Monitoring Ecosystem Health in Wetlands; Deciding How to Approach

By: Mahyar Sakari, PhD, MRSC, EP

A Healthy Ecosystem

- The condition of an ecosystem when functions in the absence of human

- Rapport, D.J., H.A. Regier, and T.C. Hutchinson. 1985. Ecosystem behavior under stress. American Naturalist 125: 617-640.
- Schlesinger, W.H. 1994. The vulnerability of biotic diversity. pp. 245-260. In: R.B. Socolow, C. Andrews, F. Berkhout, and V. Thomas (eds.). Industrial Ecology and Global Change. Cambridge University Press.
- Smith, W. K., C. C. Cleveland, S. C. Reed, and S. W. Running. 2014. Agricultural conversion without external water and nutrient inputs reduces terrestrial vegetation productivity, Geophysical Research Letters 41: doi:10.1002/2013GL058857

Examples of Ecosystems w/out Human

Facts	With Human	Without Human
Water Chemistry	Influenced by human	Fluctuates naturally
Sedimentation	Watershed Activity	Watershed features
Ecosystem Change	Accelerated	Changes naturally
Biodiversity	Affected by human	Self-balanced

International Efforts in Env'l Protection

It's about us

- Human Right

UNEP; Universal Declaration of Human Right (https://www.un.org/en/about-us/universal-declaration-of-human-rights)

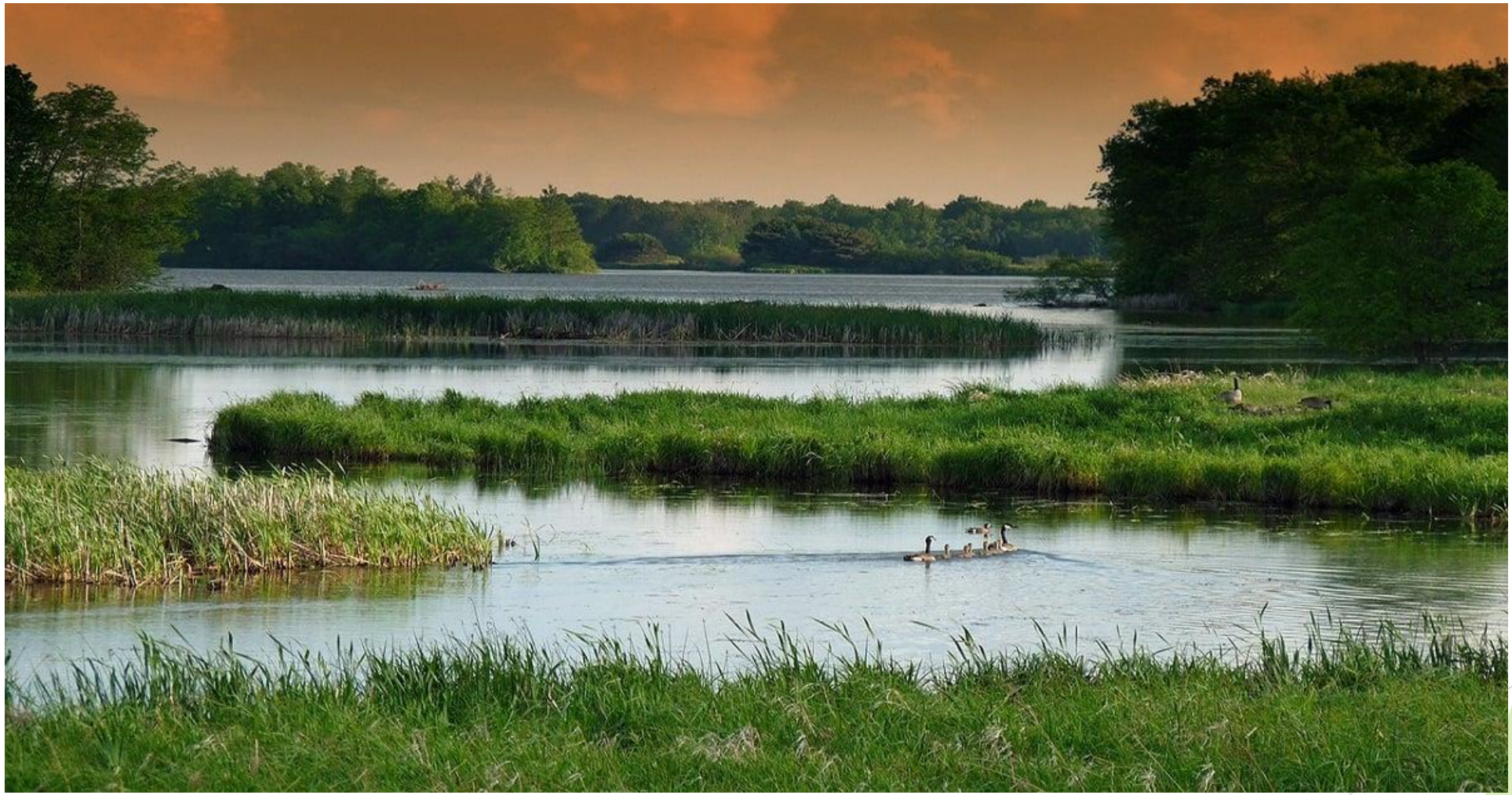
- Healthy Environment, Healthy Human

WHO; 23% of human death is caused by unhealthy environment (https://apps.who.int/iris/bitstream/handle/10665/325877/WHO-CED-PHE-DO-19.01-eng.pdf?ua=1)

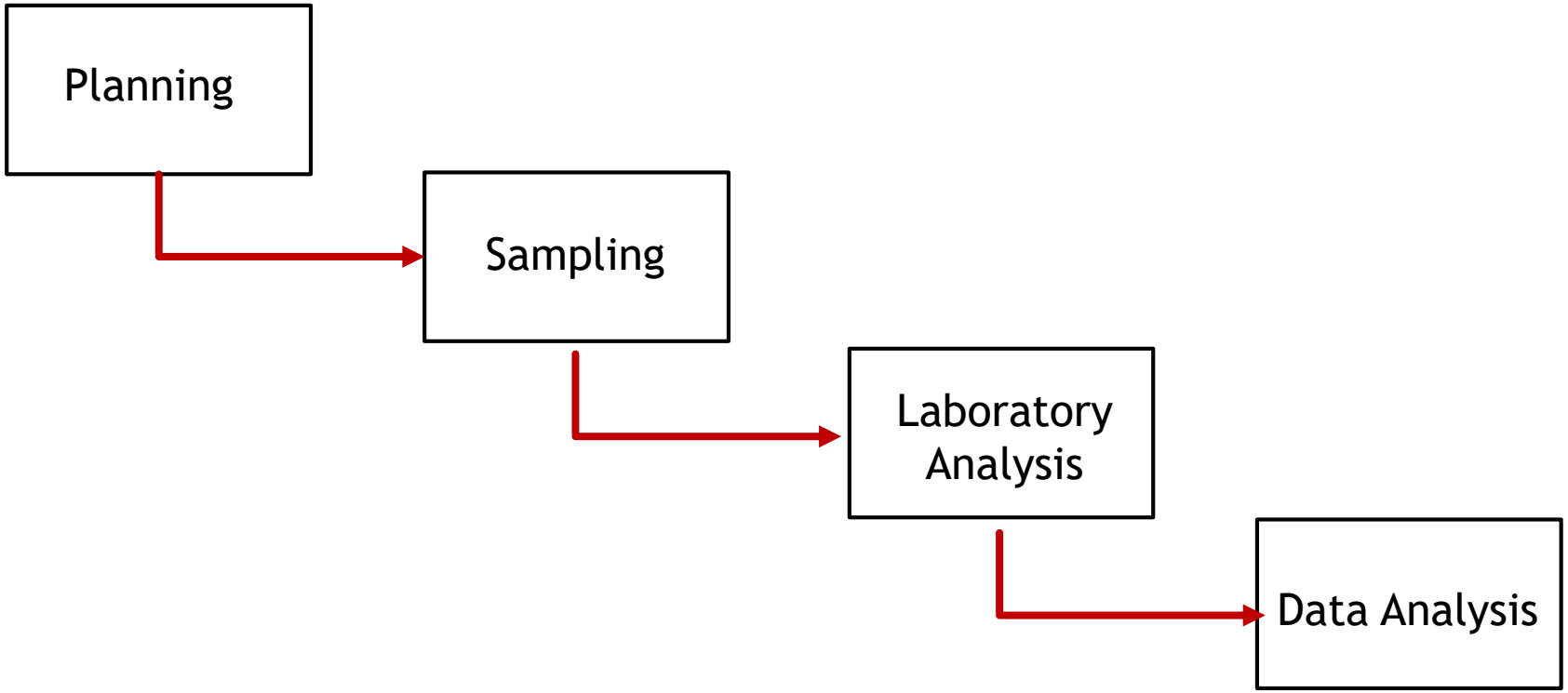
- Protect and restore ecosystems

UNHRC; (https://www.ohchr.org/en/hr-bodies/hrc/regular-sessions/session46/regular-session)

How We Do?

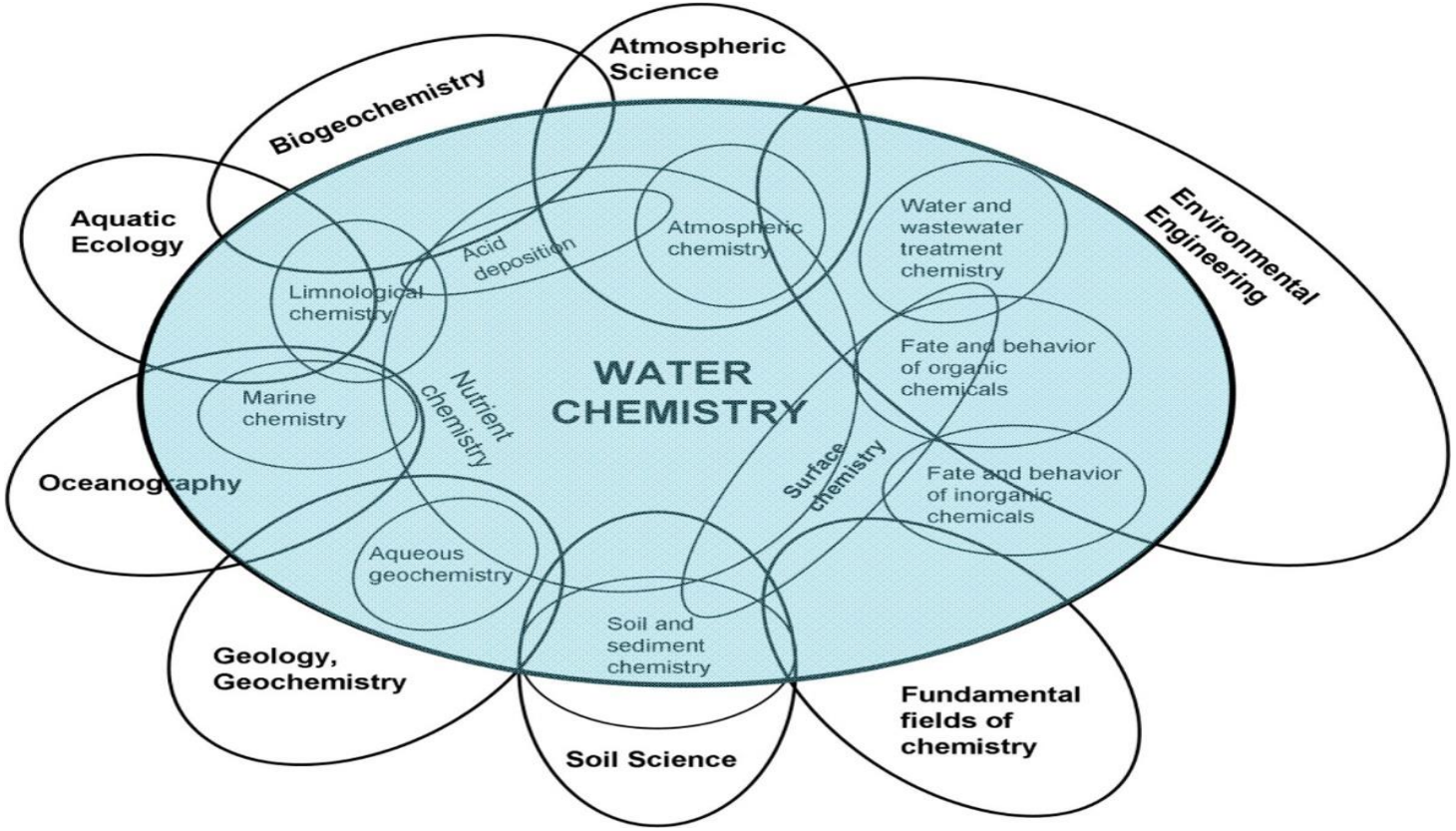


How We Plan?
Environmental Monitoring 101



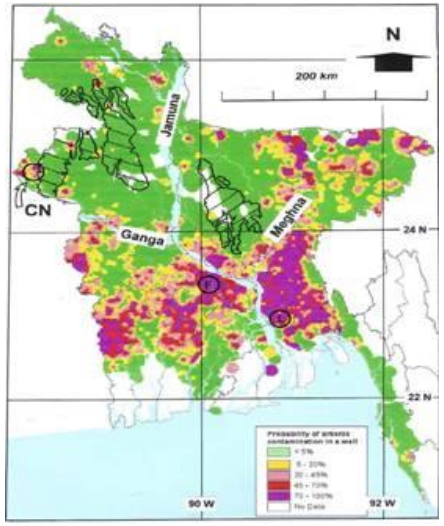
We Focus on Water Chemistry

Water Chemistry: Fifty Years of Change and Progress; Patrick L. Brezonik and William A. Arnold Environmental Science & Technology 2012 46 (11), 5650-5657
DOI: 10.1021/es300882y

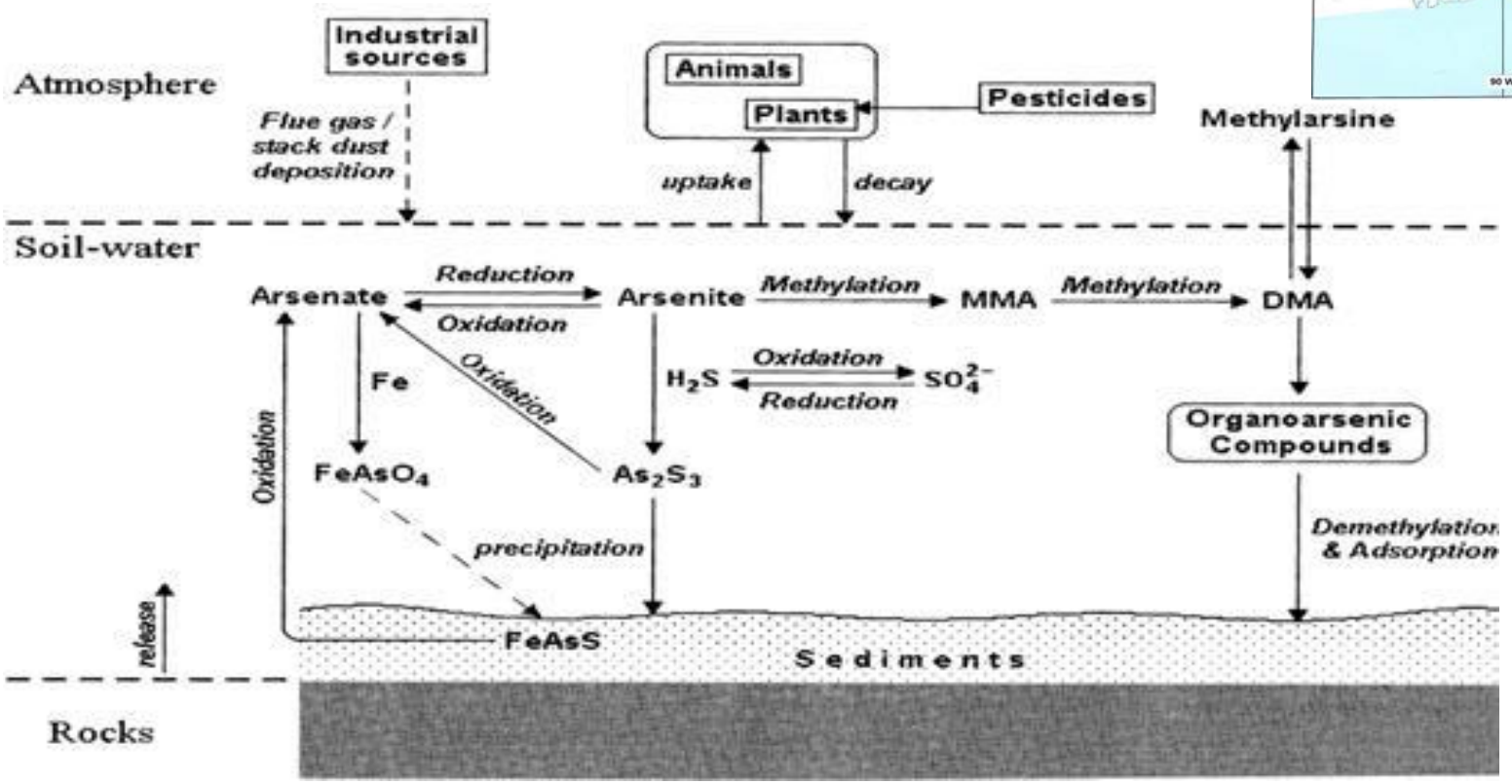


Arsenic in DW of Bangladesh; Natural or Anthropogenic?

National 50 ppb
WHO 10 ppb

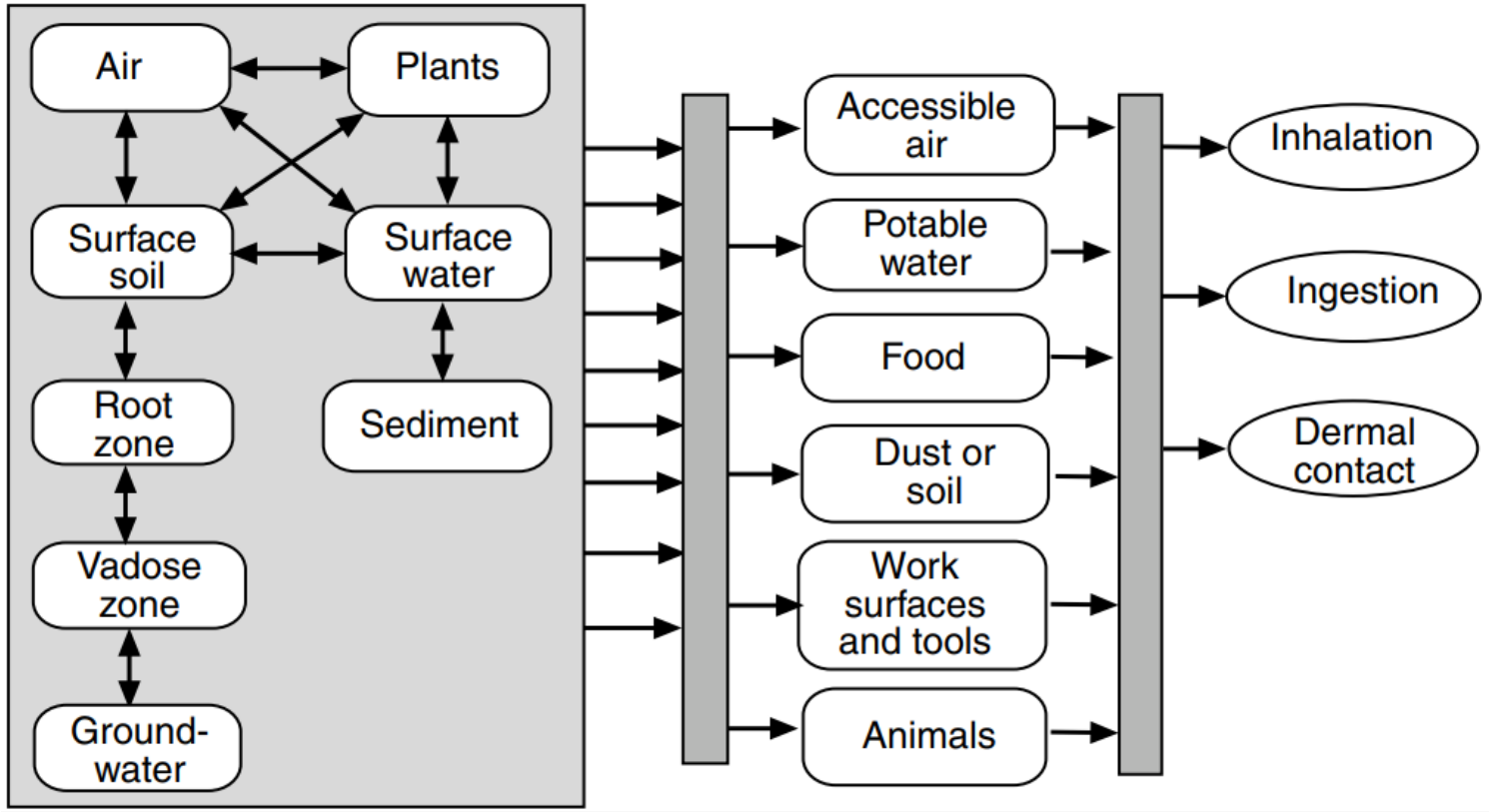


Roy P. and Saha A., 2002

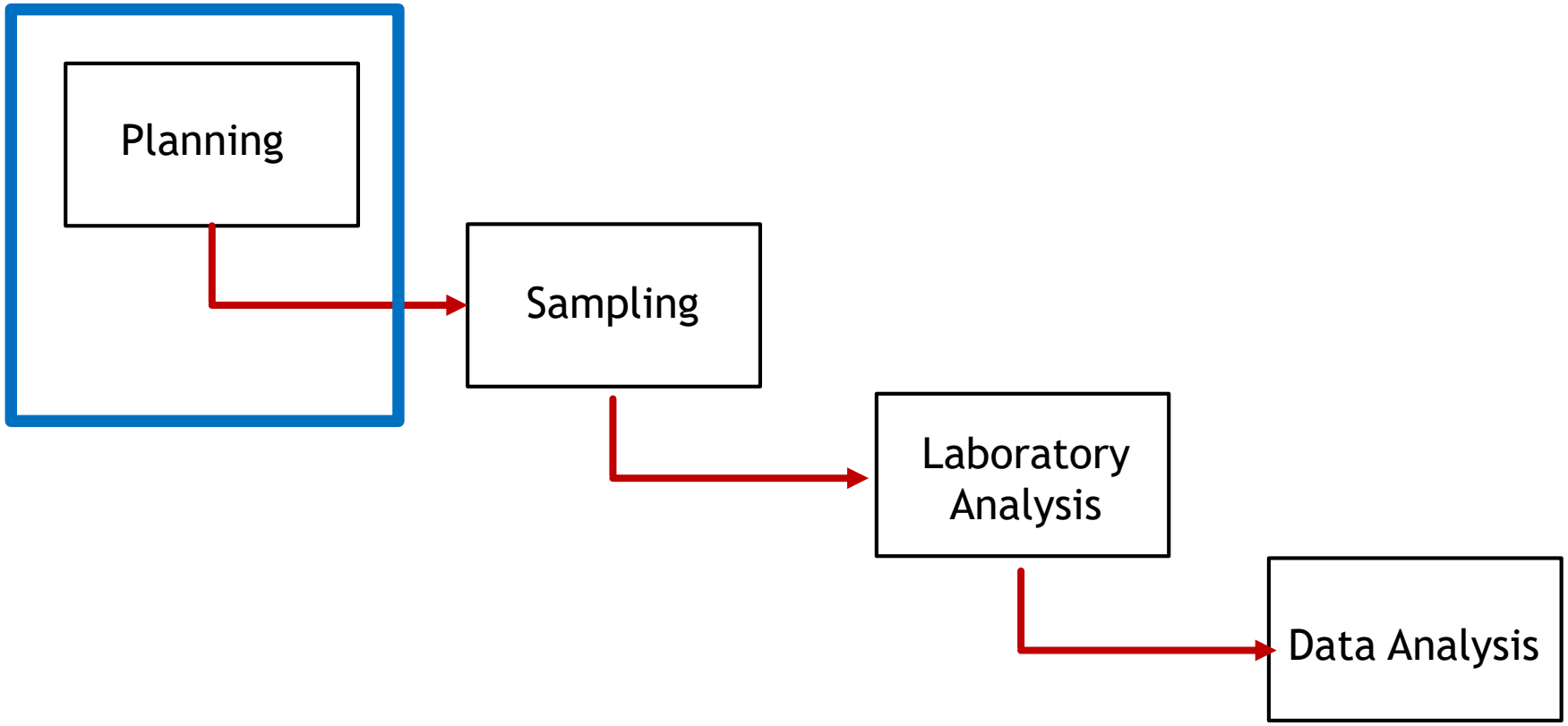


Environmental Components, Environmental Media, and Exposure Pathways

Eisenberg and McKone, 1998



How We Plan?
Environmental Monitoring 101



What to test in a wetland?

- A wetland that is surrounded by a paddy field.
- A wetland by a residential area.
- A wetland adjacent to an industrial park.
- A wetland has a major highway nearby.
- A wetland with maritime activities.
- A wetland with tourist attraction.

Key: What we do is what we test.

A wetland that is surrounded by paddy fields.

SPECIFIC FOCUS:

- Fertilizers both natural and industrial.
- Herbicides
- Pesticides
- Fungicides
- Metals
- Acute Toxicity, etc.

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

Key: What we do is what we test.

A wetland by a residential area.

SPECIFIC FOCUS:

- Herbicides
- Pesticides
- Fungicides
- Metals
- Oil and Grease
- VOC and SVOC
- Dioxin and Furans
- Antibiotics and viruses
- PCBs (including congeners), etc.

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

Key: What we do is what we test.

A wetland adjacent to an industrial park.

SPECIFIC FOCUS:

- Metals
- Oil and Grease
- VOC and SVOC
- Dioxin and Furans
- PCBs (including congeners)
- Microplastics
- Hexachromium
- What they manufacture?

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

Key: What we do is what we test.

A wetland has a major highway nearby.

SPECIFIC FOCUS:

- Metals
- Oil and Grease
- VOC and SVOC

Including GRO and DRO

- MTBE
- Tarball
- Tire residues
- What comes from vehicles

Key: What we do is what we test.

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

A wetland with maritime activities.

SPECIFIC FOCUS:

- Metals
- Oil and Grease
- VOC and SVOC

Including GRO and DRO

- MTBE
- Tarball
- PCBs (including congeners)
- Invasive species

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

Key: What we do is what we test.

A wetland with tourist attraction.

SPECIFIC FOCUS:

- Metals
- Oil and Grease
- VOC and SVOC

Including GRO and DRO

- PCBs

GENERAL:

- BOD, COD,
- EC, pH, Temperature,
- Residual Chlorine, TSS, TDS,
- Nutrients (all nitrogen and phosphorus contents,
- Coliform, Ecoli, etc.
- Cations and anions

Key: What we do is what we test.

Sampling Plan – Coverage

- Geographical: waterways, estuaries, stagnant locations, discharge locations, etc.
- Timing: monthly, quarterly, annual
- Type of sample: water, sediment, flora, fauna
- Right part of the sample: surface sediment vs. core
- Sampling after events: flooding, earthquake, peak activity season, opening or closing new activities (tourist, factory, etc.)
- Source points: wastewater plants, industrial parks, ports, etc.

- BUDGET: This is always a limiting factor. Plan accordingly and get partners to share expenses and results.

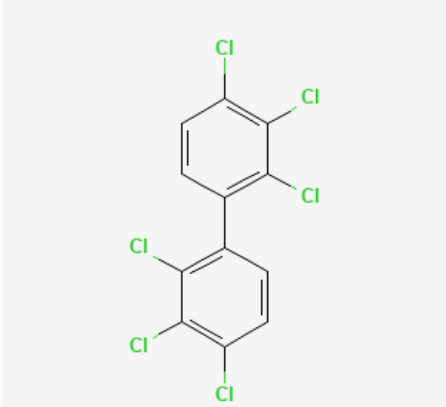
Summary of Toxicity Methods

				Discharge Limit (ug/l)	
Group	Sub Group	EPA	SM	To Aq	To Sea
Metals	Selected	200.8		0.2-10	0.2-10
	Selected	200.7		0.2-10	0.2-10
	Hg	245.1		0.2	0.2
Organics	VOC	624.1		0.2-5	0.2-5
	PCB	608		0.002-2.5	0.002-2.5
	SVOC	551		0.0038-0.95	0.0036-0.16
	PCB Congeners	1668C		2.5-5.0	2.5-5.0
	Other SVOC	525.2		0.001-5	0.001-5
		531.2		2.1	1.6
		515.3		<10	<10
	Dioxin	613		0.005	0.005
Inorganic	Hexchrom		3500	0.1	0.1
	Phenol	420		5	5

EPA	SM	
200.8		DETERMINATION OF TRACE ELEMENTS IN WATERS AND WASTES BY INDUCTIVELY COUPLED PLASMA - MASS SPECTROMETRY
200.7		DETERMINATION OF METALS AND TRACE ELEMENTS IN WATER AND WASTES BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY
245.1		DETERMINATION OF MERCURY IN WATER BY COLD VAPOR ATOMIC ABSORPTION SPECTROMETRY
624.1		Volatile Organic Carbons by Purgeable by GC-MS
608		Organochlorine Pesticides and PCBs by GC/Halogen Specific Detector
551		Determination of Chlorination Disinfection Byproducts, Chlorinated Solvents, and Halogenated Pesticides/Herbicides in Drinking Water by Liquid-Liquid Extraction and Gas Chromatography With Electron-Capture Detection
1668C		Determination of chlorinated biphenyl (CB) congeners for wastewater, surface water, soil, sediment, biosolids, and tissue matrices by isotope dilution high reolution GC and high resolution MS
525.2		Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry
531.2		DETERMINATION OF CHLORINATION DISINFECTION BYPRODUCTS, CHLORINATED SOLVENTS, AND HALOGENATED PESTICIDES/HERBICIDES IN DRINKING WATER BY LIQUID-LIQUID EXTRACTION AND GAS CHROMATOGRAPHY WITH ELECTRON-CAPTURE DETECTION
515.3		Determination of Chlorinated Acids in Drinking Water by Liquid-Liquid Extraction and Gas Chromatography With Electron-Capture Detection
613		2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN by GC-MS
	3500	3500-Cr B. Colorimetric Method
420		DETERMINATION OF TOTAL RECOVERABLE PHENOLICS BY SEMI-AUTOMATED COLORIMETRY

PCBs: An Example

Polychlorinated Biphenyls



Aroclor 1260

- Contains Hydrogen, Carbon and Chlorine
- Manufactured from 1929 and 1979 and fully man-made
- Resist heat and boiling thus they are persistent in the environment
- Electrical, heat transfer, paint, plastic, hydraulic equipment
- Monitored in the U.S under CFR-40 (Code of Federal Regulations)
- Cause cancer, affecting reproductive system, nervous system, endocrine disturbance

- Oil based paint to water based paint to eliminate PCBs

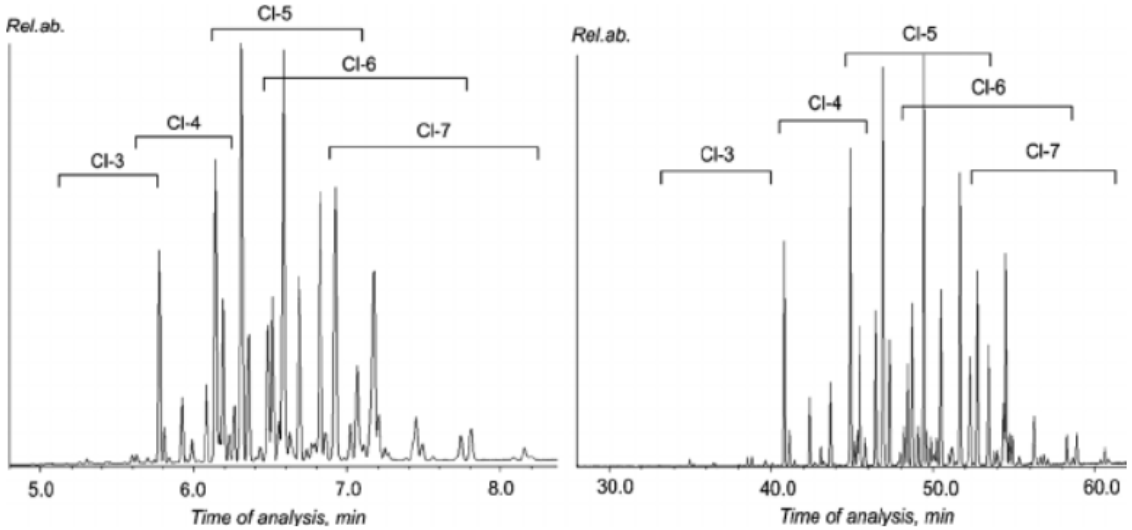
PCB Types

Table of PCB Species by Congener Number

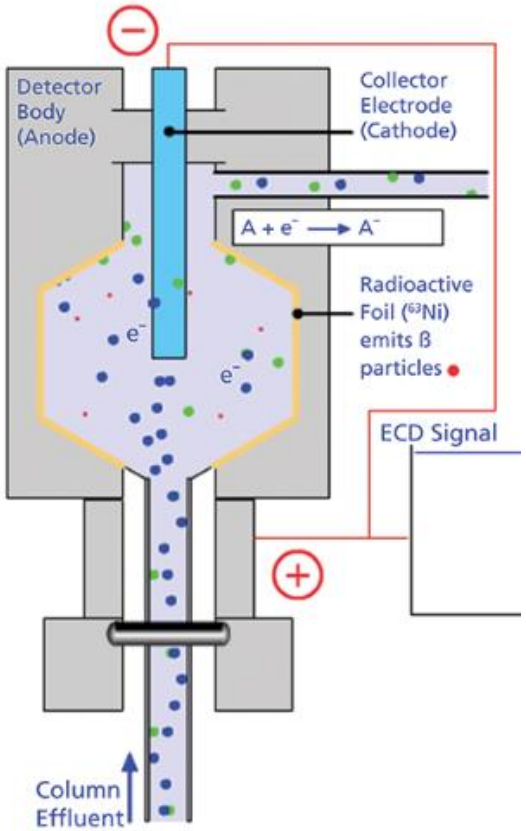
Descriptor*	CASRN	Congener Number	IUPAC Name	Type
	1336-36-3		Polychlorinated biphenyl (PCB)	Category
CP1_---_--_-	2051-60-7	1	2-Chlorobiphenyl	Congener
CP0_---_--_-	2051-61-8	2	3-Chlorobiphenyl	Congener
CP0_---_--_-	2051-62-9	3	4-Chlorobiphenyl	Congener
---_---_--_-	13029-08-8	4	2,2'-Dichlorobiphenyl	Congener
CP1_---_--_-	16605-91-7	5	2,3-Dichlorobiphenyl	Congener
CP1_---_--_-	25569-80-6	6	2,3'-Dichlorobiphenyl	Congener
CP1_---_--_-	33284-50-3	7	2,4-Dichlorobiphenyl	Congener
CP1_---_--_-	34883-43-7	8	2,4'-Dichlorobiphenyl	Congener
CP1_---_--_-	34883-39-1	9	2,5-Dichlorobiphenyl	Congener
---_---_--_-	33146-45-1	10	2,6-Dichlorobiphenyl	Congener
CP0_---_--_2M	2050-67-1	11	3,3'-Dichlorobiphenyl	Congener
CP0_---_--_-	2974-92-7	12	3,4-Dichlorobiphenyl	Congener

Table of Aroclors

CASRN	IUPAC Name	Type
12674-11-2	Aroclor 1016	Mixture
147601-87-4	Aroclor 1210	Mixture
151820-27-8	Aroclor 1216	Mixture
11104-28-2	Aroclor 1221	Mixture
37234-40-5	Aroclor 1231	Mixture
11141-16-5	Aroclor 1232	Mixture
71328-89-7	Aroclor 1240	Mixture
53469-21-9	Aroclor 1242	Mixture
12672-29-6	Aroclor 1248	Mixture
165245-51-2	Aroclor 1250	Mixture
89577-78-6	Aroclor 1252	Mixture
11097-69-1	Aroclor 1254	Mixture
11096-82-5	Aroclor 1260	Mixture
37324-23-5	Aroclor 1262	Mixture
11100-14-4	Aroclor 1268	Mixture
12767-79-2	Aroclor (unspecified)	Mixture

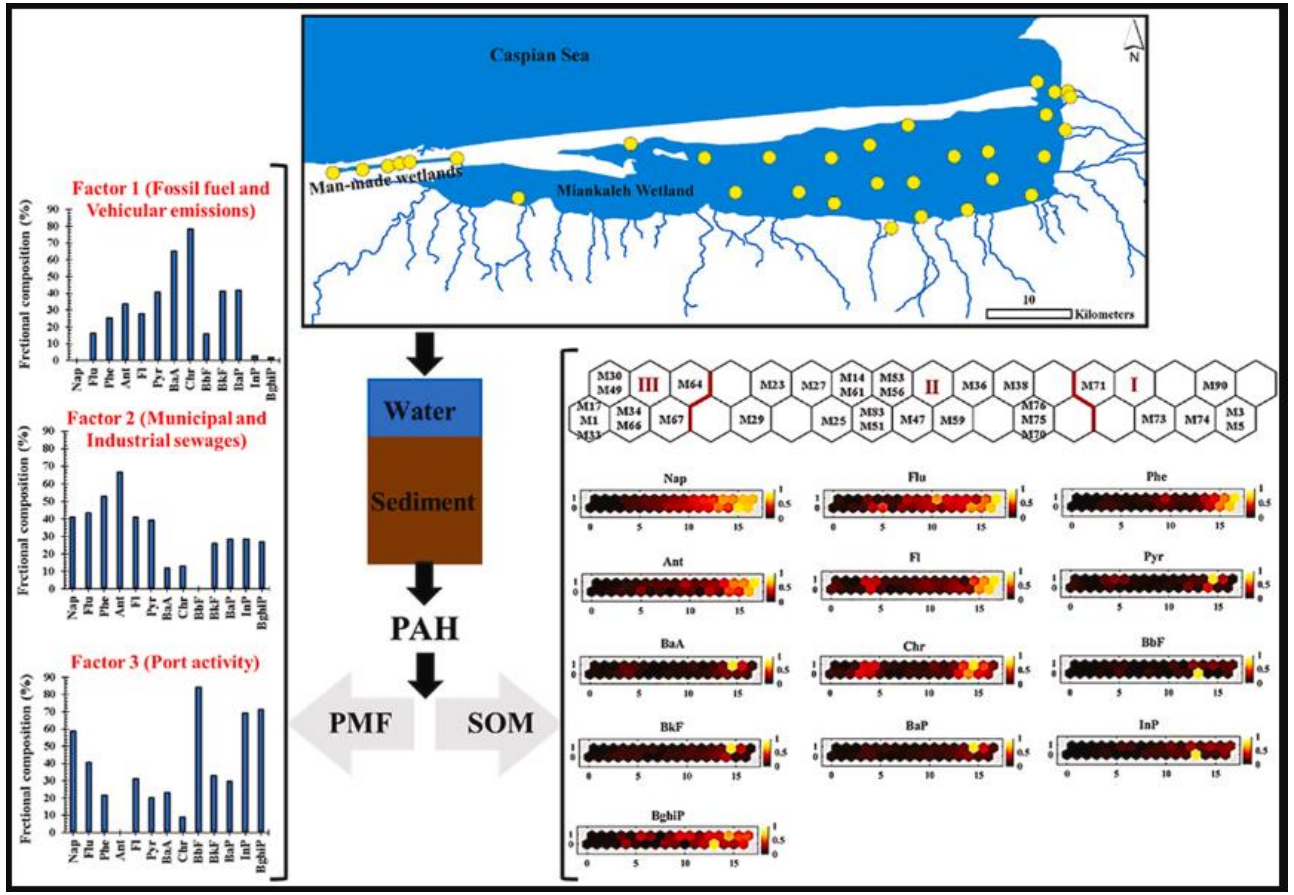


Fragments of the mass chromatograms of the standard Aroclor 1254 mixture (total PCB concentration is 20 ng = m l) with PCB isomer group windows during the chromatographic run by GC-MS = SIM. On chromatograms obtained at a column temperature gradient from 80 to 310 C at a heating rate of 40 C = min the number of identified congener peaks is 73 (left), and at the heating rate of 3 C = min, the number of identified congener peaks is 77 (right).



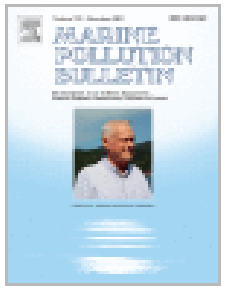
SVOC: PAHs

Rokhbar et al, 2020, Chemospher Volume 321, April 2023, 138140



Marine Pollution Bulletin

Volume 172, November 2021, 112864

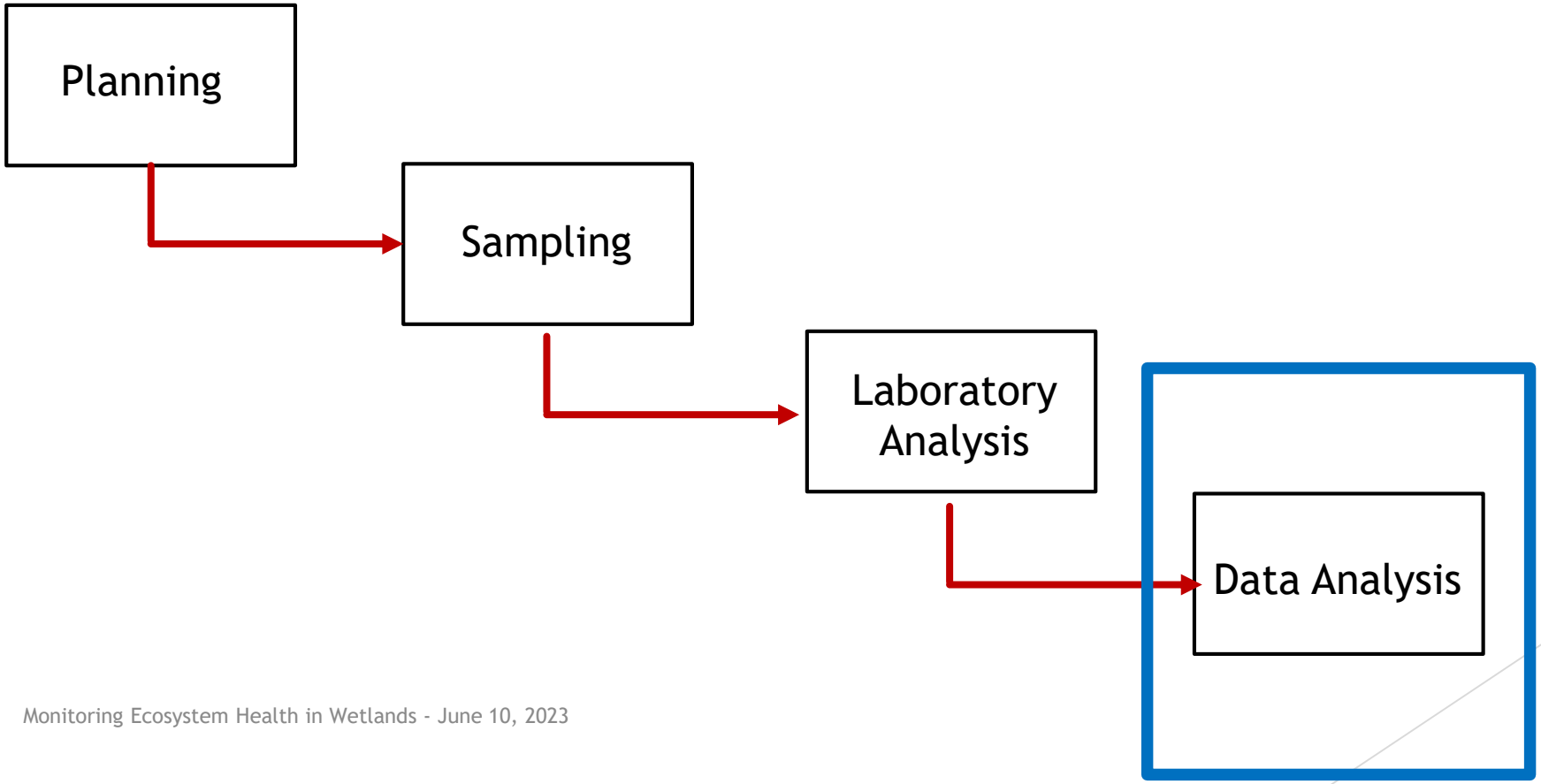


Persistent organic pollutants (POPs) in coastal wetlands: A review of their occurrences, toxic effects, and biogeochemical cycling

Lautaro Girones [a], Ana L. Oliva [a], Vanesa L. Negrin [a b], Jorge E. Marcovecchio [a c d], Andrés H. Arias [a e]

Show more

How We Plan?
Environmental Monitoring 101



Adhere to a or a combination of 2 or more benchmarks

- EPA, State, National, Provincial, WHO guidelines
- Pre-date benchmark such as Pre-1990s
- Comparing to aquatic, drinking water, or marine water standards

- Note: We **do not** determine the discharge limit for point source activities.

Data Interpretation

- Background values: Geochemistry and soil chemistry, etc. (As, Cr, Li, Ni)
- Economic activities: abandoned mining sites,
- Services: Dams, dumping sites, transport, oil terminal, pipelines, etc.
- Urban structures: bridges, water hosing, (Pb, Cu, etc.)
- Naturally occurring and elevated spikes (Al, Fe, Na, K)
- Transboundry effects; grasshopper effects, local transportation, radioactive
- Check all quality control measures of laboratory; get the QC report to review.
- Do a root cause analysis to find out why things are the way they are.
- Suggest corrective actions and help planning the implementation.

Q&A

Let’s Connect!

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