

Environmental Changes at Coastal Lakes in Japan on the Basis of Geomorphological Land Classification and Land Use

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Abstract

In the coastal lowlands in Japan we can find over 30 lakes whose basins are each more than 4km². Among these coastal lakes, those which are situated near some big cities are faced with serious environmental changes. Around these coastal lakes, rapid urbanization has occurred and the inhabitants in each drainage basin have increased during the last few decades. Consequently, some ecological changes and water pollution have been brought about in and around such lakes.

This paper is to discuss the influences of human activities on the environmental changes at lakeshore. The author researched into the types of land use and land transformation in the lacustrine lowlands and littoral zones on the basis of geomorphological land classification.

As a result, recently several types of urban land use accompanied with land transformation in littoral zones have become apparent at some coastal lakes in Japan. Aquatic plants,

especially the emerged plant community which plays very important parts in the ecosystem in the coastal lakes and improves the water quality, has gradually diminished or vanished. The landscape at lakefront also has been spoiled lately.

We should pay more attention to the environmental changes in and around the coastal lakes and consider how to preserve natural ecosystems and desirable landscapes from the urbanization of the area.

1. INTRODUCTION

In the coastal lowland in Japan, we can find over 30 lakes whose basins are each more than 4km², specially along the *Sea of Okhotsk* and the *Sea of Japan*, northeast of the *Kanto Plain* (Fig. 1). Among these coastal lakes, the lakes which are situated near some big cities, such as *L. Mangokuura* (northeast of Sendai City), *L. Kasumigaura* and *L. Inbanuma* (northeast of Tokyo Metropolitan area), *L. Hamana* (west of Hamamatsu City), *L. Kahokugata* (north of Kanazawa City), *L. Shinji* (west of Matsue City), are faced with serious environmental changes. Around these coastal lakes, rapid urbanization has occurred and the inhabitants in each drainage basin have increased during the last few decades. Consequently, some ecological changes and water pollution have been brought about in and around such lakes.

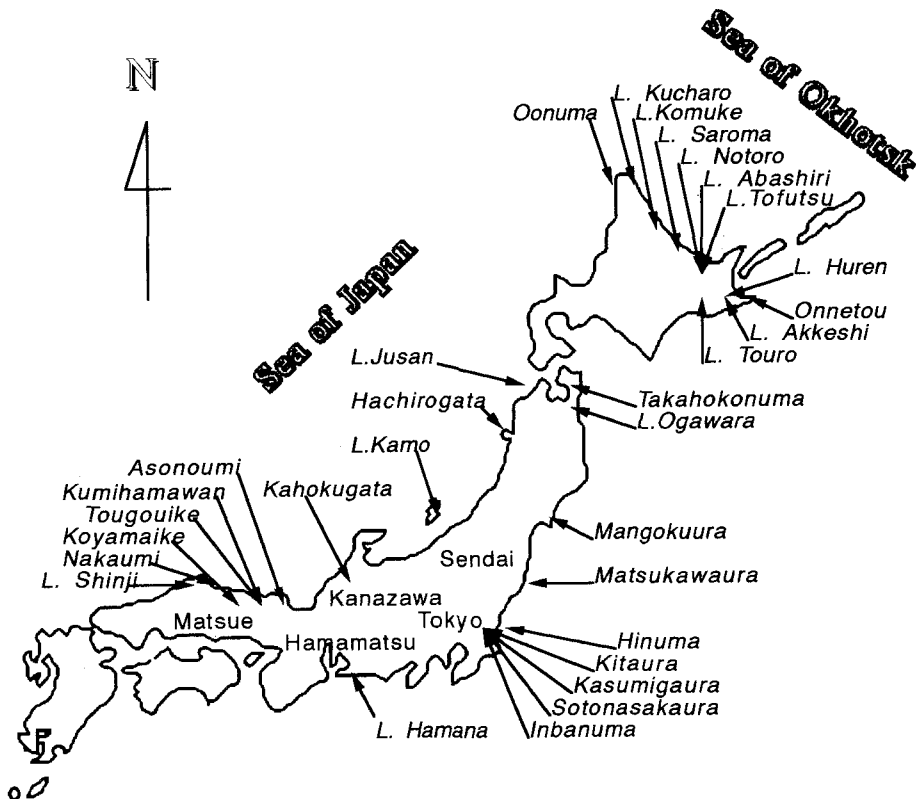


Fig. 1 Distribution of the coastal lakes in Japan (more than 4km²).

This paper is to discuss the influences of human activities on environmental changes at lakeshore. The author researched into the types of land use and land transformation at lacustrine lowlands and littoral zones on the basis of geomorphological land classification. And a emerged plant community in the littoral zone was observed as a suitable indicator of the natural environment of the lakes. The emerged plant community plays very important parts in the ecosystem in a lake.

2. GEOMORPHOLOGICAL FEATURES OF THE COASTAL LAKES

Along the shorelines of a coastal lake in Japan, we can generally find lacustrine lowlands, which stretch at an altitude of 0–5m and at a width of 200–700m, and also a littoral shelf which is only a few meters deep (Hirai, 1989).

The lacustrine lowlands are composed of two Holocene terraces and have beaches or littoral marshes. The higher terrace (littoral terrace I) is 2–5m in height and its width is 100–200m, the lower one (lacustrine terrace II) is 1–2m in height and its width is 100–500m. These two lacustrine terraces have been formed at two different high lake levels and are connected with high sea levels in the Holocene. It is assumed that lacustrine terrace I was formed about 6,000y.B.P., and lacustrine terrace II was formed about 4,000–3,000y.B.P., or about 1,000 years ago (Hirai, 1989 ; Oya et al., 1989).

On the other hand, the littoral shelf can be divided into two different surfaces, based on the differences in depth, sediment, and shape. Littoral shelf I develops widely and continuously at a depth of 0.5–2m, and a width of 200–300m. It is certain that this surface is now in the process of forming at the present water level. And littoral shelf II is supposed to have been formed as a topset surface of a river delta, a tidal delta, a sand spit or a wave-cut bench, at a low water level. This low water level is assumed to be correlated with low sea level which has appeared three times after the maximum of Postglacial transgression ; that is, about 4,500y.B.P., 3,000–2,000y.B.P., and in the 16–17th centuries. The present beach and littoral shelf I tend to develop around the widespread lacustrine terrace II, where the lacustrine terrace I often remains conspicuous (Hirai, 1987, 1989 ; Oya et al., 1989).

3. NATURAL LANDSCAPE AT LAKEFRONT

Lacustrine terrace I, whose relative height above the present water level is more than 2m, is never subjected to any floodings. Lacustrine terrace II, whose relative height is less than 2m, will be partially inundated by an extraordinary flooding. So the long-established villages are usually located on the higher terraces and the inhabitants use the lower terraces as paddy fields. On the sand ridges along the lakeshore we can sometimes find waterside forests, which are composed of willows (*Salicaceae*), alders (*Alnus japonica*), and other trees and shrubs. Some kinds of birds, such as a heron (*Ardea cinerea* or *Egretta garzetta* or *Nyc-*

ticorax nycticorax) or a kingfisher (*Alcedo atthis*), sometimes build their nests in these forests (Fig. 2).

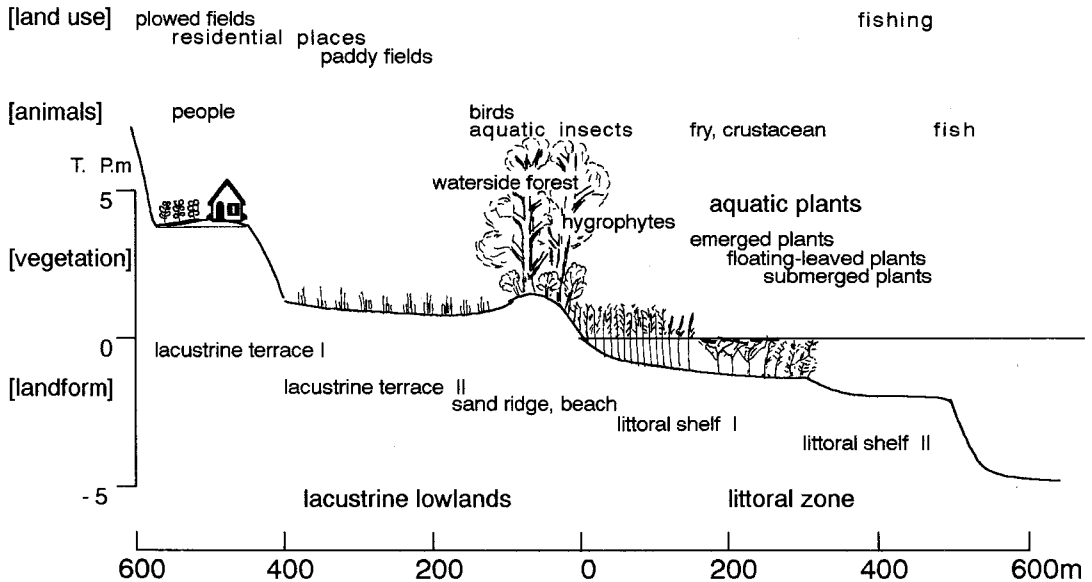


Fig. 2 Schematic natural landscape and traditional land uses at the lakefront of a coastal lake.

In the littoral marsh and on the littoral shelf I, hygrophytes and emerged plant community are often found widely at an altitude of less than 0.5m and a depth of less than 0.5m. In the littoral zones are distributed a reed (*Phragmites communis*), a water oat (*Zizania latifolia*), a cattail (*Typha latifolia*) and so on. On the littoral shelf I, at a depth of more than 0.5m, floating-leaved plants, such as a water caltrop (*Trapa japonica*) or a water fringe (*Nymphoides peltata*) or a water shield (*Brasenia schreberi*) are growing. And submerged plants composed of some kinds of waterweeds (for example, *Hydrilla verticillata* or *Potamogeton crispus*) are also found (Sakurai, 1981).

These hygrophytes and aquatic plants play some important parts in the ecosystem at the coastal lakes. The littoral zone abundant in these plants is a spawning and growing places for fishes, crustacean and other wildlife. And such a littoral zone makes for improving the water quality (Sakurai, 1991). What is better, the herb and woody vegetation in the littoral zone make the lakefront landscape more desirable for people (Sakurai, 1990a).

As mentioned above, the lacustrine lowlands and littoral zones of the coastal lakes originally consisted of some differently characterized landforms and vegetations. And the inhabitants have made a proper use of such areas in the natural ecosystem and have tried to preserve the aquatic vegetation for a long time.

4. RECENT LAND USE AND LAND TRANSFORMATION

Since the end of World War II (1945) in Japan, a large area of coastal lakes has been

reclaimed to produce the crops. Especially, the land of more than 10km^2 has been reclaimed in L. Hachirogata (167km^2), L. Kahokugata (15km^2), L. Kasumigaura (10km^2), L. Inbanuma (14km^2), and L. Nakaumi (11km^2) (Fig. 3).

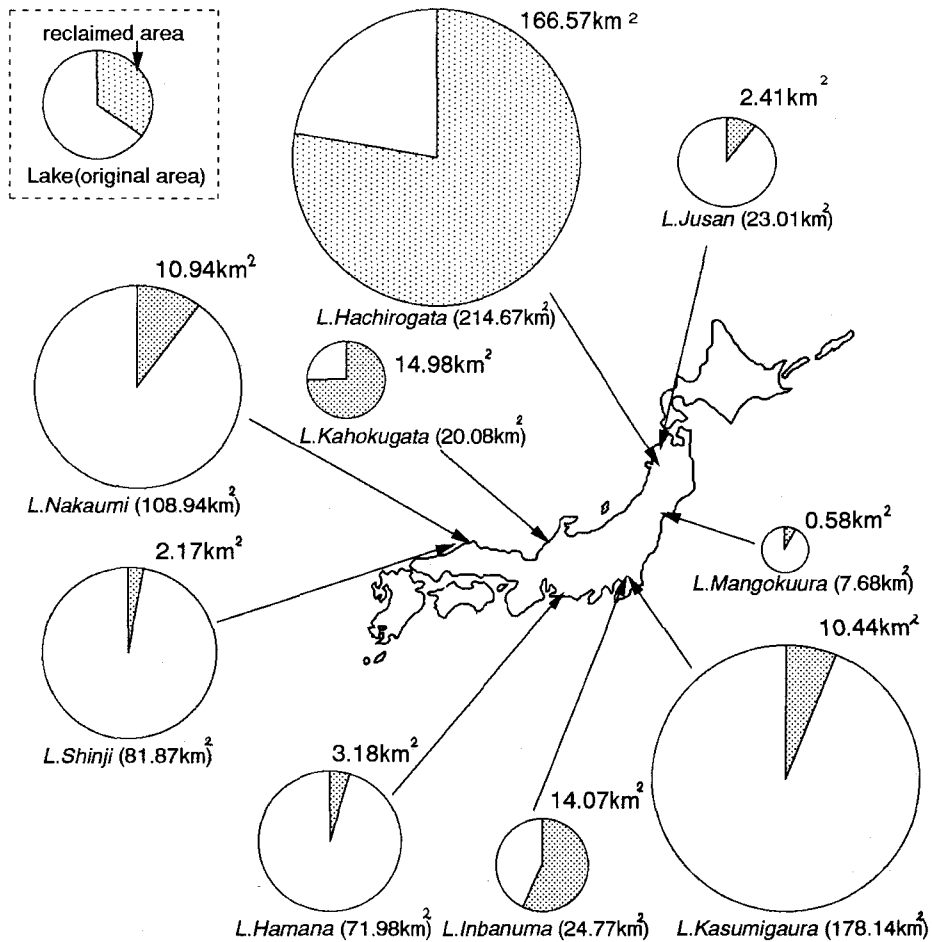


Fig. 3 Reclaimed area and its ratio to each original lake basin.

In many cases the lands reclaimed by drainage are used for paddy fields. But these days we sometimes find the reclaimed lands used for urban facilities or housing. And we can scarcely find natural shorelines without littoral banks or other artificial structures at these lakes.

For example, at L. Kasumigaura, we can find the horticulture in greenhouses or many houses built after raising the ground level on lacustrine terrace II (Fig. 4). And the hygrophytes and emerged plant community in the littoral zone have been changed into edible lotus root fields (Fig. 5) or yacht harbors or fishery ports (Fig. 6) or parking lots. On the littoral shelf and shallow lake bottom, many farming facilities and artificial trench holes can be found (Fig. 4).

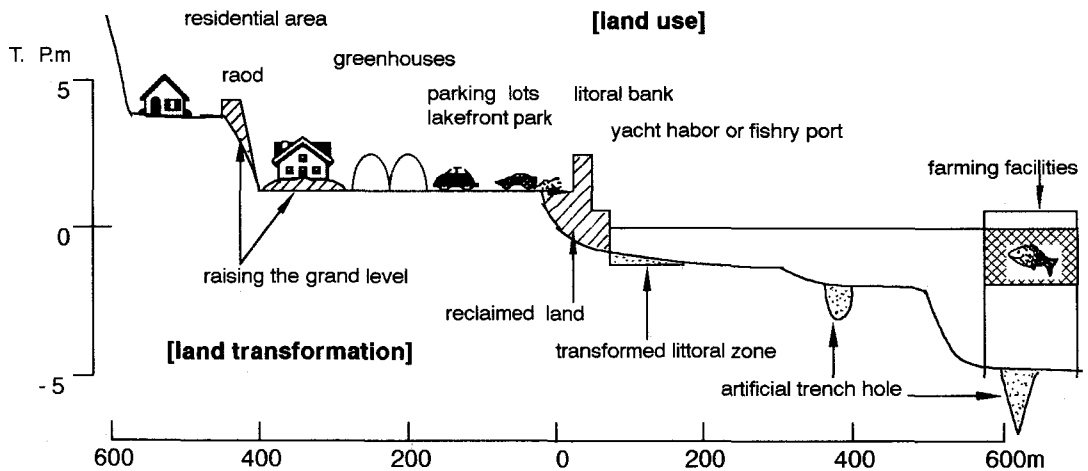


Fig. 4 Recent land uses and land transformation at lakefront of L. Kasumigaura.

5. ENVIRONMENTAL CHANGES CAUSED BY HUMAN ACTIVITIES IN LAKE KASUMIGAURA

At L. Kasumigaura, more than 90% of the whole lakeshore has been artificialized, where the water's edge is in contact with concrete revetments. Aquatic plants in this lake has been noticeably decreasing for the last two decades (Sakurai, 1981, 1990b). The author observed the distribution of emerged plant community in connection with the land use or the land transformation at lakefront in the southern and eastern part of this lake.

As a result, the emerged plant community cannot be found in 33% of the investigated area, and the community scarcely remains along 36% of the lakeshore. No vegetation can be seen in front of the reclaimed lands (Fig. 7), and few emerged plants remain in the littoral zone where sand and gravel are being dug in many places. And the emerged plant community has diminished or almost vanished where a littoral bank or a yacht harbor or a fishery port has been built lately (Fig. 8).

6. CONCLUSIONS

At some coastal lakes in Japan, such as L. Kasumigaura, several types of urban land uses accompanied with land transformation in the littoral zone have become noticeable. And the aquatic plants, especially the emerged plant community, which play very important parts in the ecosystem at the coastal lakes and improves the water quality, have gradually diminished or vanished. And the landscape at lakefront also has been spoiled lately.

And in the other coastal lakes, such as L. Ogawara and L. Nakaumi, some undesirable environmental changes will happen when the continuous littoral bank and a closing levee at the inlet of a lake are built, or when the water level is artificially fluctuated in



Fig. 5 Littoral zone changed into edible lotus root field.



Fig. 6 A fishery port and farming facilities made in the littoral zone.



Fig. 7 Lakeshore in front of a reclaimed land with no vegetation.



Fig. 8 A littoral bank built lately and diminishing emerged plant community.

order to supply the increasing water demands of the neighboring cities. Moreover, by the greenhouse effect which may result in the rising sea level, these coastal lakes will eventually be subjected to some large-scale environmental changes.

So we should pay more attention to the environmental changes in and around the coastal lakes and how to preserve a natural ecosystem and desirable landscape from the urbanization of the area.

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地形分類と土地利用にもとづく日本の 海跡湖における環境変化

あとがき

この小論は、1991年8月25日～28日に北海道旭川市民文化会館で開催された「環境変化と地理情報システム」国際シンポジウム (International Symposium on Environmental Changes and GIS ; INSEG '91) での発表のために準備したものである。シンポジウムでは、アジアを中心に海外からの85名を含め、全体で300名以上の研究者が参加し、12のテーマ別部門に分かれて発表および討論が行われた。

筆者は、水文環境 (Aquatic environment) の分科会で発表した。この部門では、中国揚子江中流の湖広盆地の洪湖 (Houghu lake) でも湖岸堤の建設、湖面干拓、湖水位の人為変動などによって湖岸線が大きく変化している様子が、衛星写真を使って報告された (俞立中 (Yu. Lizhong) ; 華東師範大学, China)。また南アジアの各研究者からは、例えば、ガンジス川中流バラナシにおいて1986年から開始されたガンジス川の水質改善のための Ganga Action Plan (GAP) についての報告 (J. Sigh and V. K. Kumra ; Banaras Hindu Univ., India) や、インド南東部のマドラス～Mamallapuram 海岸地域での都市の拡大と工業の発展、近年のリゾート開発等の影響による環境問題への対応戦略 (A. N. Sachithanandan ; Anna Univ., India)、バングラデシュ南西海岸 Paikagacha および同国東海岸の Chokoria Sundarabans における放牧地やマングローブ森林でのエビ養殖池造成による海岸生態系の破壊や社会・経済システムへの悪影響 (S. C. Das, Jahangirnagar Univ., Bangladesh) 等、最近10～30年間に於いて急激に進行してきた環境危機に対する緊急かつ深刻な発表がなされた。

いずれの研究発表も、地域の開発と生態系の保全とのバランスをどのようにすべきかという点が強く意識されており、いわゆる応用地理学的な立場からの研究が社会的に広く要請されていることを痛感した。今後、日本における環境変化に関する地理学からの研究も、この点をより考慮する必要があるのではないだろうか。

(平井幸弘)