A FRAMEWORK BASED ON A STOCK-FLOW MODEL FOR EVALUATING SUSTAINABILITY IN HILLY AND MOUNTAINOUS AREAS

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ABSTRACT

It is important that new political measures be implemented for the hilly and mountainous areas of Japan. This paper proposes a method that examines the stocks in the mountains and general inflow and outflow relationships within/to the region. The study uses a framework for evaluating decaying processes and the overall existing situation. The fieldwork shows the achievability of sustainable conditions by understanding the flow dependency of the usage of stock.

Keywords: Regional Planning, District Planning, Land Use

1. INTRODUCTION

The keywords of the national land policy in the postwar era in Japan were “the balanced development of national land,” the prerequisite being economic development and population growth. The development of hilly and mountainous areas (HMA) was supported by revenue transfer from economic activities in urban areas and public works projects. In Japan, however, the population started declining in 2005 as a result of a low birth rate and an aging population. Therefore, it is important to address the necessity, the significance of their existence, and the self-reliant development and implementation of new policies for HMA that face the difficulty of continuing support in the conventional system.

National land structural changes in Japan coincided with industrial structural changes that were advanced with urbanization. That is, aside from urban areas, the decline of agriculture and forestry has changed the land situation in a major way. Agricultural regions in Japan are categorized into four regions: urban regions, flatland agricultural regions, hilly and mountainous agricultural regions, and mountainous agricultural regions (the latter two are known as HMA). Many flatland agricultural areas have unregulated, sprawling developments, the same as suburban areas. However, because of urbanization in these areas, a decline in population was prevented.

The flatland areas largely consist of gentle slopes and large lots, and thus recently this has helped to revitalize agriculture. On the other hand, HMA, defined as an area of less than 20% cultivated land and more than 50% forest, are facing the significant onset of a low birth rate and an aging population—in some areas over 50% of the population are over 65 years old[1)]. The Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) estimated[2)] that 423 villages will disappear within 10 years, and this will lead to the serious decline of HMA.

As described above, it is useful to figure out what stocks are kept in these areas as a framework for analyzing the process of the decline of HMA, and to consider possible policy directions for recovery and sustainability. Furthermore, it enables us to comprehend the possible effects on other areas by analyzing corresponding flows.

In this study, flow is divided into inflow and outflow. Inflow is the input to an area to maintain its stocks, and outflow is what is released from the area which maintains and improves the quality of life by consuming and utilizing stocks and their relation to nature. Outflow includes the multilateral functions of forests and agricultural land, such as carbon dioxide absorption or watershed protection. This needs to be understood as it provides benefits for national land, including urban areas. Continuous circulation of the two flows while maintaining the appropriate balance and amount makes the area socially sustainable. Based on the definition introduced by the Brundtland Commission[3)] as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” the idea of sustainable development is that the production of flow enables environmental load reduction and ensures quality of life for residents by accommodating diversification of the lifestyles of future generations without stock depletion.

Using the above framework, this will be analyzed not only from the point of view of the decline of an area, which is accompanied by a residential population decrease or aging society, but also the way in which to produce flow—utilizing stock by understanding stock and revealing its potential.

The purpose of this study is to propose a methodology for describing the relationship between inflow and outflow generated by stocks held in HMA. Using this framework, additional value or

an existing value will be analyzed and a method for considering the measures of sustainability improvement will be presented.

2. STOCK/FLOW COMPREHENSION FRAMEWORK FOR HMA

In this study, HMA is considered by village (administrative district or agricultural village, known differently in each area). Each village has different characteristics and/or identity, and has stock and flows. Understanding stocks and flows enable us to acknowledge the current situation of the village.

(1) Understanding stock

In the field of economics, stock is categorized into three elements as: 1) nature (land), 2) labor, and 3) capital. According to the definition of the American Institute of Industrial Engineers (AIIE), stock is categorized as 1) human beings, 2) facilities and 3) materials. Ohno[4)] has mentioned that the current way of managing local resources in paddy fields, glebes, and forest land in mountain villages is important when considering environmental issues. Soda[5)] pointed out that maximum utilization of local resources promotes local industry. He used the word 'local resources' as defined by Sakamoto et al.[6)] as 1) natural resources, 2) cultural resources, and 3) human resources. Dasgupta[7)] divided production basis into system and capital bases and defined the capital bases as 1) artificial capital, 2) human capital, 3) knowledge, and 4) natural capital. Meadows[8)] pointed out the importance of the natural environment for considering capital and categorized this as 1) well-being, 2) human capital and social capital 3) built capital and human capital, and 4) natural capital. Uzawa cited the natural environment, social infrastructure, and system capital in the concept of common social capital and mentioned that the persistent, stable sustainment of these three items could enable the establishment of a society that is appealing to human beings.

Capital is discussed as natural capital and artificial capital in the concepts above; there is also semi-natural capital, between which natural capital is improved by human beings. Artificial forests or terraced paddy fields appear to be natural capital, but in fact they are semi-natural capital, created for more efficient agriculture or forestry, or because people settled in areas unsuitable for those purposes. As natural capital it is neither maintenance-free, nor fixed as an infrastructure asset, and so could function semi-permanently with the appropriate maintenance. Though this capital was maintained by humans, various values such as the growth of artificial forests or the functions of the protection of the watershed would be lost or reduced if maintenance were to be neglected. Semi-natural capital exists mainly in HMA and is not usually found in urban areas.

In the above categorization, in this study, HMA stock are defined as 1) region-specific knowledge and technology, 2) human capital, 3) artificial capital, 4) semi-natural capital, and 5) natural capital, as shown in Table 1.

Table 1 – HMA villages' stocks

1) Knowledge /Technology	2) Human Capital	3) Synthetic Capital	4) Semi-Natural Capital (Intermediate Space)	5) Natural Capital
Traditional farm crops Traditional local product Foresting technology devolution Understanding of forest land classification Ecotourism etc.	Workers within the areas Workers outside the areas Local residents Management entity Subsidy (Government assistance） Fund NPO etc.	Infrastructure (Dam, hospital, school, water and sewerage) Housing etc.	Natural forest (Secondary forest) Artificial Forest Degraded forest land Agricultural land (field) Abandoned crop land Storage reservoir etc.	Natural forest (Primary forest) River Ecosystem etc.

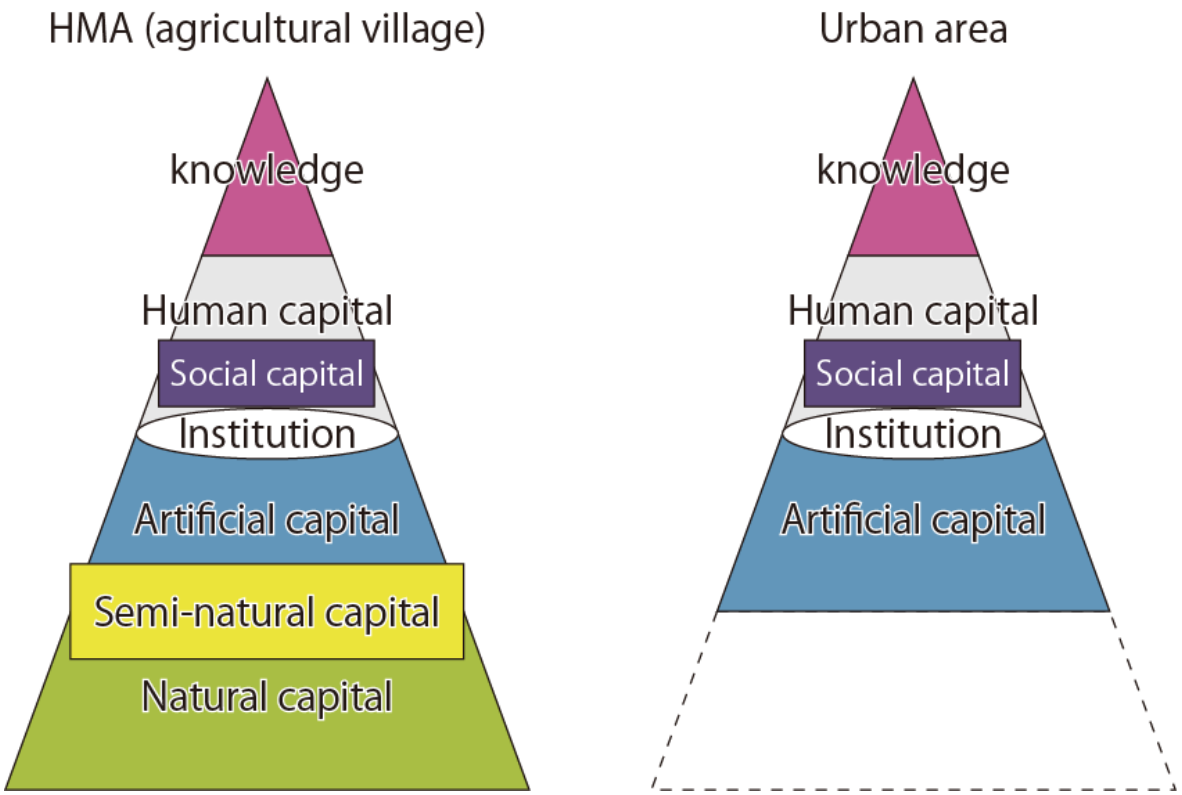

Figure 1 – Disparity and layering between HMA and urban stocks

(2) Understanding flows

In this section, the relationship of inflow and outflow to each stock is understood. Figure 2 shows a simplified image of the transition of HMA and urban areas.

During the Edo era, the exchange of materials and products between HMA and urban areas and a recycling-oriented society complemented each other. Population (labor) movement from HMA to urban areas was low and life was sufficient with the work within each area. In addition, trade with overseas territories was limited to particular areas and stocks because of the policy of national isolation. In other words, sustainable activity was possible by keeping stocks and the amount of corresponding inflows and outflows constant.

After the industrial revolution, industrialization advanced in urban areas, accompanied by the gradual movement of labor from HMA, and land resources (timber or agricultural products) became outflows from HMA. A structure was formed in which HMA received income based on outflows. The greatest outflows from HMA to urban areas were observed at that time.

However, the population drain of HMA accelerated and labor stock were dramatically decreased because the industrial structure shifted from primary to secondary or tertiary industry during the period of high economic growth. Additionally, both inflows and outflows of urban areas formed strong relationships overseas, and stock was made to increase. As a result, HMA lost out to price competition even when holding rich stock, and both inflow and outflow decreased. A shortage of funds and human resources led to the lack of stock maintenance and the deterioration of multiple functions of HMA. Currently, there is no complementary relationship between HMA and urban areas, but HMA are maintained by subsidies from urban areas. HMA produce only a few outflows and excessive inflows as rich stocks lost their quality and value due to a lack of maintenance. Urban areas now have complementary relationships overseas.

3. UNDERSTANDING THE DECLINE OF HMA

(1) The structure of industrial decline

Industry is the activity that changes stocks into outflows and it is essential in establishing self-sustaining HMA. The major industries within HMA are agriculture, forestry, and construction. Agriculture and forestry are based upon regional stocks that have consistently declined in the postwar period. This structure and related issues is summarized in Figure 3. On the other hand, the construction industry is based upon capital inflows from urban areas, and by using these inflows, regional activity could be revitalized, which would then lead to outflows. However, the reduction of public works projects has lead to a decline in the construction industry. There are also cases of infrastructure projects that have not resulted in

the revitalization of areas. Without drastic structural reform, the continuous decline of HMA is inevitable.

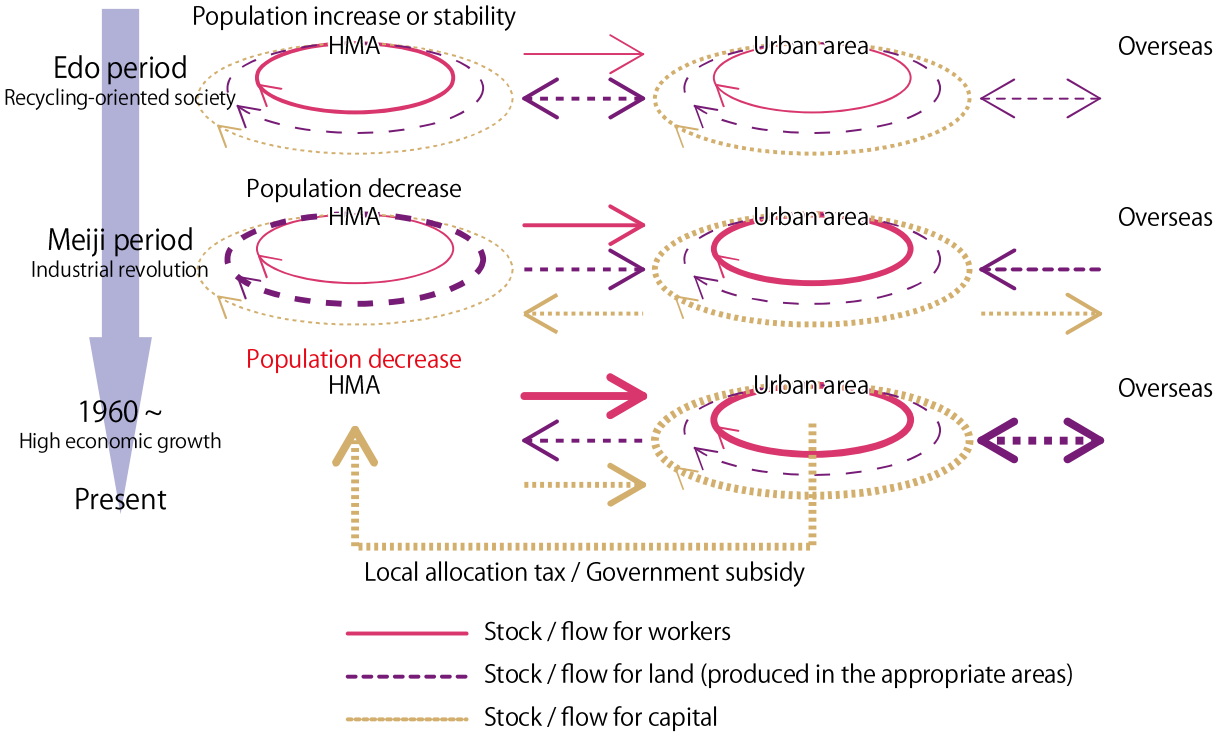

Figure 2 – Transition of stock/flow on villages of HMS

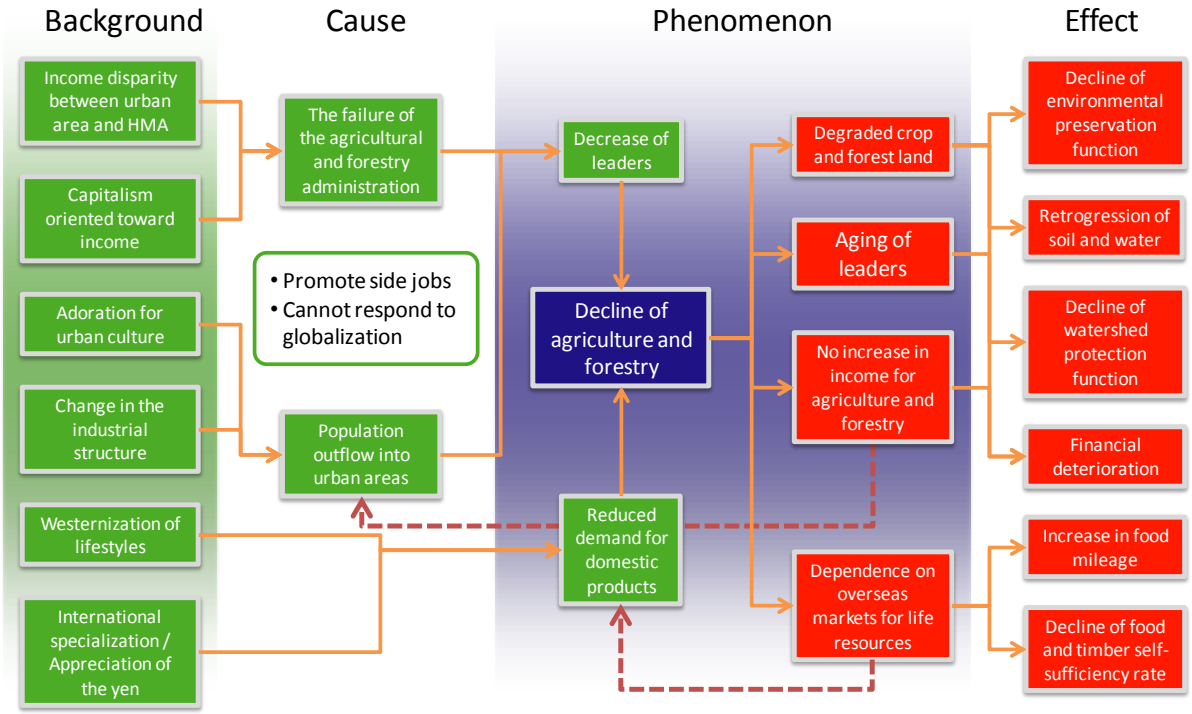

Figure 3 – Mechanisms of the decline of agriculture and forestry and its various problems

(2) The worsening employment situation

According to an analysis of the process of decline in Kawamoto town, Shimane Prefecture, conducted by Sakuno[10], the degradation of industrial civil service agencies (mainly national agencies) and limited employment opportunities caused by the failure to welcome new enterprise has led to a decline in the local economy. In addition, Sakuno[11] investigated Kitsugi town, (present-day Unnan city), Shimane prefecture, where population drain was prevented because of corporations located in the town and the existence of a university within commuting distance. This situation is a decline in stock value in HMA caused by an industrial structure shift from primary to secondary or tertiary industries. A drain on the population is inevitable in an HMA without a neighboring city because of the desire of young people to obtain better education for stability and a higher income in secondary or tertiary industry.

(3) Future possibilities for agriculture and forestry

Recently, the stock of agricultural land and forests has been considered to be able to function and produce multiple outflows, and has become important from the point of view of environmental issues. According to the Ministry of Agriculture, Forestry, and Fisheries of Japan, HMA makes up 70% of national land, 80% of forest land, 40% of agricultural land, 40% of the total number of farmhouses, and 50% of agricultural villages. The Science Council of Japan[12] estimated the monetary value of the multiple functions of forests at 70 trillion yen. Thus, a huge loss to society is expected with the dismantlement of HMA and the decline of various stocks.

It is necessary to increase the number of workers in forestry to secure proper maintenance (for example, tree thinning) since 41.2% of forests in Japan are artificial forests and most of those are in HMA. In addition, the future revival of the forestry industry is possible because of 1) the revision of domestically-produced timber, as there are negligible price margins between imported and domestic timber; 2) initiating the branding of timber by the forest certification system of the Sustainable Green Ecosystem Council (SGEC) or Forest Stewardship Council (FSC); and 3) starting specific accountability for maintenance.

In agriculture, global competitiveness has declined and the food self-sufficiency ratio in 2007 was 39% due to two contradicting policies: a reduction in rice acreage, and land improvement. The amendment of the Agricultural Land Act deregulated the condition of leases for non-farming families or non-agricultural production corporations, enabling these families or corporations to take on the agricultural land in the context of maintenance or recovery of the agricultural land from the point of view of food security. As a result, there will be improvements in the productivity of farmhouses. In tourism, agricultural experiences are also becoming popular. Agricultural productivity in HMA is limited. However, saving soil/flood control effects and watershed protection of terraced paddy fields is improving, and the demand for

tourism-based agriculture is increasing. These activities may possibly be accelerated if subsidies for the revival of the abandoned farms are increased in the future.

4. UNDERSTANDING REGENERATION CASES OF HMA

Recently, there have been new approaches in cases of the regeneration of HMA. When reviewing such cases through the framework of stock-flow, we have the mechanisms of the creation of inflow and outflow based on existing stock use. This section introduces two regeneration cases.

(1) Ohara village, Fukui Prefecture

In the Meiji period, Ohara village had, at its peak, a population of five hundred. In this period, there was a substantial HMA population and the major industries were forestry and sericulture. Thus Ohara shared its prosperity in the textile industry with Katsuyama city, located 10 km away. However, after 1960, young people moved to other urban areas due to competitive factors: the textile industry declined, a major road connecting Ohara to Katsuyama was built, and extraordinarily heavy snowfall damage occurred.

Today, Ohara's population is just three (the population of those actually living there is two, and they are both over 65). Due to this, it is impossible to maintain the village and it is just a question of waiting for it to disappear. However, there is a wide expanse of farmland that, although appearing to be large for this population of two, has been very well managed. Forest, too, has been well maintained rather than desolated.

The main stock of Ohara consists of terraced (small-area) paddy fields, artificial forests, and second-growth forest—semi-natural capital. As artificial capital, there are forest roads, several abandoned houses that need some maintenance, and a temple (built 1913). Such stocks produce flows in and out of Ohara. For example, the second-growth forest area attracts walkers on the forest roads who are classed as inflow, with QOL area of enjoyment as an outflow. The artificial forest makes inflows of a working place for those in the forestry cooperative, and serves as an additional function other than lumber sales, to keep the multiple functions of the forest.

Such flow effects construct new stock. Since 2006, students from Fukui prefecture have come to Ohara to restore the abandoned houses. One abandoned house was changed into a guest house. This guest house is in an outflow accretion area used for green tourism such as experiencing agriculture and restoring farmland. Another farming area is used by residents of inner Katsuyama City and people from other urban areas. This effect helps to decrease the

abandoned farm areas. Thus, although Ohara has only two residents, a good exchange of people maintains the forests and agricultural land stocks, so inflow and outflow are abundant.

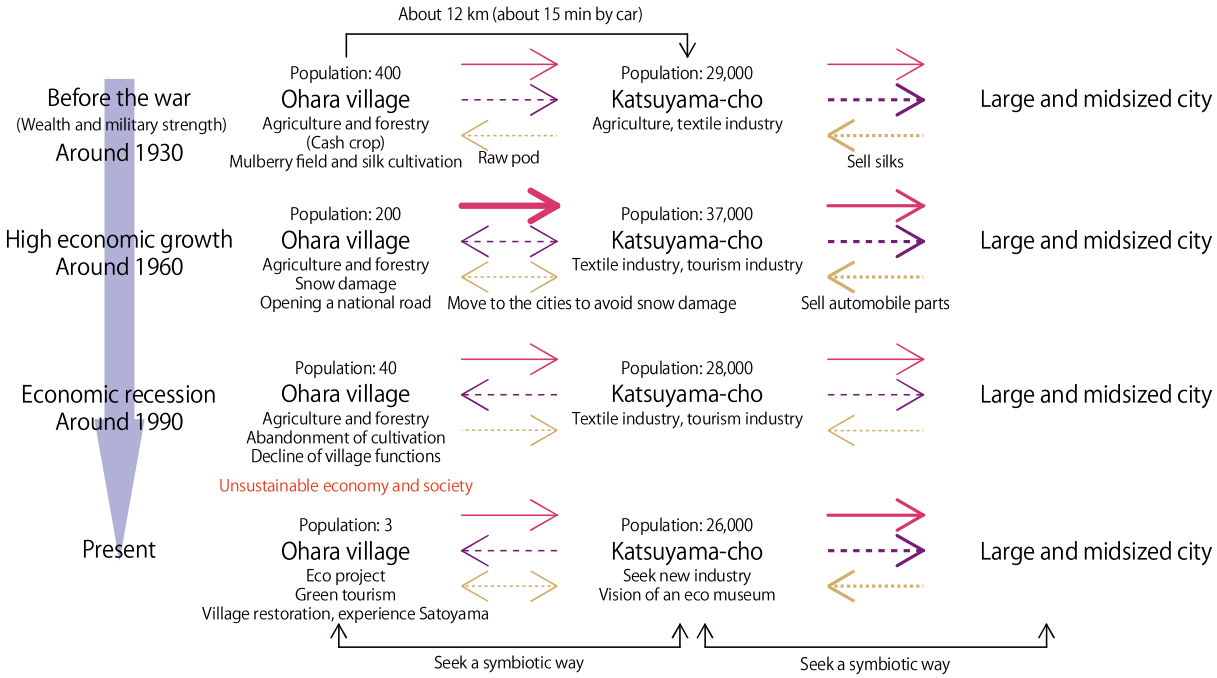

Figure 4 – Transition of stock/flow on Obara village

(2) Shinmori (Asuke-Toyota), Aichi prefecture

Shinmori district (in the Asuke area) is in the famous sightseeing area of Kourankei. However, the population is decreasing and in 1970 the area was selected by the government looking at countermeasures to depopulation. The inner Asuke area has changed to a sightseeing area, other areas are mountainous areas, and people work in agriculture and forestry.

Shinmori is a short distance from the inner area of Asuke, where people previously worked in agriculture and forestry. They lived only self-sufficiently; in the surrounding mountains and rivers, there were not enough farm areas to produce more. Following Japan's rapid economic growth, people moved to the cities to make more money. The main cause of this was the ability of industries such as the automobile industry in Toyota City to absorb this labor. The city is approximately 20 km away. In 2009, Shinmori's population was 168, with 31% of the population being classed as elderly.

The main stock of Shinmori is small-area paddy fields, abandoned farms, devastated artificial forests, and second-growth forests as semi-natural capital; there are a few abandoned houses classed as artificial capital. This is similar to other depopulated areas. But there are many people nearly retiring age—as human capital—and they produce flows. They are taking action in the movement to recover abandoned farms with people who live in urban areas such

as Nagoya City or Toyota City. These people are part of the inflow effect. People from urban areas make outflows as they obtain QOL through recreation and make their own rice and vegetables, then return home with the produce (outflows). The effect has been the rejuvenation of abandoned farms. In addition, multiple functions were restored when the farms were regenerated.

The people of Shinmori's next target is to encourage settlement. To get those residing in the cities to reside in HMA, in effect the flow of human capital stock (or so-called "I-turn") is not easy to do. HMA have important climatic differences and common practices, and in many cases, it is necessary to adapt oneself to the area. In Shinmori, developing new stock by building allotment gardens from abandoned farms creates opportunities for repeat visitors from urban areas to include this above-mentioned process of adaptation. Now Shinmori is planning new housing stocks for when it becomes apparent that some people desire to live in the village.

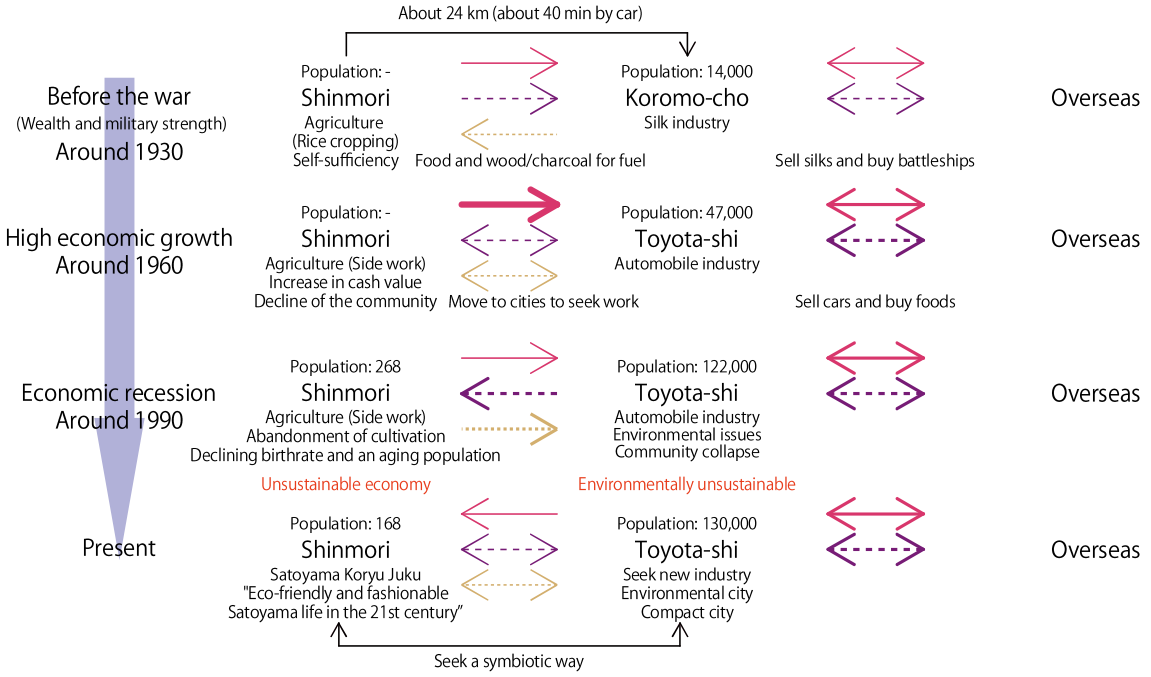

Figure 5 – Transition of Stock/flow on Shinmori district

(3) Structural outline of new flows

Aside from the previous two areas introduced, there are many new flows from HMA stocks: 1) introduction of know-how/techniques for the processing/branding of agricultural/forestry products (inflows) and resultant outflows of highly value-added products; 2) an increase in forestry workers (inflows) are an additional stock, plus maintaining forests for CO2 absorption for emission trade. Figure 6 includes the potential of HMA.

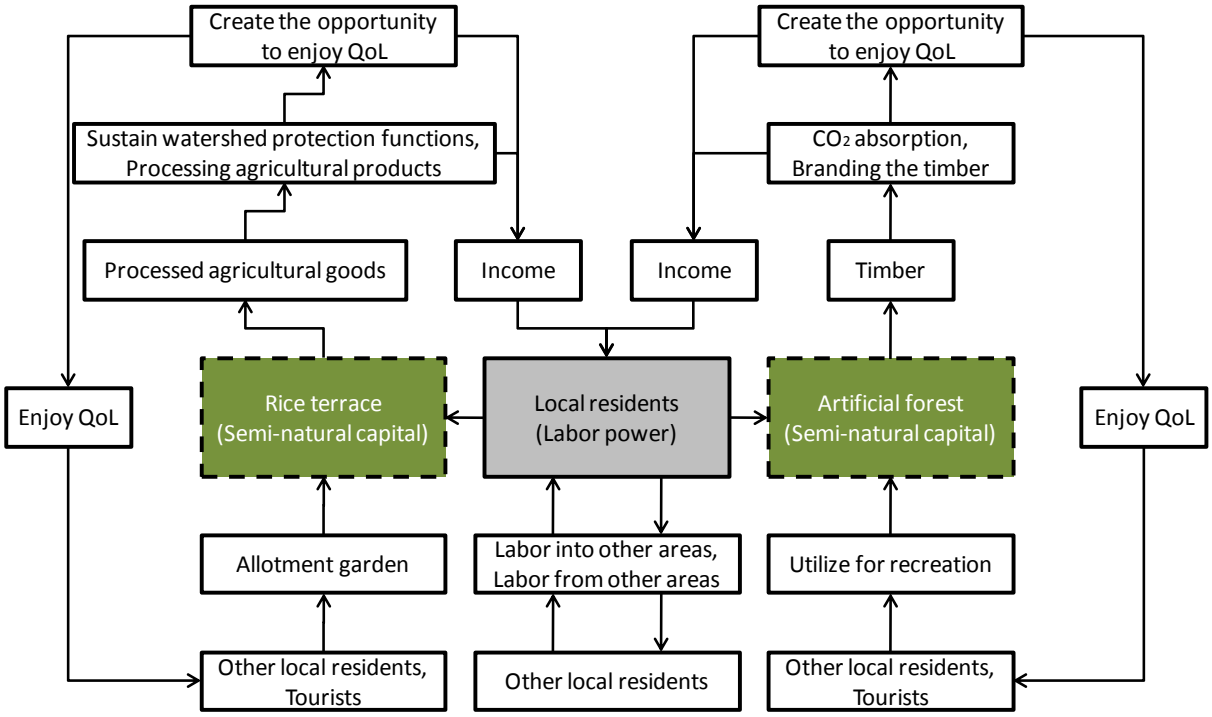

Figure 6 – Reevaluation of existing stocks and the prospect of new flows

Several flows from Figure 6 are made from semi-natural capital. This makes maintenance and advancement possible to make sustainable flows on HMA. This is a new viewpoint that includes maintenance and advancement for semi-natural capital to enforce measures. Table 2 indicates improving measures for forest and agriculture stocks.

Forest	Existing capital enforcement	Increase in people engaged in forestry
		Branding the timber (Institutions such as SFC and SGFC)
		Promotion of local/domestic consumption based on local production
	New capital enforcement	Appropriate maintenance (thinning)＝Conservation of multiple functions
		CO2 absorption and response for biodiversity
		High quality tourism and business expansion
Agricultural land	Existing capital enforcement	Heighten the added value for processed specialty products in the area
	New capital enforcement	Conservation of watershed protection function for the maintenance of rice terraces
		Revitalization of the tourism industry (such as allotment gardens and agricultural experiences)

Table 2 – Measuring the flow-creating capacity of semi-natural capital

5. CONCLUSION

This study has shown the current situation that HMA in Japan are facing, and has described the necessity of HMA and their future potential. Based not on evaluating HMA by indexes such as residential population and the industrial situation, but on understanding stocks and flows of the region, a framework for expressing how much economic value and QOL is created in the region was developed.

In the future, the authors will study several stock conditions in each HMA, especially the potential for recovering poor stock. The social necessities of the region will be defined by the relationship of flows created and the efforts to generate flows. Through quantitative evaluation of such necessities, differences of each village will be analyzed and considered, as well as what type of areas are sustainable and whether the areas have the potential to change to be fully sustainable.

Acknowledgment

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