



Toward Harmonious Green Urban Environments in Japan and Other Countries^{1*}

調和した緑の都市環境を目指して

—日本および他地方で—

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Synopsis

Natural vegetation and green environments have disappeared rapidly from cities since World War II, replaced by concrete deserts with only sparse, unnatural vegetation. Japanese cities traditionally did not destroy the surrounding vegetation except as needed for city growth, but now even in Japan there is a great need for both the ecological and socializing functions of productive, traditional green environments in the otherwise largely abiotic urban areas. True green environments are more than decorative greenery, protecting the soil, providing habitats for animals, buffering disturbances, and lending harmony to the landscape. Since the early 1970's, small, green "environmental protection forests", composed of native potential dominant species, have been retrofitted into urban and industrial areas throughout the evergreen broad-leaved forest regions of Japan, where most of the population lives. These greenbelts and other green patches combine techniques of modern vegetation science with the traditional Japanese methods of creating 'chinju-no-mori' (shrine and temple forests) and other forest areas in the built landscape. Comfortable urban environments, however, also require conservation of large green areas (e.g. patches of rural landscape) and the linking of greenbelts and other green nuclei to form interconnected green networks within the urban environment. Traditional native landscapes are the best basis for planning successful urban landscapes. "Environmental forests", based on aspects of traditional landscapes, are probably the fastest and cheapest way to create stable green environments in densely built-up cities.

Introduction

Most cities of significant size are biological semi-deserts, at least in their centers and industrial areas. The natural (spontaneous) vegetation which does occur in such areas is often dominated by weedy species plus other plants which are tolerant to disturbance and pollution. A few tolerant tree and shrub species may remain from the natural vegetation, but these often occur in cities in combinations which are unnatural elsewhere. Even where deliberately revegetated, the total urban landscape usually has a coverage by tree canopies and other taller vegetation of less than 30% (except in some parks). Introduced vegetation involves even more unusual combinations of local and foreign (exotic) species, especially when the exotic species survive better under intensive disturbance in the city than native species do. This results in chaotic, largely abiotic urban landscapes with only small remnants of natural vegetation and with patches of exotic vegetation which are often forced into the landscape in very inharmonious ways.

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In many cases, the loss of vegetation in urban and other built areas has resulted from what has come to be known as the "tragedy of the commons", by which a common-pool resource is degraded due to lack of sufficient managing control by any one authority (Hardin 1968, Hardin & Baden 1977). Users of limited resources are forced into unwanted competition for the resource, but this competition in turn may force even more resource use than would occur otherwise, yielding a runaway feedback dynamic which results inevitably in degradation or exhaustion of the common-pool resource. In cities, land is the most valuable common-pool resource. Land is taken over for buildings, transportation, utilities, etc. — each time based upon economically rational but single-purpose, non-holistic development decisions, without regard for other effects (which may be quite unpredictable). Planning for more pleasant, functional urban environments, without unwanted side-effects, can succeed only if planning is done more holistically, based on the carrying capacity and other attributes of the natural environment and on the full range of ecosystem functions and human needs.

Today, people demand a comfortable, affluent lifestyle filled with modern conveniences. They want to live in functional cities which provide the somewhat exotic way of life found in some New American and European towns. Although such conveniences may be necessary components of our working environment, we need to appreciate all the factors that contribute to the enrichment of human life, culturally, spiritually, and ecologically. It may be necessary to tolerate particular inconveniences in order to maintain our high standards of living. In urban areas it is especially important that we adopt harmonious lifestyles incorporating both modern-day comforts and at least partly self-managing, functional ecosystems. There is now an urgent need to preserve our green environments which have been kept as part of our traditional cultural landscape and to combine them with functional urban systems to create new harmonious city units.

Due to the rapid industrialization and urbanization after World War II, both the natural forest and other "greenery" within cities, which co-existed with human inhabitants, have disappeared at a drastic rate (e.g. Miyawaki *et al.* 1977, Numata 1977). As a result of the deterioration of the natural environment and disappearance of vegetation in urban areas, citizens have become more keenly aware of the need for nature conservation and preservation of green environments. Citizens are concerned about vanishing green surroundings and now are compelled to make special trips out of town to enjoy what is left of nature. It seems inadequate and superficial to regard these phenomena simply as a sign of sentimentalism or a product of affluence and leisurely life-styles. Although it is true that people's expectations of and reactions to nature vary, it is more accurate to view these phenomena as consequences of people's impulsive reactions, based on an instinctive sense of crisis over the decimation of their familiar cultural environment.

Japanese Cities in Geographic Perspective

We can put Japanese cities in perspective by comparing them with the rest of the world. As a small land with few resources but many people, Japan is characterized by intensive, space-efficient land use. This is symbolized by Tokyo, Yokohama, Nagoya, Osaka, and other cities in Japan. New Zealand, another small country but with fewer people and a shorter history of development, is similar but not so intensively developed.

For large countries one can see three main situations resulting from different factors of climate, geography, history, population size, etc. Some areas are already badly disturbed, such as China, India, and the Mediterranean region. This was due to large populations, long histories, and some poor land uses such as complete deforestation and overgrazing. These areas have not recovered. A similar case involving less severe but continuing current disturbance is that of Southeast Asia, disturbed by shifting cultivation, export of timber, etc.

A second situation in large countries involves areas which were disturbed but which have now largely recovered, such as northern and central Europe. This area was disturbed in the past by overuse and by warfare, but its climate permitted better recovery. People now have reclaimed and re-created productive, pleasant landscapes. In Japan, we have learned mainly from the successes of central Europe and from the pleasant landscapes of other countries.

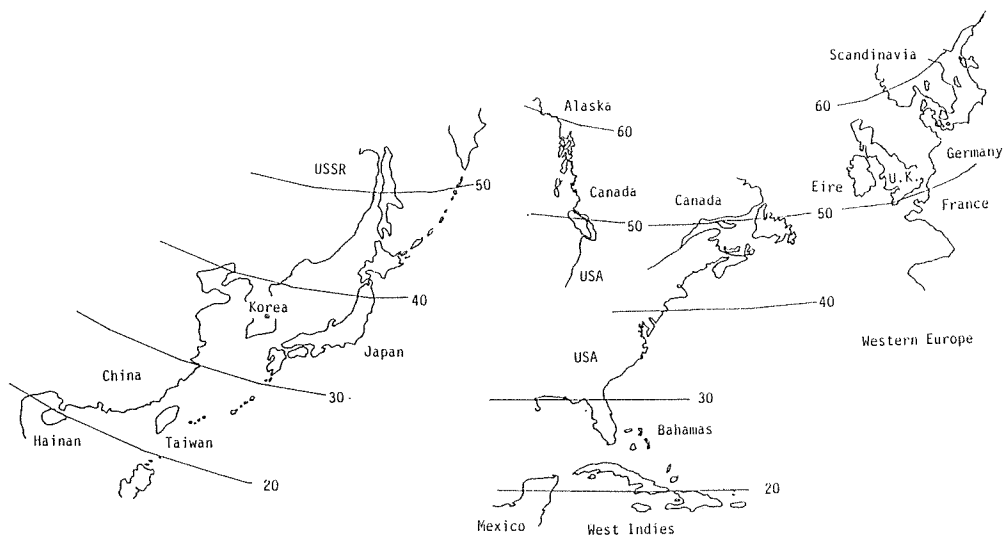


Fig. 1 Relative Geographic Positions of East Asia and Ecologically Comparable East and West-Side Continental Regions of the Northern Hemisphere.

A third situation involves areas such as North America, the Soviet Union, and Australia. These are large areas with many resources. These are now becoming greatly disturbed, at least in some areas, and are just now developing rapidly over large areas.

In planning for green environments in cities one must begin with the natural climatic-vegetation zones in which these cities occur. Japan has three main bioclimatic zones of potential natural vegetation: warm-temperate to subtropical evergreen broad-leaved forests in the south, deciduous broad-leaved forests in the typical-temperate (middle) latitudes, and mixed conifer-deciduous forests in the cool-temperate north (e.g. Kira 1977; Miyawaki 1979a, 1984, 1980–1987). In eastern North America and in China the vegetation zones are quite similar to those of Japan (Figure 1; see also



Fig. 2 Natural Evergreen Broad-Leaved Forest at (Mt.) Nachi-san on the Kii Peninsula (Mie Prefecture).

Box, in press). In addition, north-Pacific North America and much of northern Europe have oceanic climates and conifer-deciduous forest mosaics similar to those of Hokkaido, while the Caribbean area has subtropical forested limestone islands similar to southern Okinawa. Most similar climatically to Nagoya, Shizuoka, Yokohama, Handa City and much of Pacific central Honshu might be cities such as Norfolk, Raleigh, or Charleston near the east coast of the USA. Temperate-zone forest regions involve relatively productive and resilient natural landscapes, and geographic comparisons are both



Fig. 3 Protected Shrine Forest around the Gokoku (Shinto) Shrine at Shizuoka City.

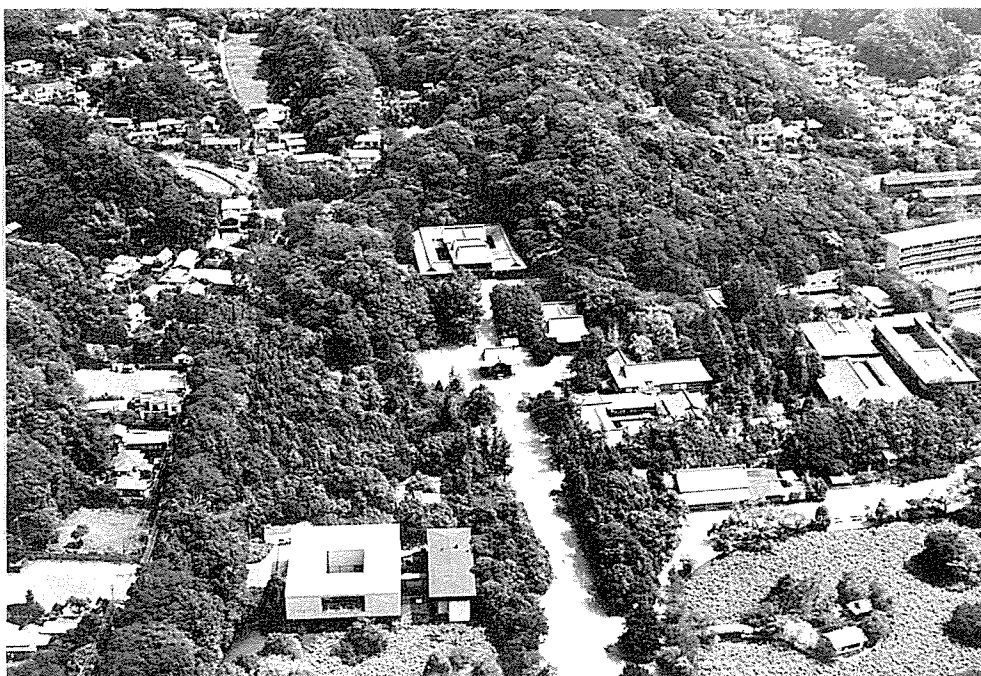


Fig. 4 Protected Temple Forest around the Hachimangu (Shinto Shrine) at Kamakura.

interesting and instructive. Each of these characteristic natural regions also has its own traditional cultural landscapes related to the natural conditions and the human economic and other cultural activity.

We have learned from the history of other civilizations that although cities were often built on land previously covered with forest, this land was virtually reduced to a desert landscape and the cities disappeared. This has been seen over several thousand years of human history beginning with the Mesopotamian, Egyptian and Greek civilizations. In Japan there was a time when most of the land was covered by forests, including the areas currently occupied by all the major cities. The land below 800m in altitude was occupied by the evergreen laurel forest, except in northern Japan (Figure 2).

The forest was largely regarded as an obstacle to human activities as far back as the Jomon and Yayoi periods. Ever since rice cultivation started about 2000 years ago, our ancestors destroyed forests to build villages and towns. But without exception, the Japanese did not destroy all of the natural vegetation. They preserved, protected and re-created the native forest, consisting of trees native to each location (*furusato-no-mori*, cf. Schwabe 1977), as shrine and temple forests and forests around old houses. These can still be found today in Yokohama and many other cities throughout Japan (Figures 3 and 4).

Functions of Green Environments

In recent years ecologists have begun to look more and more at problems involving human uses of natural environments, especially at the landscape scale and including problems of urban ecology. Landscape ecology (e.g. Forman & Godron 1986) focuses especially on functional aspects of landscapes and how the functional integrity of these landscape ecosystems (energy flow, nutrient cycles, response to disturbance, etc.) is affected by land-use activities and changes. For example, in cities, how would different urban vegetation structures/configurations control unnatural flows of energy/materials/pollutants resulting from man's activities, and which configurations might be most effective? Or, how are pollination, seed dispersal, and animal populations affected by the fragmentation of forest areas into ever smaller and less natural patches, farther from each other? Restoration ecologists have begun to try to rebuild some types of natural ecosystems and distinguish between landscape revegetation, rehabilitation, and restoration. Of course restoration of completely natural ecosystems is not possible in urban areas, but restoration of functional integrity and natural, self-maintaining processes is a necessary component of any attempts to create stable, productive human environments.



Fig. 5 Three-year old, planted "Environmental Protection Forest" on a man-made island near the Pacific coast at Gobo City (Kii Peninsula, Wakayama Prefecture, cf. Figs. 8, 9 and 10).



Fig. 6 Outside (above) and interior (below) of a 13-year old Environmental Protection Forest at the Nippon Steel Corporation Kimitsu Works (Chiba Prefecture) (Phot. by Kanto regional construction bureau, Ministry of construction).

In considering the need for green environments in cities it is important to distinguish between “greenery” (usually understood in English as decoration) and truly functional green environments. The Japanese word ‘midori’ (green) conveniently covers both of these meanings, but sometimes without emphasizing the need for green areas which perform necessary biological, ecological, and even psychological and economic functions in addition to their cosmetic value. Such natural functions may include water storage and management, soil protection, provision of habitats for other beneficial organisms, and buffering the effects of pollutants and other disturbances.

In urban and industrial areas of the evergreen broad-leaved forest region of Japan, small forest areas (greenbelts or green screens) have been created as “environmental protection forests” (EPF) in order to perform necessary functions in urban settings, including provision of some relief against otherwise starkly abiotic environments (Figure 5). Such small green areas are not always true forests. A true forest must have an interior which is not significantly reached by many effects from the surrounding outside environment (Figure 6). If one stands in the middle of a patch of trees and can feel that he is in a forest, then perhaps it is a true forest.

In urban areas, there is not always room to reconstruct true forests, even though these may be badly needed. The EPF is perhaps the next best thing. Wherever created, such “forests” are based on species of the potential natural vegetation, as determined from intensive vegetation surveys and analysis (e.g. Miyawaki *et al.* 1974, 1980–87, 1983). Such ‘environmental forests’ represent living filters against noise, airborne substances, and visual blight; very effective biological indicators of environmental changes (perhaps not easily measured otherwise); soothing green scenery for improved morale and productivity; and useful green buffers between living environments and less healthy parts of the urban-industrial landscape.

One practical function of the designed landscape, especially in cities, should be to provide harmony, physical and mental comfort, and a feeling of being “at home”, just as in more natural environments. Such positive results seem best provided by traditional landscapes which combine characteristic regional features with traditional houses, big native trees, rural areas, patches of remaining forests, and so on. The traditional Japanese landscape was a harmonious patchwork of land uses which also preserved the surrounding native forest, especially around shrines, temples, farm houses, etc. We seek to restore this traditional wooded character, including creation of man-made native forests in urban and industrial areas and integration of old and modern aspects of Japanese culture into new, multi-use human environments (e.g. Miyawaki 1982, Fujiwara 1986a).

Constructing Green Areas in Japanese Cities

The methods for the actual construction of greenbelts and other green areas in Japanese cities, using native species, have been described before (e.g. Miyawaki 1975, 1981b, 1982; Fujiwara 1986b). These techniques have been especially applicable in the evergreen broad-leaved forest region of Japan, the potential vegetation of which has been summarized by Fujiwara (1981–1986) and by Miyawaki (1979b, 1981a). These construction methods will only be summarized briefly here.

The working plan for creation of new green areas, from vegetation sampling to the final environmental protection forest, is shown in Figure 7. The planting schedule and actual plant species used for environmental forests are determined from the results of phytosociological fieldwork. At the construction site, a linear mound is created, on which the forest is to be planted. This mound is covered with a 20–30 cm layer of topsoil. Then, tall-growing, site-suitable evergreen broad-leaved young trees (0.5 to 1 m, 2–3 years old, grown in pots for development of strong root systems) are planted at a density of 1.5 to 3 trees per square meter (Figure 8). Rice straw is then scattered on the soil (4 kg/m²) to protect both the soil and the young trees. Even ideal plantations appear weak and vulnerable at first. They can grow, however, at a rate of up to 1 m per year for up to 10 years, and thereafter grow taller and more luxuriously (Figures 9 and 10) (Fujiwara 1983). After initial weeding, the plantations require no maintenance after about three years. The final result is a mature “native forest”, composed of native climax forest species, but achieved within 20–30 years by planting climax species (on a well prepared site) at the beginning. Experience has shown that understorey and edge species will come in naturally.

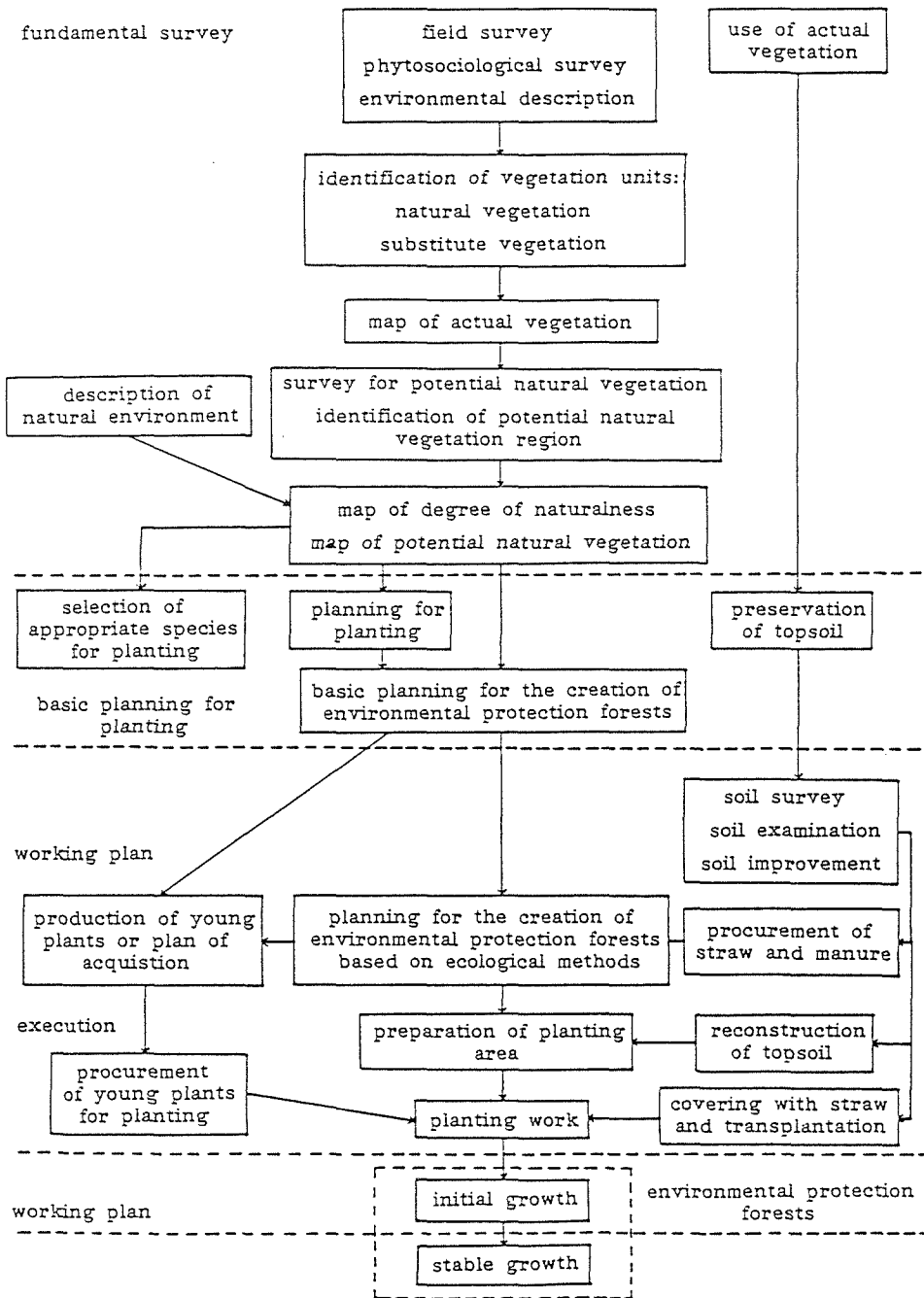


Fig. 7 Flow chart of operations for Creation and/or Restoration of evergreen broad-leaved forests as Environmental Protection Forests and Native Forests in Japan.

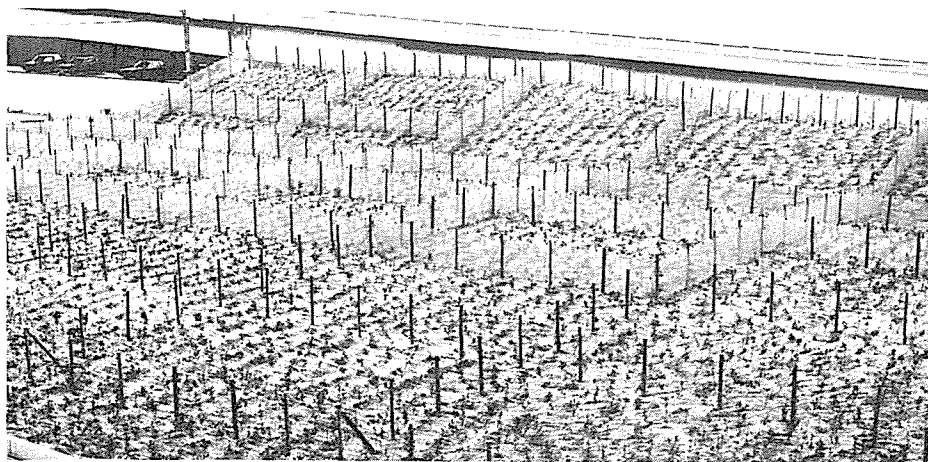


Fig. 8 Newly planted environmental forest at the Gobo Electric Power Station (Gobo City), showing seedlings, prepared mounding, and protection by rice-straw matting after planting (cf. Figs. 5 and 10).



Fig. 9 An environmental protection forest on a 5 km-long, linear embankment along the Kashiwara highway by-pass through the suburbs around Nara City. This environmental forest was planted in February 1983 by 1200 school children and has grown five meters in five years.



Fig. 10 Three years' growth of an environmental forest planted on a man-made island as a green screen around the Gobo Electric Power Station (Gobo City).

Of course, before destruction of the pre-existing vegetation of an area, a map of the actual vegetation should be drawn up. This map can be used for basic diagnosis of the environment and for identifying ecologically valuable vegetation and ecosystems as well as necessary protective measures for them (Miyawaki and Fujiwara 1975). A map of the potential natural vegetation should also be made, not only for purely scientific purposes but also as a guide to species selection for the creation and restoration of green areas.

In the 1970's, not only the preservation of nature but also the re-creation of rich green environments with biological diversity were proposed, in urban areas, industrial zones, and along transportation facilities. The re-creation of relatively natural environments can be realized by integrating up-to-date research on the potential natural vegetation and the traditionally Japanese method of creating 'Chinju-no-mori' (shrine and temple forests). Slowly but steadily, a campaign to bring native forests into largely abiotic environments has taken root in various places throughout Japan, such as:

- 1) Steel mills, factories and power stations on reclaimed coastal land.
- 2) Schools, parks, sewage disposal plants, and public facilities within urban and industrial zones.
- 3) Around transport facilities such as airports and harbors, and along streets.
- 4) Bordering mountain roads and highways.

Such plantings also perform educational functions for Japanese society (Figure 11). Through trial and error, our ancestors managed to find ways to create native forests with native trees in their towns and villages. By combining this traditional method with modern phytosociological and ecological diagnosis (i.e. maps of actual vegetation, study of site conditions) and prescription (i.e. maps of potential natural vegetation and habitats), new native forests with evergreen broad-leaved trees have already been created in more than 120 locations throughout Japan (e.g. Miyawaki 1987; Miyawaki *et al.*, in press; see Figure 13), including some surprisingly steep slopes (Figure 12).

Preservation of nature and restoration of green environments have by now become inseparable aspects of conservation and planning efforts. The efforts to restore native woody green environments, adapting the indigenous vegetation of each location, have borne fruit after periods of only 3 to 12 years. Although still insufficient, the identification of the indigenous potential natural vegetation is



Fig. 11 Planting an environmental protection forest (mainly seedlings of *Castanopsis*, *Persea*, and evergreen *Quercus*) at Ebina City in Kanagawa Prefecture. The children are from Imaizumi Middle School.



Fig. 12 Successful planting of native trees (EPF) on steep slopes around the Kanagawa Prefectural Kurihama High School, built on re-graded terrain at Yokosuka City.

expected to contribute to the formation and betterment of the human environment, a better foundation for our unique inheritance and conservation of the native landscape in each place.

With the introduction of environmental forests in cities, land with limited use can be utilized more effectively. Future maintenance costs may be reduced, and the substantial mass of three-dimensional greenery will create a landscape that is permanently attractive and indigenous to the region. In Handa also, a vegetation and ecological study has been conducted throughout the city (Miyawaki *et al.*, 1982). As a result, a map of the potential natural vegetation has been completed and has been used to develop native forests at the Itayama Primary School and other locations in Handa.

How to Plan Green City Environments

City environments should be convenient for human life. We can now use the most up-to-date scientific techniques and we know that the most harmonious landscape is the traditional native landscape (Figure 14). We can therefore combine these two factors to create a totally balanced city environment.

1) Conservation of rural areas within the city

Rural areas, especially rice fields, have produced the culture and the very nature of the Japanese people. They should therefore be preserved as important production as well as cultural areas within the urban environment.

2) Re-creation of green environments in urban areas

(a) Creating green nuclei: if native forests can be re-created at several sites within the city, such as parks or other open spaces, they can act as reservoirs and protection areas for wildlife. In more affluent cities, dense forests and other green areas can be created through "landscaping" (usually involving exotic species). This is expensive, though, and requires considerable maintenance. In cities with less money for landscaping, the method outlined above can be used, i.e. dense planting of pot-grown native tree seedlings on well prepared, mounded sites.

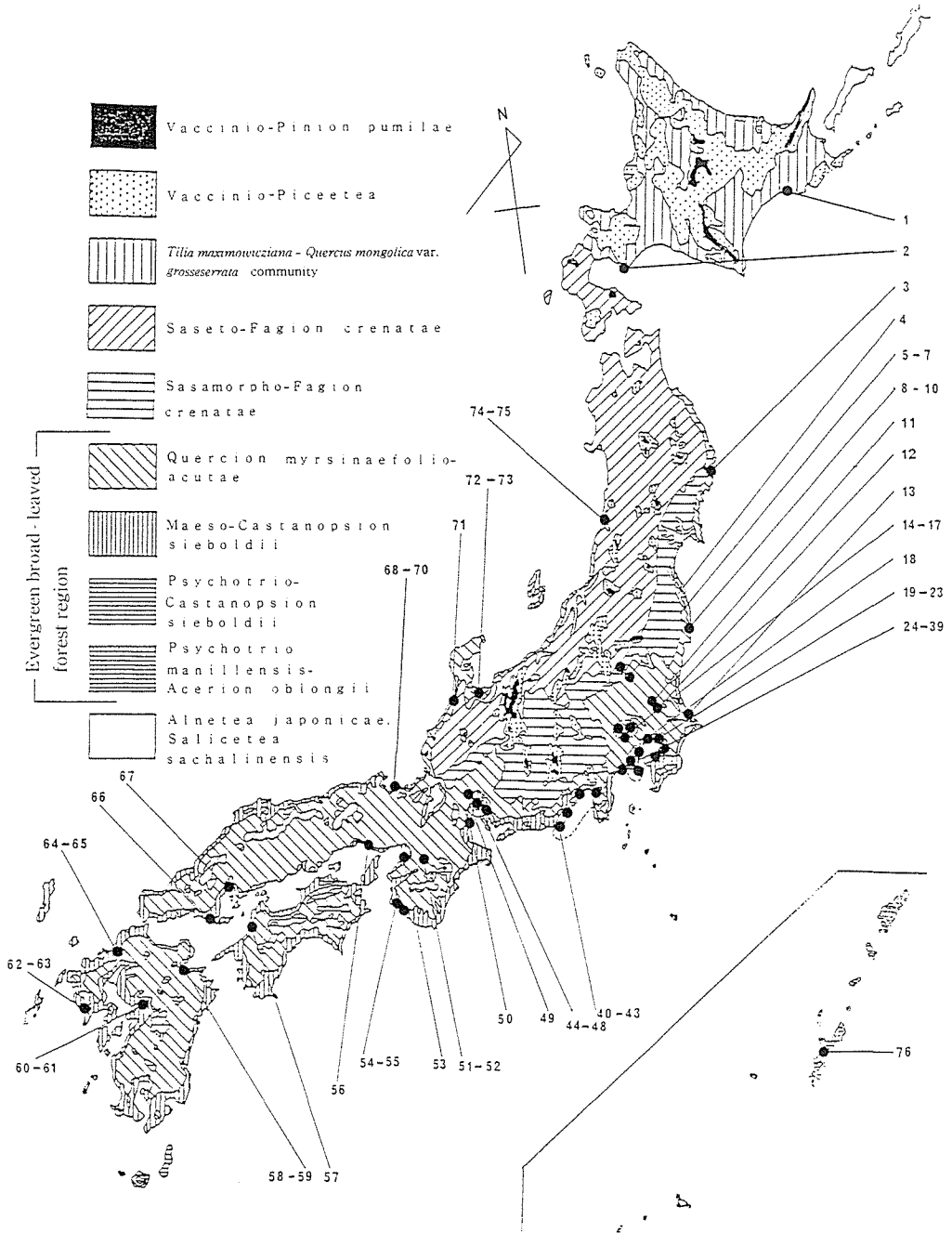


Fig. 13 Locations of recently built "environmental protection forests" in Japan, with regions of potential natural vegetation.

Environmental protection forests are needed in/around residential areas, industrial areas, public buildings, along riversides and coastlines, etc. They can range from hedges to greenbelts from several to a hundred meters wide. Linear greenbelts can be built along highways, smaller roads, and railways, as well as rivers or coastlines. Allée trees can also be planted in dense miniature patches, with tree, subtree and shrub layers.

Thick green walls guard the environment from pollution, landscape disturbances and other possible calamities. The green patches contain rich ecosystems, particularly along their boundaries (Forman and Godron 1986).

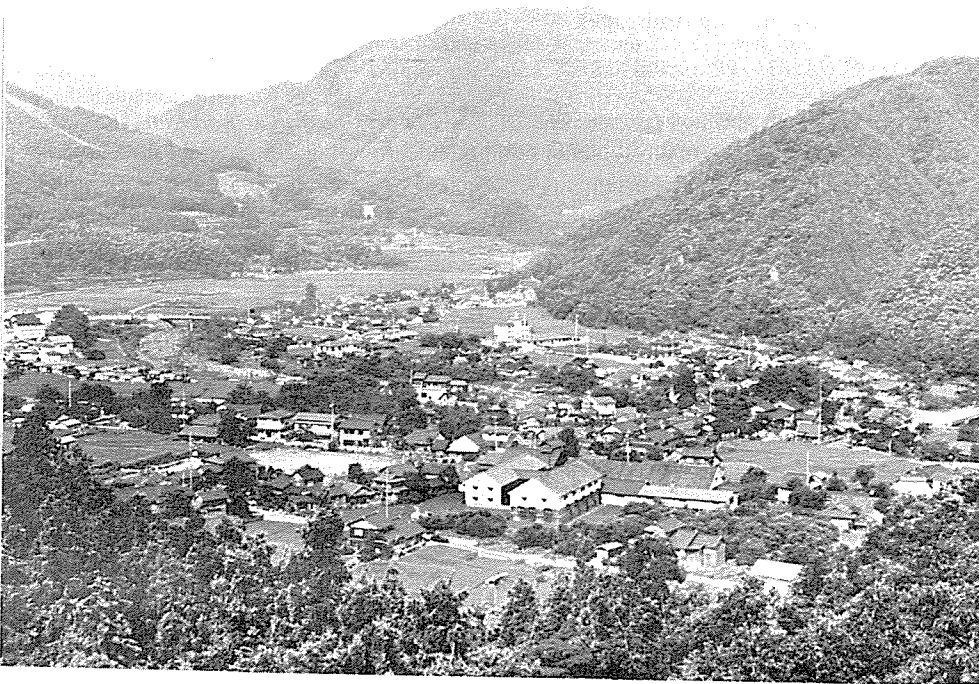


Fig. 14 Traditional town and landscape of Tsuano, near Hiroshima (southwestern Honshu), showing still forested (or reforested) slopes and traditional land uses in the flat valley. Many Japanese tourists visit this area, one of few remaining traditional landscapes in Japan.

(b) Linking green nuclei: once developed, the green areas should be at least partly linked to form green networks. Such interconnected networks provide better protection against noise, pollution, and blight as well as necessary habitats for more far-ranging animals and dispersal routes for plants.

Traditional landscapes should be, and to some extent are, the basis for successful urban and land-use planning in other parts of the world as well. In American cities near the east coast, the blend of natural and traditional landscape elements is retained in cities especially in the form of large, stately, native trees along streets and around old traditional homes. Local historical societies seek to preserve these traditional elements of urban landscapes. Other areas of many cities, however, are dominated by concrete, by impoverished areas, and by other impersonal, "hard" surfaces and structures. Although it is difficult to re-vegetate the most extreme urban deserts, introduction of green areas has proven to be a useful step in the reclamation and redevelopment of urban slums.

Beginning in the late 1960's, certain far-sighted government offices, prefectures, cities and industries in Japan began to cooperate in the conduction of large-scale vegetation surveys before land development or expansion of existing sites and facilities. This effort was expanded in the 1970's to real attempts to create new green environments where badly needed.

Of course, people's tastes in green surroundings vary considerably. In some parts of the world exotic species are much preferred by developers over native species. Interests, fashion, life-styles and experience all yield diversity. The beneficial effects of greenery on people have always been a favorite topic of conversation. All types of greenery are soothing, refreshing and necessary for our mental and physical health. However, in view of the current impoverished conditions of shrine and temple forests in Japan, what is most needed in urban areas (where 75 percent of the population is concentrated) is forest consisting of trees native to the location. It is hoped that this kind of basic urban greenery framework can be established. Considering the speed with which properly prepared seedlings can grow and the self-maintaining nature of these plantations, "environmental forests" of native species are clearly both the fastest and the cheapest way to create stable, long-term green

environments in densely built-up landscapes.

Conclusion

Green areas are one of the main dynamic components affecting the general urban landscape and should be in balance with other important factors such as city area, population size, economic structure, education systems, and the constructive activities of government officials and/or members of the public. Historically, harmonious “environmental” towns were developed by people sensitive to their surroundings. Such areas only persist today, though, if their traditional character is regarded as a major economic resource (e.g. ancient towns, tourist towns, rich resorts, areas of rural landscape).

Relationships between population increase and decrease of green environments can be amply demonstrated if necessary. We should not wait for scientific “proof”, however, before acting to improve our living environments. Looking toward the 21st century, we must base our planning for green urban environments on total harmony of human activities and a sustained richness in plant and animal life.

The following objectives seem most important in the planning for balanced urban environments:

- 1) Programs of environmental education and citizen awareness, putting situations in perspective in terms of human history and the biosphere as a whole.
- 2) Re-examination of city environmental and land-use planning, establishing which green areas should be protected and how and where new ones should be created.
- 3) Creation or re-creation of green environmental networks in cities, i.e. creating green nuclei of native forest linked with interconnecting green-belts acting as environmental corridors for plant and animal movements. In general, natural vegetation maintains itself and maintains other necessary functions of the landscape (water management, buffering, etc.), making it much cheaper and more stable than artificial “landscaping”. In addition, native species provide more natural, harmonious landscapes (and usually require less maintenance than exotic species).

Urban areas and growth in the heavily industrialized or at least heavily populated modern world must be planned, for economic and social reasons as well as for “environmental” reasons or conservation objectives. Such planning must be done holistically and must be based on the ability of the natural and enhanced landscape to support the city’s requirements over long periods of time. Perhaps especially in urban areas, one must distinguish between “greenery” which is merely decoration and greenery which represents truly functional, pleasing green environments. Planning based on green urban environments, involving traditional landscape elements as well as functional stability and self-maintenance, represents the best basis for successful cities.

It is important that administrative bodies, business enterprises and other organizations adopt a system that would make an essential contribution to the recovery of green environments, especially in urban areas. It is crucial to preserve, or create where lost, an environment in which human beings can live and co-exist comfortably, now and in the 21st Century. Such a “survival environment” is symbolised by the presence of healthy green areas. The responsibility lies with this generation to re-create green areas in cities and restore damaged and derelict land to a more salutary condition.

Green urban environments, as well as ecosystem restoration, represent an important area of current interdisciplinary research throughout the world (e.g. the International Symposium on Ecosystem Redevelopment, Budapest, April 1987, sponsored by IIASA, UNESCO and other organizations). It is our wish that the efforts in Handa toward the creation of “a city in a forest” will spread not only among Japanese cities but also to other countries.

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