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Restoration of urban green environments based on the theories of vegetation ecology[1]

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Abstract

Modern cities and industrial areas are standardized, built of non-biological materials such as iron, cement and petrochemicals. The most desirable life for citizens should be both mentally and physically sound, which are the basis of existence for all lives. A multistratal forest is estimated to have 25–30 times the green surface area monostratal grass. With underground organic compounds, multistratal forests also contribute to the reduction of CO_2. Building facilities can be completed in short term with economic backing. But it takes biological time to regenerate a multistratal forest using living green construction materials. It is urgent to start the restoration and reconstruction of native green environments immediately. To form green environments of multistructure using plants, it is necessary to systematize the data from field investigations and to follow the scientific scenario based on potential natural vegetation. We propose the restoration of native forests, which function as disaster-prevention and environmental-preservation forests in urban and pre-urban areas. Native forests grow well with no management. With the ecological technique 600 sites have been successfully revegetated in the Japanese Archipelago, in Malaysia, Melaka, Kuala Lumpur, and Bangkok in Southeast Asia, and in Belem, Brazil, and Concepcion, Chile in South America.

Keywords: Restoration; Potential natural vegetation; Multistratal forests; Green environments; Ecological scenario; Ecotechnology

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1. Environmental problems are the issue of life

The focus of environmental protection is on how to protect life. To protect human life means to protect plant communities, since human beings are living on the earth as consumers of plants.

As for CO_2 problems it may not be possible to reduce this use to zero, but it is possible to minimize concentrations in the air. It is green plants that fix carbon. Forests, especially multi-stratified native forests with native trees, are said to have 25–30 times the green surface area of monstratal grass like lawns. Forests have different functions, including wood production and decoration. But the newest and most important function is ecotechnological reforestation (Miyawaki, 1975, 1981, 1982a, 1989, 1993, 1996, 1997; Miuawaki et al., 1979, 1987; Miyawaki and Golley, 1993) and restoration of green environments in urban industrial complexes and around transportation facilities etc.

2. Ecotechnology and its vegetation-ecological approach

Vegetation science is the study of plant communities and their environment, including the influence of human activities in both temporal and spatial dimensions (Miyawaki, 1980–1988). Vegetation ecology is a field within the natural sciences and has been studied as a pure science until recently. But today the pure scientific method is not enough to maintain the development of human life. The knowledge and the perspective of ecotechnology, which is integrated ecology and technology, is inevitable.

Ecotechnology is a large field. Its vegetation-ecological approach is to build multistratal greenery to meet the potential power of the area. The goal of the vegetation ecological approach is to create real green environments as the basis of human existence (Miyawaki, 1989, 1993; Miyawaki, et al., 1993; Miyawaki and Golley, 1993; Miyawaki, 1996).

3. Afforestation based on knowledge of potential natural vegetation

In order to create ecotechnologically sound environments, field surveys are most fundamental (Miyawaki, 1981, 1982b, 1993). Potential natural vegetation is identified by remaining natural vegetation which can be judged by a few remaining native trees in the field (Tüxen, 1956), and additionally by considering the form of the land use and comparing soil profiles.

Building native forests with the functions of environmental protection and disaster prevention based on potential natural vegetation is the most important goal of ecotechnology we consider.

4. Experiment projects and the results of ecological reforestation based on potential natural vegetation

4.1. Japanese Archipelago

In 1960 we began field investigations of actual existing vegetation and potential natural vegetation for the purpose of both theoretical studies of the vegetation and preparation for restoration of green environments in various industrial/urban areas in Japan, stretching 3000 km from north to south. In the 1970s environmental destruction had come to be a social problem. We planned to utilize natural vegetation to improve the environment and to reduce pollution. Fortunately, farsighted Japanese enterprises such as Nippon Steel Corporation, Tokyo Electric Power Company, Kansai Electric Power Company, Honda, Mitsui Real Estate Corporation, Mitsubishi Corporation, Torei Company and many others, offered to help us to build environmental protection forests around ironworks, power plants, factories and new towns (Fig. 1) (Miyawaki et al., 1983; Miyawaki, 1993).

Since the 1980s, with the cooperation of local government agencies and government offices, including the Ministry of Construction, we have built environmental protection forests along highways and rivers, and around harbors, dams, airports, new towns, shopping areas, schools and houses. We have succeeded in ecological reforestation of about 600 locations. Included in the reforested areas are reclaimed lands of Tokyo Bay and Osaka Bay, Hokkaido in the cool temperate zone, and mountain highways at 1000 m above sea level, where it was once said to take more than 300 years to form native multistratal forests. We cultivated seedlings in pots

Fig. 1. Twenty years after planting 30–50 cm high pot-seedlings of *Persea thunbergii*, *castanopsis cuspidata* var. *sieboldii*, etc., the plants grew 16–18 m high to constitute a peripheral environmental and disaster-prevention forest around the industrial site in Japan, (May 1993).

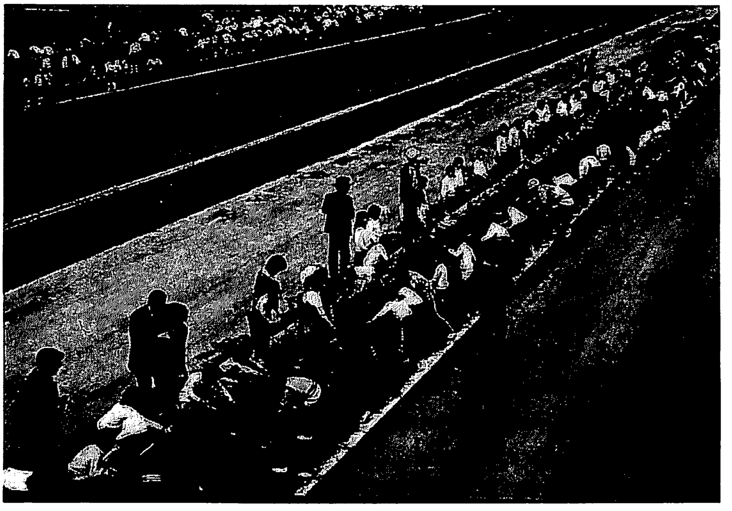

Fig. 2. Primary-school students (1300) plating seedlings of evergreen *Quercus glauca*, *Q. gilva*, *Q. myrsinaefolia*, *Q. salicina*, *Castanopsis cuspidata* var. sieboldii, *C. japonica* and others. They are all main tree species of potential natural vegetation along the Kashiwara by-pass road. (Nara National Road Office, Ministry of Construction, March 10, 1982). After 14 years the tree canopy was 11 m high (June 28, 1996).

until they grew to 30–50 cm and their roots were adequately developed. Three years after dense, mixed ecological planting there was no further need for human-based management; nature began to manage itself. Multistratal environmental protection forests in the experimental areas have reached 20 m in height over the last 23 years (Fig. 2).

On January 17, 1995, a strong earthquake hit the Kobe area in western Japan. Not only buildings of iron or cement, but also some parts of elevated highways and Shinkansen (bullet-train) railways were instantly destroyed. But according to our investigations after the earthquake, no trees of the main component of the potential natural vegetation fell. The natural vegetation includes the species *Quercus glauca*, *Camellia japonica* and *Ilex integra*, in laurel forests (*Camellietea japonicae* forests) in and around Kobe. Furthermore, theses species functioned in fire prevention. Where there was a line of such trees 1–2 m wide, fire was stopped (Fig. 3). Natural vegetation also helped to save many lives. Nearly 6000 people were crushed to death under houses, which were levelled to the ground. But these kinds of trees stopped falling roofs and pillars and made openings in the rubble, through which the people living there could probably escape.

This tragic earthquake has proved that native environmental protection forests based on ecotechnology also function as disaster-prevention forests by saving human life and property.

4.2. Southeast Asia

The knowledge we gained at 600 locations throughout Japan (Fig. 4) was also of practical use in Southeast Asia. In 1978, we began vegetation ecological studies in Southeast Asia. In Bintulu, Sarawak, Malaysia, native rain forests had been slashed. In July 1992 we planted 23000 potted seedlings of 91 species mainly from the natural tropical rain forests, with the help of the Malaysia Agriculture University (Miyawaki, 1992). We continued to plant native trees each year and by 1996 the number of planted seedlings reached 350000. These results suggest that we could regenerate tropical rain forests by the ecotechnological methods (Fig. 5).

As for environmental forests in towns, the seedlings from potential natural vegetation, such as *Hopea*, *Shorea*, *Diptrocarpus* and *Balanopsis* were planted in 2–3 m-wide belts around shopping centers and on the slopes behind the centers in Kuala Lumpur, Melaka, and Bangkok, Thailand. They grew into 5–7 m-high forests within 4 years, and provide environmental-protection and disaster-prevention forests in towns.

4.3. Brazil and Chile in South America

In a joint project with Para Agricultural University, we also succeeded in restoration of lowland tropical rain forests in Belem at the mouth region of the Amazon in Brazil. This area is called the green lung of the world. We raised 150000 seedlings from the most abundant trees like Virola, in pots. In May 1992, we held the first international sapling planting festival, at which time 1300 people gathered and planted 6000 saplings (Fig. 6). The saplings have grown 6–10 m-high within 4

Fig. 3. Flames were stopped by only 1–2 m wide tree strips of evergreen *Quercus* spp. and other potential natural vegetation in the great earthquake of Kobe, Western Japan (January 17, 1995).

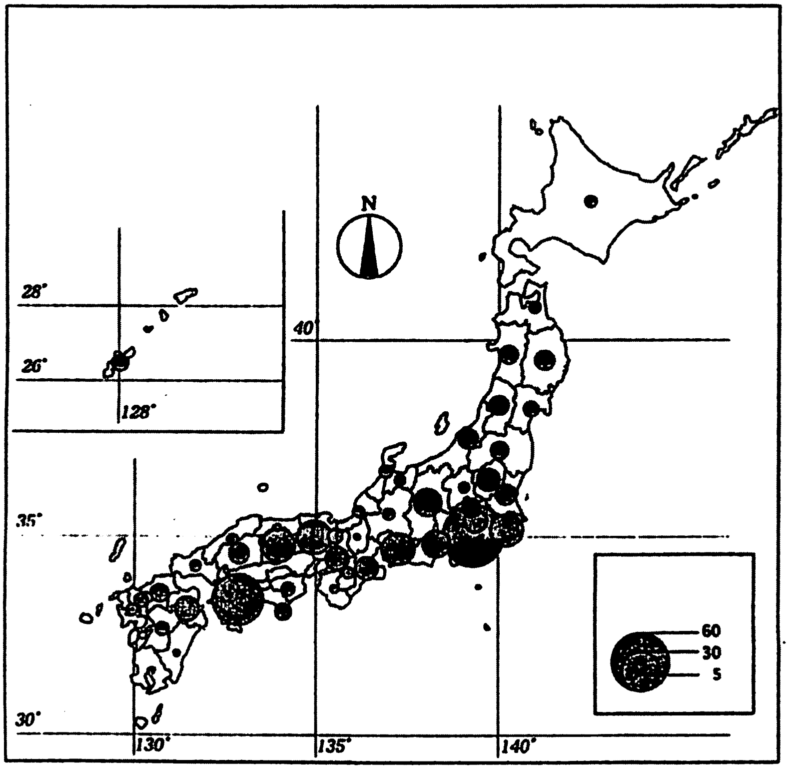

Fig. 4. Location of recently built 'environmental and disaster-prevention forests' in Japan, October 1996.

years (Fig. 7). This project of restoring lowland tropical forests in the Amazon is now held every year.

In Concepcion, Chile, we attempted to reforest Nothofagus forests corresponding to Japanese *Fagus crenata* forests. Backed by the local companies and government

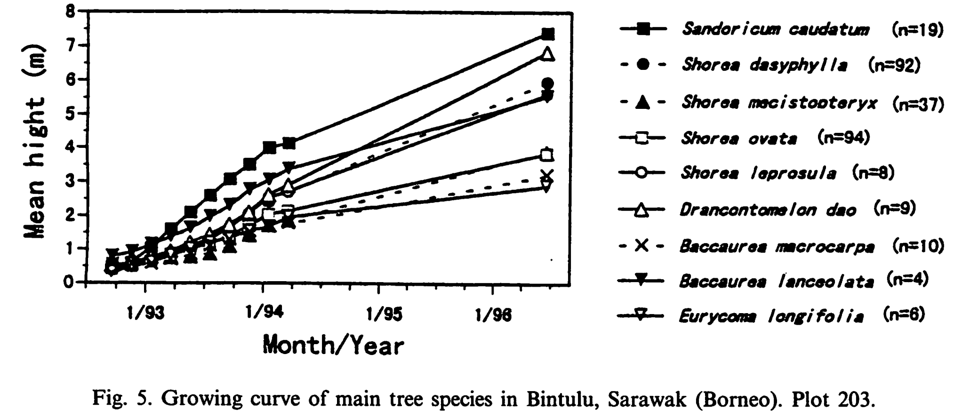

Fig. 5. Growing curve of main tree species in Bintulu, Sarawak (Borneo). Plot 203.

Fig. 6. The first international planting festival based on the vegetation ecological scenario, in Belem, May 22, 1992. This Amazonian tropical re-forestation project was a cooperative project with ECAP, Eidai do Brazil, YNU and JISE, sponsored by EDB and MC. After 4 years the trees grew 7–8 m high.

offices, we had the first planting in May, 1992. Four years later, we could see well grown, 4 m-high native forests with native trees.

5. Challenge to green forest environments around the Great Wall

We began ecotechnological research to reforest around the Great Wall with the help of the Beijing government, in August 1996. We also expect the support of the Chinese Ecological Association and Chinese Academy of Sciences. We fully understand that it will not be easy to bring this project to success. But please consider

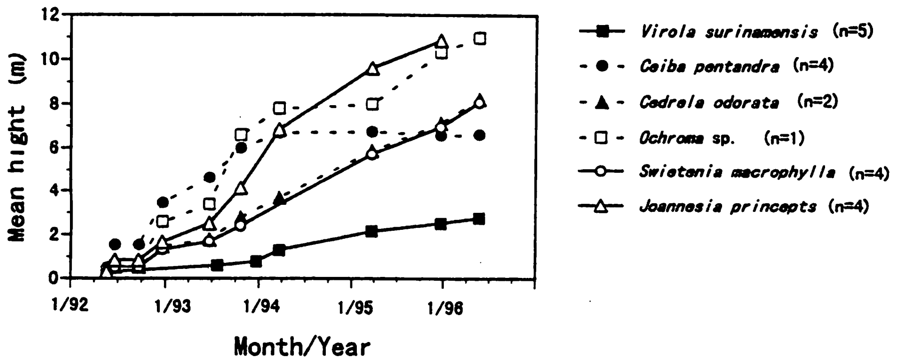

Fig. 7. Growing curve of main tree species. All are indigenous to the Belem region (Belem/Brazil).

that the area around the Great Wall was once covered with forests of *Quercus mongolia* accompanied by summergreen broad-leaved trees including some conifer trees. The Great wall is one of the most splendid legacies of mankind in the world. The reforestation around it can be said to be for the future of mankind.

The ability or research field of an individual alone cannot bring the success of environmental restoration on a global scale. It is mandate for each researcher, government, company, and citizen in particular to cooperate and support the project from their own standpoint. Fortunately, China, which has the oldest history and civilization in Eastern Asia, and Japan join hands with other environmental restoration of the earth. I expect your heated arguments on ecoengineering. And I do hope you will work together with us and these movements of reforestation will spread throughout the world from here.

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