Declining forests on acid soils

The health of Norwegian forests has deteriorated since the mid-1980s. Scientists are registering lower crown density and larger numbers of yellowing needles, signs that forests are being adversely affected.

It is impossible to point to a single reason for the death of trees, loss of crown density or discoloration of needles. One or several types of pollution may be involved, combined with climatic stress factors such as drought, wind or frost.

The crown density of the righthand spruce tree is normal given normal conditions where it is growing, whereas the crown density of the left hand tree is clearly lower.

A young spruce tree which should be a healthy green colour, but shows discolouration (classified as severe yellowing).

ACIDIFICATION SINCE THE ICE AGE

Since the last Ice Age (about 10,000 years ago) Norwegian soils have slowly but surely become more acidic as a result of natural processes. During the last couple of hundred years, human activity has
speeded up the pace of acidification. The removal of timber causes acidification because it results in basic cations being removed from the soil more rapidly than they are added by natural weathering processes. As long as trees are growing, they tend to acidify the soil because they absorb minerals, thus removing basic ions from the soil. The process is reversed as trees die and rot, releasing minerals back to the soil where they can neutralize acidic ions. When foresters remove the timber, not all the nutrients absorbed by the tree are returned to the soil. Even though twigs, needles and roots containing minerals are generally left to rot where the trees were felled, forestry operations tend to intensify acidification.

FOREST DEATH AND ACID RAIN

Early in the 1960s, more and more dead and dying conifers were found in the forested tracts of the Black Forest in southern Germany. Twenty years later, German forestry scientists estimated that one-third of the forests were damaged in one way or another. As time went on, deciduous trees such as oak and beech were affected as well. In 1984, the German authorities said that damage had been reported in more than half the country’s forests. At the same time, the alarm was raised in other countries, especially in Central and Eastern Europe, where large areas of forest were severely damaged.

All through these years, there was a fierce discussion about what caused the damage. Scientists still do not agree entirely, but no-one doubts that acid rain affects forests.

High concentrations of airborne pollutants (for example near large power stations or industrial installations) can damage leaves and needles directly. Norwegian forests are mainly affected indirectly, by the acidification of soils as nutrients are lost by leaching. Nevertheless, direct injury has been observed, for instance in the Paskvik valley in Finmark county, where sulphur dioxide in the acid smoke from the nickel refineries on the Kola Peninsula causes burns on pine needles and the foliage of deciduous trees.

The indirect effects of acid rain on forests are caused by the loss of soil nutrients. Acid rain can displace nutrients such as calcium and magnesium from the soils. Scientists have modelled these processes, and estimate that in forested areas in southern Sweden and Norway, acid rain may have leached out 20 to 70 per cent of the most important minerals.

In very acid conditions, aluminium becomes soluble and is released from the soil. At high enough concentrations, aluminium is toxic and damages tree roots. Until recently, it was thought that soil acidification was primarily caused by sulphur deposition, but scientists have now realized that nitrogen compounds from exhaust fumes can also cause damage. Nitrogen inputs increase forest growth, but the trees need other nutrients as well. Acid rain does not provide these, and fertilizes the soil in a way that can cause nutrient imbalance. Rain and snow polluted by nitrogen also contain heavy metals such as mercury, cadmium and lead. It is believed that these have negative effects on nutrient turnover in the soils. They may also injure tree roots and thus cause further damage to the health and vigour of our forests.