Thiagarajar College of Engineering

Department of Chemistry

SOIL & LIFE

TCE ENVIS RP

An ENVIS Resource Partner on Plastic Waste Management
Under Ministry of Environment, Forest & Climate Change,
Government of India

SOIL & LIFE

Heaven is under our feet as well as over our heads.”-
Henry David Thoreau

This Presentation will introduce you to an amazing world—the world beneath your feet.

Gaia Hypothesis

An idea proposed by James Lovelock
(published in 1979)

All living things on earth (biosphere) function as *one SUPERorganism* that changes its environment to create conditions that best meet its needs, with the ability to self-regulate critical systems needed to sustain life

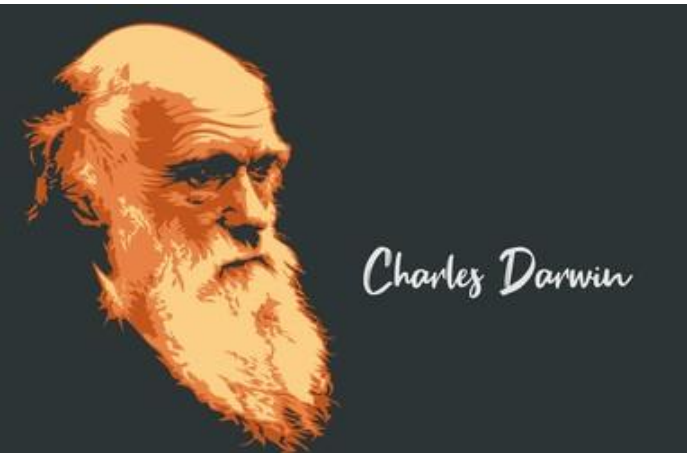
All things connect:

"No man is an Island, entire of it self"- John Donne

In this Tiny world none can survive in Isolation. To eat, the Lion must prey on Gazelle, the Gazelle must grace on grass, and the grass must extract nutrients from the **SOIL.** And all are dependent on the SUN, without whose energy there would be little or no life on this world.

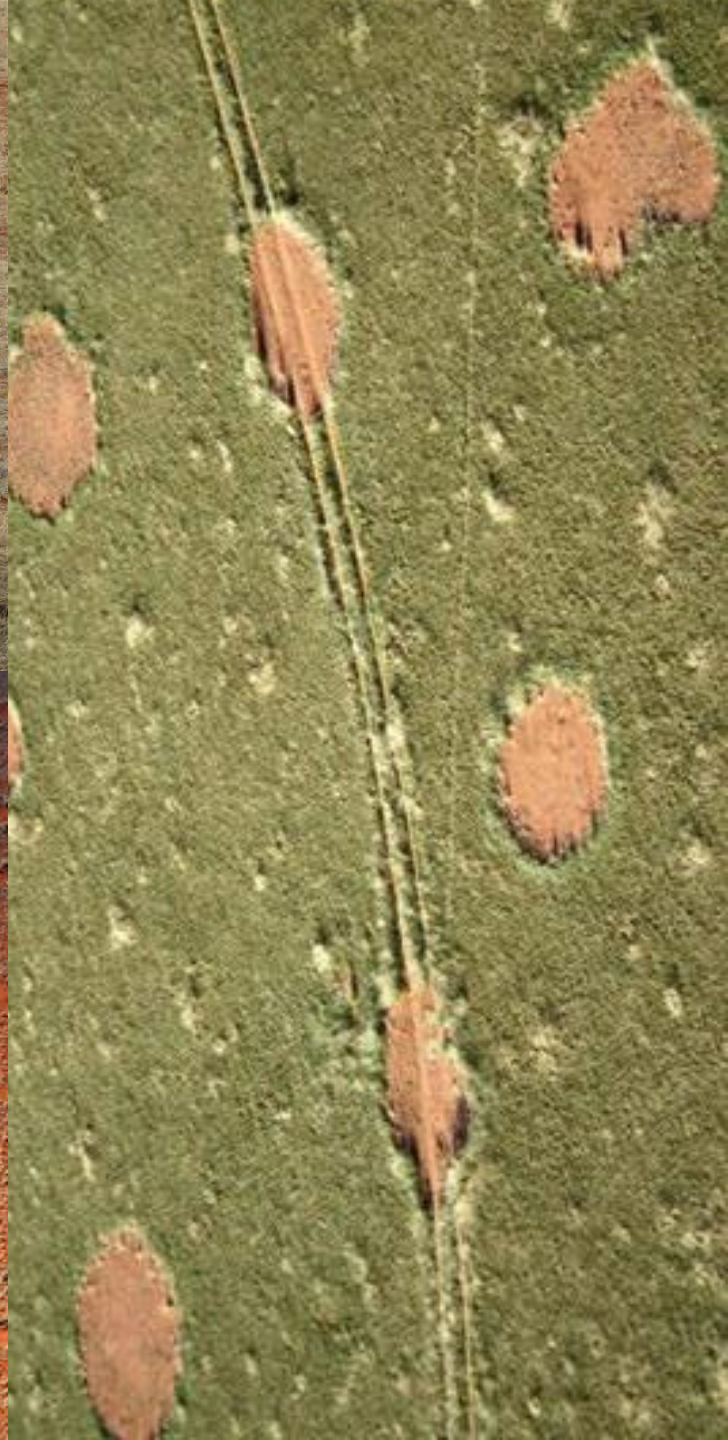
The Web of Life:

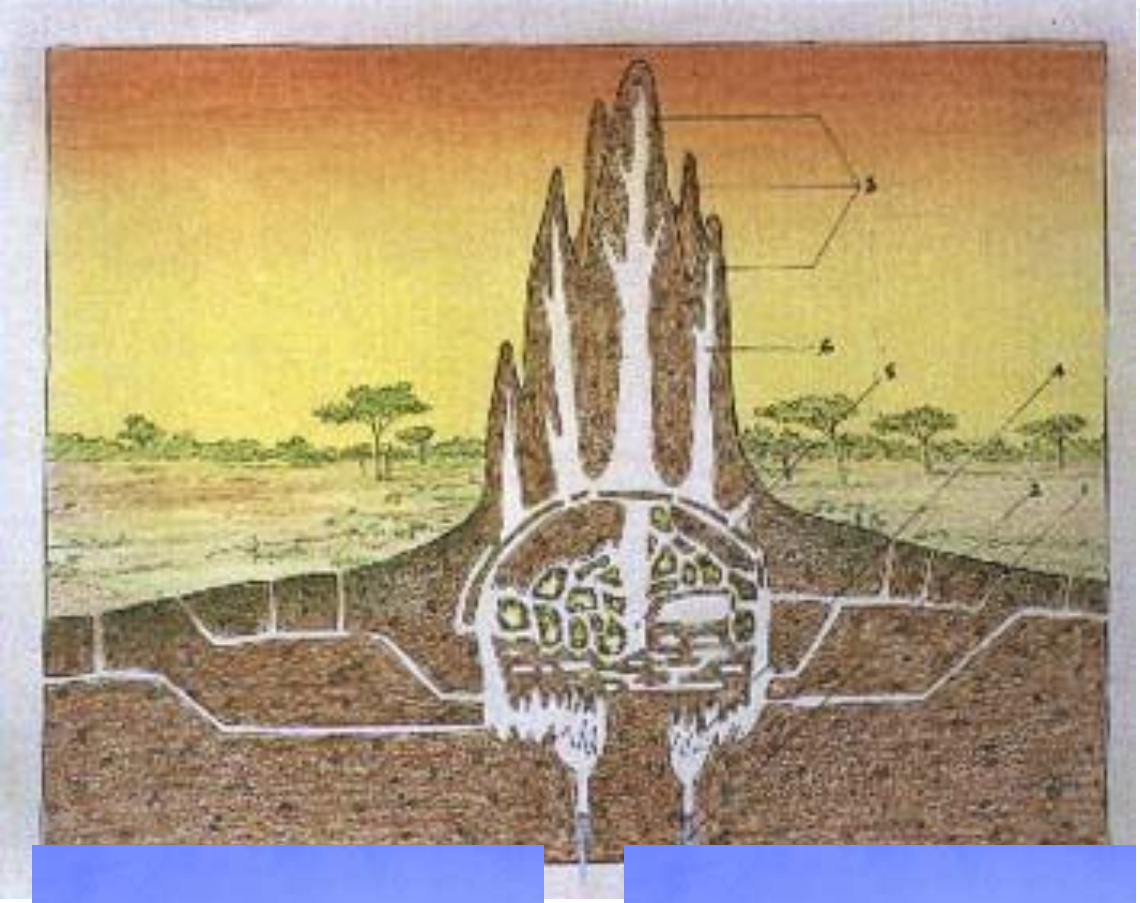
The complex interrelationship between plants and animals in Ecosystem are critical to its stability. They ensure that the flow of energy through the system is kept constant, that nutrients are available and the waste products are recycled. Although over time, individual species may change through evolution, with come disappearing altogether, while new species appear and proliferate, the overall system is kept in balance.

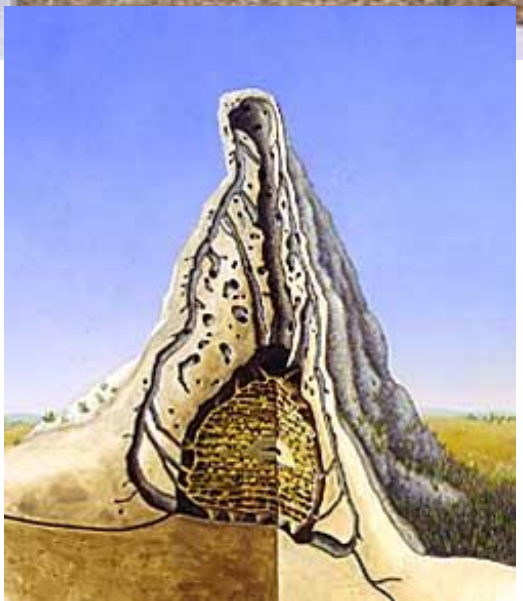


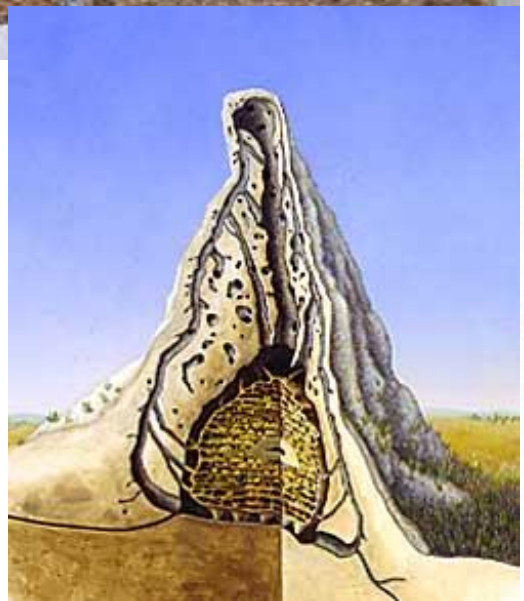
Disturbing the

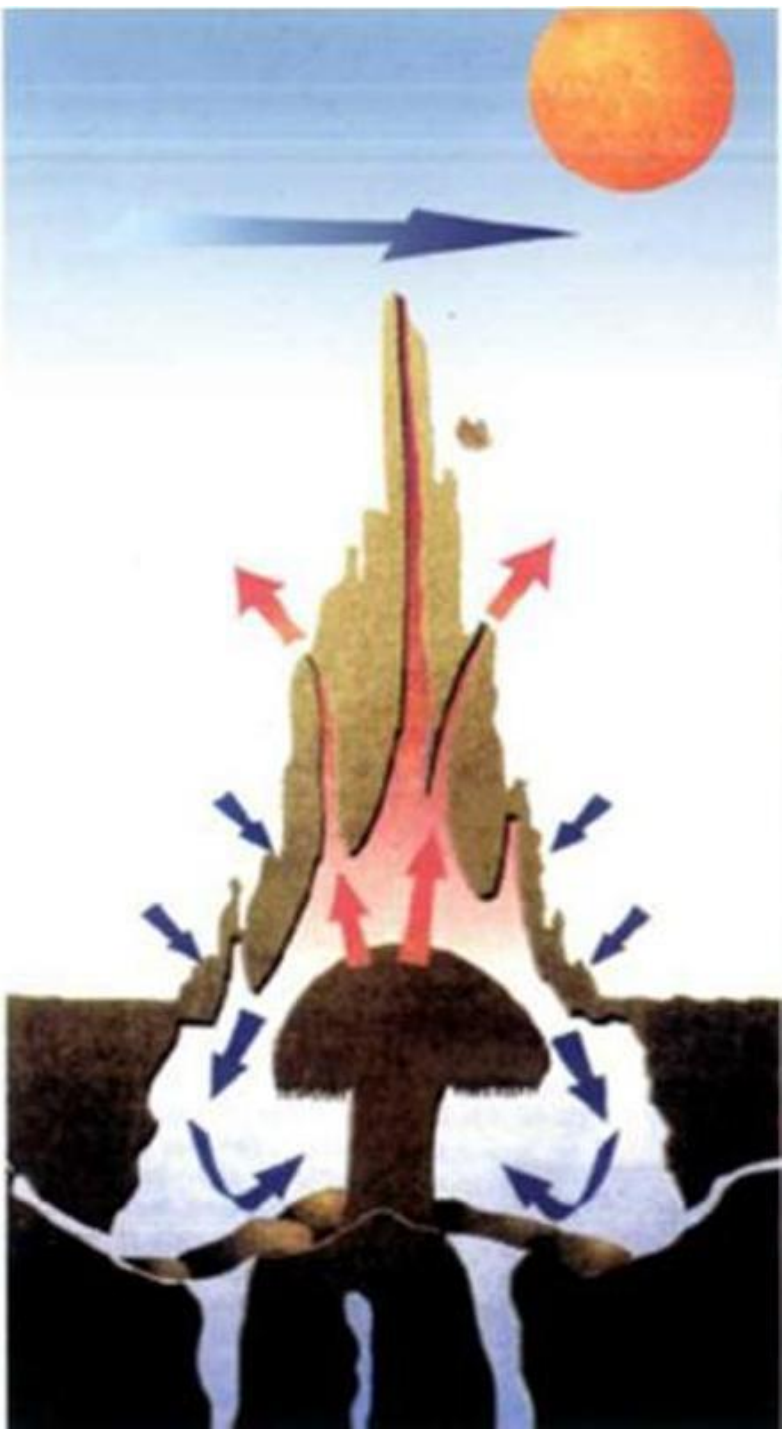
web of life











Soil is the foundation our natural living world depends on, the often-unappreciated substance of life, the *dynamic* material that civilization is built on, the *critical zone of the earth. Once you know soil* in its complexity and beauty, you will *know life with broader horizons.* Soil is not dirt. Soil is life!

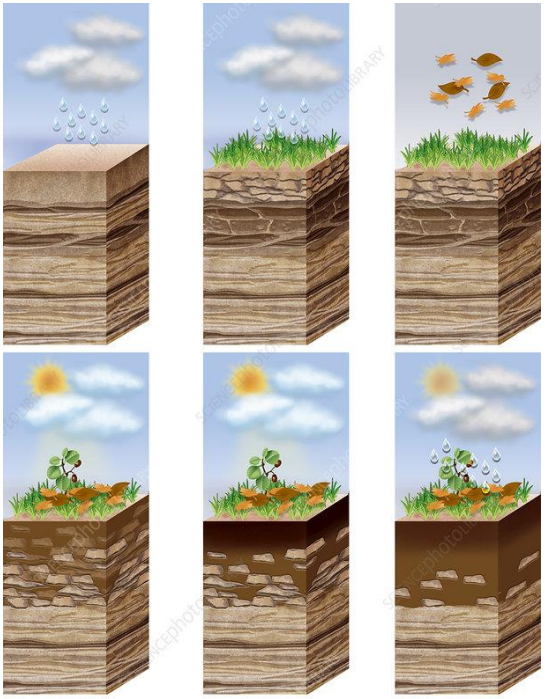
Upon further consideration it may come as a surprise that much of what we depend on—food, water, fiber, shelter—are all related to a single, often overlooked item. This is soil! Soil (the *pedosphere)* represents the critical zone of the earth where life (the *biosphere), water (the hydrosphere), minerals (the lithosphere), and* air (the *atmosphere) intersect and interact*

Definition:

A natural, three-dimensional body at the Earth's surface. It is capable of supporting plants and has properties resulting from the effects of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Perhaps the simplest is that soil is a living, *dynamic resource at* the surface of the earth.

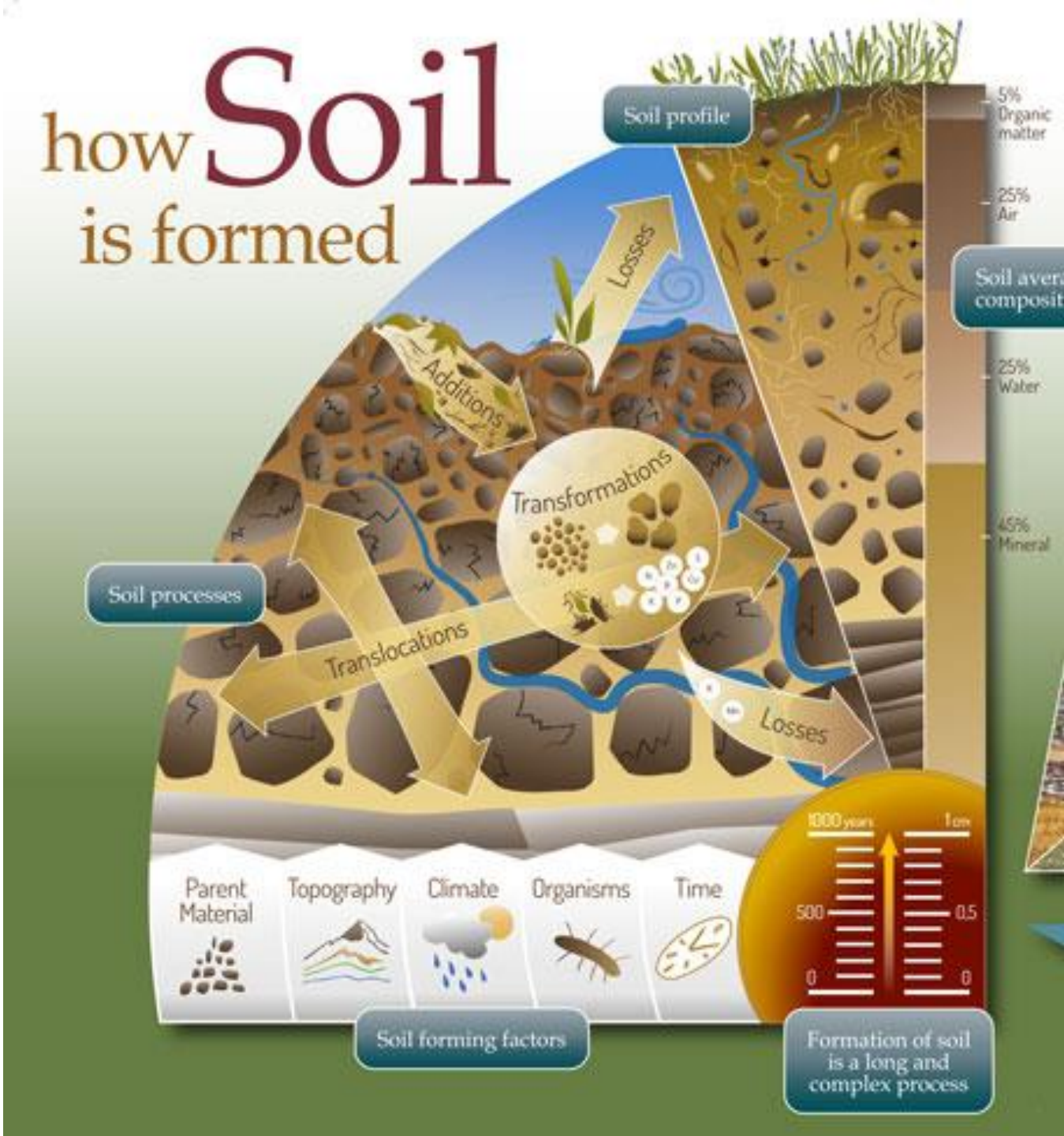
An understanding of soil—what it is, how it is formed, what it is made of, and how it is used. Soil serves as a repository of many geological and climatic events that have occurred in its location. It is a window to the past, but it can also serve as a view of the future as its properties relate to how we can and should manage this finite resource.



For soil is in part a creation of life, born of a marvelous interaction of life and nonlife long eons ago. The parent materials were gathered together as volcanoes poured them out in fiery streams, as waters running over the bare rocks of the continents wore away even the hardest granite, and as the chisels of frost and ice split and shattered the rocks.

Then living things began to work their creative magic and little by little these inert materials became soil. Lichens, the rocks' first covering, aided the process of disintegration by their acid secretions and made a lodging place for other life. Mosses took hold in the little pockets of simple soil—soil formed by crumbling bits of lichen, by the husks of minute insect life, by the debris of a fauna beginning its emergence from the sea.

A great number of processes take place in the soil, but they can be grouped together under four major categories: *additions, losses, transformations, and translocations*


how Soil is formed
Soil profile
5% Organic matter
25% Air
25% Water
45% Mineral
Losses
Additions
Transformations
Soil processes
Translocations
Losses
Parent Material
Topography
Climate
Organisms
Time
1000 years
500
0
1 cm
0.5
0
Soil forming factors
Formation of soil is a long and complex process

Additions are easy to understand. They consist of materials deposited on the soil from above, as well as materials moved in with groundwater, such as salts. Obvious examples are additions of leaf litter as trees shed their leaves, or additions of organic material as plants and plant roots die. Also obvious are additions of mineral material from flooding, landslides, and other geologic events. Rainfall is also an addition

Losses are also rather obvious. Erosion is a major form of soil loss. Loss can also occur as nutrients are taken up by plants and plants are harvested and removed. As minerals and nutrients move through soil into groundwater or out of the plants' rooting zone, this too is considered a loss.

LOSSES

WATER evaporates into the air.

Soil particles **WASH AWAY** in storms.

ORGANIC MATTER may compose into *carbon dioxide.*

NUTRIENTS and **MINERALS** leach into groundwater or are taken up by plants.

Translocations are similar to losses in that they involve movement of materials. Translocation differs in that the material is not removed from the soil; instead, it moves from one location to another. This internal movement is referred to as *illuviation* and *eluviation. Eluviation removes* material from a zone. Illuviation moves material into a zone. In other words, eluviation is material exiting, while illuviation is material entering

Understanding transformations takes a little more thought. Soils are dynamic— that means they are constantly changing, and biological, chemical, and physical transformations are part of this. For example, leaf litter falling on soil eventually decomposes. This decomposition is a transformation process. Likewise as rocks weather to soil, this too is a transformation process. The initial minerals in the rock are transformed to clays in the soils over time. One mineral can be transformed to another without additions of materials.

TRANSFORMATIONS

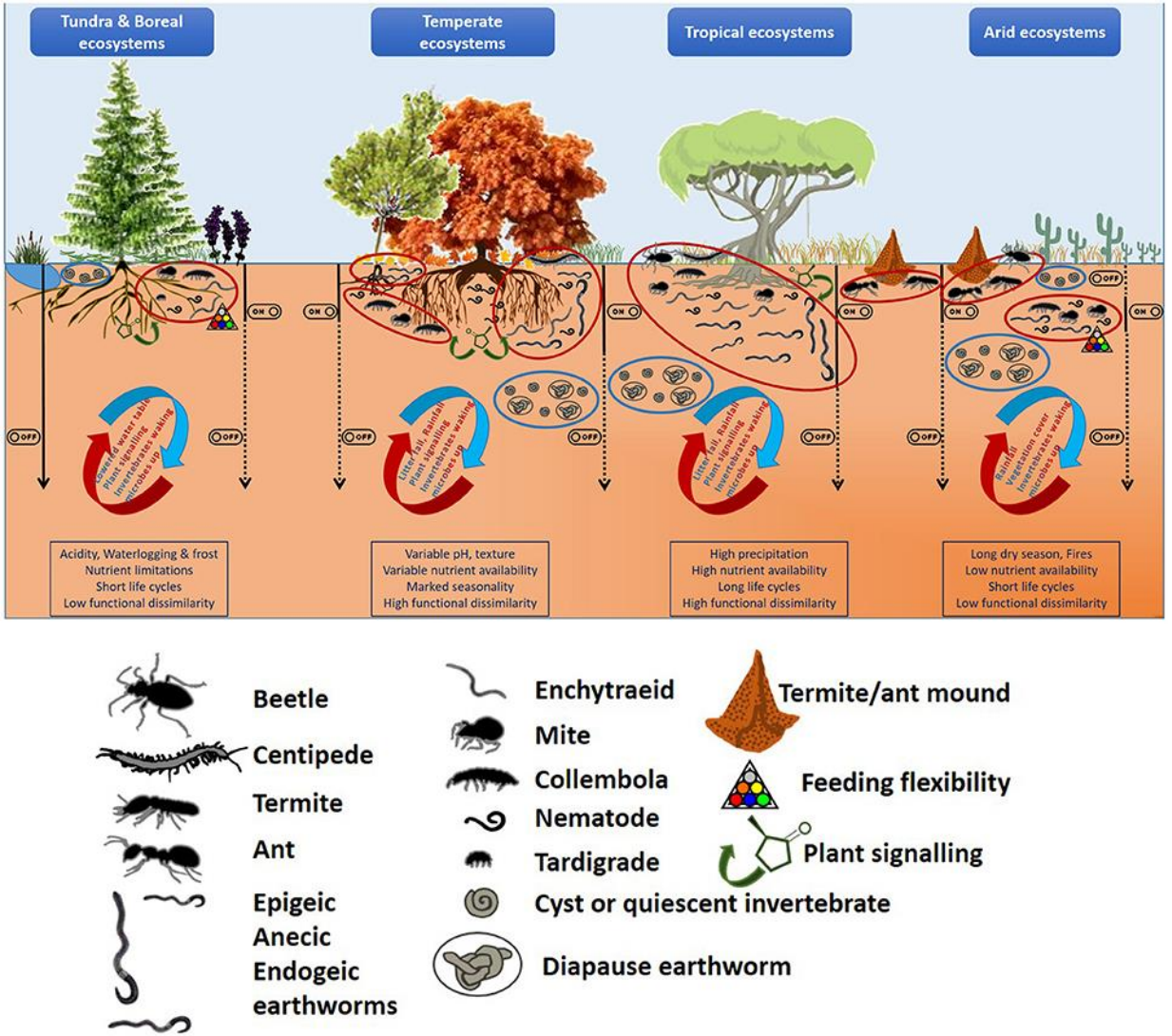
(ONE COMPONENT CHANGES TO ANOTHER)

Dead leaves decompose into **HUMUS**.

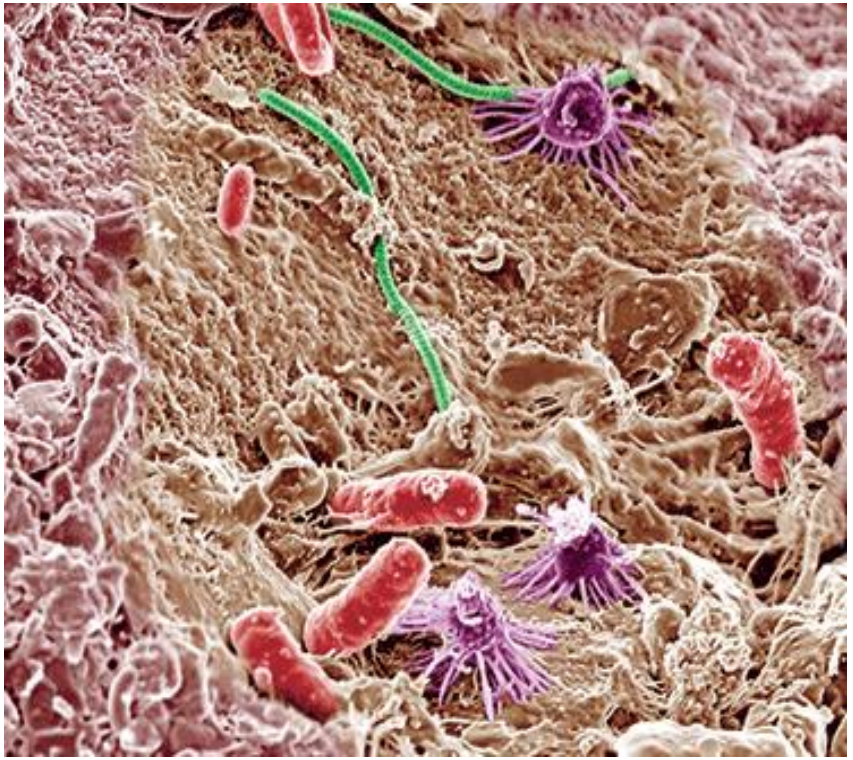
Hard rock **WEATHERS** into soft clay

Oxygen **REACTS** with iron, "rusting" the soil into a reddish color.

Life not only formed the soil, but other living things of incredible abundance and diversity now exist within it; if this were not so the soil would be a dead and sterile thing. By their presence and by their activities the myriad organisms of the soil make it capable of supporting the earth's green mantle.



The soil exists in a state of constant change, taking part in cycles that have no beginning and no end. New materials are constantly being contributed as rocks disintegrate, as organic matter decays and as nitrogen and other gases are brought down in rain from the skies. At the same time other materials are being taken away, borrowed for temporary use by living creatures. Subtle and vastly important chemical changes are constantly in progress, converting elements derived from air and water into forms suitable for use by plants. In all these changes living organisms are active agents.



Bacteria, fungi, and algae are the principal agents of decay, reducing plant and animal residues to their component minerals. The vast cyclic movements of chemical elements such as carbon and nitrogen through soil and air and living tissue could not proceed without these micro plants. Without the nitrogen-fixing bacteria, for example, plants would starve for want of nitrogen, though surrounded by a sea of nitrogen-containing air. Other organisms form carbon dioxide, which, as carbonic acid, aids in dissolving rock. Still other soil microbes perform various oxidations and reductions by which minerals such as iron, manganese, and sulfur are transformed and made available to plants.

Also present in prodigious numbers are microscopic mites and primitive wingless insects called springtails. Despite their small size they play an important part in breaking down the residues of plants, aiding in the slow conversion of the litter of the forest floor to soil.

A springtail.

Photo by J. R. Baker, NC State University

Bacteria

Bacteria is the crucial workforce of soils. They are the final stage of breaking down nutrients and releasing them to the root zone for the plant. In fact, the Food and Agriculture Organization once said "Bacteria may well be the most valuable of life forms in the soil."

Actinomycetes

Actinomycetes were once classified as fungi, and act similarly in the soil. However, some actinomycetes are predators and will harm the plant while others living in the soil can act as antibiotics for the plant.

Fungi

Like bacteria, fungi also lives in the rootzone and helps make nutrients available to plants. For example, *Mycorrhizae* is a fungi that facilitate water and nutrient uptake by the roots and plants to provide sugars, amino acids and other nutrients.

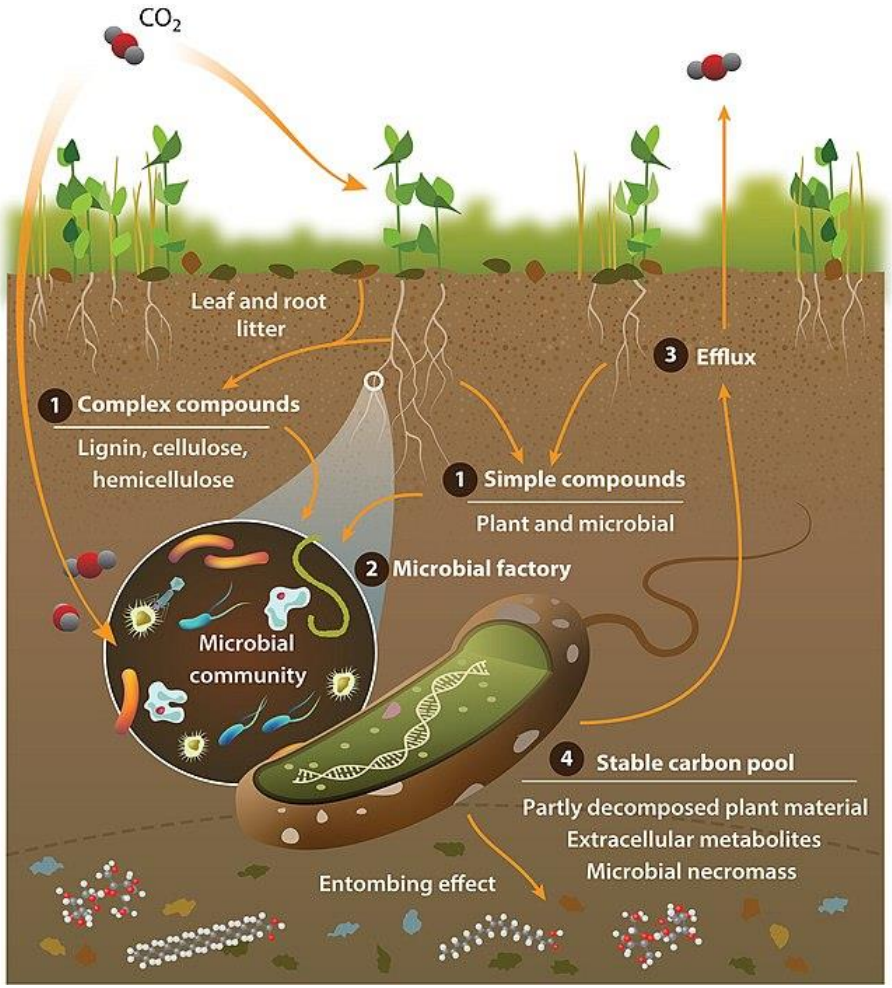
Protozoa

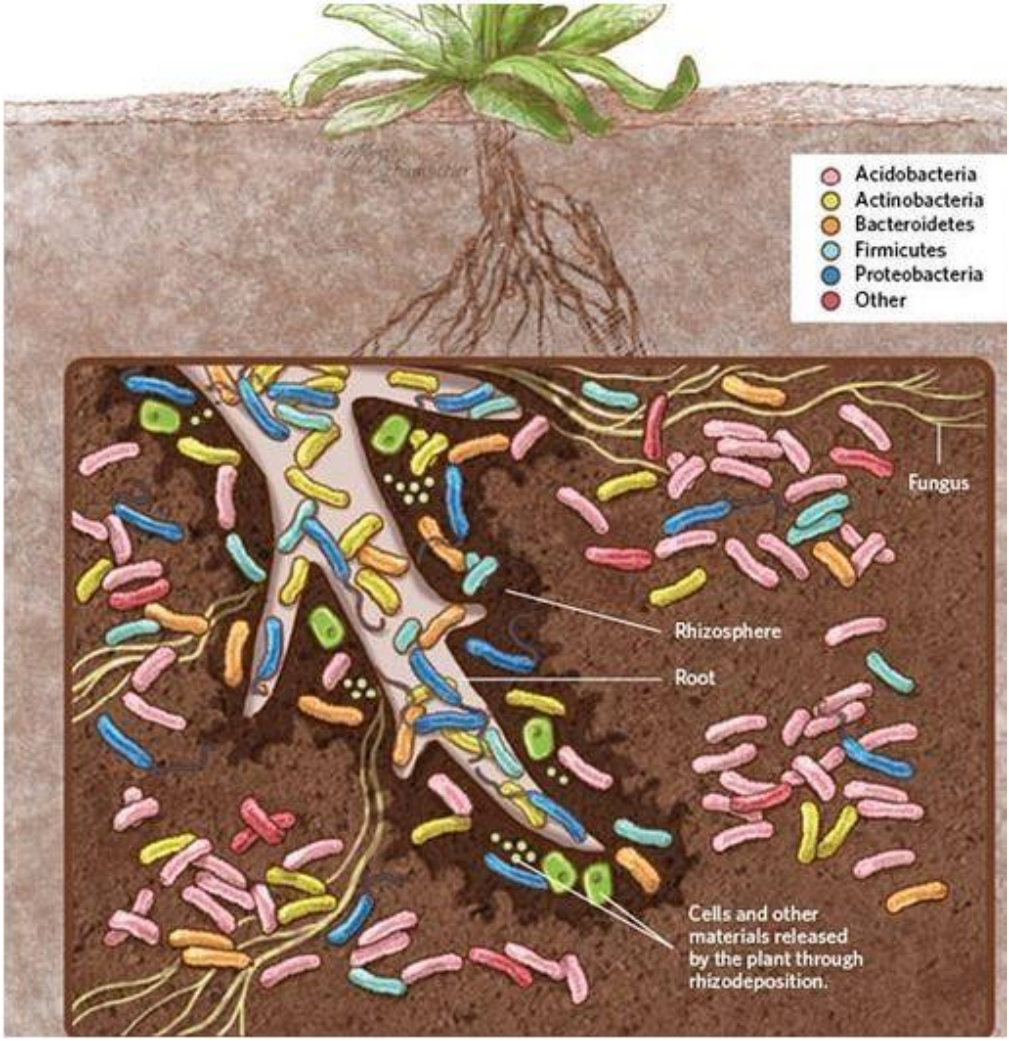
Protozoa are larger microbes that love to consume and be surrounded by bacteria. In fact, nutrients that are eaten by bacteria are released when protozoa in turn eat the bacteria.

Nematodes

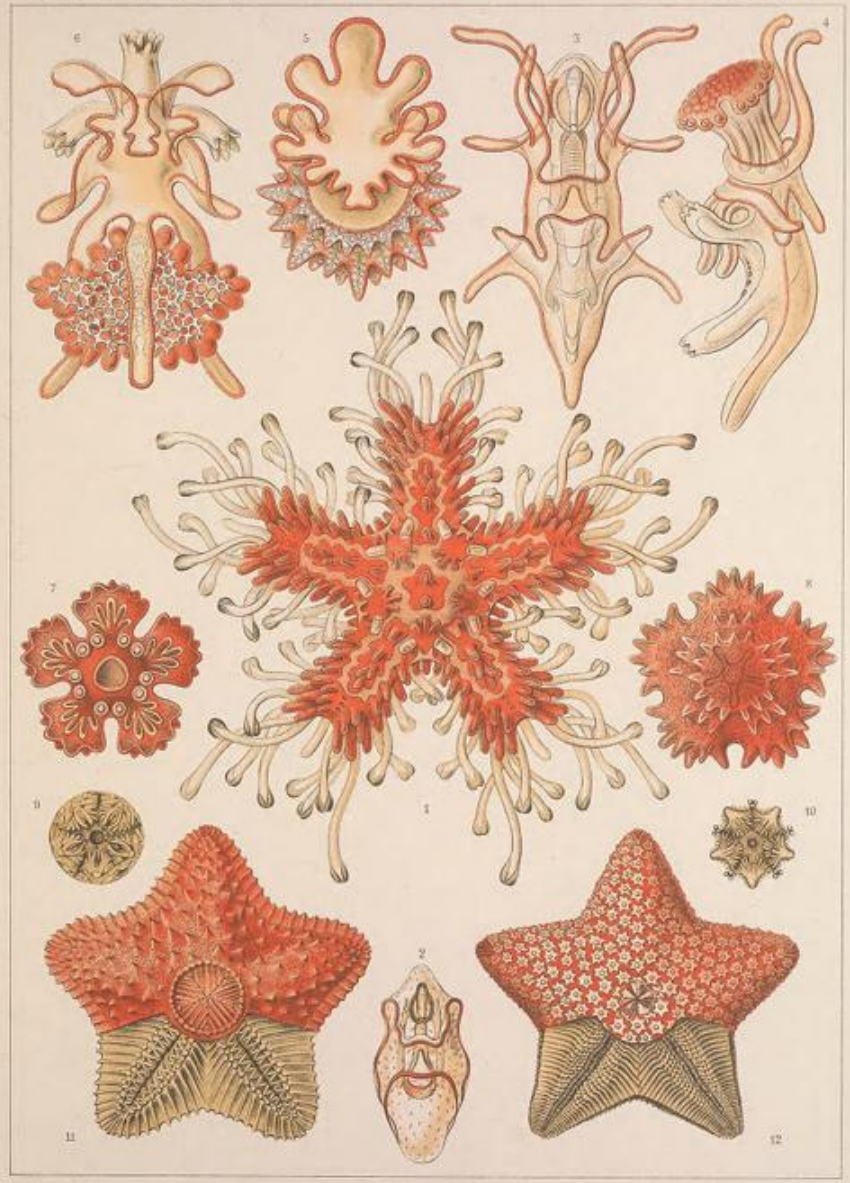
Nematodes are microscopic worms that live around or inside the plant. Some nematodes are predators while others are beneficial, eating pathogenic nematodes and secreting nutrients to the plant.

This soil community, then, consists of a web of interwoven lives, each in some way related to the others—the living creatures depending on the soil, but the soil in turn a vital element of the earth only so long as this community within it flourishes.



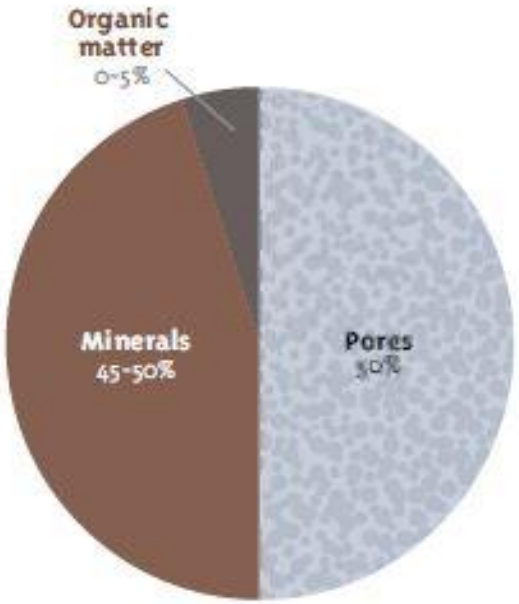


Nudibranchia. — Nacktkiemen-Schnecken.

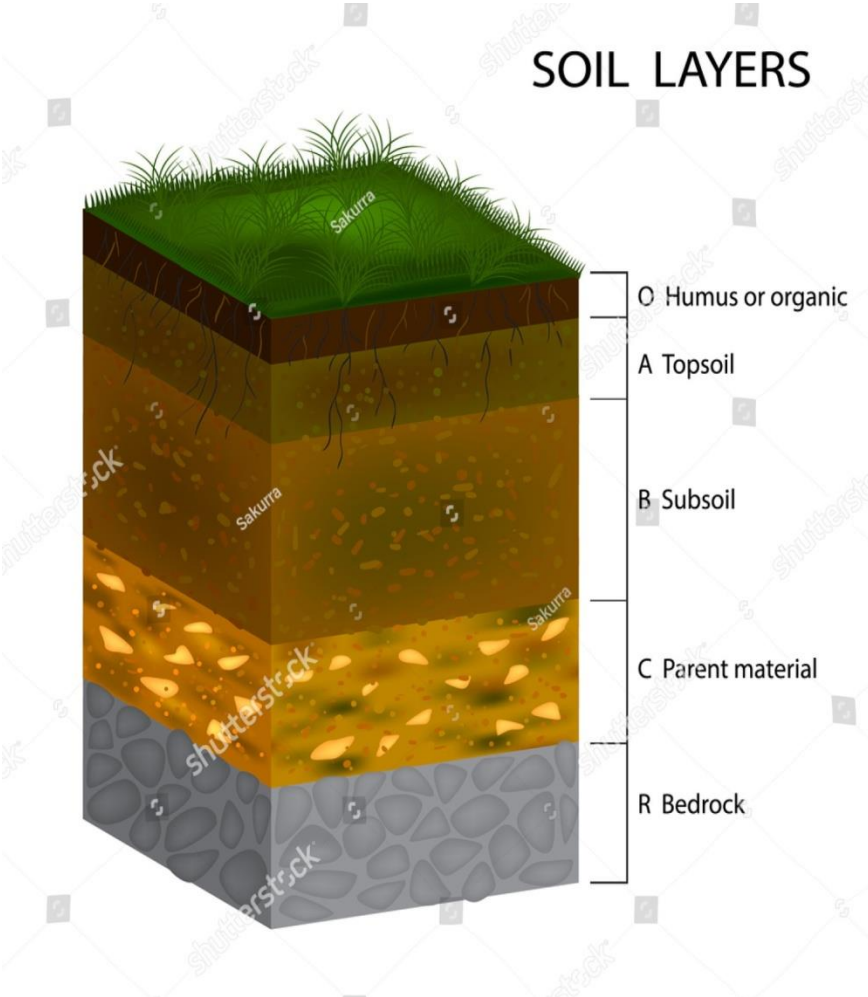


Asteridea. — Seesterne.

There are four components to every soil: minerals, organic matter (living and dead), water, and air. The minerals and organic matter make up the solid phase. The water and air make up the pore space. A typical handful of soil contains 50% pore space, 45–50% minerals and 0–5% organic matter



Percentages of each component of soil: mineral, pore space (filled with air and/or water), and organic matter.



As water infiltrates and percolates through soil, the soil's chemical, biological, and physical properties clean the water by removing contaminants. This means that soil is perhaps the largest single water (and wastewater) treatment plant in the world. Soil helps keep water clean by filtering it.

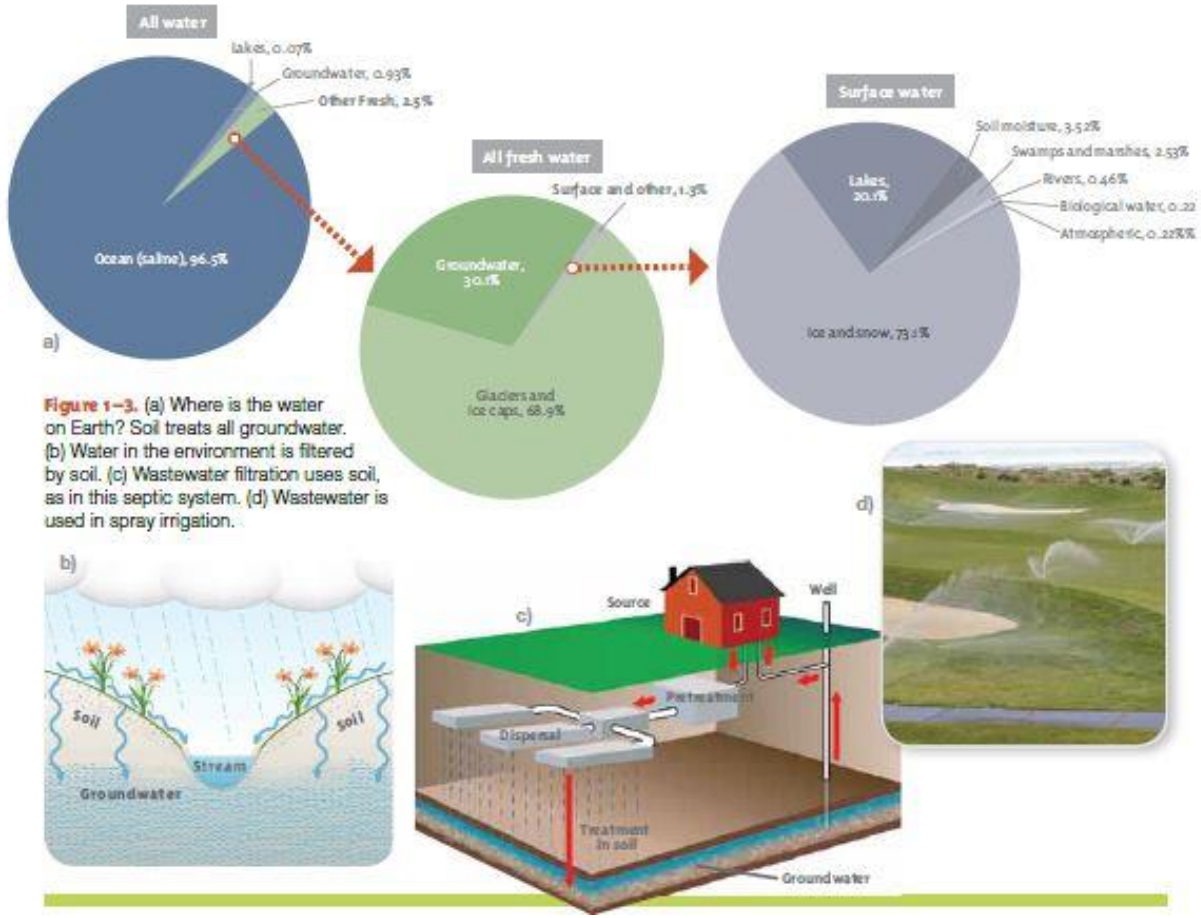
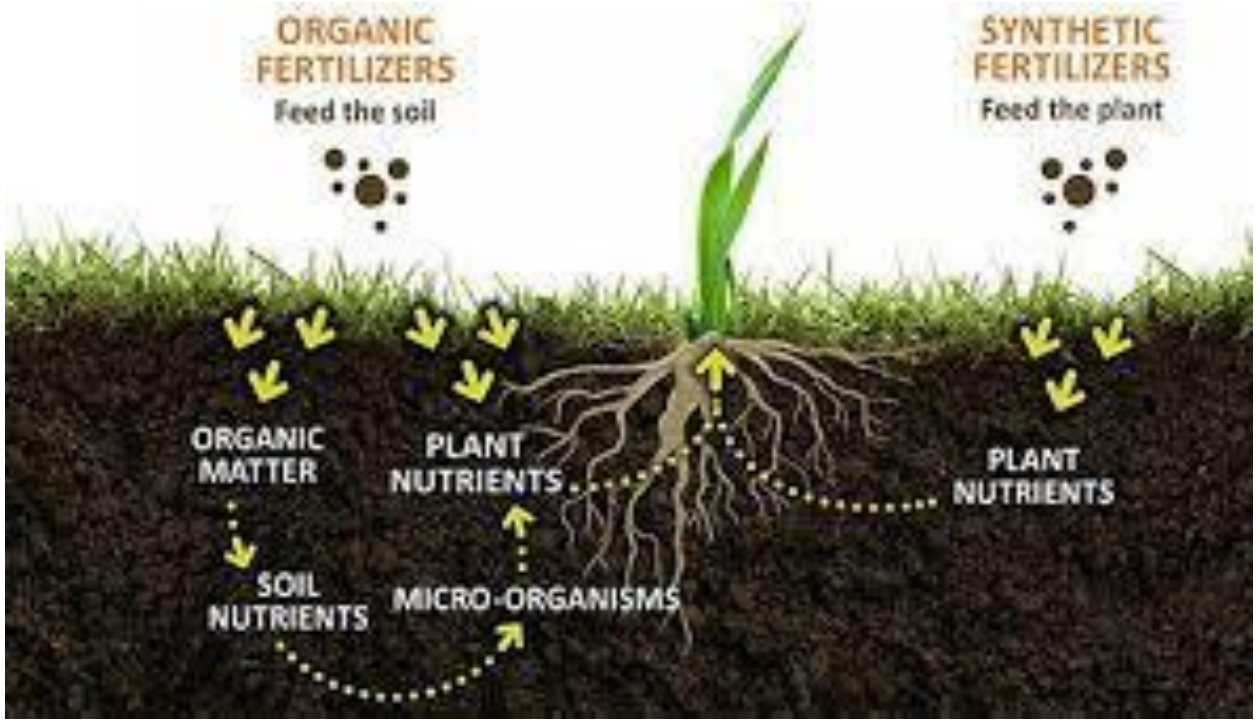


Figure 1–3. (a) Where is the water on Earth? Soil treats all groundwater. (b) Water in the environment is filtered by soil. (c) Wastewater filtration uses soil, as in this septic system. (d) Wastewater is used in spray irrigation.

Soils store the nutrients until the plant needs them. Soil acts as a nutrient reservoir for plant growth and survival. Soil also provides critical support for plant roots, preventing the plant from falling down or washing away. Soil also acts as a sponge to hold water.



Ecologists group large geographic regions with similar environments and distinctive plant and animal communities into biomes. The major terrestrial biomes include savanna and temperate grasslands, tropical and temperate rainforests, boreal and temperate forests, arctic and alpine tundra, deserts, shrublands, and wetlands. Each biome comprises several ecosystems.

The environmental factors influencing biomes include latitude, the general climate and topography of the region, and soil. Soil is the foundation of every terrestrial ecosystem.

மாயோன் மேய காடுறை உலகமும்
சேயோன் மேய மைவரை உலகமும்
வேந்தன் மேய தீம்புனல் உலகமும்
வருணன் மேய பெருமணல் உலகமும்
முல்லை குறிஞ்சி மருதம் நெய்தல் எனச்
சொல்லிய முறையாற் சொல்லவும் படுமே.

மருதத்திற்குரிய பெரும்பொழுதும் சிறுபொழுதும்:

வைகறை விடியல் மருதம்.

வைகறை விடியலும் மருதத்திற்குக் காலமாம்.வைகறையாவது இராப்பொழுதின் பிற்கூறு. விடியலாவது, பகற்பொழுதின் முற்கூறு. பருவம்

மருதத்திற்குரிய கருப்பொருள்:

தெய்வம் இந்திரன்; உணவு - நெல். மா - எருமையும், நீர்நாயும், மரம் - மருதும். காஞ்சியும், புள் - அன்னமும் அன்றிலும். பறை - நெல்லரி பறை, செய்தி - உழவு. பண் - மருதம். பிறவும் என்றதனால், பூ தாமரையும் கழுநீரும். நீர் - ஆற்றுநீரும் பொய்கை நீரும். பிறவும் அன்ன.

VAIGAI RIVER BASIN

மலைசார் உலகம் KURUNJI

Shrub: Kurunji (Strobilanthes Kuntiana).

FOOD: Tinai (millet), aivanam, vennel, bamboo seeds, avarai beans (Dolicuslablab), honey and tubers.

SOCIAL: Kalavar (farmer), Kanavar (hillmen, Vedar, Kuravar.

SOIL: Red, black soil with stone and pebbles

OCCUPATION
honey collecta,
digging roots,
cultivation
coast tendy.

ATER:
ater falls,
rings,
ntain streams
st stream

நெய்தல் உலகம்

LAI
ULLAI

Named after Jasmine (Jasminium Trichotomy) Certain parts of Kurunji and Mullai become arid.

FOOD: Varagu (millet), tinai, kol and spotted avarai beans

SOCIAL: Idaiyar (Shepherd) Ayar (cowherds)

SOIL: RED SOIL.

OCCUPATION: animal husbandry, raising dry crops, Shifting agriculture.

WATER: Forest streams and brooks (Kattaru)

நீர்புனல் உலகம் MARUTHAM

Riverine or agricultural tract.

TREE: Indian Laurel Terminalia arjuna

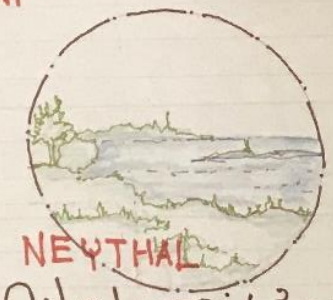
FOOD: Red and white rice.

SOCIAL: Ulavar, (farmer) Uzumagar; Verlalar, Velar-mandar (peasants) Kalamar (tiller), Toluvar (tillers).

Occupation: Agriculture, Shepherds (Podivar) Cattle herder

SOIL: Alluvial

WATER: Well, ponds, river, Stream.



NEYTHAL

பெருமணல் உல

Maritime or Littoral region

FLOWER: Neytal, Blue/white L Nymphaea odorata)

FOOD: Fish and Salt.

SOCIAL: Nulaiyar (fisherman Pimilar (oarsmen), Kin

SOIL: Sandy & Saline.

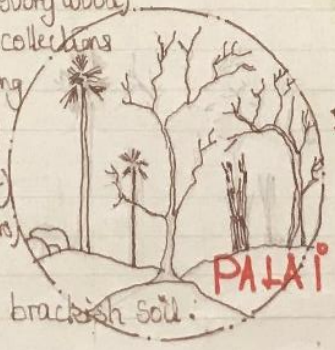
WATER RESOURCE: Sand wells dug wells in brac water.

TREE: PALAI TREE (Wrightia tinctoria, Ivory wood).

FOOD: The collections from Waylaying and molesting

SOCIAL: Eyinar (hunter) Maravar (warrior)

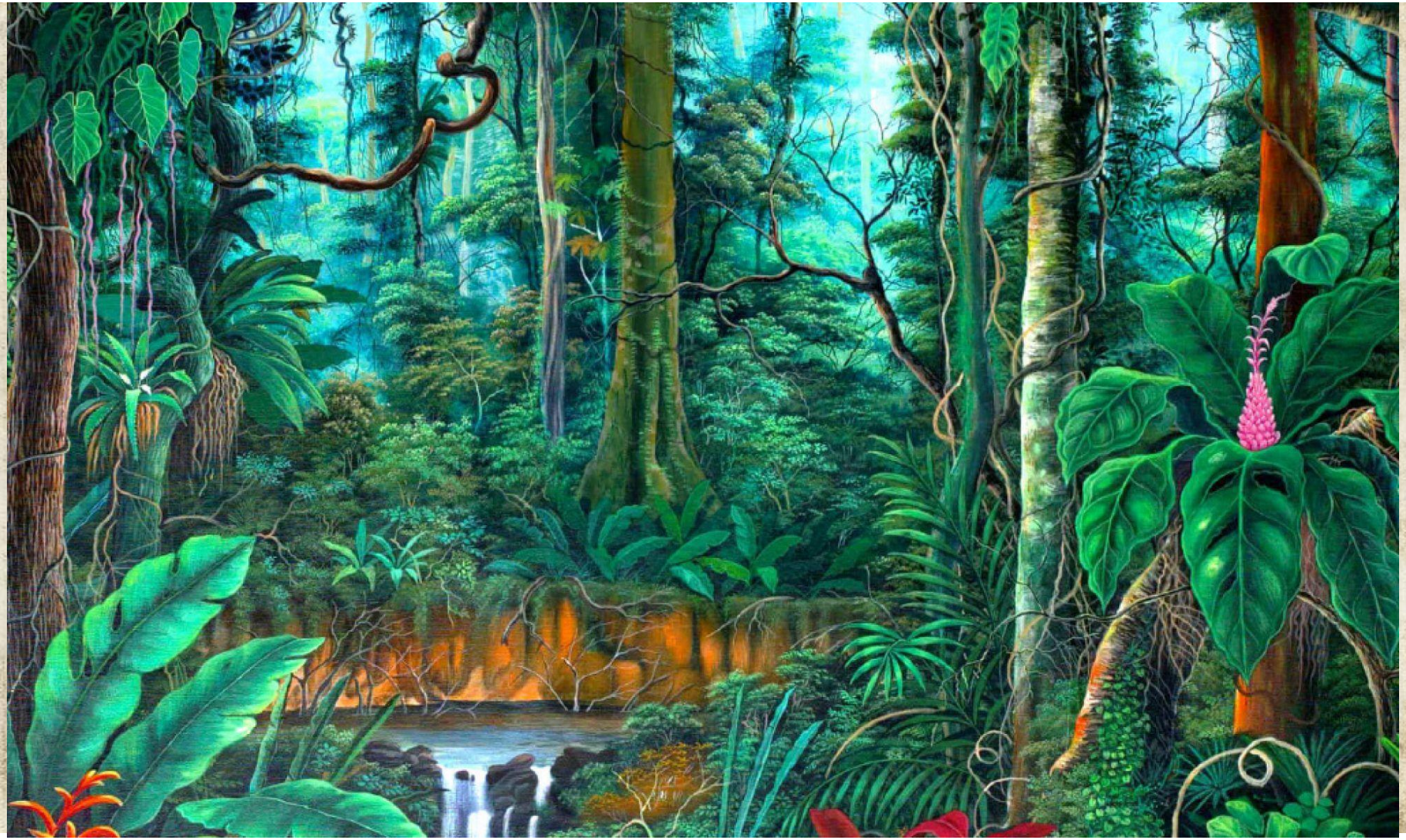
SOIL: Salt affected soil, brackish soil.



PALAI

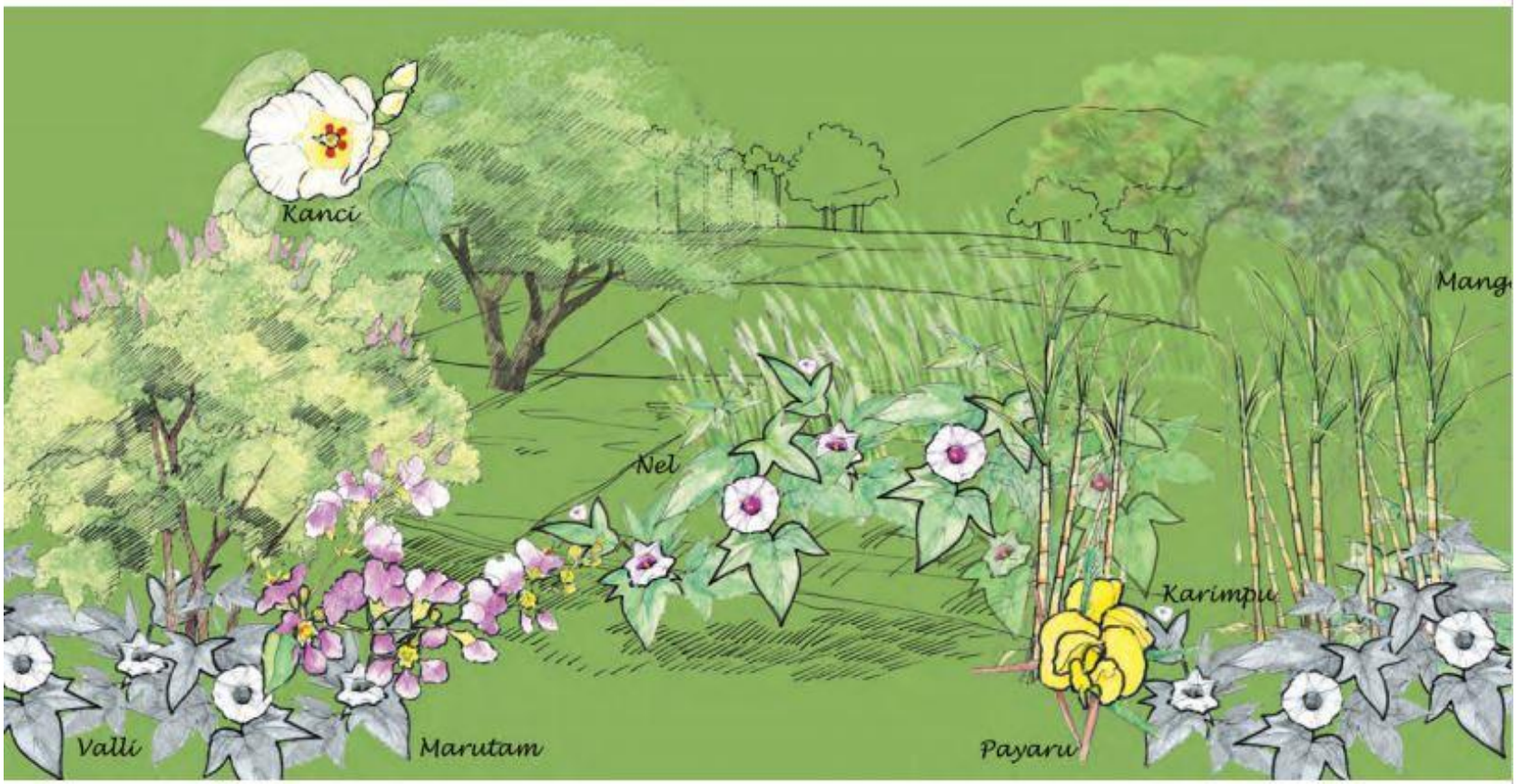
பாலை

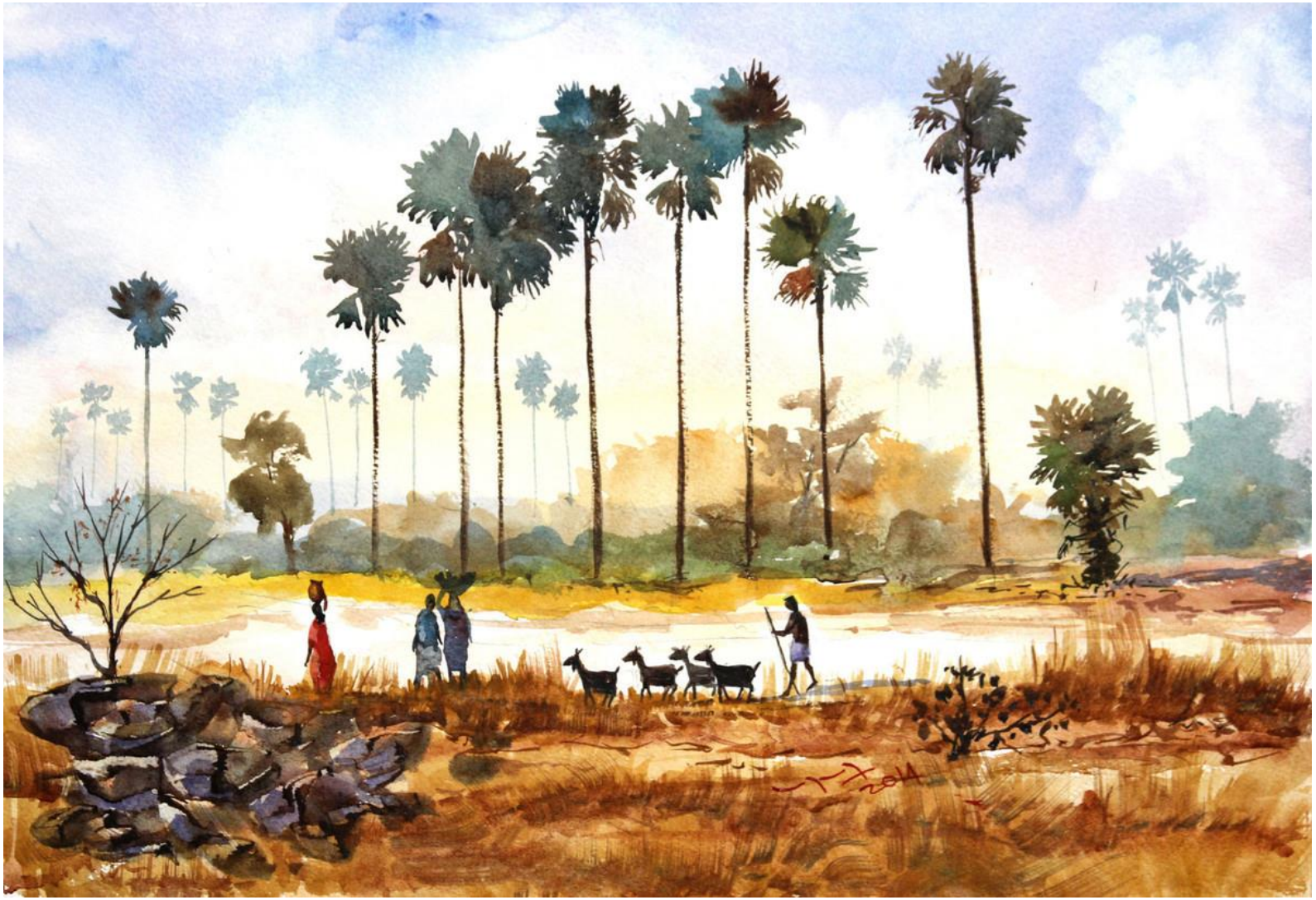
Water Sources: Fresh water ring wells (Uraikinaru) and dried springs (Urru).

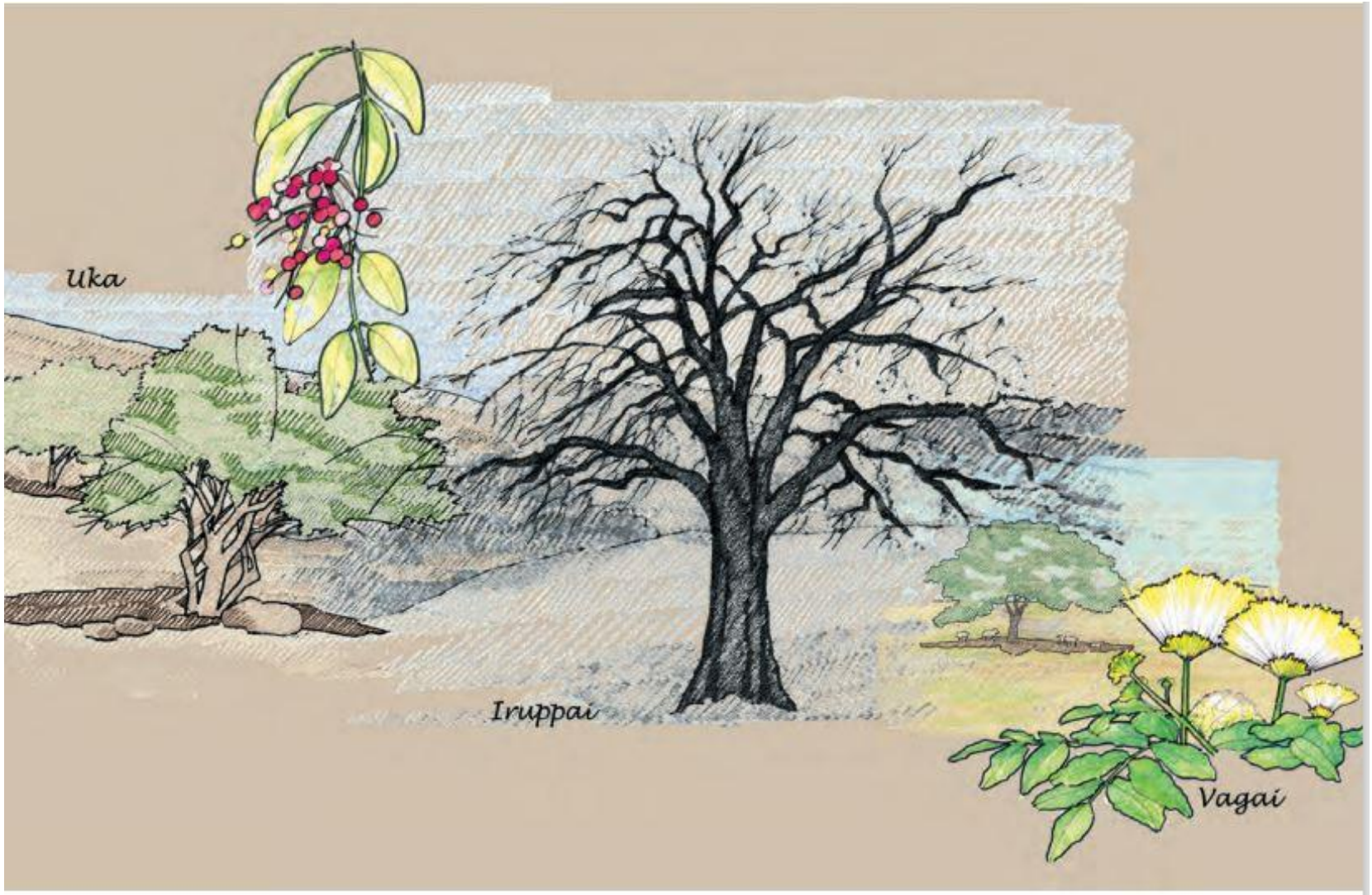


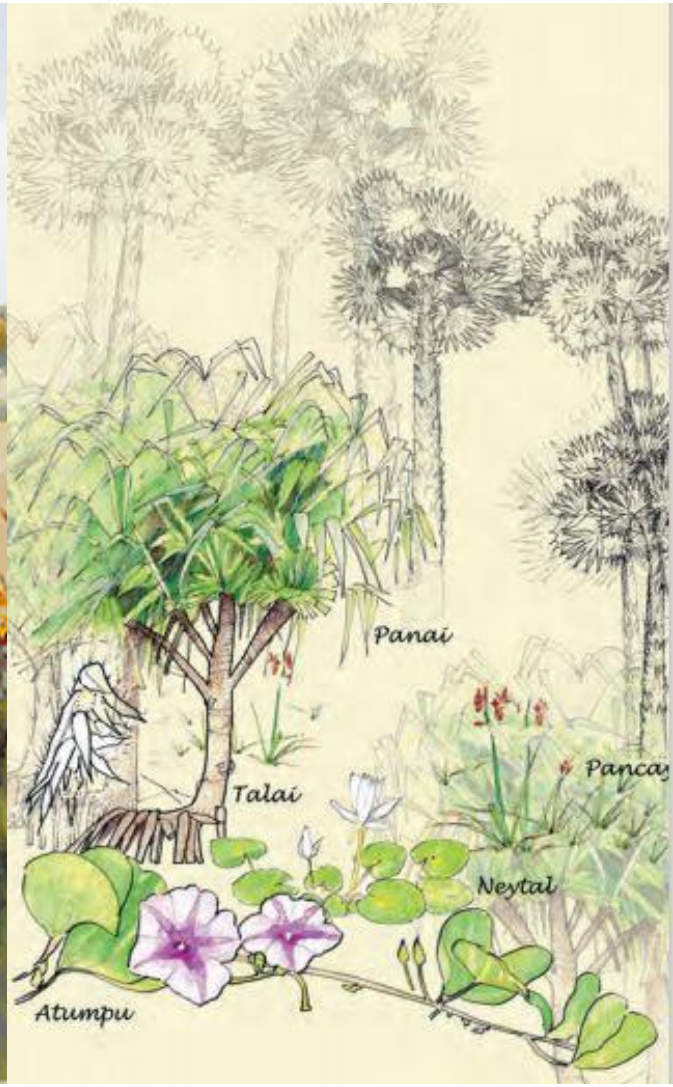

Akil
unkil
Kantal
Pala
Kutalam
Parli
Kurinci
Cembu


Kadamba
Kondrai
Kaya
Punku
Kuravam
Avarai
Mullai
Cem mullai


Kanci
Mang
Nel
Karimpu
Valli
Marutam
Payaru




Uka
Iruppai
Vagai


Panai
Talai
Pancay
Neytal
Atumpu

Under some conditions, the chemical conversions and transformations that lie at the very heart of the living world are affected. Nitrification, which makes atmospheric nitrogen available to plants, is an example.The herbicide DDT causes a temporary interruption of nitrification. In recent experiments in Florida, lindane, heptachlor, and BHC (benzene hexachloride) reduced nitrification after only two weeks in soil; BHC and DDT had significantly detrimental effects a year after treatment.

One of the most important things to remember about insecticides in soil is their long persistence, measured not in months but in years. Aldrin has been recovered after four years, both as traces and more abundantly as converted to dieldrin. Enough toxaphene remains in sandy soil ten years after its application to kill termites. Benzene hexachloride persists at least eleven years; heptachlor or a more toxic derived chemical, at least nine.

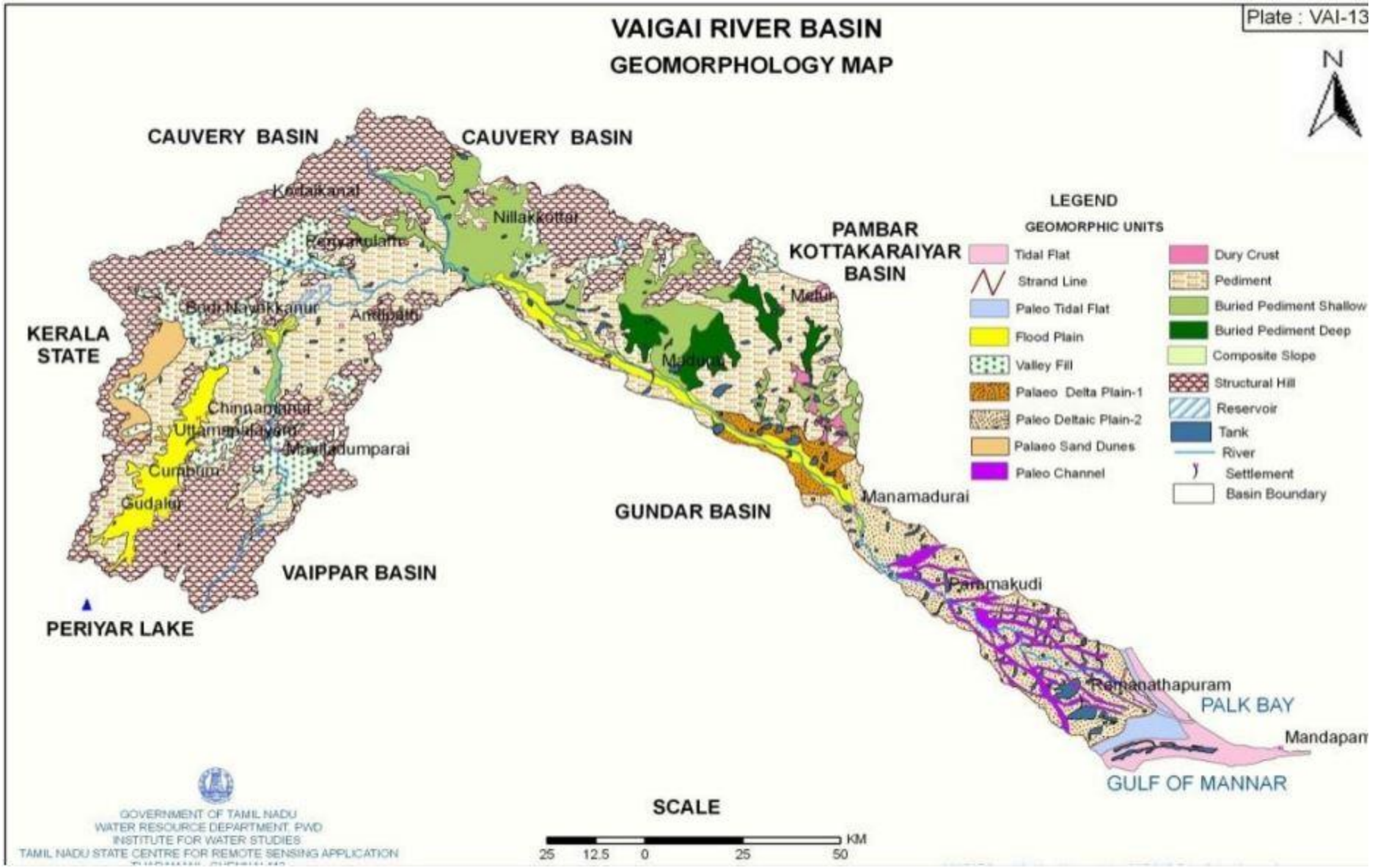
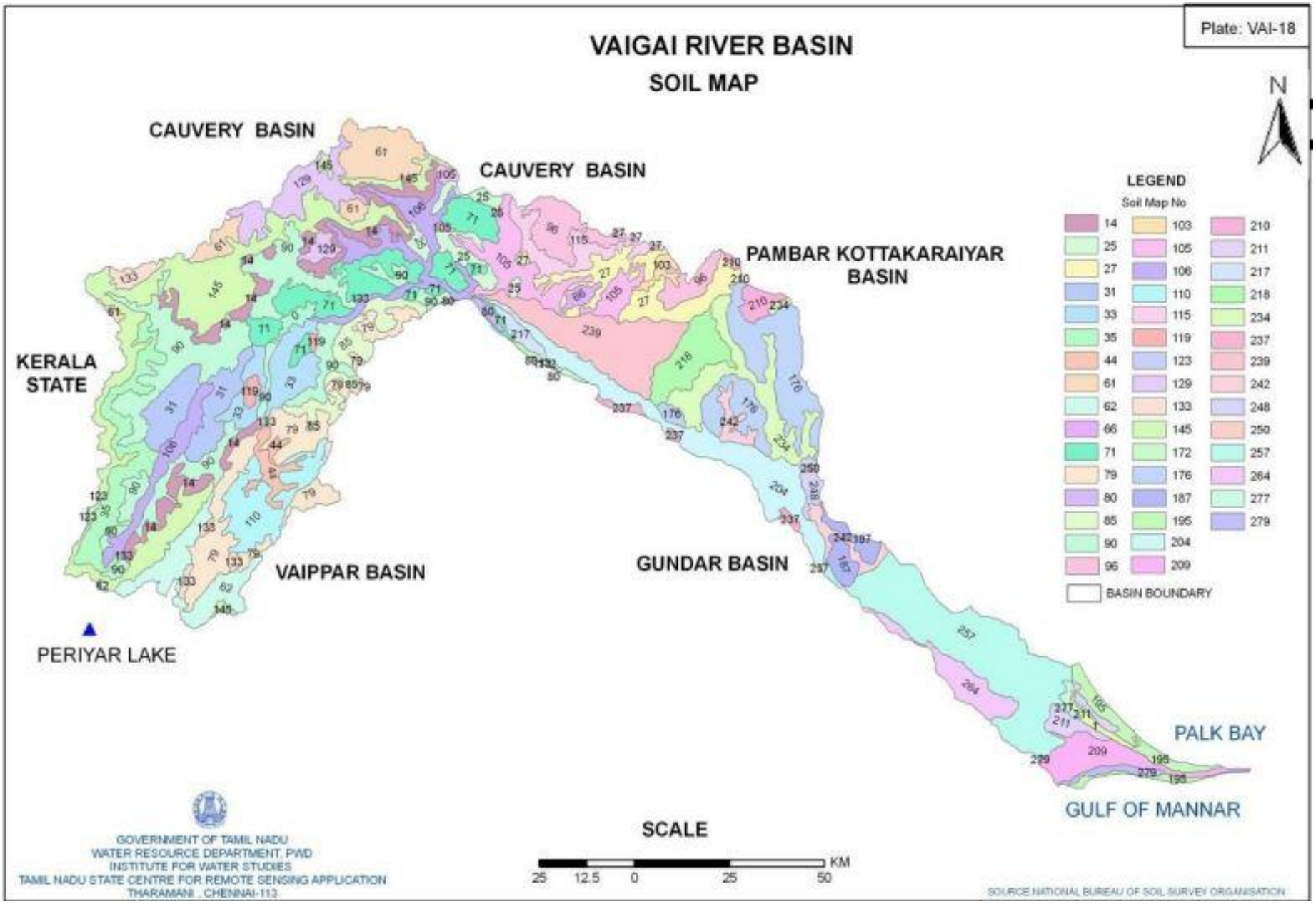


Plate : VAI-13
VAIGAI RIVER BASIN
GEOMORPHOLOGY MAP
N
CAUVERY BASIN
CAUVERY BASIN
Kotaikanal
Nillakkottai
Periyakulam
PAMBAR
KOTTAKARAIYAR
BASIN
Bodinayakkanur
Andipatti
Melur
KERALA
STATE
Madurai
Chinnamanur
Uttamapalayam
Mayiladumparai
Cumbum
Gudalur
Manamadurai
GUNDAR BASIN
VAIPPAR BASIN
Paramakudi
PERIYAR LAKE
Ramanathapuram
PALK BAY
Mandapam
GULF OF MANNAR
LEGEND
GEOMORPHIC UNITS
Tidal Flat
Strand Line
Paleo Tidal Flat
Flood Plain
Valley Fill
Palaeo Delta Plain-1
Paleo Deltaic Plain-2
Palaeo Sand Dunes
Paleo Channel
Dury Crust
Pediment
Buried Pediment Shallow
Buried Pediment Deep
Composite Slope
Structural Hill
Reservoir
Tank
River
Settlement
Basin Boundary
GOVERNMENT OF TAMIL NADU
WATER RESOURCE DEPARTMENT, PWD
INSTITUTE FOR WATER STUDIES
TAMIL NADU STATE CENTRE FOR REMOTE SENSING APPLICATION
SCALE
KM
25 12.5 0 25 50

Plate: VAI-18

VAIGAI RIVER BASIN

SOIL MAP



GOVERNMENT OF TAMIL NADU
WATER RESOURCE DEPARTMENT, PWD
INSTITUTE FOR WATER STUDIES
TAMIL NADU STATE CENTRE FOR REMOTE SENSING APPLICATION
THARAMANI , CHENNAI-113

SOURCE NATIONAL BUREAU OF SOIL SURVEY ORGANISATION

The Soils of Vaigai Basin is classified as Deep Red Soil, Red Soil, Red Sandy Soil, Black Clayey Soil, Laterite Soil and Alluvial Soil. Deep red soil is prevalent in cumbum valley near Chinnamanur, Uttamapalayam and Cumbum areas.

Between Vaigai dam and Peranai red soil is prevalent. The soil is red to yellowish red and sometimes brownish in colour and has a thickness varying from 0.25m to 3m in this area.

The Red Sandy soil is the soil mixed with sand or quartz fragments. These are found in the area in vicinity of quartzite outcrops.

Black coloured, black to brownish soil is found in some part of this area near Andipatti, Meenakshipuram in this basin area.

Lateritic soil is distributed in Kodaikanal hills and slopes and North West of Manamadurai.

Alluvial Soil occurs predominantly in lower Vaigai basin and along Vaigai river and its tributaries.

Geomorphology

GEOMORPHOLOGY INCLUDES THE STUDY OF WATER, WIND, AND ICE ACTING UNDER GRAVITATIONAL FORCES TO SCULPT THE SURFACE OF THE LAND

STRUCTURE HILL.
GWP- MODERATE AND POOR. RUN OFF ZONE. LITTLE INFILTRATION MODERATE ON THE HILL TOPS, VALLEYS & SUPER IMPOSED FRACTURES COMPOSED OF COMPOSITE RIDGES AND HILL TOP VALLEYS TRAVERSED BY SR STRUCTURAL HILLS FEATURES.

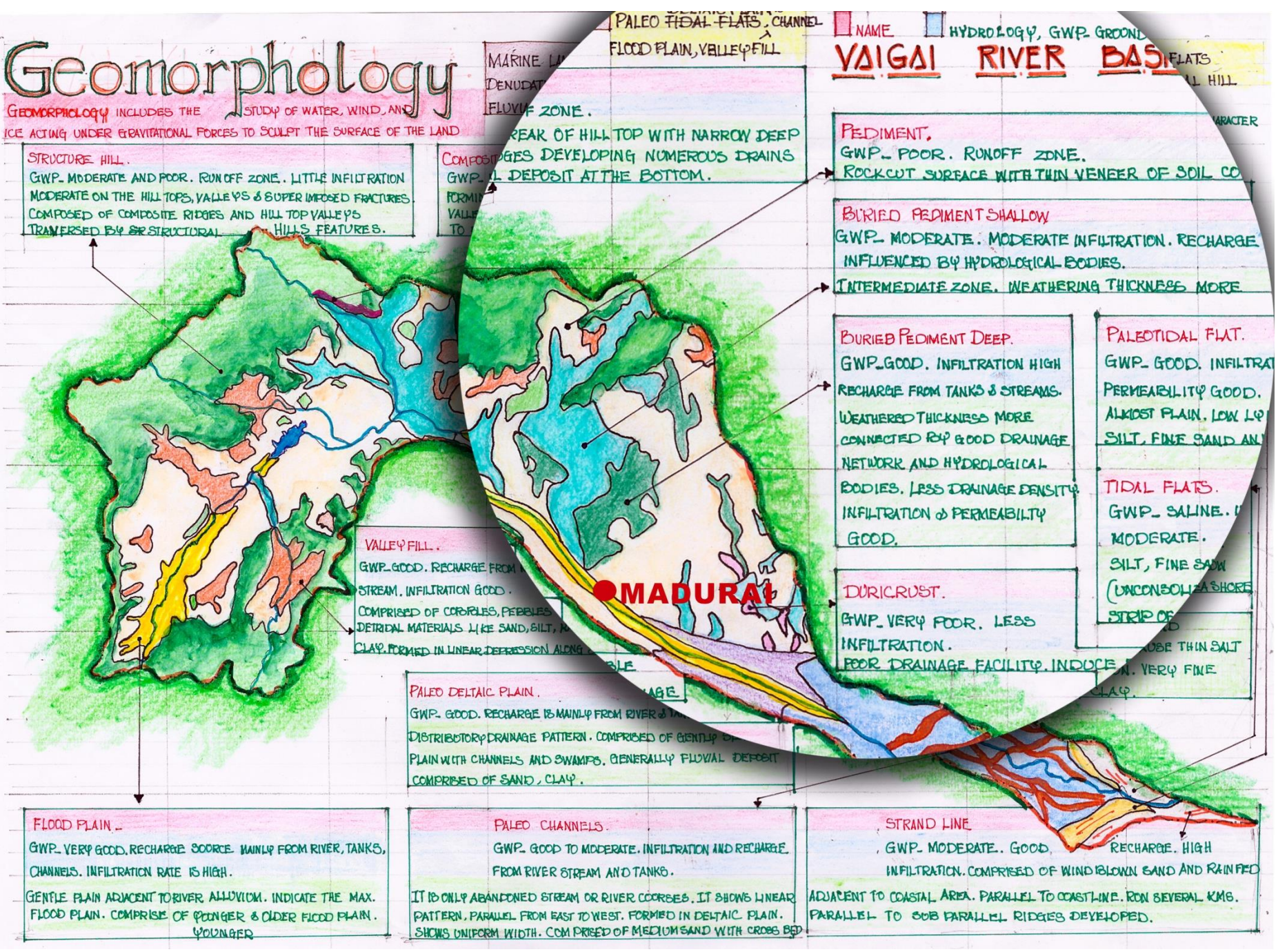
VALLEY FILL.
GWP- GOOD. RECHARGE FROM
STREAM. INFILTRATION GOOD.
COMPRISED OF COBBLES, PEBBLES
DETRIDAL MATERIALS LIKE SAND, SILT,
CLAY. FORMED IN LINEAR DEPRESSION ALONG

PALEO DELTAIC PLAIN.
GWP- GOOD. RECHARGE IS MAINLY FROM RIVER &
DISTRIBUTORY DRAINAGE PATTERN. COMPRISED OF GENTLY
PLAIN WITH CHANNELS AND SWAMPS. GENERALLY FLUVIAL DEPOSIT
COMPRISED OF SAND, CLAY.

FLOOD PLAIN -
GWP- VERY GOOD. RECHARGE SOORCE MAINLY FROM RIVER, TANKS, CHANNELS. INFILTRATION RATE IS HIGH.
GENTLE PLAIN ADJACENT TO RIVER ALLUVIUM. INDICATE THE MAX. FLOOD PLAIN. COMPRISE OF YOUNGER & OLDER FLOOD PLAIN.
YOUNGER

PALEO CHANNELS.
GWP- GOOD TO MODERATE. INFILTRATION AND RECHARGE FROM RIVER STREAM AND TANKS.
IT IS ONLY ABANDONED STREAM OR RIVER COORSES. IT SHOWS LINEAR PATTERN, PARALLEL FROM EAST TO WEST. FORMED IN DELTAIC PLAIN. SHOWS UNIFORM WIDTH. COMPRISED OF MEDIUM SAND WITH CROSS BED

STRAND LINE
GWP- MODERATE.. GOOD. RECHARGE. HIGH
INFILTRATION. COMPRISED OF WIND BLOWN SAND AND RAIN FED
ADJACENT TO COASTAL AREA. PARALLEL TO COASTLINE. RON SEVERAL KMS. PARALLEL TO SUB PARALLEL RIDGES DEVELOPED.



NAME HYDROLOGY, GWP- GROUND

VAIGAI RIVER BASIN

PEDIMENT.
GWP- POOR. RUNOFF ZONE.
ROCKCUT SURFACE WITH THIN VENEER OF SOIL CO

BURIED PEDIMENT SHALLOW
GWP- MODERATE. MODERATE INFILTRATION. RECHARGE INFLUENCED BY HYDROLOGICAL BODIES.
INTERMEDIATE ZONE. WEATHERING THICKNESS MORE

BURIED PEDIMENT DEEP.
GWP- GOOD. INFILTRATION HIGH RECHARGE FROM TANKS & STREAMS. WEATHERED THICKNESS MORE CONNECTED BY GOOD DRAINAGE NETWORK AND HYDROLOGICAL BODIES. LESS DRAINAGE DENSITY. INFILTRATION & PERMEABILITY GOOD.

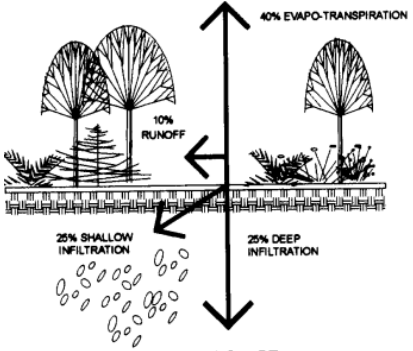
DURICRUST.
GWP- VERY POOR. LESS INFILTRATION.
POOR DRAINAGE FACILITY. INDUCE

PALEOTIDAL FLAT.
GWP- GOOD. INFILTRAT
PERMEABILITY GOOD.
ALMOST PLAIN. LOW LY
SILT, FINE SAND AN

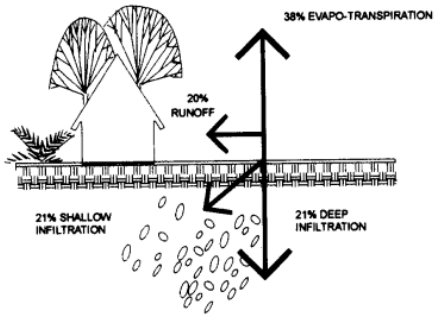
TIDAL FLATS.
GWP- SALINE.
MODERATE.
SILT, FINE SAND
(UNCONSOLI
STRIP OF
CLAY.

URBAN STREAM

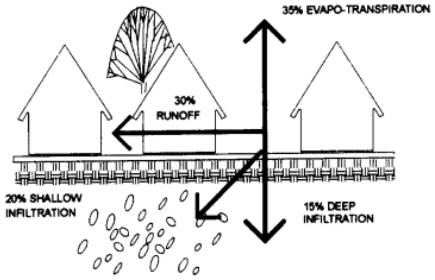
- Impervious surface cover in a region
- characters and quality of urban stream.
- Factors influencing urban stream.
- Morphology of Urban stream.
- Impervious surface cover Vs urban stream, Vs Hyporheic zone



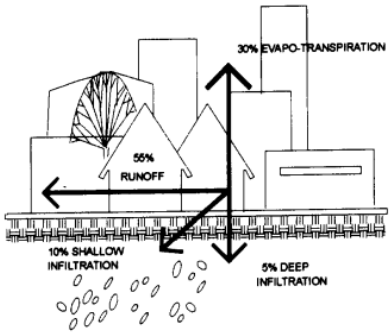
NATURAL GROUND COVER



10-20 % IMPERVIOUS SURFACE



35-50 % IMPERVIOUS SURFACE



75-100 % IMPERVIOUS SURFACE

Impervious Surface Cover (ISC)

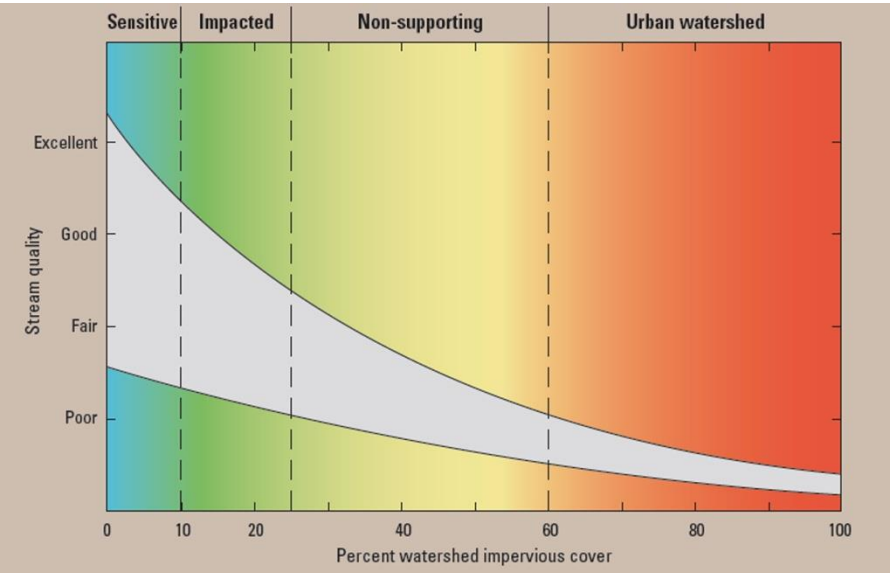
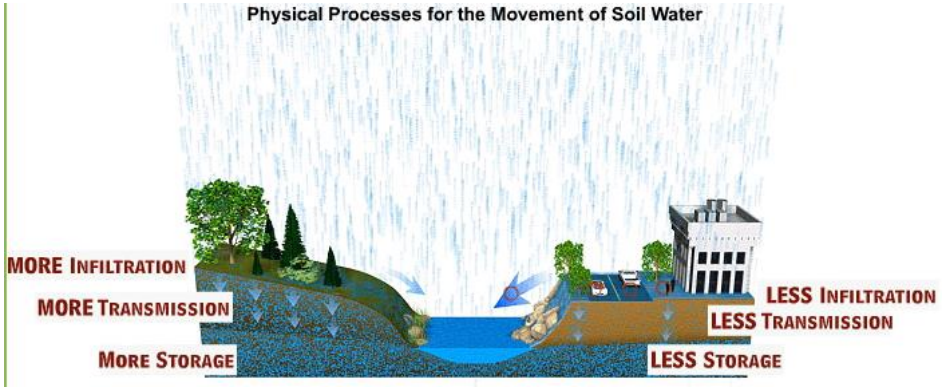
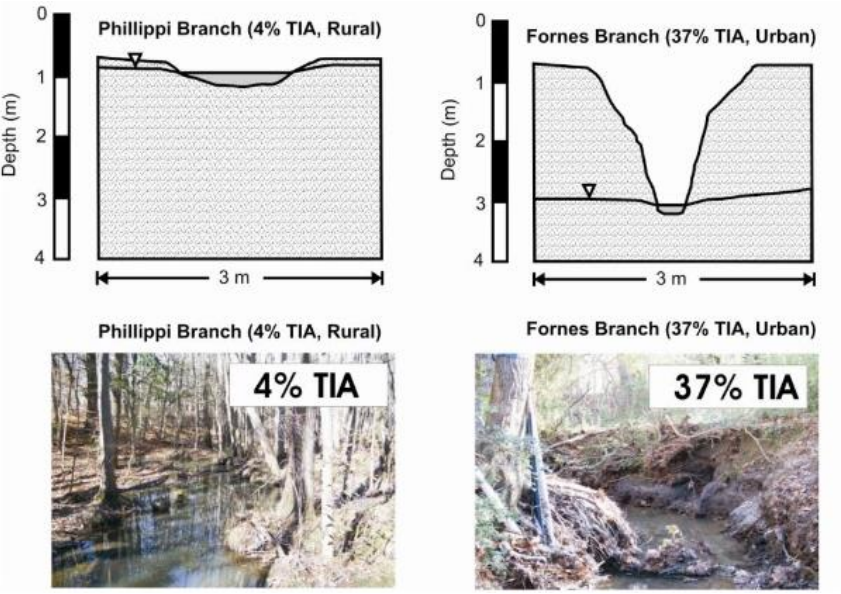


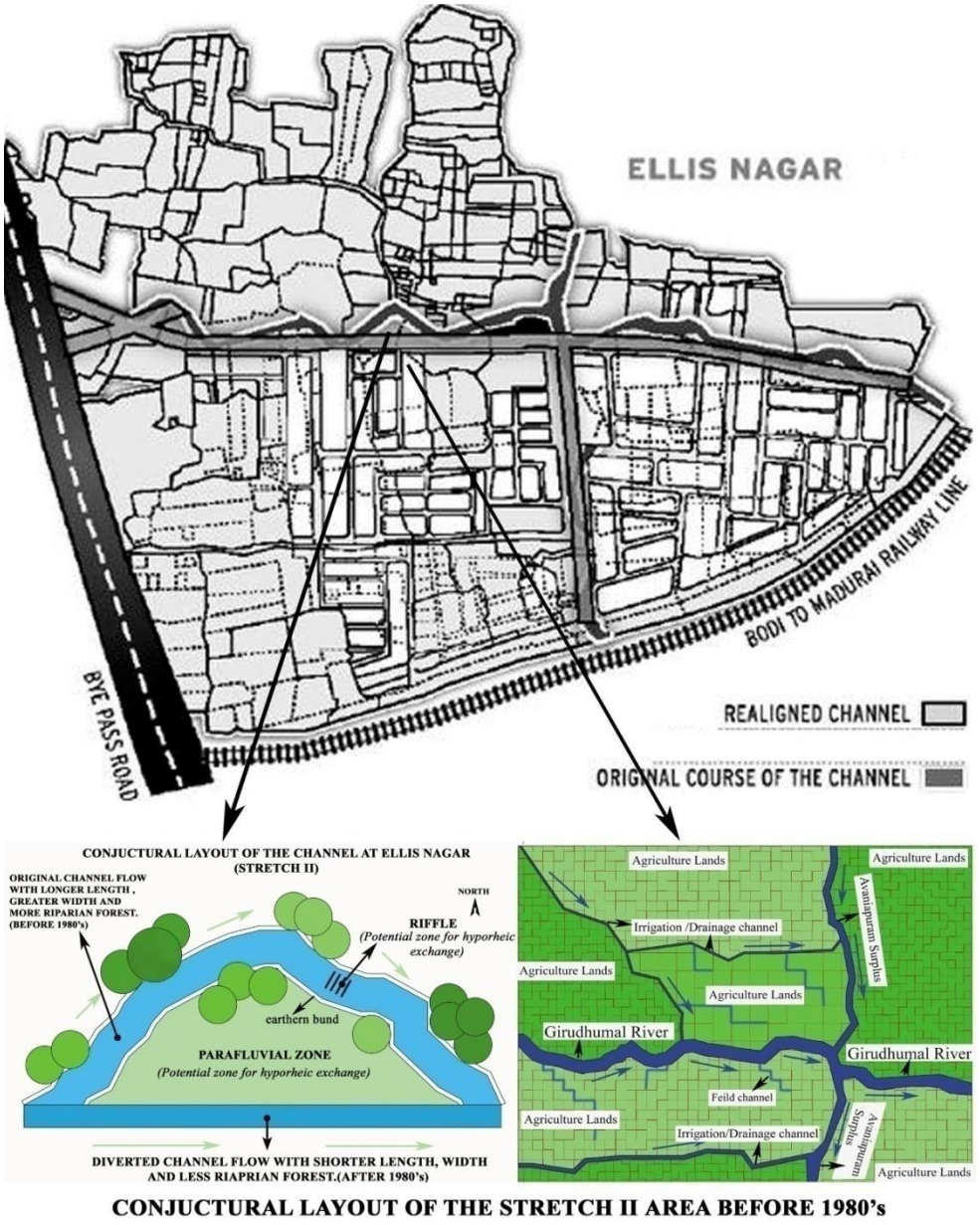
Figure 5–9. A reformulated impervious cover model indicates that adverse effects on stream condition can occur below 10-percent impervious cover and that the degree of effect can vary widely. This variability is due to such factors as predevelopment land cover. (Modified from Schueler and others, 2009.)



Channel Reconfiguration:

- Human intervention leading to channel reconfiguration such as concrete lining, building physical infrastructures like bridges, cause ways etc.
- Effect of straightening the channels
- Upstream down stream character.





Channel Reconfiguration


Google Maps
River
Vaigai River
Vaigai River
262
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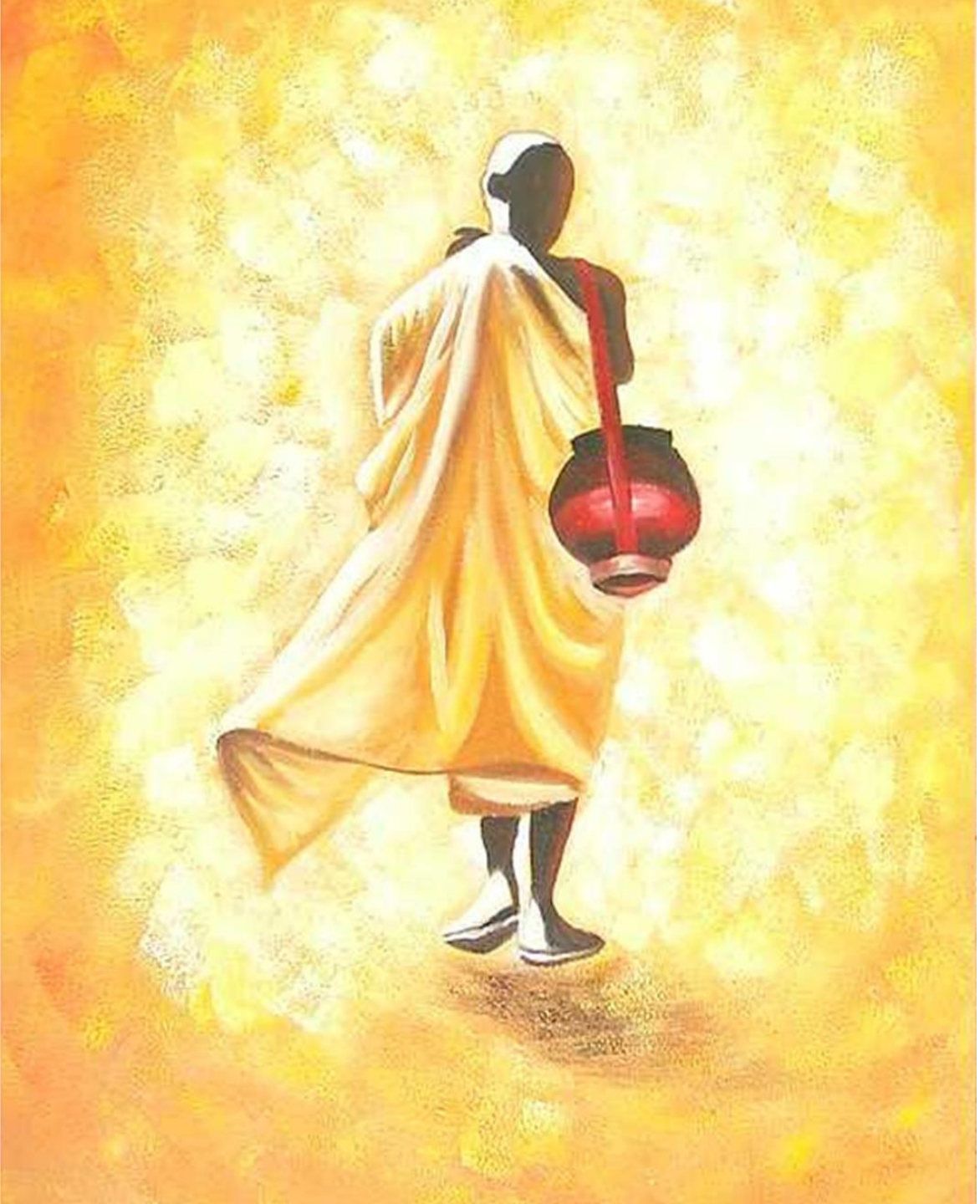

Thank you

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Researcher,

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