

Impacts of pollution on tropical montane and temperate forests of South Asia: Preliminary studies by post graduate students in India and Sri Lanka.

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RP 3

SANH Plenary
ECR and Student Session
May 26th 2022



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Project Objectives

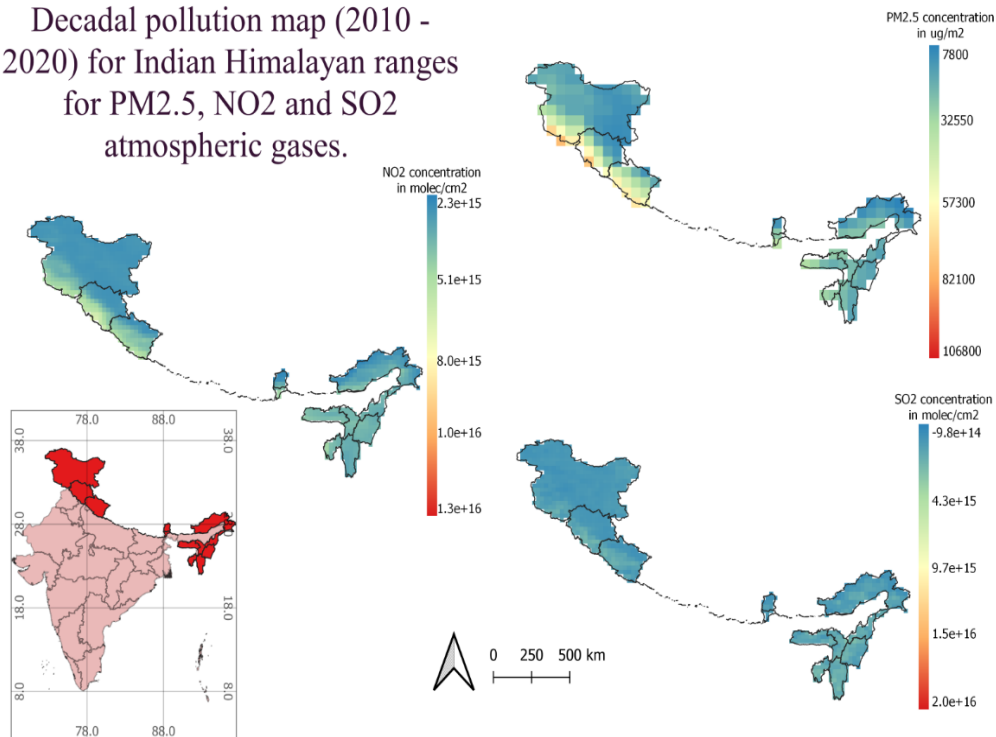
- Impacts of pollution on forest through:
 1. Identification of High-Low pollution areas through RS &GIS.
 2. N deposition on dominant forest trees.
 3. Soil Chemistry.
 4. Bark pH and its effect on associated diversity.
 5. Floristic diversity.

By 5 post graduate students from each country.

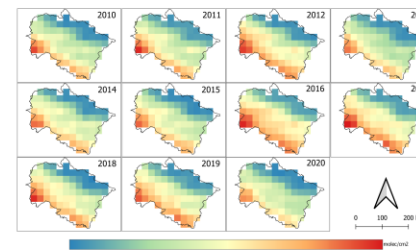
Objectives	India – convenient sampling	Sri Lanka – Transects
High-Low pollution	Remote sensing – Uttarakhand	Govt data + Remote sensing – Kandy city and 3 nearby forests.
N deposition	Total N and $\delta^{15}\text{N}$ test on lichen	Kjeldahl method on leaf and leaf litter
Soil Chemistry	Nitrate, EC and pH	pH, EC, SOC, K & Cation Exchange Capacity.
Bark pH and diversity	Oak trees' pH and lichen chlorophyll	pH measured of Dominant trees' with lichen.
Floristic diversity	Not undertaken	All flora mapped using indices though transects.

1st Objective Results - India

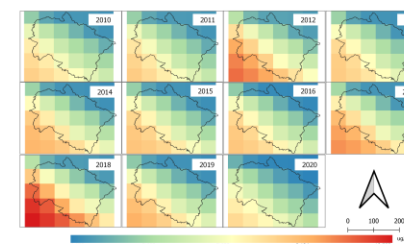
Decadal pollution map (2010 - 2020) for Indian Himalayan ranges for PM2.5, NO2 and SO2 atmospheric gases.



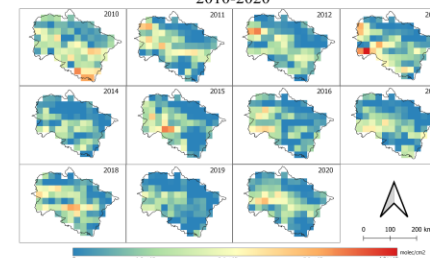
Yearly Atmospheric NO2 Concentrations in Uttarakhand from 2010-2020



Yearly Atmospheric Concentrations of PM2.5 in Uttarakhand from 2010-2020

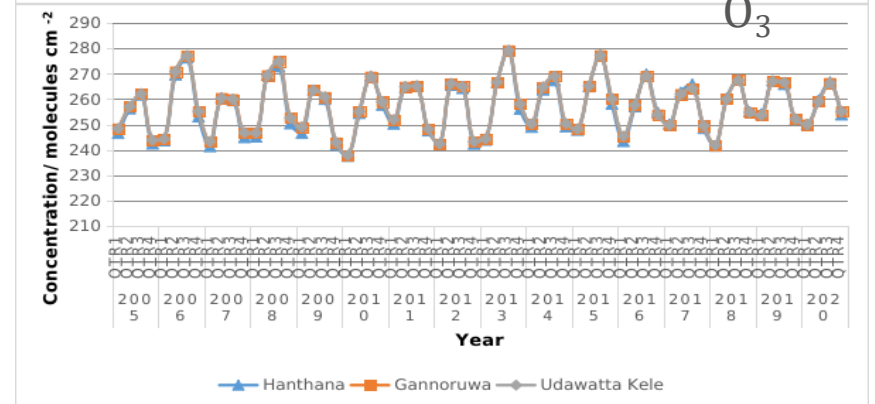
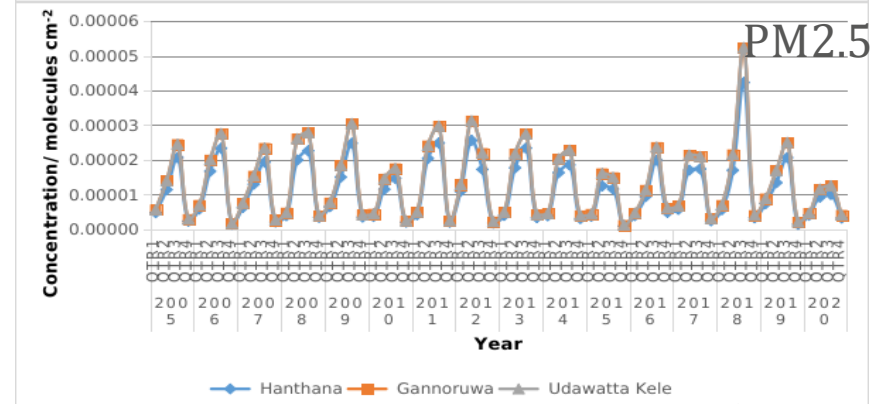
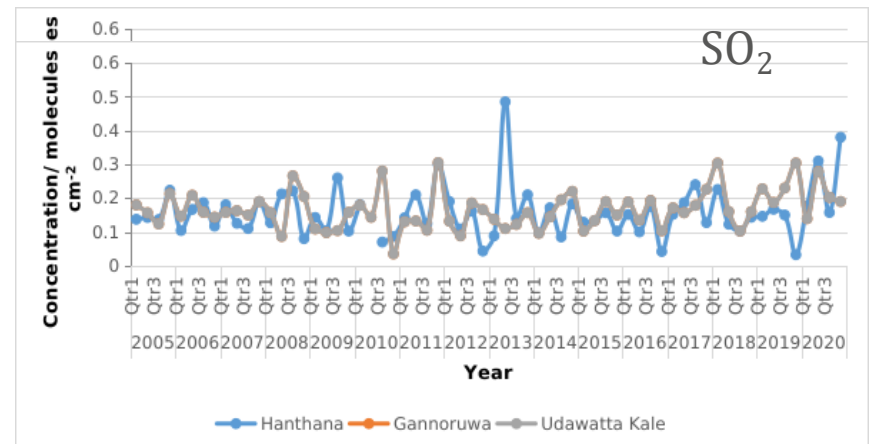


Yearly Atmospheric SO2 concentrations in Uttarakhand from 2010-2020

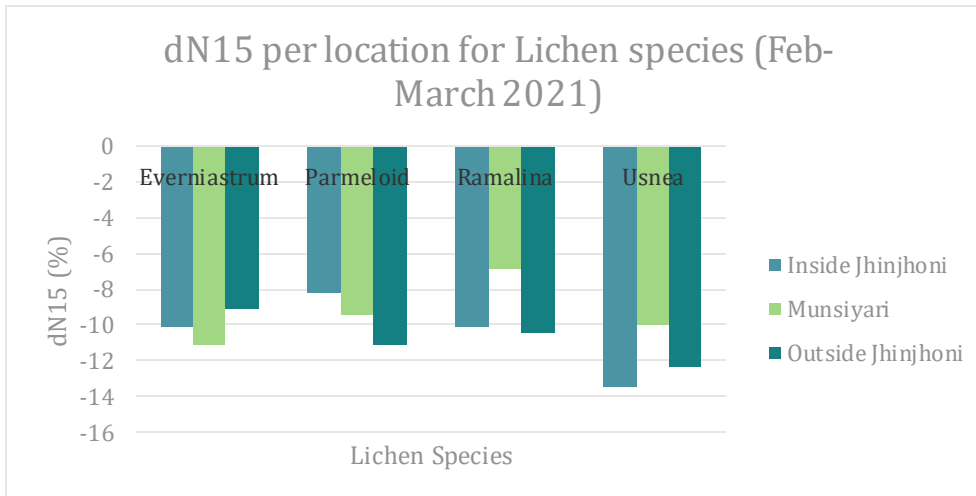
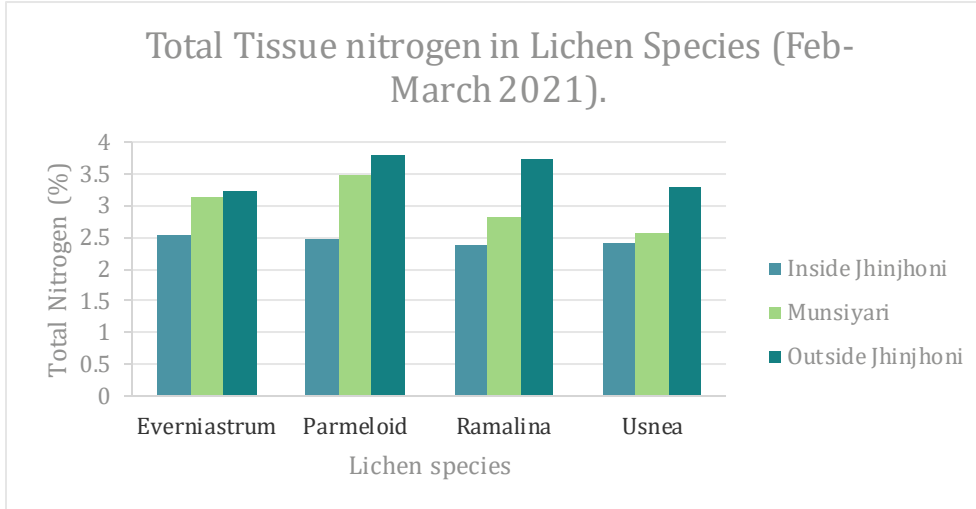


Pollutants	M-ktau	2 sided p-value	comments
NO2	0.13	0.63839	upward slope but not statistically significant
PM2.5	0.127	0.64043	upward slope but not statistically significant
SO2	-0.382	0.11947	downward slope but not statistically significant

1st Objective Results – Sri Lanka



2nd Objective Results - India



- Inside forest shows least tissue nitrogen, outside forest is highest across all lichens.
- d15N though irregular, very negative indicating organic N pollution. (Edison Armando Diaz-Alvarez, Roberto Lindig Cisneros and De, 2018)

2nd Objective Results – Sri Lanka

Leaf Litter

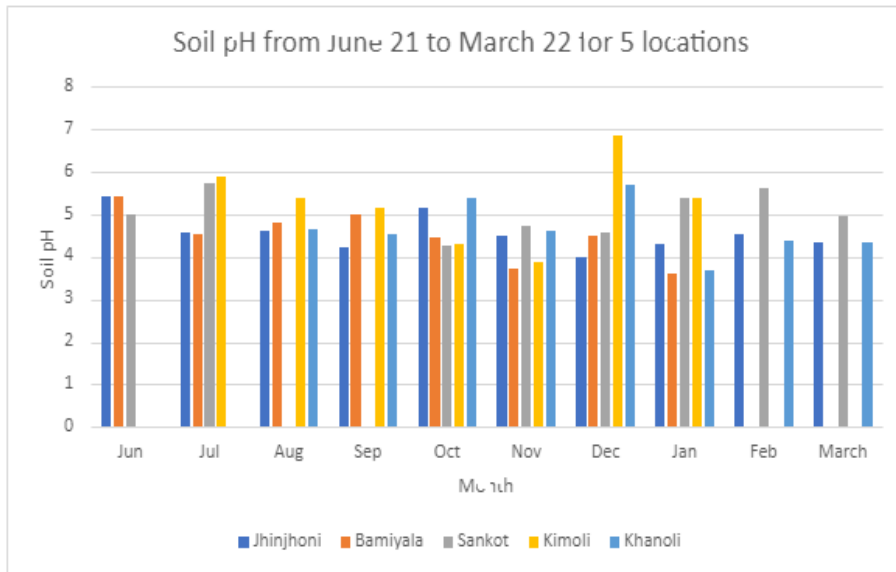
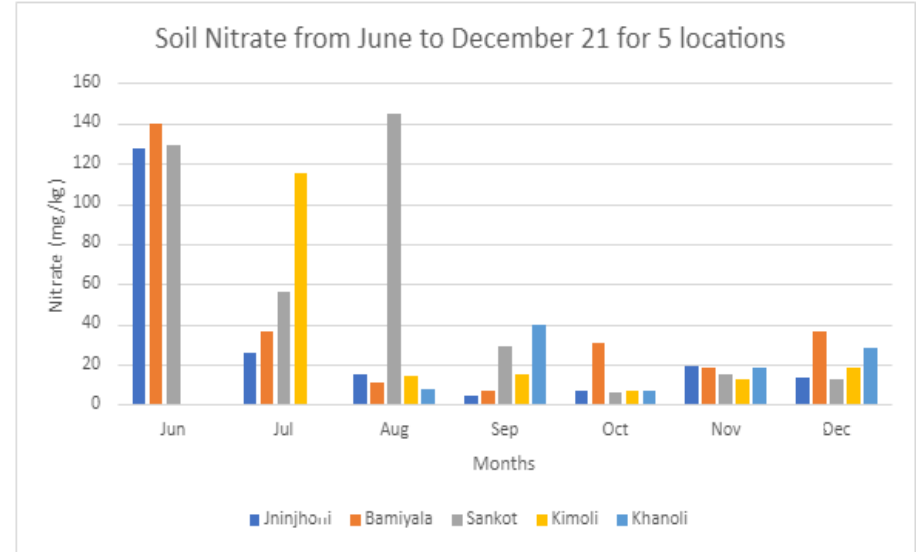
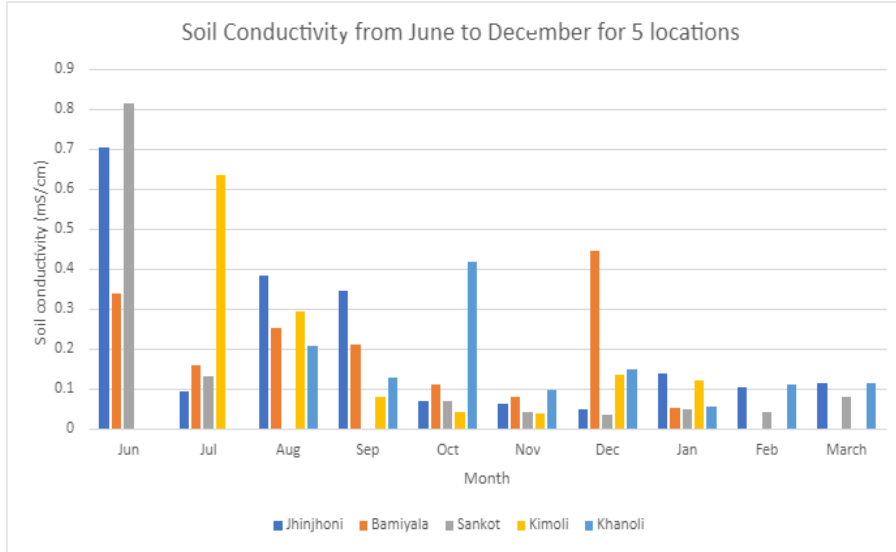
	H1	H2	H3	G1	G2	G3	U1	U2
Organic C %	14.39	18.69	16.49	22.19	21	35.11	29.98	25.94
N %	1.6	1.3	1.6	1.6	1.3	1.9	1.9	1.3
K %	0.04	0.31	0.07	0.7	0.08	0.004	0.007	0.2

No clear trend found.

Leaf

Sampling Site	Trans . No	Nirogen %	Carbon %	Potassium %
Hanthana	1	Carallia brachiata 2.65	Mangifera zeylanica 46.94	
	2	Microcos paniculata 2.32	Pouteria campechiana 45.74	Pouteria campechiana 1.5
Gannoruwa	1	Neolitsea cassia 2.32	Syzygium cumini 49.76	Sida cordifolia 1.1
	2	Pterospermum suberifolium 1.99	Diospyros malabarica 49.87	
	3			Sterculia balanghas 4.5
Udawatta Kele	1	Micromelum ceylanicum 2.65		Pterospermum suberifolium 1.7

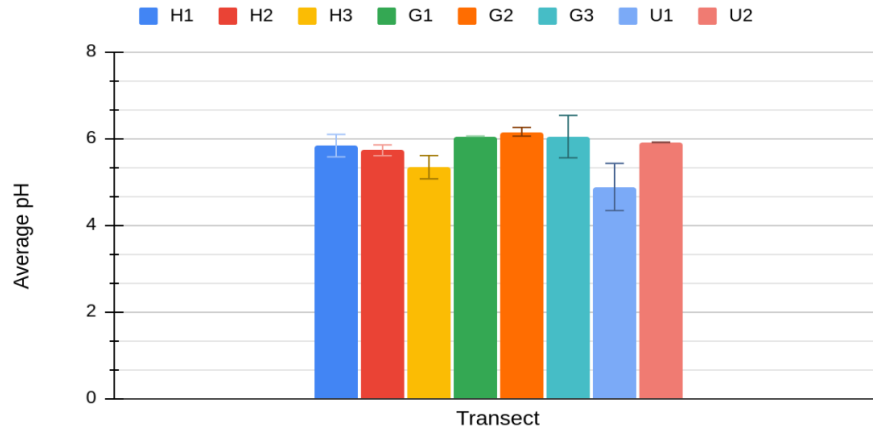
3rd Objective Results - India



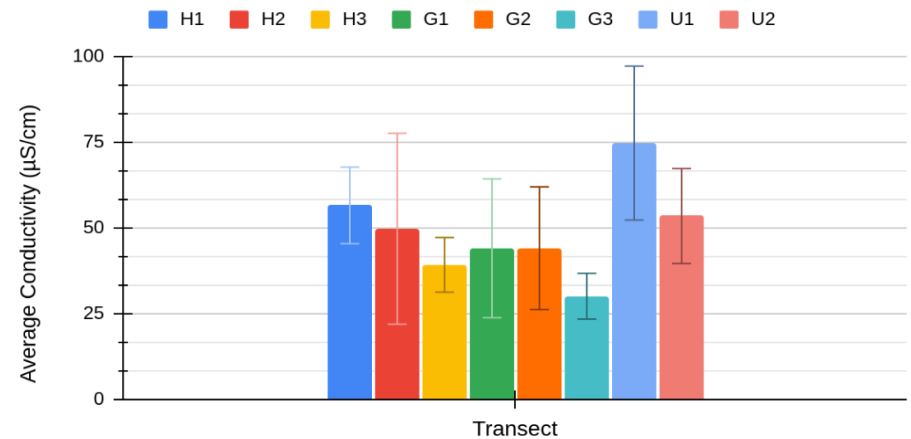
No clear trend found; between months or locations across the district of Chamoli, Uttarakhand.

3rd Objective Results – Sri Lanka

Average soil pH of each transects of Hanthana, Gannoruwa, and Udawatta Kele forest reserves



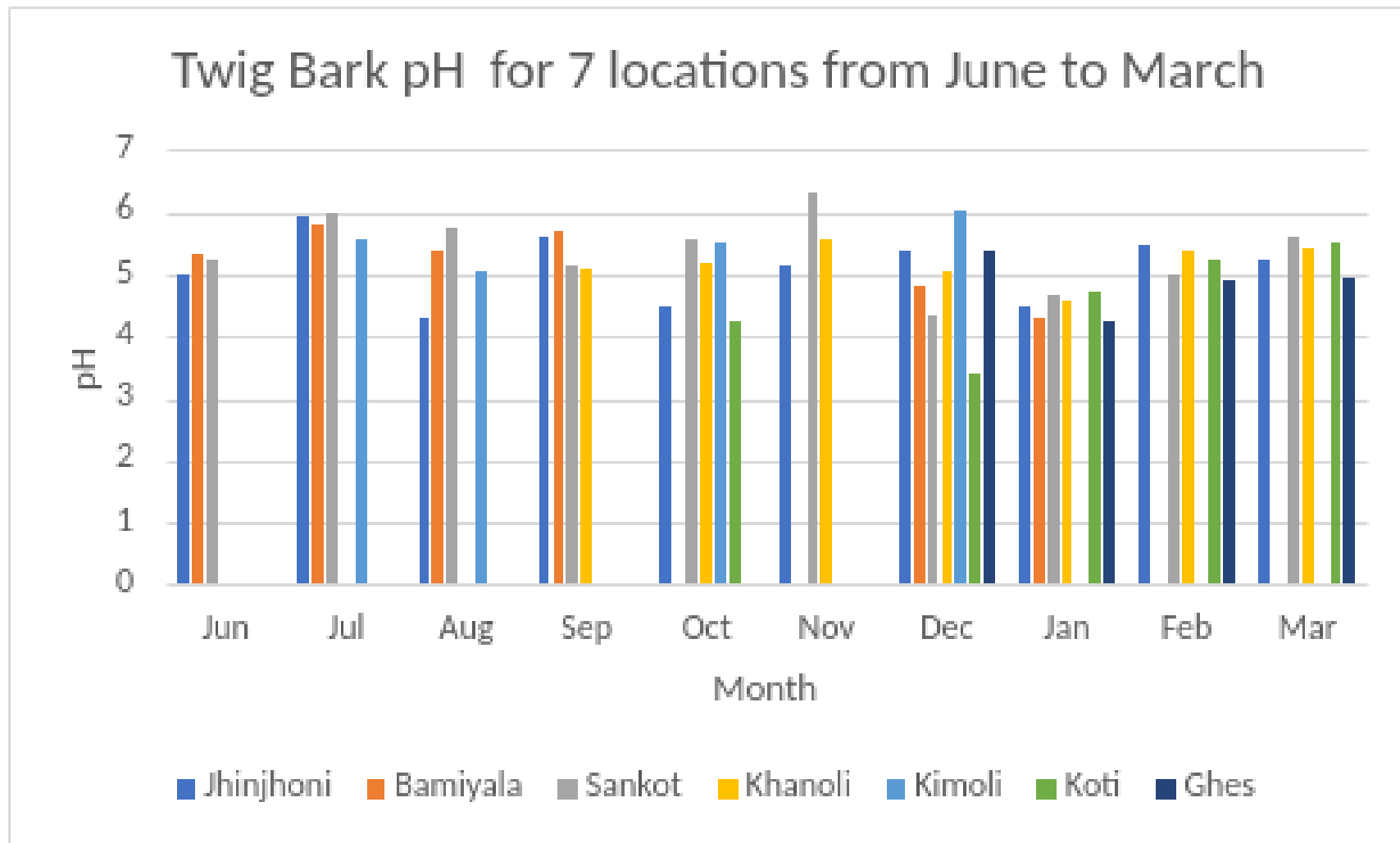
Average electric conductivity of soil of each transect of Hanthana, Gannoruwa and Udawatta Kele Forest Reserves



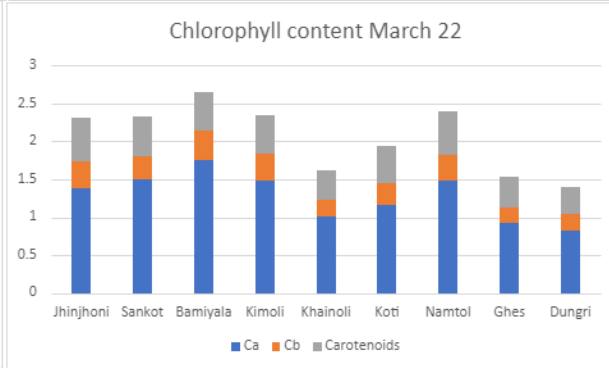
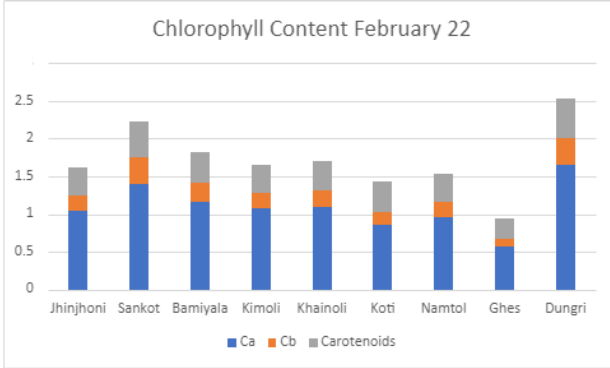
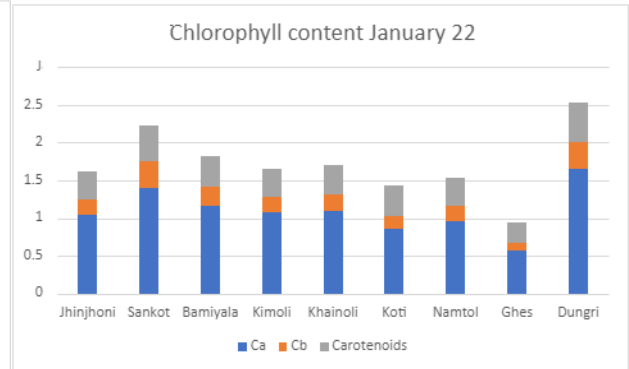
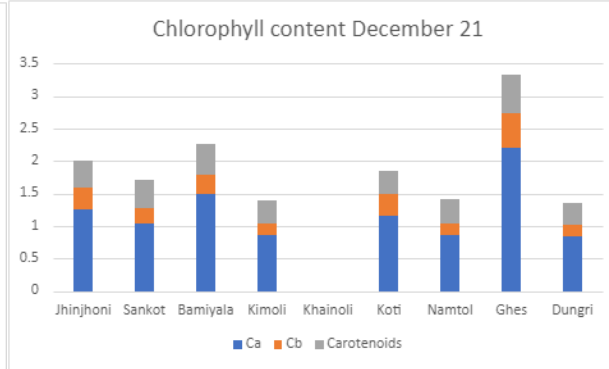
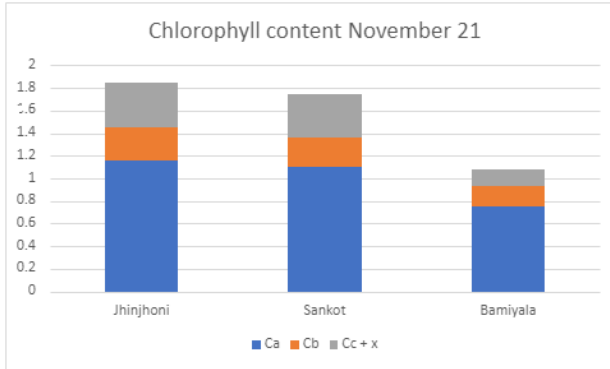
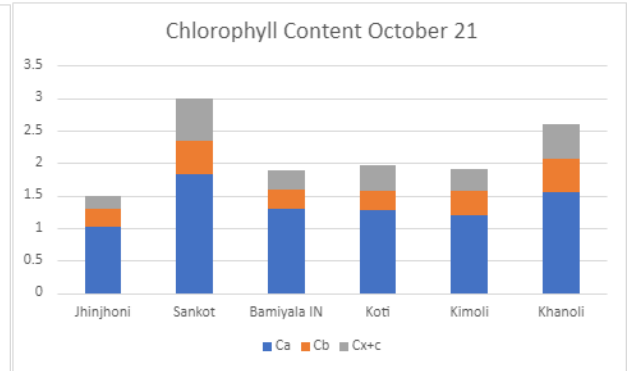
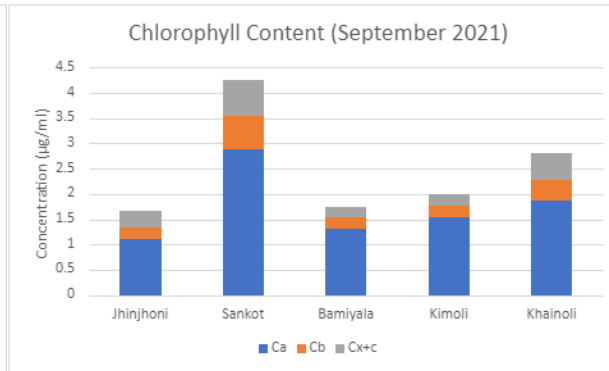
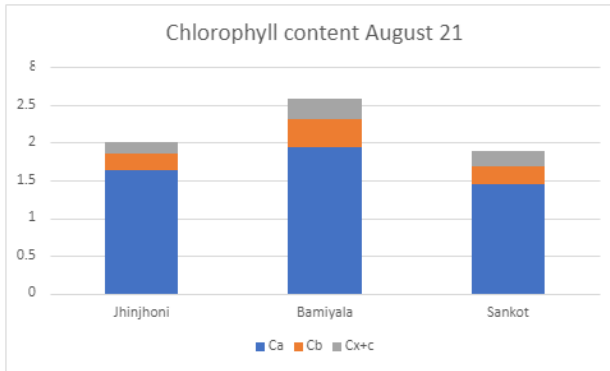
	H1	H2	H3	G1	G2	G3	U1	U2
Organic C %	21.88	10.06	8.49	9.76	19.80	16.50	4.19	5.45
K (kg/ha)	9.85	11.8	6.19	8.9	7.02	7.12	3.03	8.78
Cation Exchange Capacity	1.75	1.69	2.86	4.19	1.82	1.32	1.13	4.04

No clear trend found between different forests or tests.

4th Objective Results - India



4th Objective Results - India



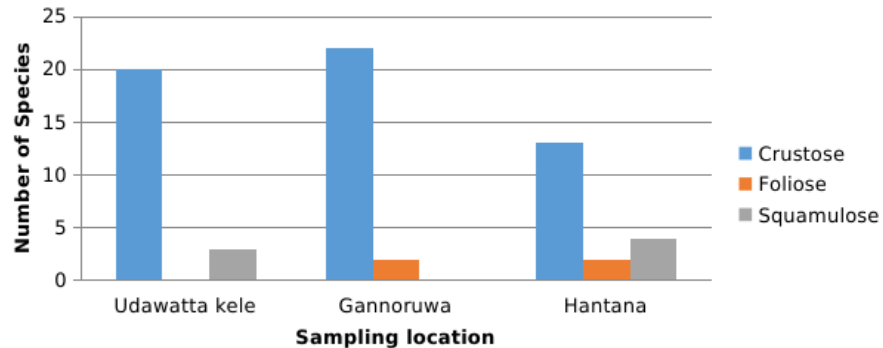
No association was noticed between chlorophyll and bark pH, between months or locations.

4th Objective Results – Sri Lanka

Sampling location	Transect Number	Average bark pH
Hanthana	H1	5.68
	H2	6.13
	H3	5.88
Gannoruwa	G1	5.82
	G2	5.4
	G3	5.71
Udawattakele	U1	6.07
	U2	5.8

Species	Udawatta kele	Gannoruwa	Hanthana
Coenogonium sp	+	+	
Leptogium cyanescens		+	+
Leptogium austroamericanum		+	+
Malmidea granifera	+	+	+
Malmidea barkeri		+	
Phyllopsora sp	+		+
Phyllopsora sp 1	+		
Phyllopsora sp 2	+		
Phyllopsora sp 3			+
Phyllopsora sp 4			+
Phyllopsora sp 5			+
Bacidia millegrana			+
	12	5	8

Lichen diversity in the three forests based on growth form



Hanthana had highest variation in growth form and most pollution sensitive lichen species.

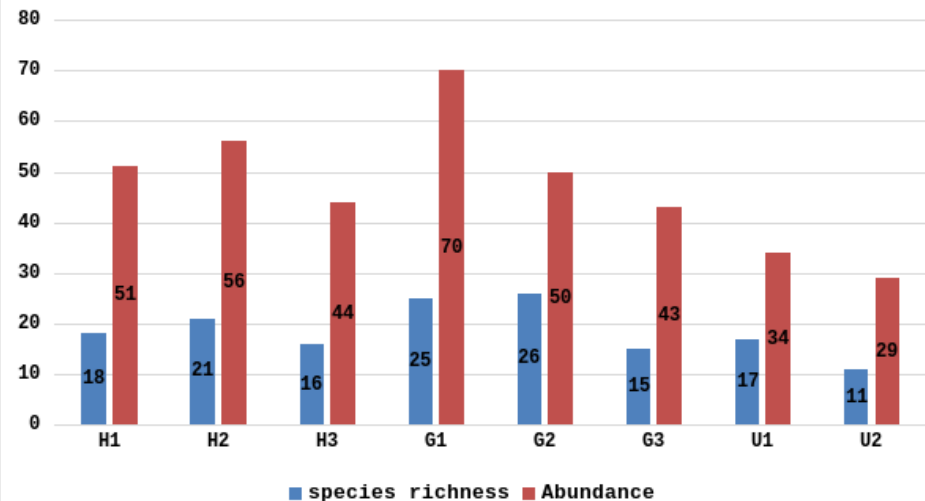
5th Objective Results – Sri Lanka

Name	Transect No	Species Richness	Abundance	Shannon Weiner Diversity Index	Simpson's Dominance Index
Hanthana	H1	18	51	2.610763	0.926274
	H2	21	56	2.727014	0.933116
	H3	16	44	2.411515	0.901691
Gannoruwa	G1	25	70	2.734219	0.908488
	G2	26	50	2.959235	0.944489
	G3	15	43	1.826205	0.688815
Udawatta Kele	U1	17	34	2.524125	0.919786
	U2	11	29	2.004435	0.820197

G3 is closest to Kandy city and also has the lowest diversity and dominance index.

Apart from that, all forests' transects were similar in their floristic composition.

Species Richness and Abundance



Summary

S. No.	Objective	Results: India	Results: Sri Lanka
1	High low pollution identification in the study area	Pollution concentrations were SO ₂ <NO ₂ <PM _{2.5} in Uttarakhand using satellite data (OMI and MERRA) for whole Uttarakhand.	Pollution concentrations were Hanthana< Gannoruwa< Udawatta Kele using satellite data. Inversely related to distance from Kandy city.
2	Nitrogen deposition on dominant forest trees	Lichens on Oak trees analysed for Total N and δ N ₁₅ . Inside forest< Munsiyari< Outside forest for Total N. δ N ₁₅ showed no trend but is highly negative indicating organic N pollution.	Dominant trees identified and leaf and leaf litter analysed for N%. No clear trend observed.
3	Soil Chemistry study with a focus on acidification	Soil pH, conductivity and nitrate was tested. Conductivity and Nitrate were different but not statistically significant observation.	Soil pH and conductivity measured. No clear trend observed. SOC, K, and CEC also not significantly different between forests.
4	Bark pH and associated pollution sensitive species	Bark pH and associated lichen's chlorophyll measured. No clear trend observed.	Bark pH is significantly higher than the pH established acidic bark by literature. Lichen diversity and pollution indicator species were noted.
5	Floristic diversity of pollution sensitive species.	Not conducted	Floral species diversity (Shannon weiner), richness, dominance(Simpson's) and abundance measured.

Project Outcomes

- Exposure to international collaborative projects for post graduate students.
- Authorship in a publication and a compiled volume.
- All data collected goes towards SANH database WP 3.1



Thank you

Special thanks to

- UNU and ProSPER.net
- Dr. Sarath Nissanka and Dr. Hemanthi Ranasinghe.
- Miki Konishi from UNU
- Dr. Sudipto Chatterjee
 - All my teammates
 - SANH group.