홍수피해 완화 농지보존 생태계 서비스 지불 (PES)의 효율성 - 일본의 사례를 중심으로 -

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The Efficiency of Payment for Ecosystem Services (PES) in Preservation of Farmland for Mitigation of Flood Damage in the age of Climate Change - Case study of Japan -

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ABSTRACT : 다수의 국가에서 농촌이 쇠퇴하는 현상을 확인할 수 있으며, 특히 경작 포기지의 비율이 빠른 속도로 향상되고 있다. 일본에서 경작 포기지의 증가는 농작물의 국내 자급률 감소, 농지의 중요한 기능 중 하나인 자연재해 방지 기능의 상실, 그리고 농촌 지역사회가 계승해 오던 다양한 형태의 무형적 자산의 소실 등을 야기하였다. 농지와 농촌 지역사회 활동의 보존은 지속가능한 개발을 위해 필수적인 요소이다. 생태계 서비스는 농지가 보유한 기능 중 하나이며, 일본의 중산간지역 직불제는 농지의 보전과 농촌 지역사회 활동을 지원하여 생태계 서비스 보존 및 유지에 일조하기에 생태계 서비스에 대한 지불(PES)이라 볼 수 있다. 본 연구의 목표는 중산간지역 직접지불제도의 혜택을 받는 지역과 RCP8.5 시나리오 하에서의 자연재해 피해액 간의 관계를 파악하여 직불제의 효율성을 간접적으로 검증하는 것이다. 본 연구의 대상지는 일본 홋카이도의 농지 전체이며, 2005년, 2010년, 2015년의 강우량 예측 패널 데이터와 농업 센서스 패널 데이터를 이용하여 한계효과를 구하여 분석하였다. 분석 결과, 중산간지역 직불제 해당지역이면서 농촌 지역사회 활동이 활발할수록 자연재해 피해액이 적었다. 따라서 특히 중산간지역 직불제 해당지역일수록 재해피해 감소를 위해 농촌 지역사회 활동이 필수적으로 요구된다. 본 연구의 의의는 중산간지역 직불제의 효율성을 자연재해 피해액을 통해 검증한 데 있으며, 향후 직불제의 효율성에 대한 논의에 기초자료로 활용될 수 있다.

Key words : PES, 중산간지역 직불제, 농지보전, 자연재해 방지 기능, 농촌 지역사회 활동

I. Introduction

Rural degradation can be observed in many countries such as Europe, South Korea, Japan and in developing countries (Deng, Xu, Zeng, & Qi, 2019), and especially farmland abandonment is increasing rapidly in these decades. The reasons of farmland abandonment are multi-dimensional such as natural constraints, land degradation, socio-economic factors, demographic structure, and the institutional framework or ecological, socio-economic reasons and reasons

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related to unadopted agricultural systems (Terres et al., 2015). Negative consequences of farmland abandonment are seen not only dropping self-sufficiency rate of agricultural production, but also in loss of disaster prevention function and loss of traditional community forms as used to see in strong connection within community in rural area of Japanese. For instance, higher farmland abandonment after floods and debris flows are associated with damaged land and irrigation networks in south of Mount Aso in Japan (Sidle, Gomi, Akasaka, & Koyanagi, 2018).

Once land was abandoned, it will take long time to recover its function. Therefore, it is necessary to maintain rural land as community asset with sustainable management structure and intervention of government.

1. Community capacity for agricultural land management in the theory of neo-endogenous rural development

In order to maintain rural agricultural land, it is required systematic approach for promoting community empowerment and governmental intervention because the farmland provides ecosystem services such as disaster prevention function which can be public goods. Community farmers have been engaged in such preservation activities since long time ago as part of their agricultural activities. However, in recent climate change, we face unexpected amount and pattern of rain falls. Moreover, the number of farmers is decreasing year by year. Thus, there is the limit to maintain farmland only by the voluntary activities by community farmers.

Then, Japanese government took the measurements for preservation of farmland in less-favored area called direct payment policy for hilly mountainous area. This policy has started since 2000 and referred to EU's direct payment policy, but distinctive feature of this policy compared to EU countries is that it is emphasize aspect of promotion of community capacity through the policy implementation. The fostering of Community capacity is the key for sustainable rural development. In the theory of neo-endogenous rural development. In this theory, in order to realize sustainable rural development, it emphasizes 1) importance of territorial integration and natural resource conservation as community asset 2) some type of intervention in the form of rural policies, 3) stakeholders of both inside and outside of the community in public and private sector as stakeholders of the development (Ray 2006). Thus, this Japanese type of direct payment plays important role to maintain farmland with promoting community collective activities in order to pursue sustainable rural development. Disaster mitigation function can be secured through this farmland conservation process.

2. PES and agricultural land in ecosystem

Payment for Ecosystem Services (PES) is the payment for ecosystems including farmland and conservation activity that has characteristics of public goods. Farmland is public goods in terms of having multifunction such as provisions of scenery, preventing natural disaster besides providing agricultural products.

Millennium Ecosystem Assessment of UN evaluated that ecosystem service of the farmland such as prevention of natural disaster was deteriorating. And it estimated that the deterioration is accelerating during 21st century. It comes to more crucial issue that we are facing climate change in these decades. Climate Change 2014 Synthesis Report from IPCC indicated that farmland preservation is necessary as approaches for managing the risks of climate change (Pachauri & Meyer, 2014).

One of the most important functions of farmland is prevention of flooding by the land holding appropriate water supply. However, farmland abandonment is accelerating and damage of flooding is getting serious especially in un-favored land in rural area where they face lack of farmers and degradation of community farming system. As a result, these abandoned areas are vulnerable to natural disaster such as flooding and at the same time, it is connecting to stagnation of community economy and culture which is vicious cycle of creating lack of population. Thus, these areas are experiencing rapid aging and depopulation along with more visible effect from recent climate change.

In order to restrain the accelerating deterioration, PES was brought as one of the solutions in many countries.

Definition of PES is not internationally established but principally, it can be defined by following conditions (Wunder, 2005).

i. Spontaneous trade by supplier and beneficiary of Ecosystem serves
ii. Defined land use or ecosystem related services
iii. Existence of purchaser of ecosystem services
iv. Existence of supplier who manage ecosystem services
v. Sustainable supply of ecosystem services by the supplier (buyer)

Since 1990, PES has been implemented around the world as an effective method of preservation of ecosystem. Under those definitions, in Japan, central government and local government have been implementing PES such as direct payment for hilly mountainous area since 2000 and environmental preservation direct payment since 2011. Although the term of PES is used as various preservation mechanism based on market theory, now in Japan, direct payment for hilly mountainous area is considered as one of the PES.

3. PES in the age of Climate change

To preserve multifunction of farmland is precondition for sustainable development in rural area through conservation of qualities and values of farmland and it is also direction towards sustaining rural economies (Antrop, 2006). However, along with farmland abandonment, the rural community is threatened by disaster damage.

According to Uetake, the decline in farmland area is reducing the capacity of agriculture to provide various ecosystem services. This affects mainly agricultural landscapes and resilience to natural disaster. Total farmland and paddy field area decreased by 12% between 1990-92 and 2010-12 respectively, and abandoned land expanded 1.8 times between 1990 and 2010. Consequences of farmland abandonment (especially rice paddy fields) and ageing irrigation systems reduce the capacity to provide resilience to natural disaster, including resilience to flooding. Risks of landslide are also increasing due toabandoned land. Research in Japan indicates that the rate of landslide occurrence is three to four times higher on abandoned land than on cultivated land (Tetsuya Uetake, 2015). Taking more than a third of the paddy fields out of rice production and leaving much of it idle has negative implications for providing agri-environmental public goods (Jones & Kimura, 2013). In the age of climate change, risk of extreme rain is increasing more and more. According to study of Gerrard and Gardner (2002), they estimated smaller amount of soil loss and land slide were occurred in the paddy and well-maintained irrigation field in Nepal compared to less water managed area (Gerrard & Gardner, 2002). Thus, such well-maintained area plays an important role in prevention of erosion, landslide and

Table 1. The number of expected heavy raining warning issued under RCP2.6 and RCP8.5

Sub-prefecture		2041-2060		2081-2100	
		RCP2.6	RCP8.5	RCP2.6	RCP8.5
1	Soya	0.50	1.50	3.00	2.50
2	Kamikawa	-	3.00	1.50	5.50
3	Rumoi	1.00	1.09	1.55	1.91
4	Ishikari	1.38	2.13	1.38	2.63
5	Sorachi	1.50	2.00	1.38	2.75
6	Shiribeshi	1.00	-	1.00	1.00
7	Okhotsk	1.00	1.00	1.00	3.00
8	Nemuro	1.00	1.17	1.00	1.17
9	Kushiro	0.74	1.00	0.95	1.21
10	Tokachi	1.00	-	-	-
11	Iburi	0.57	1.57	0.57	1.71
12	Hidaka	0.67	0.83	0.83	1.83
13	Oshima	0.71	2.00	1.14	2.43
14	Hiyama	1.00	1.20	0.80	1.00

source: Japan Meteorological Agency

flooding. Conversely, we could assume that the loss of such area means losing disaster prevention function.

Table 1 is showing estimated the number of heavy raining warning issued under RCP2.6 and RCP8.5 scenario.

In all sub-prefectures except Shiribeshi and Okhotsk, the number of warning issued estimate as increasing. Hokkaido has been less typhoon or related disaster comparing to main land of Japan. These estimations tell us that it is possible that entire Japan is going to face more frequent heavy rain and necessary to prepare for the future climate incidents. Now, we face degradation of farmland as mentioned. In order to keep disaster mitigation function of farmland, it is an urgent issue to implement farmland preservation activities. Then, PES is playing important role to promote farmland preservation activities as the incentives for farmers to restrain farmland abandonment. 4. Arguments on PES and efficiency.

4. Arguments on PES and efficiency

Meanwhile, the PES is gradually expanding its discussion to its efficiency of the payment since most of this type of direct payment is provided by government not by private sector (Lankoski, Lichtenberg, & Ollikainen, 2004). OECD and other researches indicated the inefficiency of input based or area based payment (OECD, 2010). As seen in Japanese type of direct payment, the payment is provided based on area (provided some amount per ha) depending on the condition of the land. The government provides direct payment for hilly mountainous to target areas where they fulfill at least one of the following conditions: 1) has extreme steep of farmland 15 degree of slop 2) small scale 3) temperature of on-season is extremely low (total accumulated temperatures of 2300 degrees during the period of May to October); and 4) has the rate of age 65 years old with more than 40% and the rate of farmland abandonment with more than 8%. If the area fulfill one of above conditions, and if the application form by community is approved, the payment is provided based on the targeted area (ha).

Existing literature regarding of cost-effectiveness of direct payment is mainly examined by the result of environmental direct payment. In the US, UK and European countries where they have been implementing “result based” or result oriented payment are examined as below.

Matzdorf & Lorenz found the positive impact of farmer’s motivation to reach the environmental goal and to cooperate by result-oriented incentives in Germany (Matzdorf & Lorenz, 2010). Burton and Schwarz examined the strength of results-based direct payment of agri-environmental schemes (Burton & Schwarz, 2013).

Lankoski found out that adding environmental targeting to the uniform payment policy improves the cost-effectiveness of uniform payment. His analysis shows that, when targeted payments are implemented, the gains from environmental targeting are large and exceed the increase in policy-related transaction costs (Lankoski, 2016). Tanaka studied the effect of three targeting strategies cost-benefit based, cost based and participation is based payment by using case study of Conservation reserve program in Iowa US. His model found out that cost-benefit based payment was the most efficient strategy as seen in soil condition (Tanaka, 2015). He discussed that it is necessary to investigate efficient implementation of Japanese type of direct payment as well for environmentally friendly agriculture because current policy does not consider cost and benefit of the policy implementation. Nishizawa (Nishizawa, 2017) reviewed auction type of payment or result based payment in US and European countries. In his discussion, he concluded that Japanese type of direct payment is required more studies and basis of payment should be clarified its relevance. Uetake also mentioned that Payments targeted to outcomes have proven to be more effective in improving the environmental performance of agriculture in other OECD countries. He pointed out that such payments should be considered in Japan.

The efficiency was clarified by results such as improvement of soil condition after farmers activities as reviewed above. However, Japanese type of direct payment is not aiming at specific improvement of items. So, it is hard to discuss efficiency. There are few studies mentioned efficiency of Japanese type of direct payment.

Nishizawa mentioned the importance of consideration on the efficiency on Japanese type of direct payment in the discussion part. He said that it was important to consider cost-effectiveness of implementation (Nishizawa, 2017).

There are several researches about impact of PES related policy on environmental conservation of farmland in Japan.

Uetake and Sasaki (T Uetake & Sasaki, 2016) utilize OECD's environment and economics integration model so called SAPIM to evaluate PES on impact of environment for the first time. They concluded that direct payments can improve soil condition and carbon sequestration. The policy brought different impacts both to farm economics and the environment. Ogawa et.al (Ogawa, Shima, Yoshisako, & Fukumoto, 2005) estimated soil loss under implementation of farmland conservation. They estimated cost of prevention of soil loss will increase when they do not manage their land very well due to lacking of farm management.

We assume following way. One of negative consequences of farmland abandonment was decrease of disaster prevention function. So, if we could investigate that disaster damage cost was less in the target area of the direct payment implementation, we could assume that as the result of the direct payment, the target area kept farmland function and the well-maintained land contributed to mitigate disaster damage cost compared to the area where has no treatment. If farmland was well-maintained, it could secure disaster prevention function. It also means that the direct payment was efficiently used since we could see it is securing multi-function of the farmland. Of course, there is a limitation to see the effect of farmland conservation on disaster mitigation. Moreover, each farmland has different characteristics and abilities to hold water level which cannot control only by the direct payment. However, still even partially, as long as direct payment has some effects on restraining farmland abandonment, it is possible to say that the payment was used efficiently through observing disaster mitigation condition.

5. Arguments on Stakeholders and Efficiency

In addition to discussion on efficiency of result-based payment, several statements are emphasizing the importance of community capacity for efficient payment seen as social capital. For instance, according to Swinton, where community organizations are actively working, the member helps each other to overcome threaten of degradation of farmland because community collective activities are efficient compared to the area without such organizational activities and bring benefits for whole community (Swinton, 2000). The experience in Africa on PES paradigms shows that PES is an evolutionary process of landscape management involving diversified stakeholders at local community (Leimona, van Noordwijk, de Groot, & Leemans, 2015). They also mentioned that the interdependency of fairness and efficiency is the main consideration in designing and implementing a PES scheme. The case study of Shiga prefecture in Japan evaluates impact of PES policy. In the findings and conclusion, it was clarified that if community has been accumulating social capital since long time, probability of participation to PES related program is higher. Policy would be effectively implemented by supporting such self-sustained community or farmer's organization (Ito, Feuer, Kitano, & Komiyama, 2018). According to Bauer et al. and Vila Subiros et al., it is necessary to promote participatory processes with stakeholders (Bauer, Wallner, & Hunziker, 2009; Lasanta, Nadal-Romero, Arnáez, & Policy, 2015). Bauer said that it is necessary to empower stakeholders during land management process for the efficiency and success. Therefore, community capacity must have some impacts on quality of preservation activities in order to maintain their own land. To support the establishment of efficient and fair PES schemes, it is necessary to have solutions at each community stakeholder's level in implementing PES schemes. An honest and trusted intermediary is one of the key factors of a successful PES scheme.

6. Purpose of study

In our study, we try to investigate if Japanese type of direct payment is efficiently used in terms of securing flooding disaster mitigation function. To do so, we would like to examine the influence of direct payment for farmland preservation on disaster damage cost at municipality level of Hokkaido prefecture in Japan so that as we assumed above, we could observe efficiency of the direct payment. Hokkaido is the lowest rate of farmland abandonment in Japan, but still observing rapid degradation of farmland and vulnerability toward climate change. It could be reference for other regions in the world where will face the same problem that Japan has been through. Also, we would like to see if the community capacity has some impacts on disaster mitigation in the scheme of direct payment. We could make suggestion for other regions where they face the same threaten of farmland degradation

and disaster damage.

Japanese type of direct payment for hilly mountainous area could be one of the PES because by the payment, it is possible to mitigate disaster. Based on the studies by Yonezawa & Takeuchi Keenleyside et al, Renwick and Takayama and so on, we could assume that direct payment has some effects on restrain of farmland abandonment (Keenleyside et al., 2010; Renwick et al., 2013; T Takayama & T Nakatani, 2011; K Yonezawa & K Takeuchi, 2003). Therefore, if direct payment for hilly mountainous area (=PES) is efficiently used, damage cost of flooding would be likely lower than the areas where they don't receive direct payment.

II. Data and Methods

1. Data

We use panel data of 2005, 2010 and 2015 on precipitation data and Agricultural Census. The variables are listed in the table 2. We are utilizing data of damage cost of flooding as explained variable. Damage cost was taken from flooding statistics. For this analysis, it includes damage costs on houses, office, and agricultural land due to extreme rain. Agricultural production was excluded because it might bring biases on damage cost because it affects farmers' behavior. The direct payment for hilly mountainous area has been implemented for more than 10 years which is long enough to see the effect as independent variables compare to other direct payments that just started or no data available in municipality level. We assume that if direct payment was provided efficiently, the disaster damage cost is likely lower. Therefore, as explanatory variables, we use dummy variable of direct payment received or not in municipal level. It is worth note that qualification of the participants to the DP is based on regulation, and community unit is the majority participants.

We also use precipitation variable as explanatory variables to see correlation between rain fall pattern and the impact on flooding damage cost. According to Diaz and Murnane (Stephenson, Diaz, & Murnane, 2008), taxonomy of extreme weather and climate event could be consist of 3 factors, rarity, severity and rapidity. So, to see the relation of precipitation pattern variable and flooding, we need also to consider these aspects. Rarity is the frequency of rain fall in the month. The severity should be considered rain fall in a day more than 50mm from standard of extreme rain fall of Japan Meteorology Agency. Rapidity is the duration of flooding. Through consideration of these aspects, precipitation variable could be defined. We could not gain data of the duration of flooding, but gain the number of the days of rainfall more than 30mm per hour. Therefore, as the precipitation related variable is defined as the number of the days of rainfall more than 30mm per an hour.

As mentioned before, role of collective community activities in terms of farmland management are considered as one of the important factors of efficient implementation

Table 2. Variables Description

Variables		Explanation	Reference
Dependent variable	damage	Damage cost of flooding on agricultural sector (thousand yen) (Municipal basis)	Statistics of flooding damage. (incl. houses, office, and agricultural land, excl, Agricultural production)
Independent variable	dpD	0=Not received direct payment, 1=received direct payment	Report of Implementation of DP for Hilly mountainous area (Hokkaido municipality data, MAFF)
	frm	The number of farmers (Municipal basis)	Agricultural census (municipality level)
	raincm	annual total precipitation in municipality (cm)	Japan Metrological Agency
	ov65y	% of farmers who are over 65 years old (%) (Municipal basis)	Agricultural census (municipality level) T Takayama & T Nakatani, 2011
	comactD	The community resource preservation activities (municipal basis) 0=no activities, 1= otherwise	Agricultural census (municipality level) Ito, Feuer, Kitano, & Komiyama, 2018
	landD	Rice paddy field dummy (Municipal basis) 0= upland, 1=rice paddy	Agricultural census (municipality level)

as community capacity. Therefore, as community capacity aspect, the number of farmers, dummy variable of community resource preservation activities (1=do some preservation activities such as farmland and facility maintenance, 0=otherwise) are included in independent variables. Of course, there are more social capital variables such trust, network and so on (OECD 2006) , but in this study, we focus more on the PES and flooding damage cost and take the variable on community activities dummy to see social capital aspect.

As more control variables, we use the number of farmers, rate of 65 years old among farmers and land type dummy variables if it is mainly having rice paddy field or not. In addition to see the effect of PES on disaster prevention function under RCP8.5 scenario, we would like to estimate future damage cost of flooding due to unusual rain in Hokkaido where it used to have less rainy seasons and not much damage by rain compared to other prefecture in Japan.

2. Methodology

We would like to see if the direct payment has an impact on damage cost of flooding. We aim to see if the payment is utilizing efficiently through analysis of relation between damage cost of flooding and direct payment variable and community activities. Efficient use of direct payment which would be observed in correlation between disaster damage cost and direct payment variable which is here dpD, the area received direct payment. Since sustainable rural development requires well functioned farmland and community capacity for conservation activities, it is meaningful to analyze this correlation.

Panel Tobit model

Damage cost of flooding is 0 when municipality has no damage, but when it occurs, it shows always positive value so it is censored values. Therefore, estimator of OLS would be biased. In addition, samples are municipalities where they have farmland. It is non-random selected samples. Therefore, appropriate method in this case is to estimate by Tobit model since dependent variable is the damage cost of flooding which is either equal to zero or positive. Panel data is observing data of individuals' different sections at T different times, combination of cross-section and time data. In this study, we utilize 3-year period of data. Tobit used in this study is therefore expressed as follows;

$$Y^*_{it} = \beta' X_{it} + \varepsilon_{it}$$
$$Y_{it} = Y^*_{it} \text{ if } Y^*_{it} \geq 0$$
$$Y_{it} = 0 \text{ if } Y^*_{it} < 0 \quad , N \text{ and } t=1,\cdots,T$$

where i defines the municipality and t defines the time. Xit is the explanatory variables β is a vector of unknown coefficients. OLS is not suitable here because dependent variable is the censored data. Therefore, for parameter estimations, the Maximum Likelihood Estimation (MLE) method is used in the Tobit model. The error term in panel data application is generally defined as follows:

$$\varepsilon_{it} = \lambda_{it} + u_{it}$$

where λ is the individual effects and u_{it} is the unobservable individual and random effects(Samut & Cafrı, 2016).

$$Y_{it} = \beta_0 + \beta_1 days_{it} + \beta_2 frm_{it} + \beta_3 ov65y_{it} + \beta_4 dpD_{it} + \beta_5 comactD_{it} + \beta_6 dpD_{it} + \beta_7 dpD \times comactD + u_{it}$$

In the Tobit model, we would like to estimate how the changes of each independent variables would be effective on y. To calculate the damage cost under RCP.8.5, we need to estimate marginal effect of precipitation. By using the marginal effect of precipitation obtained from our model, we can estimate changes in damage cost due to change of precipitation under RCP8.5 in 14 sub-prefectures which is provided by Meteorological Research Institute of Japan. Tobit model estimates 162 municipalities in 3-year, but predicted damage cost is estimated in 14 sub-prefectures due to data availability. Table 3 shows the description of statistics.

During the process of analysis, we have some missing variables on one or more of period of years, but having full data of variables on at least one period of year for 162 municipalities. Due to this missing variables, the number of observation and municipalities are not matched.

Table 3. Description of Statistics

	Mean	sd	min	max
damage	1.67	4.34	0.0	51
frm	258.30	258.22	0.0	1973
raincm	11.33	3.03	0.0	24
ov65y	0.42	0.17	0.0	1
dpD	0.58	0.49	0.0	1
comactD	0.86	0.35	0.0	1
landD	0.19	0.39	0.0	1
N	486			

III. Results and Discussion

1. Result of Tobit Model

As already mentioned, in order to keep disaster prevention function, it is important to preserve farmland. The estimated variable of over 65 years old is positive and statistically not significant. Problem of aging farmers is seen commonly in many rural areas. Although it is not statistically significant, it might affect on higher disaster damage cost due to aging. The estimated coefficient of rain is positive and statistically significant. This result can mean that even in Hokkaido prefecture where it used to have less disaster of rainfall, when rain fall becomes intensively in the future, it is possible to increase damage cost of flooding in this area.

We would like to see if community resource preservation activities have effects on disaster mitigation. At the same time, we think it has different feature depending on regional condition that if the area is direct payment target area or not as seen in dummy variable dpD. Therefore, we estimate direct payment dummy and community activities dummy individually and added interaction variable of them dpD#comactD. Through the interaction variable, we are able to see the impact of

Table 4. Result of Tobit model

VARIABLES	Tobit	Marginal
ov65y	2.741	
	(2.699)	
Raincm	0.471***	0.02
	(0.148)	
LandD	-0.325	
	(1.122)	
comactD	6.217*	
	(3.500)	
dpD	1.216	
	(1.236)	
comactD#dpD	-7.169*	
	(3.729)	
Constant	-10.02***	
	(2.119)	
Observations	484	484
Number of munici_code	162	162

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

community activities among two groups of DP receiving area or not receiving area. The result of dpD shows that it is not statistically significant and positively correlated with damage cost. It can be interpreted that area of direct payment target is mostly mountainous area. Therefore, it is likely to have more serious flooding damage, meaning more damage cost. The result of comactD shows positive and statistically significant. The magnitude of the coefficient tells us that even if community activities are implemented in the community's land, it does not mean that they could mitigate flooding damage in case of extreme rain which is observed recent years. However, interestingly, interaction variable of the direct payment and community activities dpD#comact are negative and statistically significant. It indicated that there is the disaster mitigation effect in the area of direct payment target along with active community collective activities. As mentioned before, the direct payment for hilly mountainous area prioritizes community activities. Through the results of dpD, comact and dpD#comact, it is possible to say that the direct payment was efficiently carried out on disaster mitigation. We would like to emphasize that community activity plays an important role to mitigate disaster damage in the direct payment target area. Dummy variable of land type showed negative and not statistically significant. Here also the magnitude of the coefficient tells us that rice paddy filed is usually recognized as having water reserve ability, so it would be consistent with the fact.

2. Predicted rainfall and damage cost of flooding by marginal effect

The Representative Concentration Pathways (RCPs) describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use. The RCPs include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high GHG emissions (RCP8.5). Scenarios without additional efforts to restrain emissions called baseline scenarios lead to pathways ranging between RCP6.0 and RCP8.5. RCP2.6. It is representative of a scenario that aims to keep global warming likely below 2°C above pre-industrial temperatures (ICCP 2014). According to Climate Change Adaptation Information Platform (A-PLAT), the average temperature of Hokkaido under RCP2.6 is estimated increasing 2.18℃ in 2031-2050, 2.14℃ in 2081-2100. The extreme scenario. The point of attention is that flooding damage could affect not only that site, but also surrounding area. It means that sustainable maintenance of farmland and related infrastructure by community are necessary to preserve function of farmland.

Table 5. Amount of change of rain at sub-prefecture level under RCP8.5

	Sub-prefecture	Amount of Change of Rain(mm) (Y2076-2095)-(Y1980-1999)
	Hokkaido total	120.054
1	Soya	87.7653
2	Kamikawa	192.5452
3	Rumoi	162.2401
4	Ishikari	74.76388
5	Sorachi	140.2344
6	Shiribeshi	13.0203
7	Okhotsk	28.7023
8	Nemuro	85.0165
9	Kushiro	104.9755
10	Tokachi	119.9071
11	Iburi	183.3101
12	Hidaka	281.5633
13	Oshima	107.2116
14	Hiyama	164.1408

Table 6. Predicted damage of flooding under RCP8.5 (thous. yen)
*average of municipalities in the sub-prefecture

	Sub-prefecture of Hokkaido	Current damage*/ha	Predicted damage/ha
1	Soya	212.0085	215.7442
2	Kamikawa	759.8798	763.9616
3	Rumoi	289.9921	294.3035
4	Ishikari	86.50152	90.54213
5	Sorachi	1873.642	1878.044
6	Shiribeshi	2397.419	2402.219
7	Okhotsk	134.4961	137.4338
8	Nemuro	207.8592	211.8997
9	Kushiro	826.7118	830.5376
10	Tokachi	181.85	185.5549
11	Iburi	385.927	389.9451
12	Hidaka	32.67772	37.47425
13	Oshima	535.4107	539.7997
14	Hiyama	942.0969	946.8984

Source: Estimated by NonHydrostatic Regional Climate Model (NHRCM05). (Meteorological Research Institute of Japan)

IV. Conclusion

Multi-functionality of farmland such as disaster prevention is losing especially in less-favored lands where they face farmland abandonment due to depopulation and aging problems. To restrain farmland abandonment by direct payment could be one of the measurements for mitigation of disaster damage. Regarding of efficient use of direct payment, we examined relation between disaster damage cost and direct payment and role of community's collective activities on preservation of farmland. We found out aging farmers had negative impact on damage cost. To secure stakeholders for disaster mitigation, it is necessary to consider shift from individual family farming to new entities of agriculture such as private company or agricultural cooperation. Through the results of dpD, comactD and dpD#comactD, we would like to emphasize that community activities are important to mitigate disaster damage as the part of direct payment program. It also means that direct payment is used efficiently where community's farmland preservation activities are executed. The community activities of farmland preservation are required especially in less-favored area where it is likely to be target area of the direct payment. We would like to see more detailed community capacity issue in our future research.

It would be hard to stop unusual pattern of rain fall, rural depopulation and aging problem in short period of time in reality. However, it is possible to aim at securing responsible entities to increase the number of stakeholders who can maintain community land. In the age of climate change, we would face more serious disaster in near future. Our result is estimated with extreme scenario of RCP8.5, but currently no one is optimistic about increasing disaster frequency toward climate change. Even though efficiency of direct payment was examined indirectly, we could conclude that result of farmland preservation activities and government intervention could number of days of extreme rain will increase 1.16times more in 2031-2050 and 1.14 times in 2081-2100. Under RCP8.5 scenario, it estimates that temperature will increase 2.10℃(2031-2050) 5.35℃ (2081-2100) and the number of days of extreme rain will be 1.16times(2031-2050), 1.30times(2081-2100). In our study, because of data availability, RCP8.5 is used to predict damage cost of flooding in 14 prefectures of sub-prefecture of Hokkaido. According to Japan Metrological Agency, if rainfall has recorded 30mm in 3-hours, a storm warning is issued. We have the data of the number of the warning in each sub-prefecture in the future and gained marginal effect of the extreme rain of 30mm+ on the flooding damage cost. Therefore, we

calculated flooding damage cost under RCP 8.5.

As we see in the table 6, predicted damage cost per ha of flooding is estimated by data of regional climate change model (NHRCM05) and marginal effect of rain.

Based on this data and applied marginal effect of rainfall variable from result of Tobit model, we estimated damage cost of flooding under RCP8.5.

Since we assume increase of damage as linear, it could be underestimation, but still we are facing increase of damage of flooding along with increase of rain fall under

lead disaster mitigation. To keep multifunction of farmland is precondition for sustainable development in rural area through conservation of qualities and values of farmland. Even though we observed disaster mitigation by direct payment to see the efficient use of the payment, the result of conservation of farmland could contribute to the arguments of efficiency. It is also linking with verification of relation between importance of farmland conservation and sustainability. For more disaster mitigation activities, community capacity is a key factor as seen in the variable of community activities. This is also seen in the neo-endogenous rural development theory that capacity building of partnership and its regulation for fostering community capacity are necessary for bottom-up and endogenous development which induces sustainability. The results of this research could bring the evidence of importance of farmland conservation and community capacity for sustainable rural development.

As limitation of this study, due to data availability, we have to exclude some municipalities from the analysis. Also, damage cost includes some of the agricultural related facilities around the farmland but we could not distinguish which facilities are they. We could exclude main infrastructures such as irrigation canals, dams, bridges but still some of the private or community irrigation system might be included in the damage cost. Even so, community collective activities for farmland preservation are including facility management. Therefore, it would be not seen significant error on the data set. Also, not all the abandonment was restrained by direct payment as we mentioned.

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