



World Business Council for
Sustainable Development

Quarry Rehabilitation Case Study

2009

Taiheiyo Cement Maintaining and growing rare plant species

This case study is part of a series on quarry rehabilitation practices by WBCSD Cement Sustainability Initiative member companies. [Read about what other companies are doing.](#)

Location and situation

In 1971, Chichibu Taiheiyo Cement Corporation (a group company of Taiheiyo Cement Corporation) and the R&D Center of Taiheiyo Cement Corporation established the mining and rehabilitation study group at Mt Buko in Chichibu, Saitama, Japan, to study how native plants and rare species could be protected. In addition to creating a botanical garden at the quarry for the preservation of rare plants, the company continues to repopulate former excavation sites with these plants by growing seeds, planting, layering and nursing seedlings.



Mt. Buko limestone mining site

In 1978 and 1983, Taiheiyo Cement developed conservation plans in cooperation with the local authority, Chichibu City. Particular attention was given to the Takeyama area of Minowa quarry, which was identified as the most important area for rare plant species within the quarry, resulting in the publication of "A Transplantation and Protection Plan for Takeyama Area". This honest and transparent approach to environmental conservation has formed the basis of the company's continued cooperation with local authorities.

Known biodiversity

Mt Buko's limestone is from the Mesozoic era and the same age as stratum composed of sandstone, slate, chert and greenstone surrounding the limestone area. Limestone is mainly distributed over the north side and greenstone on the south side in the mountain. Because of its susceptibility to erosion, the north slope of the mountain is very steep, while the south slope is relatively gentle.

There are quercus, cedar, cypress and other forests at the southwest foot of the mountain, forming natural habitats for animal species, including the Asiatic black bear, wild boar, fox, raccoon, Asiatic flying squirrel and pheasant. The specific limestone and cool humidity conditions of Mt



Cultivated seeds of Senecion furusei Kitam



Buko mean that this is one of the few habitats for rare primroses (*Primula tosaensis var rhodotricha*) and lilies (*Lilium maculatum var bukosanense*). These species are classified as “critically endangered” in the IUCN Red Data Book.

Targets and aims

To protect native plant species by traditional propagation methods and to ensure conservation of the species for the future using biotechnology, such as tissue culture methods.

Restoration activities

First, experts examined the native plants at Mt Buko and identified 20 woodland plants and 45 herbaceous plants on which to focus protection activities. In 2005 this number was expanded to 71 plants. Since 1975 these plants have been protected and then transplanted to the botanical garden that was established in part of Minowa quarry. A greenhouse was also installed and seedlings and layering were propagated for later replanting in the former limestone quarrying areas in order to re-establish them as native species.

The plants are currently replanted as much as possible as seed or layering. However, a mixture of traditional and biotechnology methods could improve the replant success rate.

More efficient conservation and propagation methods were needed to overcome:

- Shortage of staff for taking care of cultivation
- Poor plant reproduction efficiency because only few native parent plants existed
- Low ability for propagation (rate of sprouting, number of seeds)
- Adverse influence of natural phenomena such as extreme weather conditions and damage caused by disease, insects and animals
- Selective decrease of population caused by mistakes in cultivation management

The tissue culture method was selected as an effective means to overcome the above difficulties and to protect the rare species from becoming extinct.

The tissue culture method was introduced to help the protection process in 1995 and was supported by Taiheiyo Cement R & D Center. The main processes of cultivation are:

1. **Extraction of the appropriate part of the plant:** suitable parts for cultivation are selected for each plant, depending on plant type. It could be from axillaries, stems or buds. In this process complete sterilization is necessary for the extracted part.
2. **Vegetative propagation and rooting of plants:** the extracted plant tissues are placed in a culture medium in controlled air and illumination. Specific appropriate nutrient, plant hormone and pH balance conditions are identified to encourage rooting and growth for each species.
3. **Preservation with subculture:** rare species are kept in flasks from which culture tissues are successfully taken 2 or 3 times in a year.
4. **Acclimation:** propagated plantlets are gradually exposed to the air, humidity and temperature conditions of the replanting location.
5. **Raising planting material:** good seedlings grow and develop to harden off before replanting to the quarry site.
6. **Replanting of cultivated plants to the quarry.**

For a small number of species it is sometimes difficult to obtain a suitable parent plant for vegetative propagation. The tissue culture method means that a vegetative part of the plant, stem or piece of root is taken and new plants grown directly from it, i.e., not from a seed or a cutting. It can also be difficult to establish the appropriate conditions for the seed's sterilization and germination before the propagation process and for the culture medium. Such aspects of the process require extensive knowledge and experience gained mostly through trial and error.

Although very specialist skills and carefully controlled facilities are required for vegetative propagation of tissue cultures, it is possible to successfully achieve tissue cultures 2 or 3 times a year. For many of the rare species, the tissue culture method is found to be both easier and more reliable than growing new plants from layering or seed.






Since each plant species grows in its own specific environment, replanting work can often be dangerous. Great care must be taken when working at height for the replanting of the rare species.

Tissue culture biotechnology methods are effective in solving propagation problems and can supply many baby plants in a short period of time. However, problems also arise because cloning results in plants with identical genomes. In order to secure the biodiversity of a species, conventional measures of seeding and cutting in addition to tissue culture technology are carried out thoroughly and continuously.

Results

Among the plants selected for preservation at the Minowa quarry site, some appear in the IUCN Red Data Book as endangered species. Cultivation priority was therefore given to the species classified as "near threatened" and today the company has succeeded in preserving 9 kinds of plants ranked at levels IA, IB and II (see table below). The propagated plants are returned to the former mining site individually.

Red Data Book Category	Critically Endangered (IA)	Critically Endangered (IA)	Endangered (IB)
Picture			
Scientific name	<i>Primula tosaensis</i> var. <i>rhodotricha</i>	<i>Lilium maculatum</i> var. <i>bukusanense</i>	<i>Lithospermum</i> <i>erythrorhizon</i>

Threatened plants which growing in Mt Buko limestone mine

Partners

All activities have been carried out with much engagement with and cooperation from local organizations. In particular, the accumulation of species protection and plant growth expertise is based on the instruction and sharing of knowledge of many experts who have been studying the flora and fauna in the area for many years.

Innovations/highlights

A mixture of traditional and modern biotechnology methods are used to propagate the plants, taking the most effective characteristics of each method to promote overall



success. For cultivation, experience and growth conditions have been compiled in a database at Taiheiyo Cement's R&D center.

At the Minowa quarry site, staff continuously patrol replanting areas to record work undertaken and observe progress, successes and failures on a regular and systematic basis. Care of the replanted locations is also an important part of the restoration process. This protection program has been promoted and reviewed under an environmental management system in accordance with ISO 14001, 1997.

Lessons learnt

More than one method of cultivation was required to preserve and nurture the various species, particularly those that were endangered. Through a commitment at Taiheiyo Cement at the group level, cooperation with local organizations, government, experts and its R&D center, continuous progress has been accomplished to protect and nurture rare plant species as part of the step-by-step restoration and greening process of the quarry site.

However, all the efforts made to propagate, nurture and replant the rare species can be undone by nature itself as some of the plants are very popular with wildlife. Rats, deer, apes and other species can be very destructive when foraging for food, so innovative solutions, such as the provision of protective supports or covers until full growth is reached, are required to allow the plants to coexist with wildlife.

Minowa quarry remains in operation, so there are many dangers. Therefore, the botanical garden is not open to the public. However, access is permitted for guided tours organized for local people, especially school children. Furthermore, when the various plant species are in bloom, samples of the protected plants are exhibited at the local museum, providing an opportunity for people to be close to such rare species.

Further information

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