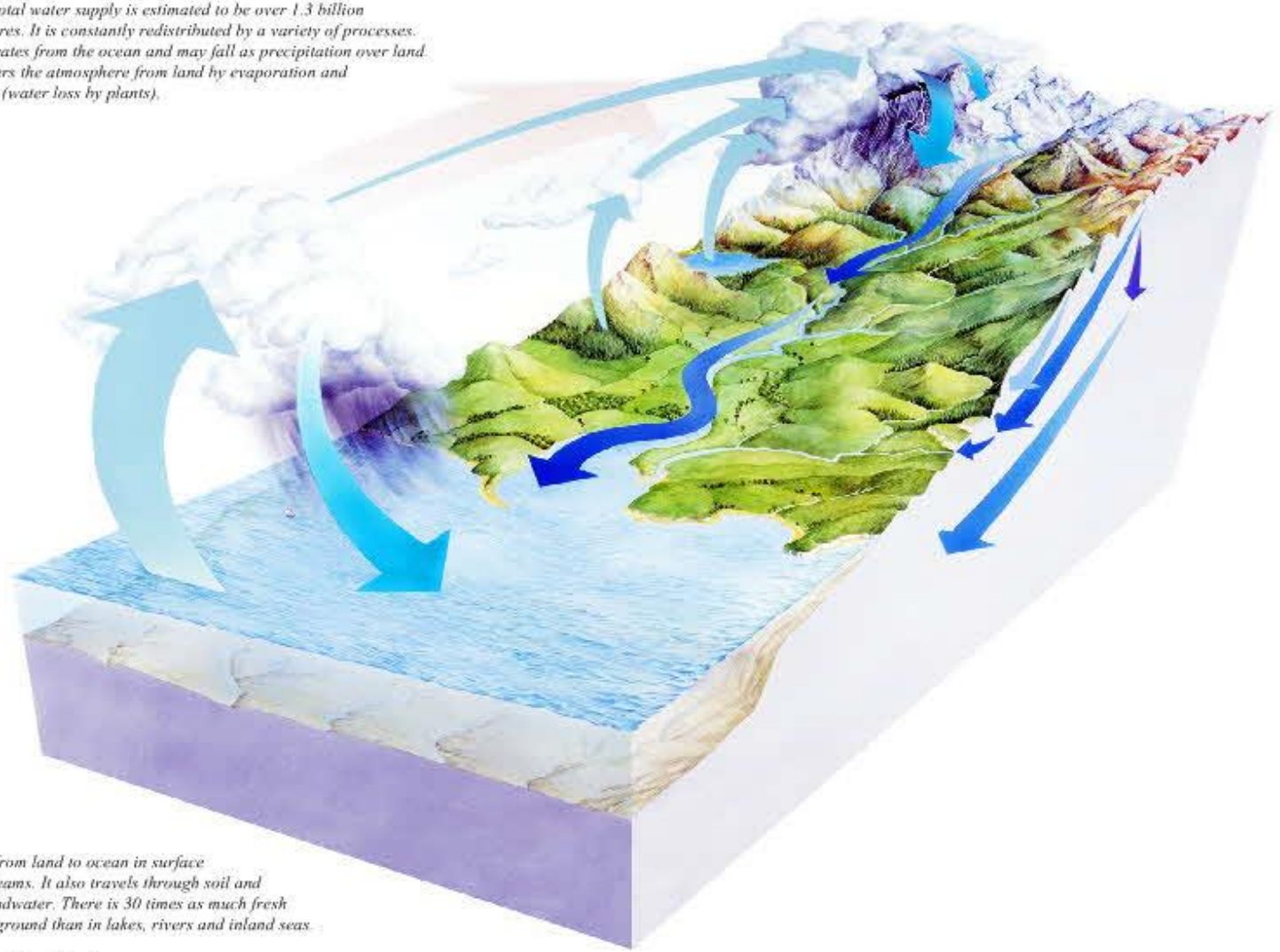
Water

Water

Water Cycle:
The Earth's total water supply is estimated to be over 1.3 billion cubic kilometres. It is constantly redistributed by a variety of processes. Water evaporates from the ocean and may fall as precipitation over land. Water re-enters the atmosphere from land by evaporation and transpiration (water loss by plants).



Water flows from land to ocean in surface riversand streams. It also travels through soil and rock as groundwater. There is 30 times as much fresh water below ground than in lakes, rivers and inland seas.

Photographer: Gary Hincks
(Science Photo Library)

TABLE 7.1
RENEWAL TIMES OF ALL WATER IN BASIC STORAGES (seawater and freshwater)[From: Southwick, C.H., *Ecology and the Quality of our Environment*, Van Nostrand Reinhold, NY, 1976.]

LOCATION IN STORAGES	DISTRIBUTION (% of total water)	RENEWAL TIME (Turnover rates, cycles)
Ocean	93.8	37,000 years
Glaciers and permanent snow	1.986	16,000 years
Groundwater (to 5 km depth) (Actively exchanged)	4.1 0.274	4,600 years 300 years
Lakes	0.0051	13 years
Atmosphere	0.000959	9 days
Rivers	0.00008	13 days
Biological water	0.000005	3.4 days

TABLE 7.2
FRESHWATER LOCATION.
Freshwater is only 3% of all water on earth, and very little is in circulation, most being locked up in storages.

STORAGE	% OF FRESHWATER
Ice and glaciers*	75.0
Groundwater more than 800 m deep	13.5
Groudwater less than 800 m deep	11.0
Lakes	0.3
Soils	0.06
Atmosphere (in circulation at any one time)	0.035
Rivers	0.03

*Frozen ground or permafrost is not assessed in this table. It represents a considerable storage (about 40% of the landmasses of Canada and the Soviet Union.


ALL WATER
FRESH WATER

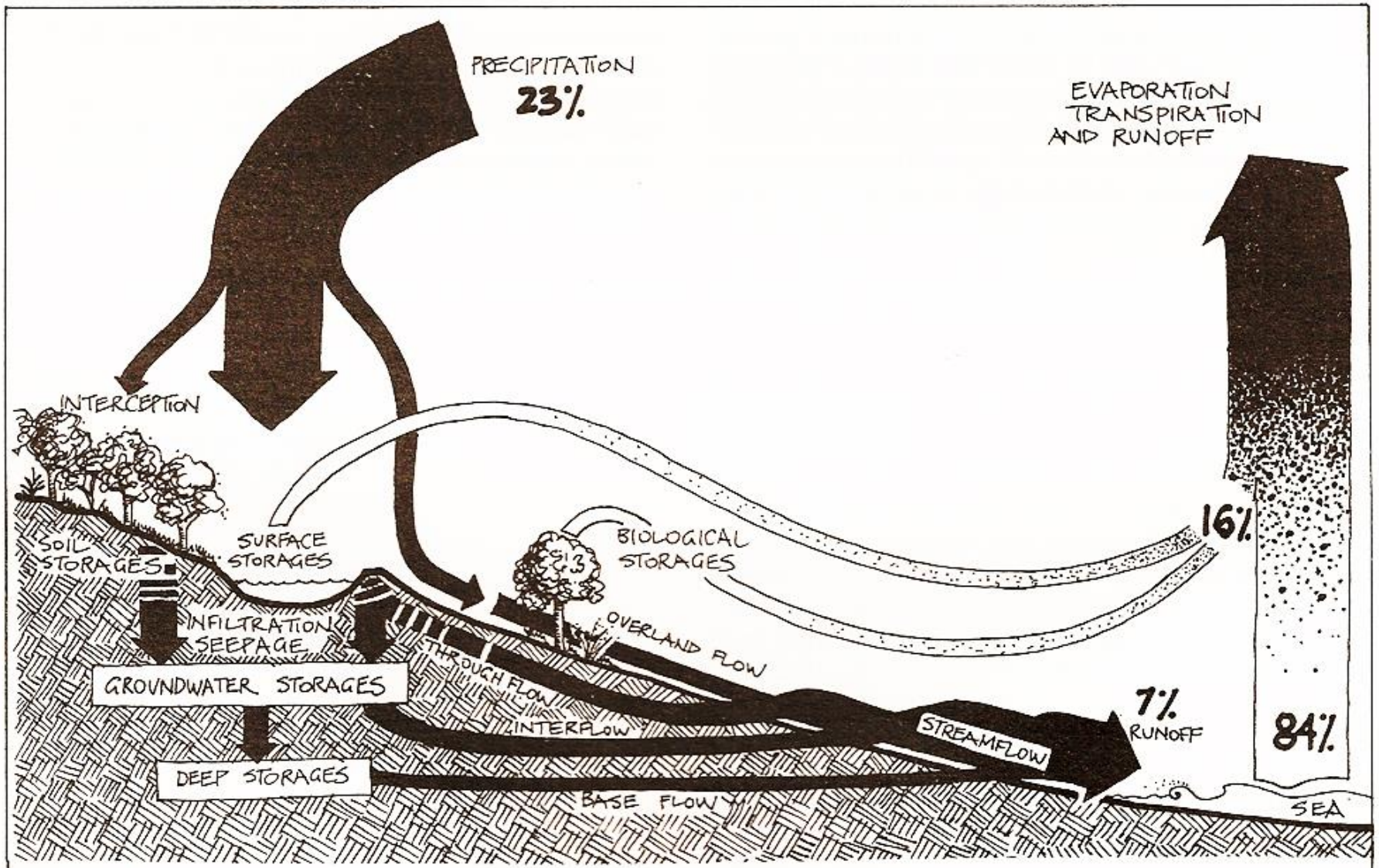


FIGURE 7.1
THE GLOBAL WATER CYCLE (Land and sea)
Omits most of the biological effects but gives the broad schematic of the water cycle. We can affect all parts of this cycle in adverse or beneficial ways.

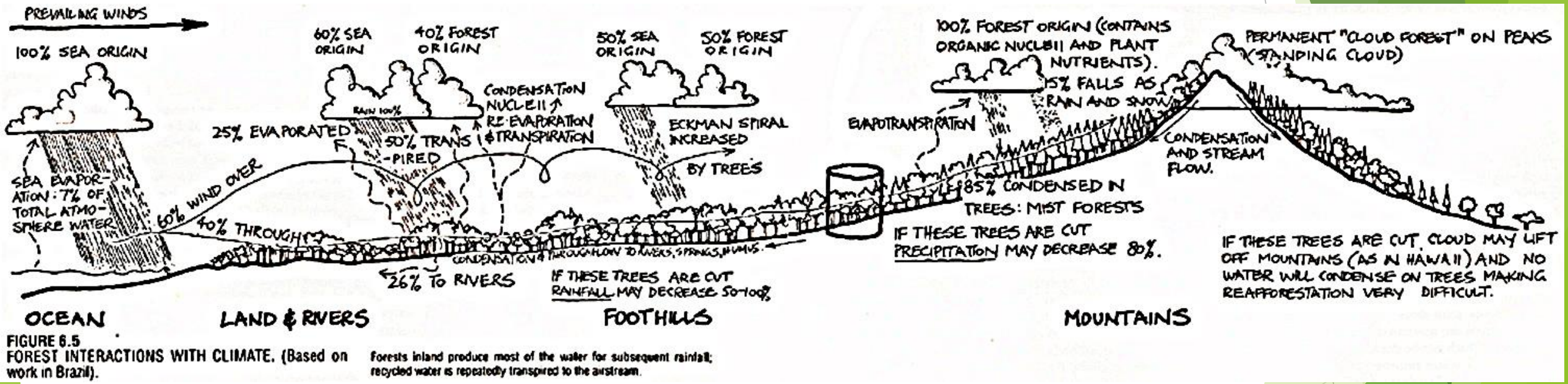
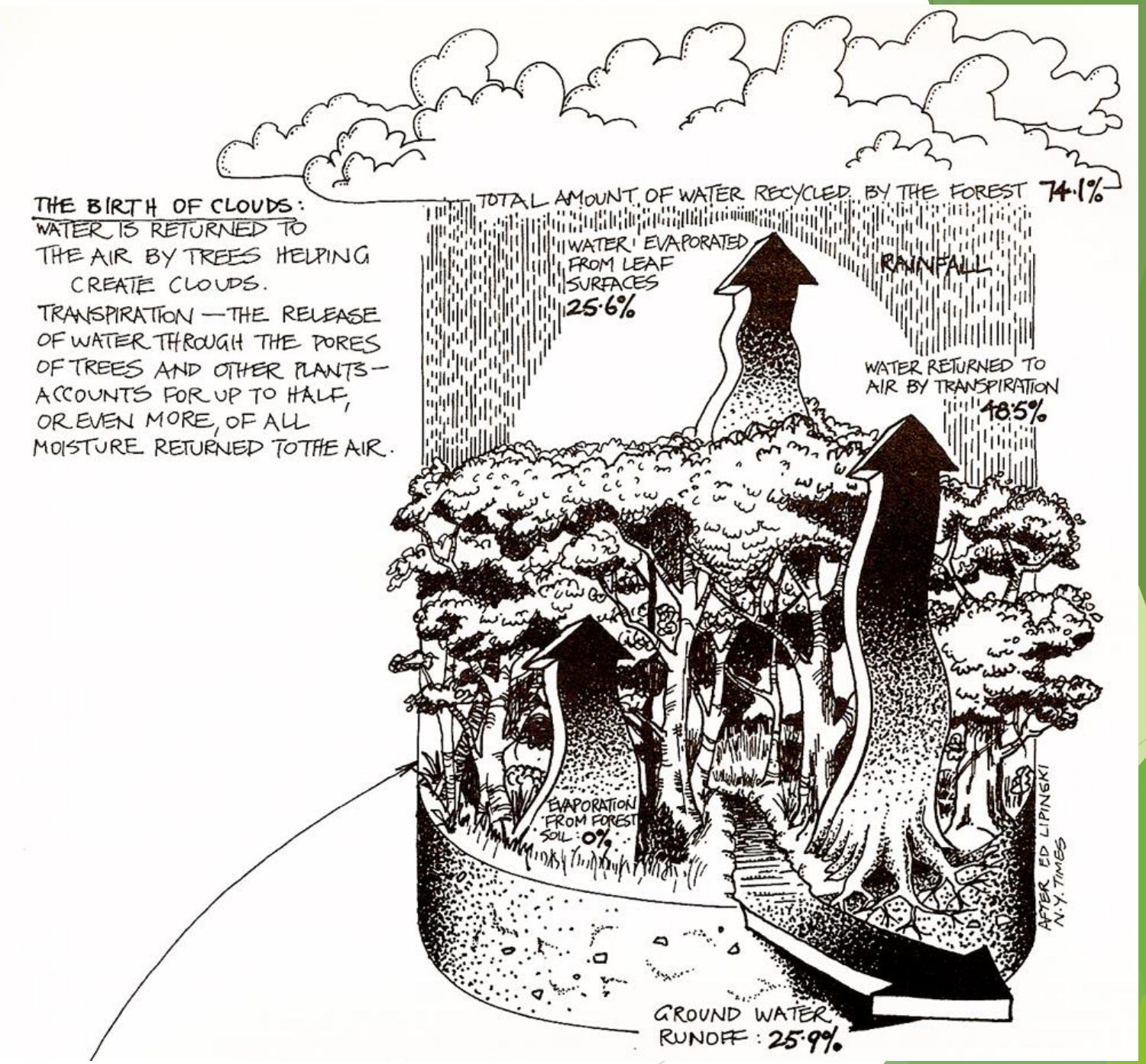


FIGURE 6.5
FOREST INTERACTIONS WITH CLIMATE. (Based on work in Brazil).

Forests inland produce most of the water for subsequent rainfall; recycled water is repeatedly transpired to the airstream.


THE BIRTH OF CLOUDS:
WATER IS RETURNED TO THE AIR BY TREES HELPING CREATE CLOUDS.
TRANSPIRATION — THE RELEASE OF WATER THROUGH THE PORES OF TREES AND OTHER PLANTS — ACCOUNTS FOR UP TO HALF, OR EVEN MORE, OF ALL MOISTURE RETURNED TO THE AIR.
TOTAL AMOUNT OF WATER RECYCLED BY THE FOREST 74.1%
WATER EVAPORATED FROM LEAF SURFACES 25.6%
RAINFALL
WATER RETURNED TO AIR BY TRANSPIRATION 48.5%
EVAPORATION FROM FOREST SOIL: 0%
GROUND WATER RUNOFF: 25.9%
AFTER ED LIPINSKI N.Y. TIMES

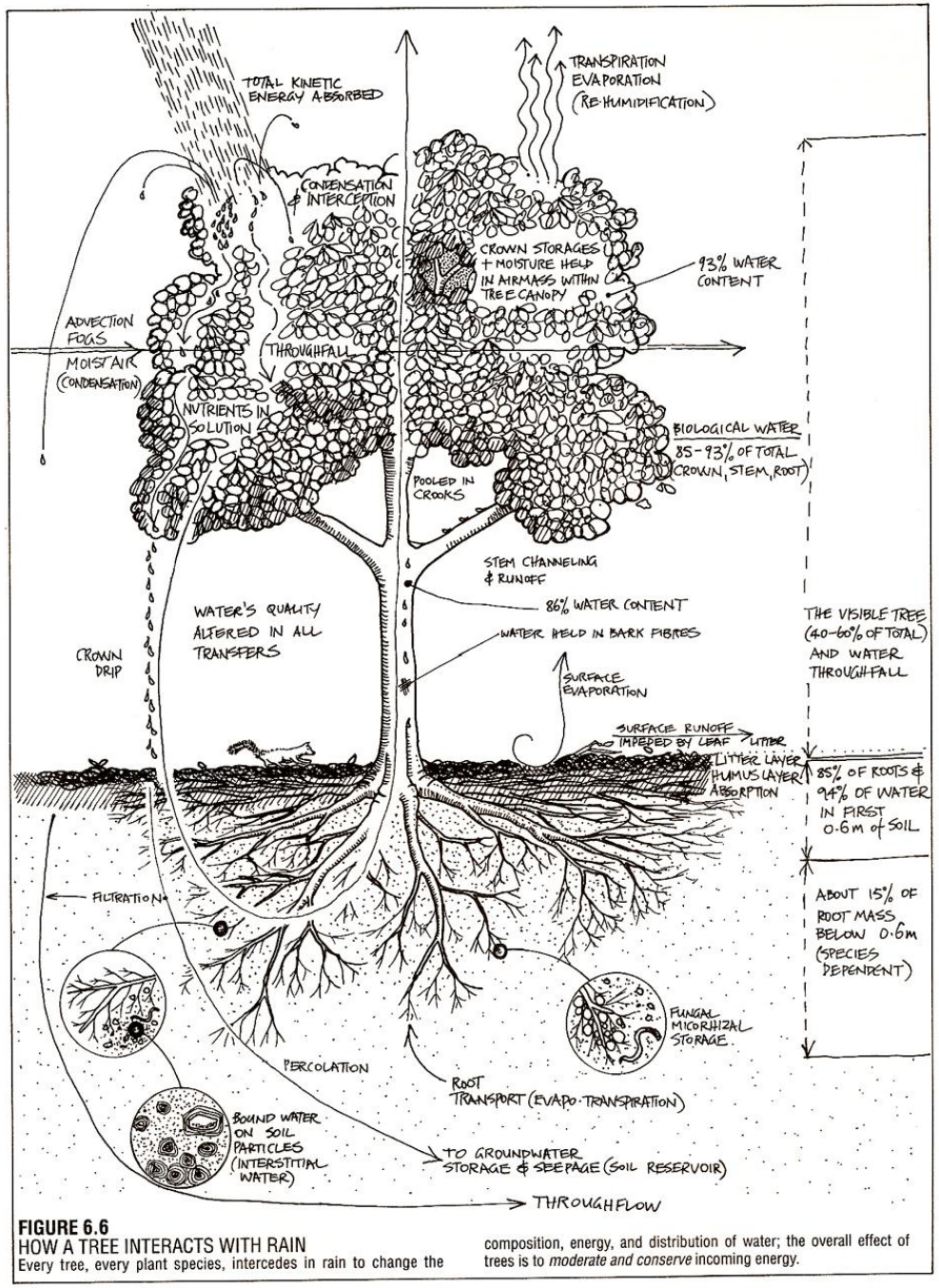


FIGURE 6.6
HOW A TREE INTERACTS WITH RAIN
Every tree, every plant species, intercedes in rain to change the composition, energy, and distribution of water; the overall effect of trees is to *moderate and conserve* incoming energy.

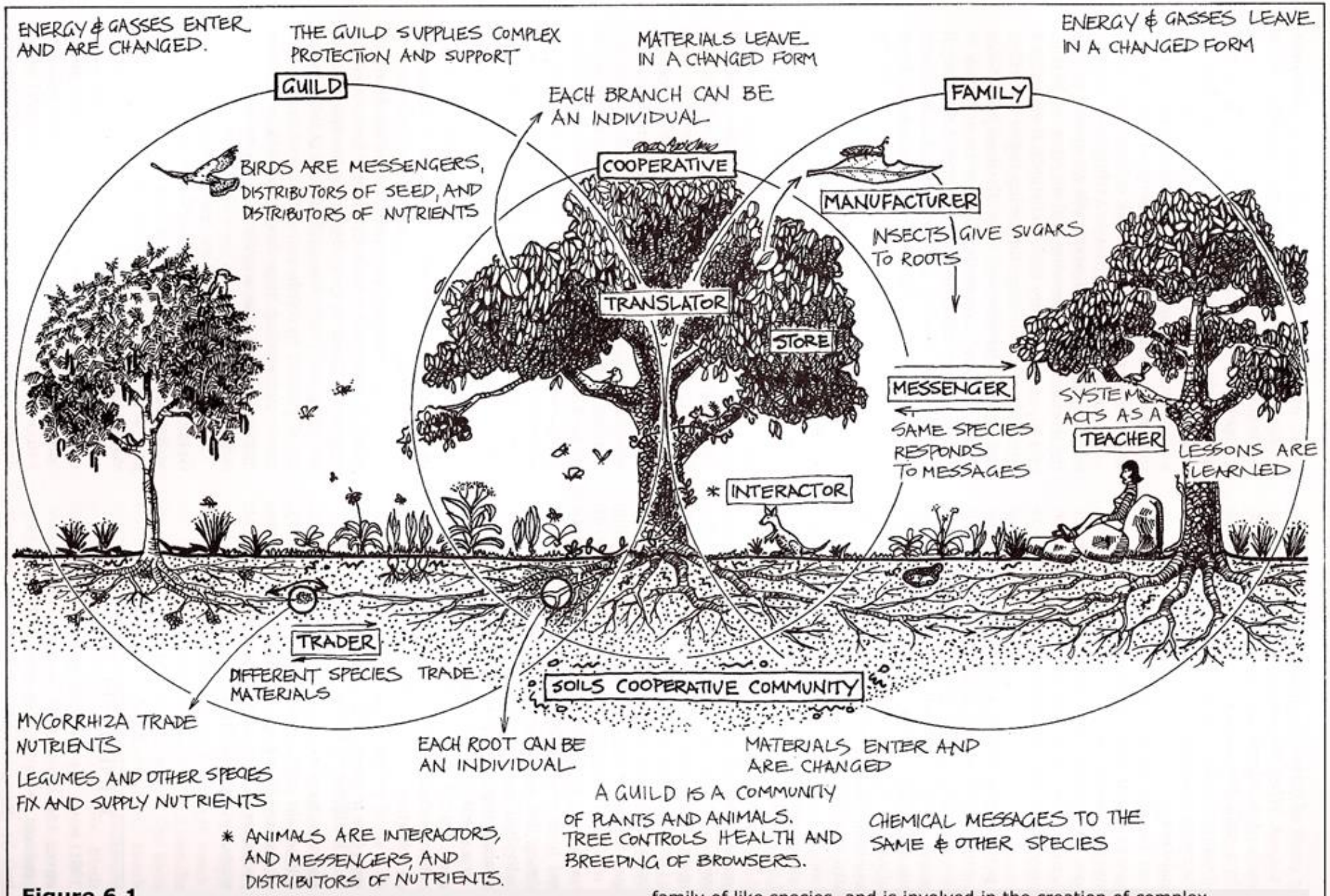
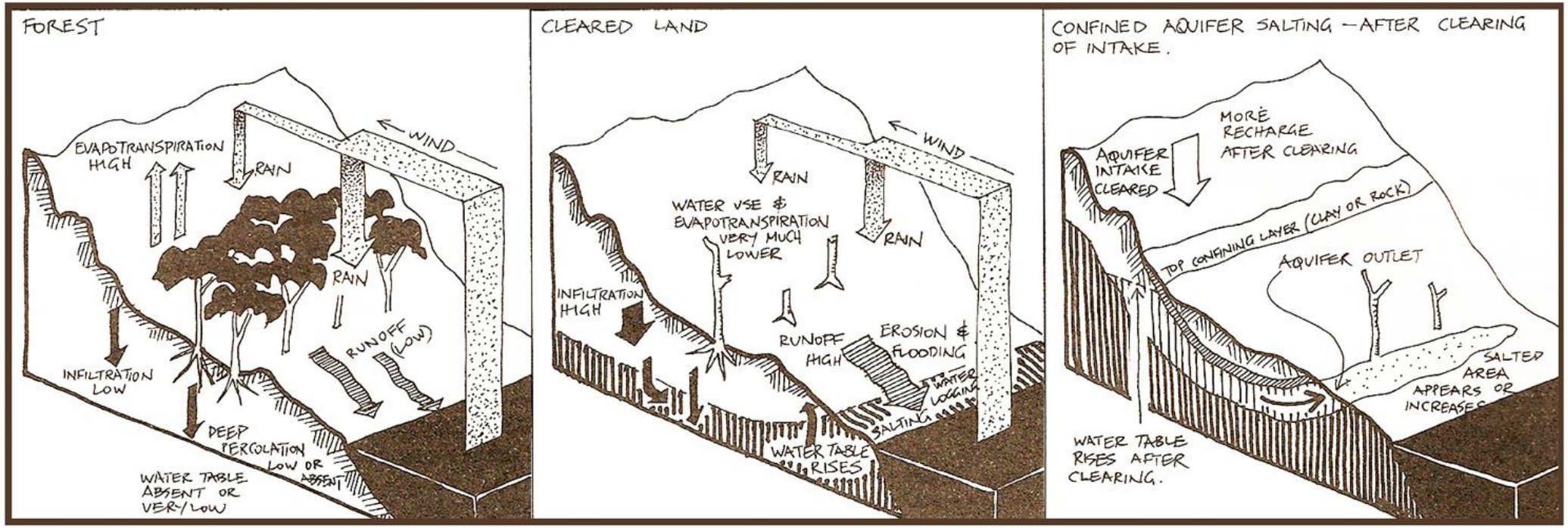
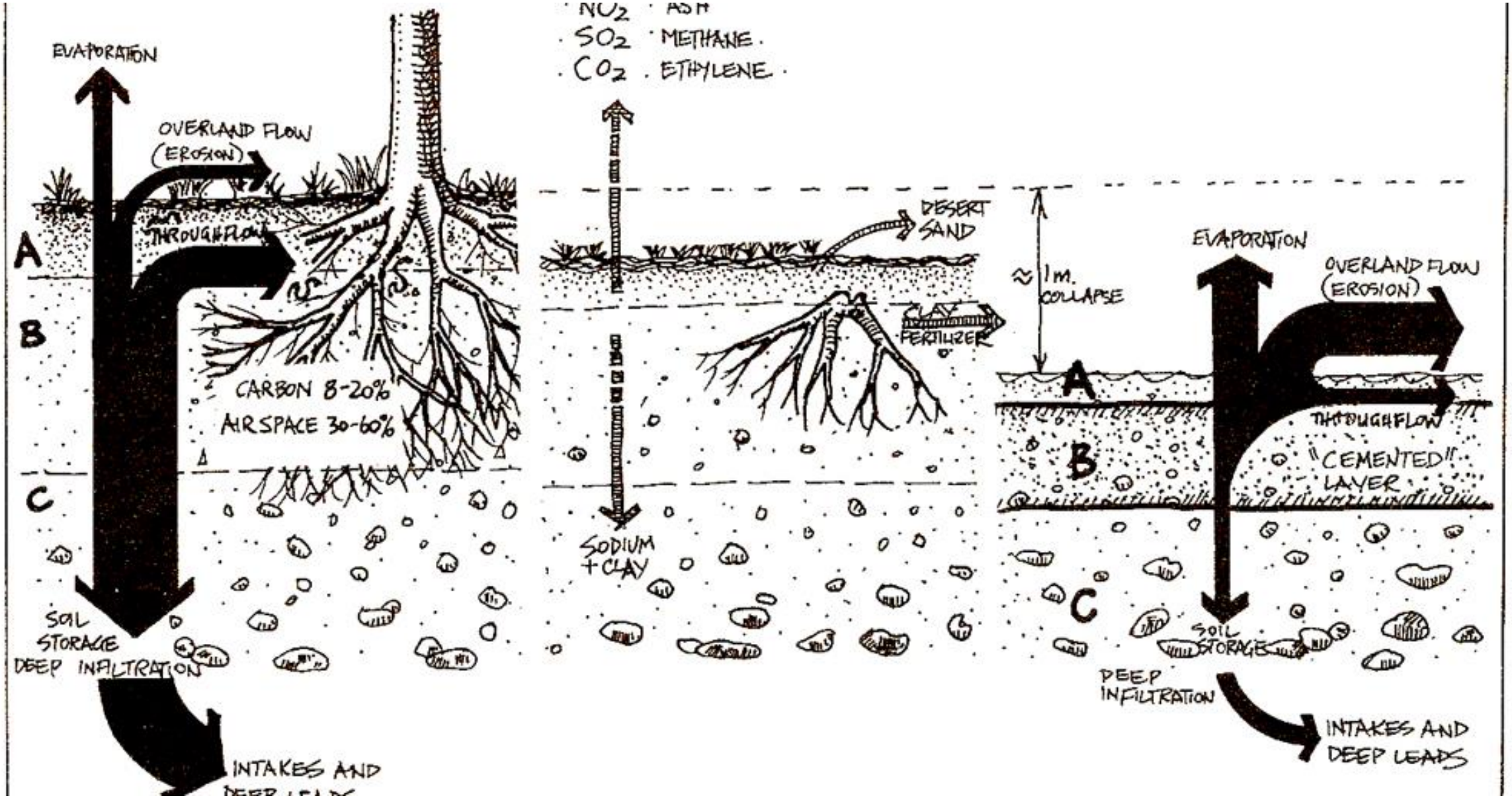


Figure 6.1
TREES IN A WHOLE SYSTEM
The tree itself is a cooperative, depends on a guild, is a member of a family of like species, and is involved in the creation of complex molecules from inorganic and organic elements - a transformer, or translator, of gases, liquids, and solids


FOREST
EVAPOTRANSPIRATION HIGH
RAIN
WIND
RAIN
RUNOFF (LOW)
INFILTRATION LOW
DEEP PERCOLATION LOW OR ABSENT
WATER TABLE ABSENT OR VERY LOW
CLEARED LAND
WIND
RAIN
WATER USE & EVAPOTRANSPIRATION VERY MUCH LOWER
RAIN
INFILTRATION HIGH
RUNOFF HIGH
EROSION & FLOODING
WATER LOGGING
SALTING
WATER TABLE RISES
CONFINED AQUIFER SALTING — AFTER CLEARING OF INTAKE.
MORE RECHARGE AFTER CLEARING
AQUIFER INTAKE CLEARED
TOP CONFINING LAYER (CLAY OR ROCK)
AQUIFER OUTLET
SALTED AREA APPEARS OR INCREASES
WATER TABLE RISES AFTER CLEARING.


EVAPORATION
OVERLAND FLOW
(EROSION)
THROUGHFLOW
A
B
C
CARBON 8-20%
AIRSPACE 30-60%
SOIL
STORAGE
DEEP INFILTRATION
INTAKES AND
NO_2 · ASH
· SO_2 · METHANE ·
· CO_2 · ETHYLENE ·
DESERT
SAND
FERTILIZER
SODIUM
+CLAY
≈ 1M.
COLLAPSE
EVAPORATION
OVERLAND FLOW
(EROSION)
THROUGHFLOW
"CEMENTED"
LAYER
SOIL
STORAGE
DEEP
INFILTRATION
INTAKES AND
DEEP LEADS

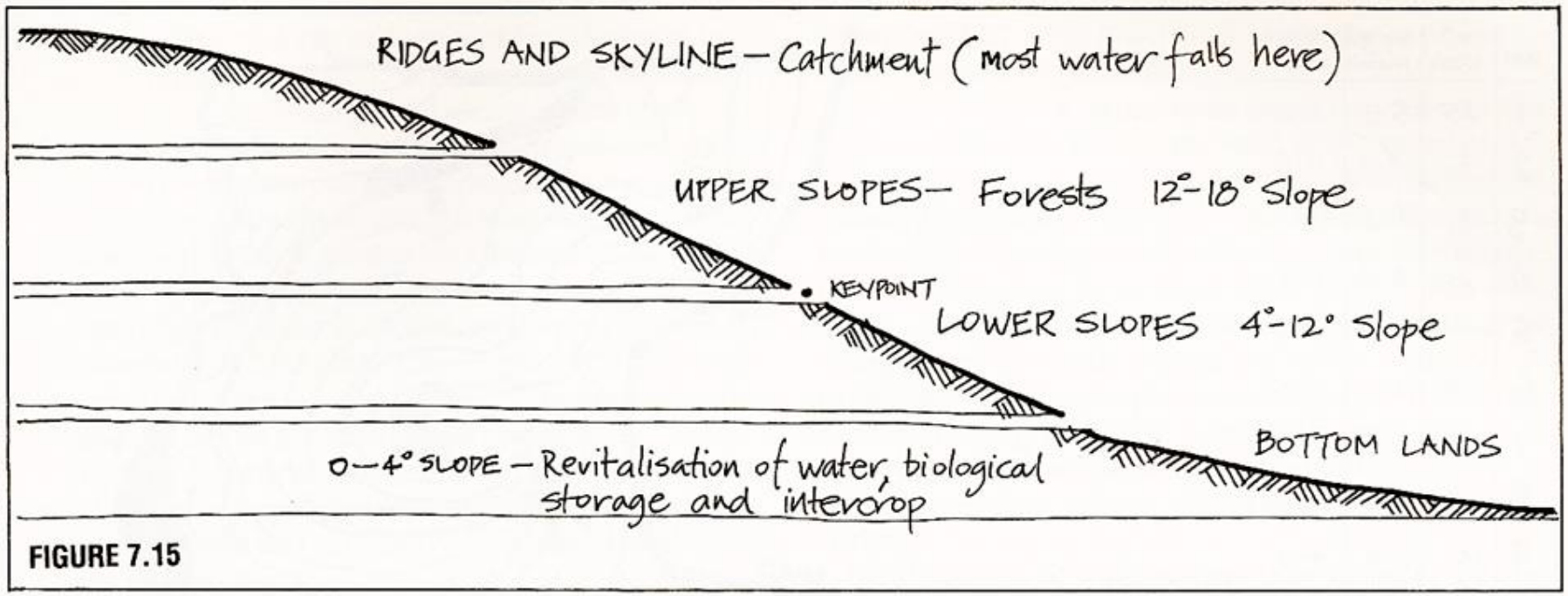

RIDGES AND SKYLINE – Catchment (most water falls here)
UPPER SLOPES – Forests 12°-18° Slope
KEYPOINT
LOWER SLOPES 4°-12° Slope
BOTTOM LANDS
0–4° SLOPE – Revitalisation of water, biological storage and intercrop

FIGURE 7.15

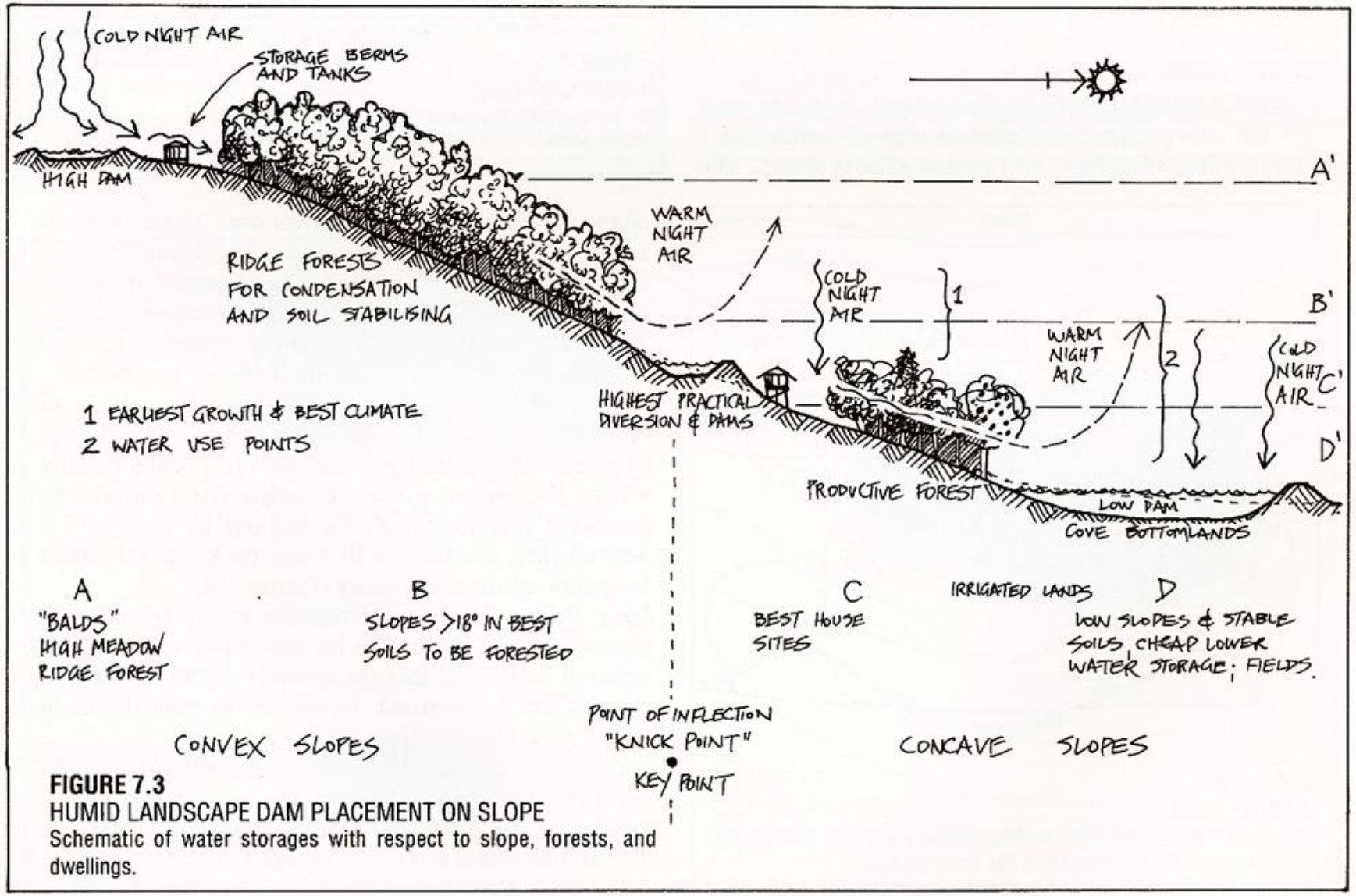


FIGURE 7.3
HUMID LANDSCAPE DAM PLACEMENT ON SLOPE
Schematic of water storages with respect to slope, forests, and dwellings.

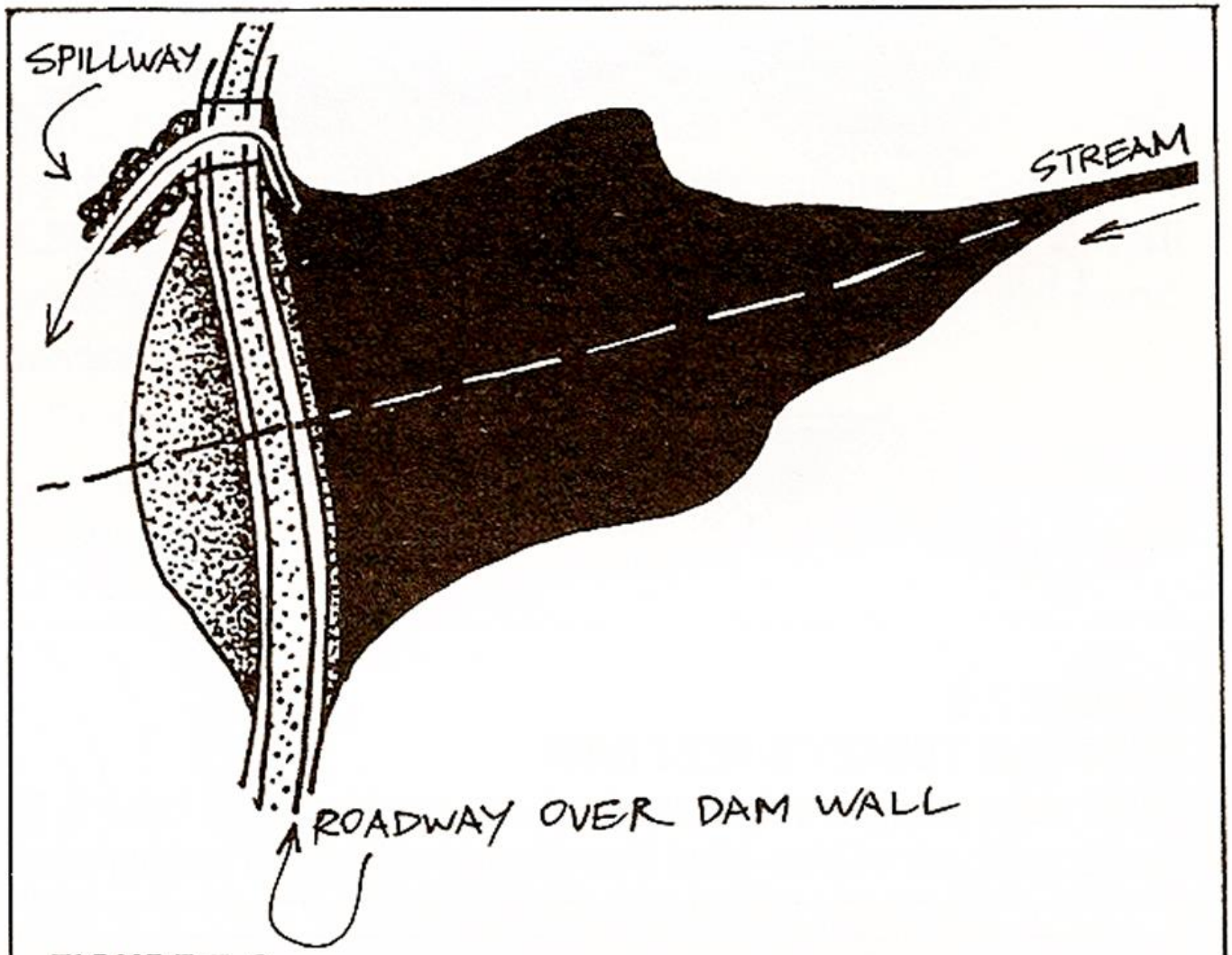


FIGURE 7.8
BARRIER DAM
"The engineer's dam." Can affect fish, migration, and be difficult to spill; works well as part of a keyline series only.

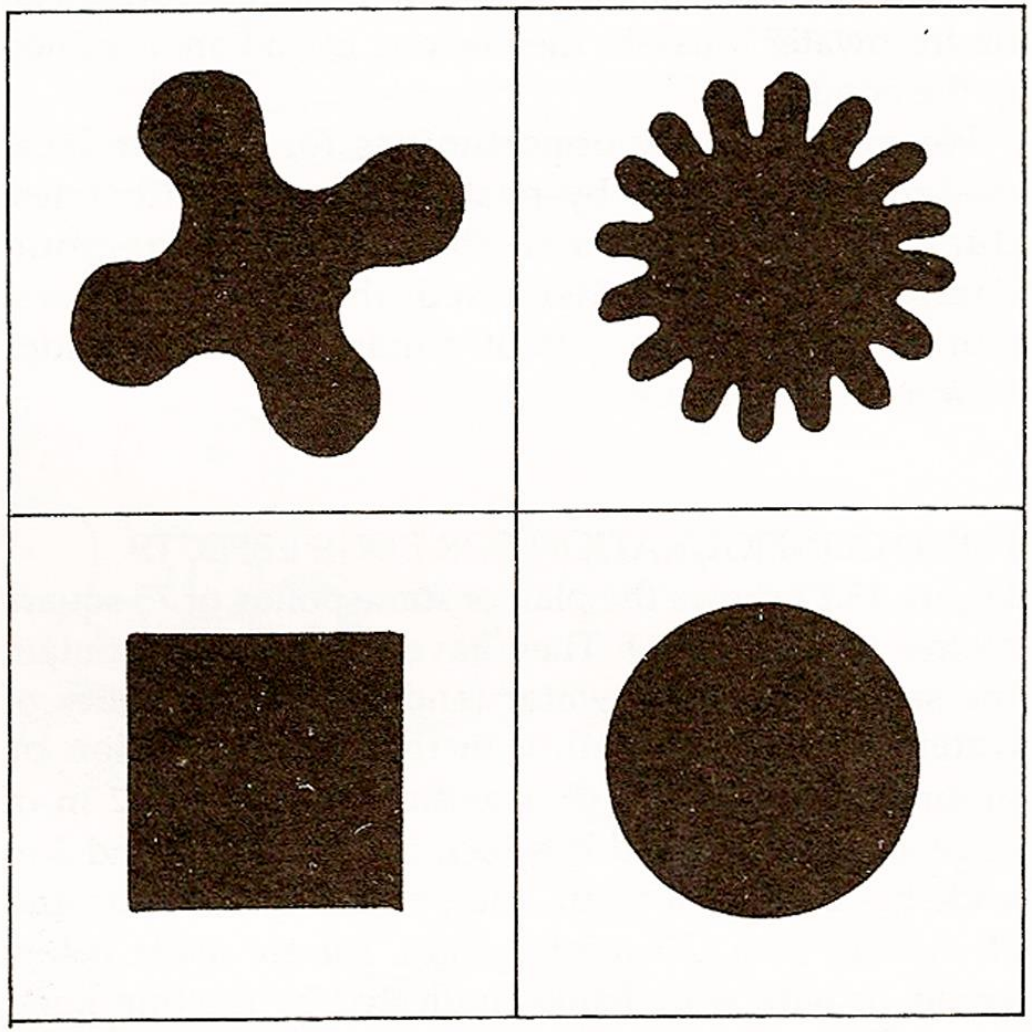


FIGURE 13.19
4 PONDSOF SAME AREA,
but differing widely in their capacity to provide for edge plants such as blueberries, to feed fish from edge vegetation, and to irrigate nearby tree roots.

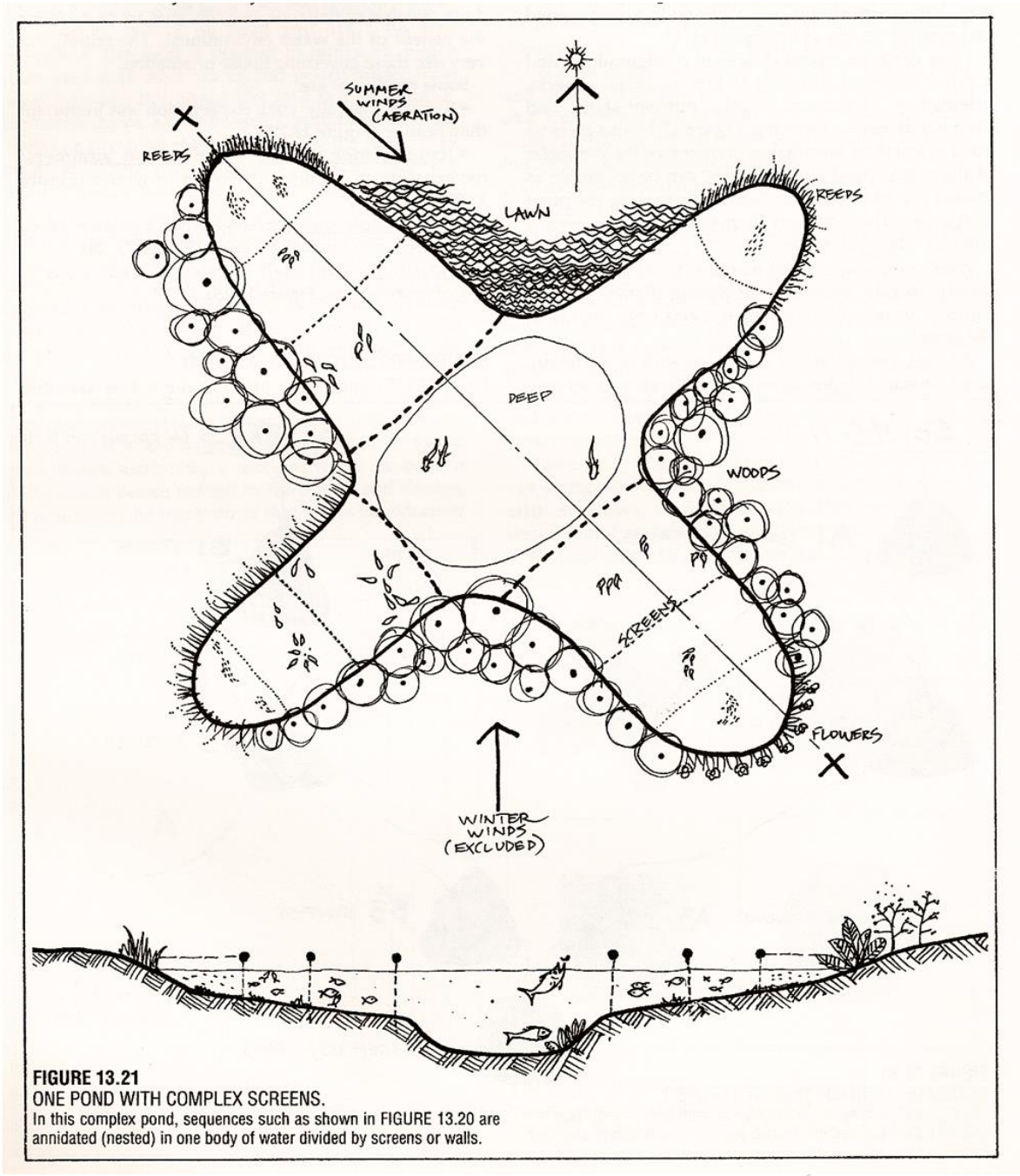


FIGURE 13.21
ONE POND WITH COMPLEX SCREENS.
In this complex pond, sequences such as shown in FIGURE 13.20 are annidated (nested) in one body of water divided by screens or walls.

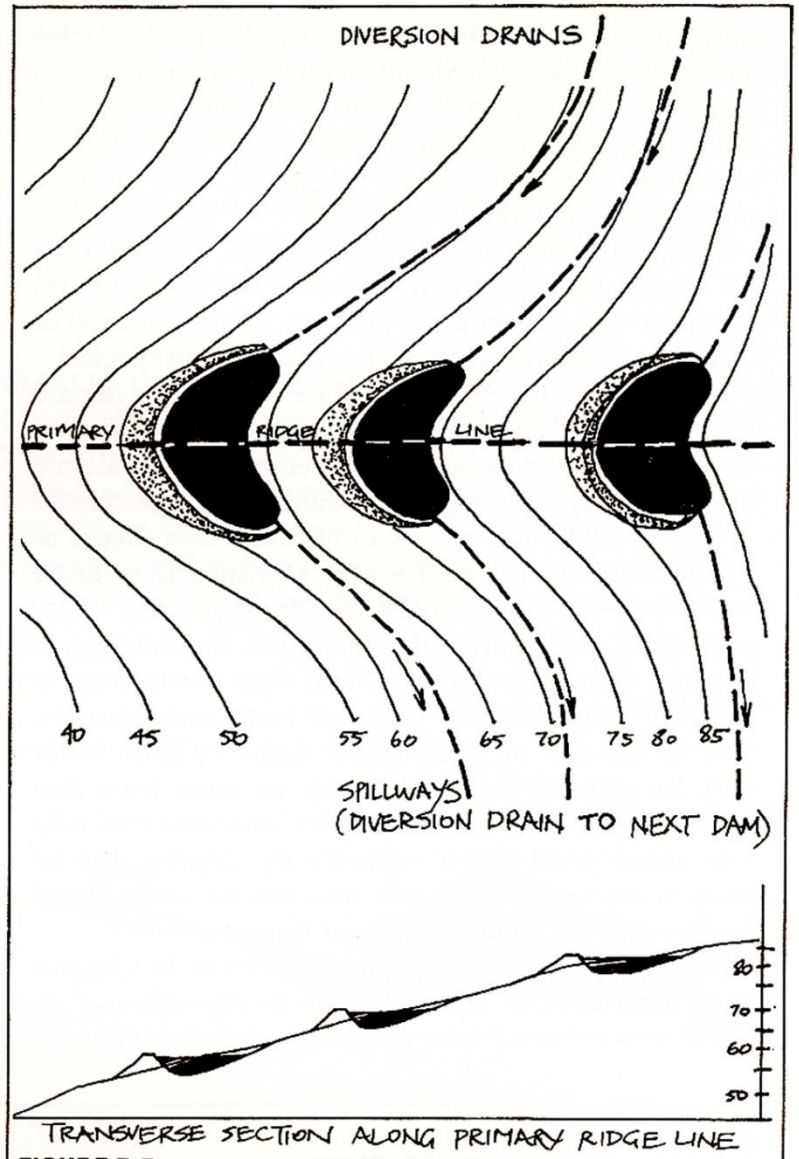


FIGURE 7.5
RIDGEPOINT DAM
or "horseshoe" dam, built on plateau areas of ridges. Uses as for saddle dams.

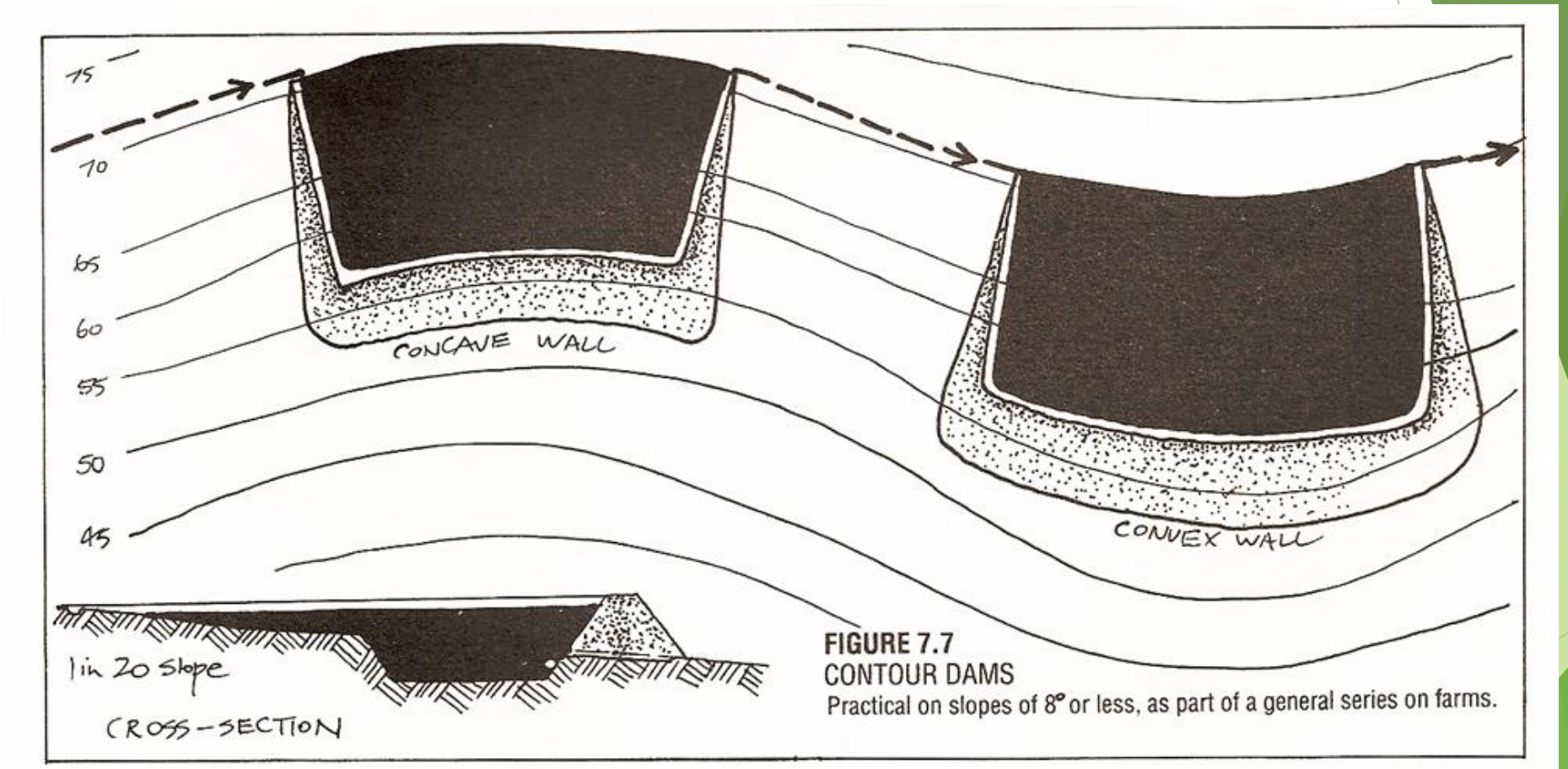


FIGURE 7.7
CONTOUR DAMS
Practical on slopes of 8° or less, as part of a general series on farms.

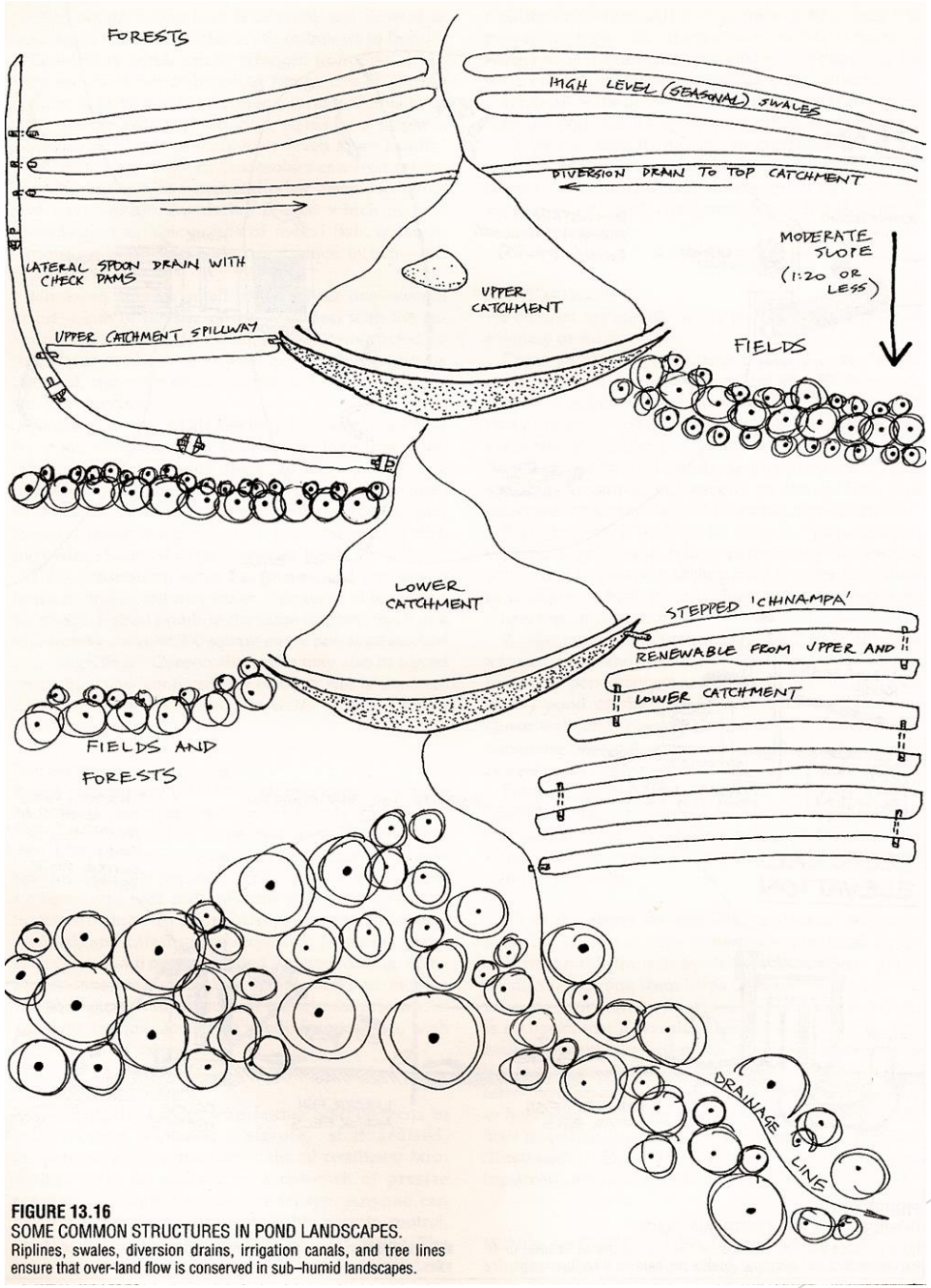


FIGURE 13.16
SOME COMMON STRUCTURES IN POND LANDSCAPES.
Riplines, swales, diversion drains, irrigation canals, and tree lines ensure that over-land flow is conserved in sub–humid landscapes.

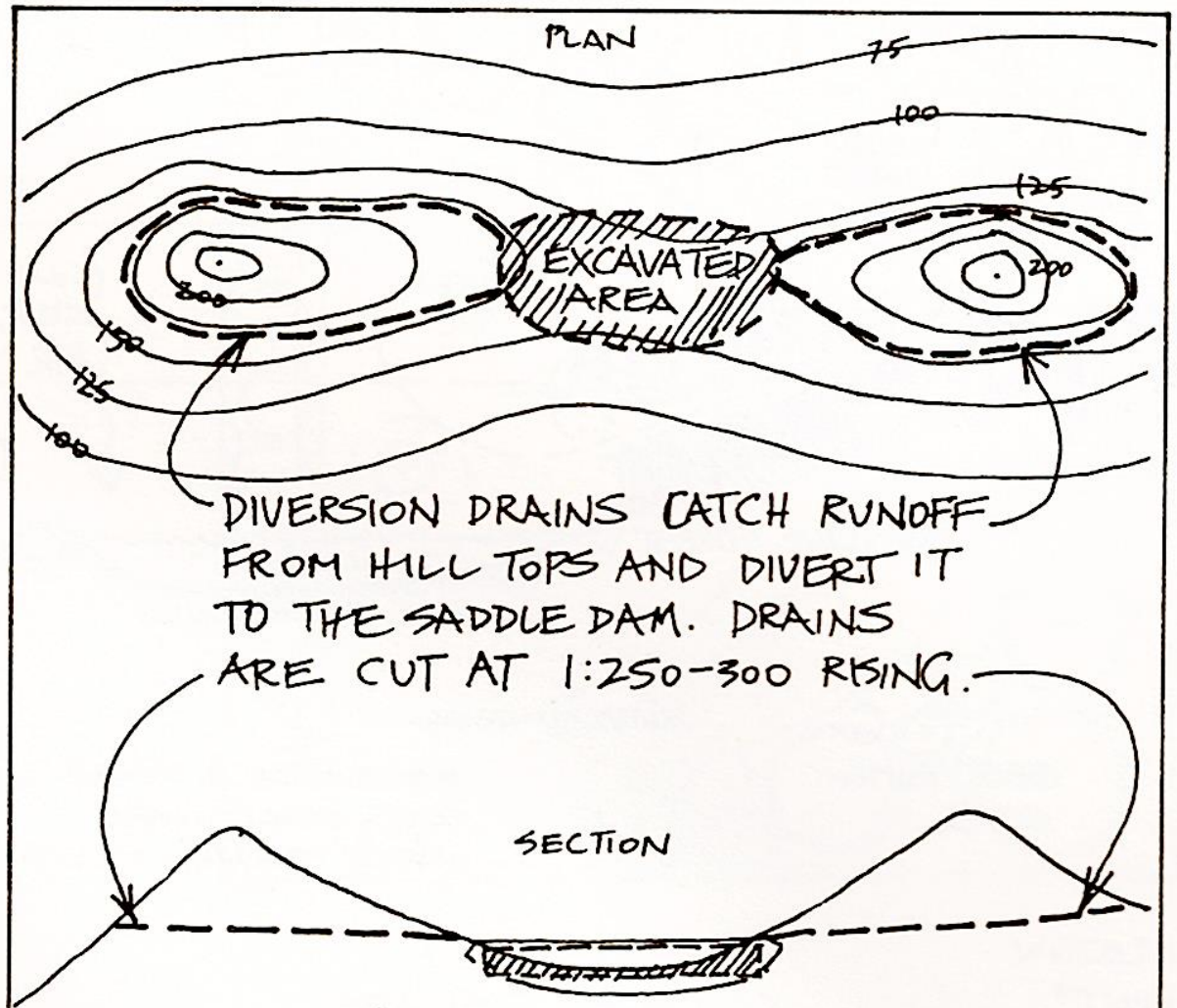


FIGURE 7.4
SADDLE DAM
Very useful for fire control, wildlife, limited irrigation. The "highest" type of dam in the landscape that fills from hill runoff.

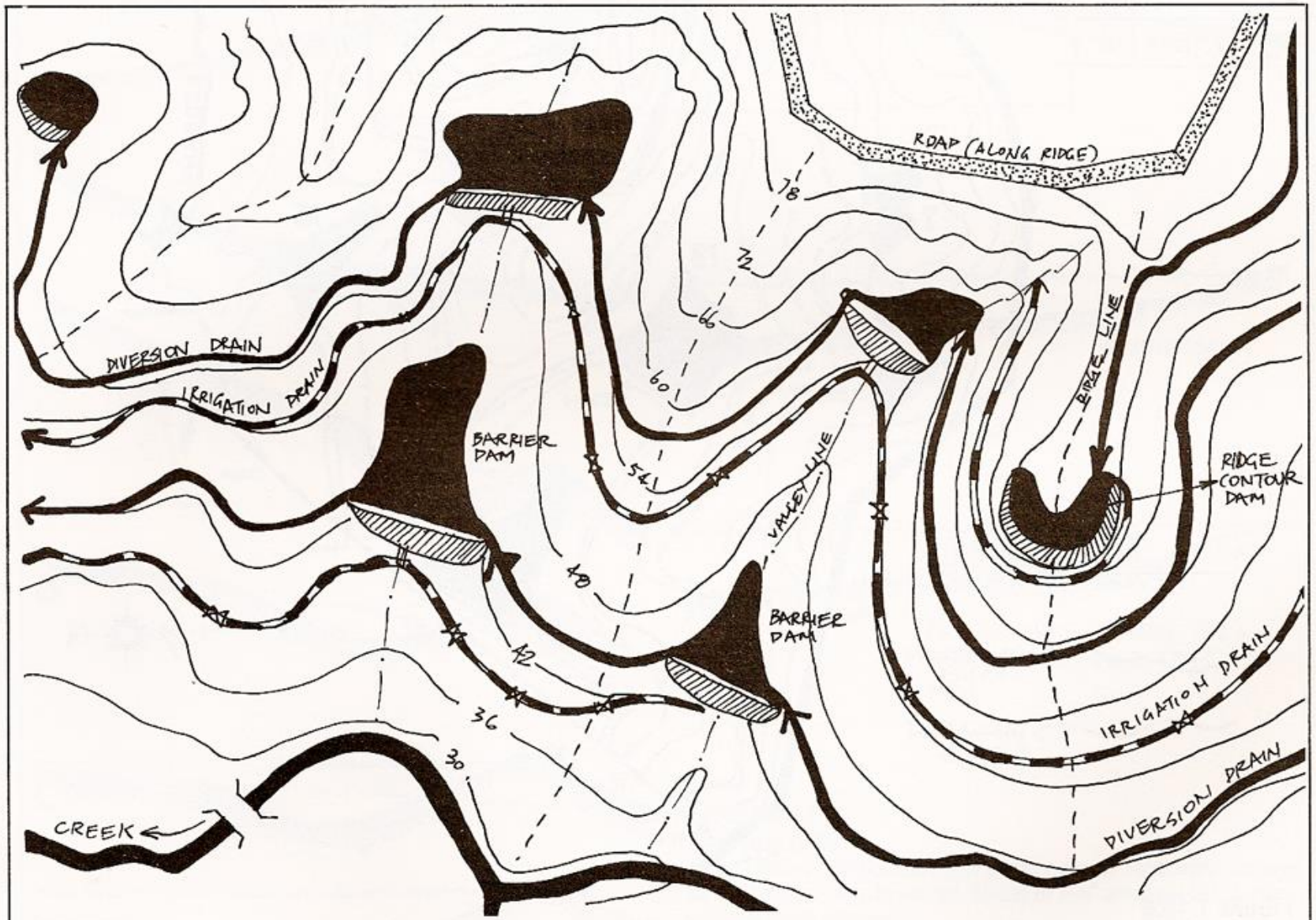


FIGURE 7.16.A

P. A. Yeomans' "Keyline" system provides drought–proofing for farms with very low maintenance and operating costs; his was the first book in English on total water design for foothill farms, access, tree belts, soil creation, low tillage, and creative water storage.

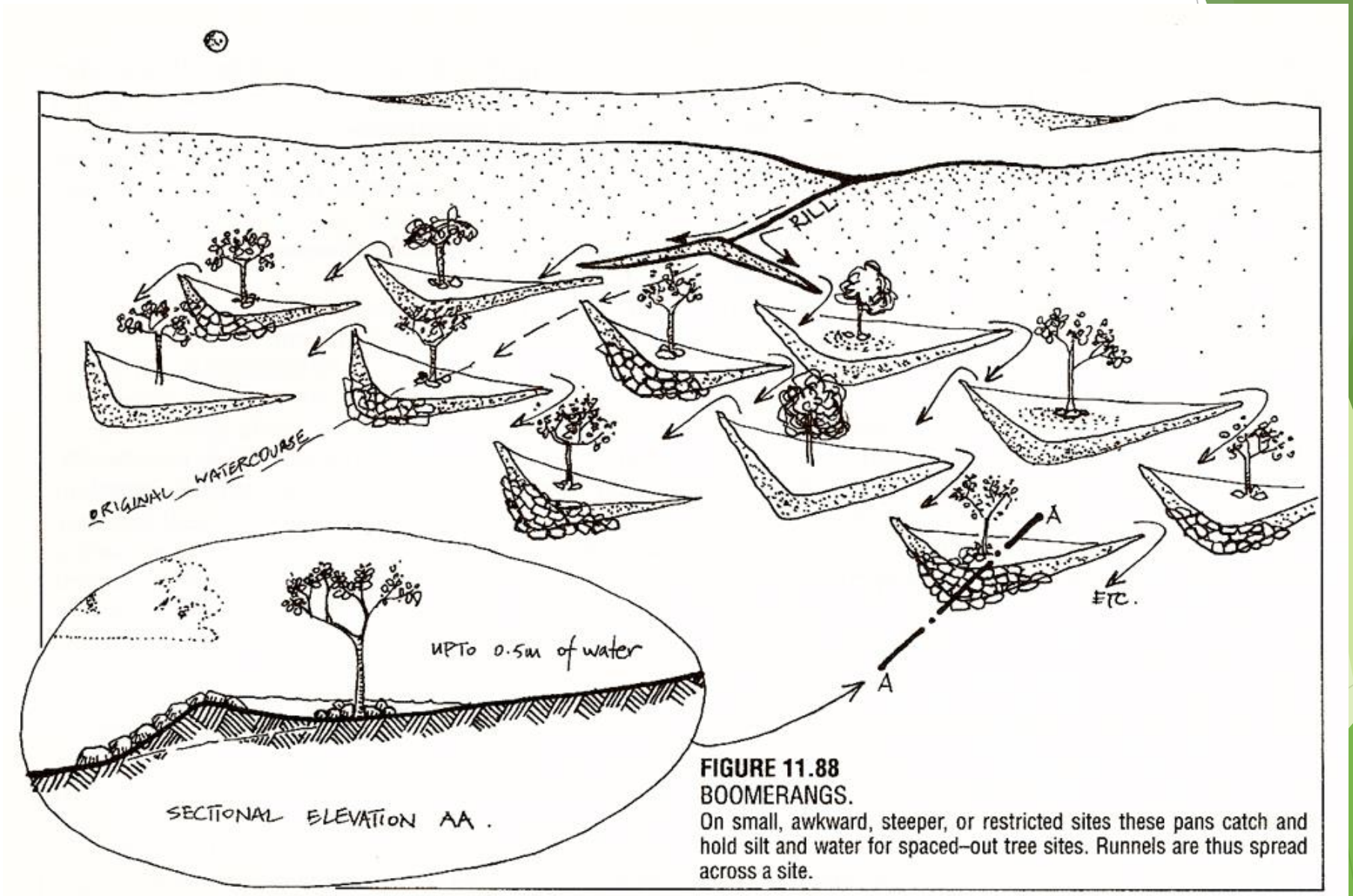


FIGURE 11.88
BOOMERANGS.
On small, awkward, steeper, or restricted sites these pans catch and hold silt and water for spaced–out tree sites. Runnels are thus spread across a site.

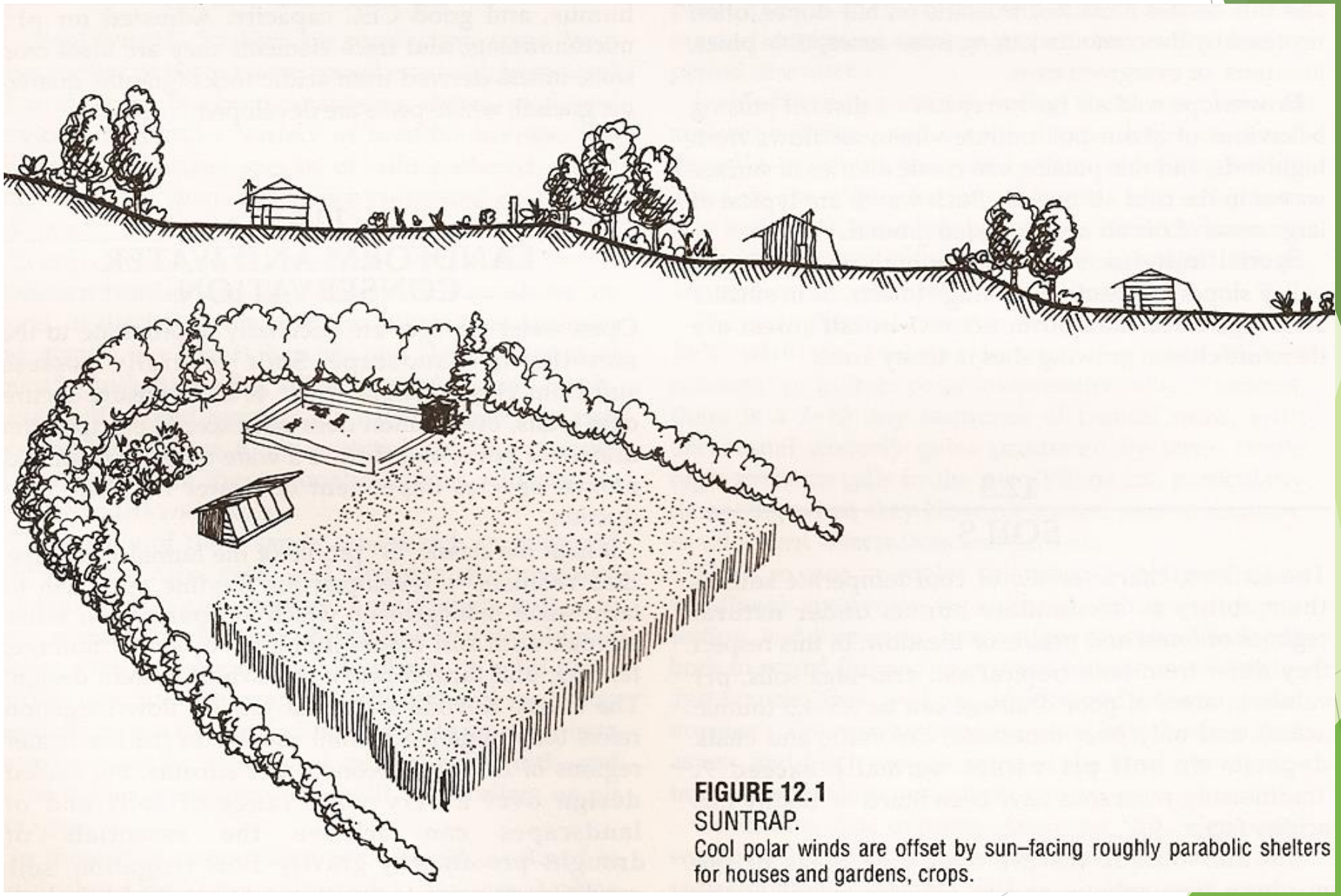


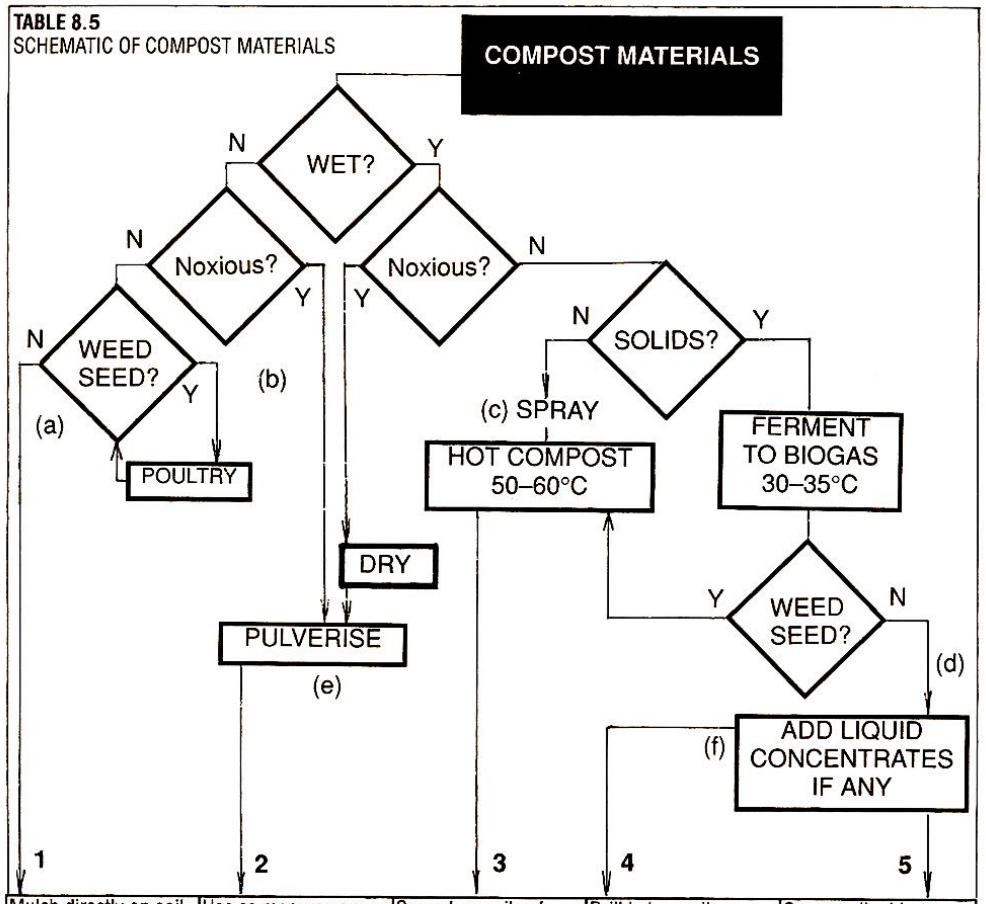
FIGURE 12.1
SUNTRAP.
Cool polar winds are offset by sun–facing roughly parabolic shelters for houses and gardens, crops.

TABLE 7.3
ANALYSIS OF RAW SEWAGE

ANALYSIS	MG/L
SOLIDS	
Total dissolved solids	1,200 (TDS)
Bilogical oxygen demand	170 – 570 (BOD)
Suspended solids	160 – 620
Volatile liquids	180 – 510
Total organic carbon	110 – 360
Anionic surfactants	1.0 – 3.6
NUTRIENTS	
Nitrite as **N**	0.05
Nitrate as **N**	0.1 – 0.3
Ammonia as **N**	5 – 32
Organic **N**	7 - 24
Total N	9 – 56.2
Orthophosphate as **P**	1.5 – 6.0
Total phosphorus	1.5 – 9.0
METALS	
Copper	0.09 – 0.35
Chromium	0.25 – 0.4
Cadmium	0.015
Iron	1.6 – 3.3
Lead	0.3 – 0.4
Mercury	0.003
Nickel	0.15
Zinc	0.4 – 0.8
COLOUR	
(as Pt/Cp Units)	100 – 300
pH	6.9 ± 2.0 (near neutral)

Of the total sewage input, from 45 – 60 % of the volume builds up as sludge in settling ponds.

TABLE 8.5
SCHEMATIC OF COMPOST MATERIALS



1	2	3	4	5
Mulch directly on soil surface at >12 cm deep. Least effort for best results in gardens. Controls weeds, lessens labour.	Use as manures on gardens. Energy used but good results obtained.	Spread on soils of intensive plots and seed beds. Most effort and most nutrient (ammonia) loss, but effective for specific materials. Energy yields as biogas, heat.	Drill below soil surface. Good results, no pollution.	Spray as liquid on fields, foliage, or use in aquatic systems. Little effort for good results. Energy yields as biogas.

EXAMPLES:
(a) Nut husks and shells; coffee, teas, and cocoa residues; shredded paper and branches; bark, woodchips, and sawdust; and old carpets, underfelt (*not* pesticide treated ones), bags, canvas(*all made of natural materials*).
(b) Hay with seed heads, weeds in flower, bulbils or roots of weeds.
(c) Sewage and sullage, liquid manure and urine, meat and animal paunches and trimmings, general household wastes. Add lime and superphosphate (1%) to hot compost.; "teas" of seaweed and manure.
(d) Sludge from digesters and weed–free manures.
(e) Chicken and bird manures, litter from animal sheds, blood, bone, feathers, hide scraps, seaweeds.
(f) Dissolved minerals, urine, seaweed and manure "teas".

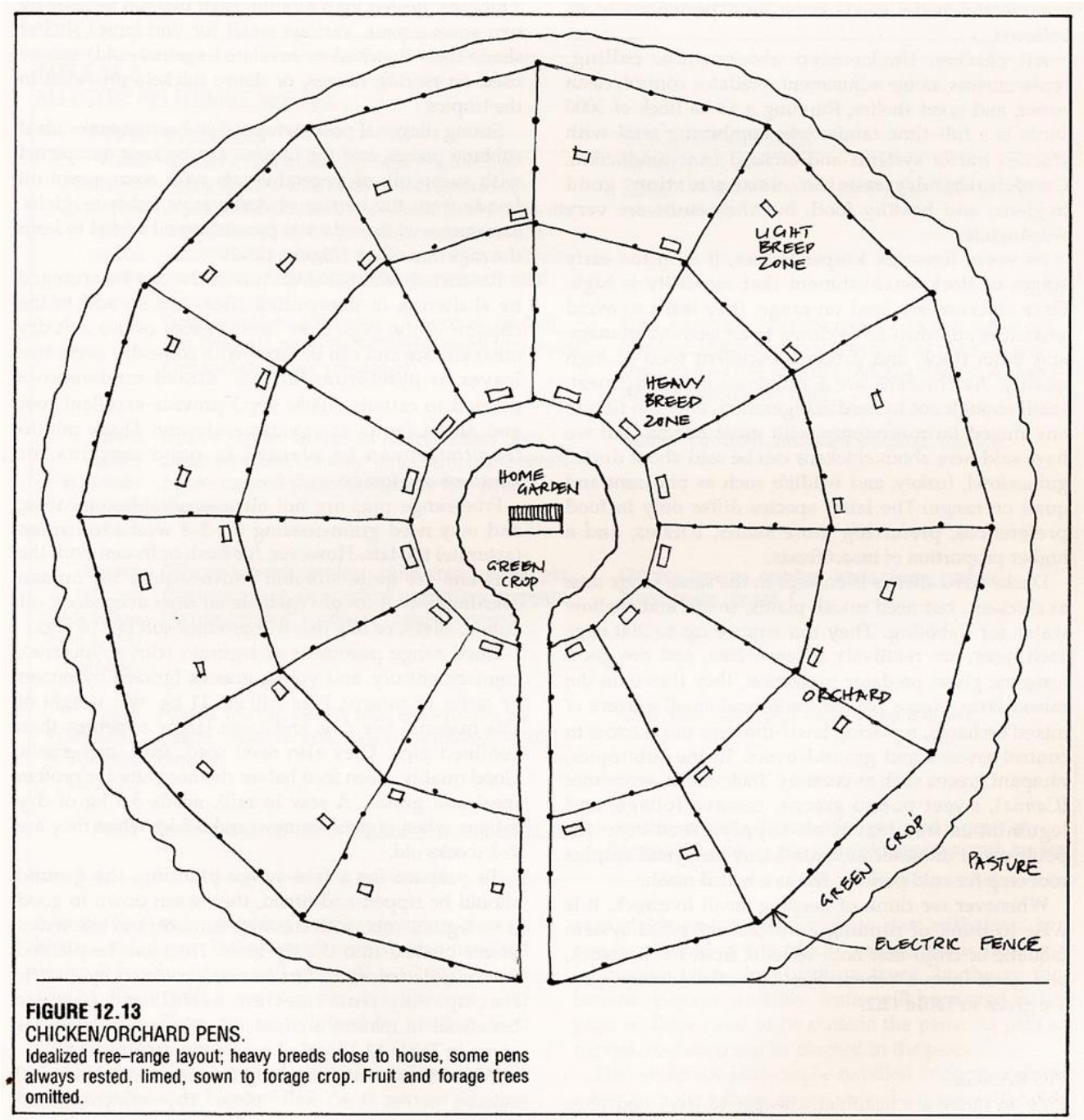


FIGURE 12.13
CHICKEN/ORCHARD PENS.
Idealized free–range layout; heavy breeds close to house, some pens always rested, limed, sown to forage crop. Fruit and forage trees omitted.