# WATER REMEDIATION APPROACHES FOR DRINKING WATER SUPPLIES
# PART B: SELECTION METHODOLOGY

*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.*

# Water remediation approaches for drinking supplies

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  - Cost-benefit analysis
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# Introduction

- Numerous strategies exist for the remediation of water – no “one size fits all”
- Requirements, regulation and socio-economics must be considered
- Appropriate selection is key to successful remediation

# Objectives

- Explore the factors which need to be considered in the selection of an appropriate remediation strategy for water quality problems
- Become familiar with some examples of remediation selection methodologies

# REGULATION, TECHNOLOGY AND SOCIO ECONOMIC FACTORS

# Remediation factors

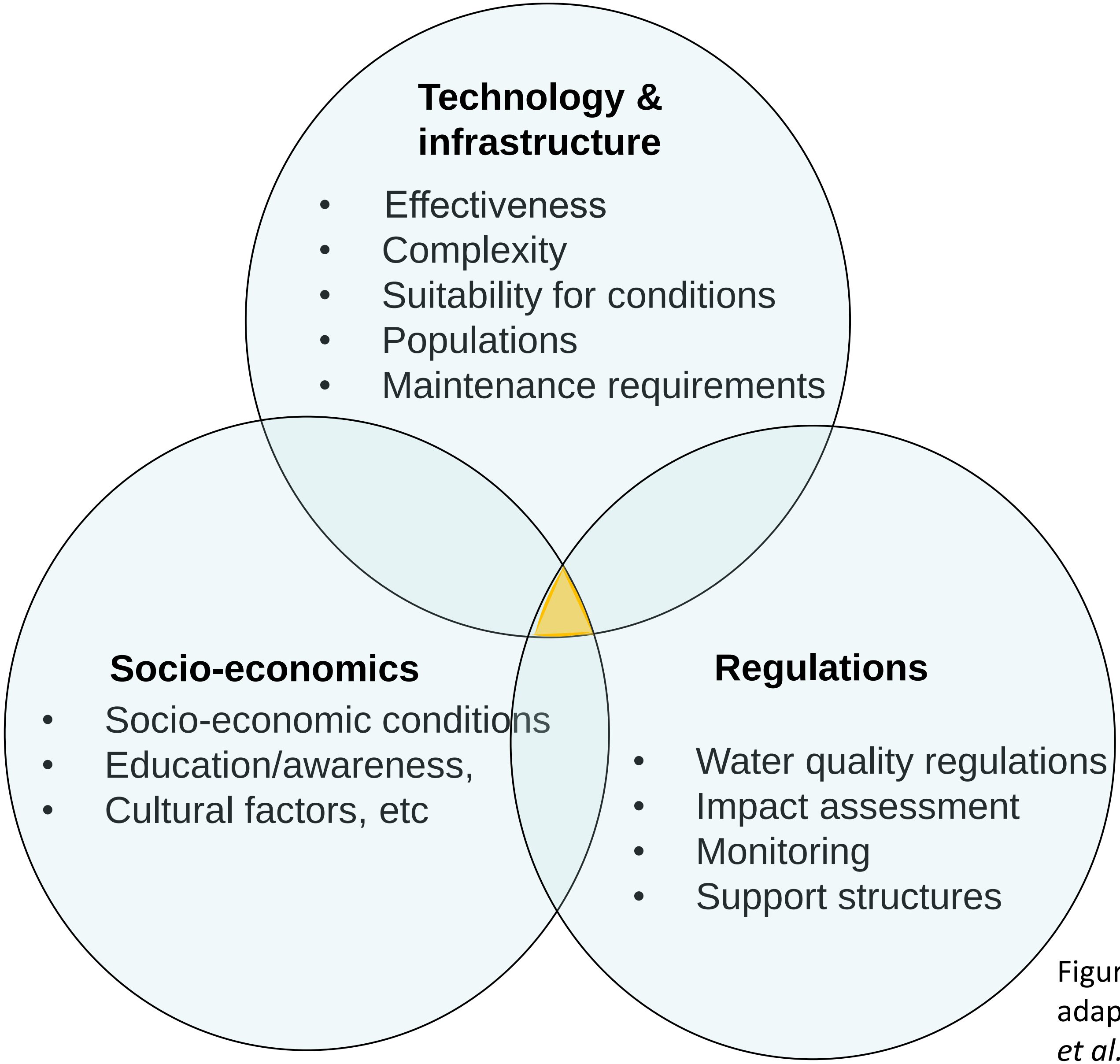


Figure made from an adaptation of Richards *et al.* (2017)

# Technology Readiness Level

- Estimates the maturity of technology
- Technology assessed in terms of requirements and capabilities; given a score between 1-9
- Assists procurement

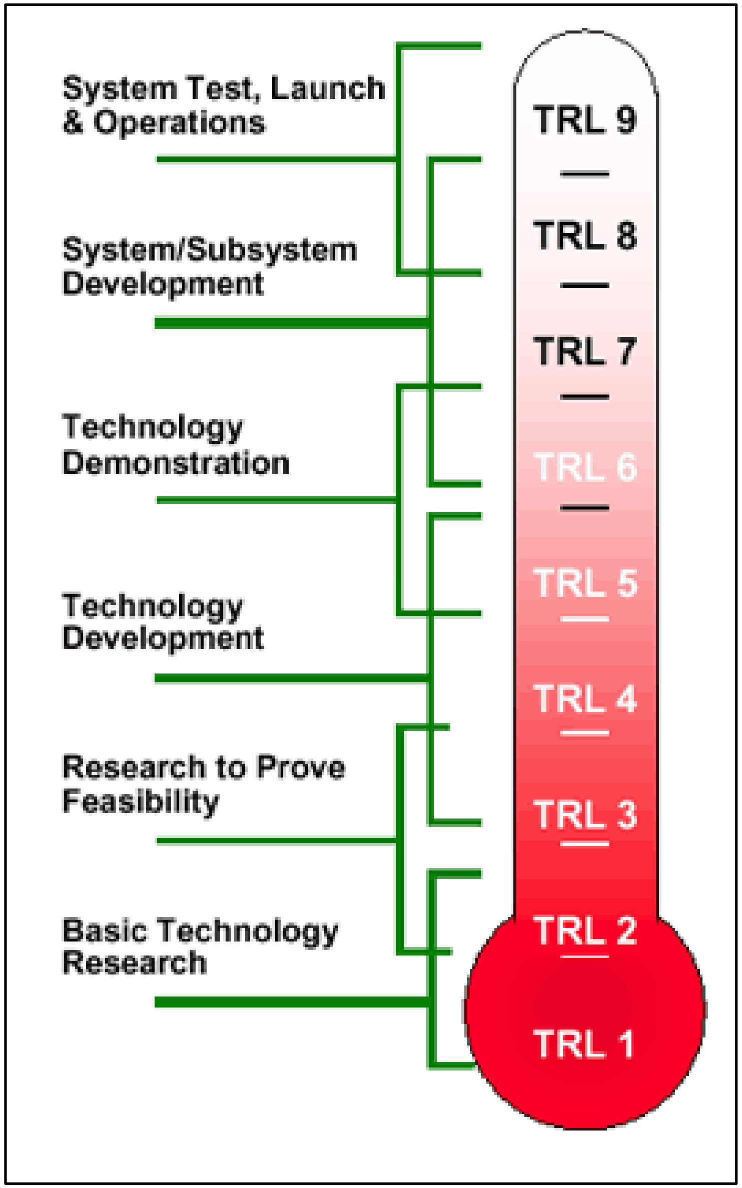


Figure from NASA (2004) (public domain image)

# Barriers for improving water quality

- Lack of communication/awareness for the need to improve water quality or for available treatment systems
- Competing challenges/projects
- Conservative attitudes towards change
- Costs in relation to benefits

(Polya & Richards, 2017) (OA)

# COST-BENEFIT ANALYSIS

# Cost-benefit analysis (CBA)

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What should we consider?

- Construction costs e.g. land acquisition, materials
- Operational costs e.g. salaries, servicing, repairs
- Decommissioning costs e.g. removal of equipment
- Benefits e.g. increased visitor numbers, production of goods

# Cost-benefit analysis (CBA)

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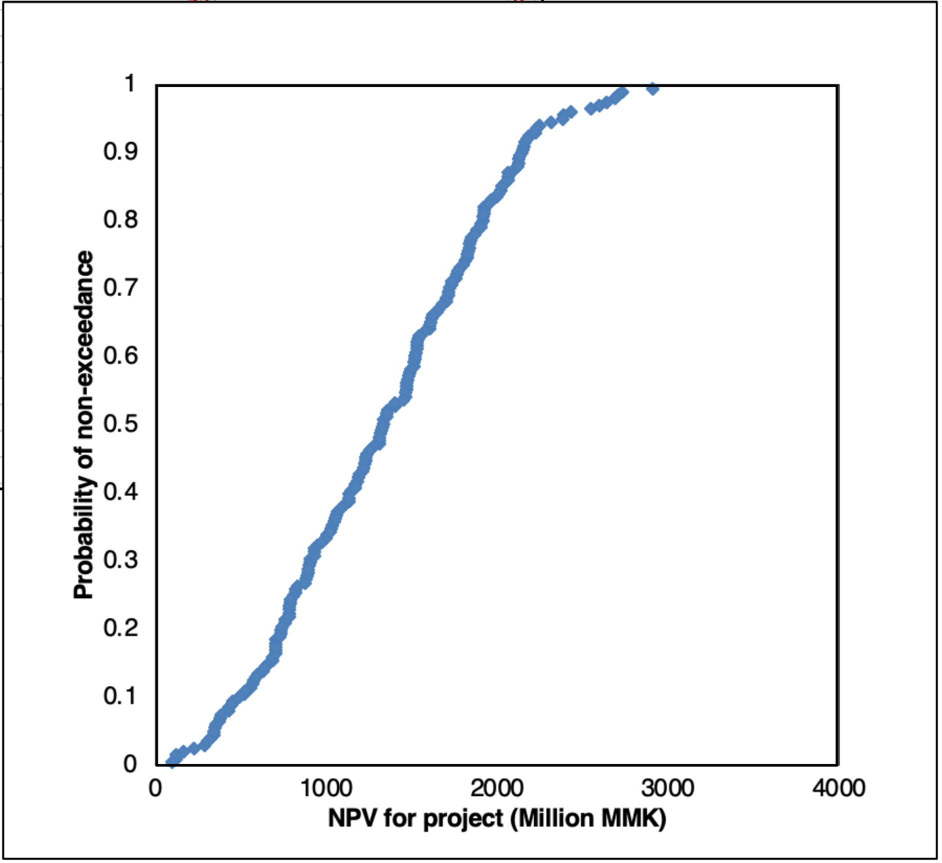
| Realisation | Lower bound inputs | Base case inputs | Upper bound inputs |
|---|---|---|---|
| | | | |
| Initial cost items: | | | |
| Initial Construction (Million MMK) | 800 | 1,000 | 1,200 |
| Land acquisition (Million MMK) | 720 | 900 | 1,080 |
| Site investigation (Million MMK) | 160 | 200 | 240 |
| | | | |
| Annual operational cost items: | | | |
| Maintenance (Million MMK) | 52 | 65 | 78 |
| Monitoring (Million MMK) | 16 | 20 | 24 |
| Externalities (Million MMK) | 34 | 43 | 52 |
| | | | |
| Initial Costs (CAPEX) (Million MMK) | 1,680 | | |
| Annual Operating Costs (OPEX) (Million MMK) | 102 | | |
| Annual Benefits (Million MMK) | 376 | | |
| Annual Discount Rate (%) | 6 | | |
| Decommissioning Cost (Million MMK) | 80 | | |
| Lifetime of Project (Years) | 20 | | |
| | | | |
| NPV Initial Costs (Million MMK) | 1680 | | |
| NPV Operating Costs (Million MMK) | 1135 | | |
| NPV Decommissioning Cost (Million MMK) | 25 | | |
| NPV Benefits (Million MMK) | 4285 | | |
| | | | |
| NPV Total cost (Million MMK) | 2840 | | |
| NPV Total benefit (Million MMK) | 4285 | | |
| NPV for project (Million MMK) | 1445 | | |
| NPV rank for project | | | |
| Probability of non-exceedance | | | |

'Monte Carlo' simulation




- Project lifespan
- Annual discount rate used in the simulation

# REMEDIATION SELECTION METHODOLOGIES / DECISION SUPPORT TOOLS

# Decision support tools

DESYRE - decision support system for rehabilitation of contaminated sites

1) Characterization
2) Socioeconomic analysis
3) Remediation technology comparison
4) Risk analysis
5) Decision making

Critto *et al*. (2006)

# Decision support tools

Multicriteria decision analysis (MCDA)

- Basic concepts included in the model:
  1) The problem or objective of the model
  2) The potential actions or alternatives that need to be ranked
  3) The ranking criteria (environmental, social, technical and economic)
- UK Environment Agency methods are a cost-benefit analysis + MCDA

Critto *et al*. (2006)

# MCDA

Modelling Framework | Decision Support Framework | Integrative Water Quality Assessment

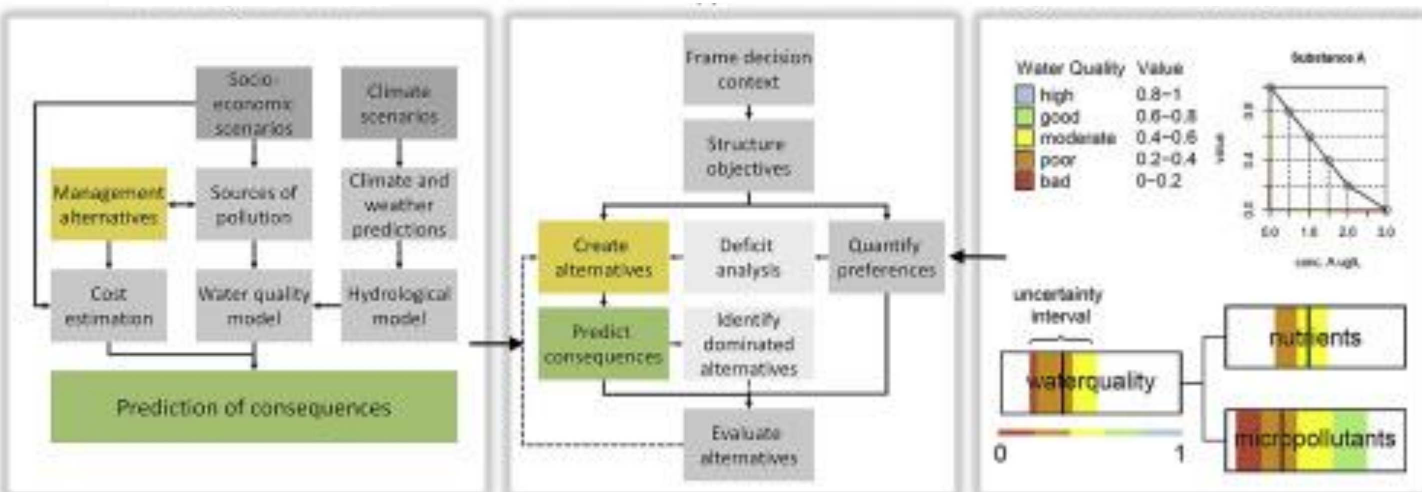



Figure from Schuwirth *et al*. (2018)

# Decision support tools limitations

- The successfulness of the (any) models depend on robust input data
- MCDA does not address uncertainty of the input parameters; cannot include every selection parameter
- MCDA reflects views of a small group of stakeholders, not the whole population
- Non-transparent findings can legitimize pre-defined decisions

(Saarikoski *et al.*, 2016)

# Cost-benefit analysis limitations



- Inaccurate costs/benefits
- A cost-benefit analysis will likely fail to quantify social and environmental costs/benefits (e.g. enjoyment of an area, species protection).

# SUMMARY

# Summary

- Technology, socio-economics and regulations are involved in the selection of a remediation strategy
- A cost-benefit analysis can model whether the project will likely make profit or loss
- No "one size fits all" solution to remediation – context-specific consideration is important
- Remediation selection methodologies can be used as decision support tools for the remediation of water quality, although they are not perfect

# LEARNING EXERCISE

# Learning exercise

1. List 5 factors which need to be considered in the selection of a remediation strategy and for each, explain why.
2. A developer wants to use solely a cost-benefit analysis to select a remediation strategy. What are the advantages and disadvantages of doing this?
3. Can you find any other examples of remediation selection methodologies, other than DESYRE and MCDA + cost-benefit analysis?

# REFERENCES & FURTHER RESOURCES

# References


Critto, A., Cantarella, L., Carlon, C., Giove, S., Petruzzelli, G. and

Marcomini, A., 2006. Decision support–oriented selection of remediation technologies to rehabilitate contaminated sites. *Integrated Environmental Assessment and Management: An International Journal*, *2*(3), pp.273-285. https://doi.org/10.1002/ieam.5630020307 (OA)

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Polya, D & Richards, L, 2017. 'Arsenic and the Provision of Safe and Sustainable Drinking Water: Aspects of Innovation and Knowledge Transfer' *United Nations Economic and Social Commission for Asia and the Pacific Asia Pacific Tech Monitor*, no. July – Sep 2017, pp. 23-30. Available at: http://techmonitor.net/tm/images/7/73/17jul_sep_sf2.pdf [Accessed 04/05/21]. (OA)

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Schuwirth, N., Honti, M., Logar, I. and Stamm, C., 2018. Multi-criteria decision analysis for integrated water quality assessment and management support. *Water research X*, *1*, p.100010. https://doi.org/10.1016/j.wroa.2018.100010 (OA)

O'Kane, M. and Wels, C., 2003, July. Mine waste cover system design–linking predicted performance to groundwater and surface water impacts. In *6th International Conference on Acid Rock Drainage (ICARD), Cairns.*

# Further Resources

**Selection of remediation technologies for contaminated land:**

EPA, 1993. *Selecting Remediation Techniques For Contaminated Sediment.* [Online] https://nepis.epa.gov/Exe/ZyPDF.cgi/20003Q0N.PDF?Dockey=20003Q0N.PDF [Accessed 28/04/21]. (OA)

**Simplified cost-benefit analysis Youtube video:**

Grow Your Career, 2013. https://www.youtube.com/watch?v=TIEWxjJ6Rzg [Accessed 29/04/21]. (OA)

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