

The 5-2 Project's Significance Considered from the Viewpoint of the Control Theory's Application

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1. Introduction

The results of the 5-2 project are expected to provide the bases for land use which enables “sustainability” or “sustainable development.” On the other hand, in order to contribute toward realizing “sustainable development,” I have researched the methodology for controlling human activities properly by applying the control theory. This paper examines the 5-2 project's significance from the viewpoint of the application of the control theory.

2. Proper Control of Human Activities and the Control Theory

I have tackled “environmentology,” aiming at resolving various environmental problems comprehensively. I have defined environmentology as “a systematized science whose purpose is that human beings control their activities properly on this finite planet” (Fujihira, 1999, p. 304). According to this definition, human beings “control” their activities properly in order to resolve various environmental problems comprehensively. Thus, I conceived the application of science that specializes in “control” such as “system control engineering.”

System control engineering can be utilized for whatever relates to “control.” In actuality, it has been utilized not only by engineering such as mechanical engineering and electrical engineering but also by other fields such as economics, medical science, and agriculture. Therefore, it can also be applied to the challenge of human beings controlling their activities properly.

In order to solve a problem by applying system control engineering, first of all, it is required to identify a “controlled object,” “the purpose of control,” and a “controlled variable.” In the case of aiming for the comprehensive resolution of environmental problems, “controlled objects” are identified as “human activities” because

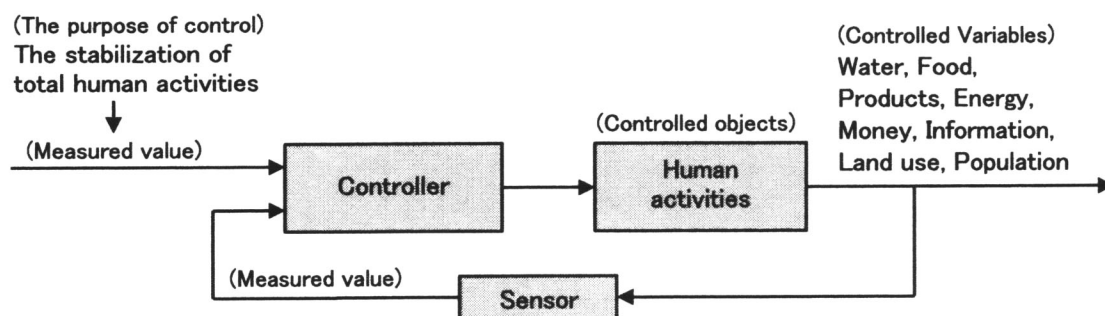


Figure 1 The control system for “proper control of human activities”

environmental problems are caused by human activities. There are various kinds of human activities such as activities performed by an individual, a family, and a corporation. “The purpose of control” is identified as “the stabilization of total human activities,” and this factor is explained in the next chapter. “Controlled variables” are the factors that belong to human activities and need to be regulated for achieving the purpose of control. From among them, I selected eight important controlled variables: “water,” “food,” “products,” “energy,” “money,” “information,” “land use,” and “population” (Fujihira, 2004 a). Following the identification of the controlled objects, the purpose of control, and controlled variables, a controlled variable is measured by a sensor, and the measured value is compared to the desired value that is derived from the purpose of control. Lastly, a “controller,” which means a device for controlling an object, is designed and implemented so that the difference between the desired value and the measured value is adjusted. Figure 1 shows the schematic block diagram for the control system in which the above factors are combined.

3. The Stability of Total Human Activities

“The stabilization of total human activities,” which is identified as the purpose of control in the last chapter, corresponds to realizing “sustainable development,” which is one of the keywords in the global environmental era. Sustainable development is defined as “development that meets the needs of the present without compromising the

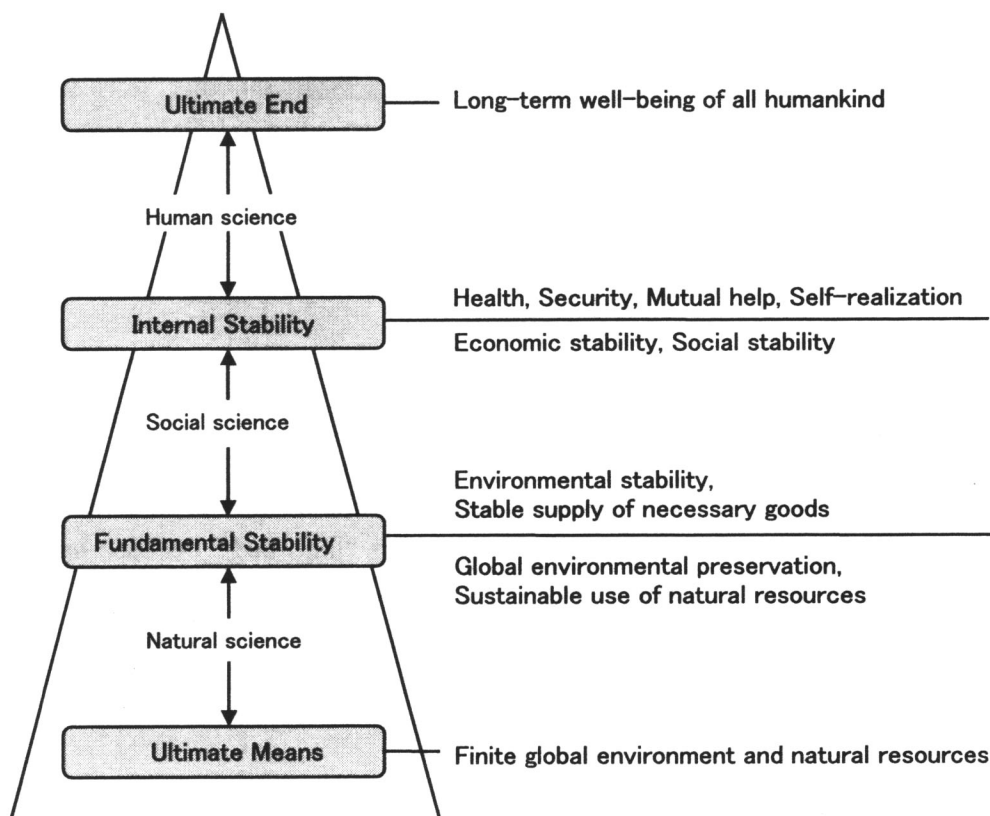


Figure 2 The model of “the stability of total human activities” (Fujihira, 2004 b)

ability of future generations to meet their own needs (World Commission on Environment and Development, 1987); however, this definition is abstract and hard to imagine. Then I have drawn Figure 2, which shows the model of “sustainable development” or “the stability of total human activities.”

The “long-term well-being of all humankind,” set at the top of the triangle in Figure 2, is the ultimate end. On the other hand, the “finite global environment and natural resources,” placed at the base of the triangle, is the ultimate means, or real absolute limitations. When human beings attempt to design a desirable society between the ultimate means and the ultimate end, it is essential to realize the “Fundamental Stability.” That is to say, global environmental preservation stabilizes the foundations where human activities are performed, and the sustainable use of natural resources connects to a stable production of necessary goods. Based on such environmental and material stability, human beings can realize the “Internal Stability.” In other words, the economy and society are stable, and a society fulfills the basic conditions for people’s well-being such as health, security, mutual help, and self-realization.

In short, Figure 2 shows that “the stability of total human activities” requires both the Fundamental Stability and the Internal Stability.

4. The 5-2 Project and the Control Theory

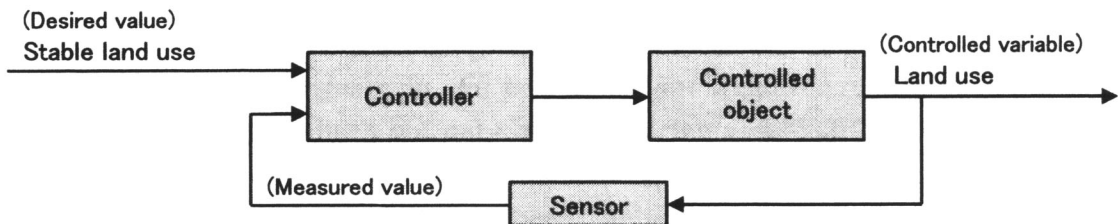


Figure 3 The control system for “proper control of land use”

(1) Desired Value of Land Use

When the research content of the 5-2 project is considered from the viewpoint of the application of the control theory, the control system can be shown as in Figure 3. In this project, a controlled object is not identified. Designing a controller is also excluded from the subjects of this project. The controlled variable is “land use,” because human activities which relate to land use such as forest lumbering or dairy farming activities are varied hypothetically and the influences of such human activities are examined. Moreover, the expected results of the project include providing bases for the desired value in land use, or the “stable land use.”

(2) The relationship between Human Beings and their Surroundings by Land Use's Classification

The first step toward providing the bases for the "stable land use" is to show the range of influences caused by land use. Then I have classified the relationship between human beings and their surroundings by land use's classification, as shown in Table 1.

The row in Table 1 shows the major categories of land use such as forest and farmland.

On the other hand, the column in Table 1 shows the relationship between human activities and their surroundings considered from the three viewpoints, namely, "environment," "production of necessary goods," and "places for human activities." The "environment" relates to "environmental stability and global environmental preservation," which is one of the two requirements for the "Fundamental Stability" shown in Figure 2. The "environment" can be divided into the five elements: "atmosphere," "water," "soil," "creatures" and "artifacts." The "supply of necessary goods" relates to the "stable supply of necessary goods and the sustainable use of natural resources," which is the other requirement for the "Fundamental Stability." The necessary goods can be classified into the four categories: "water," "food," "products" and "energy." These categories correspond to the four controlled variables that relate to the supply of goods, between eight controlled variables which are identified in the 2nd chapter. The third viewpoint "places for human activities" relates to "well-being" and "Internal Stability" in Figure 2. That is to say, it is important whether human beings can feel a sense of well-being when they perform their activities in various places. Performed human activities can be divided into the three groups: "daily life," "occupation" and "leisure."

Incidentally, in order to realize the "stable land use," it is necessary to optimize the relationship between human beings and their surroundings by land use's classification, shown in Table 1.

Table 1 Relationship between human beings and their surroundings by land use's classification

		Forest	Farmland	Grassland	Waters	Built land
Environment	Atmosphere	Absorption of CO ₂	Emission of nitrous oxide	Emission of methane (from livestock)	Absorption of CO ₂	Emission of CO ₂ Pollution from industry and traffic Urban climate
	Water	Precipitation Water on and in the ground	Precipitation Irrigation water Water on and in the ground	Precipitation Water on and in the ground	Precipitation River water Lake water	Precipitation Water on and in the ground
	Soil	Forest soil	Farmland soil	Grassland soil	Sediment	Soil in cities
	Creatures	Forest ecosystem (trees, plants, birds, animals, insects, etc.)	Farmland ecosystem (tame plants, etc.)	Grassland ecosystem (livestock, grass, etc.)	Water ecosystem (plankton, fish, shellfish, algae, etc.)	Creatures in cities
	Artifacts		Agrichemicals Fertilizer Plastic green-houses	Barns	Ships Harbors Water-power plants	Buildings Roads & bridges Manufactured goods (clothes, machinery, etc.) Waste products
Supply of necessary goods	Water		(Groundwater)		Water for life, industry and agriculture	(Groundwater)
	Food	Gathered and hunted food	Grain, Fruit, Vegetables	Meat, Eggs Milk	Fish, Shellfish Algae	Processed food
	Products	Timber	Materials from agriculture (cotton, hemp, etc.)	Materials from livestock (hides, wool, etc.)		Buildings, Roads & bridges. Manufactured goods ↑ [Underground resources]
	Energy	Firewood Charcoal	Energy from agriculture	Energy from stockbreeding	Water-power generation	Fuel refining Thermal power generation Nuclear power Generation ↑ [Underground resources]
Places for human activities	Daily life					Rest, Eating Housework, Care
	Occupation	Forestry Gathering & hunting	Agriculture	Stockbreeding	Fishery Tourism	Industrial production Food processing Service jobs
	Leisure	Hiking Forest bathing Gathering & Hunting	Vegetable gardening		Angling Bathing Sightseeing	Hobbies Pastime

5. “Cooperation between Natural Science and Humanities” and “Cooperation between Researchers and Inhabitants”

As shown in Figure 4, the methodology of this project includes two types of cooperation: “cooperation between natural science and humanities”, and “cooperation between researchers and inhabitants.”

(1) Cooperation between Natural Science and Humanities

The cooperation between natural scientists and humanities researchers results from the following necessity. As shown in Table 1, the relationship between human beings and their surroundings can be considered from three viewpoints: the “environment,” the “production of necessary goods” and the “places for human activities.” It is natural science to deal with the changes or stability of the “environment.” To cite an example of the changes of land use in a forest region, it is natural scientists who predict the influences of lumbering a forest on the atmosphere, water and soil. On the other hand, it is mainly the humanities, namely human science and social science, to deal with the “supply of necessary goods” and the “places for human activities.” As for the influences of lumbering, it is social and human scientists who study the economic value of timber or charcoal, and who study the provision of places for forestry or the disappearance of places for leisure activities. Thus, the cooperation between natural scientists and humanities researchers is essential, in order to clarify the land use’s influences which spread in various directions.

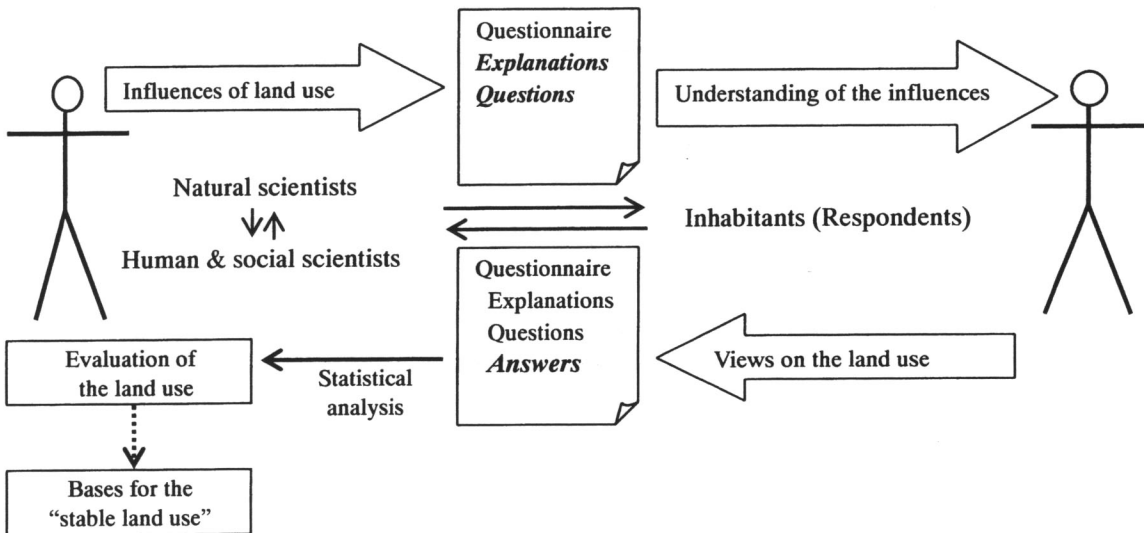


Figure 4 “Cooperation between natural science and humanities” and “cooperation between researchers and inhabitants”

(2) Cooperation between Researchers and Inhabitants

In the 5-2 project, information is exchanged between the researchers and inhabitants through a questionnaire. In this procedure, first of all, the land use's influences which are studied by the natural scientists and humanities researchers are incorporated into explanations and questions in the questionnaire. Next, the inhabitants who answer the questionnaire read the explanations and the questions in the questionnaire, and understand the influences of the land use. Then the inhabitants write down their answers which include their views on the land use. Lastly, the researchers statistically analyze the inhabitants' views on the land use in the questionnaires and obtain an evaluation of the land use.

In the above exchange of information, the researchers and the inhabitants compensate for each other's weakness and reach the evaluation of the land use. First, the researchers study the land use's influences which cannot be recognized by the inhabitants and transform them into comprehensible information to an ordinary person. For example, the inhabitants can hardly recognize the changes of the components of the atmosphere or water which are caused by lumbering a forest through their own senses; however, they learn such changes from the research information in the questionnaire. On the other hand, an important role that inhabitants perform is the "synthesis of plural values estimated by different criteria" which is the researchers' weak point. For example, lumbering influences not only the environment such as the atmosphere, water and soil but also timber production and leisure activities. It is difficult for researchers to synthesize these various influences and evaluate that lumbering. On the other hand, the inhabitants express their views on the land use through the questionnaires, synthesizing the land use's plural influences which are evaluated by using different criteria. As a result, by analyzing the questionnaires statistically, the researchers can finally obtain the evaluation of the land use.

6. Aiming at the Stable Land Use

In this project, the two different types of cooperation shown in the previous chapter enable the evaluation of land use. In addition, if the following thoughts are adopted, the bases for the "stable land use" will be able to be provided.

First, it is required to adjust the balance among phenomena which are taken as the "influences of land use." As shown in Figure 3, the "influences of land use" referred to in a questionnaire affect the "views on the land use" expressed by inhabitants. For example, if researchers focus their concentration on the change of water quality among various influences caused by lumbering a forest, the views from the inhabitants will attach too much emphasis on the water quality. Therefore, the researchers need to make a well-balanced selection of phenomenon from the "influences of land use," considering also a phenomenon's effects on the other phenomena.

Second, it is necessary to utilize Geographic Information Systems (GIS) to the utmost. A GIS consists of computer hardware and software for recording, analyzing and

displaying spatially distributed data, and GIS data can be easily updated. Therefore, in this project, a GIS is used for showing the influences of land use. In addition, GIS data should be also utilized for the information in the questionnaire. In the 21st century, in order to resolve problems about land use, which also relate to global environmental problems, it is essential for the inhabitants who deal with such problems to share a bird's-eye view of the earth's surface. Accordingly, if the researchers depict bird's-eye sights of land use's influences by using a GIS and incorporate these sights into the questionnaire, they can expect to extract the views which connect to the "stable land use" from the inhabitants. Incidentally, here returning to the control system that relates to this project shown in Figure 3, I can indicate that a GIS performs an important role as a "sensor" in this control system.

Furthermore, I have also researched the methodology of "environmental education" or "education for sustainable development" (ESD) by applying system control engineering. Now, I am planning to incorporate this research's results into the methodology of the 5-2 project and am aiming at increasing the significance of this project.

Resources

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