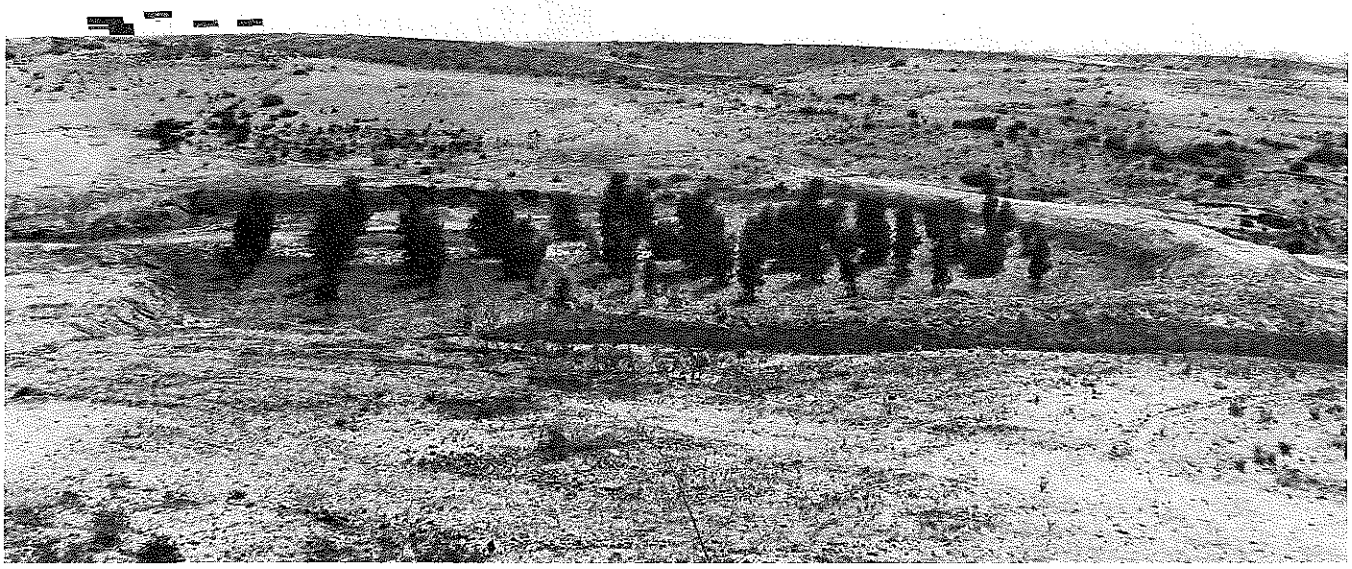
LIMANIM

BY GLEN WILSON



" . . . not even the 'jet-lag' nor lack of sleep could stifle my excitement at seeing the 'dams' planted with young eucalypts, nestling in the hollows beside the main road." The general formation of the liman can be seen in this view.
Photo: Glen Wilson.

In 1979, during study leave from the School of Environmental Design, Canberra College of Advanced Education, Glen Wilson investigated arid land planting. He spent six months at the Applied Research Institute, Research and Development Authority, Ben-Gurion University of the Negev, at Beer Sheva, Israel.

Beer Sheva is in the northern part of the Negev Desert, and has an annual rainfall average of about 200 mm (8 ins.).

Since his return, Glen Wilson has been preparing a report for publication, and it will shortly be available to purchase.

The Report is Publication No. 1 of the School of Environmental Design, CCAE, and may be ordered from the CCAE Branch of the University Co-operative Book Shop, Box 1, Belconnen ACT 2616. The price is not yet available. The report consists of 20 chapters covering many aspects of arid land planting and associated problems, and is illustrated with over 120 black and white photographs. There is also information on the Negev, Ben-Gurion University research, social problems of desert towns, and the Jojoba plant. Plant lists include species grown in the Negev without irrigation, useful dryland plants, salt tolerant species, and suggestions of Australian species worth trying in the Negev and similar climatic zones.

Two chapters of the report are of special interest to Australians: one on 'Limanin', which is reproduced below, and one on 'Runoff Agriculture' as it has been developed in the Negev.

There is a fairly comprehensive bibliography as well.

A LIMAN (from the Greek *limani*, a port) is an earth structure resembling an Australian farm dam, but with a flat bottom and carrying trees: these receive runoff water trapped to a designed depth by a 'threshold' at the entrance to the by-pass.

Limanim are a common sight in the northern Negev, constructed in depressions near the roads, and more often than not, carrying stands of eucalypts. They are designed and built by the Forestry Department of the Jewish National Fund (Keren Kayemeth Leisrael) as part of the afforestation program, and they provide the means of growing trees in low rainfall areas, where watering by other than runoff harvested from a higher catchment, would be out of the question because of cost, and where the young trees would have little chance of survival without some concentration of the light winter rainfall. Some existing limanim are displaying fine stands of *Eucalyptus occidentalis* south and east of Beer-Sheva where precipitation is in the 150-200 mm range; and others I was shown, either not yet planted or just planted in the winter of 1977/78, are in zones having an even lower average rainfall; perhaps closer to 100 mm. About 80 mm is considered to be the bottom limit for runoff collection.

It will be recalled from Chapters 4 and 12 that loess soil tends to encourage surface runoff, but once water is impounded, infiltration is good, and the generous depths of this fine silt-like soil hold moisture deep down for long

periods. Thus it is fair to say that as in the case of 'runoff agriculture', limanim have also been developed as a result of the characteristics peculiar to the loess soil of the northern and central Negev.

SIZE

The limanim I inspected varied considerably in size, some of the newest being the largest. Many of the older ones in the vicinity of Beer-Sheva have a bottom area as small as one dunam (1000 sq.m, roughly a quarter of an acre or the size of a largish suburban building block in an Australian city) whilst some of the new ones cover areas up to five dunams (5000 sq.m = ½ hectare).

CATCHMENT RATIO

The ratio of catchment to effective area (the bottom) may be as high as 500:1, and all those I saw seemed to be designed to hold from 400 to 600 mm depth of water. The calculations are based upon the expected number of floodings and the known or estimated requirements of the tree species to be planted; but it must be remembered that rain falls only during the winter months in the Negev, and is very variable, so there are many seasons when the optimum may not be achieved. Obviously further south in the Negev as precipitation drops, the catchment ratio must be increased.

THE WALLS

The construction of the walls differs from that employed in sinking farm dams in that the chances of finding the soil at optimum moisture content are rather remote; so tightening of the earth walls really depends on natural consolidation rather than on compaction during the forming operation. As a result some degree of undercutting was evident along the walls of a new limanim that has been subjected to flooding. The embankment height is usually about three or four times the designed water depth, and at the top one and a half times or twice as wide as the height. Batters are steep due to the unique 'standing' qualities of the loess soil, and elsewhere a batter of about 1:3 would seem more suitable.

ENTRY AND BYPASS

One lesson learnt from field experience is that the bypass must not be placed opposite the main inlet flow if that is down a wadi rather than sheet flow. I saw one bypass in such a position that had been badly scoured away, so that the 'step' that sets water level had been eliminated. There was also bad damage to the wall necessitating the restoration of the bank around the bypass, and the cutting of another outlet well to the side of the main flow. This type of damage emphasises that sheet flow is less likely to cause structural damage and is considered better design than single flow entry, although the latter is hard to avoid in the search for suitable sites, many of which are on the line of small wadis. Possibly some extra work above the site might result in a formation that spreads the water to enter the liman right across the width. No doubt some such solution will be achieved before long, as the design is not considered by any means static, and empirical development seems to be the norm. For the larger structures it is usual to design two bypasses in order to relieve the concentration of out-flow. A large volume of water entering at high velocity may indicate that the site is not entirely satisfactory. Sites seem to be selected in the field and afterwards may be verified by study of the contour plan.

In the latest 'models' the step at the start of the bypass is absent, but further investigation quickly discovers the floor of the bypass channel grading up to 'spillway' level some metres along, then grading down again to flow into the natural drainage line or wadi below the liman.

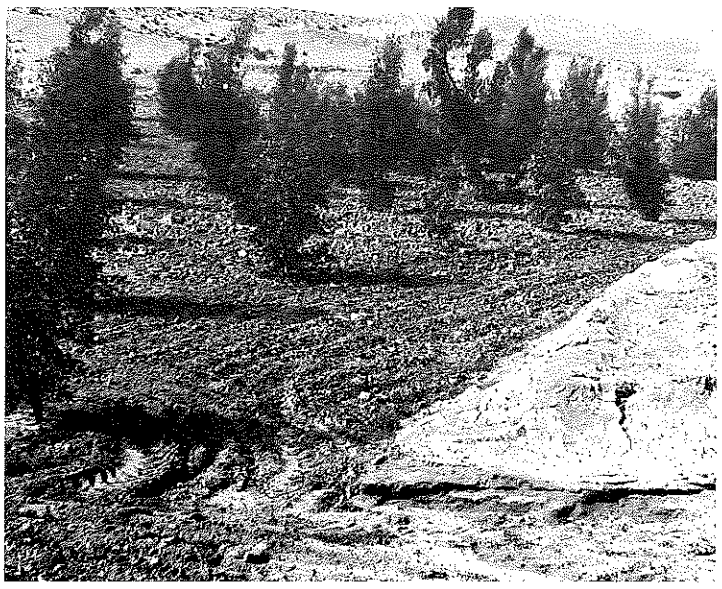
TREE GROWTH

Experience has shown that after some years the trees may be poorer on the upstream side of the liman: this is due to the silt load deposited there, which gradually reduces the depth of water trapped at that side to less than the designed depth. A possible answer may be to design the bottom with a fall toward the entry side to allow for some calculated amount of silting. Any earlier superior growth of the trees in the deeper part may eventually become less evident as the bottom levels out from silting.

EXCLUSION OF ANIMALS

Browsing animals are excluded in order to prevent the 'sheep's foot' type of compaction of the floor which naturally reduces infiltration, and to discourage the violation of this rule and to increase absorption, the bottom is cultivated annually to eliminate grass and weeds. Of course, grass and other low growing feed crops can be grown between the trees especially when they are young, but it should be harvested and removed from the liman. Fencing is not used — there are very few fences to be seen in the Negev apart from chain wire security fences around kibbutzim and moshavim; instead a program of education has been tried with the Bedouin, combined with patrolling by rangers. There seems ample evidence that this scheme works quite well. In any case fencing is difficult because of the bypass and the cost of upkeep, as it would invariably be damaged.

Vigorous young trees in a liman. The bypass is evident in the right foreground.
Photo: Glen Wilson.



PLANTING

In new limanim, the young plants are put straight into moist soil after good rain, with no follow-up watering, which would be expensive in the remote areas. The planting stock is fairly small; well developed tube plants as we know in Australia would seem to be ideal.

In the past limanim have mostly been planted with a single species; often *Eucalyptus occidentalis* because it has responded well, reaching heights of three metres in two years with a mere 50mm of rain a year. Some of the more recent plantings are of two or three species, for instance a mixture of evergreen and deciduous trees. There is as yet little consideration of ecological factors; understandably under such extreme conditions, the whole emphasis has been on planting species with the confidence that they will survive and grow steadily with a low percentage of loss.

I discussed with Dr Dov Pasternak the aesthetic disappointment of rows of equally spaced eucalypts on clean trunks, and found we both had the feeling that some landscape-ecological input is needed to improve the appearance and the usefulness of limanim. The first change needed is a breakaway from the 'orchard' rows of trees, with more casual and natural looking spacings, still allowing for cultivation if this is proved necessary. Next, a few species could be combined to form different canopies, and low growing covering plants could perhaps even eliminate the need for cultivation. Plants such as *Atriplex* spp. could be harvested regularly as a permissable source of stock feed. Given that some such ground cover plantings would prevent cultivation, we can ask ourselves whether breaking the ground to increase infiltration is really necessary. Evidence seems to indicate that it may be unimportant. As we have seen, the loess soil of the Negev has a tendency to seal at the surface and resist immediate water penetration, but once wet has a good infiltration rate. This fact and the presence of the roots of the trees and of other plants should enable water to soak down at an acceptable rate, particularly as we are dealing with water that is impounded (to a fixed depth) and cannot run away. The evaporation factor is hardly significant as the process takes place only in the winter.

WILDLIFE

One aspect of this work that needs to be investigated is whether the species suitably shelter the wildlife. One's first reaction is to select native species wherever possible, but as has already been pointed out, in the Middle East the range of rewarding native species is rather small so inevitably one plants introduced species that respond well. In Australia it is common knowledge that many native animals and birds have established themselves voluntarily and apparently very happily in introduced vegetation: the Bushy-tailed Possum is a classic example. It may well be that the same can happen in the Negev. Such an investigation would seem to be an essential part of the strong movement to re-establish in the Negev and in other parts of Israel, animals which have now become scarce or even lost.

Whilst I recognize as a very sad and serious thing that any country should lose its natural vegetation and the specific character this gives to a land, and should take on the physiognomy of a landscape completely alien to its own, the fact is that this has already happened in Israel, where the main over-canopy tree is now the River Red Gum. It is doubtful that any program could ever reverse this fait accompli.

IMPORTANCE

The liman was the first thing I saw in Israel that was directly concerned both with my work, and with the study that I had gone there to make. It was still early morning as I sat in the taxi taking me from Lod airport to Beer-Sheva, and not even the 'jet-lag' nor lack of sleep could stifle my excitement at seeing the 'dams' planted with young eucalypts, nestling in the hollows beside the main road. In retrospect I regard the liman as one of the most important discoveries of my study leave. Although I was told that other Australians had taken the idea home, I had certainly never seen or heard of it in my own country.

Even without the loess soil, I feel sure the idea can be applied in a number of different ways in Australia, and that it and its 'parent' — the runoff farm — have opened up a whole new range of possibilities for landscape planting. I see no reason why this principle of water harvesting cannot be used to trap summer rain for young trees in south eastern Australia. A removable 'threshold' could be designed to ensure that winter rain is not ponded. I discussed this possibility with Professor Michael Evenari and he was most enthusiastic. Interestingly he expressed disappointment that the results of the research which he and his team have undertaken over the years have not been applied in more ways throughout the Negev. I myself observed that Israeli landscape architects at this stage seem rather insensitive to his work, and miss many opportunities to trap runoff for irrigating plantings. Drip irrigation has become altogether too convenient.

CALCULATIONS

SIMPLIFIED CALCULATIONS FOR WATER HARVESTING IN LIMAN WATERSHEDS. Total annual runoff in the Negev is about 10-20% of total annual precipitation. This gives 10-20mm from 100mm annual rainfall. Thus every hectare of catchment yields: $10\,000\ m^2 \times 10\ mm = \frac{10\,000}{100} = 100\ m^3$ so the annual total should be 100-200 m^3 per hectare. (1mm of runoff = 10 m^3 per hectare). Now, assuming a tree species that needs 500 mm of water a year to grow well, and assuming a liman to be of 1 hectare, then $10\,000\ m^2 \times 0.5\ m = 5000\ m^3$ required. Working on the lower figure for water harvested, 100 m^3 per hectare, we have $\frac{5000}{100} = 50$. So the catchment ratio should be 50:1 in this case.

Obviously during a 'dry' winter the trees may receive a total depth of water that is below the goal. The liman in the above example would have the bypass designed to hold the 500 mm depth of water so that it would be possible for the trees to receive the full amount from one flooding.

EDITOR'S NOTE: Glen Wilson's new book 'AMENITY PLANTING IN ARID ZONES' published by the Canberra College of Advanced Education is now available. Consisting of 22 chapters and 460 pp it has very comprehensive lists of arid area plants, including a large number of Australian plants. It is available at the University Co-Op Bookshop CCAE at $13 or can be mailed at cost of $16 post included. Send orders to Box 1 Belconnen ACT 2616. (Numbers limited.)