

MDPI World Water Day 2024

A new era in Integrated Water Resource Management: RWH



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146 years ago: A memorable March 22th!

„Ich habe Afrika gesehen, und habe es noch vor Augen, wie es ist, als großes Haus der Knechtschaft, nicht wie es sein sollte, als das ungeheure Gebiet einer freien Mitarbeit an den Gesamtaufgaben der Menschheit. An einem endlichen Siege der guten Sache sowie an der Zukunft des schwarzen Menschengeschlechts werde ich nie zweifeln.“ **(Kairo, 22. 03. 1878)**

Dr. Georg Schweinfurth (1836 - 1925)

Then 42 years old!

Three friends to win!

"I will never doubt about the glorious future of the black human race"

Dr. Georg Schweinfurth (1878)

"Anyone who can solve the problems of water will be worthy of two Nobel prizes - one for peace and one for science"

John F. Kennedy (1960s)

"Education is the most powerful weapon which you can use to change the world"

Nelson Rolihlahla Mandela (1990)

What is science?

"Science is a rigorous, systematic endeavor that builds and organizes knowledge in the form of testable explanations and predictions about the world"

Wikipedia

"Wissenschaft" is made up of "Wissen" (knowledge) and schaffen (to create)

"The art to create knowledge"

German

Fresh water is lacking...

... everywhere: Africa, Asia, America, Australia, Europe...

Rainwater is freshwater and present (almost) everywhere in Africa, Asia, America, Australia, Europe...

Why are we ready to desaline seawater and less ready to harvest rainwater?

Just because “big is beautiful”!

The “big is beautiful“-approach!

RWH only when there is no other choice:

- **Surface water resources are limited!**
- **Groundwater resources are difficult to access (e.g. islands, mountains)!**
- **Groundwater resources are polluted (e.g. arsenic, fluoride, high salinity, uranium)!**
- **Surface water and groundwater resources are available but not affordable (e.g. small communities, developing countries)!**

Order: Surface water > Groundwater > Rainwater

Because “big is beautiful“...

We pipe large amounts of water from distant sources (e.g. next river)!

We withdraw large amounts of water from underground (e.g. groundwater in Berlin)!

We augment urban runoff with piped water (in addition to stormwater)!

We destroy nature and favour soil erosion with the distribution network!

We lose large amounts of water through leakages (e.g. non-revenue water)!

It is not time to question our formal education? Mainstreaming RWH?

What is really if “small is beautiful“?

We would harvest and use rainwater!

We would not augment city and farm runoff with piped water from distant rivers!

We would infiltrate stormwater on-site!

We will use drip-irrigation to conserve water everywhere!

We would avoid soil erosion and dam/pond sedimentation!

Each residence will be a water production unit and every citizen a water manager!

Is that not cool?

Rainwater harvesting is not new!



Wohnt in Altapame.

RWH is not really new!



**Bamena since the 1970
(Cameroon)**

Akkerman's Calabash (5000 L)



**Nfetom 2023
(Cameroon)**

Compound in Tanzania



Irrigation in Tanzania



School in Tanzania



Small communities

- Remote and scattered
- No electricity
- Lack of understanding of scaling process selection
- Lack of a maintenance culture
- Not enough trained personnel for O&M
- Decentralized options are appropriate!!!

Frugal innovation

- Simple to operate (no trained personnel)
- Able to function without electricity
- Based on local resources and skills
- Robust and low cost
- Chemistry free
- Address potable and non potable demand
- RWH is very welcome!!!

Technologies for recycling RW

- **Constructed wetlands (surface and subsurface water flow systems),**
- **Slow sand filtration (SSF),**
- **Filtration on geomaterials (e.g. anthracite, gravel, pumice),**
- **Filtration on biomaterials (e.g. wood),**
- **Fe⁰-amended SSF: the solution?**

Misconception and universal solution

1 Short course in Arusha (2015)

1 Master thesis in Arusha (2019)

2 Master thesis in Göttingen (2018)

Kilimanjaro Concept (2018)

Universality of the Kilimanjaro Concept (2019)

10 scientific articles with global colleagues.

Results: A sound concept to be tested/verified at pilot scale.

Yes, we still need pilot testing! However, not as a proof of concept, but rather as demonstration's units or tools to train local experts!

The coming decentralized systems

- 1 – Each residence is a water production unit (tanks)**
- 2 – Several residences have a cluster's rainwater reservoir**
- 3 – Harvested rainwater is used for all needs**
- 4 – Only a tiny fraction is treated to drinking standards**
- 5 – Brazil, China, India, Nepal, Sri Lanka, The Netherlands Antilles... have been using such systems for centuries!**
- 6 – A highway is opened for the establishment of an already efficient technology!!!**
- 7 – New opportunity for self-reliance = zero poverty!**

The science of decentralized RWH

The long-term hydrologic cycle:

$$P = E + I + R \quad (1)$$

P = precipitation, E = evaporation, I = infiltration, R = runoff

The RWH potential is calculated using Equation 2:

$$Q = C \times P \times A \quad (2)$$

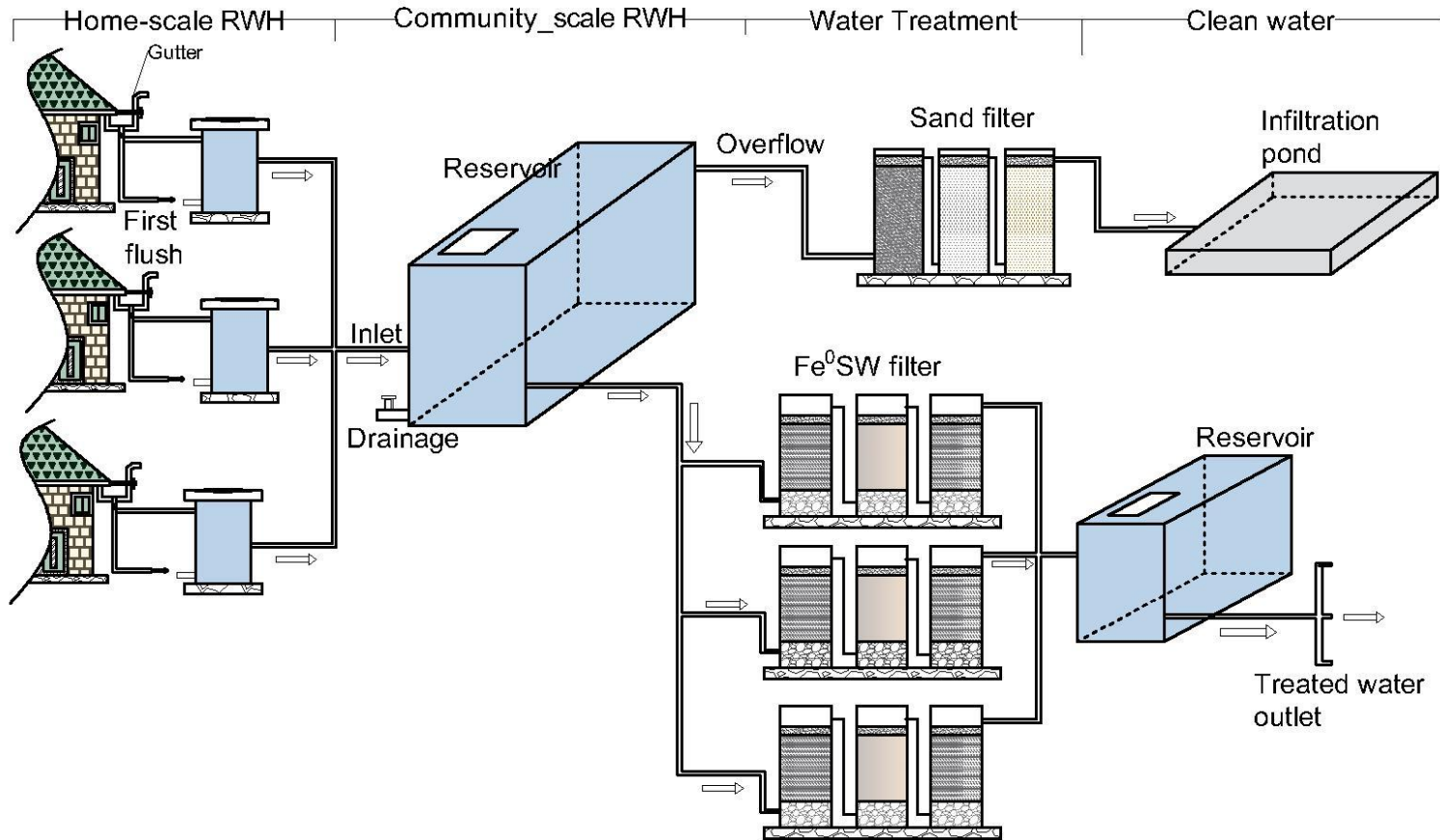
Q = harvestable runoff (m³), C = collection efficiency, P = intensity of rainfall (m/y), and A = rooftop catchment area.

With modern engineering tools:

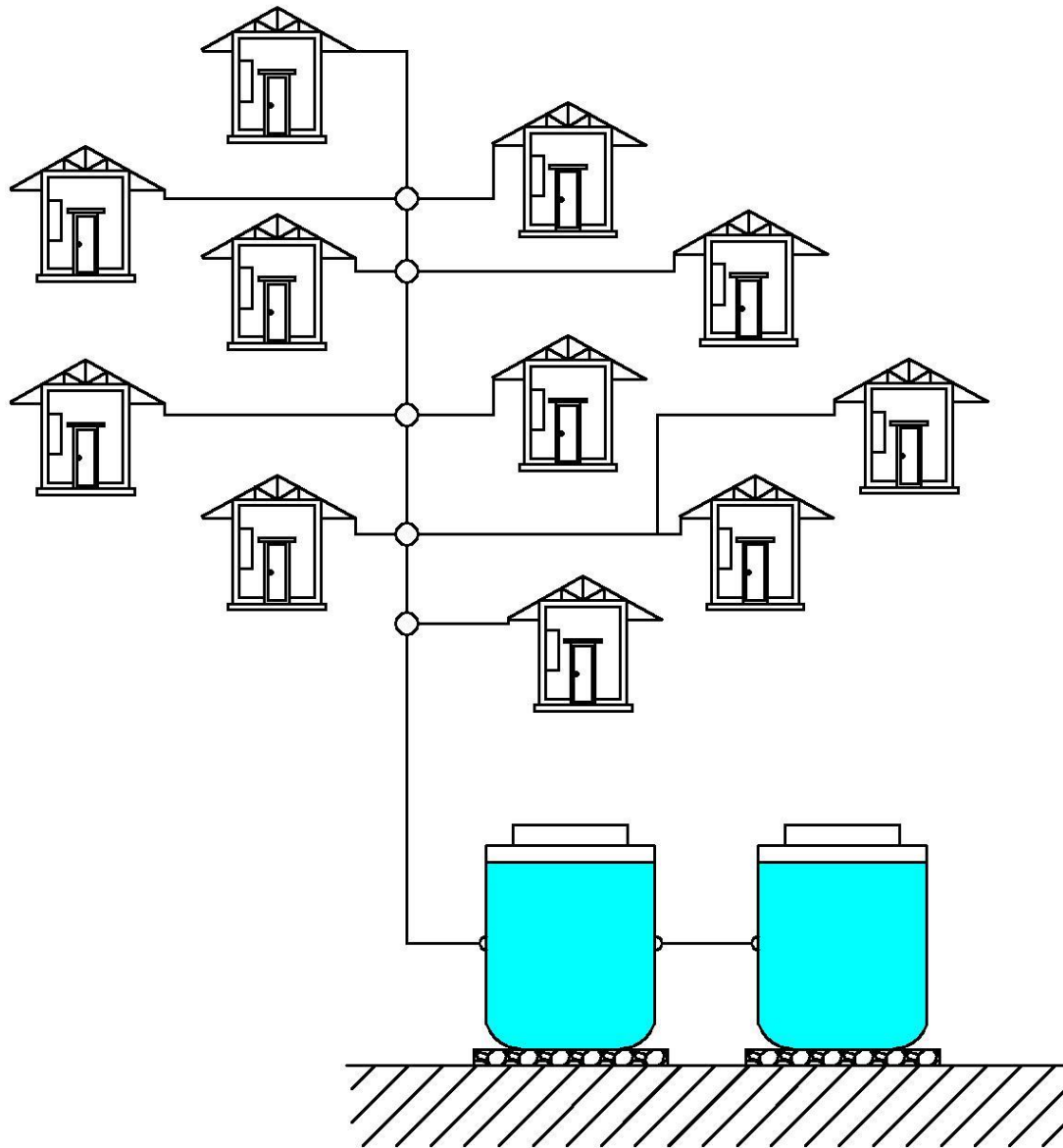
$$Q = Q(p) + Q(n-p) + Q(\text{infiltration}) + Q(\text{pond}) \quad (3)$$

$$\text{Supply} = \text{Demand1} + \text{Demand2} + \text{Demand3} + \dots$$

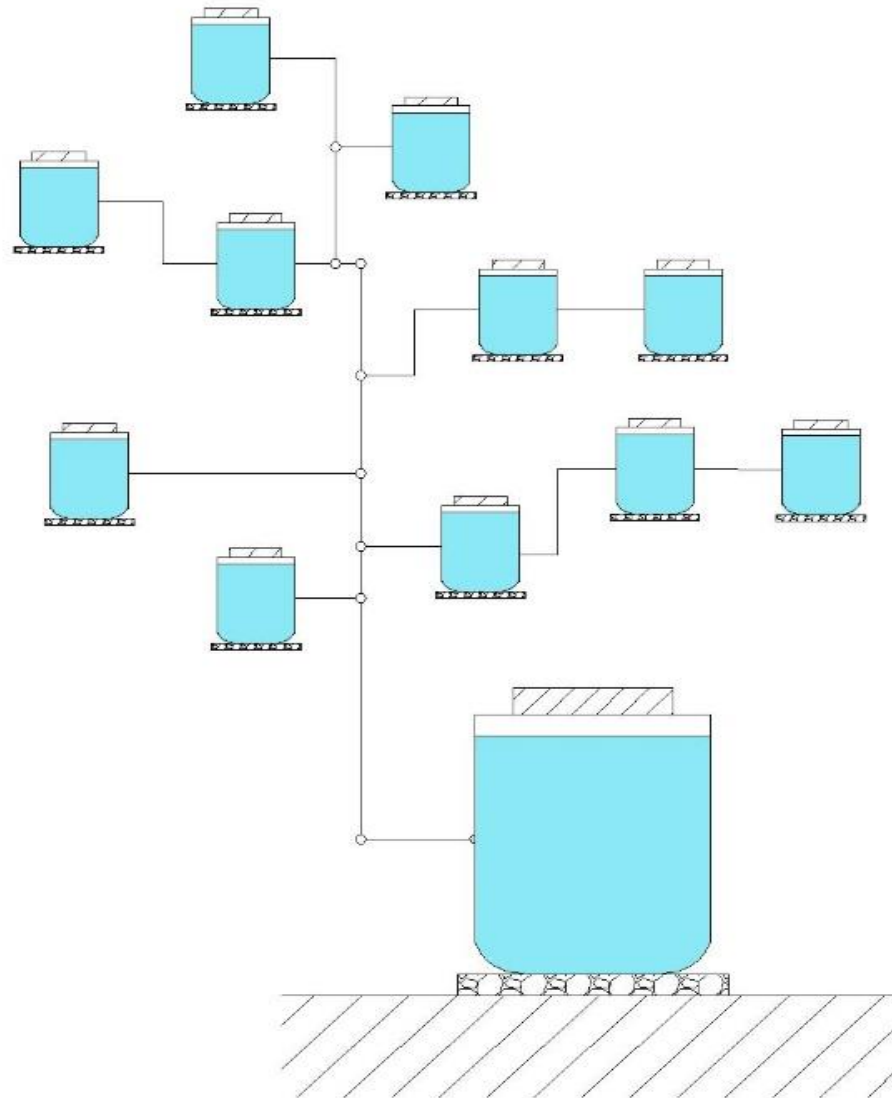
A cluster design



A cluster design (centralized 0)



A cluster design (centralized 1)



In case the home reservoir is empty?



Supply-based RWH

- 1 – Rainwater, surface water, groundwater **(this order)!**
 - 2 – RWH for domestic (including potable), fire-fighting, flood mitigation, groundwater recharge, irrigation, live stock, thermal power... **and all other uses!**
 - 3 – In dry regions: Domestic first!
 - 4 – In wet regions: Flood mitigation first!
 - 5 – Very clearly: Harvest and complete in dry regions.
 - 6 – Very clearly: Harvest and discharge in wet regions.
- Harvest rain** on the mountain and in the valley!
- Harvest rain in the village and in the city!
- Harvest rain in the North and in the South... **Everywhere!**

Conclusions

- 1 – RWH was made unconventional by formal education!**
- 2 – There is no single scientific argument against RWH!**
- 3 – The user has the choice of selecting the water treatment method (no chlorination, no disinfection byproducts)**
- 4 – Virtually, every village can meet its own drinking water needs**
- 5 – RWH ("water storage") and controlled infiltration ("water planting") increases spring and well productivity**
- 6 – Community-scale RWH helps to generate a community spirit within the village!**
- 7 – RWH provides safe water at home: distance zero!**
- 8 – New opportunity for self-reliance = zero poverty!**

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