## 6.5. Conservation Rules

Compensation for the loss of income from sand and gravel extraction will, however, be only a part of the total costs incurred when these nature reserves and landscape protected areas have been established. Forestry is important in Hedmark and, although great emphasis has been laid on not proposing more restrictions for the conserved areas than necessary, it has proved difficult to draw up rules which give enough protection without having some effect on commercial forestry.

This at once raises the problem of whether or not it is sound conservation policy to draw up regulations specially tailored for the particular needs of each area to be conserved, rather than to adopt fundamentally standard rules which apply to all nature reserves whatever their interest. Current thinking in Norway has moved towards the former viewpoint and this implies, as in the case of the Hedmark Conservation Plan, that the regulations to be introduced will restrict all activities likely to damage landforms and geological structures, but will not in principle restrict activities affecting the rest of the ecosystem. When such a policy is adopted, it is important carefully to examine exactly what it is intended conservation should achieve within the protected areas so that purely economic reasons do not govern the establishment and the managment of each nature reserve.

## 6.6. Conservation Policy and Practice

Since 1984, the Conservation Plan has gone through an extensive political and administrative process, both locally and with national authorities and organizations. Although this has resulted in a plan approved in principle, ready for the establishment of reserves and landscape protected areas, progress has now been halted through changed economic considerations. The main problem arises from new legislation for compensation (made in 1985) which has now greatly increased the costs of establishing nature reserves. This, together with the overriding priority given to pollution control and the use of the new Planning and Building Act in nature management, has left the more classical forms of nature conservation somewhat behind.

This, hopefully, is only a delay and not an end to the work on the conservation of the key areas for Norwegian Quaternary geology. The government has recently stated that conservation of such areas and localities should continue through the operation of both the Nature Conservation Act and the Planning and Building Act. In addition to this, proposals for a new Sand and Gravel Extraction Act have been prepared and such an Act will be important and useful in the field of Earth-science conservation.

By a Royal Decree of 22nd December 1989, 22 nature reserves and one landscape protected area were established as a result of the Hedmark Plan. Most of the areas excluded from the Plan were mountain areas with a low level of land-use conflict and their conservation interests are to be guarded by means of the Planning and Building Act.

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# 7. Glacial and Glaciofluvial Landscape Types of Finland and Practical Problems of their Utilisation


By OSMO KONTTURI*)


## 7.1. The Genesis of Glaciofluvial Landscapes

The glaciofluvial landscapes in Finland originated and developed as the result of a combination of geological (IGNATIUS, etc., 1980), biological and socio-economic processes over the last 12,000 years. Glaciofluvial deposits, i. e. gravel and sand areas, are very suitable for many purposes. They consist of material important for its use as aggregate and form rich stores of ground water supplies. Glaciofluvial areas are also good buidling bases for roads and railways – many towns and other centres are situated on them. On the other hand, glaciofluvial landscapes are unique natural formations even on a worldwide scale and thus are important for nature conservation. Because of their variable terrain, pleasant forests and lakes, they are very suitable for recreation. Thus glaciofluvial areas


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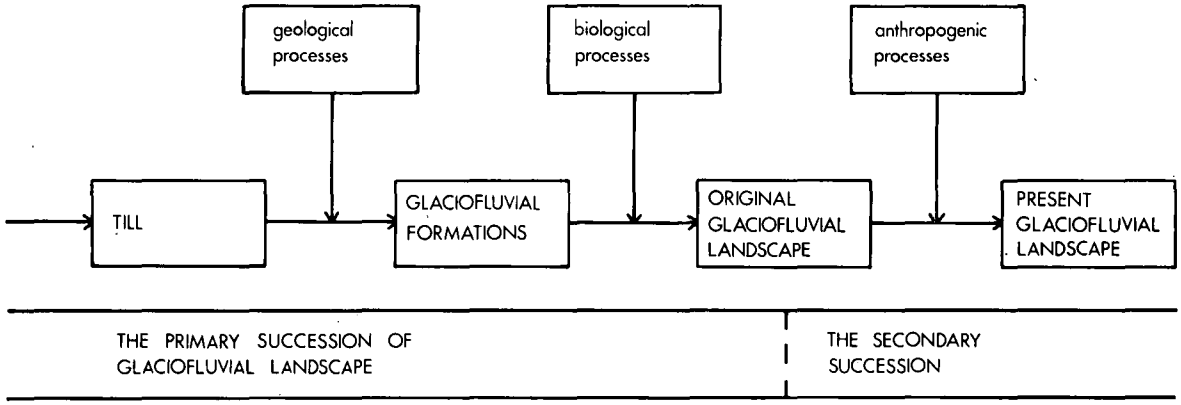


Fig. 8.
Scheme showing the development of a glaciofluvial landscape and its primary and secondary succession.

often are the focus of land use conflicts, and they give rise to difficult environment planning problems in Finland.

## 7.2. Sand and Gravel Resources

Until recently there has been lack of valid data concerning gravel resources, the extent of gravel areas, and the state of glaciofluvial landscapes in Finland (KONTTURI, 1984a; KONTTURI & LYYIKÄINEN, 1983). The main purpose of this paper is to try to reduce this lack of information by collecting data from various sources and unifying them. Only then will it be possible to estimate the future land use of glaciofluvial areas and the factors controlling it.

The results of the National Inventory of Gravel and Sand Resources published in 1979 (NIEMELÄ) estimate the total area of gravel and sand resources in Finland to be about 750,000 hectares or 2.2 % of the total land area. The total volume of gravel resources situated above the groundwater level was estimated at 47.5 billion $m^3$, of which only 1.1 billion $m^3$ (2.2 %) are suitable for crushing and usable for the most exacting construction purposes.

Gravel resources in Finland are rather unequally distributed. Although the gross resources are quite rich, there are large areas with little or no gravel. On the other hand, about 50 % of the gravel is concentrated in the zone of the Salpausselkä ice-margin formations, which account for only 10 % of the total area of the country.

## 7.3. Aggregates Consumption

Although no exact figures are available, the present annual consumption of gravel in Finland is minimal compared to the gross gravel resources. Several estimates have been presented suggesting figures of about 50 million $m^3$ per year in the mid-1970's, whereas the sum total obtained from the results of 20

Fig. 9.
Large gravel pit in the middle of Finland. These pits are often situated along national highways without any sheltering.
Photo A. LYYTIKÄINEN.

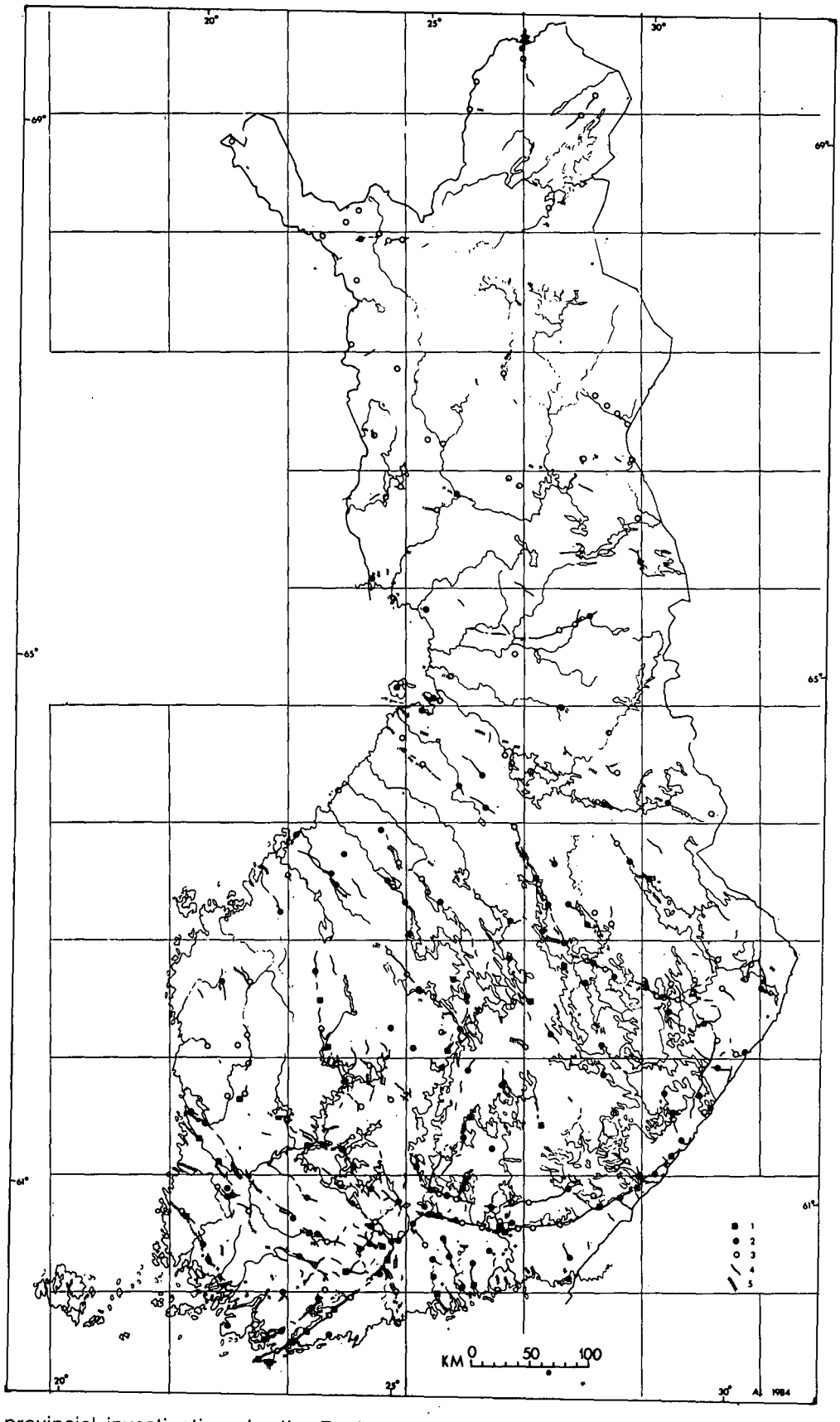


Fig. 10.
Locations of the most seriously altered and deformed esker landscapes.
This may be due to
1) towns,
2) other large built-up areas,
3) small built-up areas,
4) roads or railways,
5) gravel pits.

provincial investigations by the Regional Planning Associations places the total gravel consumption at the same time at only about 37 million m³ per year. The total consumption in historical times has been only about 4–5 % of the total gross resources.

Like the distribution of gravel resources, gravel consumption varies markedly in Finland. About 50 % of the total consumption is concentrated in the four southernmost Finnish provinces, which make up only 20 % of the total land area, although they contain about 60 % of the total population. Correspondingly, about 50 % of the total consumption takes place in urban areas. The most important sectors involved in gravel use during the mid-1970's were public roads

and railways (55 % of the total) and house-building and concrete production (over 20 %) (KONTTURI, 1983).

## 7.4. Land Use Problems

Although total gravel consumption is minor compared to the gross resources, gravel extraction has caused extensive environmental damage, e. g. destroying beautiful esker landscapes, creating groundwater hazards and detracting from the recreational use of esker areas. The large esker areas of southern and central Finland have been particularly badly damaged or destroyed, e. g. many esker chains have been exploited for many kilometres at a time. Furthermore, natural esker landscapes have largely disappeared from all areas within 40–60 km of major population centres in southern and central Finland.

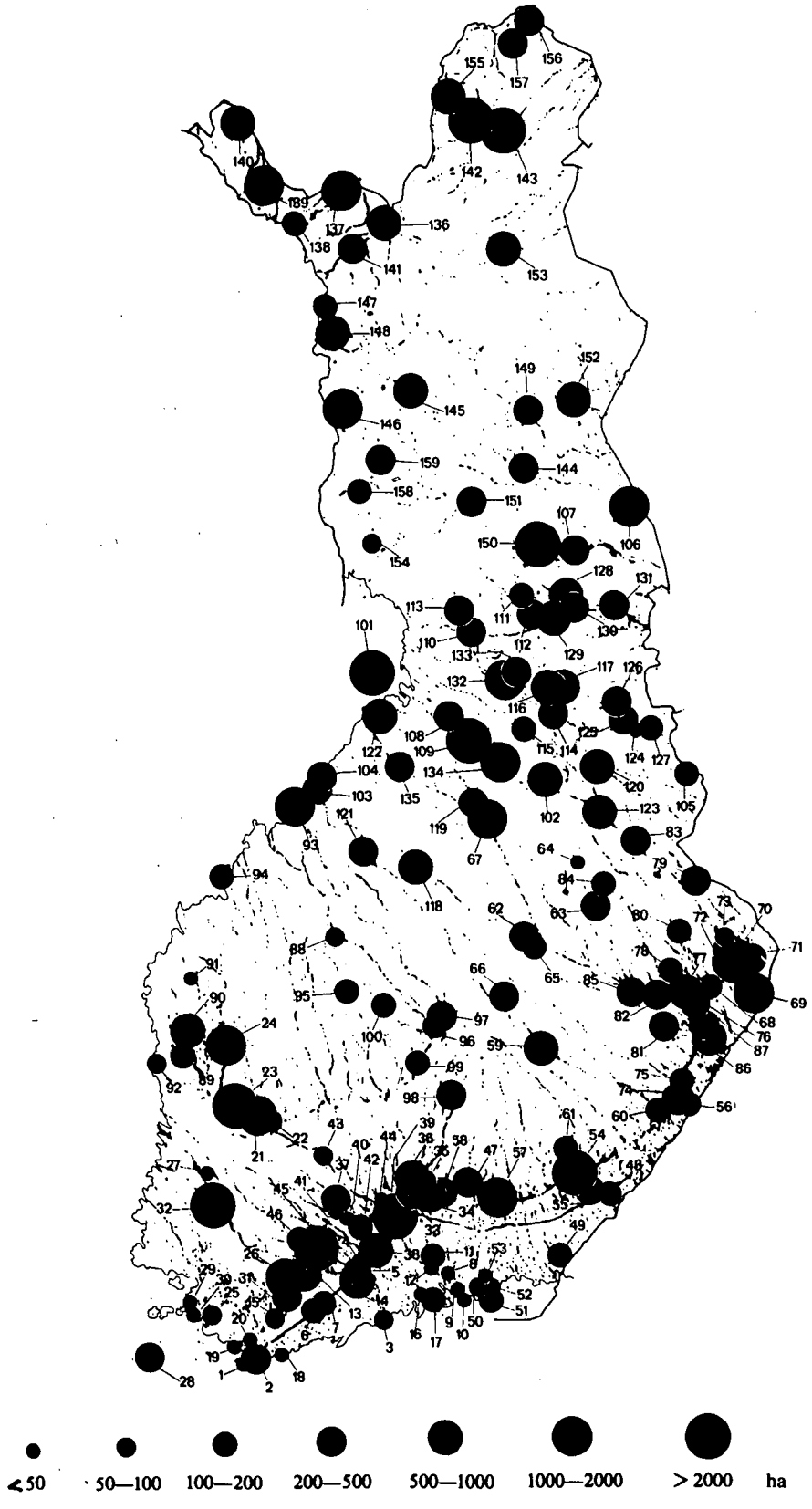


Fig. 11.
Location of sites included in the National Esker Conservation Programme and selected glaciofluvial areas.

## 7.5. Conservation of Glaciofluvial Landscapes

A nation-wide inventory carried out in 1972–1981 showed that there are still about 220,000 hectares of natural or near-natural glaciofluvial landscapes in Finland which is 0.7 % of the total land area, and 30 % of the total esker area. Today only 15,000 of hectares glaciofluvial landscape have been protected by nature conservation acts or by resolutions of authorities and thus belong to national parks and nature reserves. However, in 1984 the Ministry of the Environment prepared a special conservation program, which included 96.000 hectares of glaciofluvial landscape (HAAPANEN, 1982).

## 7.6. Controlling of the Land Use of Glaciofluvial Areas

In practice, gravel extraction in Finland has altered very markedly from 1st January 1982 onwards, with the enforcement of a new law restricting the previously almost free extraction of sand and gravel. Nowadays it is necessary to have permission from the local council and to present a plan outlining the area, the amounts. of gravel concerned, and the proposed measures for restoring the landscape after exploitation.

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