WATER REMEDIATION APPROACHES FOR DRINKING WATER SUPPLIES
PART A: SOURES AND GENERAL APPROACHES

The material presented here has been prepared by George Wilson in April 2021, with input from Dr. Laura Richards and Prof. David Polya of the Department of Earth & Environmental Sciences, The University of Manchester, and other sources as acknowledged. The associated video recordings have been made by George Wilson.

The Transformation by Innovation in Distance Education (TIDE) project is enhancing distance learning in Myanmar by building the capacity of Higher Education staff and students, enhancing programmes of study, and strengthening systems that support Higher Educational Institutions in Myanmar. TIDE is part of the UK-Aid-funded Strategic Partnerships for Higher Education Innovation and Reform (SPHEIR) programme (www.spheir.org.uk). SPHEIR is managed on behalf of FCDO by a consortium led by the British Council that includes PwC and Universities UK International. The TIDE project will close in May 2021.

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Introduction

- Increasing populations have led to to ever-increasing demand for water worldwide (Wada *et al.,* 2010) (OA)
- The World Health Organization estimates ~30% of the world' population do not have access to a safely-managed drinking water service (WHO, 2019) (OA)
- Remediation follows water quality assessment/analysis (refer to water quality assessment mini-series)

Objectives

- Explain the different types and sources of drinking water
- Be familiar with different approaches to water remediation of drinking water supplies

SOURCES AND TYPES OF DRINKING WATER

Typical sources of drinking water

- Surface water (lakes, rivers, streams)

✓ Relatively accessible

X Generally high micro-organism contamination, availability can vary depending on location / time of year

- Groundwater (71% of Myanmar's population use groundwater for drinking; NIVA 2017 [OA])

✓ Available in arid area areas or when quality/quantity of surface water in insufficient

X Requires pumping, which can contain natural or anthropogenic chemical contamination

- Rainwater

✓ Generally lower microbial and/or chemical contamination – storage dependent

X Availability is seasonal and location-dependent

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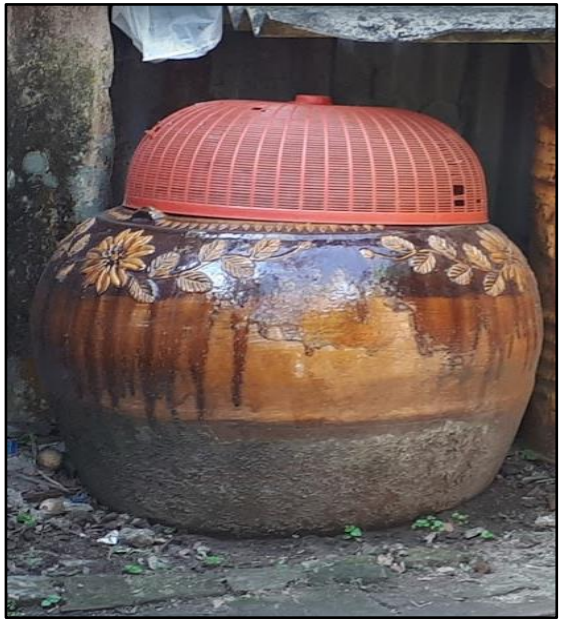
Types of Drinking Water: Myanmar



Photos from Laura Richards, 2017

Rainwater

- Storage conditions important for water safety
- Traditionally use roof rainwater harvesting (RWH) systems (ICIMOD, 2020)

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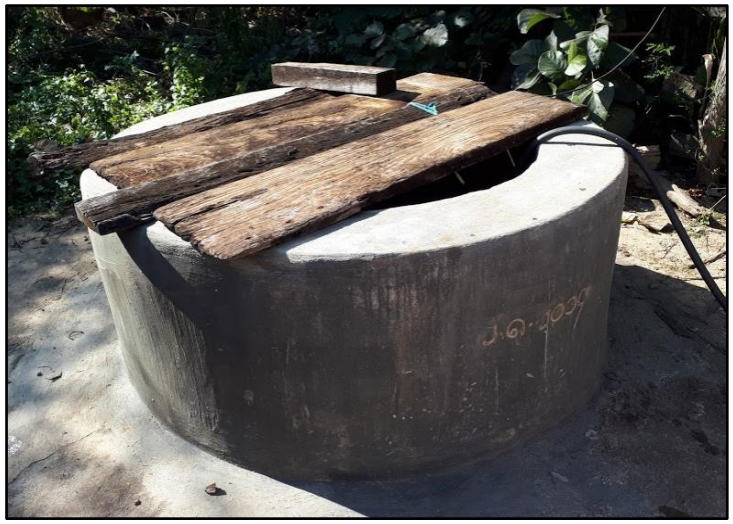
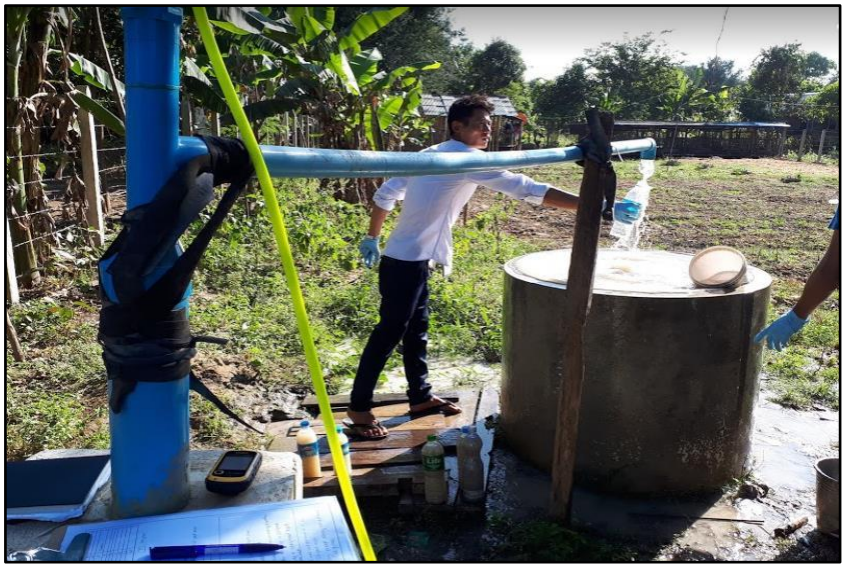
Types of Drinking Water: Myanmar



Groundwater

- Dug wells
- Tube wells

- Tube wells require less time to construct than dug wells
- Typically low in microbes but (odorless) chemical contaminants can be dangerous
- Sanitary care is important



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DRINKING WATER REMEDIATION APPROACHES

Drinking water remediation

The aims are usually a combination of:

- Improving the chemical quality of water (e.g. contaminants like heavy metals, salts, etc.)
- Improving the microbial quality of water (e.g. bacteria or viruses)
- Improving the taste, smell or colour of water to make it more aesthetically appealing

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Ways to treat water

Some common technologies/methods:

- Source switching (e.g. lower arsenic groundwater)
- Precipitation (e.g. Fe/Mn removal)
- Adsorption/ion-exchange (e.g. activated alumina)
- Membrane Filtration (e.g. nanofiltration/reverse osmosis)
- Oxidation (e.g. photochemical oxidation)
- Bioremediation (e.g. biosorbents)

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Avoidance/switching

Finding another source of better quality water to drink – simplest method

- Painting of wells (red) to indicate unsafe levels of arsenic present
- But trade-offs in quality, reliability or cost between different types of water
- Deeper groundwater claimed to be safer than shallower groundwater – not always the case

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Scale of remediation

- Household or small community supply
- Large community supplies
- Municipal supplies

Precipitation

- Coagulation (using alum/iron-based coagulant), iron/manganese removal by aeration-filtration and lime softening are traditional methods
- Relies on co-precipitation of metal (hydr)oxides

Advantages	**Disadvantages**
Relatively low capital cost	Difficult to optimize
Simple in operation	Poor removal of some contaminants
Chemicals usually available in cities	Sludge produced
Generally effective over wide water quality ranges	Other steps required (e.g. sedimentation, filtration)
Well-established design and operation	pH (re)adjustment sometimes needed

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Adsorption

- Simple process where water passes through a bed of solid media which adsorbs contaminants

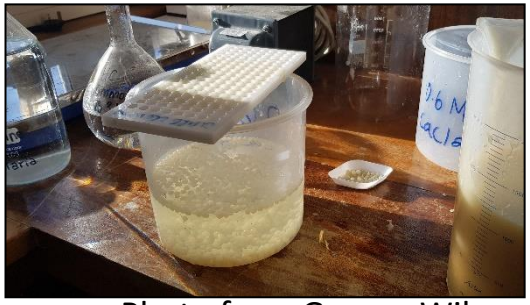

Photo from George Wilson

Advantages	**Disadvantages**
Natural and commercial products available	Variable effectiveness
Low cost option possible	Complex interactions with dissolved solutes in the water
Relatively easy operation	Hard to predict overall performance
Commonly used	Needs frequent maintenance
Well-studied	Adsorbent must be replaced / replenished

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SUMMARY

Summary

- The use of rainwater, surface water and groundwater as drinking water much depends on context and what is available to a community
- The aims of drinking water remediation are to improve the chemical or microbial quality, in addition to the smell, taste colour of the water
- There are many forms of water quality remediation and these take different scales, each with advantages and disadvantages

LEARNING EXERCISE

Learning exercise

1. Explain why one community may use primarily rainwater as their drinking water supply, whilst another may use mainly tube wells to source theirs

2. Can you think how the remediation systems designed for different scales may be different?

REFERENCES & FURTHER RESOURCES

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Norwegian Institute for Water Research (NIVA), 2017. Integrated Water Resources Management in Myanmar. Water usage and introduction to water quality criteria for lakes and rivers in Myanmar. Preliminary report. *NIVA-rapport*. Available at: https://niva.brage.unit.no/niva-xmlui/handle/11250/2449892 [Accessed 10/05/21]

Wada, Y., Van Beek, L.P., Van Kempen, C.M., Reckman, J.W., Vasak, S. and Bierkens, M.F., 2010. Global depletion of groundwater resources. *Geophysical research letters*, *37*(20). https://doi.org/10.1029/2010GL044571 (OA)

WHO, 2019. *Drinking-water.* [Online] Available at: https://www.who.int/news-room/fact-sheets/detail/drinking-water [Accessed 16/04/21] (OA)

Further Resources

A review of in-situ biological water treatment remediation options

Ateia, M., Yoshimura, C. and Nasr, M., 2016. In-situ biological water treatment technologies for environmental remediation: a review. *J Bioremed Biodeg*, *7*(348), p.2. http://dx.doi.org/10.4172/2155-6199.1000312 (OA)

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