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**Conservation of rare plant habitats in suburban area:
Changes in actors and driving forces of vegetation management
in Kashiwa city**

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Background

Conserving rare plant habitats is a fundamental step toward the goal of biodiversity conservation. Rapid urbanization and abandonment of traditional agricultural practices have caused loss and degradation of the semi-natural habitats. As a result, a number of species, which were familiar to people several decades ago, are now on the verge of extinction.

In Japan, research efforts have been dedicated to understanding the effects of vegetation management and historical land-use on rare plants. A challenge remains as to how an appropriate management can be put into practice effectively.

Contrary to the areas of urban centers with strongly reduced rare plant habitats, suburban areas still retain these habitats, and they have become the focus of the recent conservation by citizen volunteers and local governments. Ageing farmers and lack of their successors are serious issues in suburban areas, implying that the traditional farmers' management is unlikely to be sustained in the foreseeable future. Although changes in the actors and driving forces of the vegetation management are occurring in suburban areas, a study is needed to verify how such changes have taken place.

This research aimed at examining the history of rare plant habitats from two perspectives, ecological and social. The objectives of this study were, therefore, twofold:

- 1) Identifying the relationships among rare plants, land-cover change, and vegetation management history.
- 2) Verifying changes in actors and driving forces of the vegetation management at rare plant habitats.

Methodology

The study was conducted in Kashiwa city, a suburban city in Japan. 37 areas and 200 species in the city were treated as rare plant habitats and rare plant species. Data was collected through field work, past aerial photographs and semi-structured interviews. The land-cover maps for 1947, 1975 and 2011 were created through ArcGIS. The presence/absence data of rare plant species at the subdivided study sites (162 species and 216 vegetation communities) was classified by hierarchical cluster analysis followed by Indicator Species Analysis (INSPAN) and Detrended Correspondence Analysis (DCA). From the interviews to landowners, city governments, citizen volunteers, and neighboring residents, any change in actors and driving forces of the vegetation management over the past 50 years was examined.

Relationships among rare plants, land-cover change, and vegetation management history

Nine types of rare plant habitats were identified by the cluster analysis. The INSPAN and DCA clarified the characteristics of the each habitat type, and the relationships among rare plants, land-cover change and vegetation management history were identified as follows.

- 1) *Arisaema urashima* type: associated with the maintained deciduous forest and continued vegetation management in the form of mowing.
- 2) *Cephalanthera falcata* type: associated with the maintained deciduous forest and abandoned vegetation management.
- 3) *Sanguisorba officinalis* type: associated with the maintained grassland and continued vegetation management in the form of mowing.
- 4) *Liparis nervosa* type: associated with the maintained deciduous forest and abandoned vegetation management.
- 5) *Hosta albomarginata* type: associated with the maintained forest wetland and abandoned vegetation management.
- 6) *Corydalis decumbens* type: associated with the maintained grassland and continued vegetation management in the form of litter collecting.
- 7) *Clematis terniflora* type: associated with the maintained grassland and continued vegetation management in the form of litter collecting.
- 8) *Cimicifuga japonica* type: associated with the maintained forest wetland and abandoned vegetation management.
- 9) *Penthorum chinense* type: associated with the maintained wet grassland and continued vegetation management in the form of mowing.

Overall, all the habitat types have existed where the land-cover type has been the same over the past 50 years, emphasizing the significance of maintaining the land-cover for conserving the rare plant habitats. Importance of continuing the vegetation management was recognized for the *Arisaema urashima* and *Sanguisorba officinalis* types as these habitat types have contained high numbers of rare plants.

Actors and driving forces of vegetation management

Over the past 50 years, the traditional farmers' management as a part of their agricultural activities has been increasingly abandoned. Otherwise, it has changed into either of three following styles.

- 1) Vegetation management by landowners even after the abandonment of the traditional agricultural management driven by their feeling of care or responsibility for their own lands.
- 2) Vegetation management by citizen volunteers in efforts to conserve rare plant habitats.
- 3) Vegetation management by other persons or groups owing to their social or economical activities (for example: the vegetation management by shrines is conducted as a part of their traditional events; the vegetation management by schools is conducted for the use as school activity site; the vegetation management by city government is conducted at the riverbank for the safety against floods).

The study indicated that the actors such as shrines, temples, schools, city government, Boy Scouts, and companies in the third style have been important players for conserving rare plant habitats in Kashiwa city over the past 50 years. For this third type, the continuity of the vegetation management has occurred by chance, rather than intentionally. Nevertheless, this style has contributed to continuous mowing, which has been critical for maintaining the *Arisaema urashima* and *Sanguisorba officinalis* habitat types.

Finally, future implications for conservation of rare plant habitats were discussed in the context of sustainability. The sustainability of the vegetation management is shown to have been affected by the nature of the driving forces, which change in accordance with changing social needs and values of the community over time. In suburban areas, more sustainable vegetation management would require diversification of the styles of the vegetation management by incorporating multiple actors including shrines, temples, schools, Boy Scouts, companies, city governments and volunteers.