

# ECOLOGICAL APPROACHES TO THE RELATIONSHIP BETWEEN THE CONSERVATION OF NATURAL ENVIRONMENT AND DEVELOPMENT\*

Makoto NUMATA

## Introduction

Recently the International Center for Integrated Mountain Development (ICIMOD) was established by UNESCO in Kathmandu, Nepal. The First International symposium and Inauguration was held at the Royal Nepal Academy from 1 to 5 December 1983 entitled "Mountain Development 2000: Challenges and Opportunities." There I presented a paper "Conservation of the Himalayan Environment in Relationship to Development" which is in the same direction as in the present paper (Ecological approaches to the relationship between the conservation of natural environment and development "(Numata 1984).<sup>1/</sup>

What is the natural environment? In the classification of science, we usually adopt the division of natural, social and humanistic sciences, particularly in the curriculum of Japanese universities. The environment will be divided similarly. A German philosopher, RICKERT (1898)<sup>2/</sup> classified natural and cultural sciences on the basis of concepts of nature and culture. Nature means physical and biological existences excluding man, and culture means existences with value under the influence of man. The RICKERT's classification is simple and understandable for our discussion. Concretely, the natural environment includes physicochemical elements such as air, water and soil and biological elements such as plants, animals and microorganisms. When they are structured and organized, a biocentric environmental system will be established. The natural environment is a large part of an anthropocentric environmental system (human ecosystem) on the earth. As opposed to the natural environment as above, the

---

\* Read at the International Workshop on Environmental Management for Local and Regional Development: Alternative Approaches to Regional Development into the 21st Century, 9-13 June 1985, held by United Nations Centre for Regional Development, Nagoya, Japan.

cultural environment has history-oriented, non-repeated characteristics with value in historical, sociocultural and psychological fields.

At the international workshop on the "Integrated Ecological Study of Human Settlements" held by UNESCO/UNEP in Paris in 1974, the first day's discussion was concentrated on ("What is ecology?") The definition of ecology as a modern natural science is very clear in the field of biology. However, many of the participants (about twenty) were of an opinion of extending the covering range of ecology, i.e., that ecology is not only "natural ecology", but also "social and cultural ecology". The latter is almost similar to "human ecology". Therefore, the so-called ecological approach means not only that of natural ecology but also that of sociocultural ecology.

In September 1984, there was an International Expert Meeting on Ecological Approaches to Urban Planning at Suzdal, USSR. The themes were 1) integration of social, natural and technical sciences in urban planning and policy: methodological and theoretical aspects, 2) integration of social, natural and technological sciences for urban policy and planning: ecology and economics, 3) case studies of urban planning based on ecological considerations and utilization of integrated scientific information, and 4) public participation in improving the quality of urban environment: interrelationships between scientific knowledge and human experience. This is a recent tendency of ecology in a wide sense.

## **1. Development and Environmental Conservation**

### **1.1 Destruction of Natural Environment by Development**

When we refer to development, it usually means urbanization, industrialization, dam construction, road construction, etc. This large-scale technology has wrought a large-scale destruction of nature in recent times. Results of technology on atmosphere, water and soil as abiotic factors, as well as plants, animals, and microorganisms as biotic factors, will be analysed on the basis of modern science. However, the assessment and evaluation of the effect of these impacts are very difficult particularly from the socioeconomic and political viewpoint. In Japan, the Environmental Assessment Act has not been established by the Parliament in spite of the continuous effort of the Environment Agency. Even among the ministries under the same cabinet, Ministries of

Construction, and Commerce and Industries fight against the Environment Agency, and on the other hand, the Liberal Democratic Party behind the cabinet has not agreed with the proposal of Environment Agency with the support of capitalists and enterprises.

Besides the modern technologies, the primary industries, such as agriculture, forestry and animal husbandry has also conducted a large-scale destruction of nature. When we talk about the destructive function of agriculture, many people do not agree with this idea. However, after man's appearance on the earth, farmlands were developed through the burning and felling of natural forests. I have been on scientific expedition in Eastern Nepal several times over the past twenty years. During that time, the forestland was markedly decreased while farmland has increased everywhere. Agriculture has a conservational function to some degree, however, we must recognize the other side, i.e., the destructive character of agriculture, such as shifting cultivation.

When I went to Eastern Nepal in 1981 (NUMATA 1983)<sup>3/</sup> I went to the Mt.Barntse area with several colleagues and about 100 porters. There were very few camping sites for so many people for one night. There are some camp grounds left especially for mountaineering, however, they are at long intervals and are not sufficient for scientific reserch. The greatest cause of it is the extension of farmlands to support people's life with a rapid growth of population.

Agriculture is a plant industry utilizing nature. However, according to TANSLEY's terminology (TANSLEY 1923)<sup>4/</sup> he classified vegetation, natural, semi-natural and artificial. Primeval forests are natural, croplands are artificial, and weed, ruderal vegetation and coppices are semi-natural. In this sense, agriculture was the first destroyer of natural nature after man's appearance on the earth. Agriculture has characteristics of nature destruction as well as of nature conservation.

## 1 . 2 Population Pressure

As mentioned above in the example of Nepal, population growth has required the extension of farmland to support it, and soil erosion and landslides have occurred. At the United Nations Conference on Human Environment in 1972, EHRLICH put forth his idea of zero population growth at the Peoples Form (cf.EHRLICH 1968)<sup>5/</sup> However, it was considered as an intrigue of the white man or a 'plot' by developed countries for African people who did not agree with this idea. COMMONER (1971)<sup>6/</sup> also has another

idea of "misuse of natural resources" which was rather effective for destruction of nature than population growth.

Nevertheless, population growth has a great impact on nature. People need not only farmlands, but also their residence area. In some rich countries, they can import food from agricultural countries, however, in poor countries they cannot import food, so must produce food on their own land. After I observed the state of nature conservation of many countries, I concluded the greatest cause of destruction of nature is the rapid population growth.

### 1.3 Sustainable Development

There was a very impressive seminar on "sustained yield forestry" held by the Environment Policy Institute of East-West Center, Hawaii in December 1978. The utilization and management of forestlands in relation to their potential were discussed there. The potential of forestlands means not only timber production, but also the carrying capacity for recreation (for example, less than 300 persons per 20 ha will maintain a good balance in nature), the carrying capacity for wildlife (for example, about twenty territories for pairs of great tit will be retained during the breeding season), etc. Thus, integration of various kinds of forest potential is the so-called sustained yield forestry which will not have a detrimental effect. The concept of sustained yield was raised in the grazing land to maintain a level of herbage production under some grazing pressure of a herd of cattle and duration of grazing. The so-called proper use of grassland means sustained yield utilization. The MSY (maximum sustained yield) for whales has a similar meaning as the guideline for practical whaling. To extend the concept of sustained yield multipurposively will be the guideline for rational use and development of natural resources which will balance with conservation.

In the Fifth Tropical Ecology Symposium held in April 1979 in Kuala Lumpur, Malaysia, the main theme was "Ecology and Development" the proceedings of which were published in 1980 (FURTADO ed.1980).<sup>2)</sup> In this symposium, research, education and strategies for ecodevelopment, land use policy and planning, etc., were discussed. For ecodevelopment, minimizing the industrialized area and distributing small-scale industries, with the concept of carrying capacity for industrial development are very important. Co-existence of man and his environment with appropriate technology is

also important. "World Conservation Strategy" by IUCN/UNEP/WWF has also a strong philosophy of ecodevelopment balanced with conservation.

#### 1.4 Conservation of an Ecosystem

Human beings used their extraordinarily strong influence among organisms on the earth to change nature. The example of the Aswan-High-Dam which destroyed the ecosystem of the Nile River Basin teaches us many things. Concentrating the Nile's water behind the huge dam lets the nutrients of the river water from Ethiopia deposit at the bottom of the dam. Then the water used for irrigation in the lower reaches has poor nutrition, and, ironically, people must use the irrigation water added to chemical fertilizer manufactured by electricity supplied by the plant of the dam-site. The irrigation channel was completed with concrete, and the marsh snail as an intermediate host breeding vigorously caused the spread of snail fever. Lastly sardine has not been harvested because of the decrease of plankton at the mouth of the river. The connexion of action and reaction in the Clementsian terminology leads a counter-attack of an ecosystem. Such repercussion of nature revolution can be predicted by environmental assessment based on the structure and function of an ecosystem, however, it can only be observed in retrospect.

I studied before an ecological approach to the afforestation for sand prevention. The usual method was to plant sandbinding grasses and sedges such as *Carex kobomugi* covered by sand prevention fences (MITSUDERA and NUMATA 1964).<sup>8/</sup> After stopping flying sands like this, pine saplings were planted. However, such biological methods require much time, and then a technological method using concrete bank for sand prevention was replaced, and pine saplings were planted behind the concrete bank. Then, the salt spray damages were found just behind the bank by the wind turbulence. Sandy soil is used instead of concrete to construct the sand prevention bank, and sandbinding grasses and sedges were planted on the sandy soil, that is, both use of biological and technological methods are most desirable. Over-confidence of technology is an anti-ecological idea. In the agricultural field, an integrated pest control can utilize natural enemies as well as pesticides. Such an integrated method and concept is most important in solving environmental problems from the viewpoint of an ecosystem.

In the case of miracle rice, its high productivity is realized by advanced irrigation

system, sufficient fertilization, sufficient pesticides, mechanization of agricultural work, etc. If the support system is not sufficient, even miracle rice cannot realize its productivity potential, though it has a genetic possibility. In other words, high productivity of miracle rice is realized within the framework of the structure and function of a regional ecosystem.

#### 1.5 Natural Ecosystem as Genetic Resource

As many people recently point out, rapid destruction of tropical rain forest is an important problem. However, temperate forests and grasslands as genetic resource are also important. Rapid advancement of biotechnology, particularly techniques of gene recombination has brought successful results, and pollens and seeds are kept in gene banks.

Some of constituent species of tropical rain forests have exterminated without taxonomical identification, therefore it will be a useful method of genetic preservation that pollens and seeds are kept in the gene bank to be used for research if necessary.

Preservation of species collected in botanical gardens and zoos is a method used from old. However, in case of botanical gardens, there are various forms from a sort of university institute to a recreation ground, which have a general rule of open to the public. Botanical gardens attached to the university have a main object of research, even open to the public, and they collected and grew a lot of plants.

What kind of botanical garden is good to play a role as the gene pool? If simply thinking, to collect and grow as many plants as possible is good. However, there is a limitation of climate and soil. For that, there is the Chibodas Botanical Garden on a mountain as well as the Bogor Botanical Garden in lowland in Java Island (Indonesia). In case of Botanical Gardens of the University of Tokyo, Koishikawa (Tokyo) in lowland versus Nikko in highland is a similar example. Botanical gardens as exhibitions have many exotic plants as well as indigeneous plants. Those plants are planted as a mixture in Bogor and in Rio de Janeiro. Foreign visitors want to see indigeneous plants separated from exotic plants.

From the ecological point of view, it is undesirable that various species are planted as individuals, but they should be planted included in a vegetation to which they belong. They should be situated in a floristic composition with some characteristic species

having high fidelity. Stratification of forests and grasslands and combination of growth forms such as erect, prostrate, climbig, etc, should be considered, too. If a botanical garden is composed of such vegetation types, indigeneous plants grow well in the framework of vegetations which play a role of the gene pool.

As an conclusion, it is best to preserve indigeneous ecosystems as it is in different sites, such as wilderness areas, strict reserves in national parks, national natural monuments and others.

## 2 . Ecological Approach to Development and Conservation - Examples in Japan

### 2 . 1 Construction of Roads in Mountainous Areas

In 1973, the possibility of construction of a mountain motorway in the Mt.Daisetsu National Park was discussed in the Natural Enviroment Conservation Council. At that time, chairman of the Council proposed the guideline that construction of mountain motorways in the alpine and subalpine zones should not be permitted, though a member strongly opposed it, because the guideline might be a barrier to construction of the forestry motorway to establish high mountain plantations.

The extension of the Venus Line (a subalpine highway on Utsukusigahara Heights) was also debated in the Council. Enviroment Minister, Mr.OISHI stopped the extension, however construction of the highway was later permitted. Logic of permission is that the degree of naturalness along the route of the highway is low. The reason was that the *Abies veitchii* forest along the route is a secondary forest felled in the Meiji Era, and the *Festuca ovina* pasture is a semi-natural vegetation under the grazing pressure. However, the *Abies veitchii* forest is very similar to a natural forest including rich wildlife fauna, and the *Festuca ovina* pasture is one of indigenous grassland types particularly in the subalpine zone. If a motorway passes through the forest, wildlife fauna is divided into two sections. In that case, a specialist proposed a bridge for animals. However it is only a desk-plan. Though the degree of naturalness from the standpoint of succession is not so high in the forest and pasture along the highway route, the degree of conservation is very high. The degree of naturalness is similar to the degree of succession (NUMATA 1978)<sup>9/</sup> from the pioneer to the climax stage. It has no value concept, however, the degree of conservation is a man's judgement from the viewpoint of value concept. Therefore, the importance of various vegetation types

should be judged by the degree of conservation, but not by the degree of naturalness. The Utsukushigahara Heights belong to quasi-national park because of the beautiful scenery of grasslands with *Rhododendron japonicum* which is made by the cattle-raising. Beautiful spots in national parks with various rhododendrons (*Rhododendron brachycarpum* on Mt.Donden of Sado Island, *Rhododendron kiusianum* on Mt.Kirishima in Kyushu, etc.) are all products of grazing in natural stands. In Utsukushigahara Heights, some of grassland parts having rhododendrons were denuded by bulldozers, and European forage grasses and legumes were sown for milk-cow grazing. I do not deny animal husbandry in the subalpine zone, however, I reject it in the core zone of a national park. The *Festuca ovina* pasture is an indigenous type grassland, however, the orchard grass-timothy-ladino clover sown pasture is an exotic vegetation which is not fit for the landscape of a national park. Recently the Biosphere Reserves are designated by UNESCO/MAB. The reserve has the core, buffer and cultural zones. In the above case, the core zone has a cultural area which is not fit for the idea of national parks and reserves.

One more striking example is the Southern Alps Super-Forestry Motorway in Central Japan. The so-called Super-Forestry Motorway is a multipurpose motorway stressing tourism. The highway passing through high places in the subalpine zone is not considered as a forestry road. In fact, a responsible person of Forestry Agency said that there was no plan to fell the subalpine natural forest and to make plantations. It is not effective as the countermeasure for village people's migration to other developed areas. The period of usage of the road is limited to May-to-October. The Ecological Society of Japan recommended the Preservation Plan of Natural Forests to the Science Council of Japan and the Government in 1964 including the preserve area of Kitazawa Pass of Southern Alps covered by natural coniferous forests. In spite of that recommendation, the route of the Super-Forestry Motorway passing through the Southern Alps National Park was, planned and began to construct. After that, Environment Minister, Mr.Oishi requested to stop temporarily the continuation of construction of the road, because of geological instability. At that time, 160 m was left for the completion of the Motorway. I proposed to leave that last part of 160 m as a monumental reserve. However, the agreement to connect the last part of 160 m was obtained in the Council, and land slides and erosion have occurred every year particularly in the typhoon season after the completion. The villages along the road have now heavy burdens to repair land slides



every year.

As I mentioned earlier, a bridge between two parts separated by a highway was proposed. But animals utilizing the bridge may be dog, vole, and the like. When the route of a highway was planned to pass through a wetland including a rich flora of insectivorous plants, the construction authorities recommended us to transplant those plants to paddy fields. The ideas of bridge, transplantation, etc. are dangerous alternatives for nature conservation. It is apparently nature conservation, but in fact it is anti-conservation.

## 2.2 Expansive Afforestation Policy

Forestry is usually considered as a tool of increasing of forested areas. However, it contributed to the greatest destruction of nature in Japan after the war. During the war time, the timbers were felled for the purpose of war. After the war, the Government (Forestry Agency) adopted the policy of extensive plantation, such as *Larix kaempferi* in the north or high altitudes, and *Cryptomeria japonica* and *Chamaecyparis obtusa* in the south or low altitudes. For that, natural forests of *Fagus crenata* were felled all over the country.

In addition to this, the budget of Forestry Agency was separated from the Governmental budget, and Forestry Agency itself must earn all its expenses including salary, facilities and so on by selling the timbers of natural forests. For that, natural beech forests have been mostly felled throughout the country. Recently, some natural stands left in Aomori and Akita Prefectures, etc. are the most important objectives of the conservation movement. The Nature Conservation Society of Japan has "the Conservation Funds for Beech Forests" to which many people have contributed. The natural forest of *Fagus crenata* is the most representative of summer green forests in cool-temperate zone in Japan, which is closely related to the beech forests in Eurasia and North America. After the war, the directors of Regional Forestry Bureaus were said to have upper positions because of conquering and diminishing natural beech forests.

In Hokkaido, there were good stands of conifers such as *Abies sachalinensis* and *Picea jezoensis* which are typical shade trees. The seedlings of those trees must be kept at the nursery covered by screen for several years. The natural forests and plantations of *Abies* and *Picea* in Hokkaido and natural beech forests in northeastern part of Honshu

and in the mountainous zone in Honshu were replaced by the plantations of *Larix kaempferi* after the war. However, the growth of the larch plantations is not always good, and the larch timber is also not good. In the conifer plantation, particularly of *Chamaecyparis obtusa*, Japanese serow has increased the number, and its browsing damage was raised. However, Japanese serow is a special national monument and people cannot kill or seize without the governmental permission. In some villages where the browsing damage by serow took place, people fight against the authorities. This is mainly caused by the change of tree species from *Fagus crenata* of natural forests to *Chamaecyparis obtusa* of plantations which is preferred by serow.

As a result, the expansive afforestation policy adopted by the Forestry Agency after the war was recently been criticized. The expansive afforestation programme has been equal to the expansive nature-destruction programme as a conclusion.

The most important guideline for forestry must be a balanced allocation of natural, semi-natural and artificial forests (not so extensive) in an area. Simple policy only for extensive plantations is not desirable.

### 2.3 Large-scale Grassland Establishment

Following the extensive plantation policy by the Forestry Agency, Ministry of Agriculture, Forestry and Fisheries promoted a new policy of extensive man-made grassland establishment. Japan is under forest climate, and semi-natural grasslands exist under biotic pressures of mowing, grazing and burning. Such kinds of grassland were easily found everywhere before the war. However, the utilization of herbage decreased after the war, because village people do not breed horses and cows, animal husbandry is performed under cover, people do not use grasses for thatch, and so on. We have many national and quasi-national parks with grassland landscape just after the war, such as *Festuca ovina* pasture and *Calamagrostis longiseta* meadow at Utsukushigahara Heights mentioned above, *Zoysia japonica* pasture in Hakkoda National Park, dwarf bamboo (*Pleioblastus chino*) pasture and meadow on Mt.Sambe in Daisen-Okii National Park and Mt.Aso and Mt.Kuju in Aso National Park, and so forth. Such kinds of semi-natural grassland are found only in national parks. Even those, some of them are changing their physiognomy, structure and composition, because biotic factors are weakened.

Besides those reserved areas, large-scale grassland establishment was recommended in relation to the land development programme by the Government. Following this guideline, several large-scale (more than 1,000ha) and many mid-scale (more than 200ha) grasslands were established by large-scale technology. Land surface was denuded, and seeds and fertilizer were distributed from the air. This establishment of American style grassland is not suited to a small, mountainous country like Japan. After denudation on a slope, a large-scale landslide occurred, and then rows of trees were planted along the contour line. There were originally woodlands which were denuded by agricultural machines. Some fragments of woodland should be left, but technicians do not like to leave woodlands because of technological difficulties.

In the Oshima Peninsula of Hokkaido, there were *Zoysia japonica* pastures for horse grazing for long years with thin soil layer on the volcanic ejecta. There were two opinions: (1) maintenance of permanent pasture of *Zoysia japonica*, or (2) establishment of sown grass-legume pastures by governmental subsidy. The latter opinion of development was dominant, and the town assembly decided to establish new man-made pastures. Then, bulldozers denuded the *Zoysia* pasture and foreign forage grasses and legumes were sown. However, there was the volcanic deposit underneath the thin soil layer, therefore there was almost no soil after denudation. Though the fertilizer and water were given for the grass-legume mixture, those passed through the volcanic deposit to the bottom like a sieve. Thus, the development to a new man-made pasture absolutely failed.

I once observed a beautiful pasture along the seashore near Bangor in U.K. from the window of train. Native *Festuca rubra* pasture was from the seashore to the railway, and sown pasture of a variety of *Festuca rubra* was inland from the railway. This is a good example of the allocation of native and sown pastures. Sown pastures are more productive than native pastures, but they are sensitive to severe natural conditions such as salt spray and flying sands.

The Council on Technologies of Agriculture, Forestry and Fisheries published an excellent report entitled "Report on Survey and Research of Land Utilization: Methodological Studies on the Standardization of Land Use Classification" (1963), in which a proper allocation of croplands, grasslands and woodlands was proposed. It is highly evaluated as a cooperative study to pursue a guideline for effective use of agricultural lands aiming at high productivity. But, its central idea is high

productivity, and the concept of environmental conservation lacked. From the viewpoint of environmental conservation of lands, a proper allocation of urbanized areas, industrial areas and rural areas as well as croplands, grasslands, woodlands, natural forests, national parks, etc is important. It is an ecosystemic viewpoint. If it is limited to grasslands, semi-natural, improved, and sown grasslands (pastures and meadows) should be properly allocated.

#### 2.4 Wildlife Conservation

There are problems of overpopulation and damage to the Japanese monkey, Japanese serow, Japanese deer, etc. In Chiba Prefecture where I am now living, there are more than 10 troops of Japanese monkey designated as a national natural monument. Before the war, there were many stands of coppice for fuel and charcoal where the Japanese monkey lived. Coppices have a felling cycle of 20-30 years, therefore the area has a variety of coppices from young (just after felling) to old (20-30 year old stands) which is very suitable for the monkey's daily life (nomadism and nomadic range of a troop).

After the war, coppices (deciduous broad-leaved forests) for fuel and charcoal are not useful in the energy revolution. Coppices in the central part of Boso Peninsula (Chiba Prefecture) were almost felled, and replaced by coniferous plantations (*Chamaecyparis obtusa* and *Cryptomeria japonica*) where monkey cannot live, because of no foods and no playground. On the other hand, researchers tried to feed a group of monkeys to pursue their behaviour and sociological structure, and village people wanted to utilize monkey as a tourist industry. Meanwhile, monkeys increased their population by the feeding, and they extended their home range to paddy fields, vegetable fields, and orchards of villages. This is the so-called "monkey's damage." Radical conservationists insisted that village people should retreat, because people deprived monkey's home ground. On the other hand, village people requested to the Governor to have permission to seize or kill monkeys. Thus, the conflict between conservationists and village people became serious. After the conflict of about 25 years, a new direction has occurred. It is a tactic of driving monkeys into the designated area by the cooperation of village people, researchers, conservationists and prefectural officials with the financial support by the Cultural Agency. It is a trial to limit the living area of a group of monkeys to the designated area by the Government. But, monkeys do not know the border of the

designated area, therefore electric fences, fireworks, and pachinko shooting were used for monkeys to realize the designated area. Prefectural coniferous plantations (*Cryptomeria japonica*, 40 years old) are in the area. It does not suit the monkeys' lifestyle. Then the Prefectural Forestry Section decided not to replant conifers, but to plant wild fruit trees which monkeys like, and deciduous broad-leaved trees in coppices. This is a very drastic decision for foresters. When coppices regenerate as before the war, co-existence of wildlife and man will be achieved. Monkey in Chiba Prefecture is a local problem, however the relationship between wildlife and man is found all over the world. In this meaning, the relationship between wild monkeys and man in Chiba Prefecture is a kind of global environmental problem. Not only wildlife but also natural biota are very important gene pools. For our children and grandchildren and so on, we must preserve the gene pool.

UNEP proposed GEMS (the Global Environment Monitoring System) including health-related monitoring networks, climate-related monitoring networks and renewable natural resources monitoring networks. Preservation of biota including wildlife will be included in the renewable natural resources monitoring networks.

## 2.5 Application of Bio-indicators

The Ecological Society of Japan (1975)<sup>10/</sup> sent a proposal to the Environment Agency in connection with the Global Environmental Monitoring Program of SCOPE. In the proposal, the Government was requested to implement environmental monitoring not only with physicochemical measurements but also with bio-indicators using various biological phenomena of a site. In particular, this includes observing species, the number of individuals, biomass and the community dynamics of existing indicator organisms, and from these estimating past conditions. It is necessary to measure other aspects by bio-indicators when it is not possible to measure them by physicochemical instruments.

Environmental evaluation using bio-indicators has disadvantages as well as advantages. To measure the momentary intensity of a single inorganic factor, the physico-chemical measurement is very useful. But to evaluate the average effect on organisms over a long period of time, or the mass effect on a complex of factors, it is not so useful. The environmental effectiveness to an organism or a community will be

measured by the response of those organisms used as the indicator.

The indicator phenomena of urbanization cover a wide area of physico-chemical, biological, socio-economical, cultural, psychological and political. However, bio- (biological) indicators are mainly considered here.

The concept of bio-indicator originally means to judge an environment by presently existing plants, animals, and microorganisms in the field. On the other hand, the biometer is a method by which to measure environmental conditions using especially prepared plants and animals in the containers. The bio-indicator and biometer indicate a complex of factors as well as any single factor, including biotic factors as well as abiotic factors. The levels of indicator organisms are individuals, populations of a species, plant and animal communities, etc.

Plants and plant communities having indicator values were searched on one environmental factor such as pH, depth of water table, temperature, etc. and an environmental complex such as maturity and productivity of soils, a climatic type, etc. CLEMENTS and GOLDMITH (1924)<sup>11/</sup> tried to measure those environments with especially prepared plants planted in containers. In any event, the methods of bio-indicator and biometer are applied in the field, and on the contrary, the method of environmental bioassay has been used in a laboratory, such as the ratio of abnormal early development of sea urchin in polluted sea waters. The bio-indicator method in a wide sense includes the aspects of biometer and bioassay as well as biological indicator in its original meaning.

Before the so-called environmental problems appeared in 1960's, the bio-indicators were almost used for agriculture, forestry and grazing (CLEMENTS 1920)<sup>12/</sup>. Recently the method of bio-indicator is used for judging the quality of environment, such as ocean, inland waters, air, soil and cities. Among them, the effect of urbanization on the degradation of the quality of environment is very great.

Some lichens, mosses and liverworts are used as bio-indicators of air pollution, and some flowers indicate the acid rain by their leaching. In Japan, some bryophytes used for bryometer and morning glory (*Pharbitis nil*) planted in pots are used as biometers for SO<sub>2</sub> pollution and photochemical smog respectively (MITSUDERA et al. 1974,<sup>13/</sup> TAODA 1972,<sup>14/</sup> 1976,<sup>15/</sup> SUGIYAMA and OKADA 1977)<sup>16/</sup>. Besides these, crops such as rice, *Colocasia*, spinach, stone leek, radish, etc. show the characteristic chlorosis and necrosis in response to ozone. The limit of tolerance and practical utilization of indicator or

phytometer plants are also now being studied.

The concept of bio-indicators has been discussed in detail earlier in my book "*Methodogy of Ecology*" (1953)<sup>17/</sup> Generally it means to judge an environment by presently existing organisms in the field. On the other hand, the biometer method proposed by CLEMENTS and GOLDSMITH (1924)<sup>11/</sup> and SHELFORD (1929)<sup>18/</sup> was to measure environmental condition using biological instead of physico-chemical instruments.

The concept of bio-indicators has been used to estimate macro-environmental as well as micro-environmental conditions. RAUNKIAER (1934)<sup>19/</sup> tried to express a climate on the basis of statistics of life-forms. He called it "the plant climate". Along with the same guideline, we can call plant soil, plant water, plant temperature, plant air, animal climate, animal soil, human climate (for example, sensible temperature and discomfort index), etc. From this point of view, the concept of bio-indicators is the bio-centric environment concept.

Before the so-called environmental problems appeared, the bio-indicators were almost used along the guideline of CLEMENTS (1920)<sup>12/</sup> and ELLENBERG (1950)<sup>20/</sup> That is, plants and plant communities were used for judging a suitable site and suitable intensity for growing crops, trees, etc. For that, plants and plant communities having indicator values were searched on one environmental factor and an environmental complex. The biometer method became practical when they found some sensitive structural and functional responses to environmental changes.

After the environmental problems appeared, the concept of bio-indicator methods has been changed and concentrated in application of the methods to evaluate the degree of degradation of human environment (NUMATA 1982)<sup>21/</sup>

## 2 . 6 Effects of Local Development

The contents of local development are of various kinds, however, I found from a helicopter that housing sites and golf links made a large-scale nature destruction in the Tokyo Metropolis and its adjacent areas. Preparation of the housing site like the Tama New Town changes the natural topography by bulldozers, builds concrete high buildings on the denuded land, and paved the soil surface. Thus, the rain water does not penetrate, enter sewer pipes, and then go into a river. The time between the beginning of rain and runoff peak shortend by local development of a watershed area. The rain

water is the input of water into an area, however it flows out frequently without utilization.

We want revegetation on naked soil surface without pavement, but it is difficult to grow plants on the red subsoil. According to a newspaper, resident of the Tama New Town bought fertile black soil and covered the red subsoil. Denudation and later buying surface soil is quite foolish. Preparation of housing sites is necessary in relation to population growth. However, the housing sites like the Tama New Town mentioned above destroy local ecosystems, and produce various effects such as changes in water balance, wind system, etc.

New construction of golf links is not permitted in Chiba Prefecture. The large-scale nature destruction by golf links is reprehensible. Sometimes, golf links were said to be good for their revegetation. However, construction of golf links destroys topography and original vegetation by bulldozers like residence construction, and then sows seeds of exotic forage grasses with much amount of fertilizers, pesticides and herbicides. Water flowing out of a golf link enters a river with toxic substances and eutrophication effect. Besides these, there is a problem of exclusive use of a large area by a small number of people.

Local development includes tourist industry, industrialized zone, motorway network, etc. It is not always bad to construct recreational facilities as a base of tourism. Future recreation should have not only man-made facilities like a big wheel, observation tower, waterworks, but also devises to use and enjoy nature itself. If we make recreational facilities with the same idea of residence construction as mentioned above, we must realize that more money and time must be expected in order to regenerate excellent nature.

Regarding construction of industrial zone, particularly on the coastal landfill, there are difficult problems on soil conditions, distribution of sulphur oxides, nitrogen oxides, hydrogen fluorides, etc. Recently chimneys are very high, and the effect of pollutants of coastal industrial zone is found at distant places 15-20 km apart from the seacoast. The transportation of atmospheric pollutants is not prevented by the tree plantation around the factories which is effective to stop flying sands, salt spray and dust.

Waste water and warm water affects the life of oceanic organisms such as algae, shells and fishes. Landfill affects the flow of sea current. The front of the landfill is usually covered by concrete, and original seashore and mudflats were lost. The mudflat



is utilized by migratory sea birds and the site of self-purification. Thus, an ecologically very important place in the front of seashore has been lost by the coastal development. The healthiness of coastal vegetation, surface temperature, the flow of smoke, stagnant place, etc. are clarified by the remote sensing and the ground truth, and effect of local development to an area can be diagnosed more accurately than before.

Development around lakes or ponds affects the water body with eutrophication by nitrogen and phosphorus. As a result, water bloom occurs and many fishes die from deficiency of oxygen. These phenomena are well known in Kasumigaura, Suwa, and Biwa Lakes. To control the conditions of eutrophication, inhibition of phosphorous detergent, purification of waste water, and so on were adopted as countermeasures.

Wetlands are very fragile ecosystems. For example, Ozegahara wetlands (marshes and bogs) of Nikko National Park is a typical wetland in Central Japan which has been preserved in good condition for a long time. However, the idea of utilizing the water of Ozegahara for electricity was raised after the war. A group of conservationists fought against this idea and established the Nature Conservation Society of Japan in 1951. Ozegahara wetlands are extremely important scientifically as a nature reserve and recreational area. As a result, the hydroelectricity development using Ozegahara was cancelled, and a scientifically very important site was preserved.

The preservation of wetlands is promoted by an international treaty "Convention on Wetlands of International Importance especially as Waterfowl Habitat" (Ramsar Convention), and a part of Kushiro Wetland is designated by the treaty, particularly for the protection of Tancho crane and its habitat. However, in some villages around the wetland, sown pastures are extended for cattle raising. The fertilizer and animal waste (dung and urine) come into the natural wetland, and the species composition of wetland is changing. This is an example of nature destruction by agricultural development.

In the midst of Kushiro Wetland, a motorway has been constructed, and the water table and floristic composition of wetland vegetation are changing.

## 2.7 Urbanization and Industrialization

The process of urbanization includes changes in the land use pattern, distribution of population, forms and levels of industrialization, transportation network, hydrological cycle, the amount and extent of pollution, etc. Impact of urbanization and responses of

living things to the urbanized environment have the distributional pattern and health of plants and animals, human physical and mental health, behaviors, psychological responses, the self-domestication of man to higher forms of civilization, bio-indicators, biometers, laboratory bioassays of environmental quality, etc. Including food chains of which man is an integral part, the flow of energy, material, people and information, the metabolism of a city, its carrying capacity related to human well-being in various senses, etc. are important items to be solved (NUMATA 1976, 1978).<sup>22/</sup>

Among the conceptual frameworks developed at the Paris meeting on human settlements, one common opinion was that human settlements act together to become a city. A city or cities and their immediate environment act together to form an urban system into which matter, energy, people and information flow from other urban systems and out of which organized and degraded matter, degraded energy, people and information flow. Project 11 of MAB originally aimed only at the energy flow of urban and industrial systems. However, the title of the project has been changed to include more integrated studies. The objectives of MAB are closely linked to decision-making and planning, but at this stage of study, we are conducting a problem-oriented basic research for those purposes.

In the Nature Study Park where we have been studying since 1950, various trees died over the last 25 years and the floristic composition of vegetation has changed. Usually the survival ratio of trees is deteriorated by air pollution. In fact, the concentration of SO<sub>2</sub> has become higher, until recently. However, it would not be wise to assume that the two phenomena are directly related. These are an earlier cause and a later effect. A complex sequence of cause and effect is involved here.

The survival ratio of the climax tree, *Castanopsis cuspidata* var. *sieboldii*, is rather high, but its health condition is not always good. Its vigor is gradually declining, due to the defoliation done by the leaf miner and other noxious insects from May to June, every year. The same thing holds true in the case of the deciduous trees. This abnormal and unseasonal defoliation increasingly deteriorates the vigor of trees. One of the causes to the outbreak of such insects may be the disappearance of insectivorous birds in the area. The disappearance of some birds results from urbanization, such as noise, air pollution and decrease in the number of habitats. The combination of such complex causal relations reduces the survival ratio of the trees. This means a deterioration of the environmental quality of the city, which in turn affects man's health and behavior

patterns. On the basis of various accumulated data, a simulation model of the urban ecosystem will be established. It will include the flows of energy, materials and population as well as the network of components related to man's well-being. Our present study can be considered a part of the ecosystem studies based on these guidelines.

## 2 . 8 Immediate Nature Around Us

In International Symposim on Environmental Education held in Tokyo in 1974 (NUMATA, BENNINGHOFF and WHITFORD 1977),<sup>23/</sup> PIGNATTI from Italy pointed out the coexistence of man and nature in Japan after observing the forests around shrines and temples. In fact, there is no forest around the Christian church in Europe, however, Europeans know well how to enjoy nature itself, such as Vienna's Forest, Boulogne Forest, etc. There are natural or semi-natural forests around or in European cities. In Japan, local governments established many memorial forests, such as Prefectural Forest, Citizen's Forest, etc. However, such a kind of forest is only nominal, and it is almost a kind of playground, that is, wide lawn, row of cherry trees, a patch of *Cryptomeria japonica* plantation, tennis court, and so on. It is quite different from Vienna's Forest. In Japan, the grove of the village shrine and temple is natural or subnatural forest which has religious meaning. Before the war, we have coppices for fuel and charcoal around us, but now their area is very much diminished, though timbers of *Quercus serrata* and *Quercus acutissima* are used for bed logs of Shiitake mushroom production. On school campuses, there are non-agricultural weeds and ruderal plants which are immediate nature around us as well as coppices.

On the other hand, Japanese people are skillful at creating Japanese style gardens such as Korakuen of Okayama, Suizenji Park of Kumamoto, Kenrokuen of Kanazawa, etc. The Japanese are also skillful and like to make Bonsai and Ikebana (flower arrangement), which are miniatures of nature.

Herbs of a flower bed or planted in a pot were used as biological materials in schools. This is also a miniature of nature. When we use the seeds of crops and horticultural herbs as biological materials in schools, they germinate easily with water, oxygen and temperature. However if we use the seeds of weeds and ruderal plants, the seeds of *Ambrosia artemisiifolia* germinate with the vernalization effect of low temperature in the winter, and *Plantago asiatica* and *Eragrostis ferruginea* germinate

without oxygen. Germination of weeds and ruderal plants is heterogeneous which is really naturalistic. Crops and horticultural herbs easily follow man's imperative and do not have self-insistence. If we say immediate nature around us, we should notice its importance, utilization and conservation.

## 2.9 Establishment of Conservation Areas

Endangered species, plants and animals which are rare and have limited distribution, and so on, are designated as natural monuments. But wildlife and its habitat is designated as wildlife sanctuary. National and quasi-national parks have Special Protection Areas, First, Second, and Third Special Areas, and Common Areas among which Special Protection Area is strictly preserved. As modification of natural monument, there is Natural Protection Area such as Ozegahara Wetlands. Wilderness Areas are designated as Strict Reserves such as Minami-Iwo Island. Besides these Natural Environment Conservation Areas is designated as scientific nature reserves. Some national forests are designated as Scientific Protected Forest.

The designation as protected areas mentioned above is diversified into several agencies, such as Natural Protection Areas by Cultural Agency, Wilderness Areas and National Parks by Environment Agency and Protected Forest by Forestry Agency.

Protection of the Japanese serow is guaranteed by the Forestry Agency. It is designated as a protected species by the Cultural Agency, its habitat is designated as a protected area by Environment Agency, while effects of browsing damage are safeguarded against by the Forestry Agency.

In any case, diversity and disunity of Governmental policy according to Agencies should be improved. Natural Environment Council connecting directly to the Cabinet as a superstructure beyond ministries and agencies will be more effective.

## 2.10 Environmental Education

Environmental education covers such a wide range of subjects as nature study, natural history, nature conservation, environmental conservation (including anti-pollution) and environmental science (NUMATA 1978).<sup>24/</sup> Promotion of environmental education after the war strengthened by the Nature Conservation Society of Japan which

requested Ministry of Education, Science and Culture to promote environmental education. The recommendation said that school curriculum must have a unit of nature conservation with clear-cut aims and methods not only in science, but also in social study, literature and moral education.

In the 11th Pacific Science Congress held in Tokyo in 1961, the research natural reserves were recommended to be established to the Japanese Government (JIBP-CT 1966).<sup>26/</sup> The 64th Parliament in 1970 was called Kogai-Kokkai (pollution-assembly). That protection of people's health and conservation of environment are more important than economical development was certified. The expression "the harmony between environmental conservation and economic development" was not preferred there. After that, anti-pollution education was adopted in social study in schools as a kind of environmental education.

At the opportunity of symposium of the International Society for Vegetation Science being held in Japan in 1974, an International Symposium on Environmental Education was held in Tokyo. Man's activities make a great impact on his environment and reform it. On the other hand, man adapts himself to a reformed environment. How and what to teach on such relationships between man and environment is very important for environmental education. These matters were discussed and the outcome was successful (NUMATA, BENNINGHOFF and WHITFORD 1977).<sup>23/</sup>

Since 1974, I organized a project team on environmental education, and the methodology was discussed in the team for 10 years from primary, middle, high schools to universities (including postgraduate levels). Our project team recommended concrete contents and methods of environmental education to Ministry of Education, Science and Culture several times.

In 1977, the Guidance Manual for Teachers in Middle Schools was revised by the Ministry. A new unit "Man and Nature" was adopted in the Biology and Earth Science Course where matter and energy supporting human life, and balance of nature and environmental conservation were the main themes. As the basis for that, there is another unit on the web of life.

In the revised Guidance Manual for Teachers in High Schools, balance of nature (heat balance of the earth, ecosystem and cycling of matters, etc.) and man and nature (resources, conservation of natural environment, etc.) have the contents of environmental education.

The Nature Conservation Society of Japan holds training courses for leaders in field education with prefectural authorities every year, and the trainees have licences for it. The Society publishes a "Handbook for Leaders in Field Education." The Nature Study Park attached to the National Science Museum holds training courses on ecology and nature conservation, field exercises and so on for citizens.

In science education until now, we have a chapter "Organisms and environment", however man is not included in organisms. Biology encompasses botany, zoology and microbiology, but usually does not include human biology. Anthropology is really a human science, but it usually treats prehistoric man or primitive society, and does not treat modern man of urbanized and industrialized society. There are sociology, psychology, economics, geography, medicine, etc. to treat modern man, however, human biology or ecology including various contents is not included in biology. Organisms dealt with in biology in schools also do not include man, therefore man has not great role in the concept of food chain and ecosystem. The fact that science education overlooks man and organisms is a sad oversight of environmental education.

The basic concept of environmental education is "ecosystem" proposed by TANSLEY (1935)<sup>26/</sup> and I use "biocentric or anthropocentric environment system" (NUMATA 1953)<sup>17/</sup> as a more comprehensive concept as I earlier mentioned. In the earth ecosystem, man is a newcomer to produce undecomposable and toxic substances. Man is a producer, consumer and decomposer which does not fit in with the usual ecosystem diagram in a biology textbook.

Man has posed great challenges to nature such as atomic power generation, etc. as well as atomic and hydrogen bomb experiments. As COMMONER (1971)<sup>6/</sup> pointed out, ash of an atomic bomb experiment in a South-Pacific island reached the stratosphere, migrated to the north by jet stream, reached the ground of the north pole as fallout, lichens of the tundra absorbed it, caribous ate lichens, and then radioactive pollution of Eskimoe was found within six months. Atomic dust had formerly been considered not to reach the ground so quickly. Anyway, this example shows the characteristics of an ecosystem.

The integrated management of nature advocated at the UN Conference on Human Environment in 1972 was also the standpoint of an ecosystem. This is a main point of environmental education.

Environmental education has been promoted in the framework of school education,

however environmental education in social and lifetime education is more important. Environmental education is effective as an out-of-school education connected with a citizen's movement. In the coastal pine forest plantation activity in Chiba city, citizens buy saplings of *Pinus thunbergii* and a coastal pine forest belt as a sand prevention forest has been made by themselves. This kind of greening is a practice of environmental education.

### 2 . 11 Vegetation Mapping and Naturalness Rating

Vegetation maps are used as a useful tool, and Cultural Agency made a set of prefectural vegetation maps (1/200,000) in relation to an urgent survey of natural monuments in 1968. This is the first governmental vegetation map based on dominant species and physiognomy of vegetation. After that, Environment Agency made another set of prefectural vegetation maps (1/50,000) based on plant associations. Besides these, MIYAWAKI and his colleagues are conducting vegetation survey and mapping all over the country (MIYAWAKI 1980~).<sup>27)</sup> These are actual vegetation maps, whereas potential and climax vegetation maps are also useful. For example, potential vegetation on landfill along the Tokyo Bay is coastal grassland similar to the actual vegetation, however climax there may be *Persea thunbergii* forest. the mapping of actual, potential and

Table 1 . Vegetation naturalness rating

Naturalness Degree	Remarks
1	Urban, housing area
2	Farmland
3	Orchard, tea and mulberry plantation
4	Shortgrass grassland
5	Tallgrass grassland
6	Afforested land
7	Secondary forest
8	Secondary forest close to climax forest
9	Climax forest
10	Climax grassland such as alpine meadow

climax vegetation will be useful for environmental diagnosis and planning.

In relation to vegetation mapping, Environment Agency (1976)<sup>28/</sup> has adopted a vegetation naturalness rating (Table 1). This is almost a sequence from pioneer to climax stage, but is not equal to the degree of importance of vegetations for preservation.

### 3 . Concluding Remarks

In this paper, impacts of development on natural environment are reviewed from the ecological (particularly ecosystem) viewpoint. An ecosystem is an ecological, holistic system consisting of biotic and abiotic factors with one leading factor (phytogenic, zoogenic, anthropogenic systems, etc. ). This is also biocentric integrated approach. In our urban ecosystem studies, the impacts of urbanization on the components were studied independently at first, and then the reaction of components to the environment was studied. At this stage, the action and reaction in Clementsian terminology was pursued. This stage is multidisciplinary, but not sufficiently interdisciplinary, and needless to say, not integrated.

At the next stage, the biocentric and anthropogenic interdisciplinary approach was tried. Studies on the impact of the urban environment on vegetation are very easy and familiar for a plant ecologist. However, phytogenic, interdisciplinary studies on influences of vegetation to animals and man and their environment are not so easy and familiar for a plant ecologist.

At the third stage, the integration of the structure, function and dynamics of urban ecosystems was tried, particularly through the role of water, not only urban hydrology but also the role of water as throughput and increasing entropy. Water utilized in production process (input and output) and water as throughput are tools of integration.

Thus, multidisciplinary → interdisciplinary → integrated studies with biocentric or anthropogenic concept are our ecological approaches to environmental problems.

I have reviewed basic concepts on development and environmental conservation and provided examples of the ecological approaches to these problems. Important points have been discussed in each section. Among them, I must emphasize as being of particular importance, the following: an understanding of the concepts of a biocentric and anthropogenic environmental system (rather than the concept of ecosystem), the



importance of sustainable ecodevelopment, and realization of the role that sound environmental education can play.

### Literature cited

- 1/ M.NUMATA (1984) ICIMOD and its background. *Expert Bulletin*, 5 (3), 1-11.  
Association for International Cooperation of Agriculture and Forestry.
- 2/ H.RICKERT (1898) *Kulturwissenschaft und Naturwissenschaft*. Berlin.
- 3/ M.NUMATA ed. (1983) *Structure and Dynamics of Vegetation in Eastern Nepal*.  
Chiba University. Chiba.
- 4/ A. G.TANSLEY (1923) *Practical Plant Ecology*. London.
- 5/ P.R.EHRLICH (1968) *The Population Bomb*. N.Y.
- 6/ B.COMMONER (1971) *The Closing Circle*. N.Y.
- 7/ J.I.FURTADO ed. (1980) *Tropical Ecology and Development*, Part I, II, Kuala Lumpur.
- 8/ M.MITSUDERA and M.NUMATA (1964) Ecological studies on the coastal pine forest, II. Investigation on environmental factors checking the growth. *J.Coll. Arts & Sci., Chiba Univ.* 4, 36-46.
- 9/ M.NUMATA (1978) Logic supporting nature conservation. *Iwanami Lecture Series on Modern Biology-Monthly News* No. 1, 1-3 (in Japanese).
- 10/ Ecological Society of Japan (1975) *Environments and Bio-Indicators*, Vol. I, II. Kyoritsu-Shuppan, Tokyo.
- 11/ F.E.CLEMENTS and G.W.GOLDSMITH (1924) *The Phytometer Method in Ecology. The Plant and Community as Instruments*. Carnegie Inst. Wash. Pub. No. 359.
- 12/ F.E.CLEMENTS (1920) *Plant Indicators*. Carnegie Inst. Wash. Pub. No. 290.
- 13/ M.MITSUDERA, S.CHIBA & T.SUGAWARA (1974) Changes in urban environmental atmosphere and transitions in biotic communities. *Urban Ecosystem Studies* (1974), 1-12.
- 14/ H.TAODA (1972) Mapping of atmospheric pollution in Tokyo based upon epiphytic bryophytes. *Japanese Journal of Ecology* 22, 125-133.
- 15/ H.TAODA (1977) Bryophytes in the urban ecosystem, M.NUMATA ed. *Tokyo Project. Interdisciplinary Studies of Urban Ecosystems in the Metropolis of Tokyo*, 99-117.

- 16/ K.SUGIYAMA and G.OKADA (1977) Lichens as a bio-indicator of SO<sub>2</sub> air pollution in urban areas. M.NUMATA ed. *Tokyo Project*, 131-137.
- 17/ M.NUMATA (1953) *Methodology of Ecology* (Revised and enlarged editions, 1967, 1979). Kokonshoin, Tokyo (in Japanese).
- 18/ V.E.SHELFORD (1929) *Laboratory and Field Ecology*. New York.
- 19/ C.RAUNKIAER (1934) *The Life-Forms of Plants and Statistical Plant Geography*. Oxford.
- 20/ H.ELLENDERG (1950) *Unkrautgemeinschaften als Zeiger für Klima und Boden*. Eugen Ulmer, Stuttgart.
- 21/ M.NUMATA (1982) Bio-indicators of human environment, particularly of urbanization. M.NUMATA ed., *Chiba Bay-Coast Cities Project IV*, 141-48.
- 22/ M.NUMATA (1976) Methodology of urban ecosystem studies. *Science for Better Environment*, 221-27. M.NUMATA (1978) Balancing human well-being and environmental carrying capacity in the quest for quality of life. *Urban Ecology* 3, 289-291.
- 23/ M.NUMATA, W.S.BENNINGHOFF and P.B.WHITFORD ed. (1977) *Proceedings of the International Symposium on Environmental Education*. Chiba.
- 24/ M.NUMATA (1978) The viewpoints of environmental education, *Quarterly Environmental Research*. No. 20, 90-108 (in Japanese).
- 25/ JIBP-CT (1966) *Abstracts of Papers and Resolutions Related with Nature Conservation*. Chiba.
- 26/ A.G.TANSLEY (1935) The use and abuse of vegetational concepts and terms. *Ecol.* 16, 284-303.
- 27/ A.MIYAWAKI (1980~) *Monograph of Japanese Vegetation*. 10 Vols. Shibundo, Tokyo.
- 28/ Environmental Agency (1976) *National State of Nature Survey Report*. Tokyo.