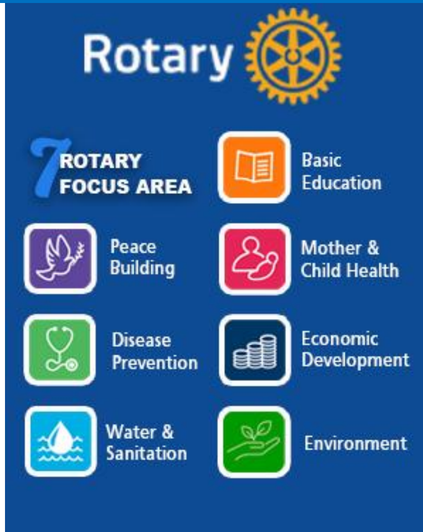
Rotary
District 5100

Rainwater Harvesting - Tips

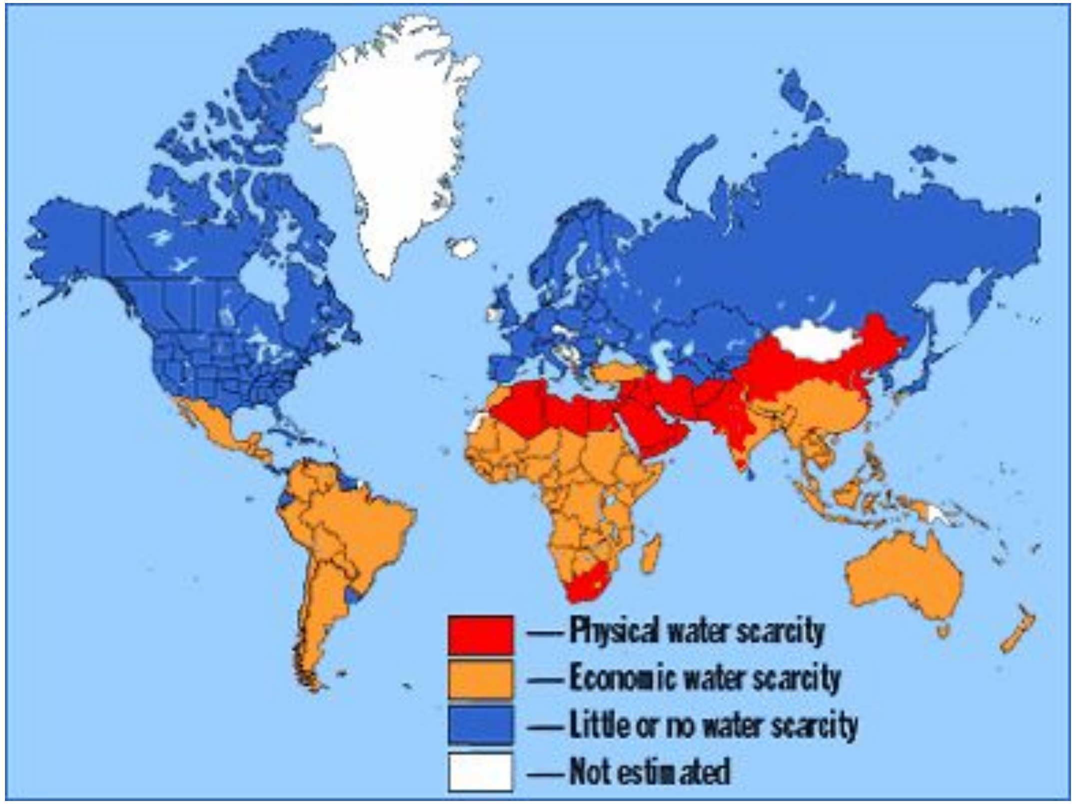
presented by **Stew Martin** (StewMartin2@gmail.com)

RC Seaside, D5100, Cadre, WaSH-RAG, Transform Int'l.

at the Hub in Singapore – RI Convention
on 29 May 2024



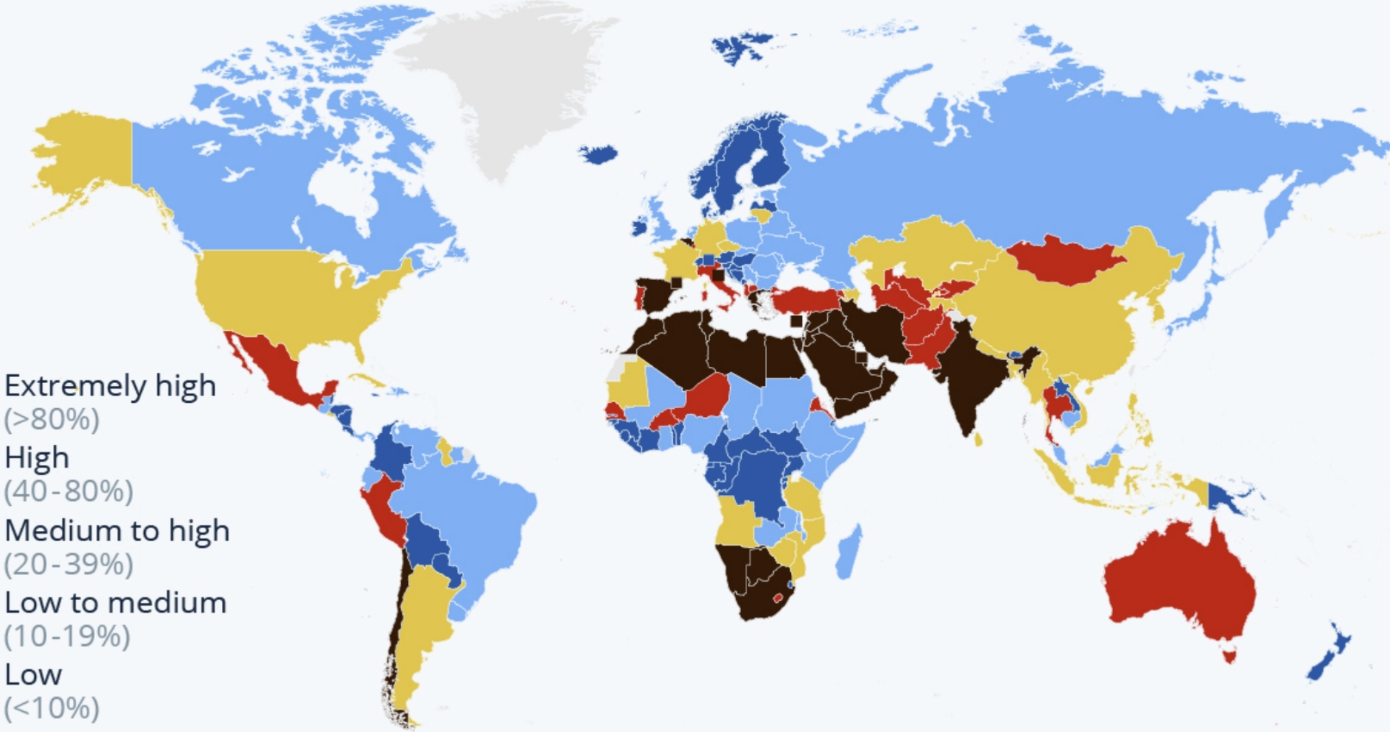
Water Stress is Rising Rainwater Harvesting



Read more on water scarcity:
https://www.un.org/waterforlifedecade/scarcity.shtml

Where Water Stress Will Be Highest by 2050

Projected ratio of human water demand to water availability (water stress level) in 2050*



- Extremely high (>80%)
- High (40-80%)
- Medium to high (20-39%)
- Low to medium (10-19%)
- Low (<10%)

* According to "business as usual" scenario=middle-of-the-road future where temperatures increase by 2.8°C to 4.6°C by 2100

Source: World Resources Institute

Rainwater Harvesting – Cover Today

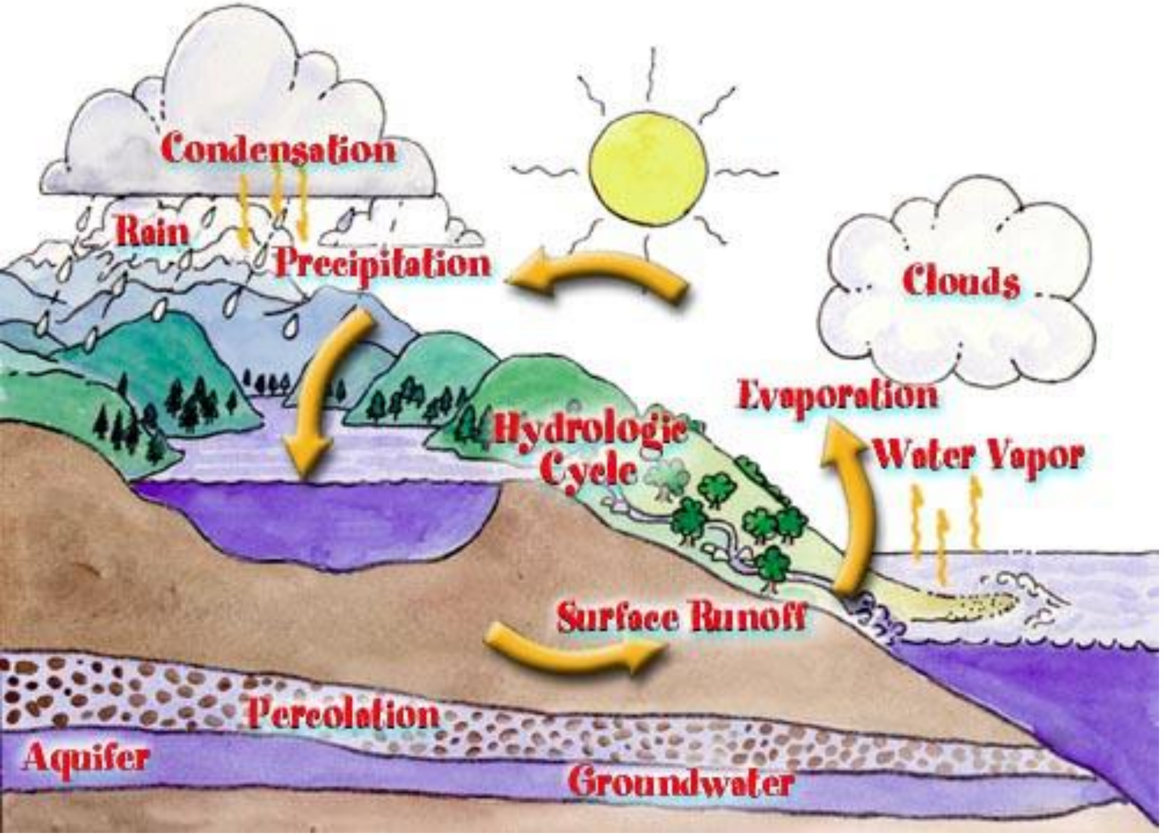
- Truths & Myths around RWH
- Geography matters
- Law & Policies
- Water Demand, Distance & Appropriate Sizing
- Why RWH? Other sources
  - Appropriate & Affordable?
  - Cultural Context & Fit?
- RWH System - Components
- Costs & Methods
- Water Quality
- Implementation … Training
- Examples (Kenya & Indonesia)
- Your experiences? Q&A?
- Additional Reading
- A.I.

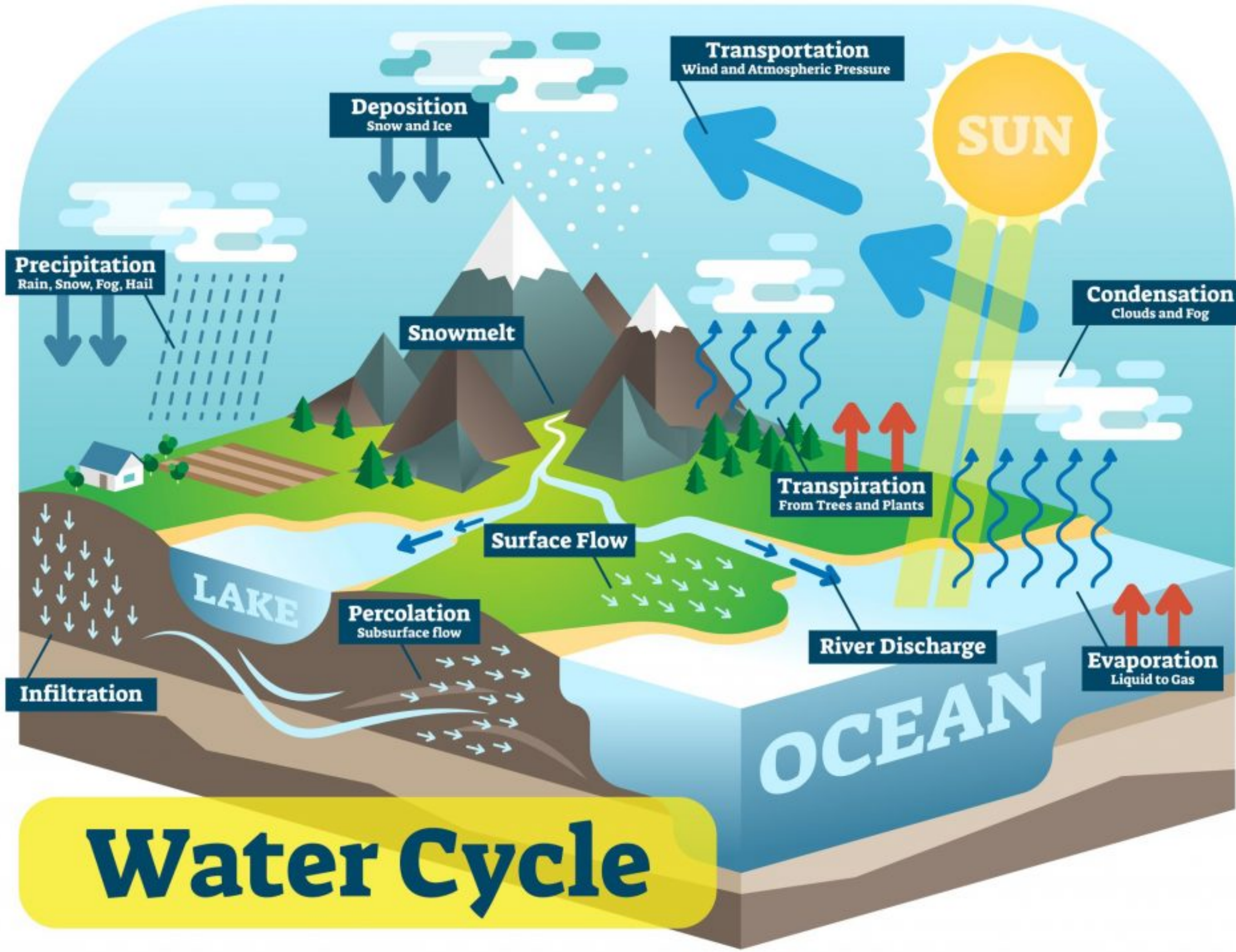
Rainwater Harvesting – Truths & Myths

True or Myth?

1. Rain water is free (natural, s/be freely available)
2. Rain water is healthy, safe to drink
3. Rainwater harvesting is a *cool new idea*
4. RWH is the best sole water source
5. Others?

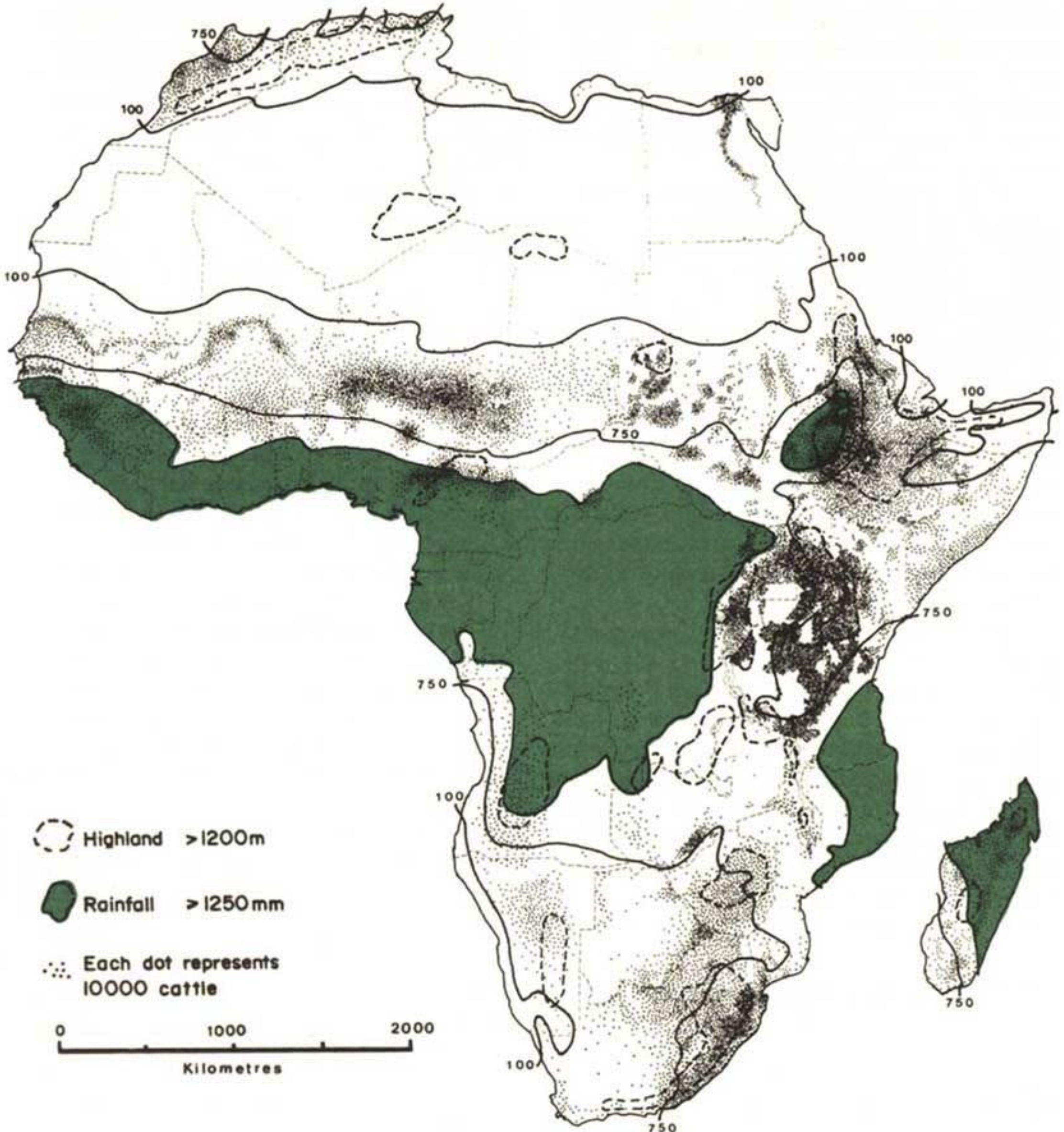
Rainwater Harvesting – the Cycles

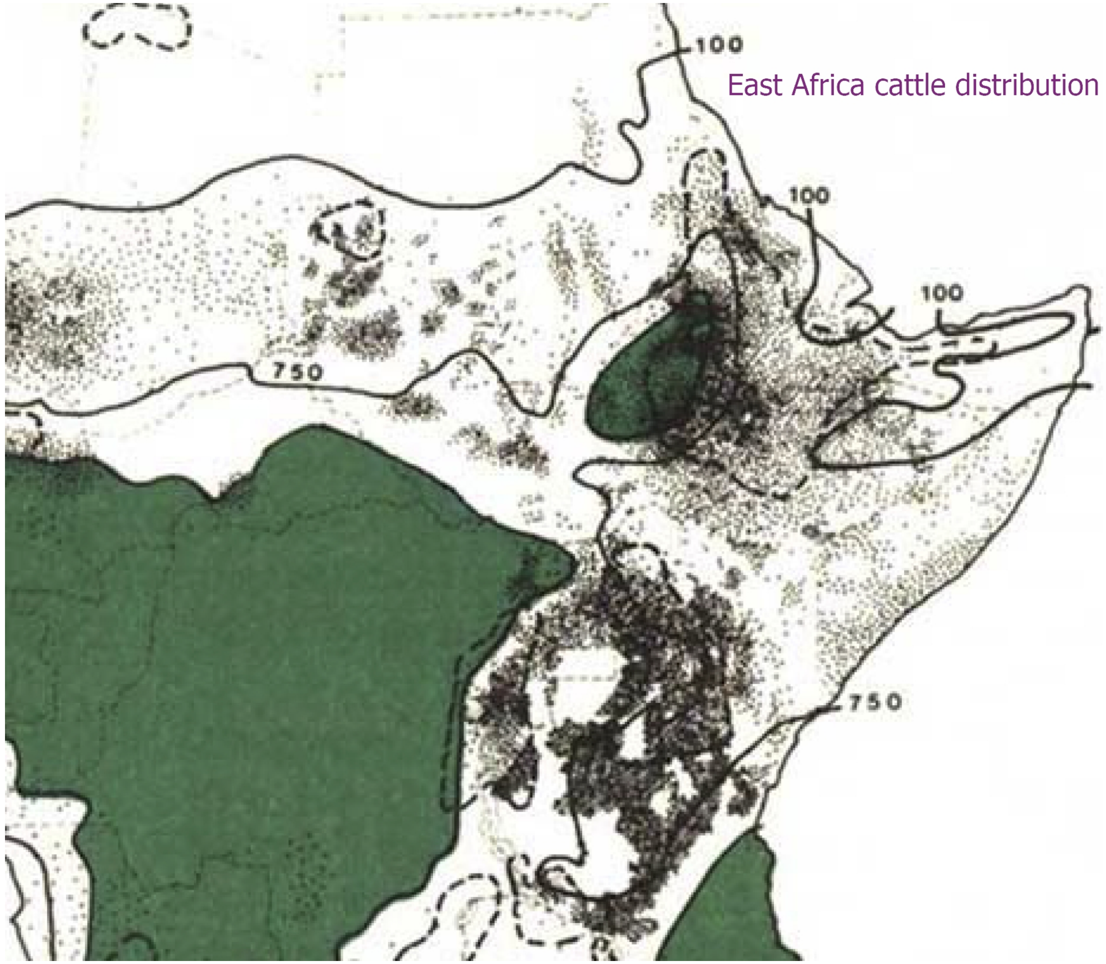




Rain relates to Surface and Groundwater

Rainwater Harvesting – Available Where Animals Are?

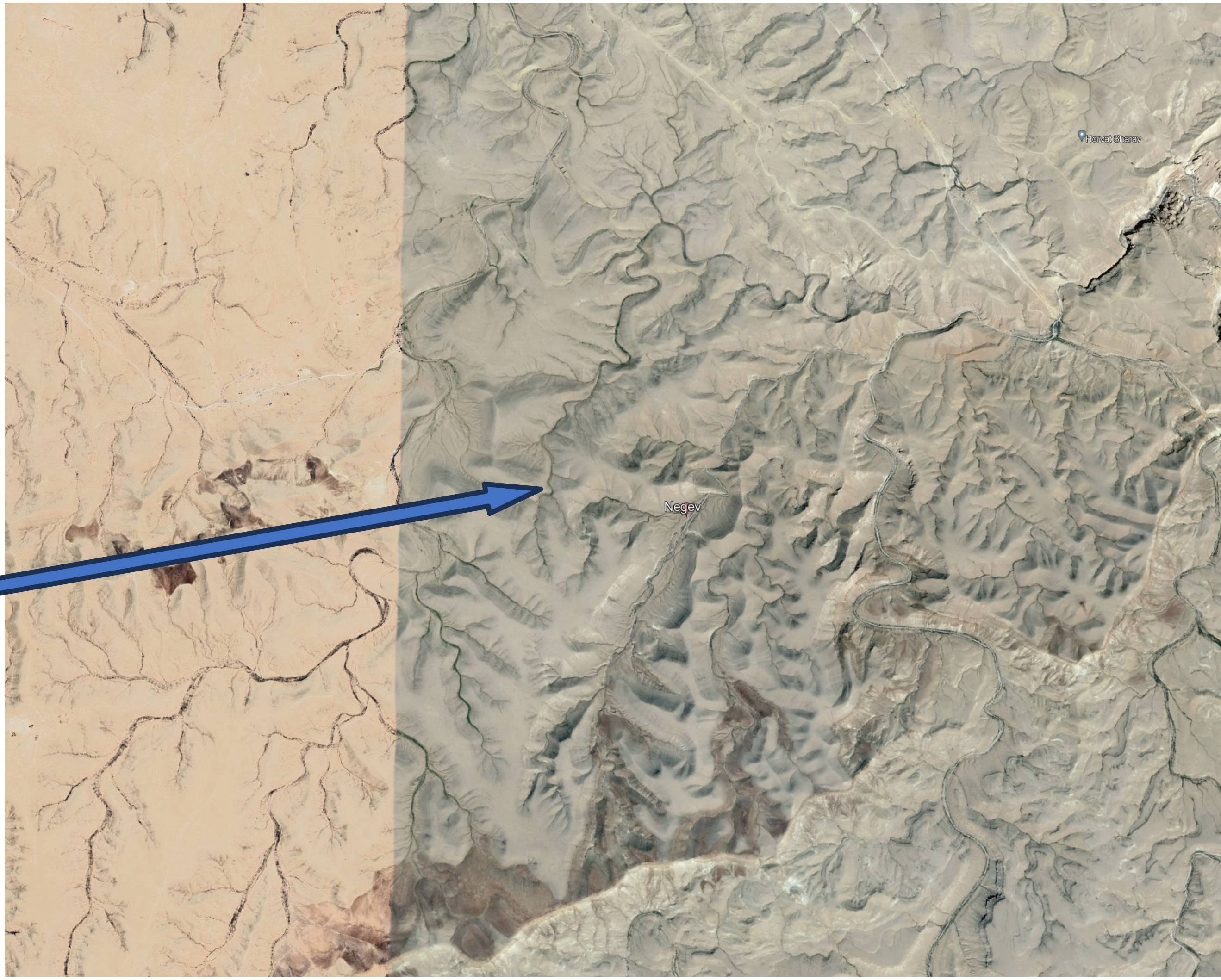




Rainwater Harvesting – Available Where??

Rainwater & Moisture Collection in Deserts

e.g. Resafa (Syria) and Negev desert (Israel) – 2-4000 years



Country Rules, Policies, Initiatives – Check It Out

Country laws, rules & practices – know them.

- **Kenya:**
- 5 year program to increase storage.
- Min. recommended available water / capita / year for basic personal use is 600m3 (600,000 L/pp/yr)

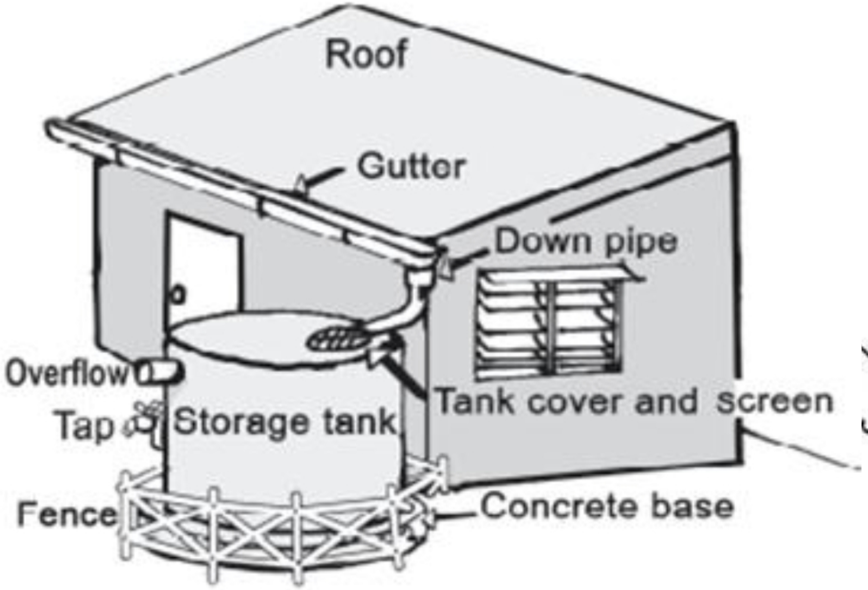
- **USA (CDC):**
- Recommends RW not to drink, cook, brush teeth, or use in edible garden.
- OK for lawns, cleaning cars & bikes, etc.

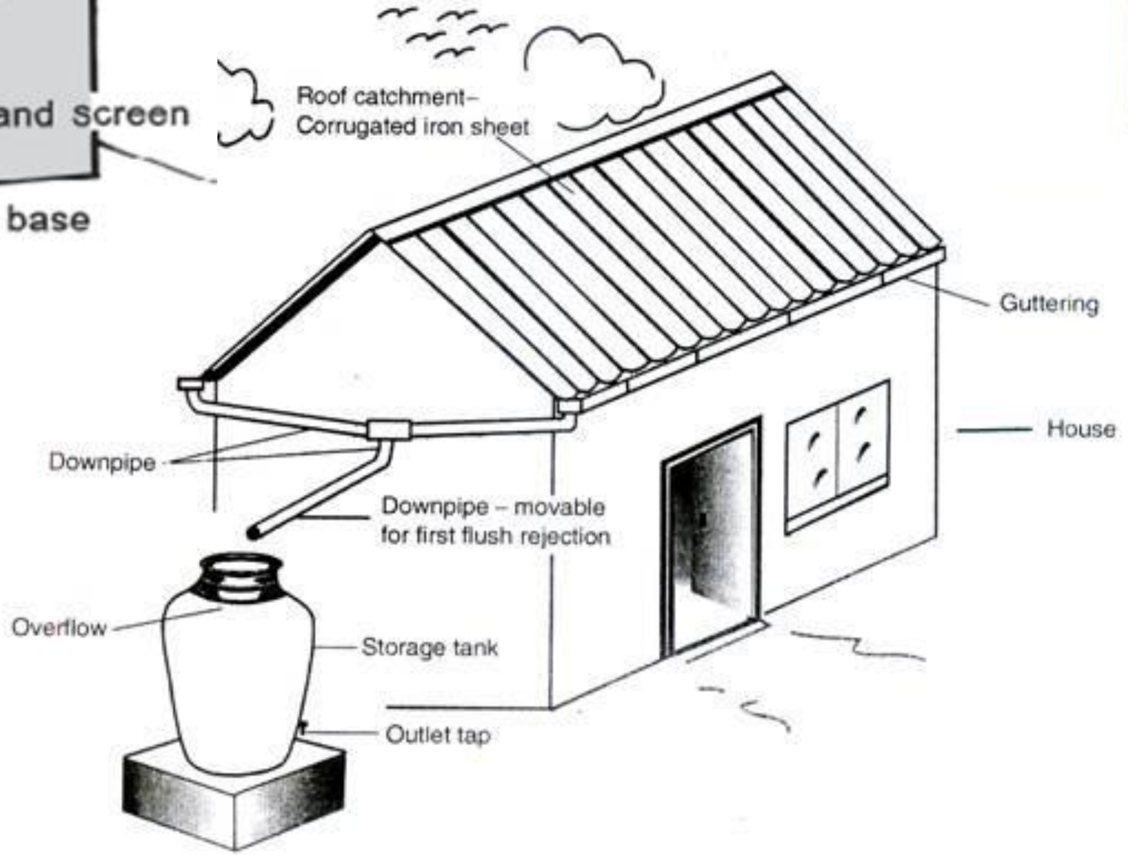
- **USA (States)**
- Until 2010 it was illegal in Utah to collect rainwater. Now you can collect 100 gals.
- If register, collect up to 2500 gals. Estimated 15-23,000 gals (55-80K Liters) falls on typ. house in SLC

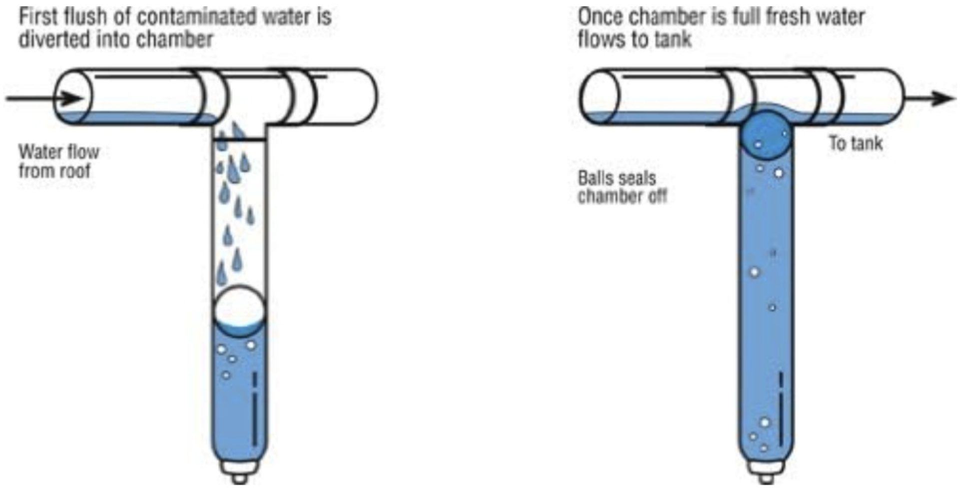
RWH System - Essential Components

- **Catchment Surface**: Area collecting, usually roof or large surface
- **Gutters and Downspouts**: Channels rainwater from catchment to storage or filter
- **First Flush Diverter:** Diverts initial contaminated flow away from storage (empty it)
- **Leaf Screens and Mesh Filters:** Prevents leaves, debris from entering
- **Storage Tanks or Cisterns:** various sizes and materials
- **Delivery System:** Pipes, pumps, and taps - deliver to where needed
- **Filtration and Purification:** Filter, UV disinfection, chlorination (potable use or not?)
- **Overflow System:** Excess water channel away, prevents flooding (w.table recharge?)
- **Water Level Indicator:** Monitoring stored water level
- **Backup Supply:** Alternate water source (well, municipal, purchase)

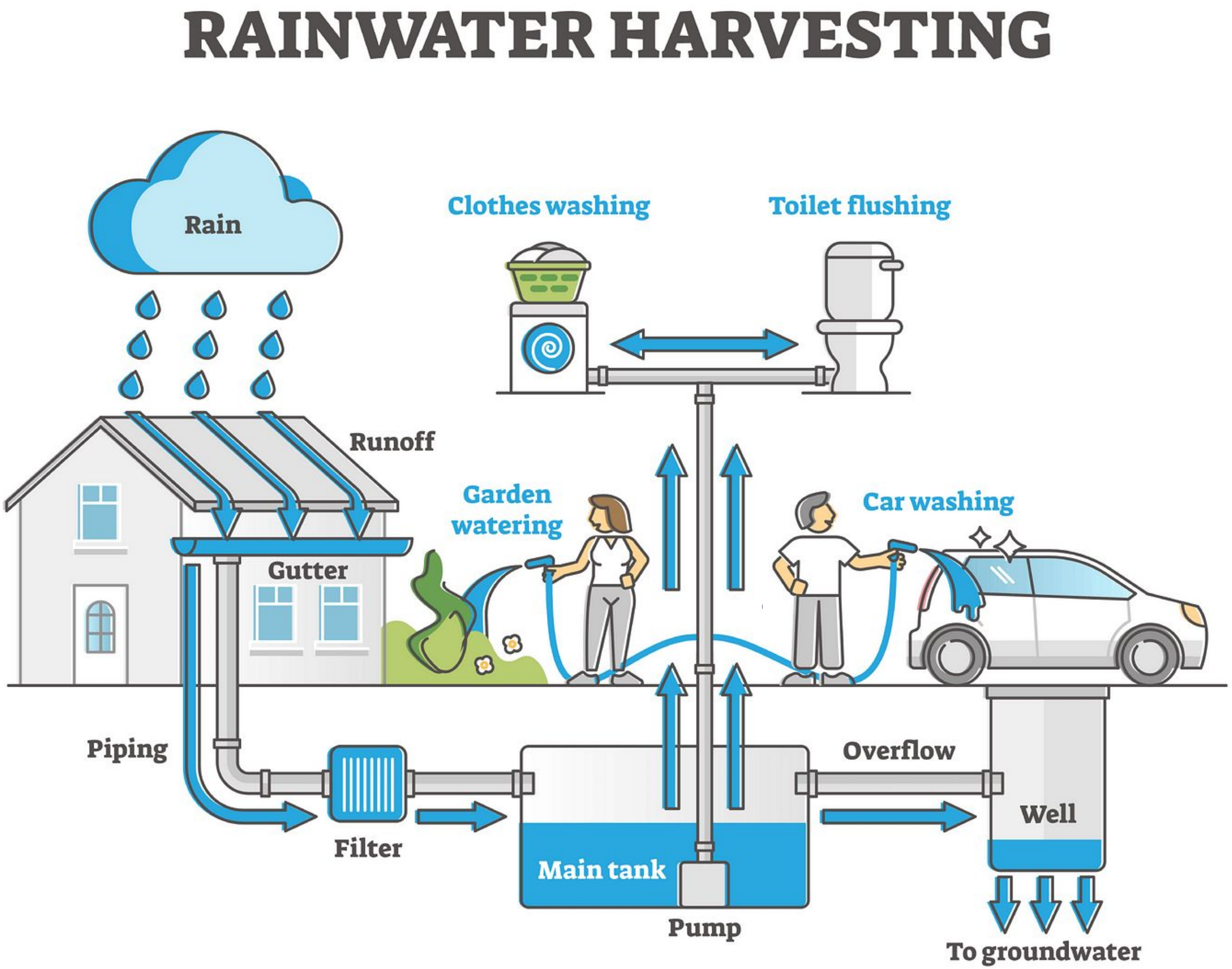
First Flush Diverter - a common Omission or Mistake







Developed Countries - Limited Uses (protecting public)



RWH Free? Cheap? - Sample Capital Costs

Example Component Costs:

- Catchment Surface (Roof Modification): Many rural homes already have roofs, but modification might be necessary. Estimated Cost: $100 - $500
- Gutters and Downspouts: Channels and pipes to direct water from the catchment surface to the storage tank. Estimated Cost: $50 - $150
- First Flush Diverter: Diverts initial runoff reducing contaminants from entering storage. Estimated Cost: $30 - $100
- Leaf Screens and Mesh Filters: Prevents leaves and debris from clogging the system. Estimated Cost: $20 - $50
- Storage Tank: The main container for storing collected rainwater, typically a plastic or masonry tank. Estimated Cost: $400 - $1,500 (for one)
- Delivery System: Pipes, pumps (if necessary), and taps for distribution of water. Estimated Cost: $50 - $200
- Filtration and Purification: Filters and/or purification units to ensure water quality. Estimated Cost: $50 - $200
- Overflow System: Additional pipes or channels to divert excess water away. Estimated Cost: $20 - $50
- Water Level Indicator: A simple float-based indicator or gauge to monitor water levels. Estimated Cost: $10 - $30
- Maintenance and Monitoring Tools: Basic tools and supplies for maintaining the system. Estimated Cost: $20 - $50
- Labor Costs: Installation and setup costs for skilled workers. Estimated Cost: $100 - $300
- **Estimated total cost**: For a rainwater harvesting system in rural Kenya, the estimated total cost ranges from approximately $850 to $3,130, depending on size, materials, specific requirements of the system. This estimate considers variations in the availability and cost of materials, as well as labor expenses.

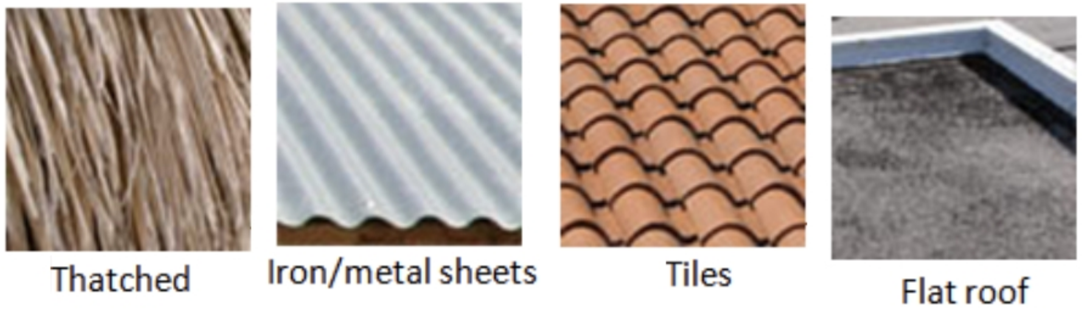
Water Treatment & Materials - Options

Water Quality (Potable) - Treatment Options:

- Microfiber filter (ultra filtration)
- Chlorine (powder--> solution, or salt generator?)
- Biosand filter (BSF)
- UV (ultraviolet light)
- Not recommend SODIS (questionable purification, not drink more micro- & nano-plastics)

Materials choices – avoid:

- leaded paint
- poor roofs (dirty, rusty, or peeling paint or plastic)
- thatched or organic or asphalt roofs
- gutters w/ mildew or mushrooms *(fix gutter leaks)*



RWH – Case Studies

Case Studies (large to small):

- Masai Mara, Kenya - large collection, metal roof & ferro-cement tank - storage & community use below
  - The Maa Trust

- Schools RWH Kisii region, Kenya - both for drinking (to filers) and handwashing at toilets
  - Aqua Clara Kenya

- Kali Ngara village, Sumba, Indonesia - 3-5 HH shared tank, 5000L, local coral/block hand-built w machete

- Consider: ISSB compressed earth-cement blocks, radiused to make RWH tank
  - Friendly Water for the World

RWH –Kenya - Interlocking Stabilised Soil Blocks

RWH – Scale – Masai Mara, The Maa Trust

Features:

- ISSB blocks □ large water tanks
- Metal frame, corrug. galv. steel roof
- Storage & business stalls underneath
- Economy of scale + kiosk delivery

Concerns:

- Some long walks, home & back
- Some still take surface water
- Animals roam under roof
- Villagers don’t fully understand germs

RWH – Schools & HCFs in Kisii region Kenya - ACK

Features:

- Local supplies (tanks, gutter, pipe)
- Long-ish rainy season, good quantity
- 26 schools + 50 HCFs in one GG; highly efficient use of Rotary funds
- Central training + school visits

Concerns:

- Teachers transferred, materials lost
- Lack of WaSH budget
- Some head teachers lack motivation
- Low “ownership” & follow-through
- Insufficient MERL

RWH – Kali Ngara, Sumba, Indonesia - YHS

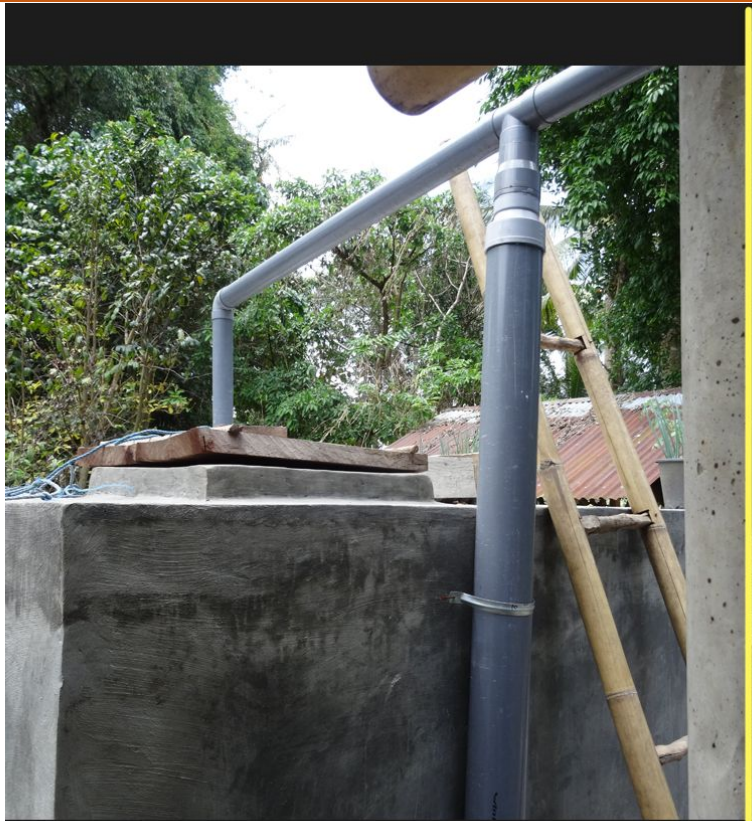
Features:

- Local stone, hand-built by villagers
- 5000 L size allows shared HH, truck delivery
- They built, they can repair – sustainable!
- Schools have large roofs, often OK

Concerns:

- Not used to plastic (gutter, pipe)
- Broken? Use machete & bamboo (known tech)
- Not use screens, filters – raw RW
- Low education (3rd grade), low capacity to learn, change, improve

RWH – Kali Ngara, Sumba, Indonesia - YHS



Daily Use – Behaviors – Sustainability

- **Assess the culture** – are people curious? Willing to learn? *(this List holds some "Seeds of Failure")*
  - Will they do daily tasks - if not, explain "can't do" RWH system
  - Stress importance of full maintenance - or unsafe water, illness, absenteeism, lost income etc.
- **Frequent Tasks:**
  - Empty First Flush after every rain (so ready to receive next "flush")
  - Clean leaves, debris from screen
  - Check gutters, connections, repair leaks or separations (if not you, will hire a "plumber"?)
  - Keep lid on, locked
  - Water Quality - backwash fiber filter, check free CL2 levels – if "off" must act now
- Other Tasks:
  - Inspect tank opening
  - Inspect water in clear clean glass - are there particles? Algae? Odor?
  - Look for animal intrusions - birds, frogs, mice, insects etc.
  - Take Samples, Water tests 1-4x a year (both organic & mineral; in future PFAS/nanoplastics?)
  - Sanitize tank - once a year?

Longer Term Sustainability:

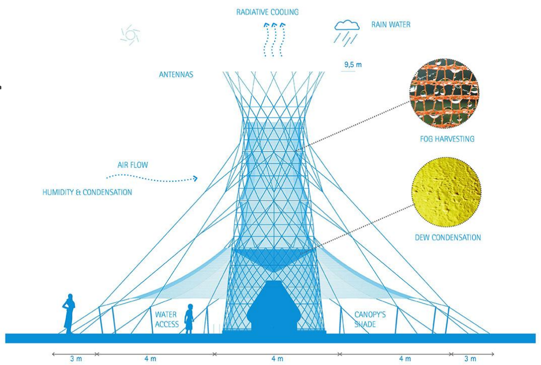
- Document system, maintenance, training - refer to it - keep Institutional (or household) knowledge alive
- Sinking fund: set aside funds every week (for repair, replacement, upgrades - can buy a new system if needed?)

Other Water Collection Methods (Less Typical Pg 1)

- Solar-powered water harvester
  - This device has two parts: an energy unit that uses solar panels to store and draw power, and a water maker that uses the energy to cool a metal plate. When the plate is cool enough, humidity in the air condenses on it, forming water droplets that drip into a collection area. The water can be used for drinking or agriculture.
- Metal-organic framework (MOF) water harvester
  - This device uses a MOF material that's exposed to the air to extract water at night and collect it during the day when exposed to sunlight. In August 2022, a MOF water harvester in Death Valley collected 114–210 grams of water per kilogram of MOF per day.
- Gel film
  - A low-cost gel film made from common materials can extract water from the air in dry climates. In areas with less than 15% relative humidity, one kilogram of the film can produce more than 6 liters of water per day.
- Konjac gum and salt
  - Konjac gum is a powder made from an Asian root vegetable that absorbs moisture when combined with salt. The open pores in the gum help expose it to air.
- Moth
  - A small, handheld device with a container and two grams of moth can collect water from the air. At night, the moth is exposed to the air, and water from the air goes into the moth. During the day, the container is closed and exposed to sunlight, and the interior heats up, causing water droplets to form.

Other Water Collection Methods (Less Typical Pg 2)

- Fog collectors
  - These structures look like tall volleyball nets and are made of a mesh that traps water droplets from fog. The water drips into a gutter and is channeled to a water tank. Fog collectors are best suited for arid and rural areas at high elevations.
- Atmospheric water generators (AWGs)
  - These machines use condensation to produce potable water from the air. They can produce up to 300 gallons of water per day and can have filters to increase purity and add nutrients.
- Sheet metal or Plastic drape
  - Farmers can hang sheet metal vertically over a collection trough to collect water from the air. The metal cools down at night and water vapor condenses on it, running down into the trough. A plastic sheet weighted in middle can trap water from soil.
- Moss
  - Moss leaves in arid lands have microscopic grooves and barbs on their white hair-like projections called awns that act as water pumps to collect water from humid air.
- Warka Water towers
  - These towers have an inner mesh that collects water by condensation, which is stored in a reservoir. Each tower can provide 100 liters water per day.



Resources & Frameworks

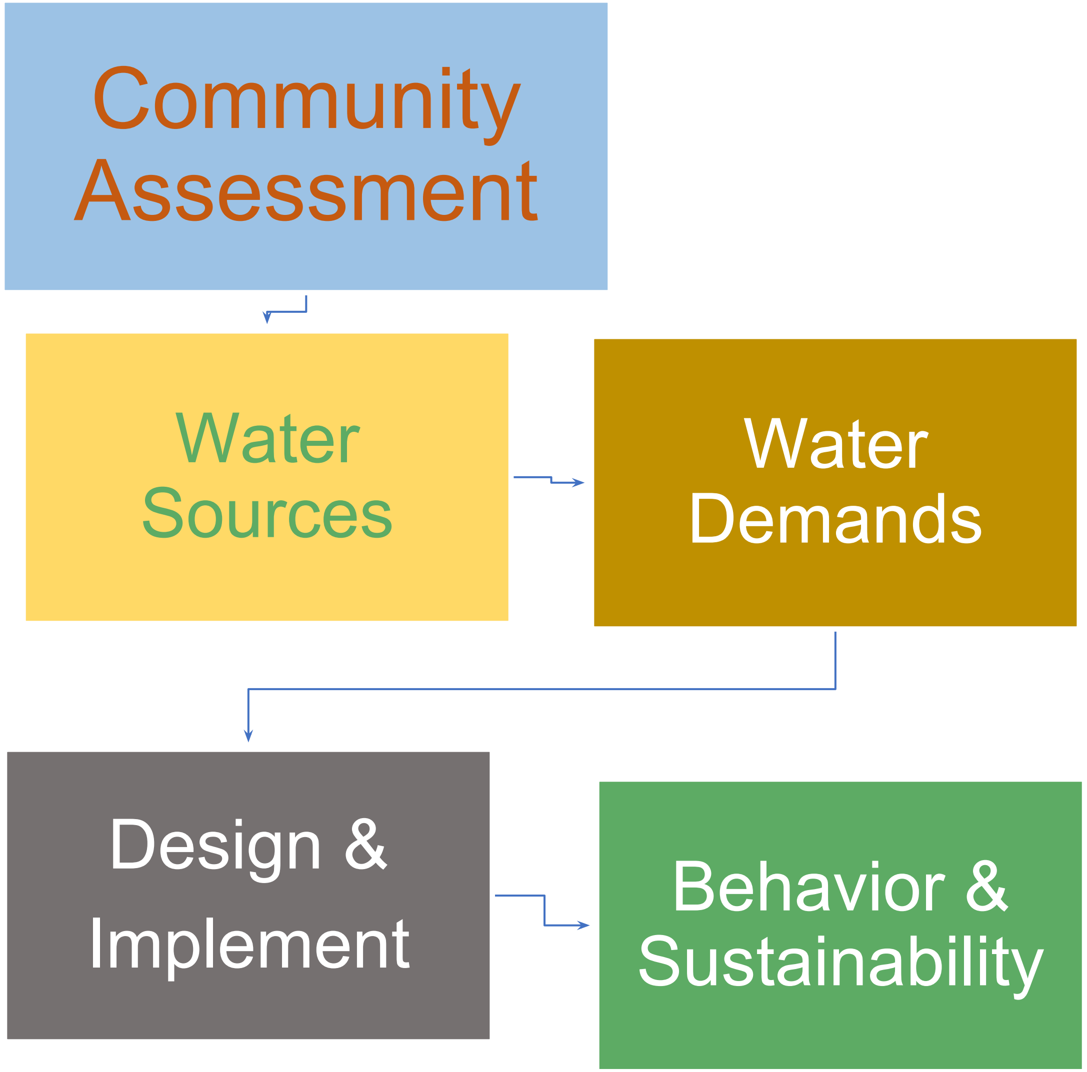
Rainwater Harvesting – Additional Reading
Prepared by Stew Martin, WaSH Rotarian, D5100, Cadre, WaSH-RAG 28May2024

To deepen understanding of RWH -- knowledgeable organizations, key websites and documents:

Organizations

1. **International Rainwater Harvesting Alliance (IRHA)**:
   - **Focus**: Promoting rainwater harvesting and management globally. **Website**: IRHA
2. **Rainwater Harvesting Association of Australia (RHAA)**:
   - **Focus**: Advocacy and information sharing on rainwater harvesting in Australia. **Website**: RHAA
3. **American Rainwater Catchment Systems Association (ARCSA)**:
   - **Focus**: Providing resources & information on rainwater harvesting in the United States. **Website**: ARCSA

See full Resource list: *https://drive.google.com/drive/folders/1E0APdd2VuuM5rjsbYdMZiVFaD7Ot6poD?usp=sharing*



Questions?

Other Solutions?

Role of A.I. In your Work?

(and Life)

Scale and Calculations

Scale & Calculations:

- RWH s/be at household (HH) ⍰ can be large scale, clusters of HH, or at each HH
  - efficient infrastructure + reduced maintenance vs. distance to walk
- people calcs: daily need pp x ppl x # days/mo. .... compare to rainfall, roof/collection area, %
- animal usage: type x # x qty/day = animal need

Formulae, spreadsheets, websites (many):

- Simple: Roof Area (m2) (x pitch) X Precip. Amount (mm) = Amount Collected (liters)

100m2 x1.05 x 1000mm/yr = 100,000 Ltrs/yr or 100m2 x1.05 x 100mm/mo. = 10,000 Ltrs/mo. or 300/day

- Be conservative; imagine changing weather, dry spells *(5 yr to 100 yr events)*

Water Demand - Quantity of Water

- **People:** UNICEF/WHO 40+ L / day plus animals (water-stressed environs, 10-20 L/day is acceptable)

- **Animals:** *Daily drinking water requirement in Liters/day:*

Animal	Water Required	Range of consumption
Dairy cow	80	60-96
Cow-calf pair	60	46-78
Yearling cattle	40	24-54
Horse	40	30-54
Sheep	8	7-11

Source: OSU Extension (Oregon USA)

Species	Weight (kg)	Mean	Theoretical max	Practical guide
Goat	30	2.0	5.4	5
Sheep	35	1.9	5.2	5
Zebu bovine	350	16.4	56.1	25
Camel	500	18.4	34.0	30 (est.)

Source: Barrett and Larkin (1974); Classen (1977); King (1979)

Scale & Calculation Examples

Examples:

- Water Demand: Per capita water usage in rural areas often around 50 liters per person per day (LPD). Family of 6, that's 300 LPD (50 x 6). Add for domestic animals, another 100 LPD, totaling 400 LPD.
- Annual Water Usage: Assume they need water 365 days, family may require 146,000 liters per year (400 x 365).
- Rainfall Period and Collection Efficiency: If it rains 5 months (150 days), storage system to hold enough for the five dry months... 2190 liters/day over 150 days or approximately 328,500 liters.
- Rainfall Intensity: Assuming the region receives moderate rainfall (e.g., 50 cm during the rainy season), and a collection efficiency of 80%, the amount of water collected would be:
- Catchment Area: approximately 215,000 square meters to collect enough during the rainy season, to last the dry
- Storage Capacity: A storage system with a capacity of about 86,000 liters would be needed to supply the family through the dry months.

If we adjust personal usage to 10 LPD, other figures the same, we get:

- Catchment Area: The required catchment area 86,000 square meters (100m x 86m)
- Storage Capacity: approximately 34,400 liters (7 x 5,000 L tanks)

- *So, what's a family to do? What's a system designer to do?*