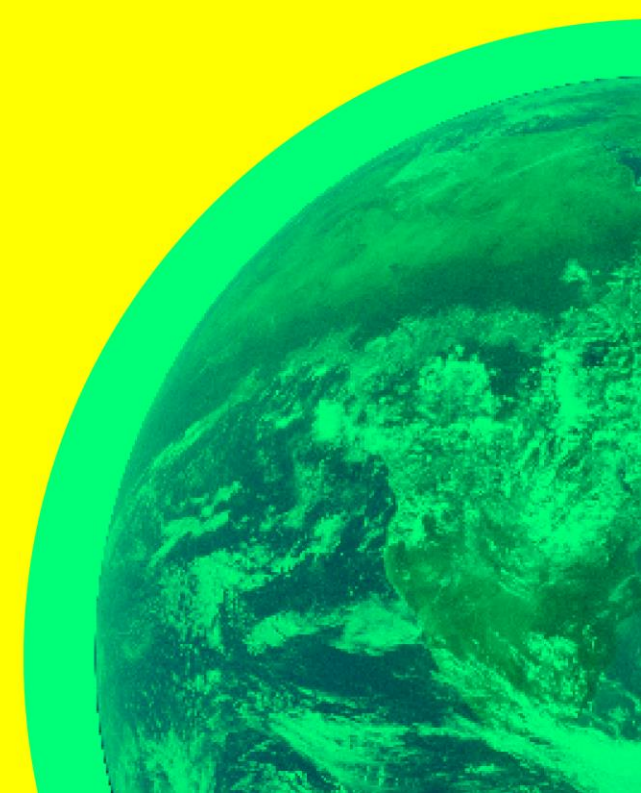# Design of Water Sustainability

Trees in Arid and Semi-Arid Climates

Prof Terence Love, PhD

Industrial Design, University of Tehran, Kish and CEO, Love Services Pty Ltd (Sustainability Consultants)

About

- 40 years consultancy support and research in sustainability projects:

- Food production (Australia, Rwanda, Philippines, Cambodia, Vietnam, Borneo, Kenya, Tanzania, UK)

- Water provision and research for food production in arid and semi-arid regions: Australia, India, Iran, Rwanda, Philippines, Cambodia, Vietnam, Borneo, Kenya, Tanzania.

- Research into aquifer depletion and effects of evapotranspiration.

- Consultant to SRDS India (won the Energy Globe World Award water category for bore-well recharge)

- Economical accommodation for people in temporary housing need (– currently 22 bed spaces)

- Solar power research (Spain, UK, France, Australia)

- Eco-design
  - Aerial planting of pre-germinated tree seed for Sudan
  - Wi-fi controlled remote lighting and energy management

- Low-cost eco-house design and build projects

DESIGN COMMIT
1ST INTERNATIONAL CONFERENCE
ON DESIGN & INDUSTRY · 2024

Environmental differences for arid climates

▶ In arid and semi-arid climates:

  ▶ Planted trees cause aquifer loss, collapse of food production and desertification

  ▶ Vegetable crops are considerably more water efficient than trees

  ▶ Built structures (roofs, walls) are environmentally better than using trees for shade.

  ▶ Airconditioning can offer an environmentally better solution than tree shade

DESIGN COMMIT
1ST INTERNATIONAL CONFERENCE
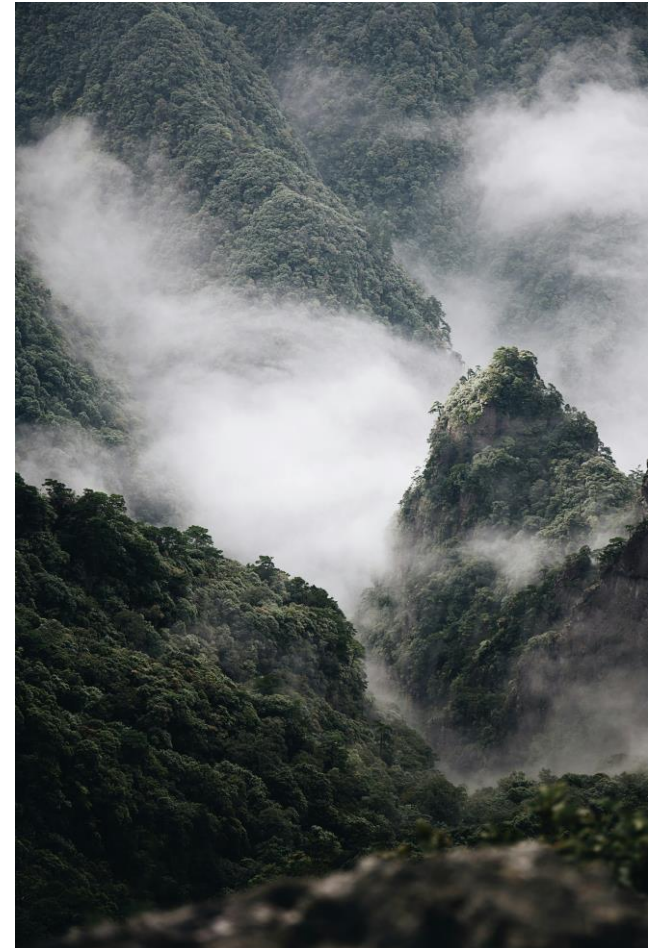ON DESIGN & INDUSTRY · 2024

Water in arid regions

Water availability is typically limited by combinations of:

▸ Low rainfall

▸ High rainfall and even higher evaporation

▸ High rainfall in short periods lost from run off

▸ Limited access to water in streams/rivers, lakes and aquifers
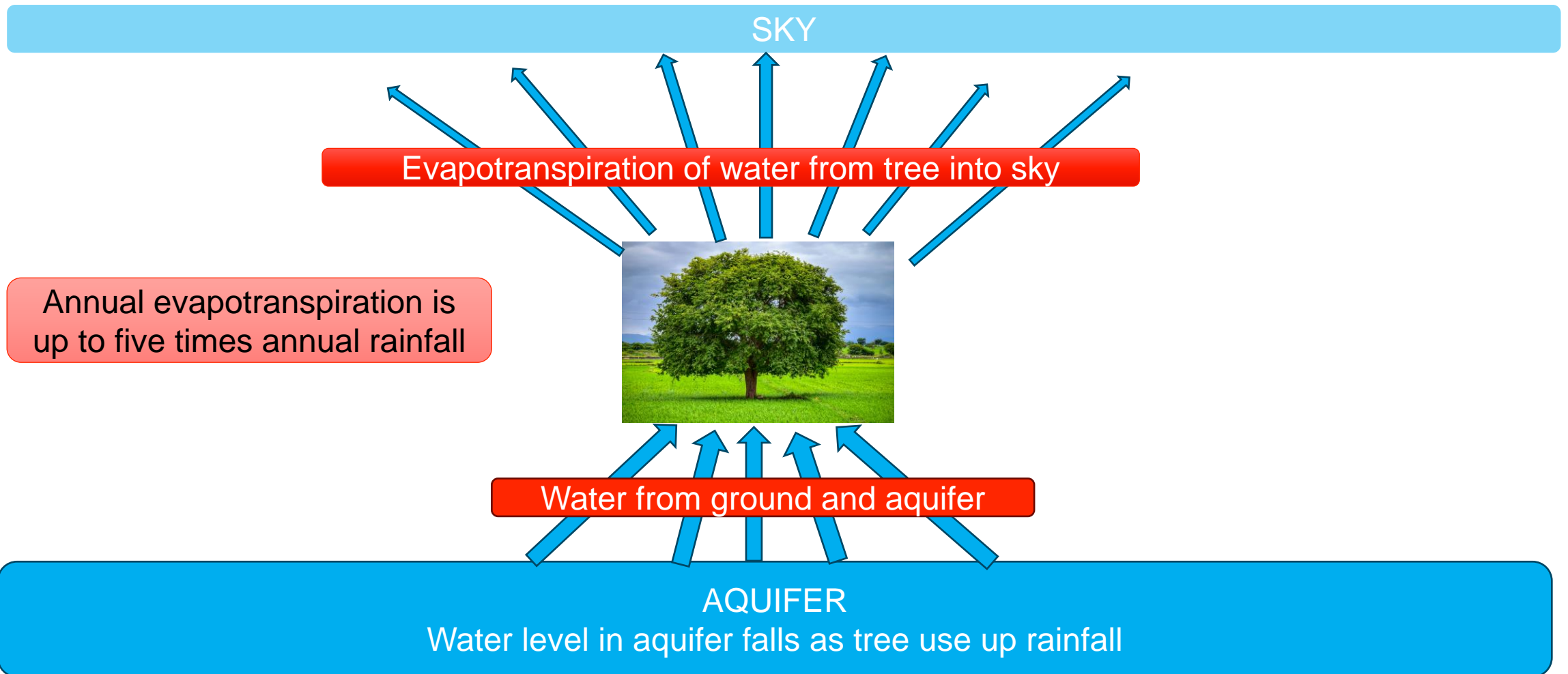
Trees and evapotranspiration

▸ Trees pump water from the ground into the sky from their leaves.

▸ This pumping ground water into the sky is called ***evapotranspiration***

▸ It is like a fountain and is why sitting under a tree feels cooler

▸ Annual evapotranspiration from a tree is typically up to 5 times the amount of rainfall that falls on it.

DESIGN COMMIT
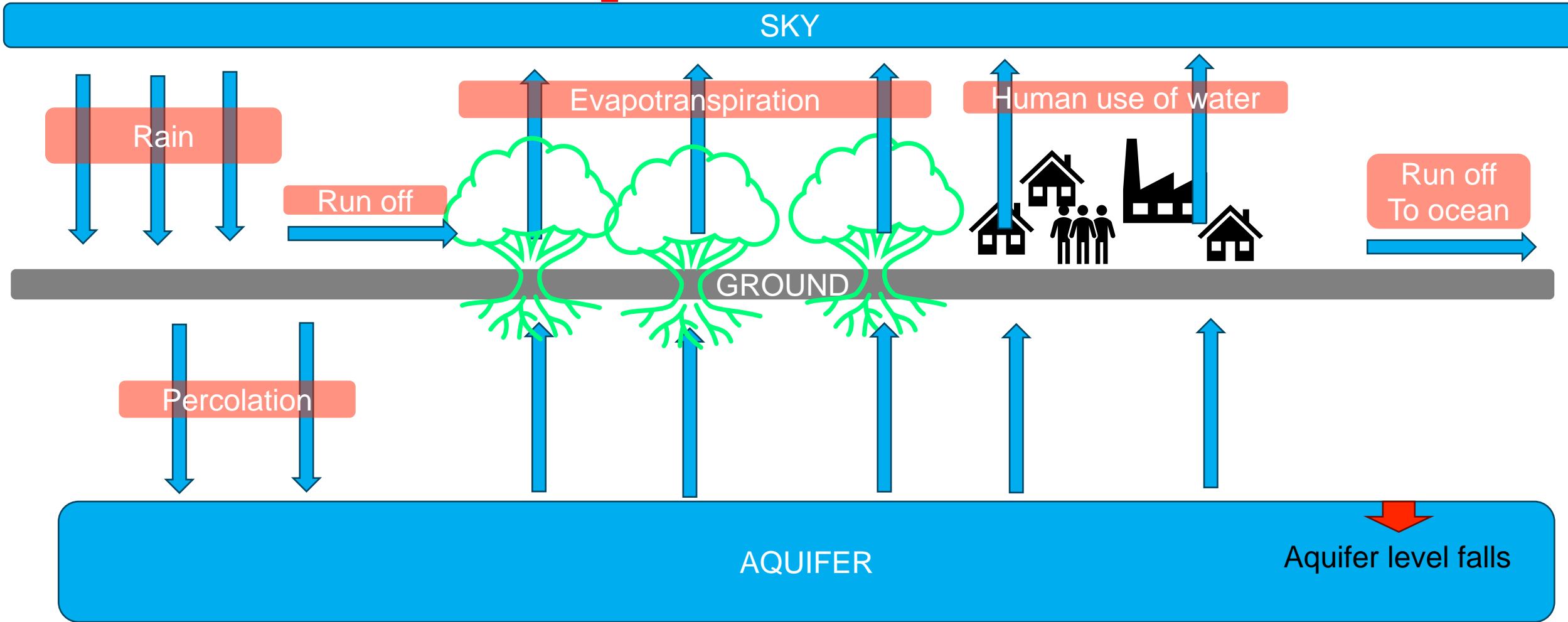1ST INTERNATIONAL CONFERENCE
ON DESIGN & INDUSTRY · 2024

Image: ren-ran-HG5QX-GXV5A-unsplash.jpg

Evapotranspiration

SKY

Evapotranspiration of water from tree into sky

Annual evapotranspiration is up to five times annual rainfall

Water from ground and aquifer

AQUIFER
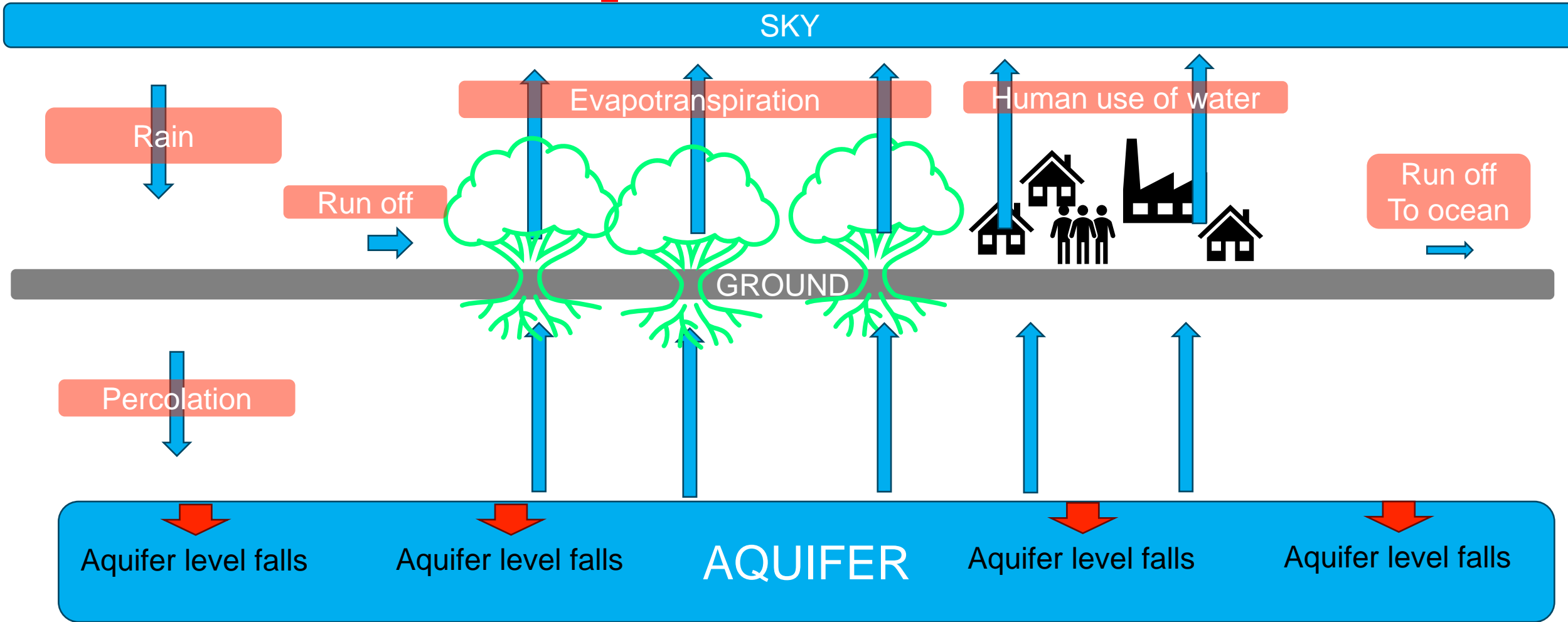Water level in aquifer falls as tree use up rainfall

Importance of aquifers

▸ In arid regions, aquifers are important:

▸ Long term storage of water

▸ Zero evaporative loss if not tapped by vegetation roots

▸ Accessible by bore from anywhere (i.e no water loss from piping)

▸ Large capacity compared to dams and other water storage

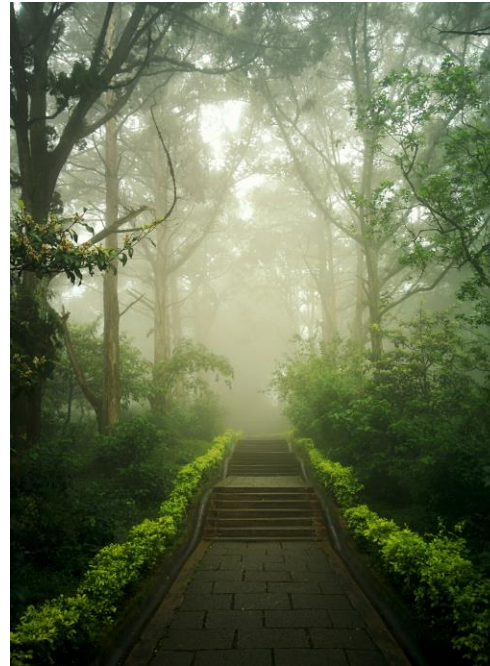▸ Percolation and microbes provide filtration

Water and aquifer flows

SKY

Rain

Evapotranspiration

Human use of water

Run off

Run off
To ocean

GROUND

Percolation

AQUIFER

Aquifer level falls
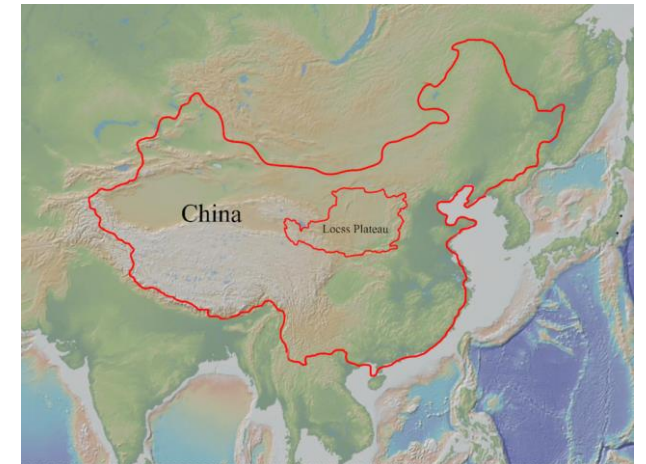
Water and aquifer flows - ARID

Evapotranspiration of water from trees

China – Loess Plateau

▸ 400,000 sqkm of thick wind-erodible sedimentary dust desert

▸ Originally sparse native forests, rivers, streams, wetlands

▸ Billions of trees being planted

▸ Result:
  ▸ Loss of streams and rivers
  ▸ Collapse of native forests
  ▸ Wetland losses
 ▸ Soil desiccation
  ▸ Deep soil water loss

Yazd, Iran

- Low rainfall (<60mm/y), high evaporation, high temperatures, sandy, rocky desert

- Established around 400BC Current population 500,000

- Water supply from underground qanats and aquifers

- Avoids planting trees

- Exception small fruit trees in tall courtyards

DESIGN COMMIT
1ST INTERNATIONAL CONFERENCE
ON DESIGN & INDUSTRY·2024

Portugal Algarve

▸ Algarve until recently self-sufficient in water

▸ Recent expansion of tree-based agriculture

▸ Evapotranspiration seems overlooked

▸ Tree crops (e.g. avocado, fruit, nuts, olives) now use 70% available water in Algarve

▸ Result - collapse of aquifers, water shortages, expensive reservoirs and piping.
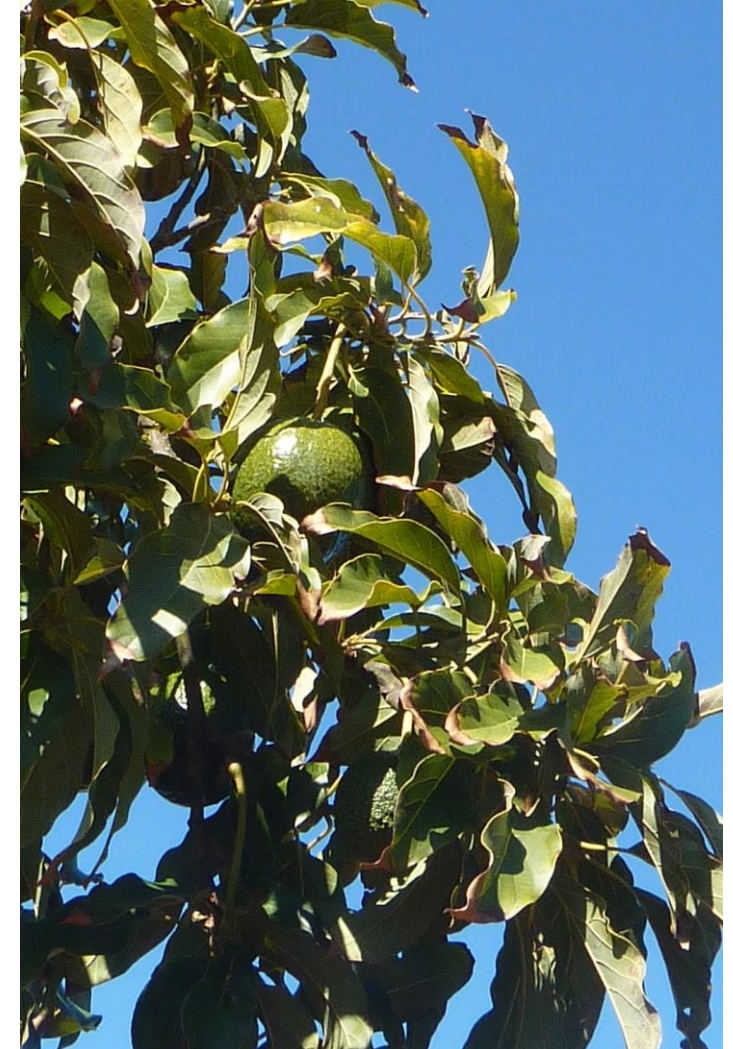
Built form rather than trees for climate control

DESIGN COMMIT
1ST INTERNATIONAL CONFERENCE
ON DESIGN & INDUSTRY · 2024
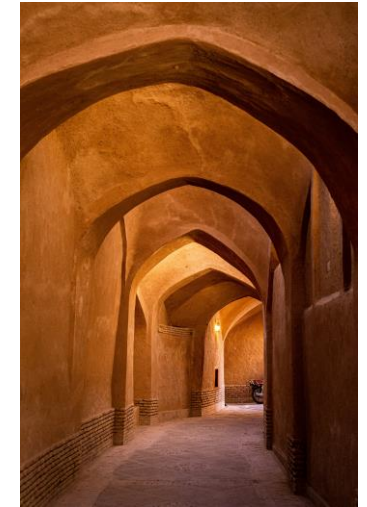
Design Guide: Trees in Arid Areas

▸ Avoid planting trees, including fruit trees

▸ Use aquifers for water storage (avoid using reservoirs)

▸ Courtyard gardens in multi-storey buildings more water efficient

▸ Direct rain to aquifers (percolation, bore-recharge, pits, swales)

▸ Use physical devices (rocks, walls, roofs, courtyards, cellars etc) – avoid using trees as shade

▸ Prioritise vegetables and non-tree food crops – plant over impenetrable layers & with drip irrigation

▸ Use physically constructed breezeways and air management

▸ Avoid creating roof gardens in arid areas

▸ Theories trees increase water by rainfall are false in arid areas

▸ Persuade non-arid areas 100-200km upwind to plant trees to increase local precipitation

Questions and comments?

Contact details:

Prof. Terence Love, PhD
CEO, Love Services Pty Ltd (Sustainability Consultants)
admin@loveservices.org
+61 434975848