The Effects of Exotic Forests on Soil, Ground Water, Water Quality, Air Quality and Native Flora and Fauna

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EFFECTS OF PINE TREES ON THE SOIL

Pine trees have the same effects on soil as native trees (except kauri[2])), no more, no less. There is strong evidence that pine forests improve soils.

Approximately 2/3rds of the Ngati Hine Forestry Trust land has extremely old, infertile gumland[2] soils. It is of low natural fertility, is highly erodible and has been in short scrub and eroding since well before Maori arrived in this country. This land got this way because it previously carried dense kauri forests, most of the kauri having killed itself off long prior to the arrival of the first Polynesians[2].

The remaining third is clay hill country which would have originally carried broadleaf (puriri, taraire, kohekohe) and podocarp (rimu, matai, totara, kahikatea, and some kauri) bush.

1. All trees remove and return nutrients from and to the soil. Kauri, however returns few nutrients to the soil and makes it so poor and acidic that it eventually kills itself out. (See explanation in Reference 2)
2. Trial work in New Zealand has shown that pine trees do not degrade or kill the soil. Instead, they improve nutrient cycling in the soil and improve internal soil drainage.
3. Pine trees make the soil no more acid than native bush, certainly nothing like kauri, and recycle nutrients in the same way as native trees. Trials on sand dune forests have shown that pine trees do not 'leach' soils of nutrients like kauri trees.

EFFECTS ON GROUND WATER

Pine trees have no greater effect on soil water than native trees of the same height and forest density.

Trees, native or pines, have several effects on water in the soil and the rocks beneath.

1. Interception – Rain falling on trees catches on the leaves, needles and branches. The height of the tree rather than the type of tree has the main influence on interception. Only the first 0.5 to 2.5mm of each rain is intercepted by the plant, the rest finding its way down to the ground.
2. Evaporation – Some of the rain, fog and dew intercepted by trees evaporates from the leaves and trunks, and does not reach the ground.
3. Transpiration –All plants take up water through their roots, pump it up through the plant and transpire or breathe it out through pores in the leaves. Interception of heavy rain by bush or forests slows down the rate of runoff and can reduce flood peaks in smaller catchments.
4. Tree roots, growing much deeper in the soil than grass or scrub, soak up water and transpire it through the leaves. This has three main effects:

i. It slows down slip movement;
ii. It soaks up water from our heavy, often waterlogged clay soils, provides drainage and improves the soil; and

iii. It can reduce the amount of water than finds its way down into the rock beneath and so reduces spring flow; **although**,

5. It can increase the amount of water getting down to groundwater by tree roots creating drainage through heavy clays soils and pans.
6. The combined effect of interception, evaporation and transpiration by bush or forests can use up to 40 and 80mm of the rain falling each year. Kawakawa receives an average 1400mm of rain each year while Kaikohe receives 1860mm. If the whole area was in forest it could reduce the yield of the Kawakawa River catchment by 2.5 to 6%. Most of the catchment, that is the area draining into the Kawakawa River, has a higher rainfall than Kawakawa so the total effect would be minimal. Pine forests are only returning the catchment flows to what they were when the catchment was in native bush.

Work by Waugh(3) showed that low flows in Northland during a drought are determined by rock type - some rocks hold more water which they can release for longer. The sedimentary rocks under the Ngati Hine Forestry Trust land, shale, mudstone and sandstone, are not good water-yielding rocks because they do not have a large number of voids or cracks in which water can be stored.

This is partially offset by the large wetlands that remain within the Kawakawa River catchment and the swampy valley bottoms that have been restored to their natural state with afforestation and prevention of fires. That is, while the rock types do not yield much water in a dry year, the wetlands, which have stored winter rains, do help sustain low flows.

EFFECTS OF PINE TREES ON WATER QUALITY

"The water quality of streams draining relatively mature, undisturbed stands of exotic conifers is generally high and comparable with water quality of streams draining native forests"– O'Loughlin and Will 1981 and 1996(4)

Trial work throughout New Zealand show that pine plantations control soil erosion and improve water quality better than scrubland or grassland. There is, however, a risk of erosion or sediment and nutrient loss during harvesting and for the next three to five years until the new trees become established.

Good management practices like retaining wetlands, allowing or encouraging reversion of riparian areas to native vegetation, using logging techniques that reduce land disturbance, retaining slash on the land during harvesting, carefully maintaining roads to prevent erosion and not using fire to prepare land, all reduce the short-term impact of logging. Most of the Ngati Hine Forestry Trust plantations drain into wetlands which capture any sediment washing off newly logged areas and from roads.

Scientific evidence shows that:

1. Sediment yield from pine forests is similar to or less than that from mature native forests.

2. In a pine forest, sediment and nutrient loss is much less and therefore water quality will be far superior to that in eroded scrub or grassland.

3. Sediment load will rise during harvest and for up to five years afterwards but this rise can be minimised by following good forestry practices.(5)

4. The pH, acidity, of pine forest streams is the same as native forest streams.

Pine trees or pine needles do not 'poison' water. Any discolouration of the water in Ngati Hine Forests will be due to peat-stained water draining out of the numerous wetlands that have re-established within the pine forests since burning has been controlled. These peat swamps are large natural filters, capturing any silt and nutrient runoff from adjoining forest land, and storing and gradually releasing floodwaters.
Fish and stream fauna studies in Waitangi, Glenbervie and Waipu forests show high numbers of fish, including trout, rare frogs, etc.
Any sort of tree shading a stream will keep the water cool and provide a better habitat for fish.

EFFECT ON AIR QUALITY

Radiata pine pollen is not generally allergenic.

1. Pine pollen is produced for a short period in late July and early August and, being smooth, when compared with other pollens, rarely affects health. All plants produce pollen and some like grasses, privet, gorse and wattles do cause allergies. (Tests of a sample of 200 people in the USA showed 155 had allergic reactions to pollen but only 5 reacted to radiata pine pollen.)
2. Trees, and particularly pine trees, trap air particles in the air – they filter the air – catching dust and absorbing things like sulphur from smoke.

EFFECT OF PINE TREES ON NATIVE FLORA AND FAUNA

Pine plantations, particularly those in Northland with patches of native bush, provide favourable habitat for native flora and fauna.

1. Waitangi Forest supports one of the highest populations of North Island brown kiwi populations in New Zealand. DoC has collected kiwi eggs from Glenbervie for their Operation Nest Egg.
2. Mahurangi and Waipu Forests have populations of the rare Hochstetter's frog, there are long tail bats in Riverhead and Te Kao Forests,and Tom Tits have been mist netted in the pine plantations of Glenbervie Forest to recolonize indigenous areas where they are no longer found.
3. Control over burning near the pine forests has protected the pockets of native bush and wetlands, allowing them to recover and thrive.
4. Pest control (possum and goats) during pine forest establishment has protected adjoining native plants and bush.
5. Wider riparian strips or edges between pine trees, wetlands and streams would provide even greater opportunity for native flora and fauna to spread.

REFERENCES/EXPLANATIONS

(1) Maclaren, J. P., Environmental Effects of Planted Forests in New Zealand, F.R.I Bulletin No 198, New Zealand Forest Research Institute 1996

(2) Gumland –A dense stand of kauri strips everything out of the soil and eventually makes the site so poor, so hostile, that the kauri dies off. The only plants that can survive on such poor sites are very low fertility-demanding short scrub plants like manuka, rushes, umbrella fern, club mosses, orchids and sun-dew (insect-eating plants) – gumland scrub.

Kauri trees drop large volumes of litter – bark, leaves and small branches – which, because it is very acid, doesn't break down to form humus and mix into the topsoil. Instead, the acid litter is 'pickled', just as you do when you pickle food using an acid like vinegar or lemon juice, and remains on the surface of the soil as a peaty layer. Rainwater draining down through the litter carries what is a relatively strong acid down through the soil. All iron and aluminium (which give most of the brown colour in the soil) and all nutrients are leached (stripped or washed) out of the upper layers of the soil, leaving behind a layer of white or light grey, almost pure silica. The white layer is often called 'pipe clay' but is really sand or silt as clay is also leached out of the upper layers.

Gumland scrub produces acid litter, just like kauri, so the soil remains poor. Providing the gumland soil remains intact, it is not eroded away, the vegetation will remain low scrub, at best manuka 3 to 4 metres high. Only if the silica pan is eroded away and the sticky clay layers or the rock beneath exposed will bush regenerate.

(3) Waugh, J.R. 1970. The Relationship between Summer Low Flows and Geology in Northland, MWD Water Soil Misc. Hydrology Pub. No 6.

(4) O'Loughlin, C.L. and **Will, G.M**. 1981, The effects of exotic forestry, Water and Soil Misc. Publication No. 23, National Water and Soil Conservation Organisation, NZ, and **O'Loughlin, C.L**., 1994 The Forest and Water Relationship, New Zealand Forestry, November 26-30.

(5) Best Environmental Practice –The New Zealand Environmental Code of Practice for Plantation Forestry was developed and adopted by the NZ Forest Owners Association, the NZ Farm Forestry Association and the Forest Industry Contractors Association to ensure all forest operations are carried out in an efficient, economic and effective manner whilst meeting appropriate environmental standards. This is a comprehensive handbook which should guide all those working in the forest industry. It provides instruction on how to implement what is accepted best environmental management practices in production forests.

(6) Burridge, B.E. & Cathcart, R.W., 1967, Soil Conservation Survey of the Kawakawa River Catchment, Northland Catchment Commission.