Minor Projects on Water & Soil Analysis

Minor Projects on Water and Soil Analysis

Workshop on Student Projects for B.Sc. Chemistry (Core)
07th September 2012
Department of Chemistry, UoK, Kariavattom Campus, Trivandrum

Joined Programme of DoC & ACT

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OUTLINE

- Water distribution
- Physic-chemical parameters
- Instruments & accessories
- Analytical Procedures
- General methodology
- Type of research projects
- Proposed titles for research programme
- Major ion Chemistry (Modeling)

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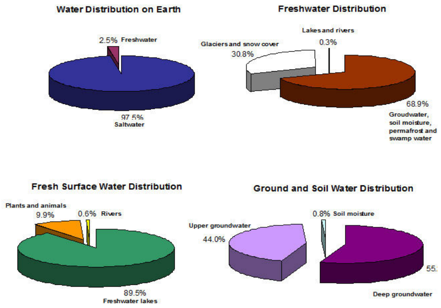
WATER DISTRIBUTION



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Physic-chemical Parameters

pH, Temperature, Turbidity, Conductivity, DO, TDS, TSS, BOD

Alkalinity, Acidity, Hardness

<u>Major ions</u>
Cations: Ca, Mg, Na, K
Anions: SO_4^{2-}, HCO_3^-, Cl^-, CO_3^{2-}

<u>Minor ions</u>
Cations: Fe, Ba, Mn
Nutrients: NO_3^-, NO_2^-, NH_3, PO_4^{3-}, SiO_4^{4-}

<u>Trace ions</u>
Heavy metals (Hg, Cd, Pb, Zn, Cu)

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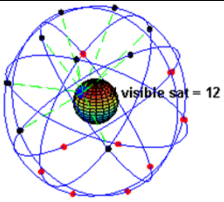
INSTRUMENTS & ACCESSORIES

FIELD
GPS, High end Camera
Portable Water Quality Analyser

Bottles (Normal type, DO Bottles, BOD Bottles)
Bucket, Mug and funnels, Vials for microbiology, measuring tape, rope, filter papers, Secchi disc

LAB
Bench type multiparameter analyser, Turbidimeter, Spectrophotometer, Flame photometer, Cadmium column, APHA (analytical manual)



GPS (Global Positioning System)
Application: Latitude (N) and Longitude (E)
GPS is a space based satellite navigation System that provides location and time information in all weather, anywhere on o. near the Earth, where there is an unobstructed line of sight to four or more GPS satellites
It is maintained by the DoD, United States Govt. and is freely accessible to anyone with a GPS receiver
(24 satellites, fully operated in 1994)

Portable Water Quality Analyser
Applications: pH, Temperature, Conductivity, TDS, DO, ISE (Ion Selective Electrode)

Make: 1. WTW 350i, German (Rs. 2.0-3.0 lakhs)
2. Thermo Orion, USA (1.0-1.75 lakhs)
3. Eutech, Singapore (1.0-1.75 lakhs)
4. Elico, India (0.3-0.5 lakhs)

Bench Type Multiparameter Analyser
Applications: Same as above

Make: 1. WTW German (Rs. 2-4 lakhs)
2. Thermo Orion, USA (1.00-2.25 lakhs)
3. Eutech (simultaneous analysis of 4 parameters) Singapore (2.00 lakhs), Deluxe Model (0.70 lakhs)
4. Elico, India (0.75 lakhs)

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Flame photometer

Na & K
Ca & Ba

Spectrophotometer

cations & anions
Dyes
(Colorimetry)

Cadmium column

Turbidity meter

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ANALYTICAL PROCEDURES

***Insitu* Analysis**

- Water temperature, pH, Electrical Conductivity & DO are measured insitu with water quality analyzer

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ALKALINITY

- Alkalinity in natural waters are caused by OH^-, CO_3^- and HCO_3^-
- Reagents- 0.02N H_2S0_4 , mixed indicator (Methyl Orange + bromocresol green indicator)
- Procedure- It is estimated by titrating 25 ml sample with standard H_2SO_4 using mixed indicator. End point- colour change from blue to green.
- Alkalinity as mg/L of CO_3^{2-} = Titer value x 1000/Vol. of spl
- Hence amount of HCO_3^- = amount of CO_3^{2-} x 1.22 mg/L

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ACIDITY

- Acidity of water is its quantitative capacity to react with a strong base to a designated pH
- Reagents- 0.02 NaOH, , phenolphthalein indicator.
- Procedure- It is estimated by titrating 25 ml sample with standard NaOH using phenolphthalein indicator. End point- colour change from pink to colourless.
- As each mL of 0.02 NaOH = 1 mg $CaCO_3$

  Acidity as mg/L $CaCO_3$ = Titer value x 1000/Vol of spl

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TOTAL HARDNESS

- Water hardness- measure of the capacity of water to precipitate soap.
- Reagents - 0.01 M EDTA, NH_4Cl-NH_4OH buffer, Eriochrome Black- T indicator.
- Procedure- It is estimated by titrating 50 ml sample with standard EDTA + 1ml buffer, using Eriochrome Black- T indicator. End point- colour change from wine red to blue.
- Total hardness (as $CaCO_3$ mg/L) = Titer value x 1000/vol spl

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CALCIUM HARDNESS AND MAGNESIUM HARDNESS

- Reagents - 0.01 M EDTA, 1N NaOH as buffer, Murexide indicator.
- Procedure for Ca hardness- It is estimated by titrating 50 ml sample with standard EDTA + 1ml buffer, using Murexide indicator. End point- colour change from pink colour to purple.

Calcium hardness as $CaCO_3$ (mg/L) = Titer value x 1000/vol spl

- Magnesium – determined by calculating the difference between total hardness and calcium hardness of sample.

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CHLORINITY

- Chloride in aqueous solution is not stable and the chlorine content of the sample decreases rapidly.
- Estimated by Argentometric method.
- Reagents – 0.01N $AgNO_3$, K_2CrO_4 indicator.
- Procedure- It is estimated by titrating 50 ml sample + 3 drops of K_2CrO_4 indicator using standard $AgNO_3$. End point- colour change from yellow colour to dirty orange.
- Amount of chlorine = N_{AgNO3} x Titer value x 1000/vol spl

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SULPHATE

- The sulphate ion is one of the major anions occurring in natural waters.
- It is estimated by turbidimetric methods.
- Reagents – Barium chloride crystals
- Procedure- 25ml sample + few barium chloride crystals- shake well- light absorbance of $BaSO_4$ measured spectrophotometrically at 420nm.

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Na and K

- Na and K estimation- based on emission spectroscopy.
- Trace amounts of Na and K can be determined by flame emission photometry.
- Intensity of light measured by photodetector.

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SILICATE

It is estimated by colorimetric methods.

- Reagents – ammonium molybdate, 10% $H_2C_2O_4$ and ascorbic acid solution
- Procedure- 20ml sample + 1 mL ammonium molybdate + 1mL 10% $H_2C_2O_4$ + 0.5 mL ascorbic acid solution. Blue color developed- measured spectrophotometrically at 810nm.

Calculation

For the three standards, the concentrations are 25, 50 & 75 μg/mL, which is C_1, C_2, C_3

F = Concn/Abs

$f_1 = C_1$/Abs, $f_2 = C_2$/Abs and so on

$F = f_1+f_2+f_3/3$, S = Fx1000/vol spl

If it is diluted, a dilution factor is also multiplied

Amount of silicate = Abs x S

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IRON

- It is estimated by colorimetric methods.
- Reagents – 1:1 HCl, hydroxyl amine hydrochloride, ammonium acetate buffer and 1,10- phenanthriline.
- Procedure- 50ml sample + 1mL1:1 HCl +1mL hydroxyl amine hydrochloride- reduced to 20 ml, add 5ml ammonium acetate buffer + 5ml 1,10- phenanthriline. Light orange colour developed- measured spectrophotometrically at 510nm.
- Amount of iron in mg/L=Absorbance x S

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NITRITE- NITROGEN

- Nitrite is found in waters by oxidation of ammonia compounds or by reduction of nitrate.
- It is estimated by colorimetric methods.
- Reagents – Sulphanilamide, NNED.
- Procedure- 20ml sample + 0.5 ml Sulphanilamide + 0.5 ml NNED. Pink colour developed- measured spectrophotometrically at 540nm.
- Amount of NO_2-N in µg/L=Absorbance x S

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NITRATE- NITROGEN

- Nitrate in water is reduced to nitrite by passing through reduction column.
- Reagents – NH_4Cl buffer, Sulphanilamide, NNED.
- Procedure- 50ml sample + 50ml buffer- passed through cadmium column. Last 20ml of reduced sample collected +0.5 ml Sulphanilamide + 0.5 ml NNED. Pink colour developed- measured spectrophotometrically at 540nm.
- Amount of NO_3-N in µg/L=Absorbance x S

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INORGANIC PHOSPATE

- Phosphorus occurring as orthophosphate can be measured colorimetrically.
- Reagents –mixed reagent (ammonium molybdate + 9N H_2S0_4) and ascorbic acid solution
- Procedure- 20ml sample + 0.5 mL mixed reagent + 0.5 mL ascorbic acid solution. Blue color developed- measured spectrophotometrically at 880nm.
- Amount of PO_4^{3-} in µg/L=Absorbance x S

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FLUORIDE

- Fluoride is more common in ground water than in surface water. It is estimated by colorimetric methods.
- Reagents – mixed reagent (equal volumes of SPADNS solution and zirconyl acid reagent mixed together).
- Procedure- 90ml sample + 10ml of mixed reagent. Deep red color developed- measured spectrophotometrically at 570nm.
- Amount of F^- in µg/L=Absorbance x S

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Rock/Sediment/Soil - Analysis

- **Texture, Particle Size, nutrients/metal constituents**
- **X-RD (Rs. 200/- sample)**

Metal oxides

X-RF (Rs. 200/- sample)

Major (Si, Ti, Mn, Fe Ca, Mg, Na, K, P etc) and minor elements (V, Cr, Co, Ni, Cd, Pb, Zn, La, Ba, Ce, Th, Sr etc)

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General Methodology

FIELD WORK

- **System Identification (Riverine based, Marine Based)**
- **Study Area: Locating & Mapping**
- **Land use & Physical processes**
- **Sampling (water & soil)**
- **In situ and naked eye analysis**
- **Lab analysis**
- **Data Processing**
- **Evaluation of Data**
- **Modeling and Interpretation**

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GPS-Locate and Map (GIS-Geographic Information System)

S T U D Y A R E A

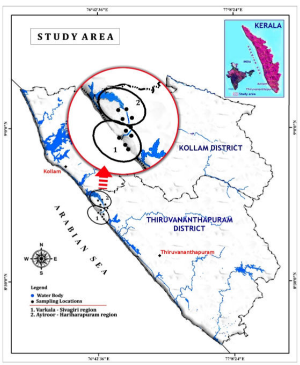

Fig.1 Study Area

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Field Data Sheet (Freshwater)

Field Data Sheet for Fresh Water Sampling

Lat. & long.:
Panchayat:
Block:
District:
River basin:

Physiography: Lowland/Midland/ High land
Geology: Khondalitic /Granitic /Charnockite
Geomorphology: Plateau/valley fills/ Coastal
Soil type: Laterite, Clay, Sandy clay, Silty clay etc

Nature of Pond: With lateritic exposures inside, eutrophic
Type: Perennial
Storage structure/structural protection if any: protected
Land use : Mixed/ cultivated /irrigated/
Present usage: Bathing, washing & agricultural purposes

Parameters	Value
pH	
E_h, mV	
Conductivity, µS/cm	
DO, mg/L	
DO, %	
Temperature, °C	

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Field Data Sheet (Marine)

CENTRE FOR EARTH SCIENCE STUDIES															
Date & Frequency of Sampling	Field Data Sheet for Marine Sampling														
	Station Name:-														
	GPS Data:-														
	6.00 Hrs			9.00 Hrs			12.00 Hrs			15.00 Hrs			18.00 Hrs		
Atmospheric temp.(°C)															
State of the sea															
Froarthiness															
Floating Matter															
Station depth(m)															
Tide															
Transperancy (m)															
Salinity (psu)															
	Surface	Mid	Bottom	Surface	Mid	Bottom	Surface	Mid	Bottom	Surface	Mid	Bottom	Surface	Mid	Bottom
Colour(HU)															
Odour															
Water temperrature - °C															
pH															
Conductivity (µS/mS)															
Eh (mV)															
DO(mg/L)															
Turbidity (NTU)															
BOD															
Site Obsevation & Reamarks															

Name and Designation of Data entered person:

Signature with date:

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Land Use & Physical Processes

Visual Observation:

Type of agricultural activities, industries (local/small scale/etc) Presence of Road/bridges/etc, In general, manmade activities

Natural observations

Heavy rain, Strong wind, Geomorphology, Geology

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Sampling

Niskin Water Sampler (Deep Water), Bottom Sampler (just 2/3 m), Simple pot (surface water sampling-Bucket)

Floating particulates should be removed during sampling

Labelling most important (including date and time of collection)

Normally, 2 L of water sample is required for Major ions and nutrient analysis (1 L each)

1 L for Heavy metals (fixed using conc. HNO_3, pH < 2.0)

1 L for major ions and nutrients

But for DO and BOD, separate bottles (250 mL and 300 mL, respectively)

Preserving Temp. for all samples: < 5.0°C

DO – fix using Winkler A & B

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Research Project Type: 1

Focus on River basin

Eg: Neyyar Basin

System: five Ponds, Five Well water, Five river water samples (Total 15 sampling points)

GPS Lat (N) and Long (E)

For each sampling point cover the land use

Water & Soil Samples – Initial observation

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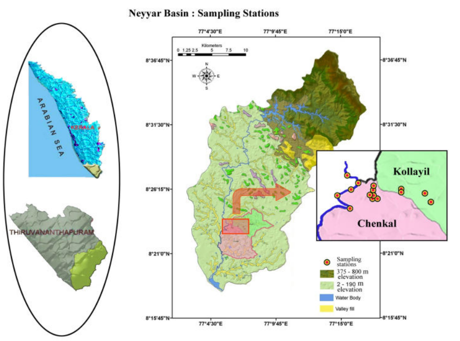
STUDY AREA



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Lat. & long. : N 8° 23' 8'' E 77° 06' 18.2''
Municipality : Neyyattinkara, Ward- 30
Block : Perumkadavila
District : Thiruvananthapuram
River basin : Neyyar
Physiography : Lowland
Geology : Khondalite/Migmatite complex
Geomorphology : Lower lateritic plateau/valley fills
Soil type : Very deep well drained gravelly clay soils
Nature of well : Developed with scanty vegetation inside
Type : Perennial
Storage structure/structural protection if any: Well protected
Land use : Mixed crops; dominance of coconut cultivation/paddy
Well Depth (m) : 3.75
Present usage: One family used for drinking, bathing and washing purposes

Well (*W1*)
Location : Amaravila

Parameters		Value	Parameters		Value
pH		5.58	Total N,	µg/L	56.78
Conductivity,	µS/cm	301	Total P,	µg/L	138.2
DO,	mg/L	2.02	PO_4	µg/L	131.9
BOD,	mg/L	0.18	Fluoride,	µg/L	287.83
Turbidity	NTU	3.75	Silicate,	mg/L	44.9
Alkalinity,	mg/L	53.68	Ca,	mg/L	67.3
Acidity	mg/L	5.2	Mg,	mg/L	29.1
Chloride,	mg/L	44.24	Na,	mg/L	22.9
Sulphate,	mg/L	22.82	K,	mg/L	4.1
Hardness,	mg/L	288	Fe,	µg/L	BDL
Nitrite -N,	µg/L	3.75	TDS,	mg/L	215
Nitrate -N,	µg/L	50.80	TSS	mg/L	12

Lat. & long. : N 8° 23' 0.4'' E 77° 7' 15.7''
Panchayat : Kollayil, Ward-2
Block : Perumkadavila
District : Thiruvananthapuram
River basin : Neyyar
Physiography : Lowland
Geology : Khondalite/Migmatite complex
Geomorphology : Lower lateritic plateau/valley fills
Soil type : Very deep well drained gravelly clay soils
Nature of Pond : With lateritic exposures inside, eutrophic
Type : Perennial
Storage structure/structural protection if any: protected
Land use : Mixed crops with the dominance of plantain, tapioca, rubber & coconut
Present usage : > 250 families intensively used for bathing, washing & agricultural purposes

Chirakkulam(P1)
Location : Eythukondankani

Parameters		Value	Parameters		Value
pH		6.1	Total N,	µg/L	41.18
Conductivity,	µS/cm	77.2	Total P,	µg/L	182.07
DO,	mg/L	5.29	PO_4	µg/L	150.7
BOD,	mg/L	1.85	Fluoride,	µg/L	159.61
Turbidity	NTU	16.8	Silicate,	mg/L	29.8
Alkalinity,	mg/L	29.28	Ca,	mg/L	20.8
Acidity	mg/L	20.8	Mg,	mg/L	13.6
Chloride,	mg/L	14.46	Na,	mg/L	5.0
Sulphate,	mg/L	4.32	K,	mg/L	0.9
Hardness,	mg/L	108	Fe,	µg/L	109.9
Nitrite -N,	µg/L	0.89	TDS,	mg/L	55.14
Nitrate -N,	µg/L	15.1	TSS	mg/L	19.2

Lat. & long. : N 8° 23' 22'' E 77° 05' 52''
Panchayat : Chenkal
Block : Perumkadavila
District : Thiruvananthapuram
River basin : Neyyar
Physiography : Lowland
Geology : Khondalite/Migmatite complex
Geomorphology : Lower lateritic plateau/valley fills
Soil type : Very deep well drained gravelly clay soils
Nature of the site : Heavy flow& land slumping, sand mining with thick riparian vegetation
Structural protection if any: Protected with Checkdam
Riparian vegetation : Trees, Climbers, herbs & shrubs
Present usage : Human usage in large scale, agricultural & irrigation

Neyyar (R1)
Location : Amaravila bridge

Parameters		Value	Parameters		Value
pH		6.16	Total N,	µg/L	31.81
Conductivity,	µS/cm	84.98	Total P,	µg/L	117.2
DO,	mg/L	6.33	PO_4	µg/L	110.1
BOD,	mg/L	1.69	Fluoride,	µg/L	231.57
Turbidity	NTU	8.13	Silicate,	mg/L	31.4
Alkalinity,	mg/L	19.52	Ca,	mg/L	20.8
Acidity	mg/L	11	Mg,	mg/L	12.64
Chloride,	mg/L	30.61	Na,	mg/L	3.9
Sulphate,	mg/L	7.92	K,	mg/L	1.2
Hardness,	mg/L	104	Fe,	µg/L	244.3
Nitrite -N,	µg/L	1.97	TDS,	mg/L	60.7
Nitrate -N,	µg/L	20.37	TSS	mg/L	34.8

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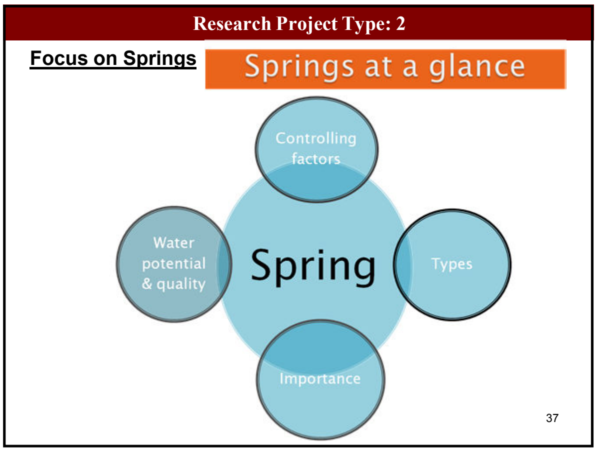

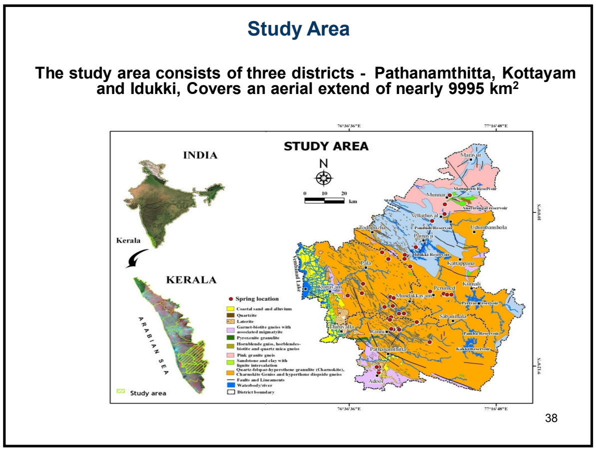

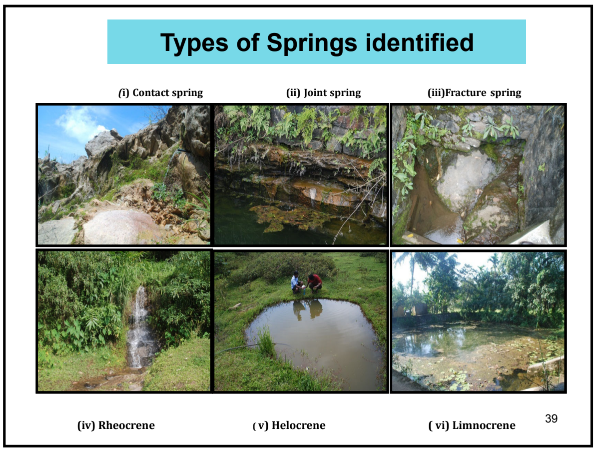

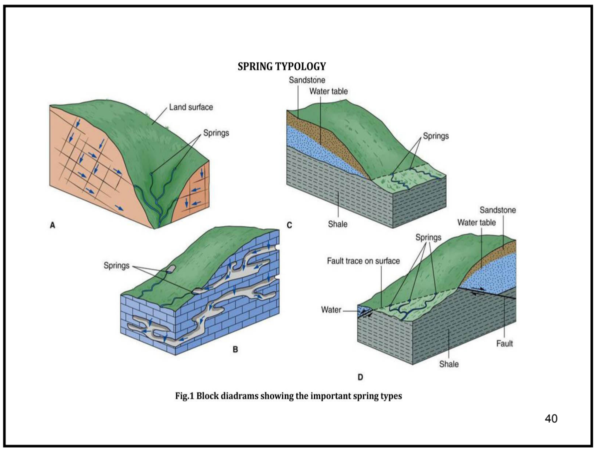

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Spring classes identified:

- ***Contact spring:*** *Water discharges where the contact zone between the strata intersects the land surface*
- ***Joint Spring:*** *Occurs along joints, fractures or faults where they intersect the land surface*
- ***Fracture spring:*** *The fracture zone between two opposing rock strata provides a flow path for groundwater to discharge*

- ***Spring typology:***
- ***Rheocrene:*** *Spring's discharges form a flowing stream*
- ***Helocrene:*** *Small springs (seepages) form a spring-fed marsh*
- ***Limnocrene:*** *Spring dischrges through the bed of a pond or lake*

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Utilization of Spring

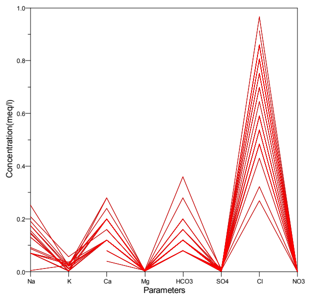
Direct method

Pumping

Major Ions

❖Ca^{2+} and Na^{+} are dominating *cations*

❖Cl^{-} and $HCO3^{-}$ are dominating *anions*



Schollinger diagram

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Heavy metals

Zn- 0.006 - 4.432
Pb- 0.066 - 0.184
Cd- 0.002 - 0.022
Cu- 0.002 - 0.887

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Quality comparison with BIS & WHO

Parameters	BIS(2007)	WHO(2007)	Springs of Central Kerala
Colour	5 HU	Pt.scale 5	<2HU
Odour	Agreeable	Un objectionable	Agreeable
pH	6.5- 8.5	7.0- 8.5	4.81-6.67
Turbidity	10 NTU	2.5 JTU	0.09-13.0
TDS	500 mg/l	500 mg/l	15.81-236.0
Nitrate	50 mg/l	50 mg/l	0.0003-15
Sulphate	250 mg/l	250 mg/l	0.00-0.59
Chloride	250 mg/l	250 mg/l	9.52-34.29
Hardness	300 mg/l	200 mg/l	0.00-18.0
Calcium	75 mg/l	75 mg/l	0.80-5.61
Magnesium	30 mg/l	30 mg/l	0.00-0.0729

BIS. (2007), Bureau of Indian Standards, http;//www.cfeindia.org/misc/cola-indepth/cola 2006/pdf/BIS-standard.pdf.
WHO.(2007),WorldHealthOrganization,http;//www.who.ing/water_sanitation_health/dwq/gdwq 05-06.pdf .

Key Findings

- *Lack of awareness among public*
- *Unscientific agricultural/developmental activities in spring head region*
- *Irrational land use changes curtains the 'Spring boils'*
- *Lack of proper approach pathway towards Spring region*
- *Insanitation is a common scene*
- *Lack of protective measures in spring fed catchment areas*
- *>20% of observed springs are on the verge of destruction*

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Conclusion

- Spring water is generally acidic (4.81-6.67) in nature
- EC ranges from 22.14 to 330.4 μS/cm with an average of 57.5 μS/cm indicating low range of dissolved salts
- TDS varies between 15.81 to 236 mg/l with an average of 41.06 mg/l
- Major ion concentration was lowest
- Low concentration of nutrients were noted
- Chemical quality satisfies BIS/WHO (Table1) drinking water standards (except pH)
- Human settlements are associated with the surroundings of springs

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- Protected springs are mostly in association with temples having good water potential
- Highland and midland regions are enriched with springs and most of them are used by local people (using tubes and other pumping measures)
- The heavy metal contents (Zn, Cd, Pb and Cu) noticed in some springs may be an indication of pesticide impact
- Presence of *coliforms*, *Faecal streptococci* indicates anthropogenic source of contamination
- *Chromobacterium violaceum* species which is non ubiquitous in spring waters were identified in several samples point towards need of proper maintenance and management of spring resources

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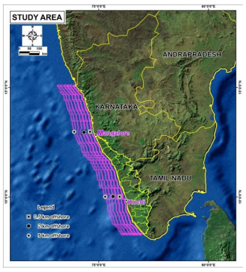
1. Aaliyirakkam Spring (S1)

Typology: Contact Spring
Location: Arthanareeswara temple, Chilakkoor
Lat. & Long: N8˚43'12″ E 76˚42'58″
Municipality: Varkala, Ward-19
Block: Varkala
District: Thiruvananthapuram
River basin: Ayiroor
Physiography: Coastal zone/lowland
Geology: Clay with lignite seams
Geomorphology: Coastal plain/lower lateritic plateau
Soil type: Very deep well drained gravelly clay soil
Nature of Spring: Undeveloped, with thick natural vegetation.
Genesis: Perennial
Storage structure/ structural protection if any: Nil storage/protection structure
Spring Environment: Beach/cliffs herbs and shrubs
Flow rate (LPM): 17
Present usage: > 400 people use for drinking, bathing, and washing.

Parameters	Value	Parameters	Value
pH	4.14	PO_4, µg/l	50.6
Conductivity, µS/cm	228	TP, µg/l	112.03
DO, mg/l	6.61	Fluoride, µg/l	86
BOD, mg/l	3.11	Silicate, mg/l	3.6
Alkalinity, mg/l	4	Ca, mg/l	3.2
Chloride, mg/l	36.1	Mg, mg/l	2.91
Sulphate, mg/l	4.58	Na, mg/l	21.4
Hardness, mg/l	20	K, mg/l	0.9
Nitrite-N, µg/l	0	Fe, µg/l	73
Nitrate-N, µg/l	1107	TDS, mg/l	173.28
TN, µg/l	1536	TSS, mg/l	3.7

Research Project Type: 3

Focus on coastal ocean



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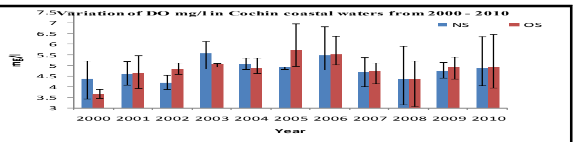

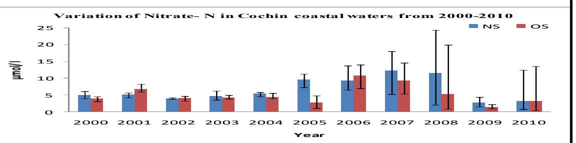

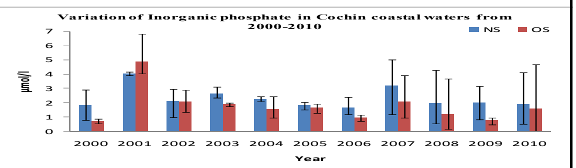

Major Ion Chemistry

- Water derives some of the dissolved chemicals such as HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}, SiO_2, SO_4^{2-}, and several others due to chemical interaction between soil mineral matter, rocks below the soil and contributions from rain, moisture and air
- The solute load of the water --- TDS ---- affect the quality of water
- Weathering plays an important role in buffering of surface and ground waters (soluble basic cations: Ca, Mg, K and Na)
- In General, Dissolved constituents in water *indicates* Geological Evolution, mode of origin with in the hydrological cycles, soil or rock mass influences, influence of flora and fauna, the extent of pollution

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Interpretation of Physic-chemical Data

- The Box Plot
- Stiff's Diagram
- Piper (Trilinear) Diagram
- Durov Diagram

<u>Softwares</u>

AquaChem

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The BOX Plot

- Simple visual method to interpret data
- The box plot uses the median, the approximate quartiles, and the lowest and highest data points to convey the level, spread, and symmetry of a distribution of data values
- The box plot is more than a substitute for a table
- It is a tool that can improve our reasoning about quantitative information

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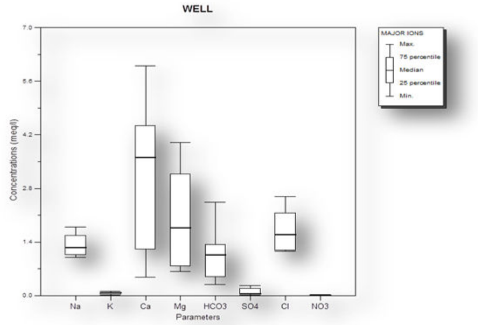

Box plots showing the distribution of major ions in the ground water samples. The box represents interquartile range and either end of the line indicates the minimum and maximum values. The major ionic concentration of the ground water shows the following general pattern as:

***Well:** Ca > Mg > Cl > Na > HCO_3 > SO_4 > K > NO_3*

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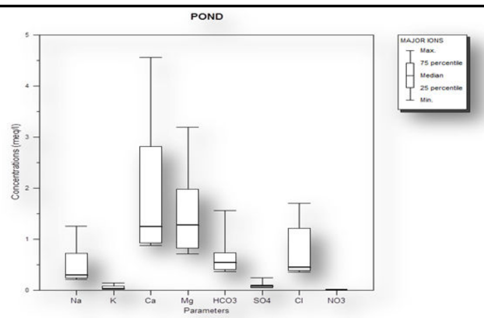

Box plots showing the distribution of major ions in the pond water samples. The box represents interquartile range and either end of the line indicates the minimum and maximum values. The major ionic concentration of the pond water shows the following general pattern as:

***Pond:** Ca > Mg > HCO_3 > Cl > Na > SO_4 > K > NO_3*

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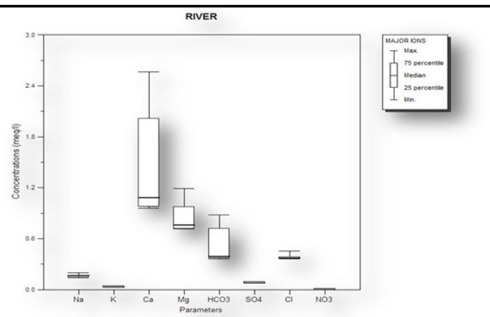
Minor Projects on Water & Soil Analysis



Box plots showing the distribution of major ions in the river water samples. The box represents interquartile range and either end of the line indicates the minimum and maximum values. The major ionic concentration of the river water shows the following general pattern as:

River: Ca > Mg > HCO_3 > Cl > Na > SO_4 > K > NO_3

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Well: Ca > Mg > Cl > Na > HCO_3 > SO_4 > K > NO_3

Pond: Ca > Mg > HCO_3 > Cl > Na > SO_4 > K >NO_3

River: Ca > Mg > HCO_3 > Cl > Na > SO_4 > K > NO_3

The Ca-Mg-HCO_3 & Cl type waters are dominating in the case of major ions in analyzed water sources of the study area.

But the rainwater acts as a medium which brings the Cl & NO_3 to the shallow groundwater aquifers which indicate organic pollution and fertilizer input.

Overall the studied water sources seem to have more lithologic affinity since HCO_3, Ca and Mg dominated because of rock-water/ sediment –water interaction processes/feldspar dissolution leading to cation exchange processes.

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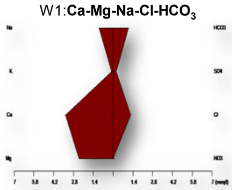
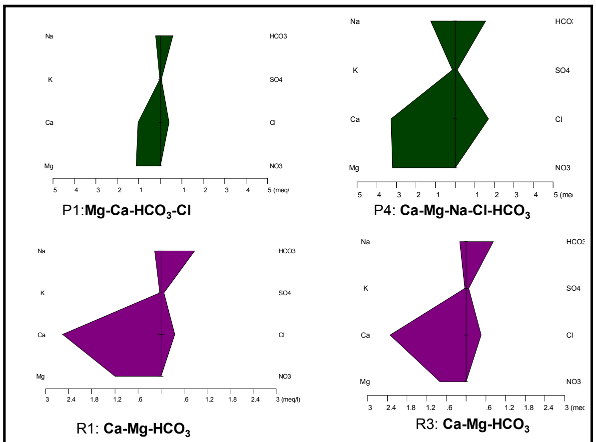
Stiff's Diagram

- Stiff's Diagram is a sophisticated method for demonstrating vertical changes in the chemical composition of water
- The basic of Stiff's diagram is a vertical line which has two functions
- It is both a depth scales of aquifers and vertical zero axes from which the concentrations of ions are plotted on four parallel horizontal axes extending on each side. Each different pattern represents a different type of water

W1:Ca-Mg-Na-Cl-HCO_3



- The Stiff system is a relatively distinctive method of showing differences or similarities in waters and changes in water composition with depth.
- It is useful especially for illustrating chemical composition in hydrogeologic cross sections.
- It can be used also for classification purposes, and is useful as a symbol on a map.



Piper (Trilinear) Diagram

- Piper diagram is an excellent tool for Hydrochemical analysis using a series of water quality analyses into a spatial context
- understanding and describing the chemical evolution of groundwater which depends on pattern recognition techniques and permits the classification of waters (seven types)
- It can also define the patterns of spatial change in the water chemistry among geological units, along a line of section or along a path line
- In understanding the water flow and water quality and the changes in water types and mixing relationships based on the relative proportions of major ions rather than the bulk concentrations
- Method for the delineation of hydrochemical evolution and identification of the dominant processes that control water chemistry

Finally, this diagram was modified by Back and Hanshaw to segregate the water type categories (hydrochemical facies) that form the basis for one common classification scheme for natural waters.

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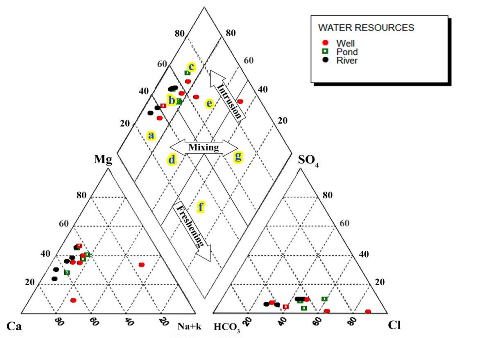
WATER RESOURCES - NEYYAR BASIN



Piper diagram showing the relative percentage of various waters of the study area

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Durov Diagram

- Durov diagram is based on the percentage of the major ions in meq/L.
- Both the positive and the negative percentages total 100%.
- The values of the cations and the anions are plotted in the appropriate triangular and projected into the square of the main field.
- The advantage of this diagram is that it displays some possible geochemical processes that could affect the water genesis.
- Durov diagram for the major cations and anions plotted by Aquachem software (*version: 4.0*).
- The fields and lines on the diagram show the classifications of LIoyd and Heathcoate (1985).

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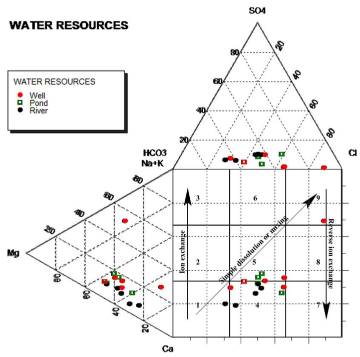
WATER RESOURCES



Durov diagram suggests processes of dissolution and mixing; the trend being from fresh, Ca-Mg-HCO_3 water and its association dominant

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Minor Projects on Water & Soil Analysis

PROPOSED TITLES

1. Major ion chemistry in selected well water resources
2. Nutrient flux in Pamba River at Pamba (your place), Kerala, India
3. Appraisal of physico-chemical characteristics of various water resources from Karamana river surroundings at Vilappilsala (at your place), Trivandrum
4. Hydrological studies on the coastal spring water along the southwest coast of India in Kollam district of Kerala.
5. Hydrography of Temple Ponds in Chempazhanthy rural area (at your place) of Trivandrum district, Southern Kerala
6. Modeling of groundwater chemistry of Palakkad urban area (at your place) using statistical tools
7. Physico-chemical aspects of well water resources in coastal areas of Neendakara, Kollam district

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Conti…….

1. **geochemical characterization of recently deposited sediments of ashtamudi estuary, kollam, southwestern india**

- **hydrochemical framework of killi *ar*, a major tributary of karamana river, thiruvananthapuram, southern kerala**
- **major ion chemistry and compositional structure of selected groundwater sources of karamana river basin, southern kerala**
- **hydrochemistry of peppara and aruvikkara reservoirs with special reference to drinking water quality**
- **the dynamics of phosphorus in an urban-fringe estuarine system:an example from cochin, sw coast of india**
- **"mercury geochemistry of recent sedimentary environs of the river dominated mixing zone in a tropical coastal estuarine system", sw india**

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Conti…….

- **hydrochemical framework and the reaction of subsurface coastal aquifers to climate and land use changes in kerala: modelling of groundwater refreshening patterns under natural recharge conditions**
-
- **investigation of groundwater quality for domestic and irrigation**
- **purposes around palakkad and environs, northern kerala**
-
- **transfer of nutrients and heavymetals from kallada basin, south-west coast of india: a geochemical perspective**
-
- **hydrochemical investigation of water from southern kerala wells and springs**
-
- **geochemical evolution of groundwater in the quaternary aquifers of kerala**

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