WATER AND WASTEWATER MONITORING

Designing of Monitoring Programme

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Chapter Description

- Aims
  - Student understands the designing of monitoring programme
  - Student identify the type of monitoring programme
  - Student analyse the need for monitoring

- Expected Outcomes
  - Student should be able to understand the designing of monitoring programme
  - Student should be able to identify the type of monitoring programme
  - Student should be able to analyse the need for monitoring

- Other related Information
  - Environmental Protection Agency
  - Natural Resources Conservation Service

- References

  - Burden, Foerstner, McKelvie, and Guenther (2002) **Environmental Monitoring Handbook**, The McGraw-Hill Companies, Inc.
  - Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.

DESIGNING OF MONITORING PROGRAMME?

- Clear statement of aims and objectives
- Information expectations and intended uses
- A description of the study area concerned
- A description of the sampling sites
- A listing of the water quality variables that will be measured
- A proposed frequency and timing of sampling,
- An estimate of the resources required to implement the design and
- A plan for quality control and quality assurance

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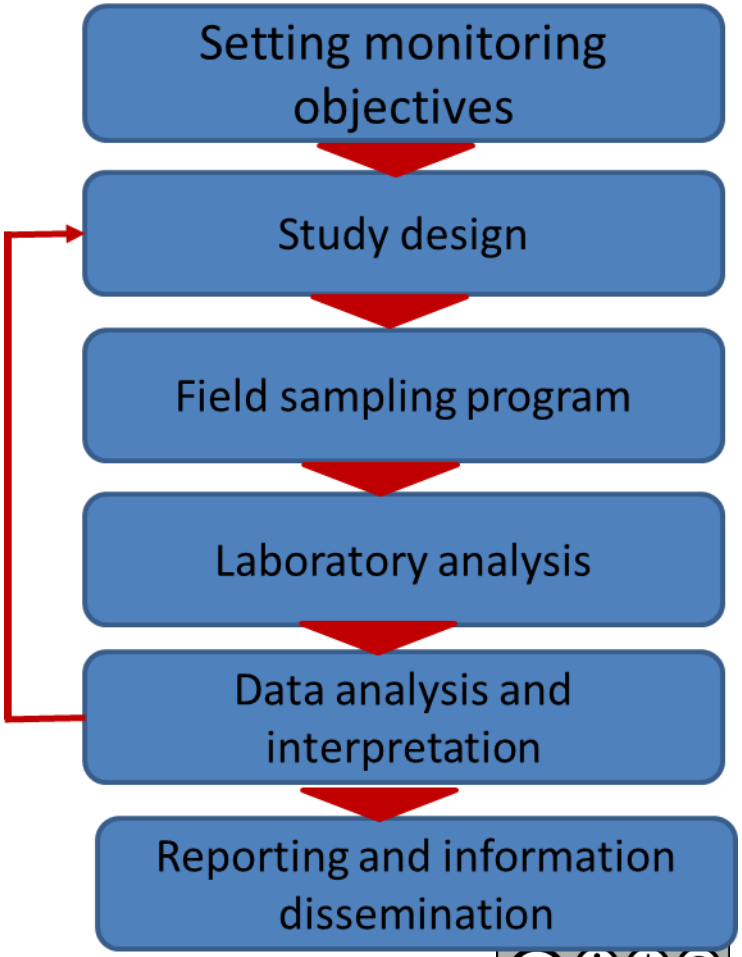
FRAMEWORK FOR WATER MONITORING



TYPE OF MONITORING PROGRAMME

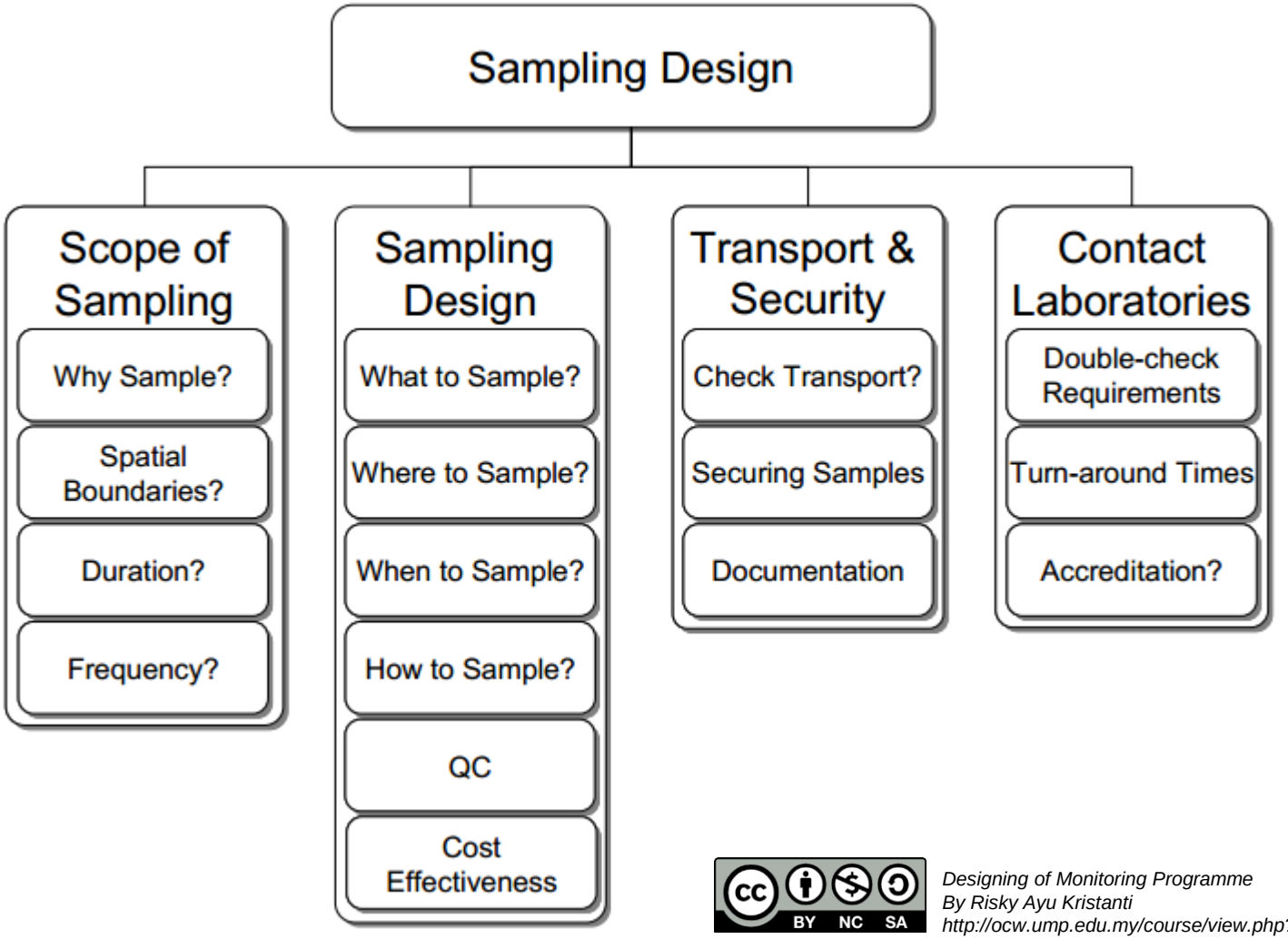
- Single objective

  → set up only for one problem

- Multi objective programmes

  → Cover various water uses, such as drinking water supply, industrial manufacturing, fisheries, irrigation or aquatic life

THE NEEDS FOR MONITORING



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IMPORTANCE OF UNDERSTANDING THE SYSTEM BEING SAMPLED

- What are the major issues of concern
- What ecosystem (including subsystem type) should the model describe ?
- Which state of flow should the model describe ?

IMPORTANCE OF UNDERSTANDING THE SYSTEM BEING SAMPLED

- Key processes
- Cause–effect relationships
- Important questions to be addressed
- Spatial boundaries
- Valid measurement parameters for the processes of concern; what to measure, and with what precision
- Site selection
- Time and seasonal considerations.

WHAT TO SAMPLE?

What material is relevant to collect sample of, and what measurement should be taken?

Sampling media

→Waste released to water body (or potentially released)

→The receiving environment via permanent/temporary and bottom sediments of those

→Specimens of animal or plant life

Characteristics	Water	Particulate matter		Living organisms			
		Suspended	Deposited	Tissue analyses	Biotests	Ecological surveys[1]	Physiol. determin.[2]
Type of analysis or observation	← physical →						
	← chemical → [3]						
				← biological →			
Applicability to water bodies	rivers, lakes, groundwater	mostly rivers	lakes, rivers	rivers, lakes	rivers, lakes	rivers, lakes	rivers, lakes
Intercompara-bility[4]	← global →			depends on species occurence	global	← local to regional →	
Specificity to given pollutant	← specific →				← integrative →		
Quantification	← complete quantification of concs & loads →		concen-trations only	quanti-tative	semi-quan-titative	← relative →	
Sensitivity to low levels of pollution	low	← high →			variable	medium	variable
Sample contam-ination risk	high[5]	medium	← low →		medium	← low →	
Temporal span of information obtained	instant	short	long to very long (continuous record)	medium (1 month) to long (> 1 year)	instant. to cont-inous[6]	← medium to long →	
Levels of field operators	untrained to highly trained[7]	trained	untrained to trained	trained	← medium to highly trained →		
Permissible sample storage duration[7]	low	high	high	high	very low	high	na
Minimum duration of determination	instant. (*in situ* determ.) to days	days	days to weeks	days	days to months	weeks to months	days to weeks

Measured variable	Streams: baseline and trend	Headwater lakes: baseline and trend	Groundwaters: trend only	Global river flux stations
Water discharge or level	x	x	x	x
Total suspended solids	x	—	—	x
Transparency	—	x	—	—
Temperature	x	x	x	x
pH	x	x	x	x
Electrical conductivity	x	x	x	x
Dissolved oxygen	x	x	x	x
Calcium	x	x	x	x
Magnesium	x	x	x	x
Sodium	x	x	x	x
Potassium	x	x	x	x
Chloride	x	x	x	x
Sulphate	x	x	x	x
Alkalinity	x	x	x	x
Nitrate	x	x	x	x
Nitrite	x	x	x	x
Ammonia	x	x	x	x
Total phosphorus (unfiltered)	x	x	—	x
Phosphorus, dissolved	x	x	—	x
Silica, reactive	x	x	—	x
Chlorophyll *a*	x	x	—	x
Fluoride	—	—	x	—
Faecal coliforms (trend stations only)	x	x	x	—

Where to Sample

Where should sample be collected and measurement taken?

→Judge based on environmental authorities

→Judge based on the representative of the release material (and the receiving waters, where relevant)

→Depend on environmental pollution incidents (licensed and unlicensed source pollutant licensed)

Sampling for River Water

Average width (m)	Mean depth (m)	Estimated distance for complete mixing (km)
5	1	0.08–0.7
	2	0.05–0.3
	3	0.03–0.2
10	1	0.3–2.7
	2	0.2–1.4
	3	0.1–0.9
	4	0.08–0.7
	5	0.07–0.5
20	1	1.3–11.0
	3	0.4–4.0
	5	0.3–2.0
	7	0.2–1.5
50	1	8.0–70.0
	3	3.0–20.0
	5	2.0–14.0
	10	0.8–7.0
	20	0.4–3.0

Sampling for Composite Sample in Water Flowing

Average discharge ($m^3 s^{-1}$)	Type of stream or river	Number of sampling points	Number of sampling depths
< 5	Small stream	2	1
5–140	Stream	4	2
150–1,000	River	6	3
≥ 1,000	Large river	≥ 6	4

Sampling at Lake and Reservoir

- 1 m below the water surface,
- just above the determined depth of the thermocline,
- just below the determined depth of the thermocline, and
- 1 m above the bottom sediment (or closer if this can be achieved without disturbing the sediment).

Sampling at Ground Water

certain information collect prior sampling:

- well, including depth, depth to the well screen, length of the screen and
- the amount by which the static water level is lowered when the well is pumped.

Aquifer, springs and boreholes drilled can be useful groundwater sampling point.

When to Sampling

- Timing of sampling

→should address the pre-defined objective

→If suspected environmental incident, sample ASAP after the incident has occurred

→Depend on some environmental condition or under certain weather conditions

→Sampling multiple before and after reference site (impact assessment)

→During baseflow or during flood event condition

Water body	Sampling frequency
Baseline stations	
Streams	Minimum: 4 per year, including high- and low-water stages Optimum: 24 per year (every second week); weekly for total suspended solids
Headwater lakes	Minimum: 1 per year at turnover; sampling at lake outlet Optimum: 1 per year at turnover, plus 1 vertical profile at end of stratification season
Trend stations	
Rivers	Minimum: 12 per year for large drainage areas, approximately 100,000 km^2 Maximum: 24 per year for small drainage areas, approximately 10,000 km^2
Lakes/reservoirs	For issues other than eutrophication: Minimum: 1 per year at turnover Maximum: 2 per year at turnover, 1 at maximum thermal stratification For eutrophication: 12 per year, including twice monthly during the summer
Groundwaters	Minimum: 1 per year for large, stable aquifers Maximum: 4 per year for small, alluvial aquifers Karst aquifers: same as rivers

How to Sample ?

- How many sample should be collected?
  - → single : just only if sample well mixed
  - → Dupli/triple: multiple readings for in situ measurements and multiple samples where laboratory analysis is involved
- Is grab sampling adequate or should composite sample be taken ?
  - → To confirm the presence of the hazardous substance
  - → Well mixed the tested body of water

Quality Control in Sampling

to check whether bias, sample contamination, or analytic loss could affect the results, leading to invalidate the process.

- Reference site: comparable (but unimpacted) locations where samples are taken for comparison with others (e.g, upstream of a discharge point, or a tributary other than the one of interest).
- Due to its variability, it is often wise not to rely on a single reference site

Laboratory Services

- Contact the appropriate laboratories

→ to ensure that analysis can be performed before expiry of the maximum holding times.

→details concerning the samples :

range of concentrations for choose a suitable analytical method with appropriate 'limit of reporting' (LOR) and to preven out of range concentration

Sampling Schedule

- where and when the samples are to be collected
- source of each sample—whether from wastes, waters or sediments
- the nature of the material to be sampled
- the quality characteristics being sampled
- the sampling containers (and associated paraphernalia) needed
- preservatives needed
- the maximum holding time for each sample

Conclusion of The Chapter

- The design of monitoring programme should be based on clear and well thought out aims and objectives and should ensure as far as possible, that the planned monitoring activities are practicable and that the objectives of the programme will be met

Reference

Jamie Bartram and Richard Balance. 1996. **Water Quality Monitoring: A Practical Guide to Design and Implementation of Freshwater Quality Studies and Monitoring Programmes**, CRC Press.