In Country Training Programme under "Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia"

Jointly organized by National Environment Commission (NEC) Bhutan, SEI, SACEP and UNEP RRC.AP, with the financial support from Sida

Report on Bhutan

Introduction

As a signatory to the Malé Declaration, Bhutan has agreed to participate in the monitoring of longrange transport of air pollution and its likely impacts. Accordingly, Bhutan was recommended one monitoring station by the United Nations Environment Programme (UNEP) for this programme. The National Environmental Commission (NEC) is the National Implementing Agency (NIA). The work of sample collection and analysis was delegated to the Department of Meteorology.

Monitoring Site

Site location: A site close to the Gelephu town, Bhur district, was chosen for the monitoring station. Gelekphu is on the Indian border, across Bongaigaon town in West Assam. The station is in the premises of the Meteorological Department's meteorological station. Data on the site and surroundings, as required in the formats provided by UNEP have been received.

The map of the monitoring site and its surroundings are provided in Fig 1,2 and 3.

Site type: From maps it is known that the site is close to the Manas forest, which extends on both sides of the Bhutan-India border and has the status of a protected area in both countries. Therefore, good deposition and ecological monitoring sites should be available in close proximity to Gelekphu.

Monitoring and laboratory equipment

Equipment: The monitoring and laboratory equipment and glassware given in Annex 1 was handed over to NEC during the training programme held in May 2003.

Installation: From reports provided by NEC, the PM_{10} sampler, wet only collector, two bulk collectors and diffusive samplers for SO_2 and NO_2 were installed at the site in June 2003, a fortnight after the training programme was completed.

Training programme

An "In Country Training Programme under "Malé Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia" was held in Thimbu between 28 May and 1 June 2003 (The Bhutan Chamber of Commerce and Industry meeting hall, 28-29 May 2003, NEC meeting room, 30 May-1 June 2003).

The training programme's objective was to build national capacity to provide hands on experience on sampling and analysis of transboundary pollutants.

The NEC organized the training programme in collaboration with UNEP RRC.AP, SACEP and SEI.

The training programme was started with the welcome address by Mr Nedup Tshering, NEC. Mr Sagar Dhara facilitated the training programme.

The technical sessions in the training programme were handled by Dr Rajendra Prasad, Mr M. Iyngararasan, Mr Sagar Dhara, Dr Martin Ferm, Dr Lennart Granat, Dr R H Siddiqi and Dr Kevin Hicks. The training programme content is provided in Annex 2.

Participants: The trainees were from NEC the Meteorology Department, and the Ministry of Agriculture. Resource persons were from IVL, MISU, Envirotech, UNEP RRC.AP and SEI. A list of participants is enclosed in Annex 3.

The trainees were young and had bachelor-level degrees in science. Most of them were meteorologists. The team exhibited the capacity to learn the practical aspects of the work quickly.

Equipment: Training was provided to handle the following equipment:

Envirotech International: High Volume Sampler– Envirotech APM 460NL—for TSPM, PM10, gaseous sampling
IVL : Passive Samplers for SO_2 and NO_2
MISU: Wet only collector, Bulk collector

No damage was noticed to the equipment or glassware when they were opened at NEC.

Evaluation: A test paper (annex 4) was circulated amongst the trainees to assess how successful the training programme was in imparting knowledge and skills to the trainees. The answers were not marked but the answers were discussed collectively.

Training programme experience: As a major portion of the training was hands-on, the trainees were enthusiastic and quick learners. Dust samples and gaseous samples were collected at the NEC building and analyzed by the trainees. As it rained during the training programme, rainwater samples were collected and analyzed for pH and electrical conductivity. Knowing the results of their monitoring boosted the confidence of the trainees.

Recommendations

1. A site assessment should be made by UNEP.
2. A follow-up visit should be done by a technician-level person in the first year after equipment installation to help sort out any problems that may exist with, sample collection and analysis, and equipment handling.
3. A follow-up visit by a UNEP representative (MoC-level or equivalent) may be done in the first year after monitoring has begun to sort out problems related to data management and reporting, QA/QC, further capacity building, site change, etc.
4. Theoretical aspects of the subject, eg, basic chemistry and statistics, QA/QC need to re-cover in future refresher courses.

Annex 1

List of Equipments and Consumables

1 Site Equipment

No.	Description	No. of Unit	Remark
1.1	PM10 air sampler	1	Envirotech model APM 460(NL)
1.2	pH meter	1	Hand held WTW model pH 300i (pH meter)
1.3	EC meter	1	Electrical conductivity meter, hand held WTW model COND 330i
1.4	Thermometer	1	Best Indian Make (-20 to 15degree C, least count 0.1 degree)
1.5	Diffusive samplers	2	For measurements at 1 site on a monthly basis during one year
1.6	Bulk sampler	2	
1.7	Wet only Collector	1	Included solar panels, solar shunt regulator

2 Laboratory - Equipment

2.1	Spectrophotometer	1	U/V and Visible Best Indian Make, Elico SL 171
2.2	Oven	1	Best Indian Make (50 to 250 degree range, 220-240V, 0.5KW)
2.3	Balance	1	Electronic Balance, Sartorius Make. Model BL210S Capacity 210g. Readability 0.1 mg
2.4	pH meter	1	Hand held WTW model pH 300i (pH meter)
2.5	Electrical conductivity meter	1	Electrical conductivity meter, hand held WTW model COND 330i
2.6	Desiccator	1	Mark 'Duran' Size 300mm
2.7	Distallation Unit	1	
2.8	Magnetic stirrer 1 L	1	Though listed as being reqd for soil qlty analysis, would be preparing for preparing solutions for DD/WD sample analysis
2.9	pH electrode for low ion concentration	1	
2.10	Calibrators		
	a) Soap Bubble Meter (manual type) (Calibrator for Rotameter)	1	
	b) Top loading Flow Calibrator	1	

3 Laboratory Consumables

A	***Glassware and other consumables***		
3.1	Washing bottle with ground glass stopper 500 ml	2	
3.2	Measuring cylinder 100 ml, 50ml, 25 ml. 10 ml	8	100 ml x 2 nos, 50ml x 2 nos, 25ml x 2 nos, 10ml x 2 nos
3.3	Glass tubes with ground-in stopper (Nessler's tubes)	12	
3.4	Volumetric flask 1000ml, 500 ml, 250 ml, 100 ml	7	1000ml x 2nos, 500 ml x 1 nos, 250 ml x 2 nos, 100 ml x 2 nos
3.5	Pipette 10 ml, 25 ml	4	10 ml x 2 nos, 25 ml x 2 nos

3.6	Filter paper Whatman 41, dia 47 mm	3	1 box = 100 nos
3.7	Bottle polypropylene 1 L, 500 ml	14	1 L x 6 nos, 500 ml x 8 nos
3.8	Beaker 100 ml, 250 ml	16	250 ml x 2 nos, 100ml x 12 nos
3.9	Regaent bottles 100ml	6	100ml x 6nos
3.10	Regaent bottles 250ml	6	250ml x 6 nos,
	Chemicals and other consumables		
3.11	2 monitoring kits		

4 Site Consumables

4.1	Filter paper Whatmans GF/A	2	Size 8"x10", in sealed pkt. Of 100 sheet
4.2	Impingers	4	35ml capacity, 4 will be supplied with hvs, 4 more are reqd as spare
4.3	Syringe 100 ml	2	5.00 each packet, in pkt. Of 10
4.4	Glass/inert plastic tubing	3	per meter, Silicon tube
4.5	Silicon grease	2	for 100 gm packet
4.6	Measuring cylinder 100 ml	2	each
4.7	Pipette 20 ml	3	10 ml x 2 nos, 20 ml x 1 nos
4.8	Polyethylene containers 20 ml	100	each - 60ml
4.90	Funnel	6	50 mm x 3 nos, 75 mm x 3 nos
4.10	Capped bottles 1 L	3	each (Tarson)
4.11	Ice box	2	each (medium size)
4.12	Power Cord 5 meter long	2	
4.13	Junction Box (Extension Board)	1	1 set
4.14	Burette (50 ml)	1	
4.15	Burette Stand	1	
4.16	Cleaning Brush for Glassware	2	
4.17	Printed paper envelopes to keep filters	1pkt	1 pkt. of 12 Nos.
4.18	Graph Pad	1 Pad.	
4.19	Iodine flask (250ml)	2	
4.20	Membrane Filtration Assembly	2	
4.21	Petridish	1	
4.22	Pipette (1 ml)	1	
4.23	Pipette (2 ml)	1	
4.24	Pipette stand	1	
4.25	Plier	1	
4.26	Pipetting Pump	1	
4.27	Silica gel (500 gm)	1	
4.28	Torch	1	
4.29	Tissue Roll	1	
4.30	Tweezer	1	
4.31	Sampling Bag	1	

Annex II

Training Programme

Day	Topic	Contents	Venue	Instructor
28 May Morning	Basic Theory	• Introduction to the Malé Declaration (15min) • Objectives of wet deposition and air concentration monitoring & scope of present programme (20 m) • Air pollution sources & effects (30 m) • Acid gas deposition and their impacts (30 min) • Basic concepts in meteorology (30m) • Long range transport of air pollutants (30m)	Class room	MI SD/SKG RP KH RHS LG
28 May Afternoon	Basic theory HVS PM sample	• Units and materials and energy balance • HVS – features, and setting it up • Basic statistics • QA/QC	Class room	RHS RP RHS RHS
29 May Morning	Gaseous samples Basic Theory Precip sample	• Basic chemistry concepts (45 m) • Passive sampling – theory & practice of PS/BC use (1.5 hrs) • Wet only collector – theory and practice (30 m)	Class room	RHS MF LG
29 May Afternoon		• Spectrophotometric analysis • EC meter • pH meter • Monitoring protocol	Class room	RHS RP RHS SD/MI
30 May Morning	Lab	• HVS	Lab	RP
30 May Afternoon	Lab	• Wet only collector • QA/QC	Class room and Lab	LG LG
31 May Morning	Lab	• HVS	Lab	RP/RHS
31 May Afternoon	Lab	• Spectrophotometer • EC & PH	Lab	RP/RHS RP/RHS
1 June Morning	Lab	• Passive samplers • Bulk collectors • HVS	Lab	MF MF/LG RP
1 June Afternoon		• Conclusion		

KH: Kevin Hicks, SEI
RP: Rajendra Prasad, Envirotech
LG: Lennart Granat, MISU
MF: Martin Ferm, IVL
SD: Sagar Dhara, MoC
RHS: R. H. Siddiqi, Envirotech
MI: Mylvakanam Iyngararasan, UNEP/RRC.AP
SKG: S. K. Gupta, Envirotech

Annex III

Participant List

#	Participants	Designation	Organization
1	Mr. Phurba	Meteorologist	Meteorology Division
2	Mr. Jamyang Phuntshok	Meteorologist	Agro met, MOA
3	Mr. Tshering Phuntshok	Meteorologist	Meteorology Division
4	Ms. Tshering Yangchen	Meteorologist	Meteorology Division
5	Mr. Ranjit Tamang	Meteorologist	Meteorology Division
6	Mr. Jamyang	Chemist	Soil, Plant Analysis Laboratory, MOA
7	Mr. Karma Tenzin	Meteorologist	Meteorology Division
8	Ms. Peldon Tshering	Environmental Engineer	National Environment Commission
9	Mr. Thinley Namgyel	Botanists	National Environment Commission
10	Mr. Tenzin Khorlo	Chemical Engg.	National Environment Commission
11	Mr. Nedup Tshering	Program Coordinator	National Environment Commission

Resource Participants list

1)	Kevin William Hicks	SEI
2)	Rajendra Prasad,	Envirotech
3)	Martin Ferm,	IVL
4)	Mylvakanam Iyngararasan,	UNEP RRC.AP
5)	Lennart Granat,	MISU
6)	Rashid H Siddiqi,	Envirotech
7)	Sagar Dhara,	MoC
8)	S K Gupta,	Envirotech
9)	Lokendra Upadhyay	Envirotech
10)	Naw Wah Wah Htoo	UNEP RRC.AP

Annex 4

(**TEST PAPER**)

1. Which are the participating countries of Malé Declaration?

……

2. Name the National Focal Point for Malé Declaration in Bhutan?

……

3. Why is the Malé Declaration monitoring site located in remote areas?

……

4. Name the three main pollutants the Malé Declaration wishes to measure in AAQ monitoring?

……

5. What effects do air pollutants of immediate concern to us in the Malé Declaration have on human health?

……
……

6. Air pollution can potentially result in fish kills in lakes.
   True or False

7. Air pollution can cause the corrosion of statues and man made materials such as paints.
   True or False

8. Indicate if true or false:

a)	Concentrations of particulate air pollutants are measured in ppm by volume.	True	False
b)	5 mg/L is the same as $5g/m^3$.	True	False
c)	High Volume Sampler can be used to measure dust fall	True	False
d)	1PPM is equal to 1000PPb	True	False
e)	EC meter can be used to indicate dissolved solids concentration.	True	False
f)	Impingers are here used to collect SPM in air.	True	False
g)	Unfiltered air is bubbled through impingers for collection of gaseous pollutants – SO_2 and NOx.	True	False
h)	Water in the manometer in High Volume Sampler should be replaced every 6 months.	True	False

9. Indicate the most appropriate or correct answer:

   (a) With increase in altitude
   (i) pressure decreases (ii) temperature remains constant (iii) density of air increases (iv) wind speed decreases

   (b) which of the following is a secondary pollutant
   (i) NO (ii) SO_2 (iii) O_3 (iv) Pb

   (c) Wind rose diagram is a representation of
   (i) Wind temperature (ii) Wind direction and speed
   (ii) Wind humidity (iv) Wind pressure

   (d) Which of the following instruments measures Hydrogen Ion Concentration
   (i) EC meter (ii) Spectrophotometer (iii) Bulk collector (iv) pH meter

(e) The cyclone in Hi-vol sampler

(i) collects respirable dust (ii) protects filter paper from moisture (iii) collects particles less than 10 μm size (iv) collects particles greater than 10 μm size

(f) If 1 mL of a 10 mg/L standard NO_2 solution is added to 9 mL of reagents the concentration will be

(i) 10 μg/L (ii) 1 μg/10 mL (iii) 1 g/m3 (iv) 1 ng/mL

(g) If 10 g S is burnt SO_2 production will be

(i) 10 g (ii) 20 g (iii) 32 g (iv) 64 g

(h) For gaseous sampling using impinger the air flow rate is usually kept at

(i) 1-3 m^3/h (ii) 1-4 m^3/min (iii) 0.2-1L/min (iv) 1-4 mL/min

(i) 26μg/m^3 is equal to

(i) 1 PPM (ii) 0.1 PPM (iii) 0.01PPM (iv) 1 PPB

(j) Calculate the amount of $NaNO_2$ need to be dissolved in 1000ml of distilled water to obtain NO_2 concentration as 1000μg/m^3. Assay of $NaNO_2$ is 97%.

10. Calculate the dust concentration in air in μg/m^3 if 2 g dust is suspended in 1000 m^3 of air.

11. What is the total amount of air in m^3 which is filtered if a Hi-Vol sampler sucks air at an average rate of 0.5 m^3/min for 8 h.

12. What will be the volume of 273 m^3 of air which is at 0°C, if heated to 27°C.

13. What is wet deposition

…….

…….

14. What is dry deposition

…….

…….

15. What is the approximate average time a sulfur compound (as SO_2 or sulphate particle) spends in the atmosphere
    a) 6hrs b) 1 day c) 4 days d)10 days e) 1 month f) 6 month g) 1 year

16. Deposition of pollutants from the atmosphere can be a problem. Give some examples?
……
……

17. Can diffusive (passive) sampler be used for measuring the SO_2 concentration in air?
……

18. Do you need a pump for diffusive (passive) sampling?
……

19. What is the current plan to analyse the diffusive (passive) samplers?
……

20. How should the diffusive (passive) sampler be mounted?
……

21. What should you do with the sample if you find bird dropping in the funnel of bulk collector?
……

22. Why do you need gloves when handling the bulk sampling equipment?
……

23. Why should you shake the sample a little before taking out a fraction of it from a bulk sampling equipment?
……

24. Why do we need to measure the volume of the precipitation?
……
……

25. Suppose that it is raining a lot and the bottle is more than 80% full already after 3 days. What do you do?
……
……

26. Why are two different equipments used for rain collection?
……
……

27. For a wet only collector, what do you do
    (a) If the lid becomes damaged?
    (b) If the collector does not work properly or not at all and there is no obvious error?

28. Are you aware of the health and safety issues associated with analyzing the samples in the laboratory? Give example.
……
……

Some Photographs from the Training Programme

Monitoring Site

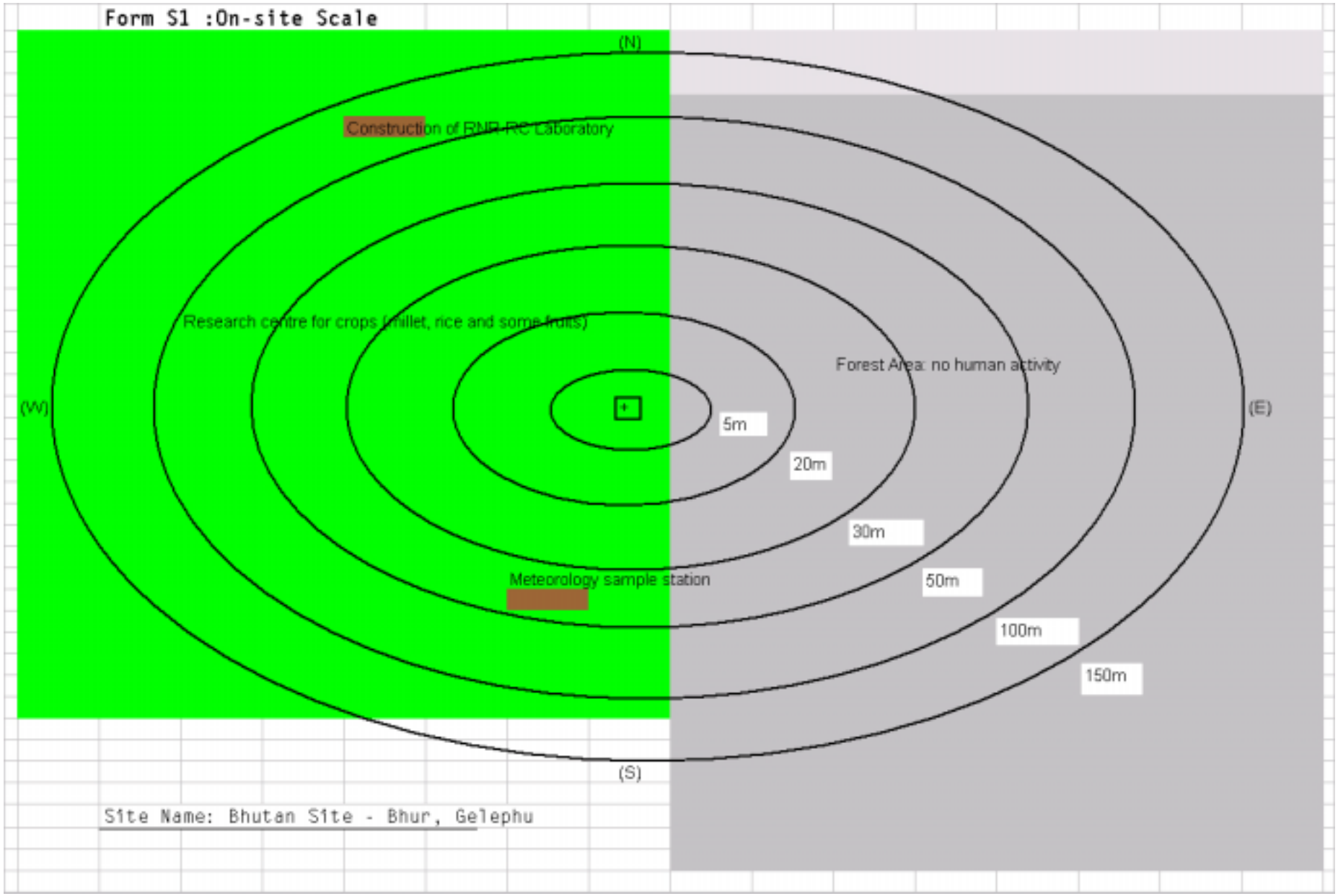
Form S1 :On-site Scale
(N)
Construction of RNR-RC Laboratory
Research centre for crops (millet, rice and some fruits)
Forest Area: no human activity
(W)
(E)
5m
20m
30m
50m
100m
150m
Meteorology sample station
(S)
Site Name: Bhutan Site - Bhur, Gelephu

Fig. 1

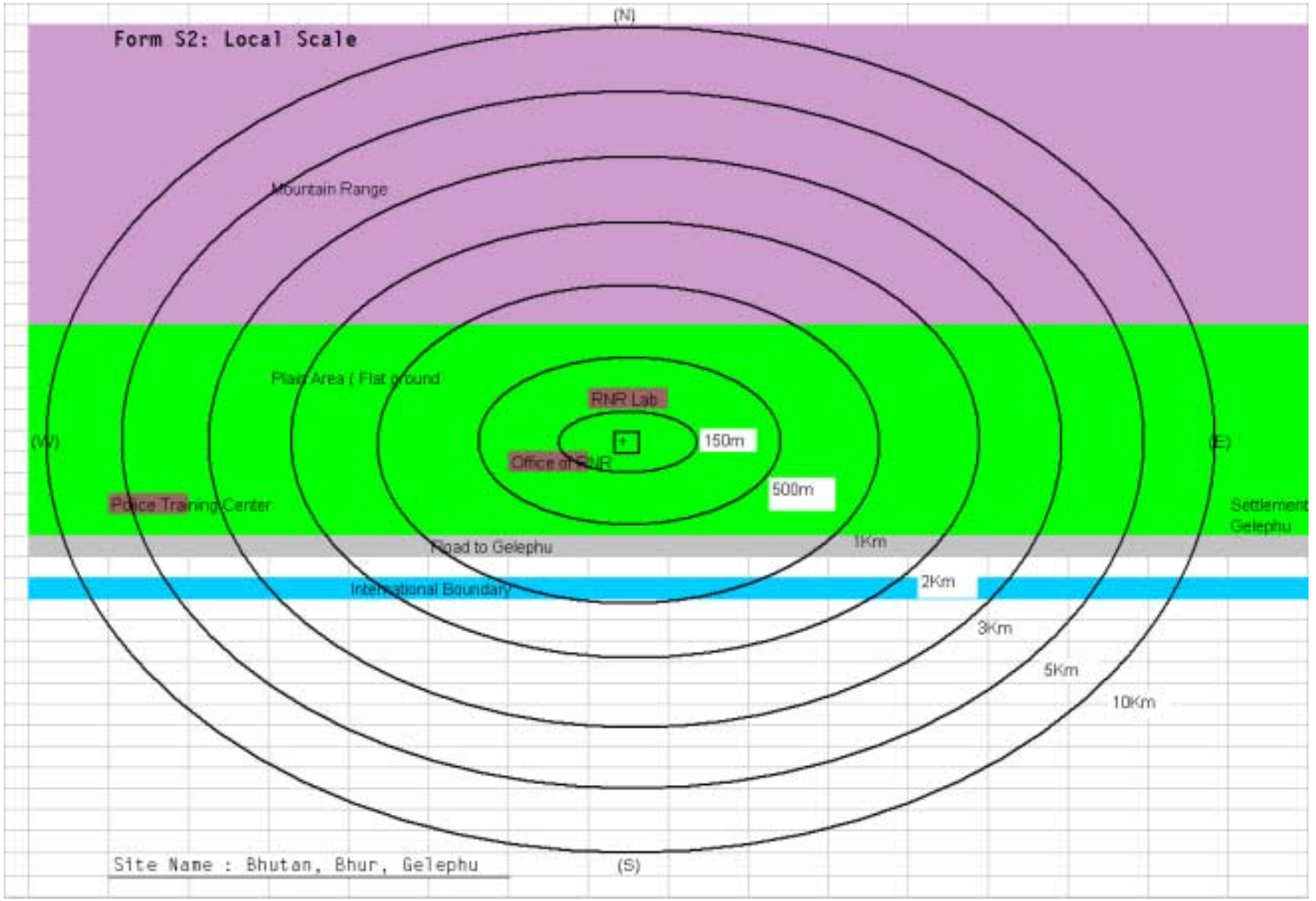
Form S2: Local Scale
(N)
Mountain Range
Plain Area (Flat ground
RNR Lab
150m
Office of SUR
500m
(W)
(E)
Police Training Center
Settlement
Gelephu
Road to Gelephu
1Km
International Boundary
2Km
3Km
5Km
10Km
Site Name : Bhutan, Bhur, Gelephu
(S)

Fig. 2

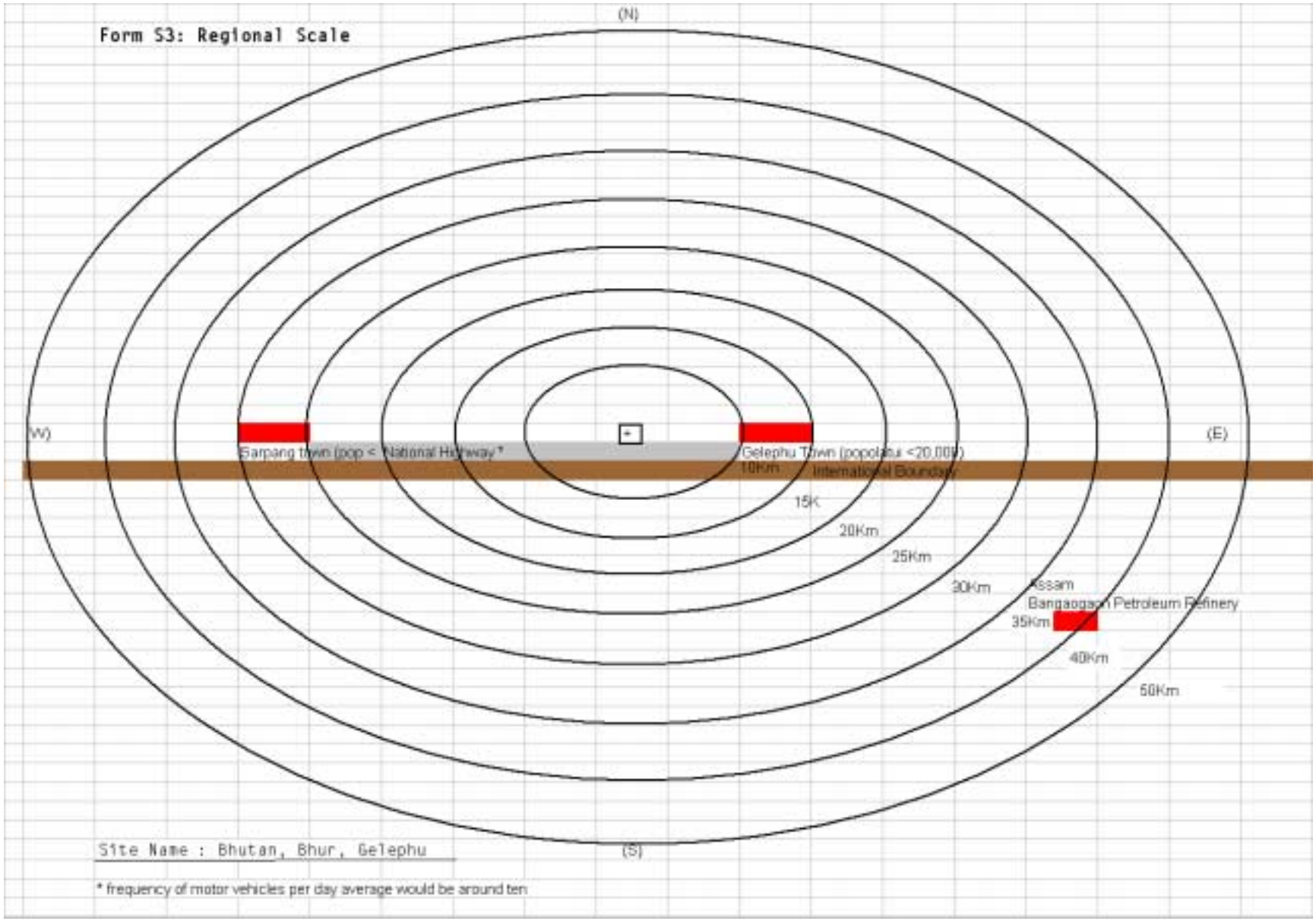
Form S3: Regional Scale
(N)
(W)
(E)
(S)
Barpang town (pop < National Highway*
Gelephu Town (population <20,000)
10Km
International Boundary
15K
20Km
25Km
30Km
Assam
Bangaogaon Petroleum Refinery
35Km
40Km
50Km
Site Name : Bhutan, Bhur, Gelephu
* frequency of motor vehicles per day average would be around ten

Fig. 3