International Nature Education and Experience

Training Programmes

College of Natural Resources
Royal University of Bhutan
Lobesa, Punakha, Bhutan

The syllabus of this progrme may change from time to time based on emerging needs, learning conditions, experiences and resources.

Contents

Overview 1

Training One: Learning Statistics using R 2

Training Two: Organic Agriculture 5

Training Three: Community-Based Forestry for Conservation and Livelihoods 9

Training Four: Biodiversity Conservation Techniques 13

Training Five: Climate-smart Agriculture using Geospatial Technologies 17

Royal University of Bhutan

Overview

The International Nature Education and Experience (INEE), College of Natural Resources, Royal University of Bhutan, conducts comprehensive trainings in areas of biodiversity, natural resources, climate-smart agriculture, organic agriculture, and statistical analysis using R. The biodiversity training programme emphasizes hands-on activities, field surveys, and practical exercises, fostering skills in biodiversity monitoring and habitat restoration. Natural resources management training covers sustainable practices such as water conservation, soil health improvement, and responsible forest management. Climate-smart agriculture programme provide participants with practical insights into climate-resilient farming practices, including water-efficient irrigation and precision agriculture. The organic agriculture training focuses on environmentally-friendly farming methods, enriching soil health, and pest management without synthetic chemicals. Additionally, the training includes a module on R statistics, offering participants the skills to conduct statistical analysis for research in biodiversity, natural resources, and agriculture. Through hands-on, field, and practical training, the College of Natural Resources equips participants to contribute effectively to environmental conservation, sustainable agriculture, and data-driven decision-making in Bhutan and beyond.

The College provides the following trainings:

1. Learning Statistics using R
2. Organic Agriculture
3. Community-based Forestry for Conservation and Livelihoods
4. Biodiversity Conservation Techniques
5. Climate-smart Agriculture using Geospatial Technologies

Royal University of Bhutan

Training One: Learning Statistics using R

Training : Learning Statistics using R
Course Director : Jigme Tenzin (jtenzin.cnr@rub.edu.bt)
Duration : One Week

Training Overview

This training provides participants with a comprehensive understanding of the R progrming language and its use in data visualization and statistical analysis. It will cover basic syntax in R progrming, types of data, visualization, and statistical inference. The course also emphasizes reproducible research practices and the use of R Markdown or Quarto for publishing high-quality reports, documents, or publications. This training includes hands-on lab exercises to equip with R progrming, visualization, and statistics.

Learning Outcomes

On completion of the course, participants will be able to:

1. Explain the basics of R as a progrming language and statistical software.
2. Identify and work with different data types and structures in R, including vectors, matrices, and data fres.
3. Apply subsetting and manipulation techniques to explore and analyze data in R.
4. Create and customize various types of plots using basic and advanced plotting functions in R.
5. Calculate and interpret summary statistics and measures of correlation and explore data distributions using R.
6. Apply inferential statistics techniques such as hypothesis testing, regression analysis, and nonparetric statistics to analyze and interpret data in R.

Training content

Time	Day 1: Introduction to R progrming language	Facilitator
08:45–09:00	Registration and welcome, opening, setting the stage and participants introduction	
09:00–10:15	Overview of R as a progrming language and statistical software	Dr. Jigme Tenzin
10:15–10:30	Break	

10:30–12:00	Installation and setup of R and RStudio	Dr. Jigme Tenzin
12:00–13:00	User Interface	Dr. Jigme Tenzin
13:00–14:00	Lunch Break	
14:00–14:30	Basic syntax and commands, scripts, packages	Dr. Jigme Tenzin
14:30–15:00	Lab 1: Basic syntax and commands, scripts, and packages	Dr. Jigme Tenzin
15:00–15:15	Break	
15:15–15:45	Data types	Dr. Jigme Tenzin
15:45–17:00	Lab 2: Data types	Dr. Jigme Tenzin
Time	**Day 2: Exploratory Data Analysis**	
09:00–10:15	Using inbuilt dataset to explore data	Tenzin Wangchuk
10:15–10:30	Break	
10:30–12:00	Data import and manipulation (subset, select, mutate)	Tenzin Wangchuk
12:00–13:00	Lab 3: Data import and manipulation (subset, select, mutate)	Tenzin Wangchuk
13:00–14:00	Lunch Break	
14:00–14:30	Introduction to Tidyverse package to manipulate data	Tenzin Wangchuk
14:30–15:00	Lab 4: Using Tidyverse to manipulate data	Tenzin Wangchuk
15:00–15:15	Break	
15:15–15:45	Data cleaning and preprocessing	Tenzin Wangchuk
15:45–17:00	Lab 5: Data cleaning and preprocessing	Tenzin Wangchuk

Time	**Day 3: Data Visualization**	
09:00–10:15	Data visualization in base R and ggplot2	Ugyen Dorji
10:15–10:30	Break	
10:30–12:00	Lab 6: Base R plotting	Ugyen Dorji
12: 00–13:00	Lab 7: Plotting with ggpot2	Ugyen Dorji
13:00–14:00	Lunch Break	
14:00–14:15	Descriptive statistics	Ugyen Dorji
14:15–15:00	Lab 8: Descriptive statistics	
15:00–15:15	Break	
15:15–17:00	Lab 9: Descriptive statistics	Ugyen Dorji
Time	**Day 4: Inference from the data**	
09:00– 9:15	Introduction to inferential statistics	Dr. Jigme Tenzin
09:15 –10:15	Lab 6: Correlation (tables, Pearson correlation, Spearman's rank correlation, Chi-square test)	Dr. Jigme Tenzin
10:15–11:45	Break	

11:45 –13:00	Hypothesis testing	Dr. Jigme Tenzin
13:00 –14:00	Lunch Break	
14:00 –15:00	Lab 7: *t*-test, ANOVA, ANCOVA	Dr. Jigme Tenzin
05:00 –15:15	Break	
15:15 –16:00	Non-paretric statistics	Tenzin Wangchuk
16:00 –17:00	Lab 8: Wilcoxon test, Kruskal-Walli's test, Friedman test	Tenzin Wangchuk
Time	**Day 5: Inference from the data**	
09:00 –9:15	Introduction to simple linear regression and multiple linear regression	Ugyen Dorji
09:15 –10:15	Lab 8: Simple linear regression and multiple linear regression	Ugyen Dorji
10:15 –10::30	Break	
10:30 –11:00	Reproducible research and reporting	Dr. Jigme Tenzin
11:10 –13:00	Lab 9: R markdown and quarto for reproducible research	Dr. Jigme Tenzin
13:00 –14:00	Lunch Break	
14:00 –15:45	Lab 10: Data analysis report and documentation	Dr. Jigme Tenzin
15:45 –16:00	Break	
16:00 –16: 40	Training evaluation	
16:40 –17:00	Training Closure	

Materials/Resources required

Laptop/Desktop, R, R Studio

Reading Materials

Bryan, J., & von der Heyde, M. (2018). *Happy Git and GitHub for the useR.* (Version 3.0). Retrieved from https://happygitwithr.com/

Dalgaard, P. (2008). *Introductory statistics with R*. Springer Science & Business Media.

Diez, D. M., Barr, C. D., & Cetinkaya-Rundel, M. (2012). *OpenIntro statistics*. Boston, MA, USA:: OpenIntro. Retrieved from https://www.openintro.org/book/os/

Wickh, H., Çetinkaya-Rundel, M., & Grolemund, G. (2023). *R for data science*. O'Reilly Media, Inc. Retrieved from https://r4ds.hadley.nz/

Xie, Y., Allaire, J. J., & Grolemund, G. (2018). *R markdown: The definitive guide*. Chaan and Hall/CRC. Retrieved from https://bookdown.org/yihui/rmarkdown/

Royal University of Bhutan

Training Two: Organic Agriculture

Course Director : Tenzin Wangchuk (tenzin.cnr@rub.edu.bt)
Training Duration : One week

Training overview

The week-long training on Organic Agriculture (OA) covers various aspects of organic farming, including its definition, principles, historical context, benefits, and challenges. The training also delves into the regulatory bodies involved in organic standards, organic certificate, certification process, and documentation management. Additionally, the participants will learn about organic soil fertility management techniques, including soil testing and analysis, different organic fertilizers, composting, crop rotation, nutrient management plans, and bio-fertilizers. The training also covers plant protection in organic farming, including identifying common weeds, pests, and diseases, understanding their life cycles, and developing a plant protection plan. The training culminates in a field visit to a nearby OA farm, followed by feedback/evaluation and certificate distribution.

Learning outcomes

At the end of the training, the participants will be able to:

1. Understand the principles of organic agriculture, as well as its evolution, need, and drivers.
2. Comprehend the benefits and challenges of organic farming.
3. Filiarize with the different organic standards and certifications, regulatory bodies, and the certification process.
4. Learn about the soil and nutrient management techniques in organic farming.
5. Gain knowledge on plant protection in organic agriculture.

Training Contents

Time	Day 1: Introduction to OA	Facilitator(s)
08:45 –09:15	Registration and welcome, opening, setting the stage and participants introduction	Tenzin Wangchuk
09:15 –10:15	Definition and principles of organic agriculture	Sonam Tashi
10:15 –11:45	Break	
10:45 –13:00	Historical context and evolution of organic farming Need for OA Drivers of OA	Sonam Tashi
13:00 –14:00	Lunch Break	

14:00 –15:00	Benefits of organic farming • Food safety and health • Soil/water/environment health	Sonam Tashi
15:00 –15:15	Break	
15:15 –15:45	Challenges in organic farming • Inputs/production related • Documentation/certification related • Market related	Sonam Tashi
15:45 –16:45	Debate on OA Vs Conventional agriculture	Sonam Tashi/Tenzin Wangchuk
16:45 –17:00	Question and answer session	

Time	**Day 2: Standards and Certifications in Organic Farming**	
09:00 –9:15	Reflection	Tenzin Wangchuk
09:15 –10:15	Standards in OA • Definition of organic standards • Importance of standards in organic farming • Overview of different organic standards	Expert from NCOA
10:15 –11:45	Break	
10:45 –12:00	Benefits and challenges of organic certification	Expert from NCOA
12:00 –13:00	Regulatory bodies involved in organic certification	Expert from NCOA
13:00 –14:00	Lunch Break	
14:00 –17:00	Organic certification process and documentation • Understanding organic certification requirements • Documentation required for organic certification • Inspection and audit processes • Record-keeping and documentation management Organic certification and market opportunities	Expert from NCOA

Time	**Day 3: Soil and Nutrient management**	
09:00 –9:15	Recap from the previous day and reflection on key insights	Tenzin Wangchuk
09:15 –10:15	Importance of soil fertility in organic farming Soil nutrient management techniques in organic farming • Soil testing and analysis Organic Fertilizers • Types of organic fertilizers • Properties of organic fertilizers • Benefits and limitations of organic fertilizers	Mahesh Ghimiray/ Tenzin Wangchuk
10:15 –11:45	Break	
11:45 –13:00	Composting • Process of composting	Mahesh Ghimiray/

	• Composting techniques • Use of compost in organic farming Crop Rotation and Nutrient Management Plan • Crop rotation and its role in nutrient management • Nutrient management plan for organic farming Bio-fertilizers • Importance • Types	Tenzin Wangchuk
13:00 –14:00	Lunch Break	
14:00 –17:00	Field Work/practical on the cpus	Mahesh Ghimiray/ Tenzin Wangchuk

Time	**Day 4: Plant protection in OA**	
09:00 –9:15	Recap from the previous day and reflection on key insights	Tenzin Wangchuk
09:15 –10:15	Weeds, Plant Pests and Diseases • Identification of common weeds, pests and diseases in crops • Life cycles and habits of weeds, pests and diseases • Understanding pest and disease epidemiology Biological Control Agents • Introduction to biological control agents • Types of biological control agents • Benefits and limitations of biological control agents	Ongpo Lepcha/ Karma Wangchuk
10:15 –11:45	Break	
11:45 –12:15	Crop Rotation and Intercropping • Crop rotation and its role in pest management • Intercropping and its role in pest management • Benefits and limitations of crop rotation and intercropping	Ongpo Lepcha/ Karma Wangchuk
12:15 –03:00	Plant Protection Plan and Methods	Ongpo Lepcha
13:00 –14:00	Lunch Break	
14:00 –17:00	Field Work/practical on the cpus	Ongpo Lepcha/ Karma Wangchuk

Time	**Day 5: Field visit and closure**	
09:00 –15:45	Visit nearby OA farm and interact with farmers	Tenzin Wangchuk/ Ongpo Lepcha
15:45 –16:00	Break	
16:00 –16: 40	Certificate Distribution and Feedback/evaluation	Tenzin Wangchuk
16:40 –17:00	Closing Ceremony	Tenzin Wangchuk

Materials
1. Training venue
2. Training materials
3. Audio-visual equient
4. Flip charts and markers
5. Guest speakers
6. Evaluation forms
7. Certificates
8. Refreshments
9. Travel and accommodation (if applicable)

Reading Materials

DoA. (2018). Sustainable Socio-economic develoent through commercialization of organic farming. MoAF, ARDC Yusipang, Thimphu, Yusipang.

FAO. (2018). Transforming food and agriculture to achieve the SDGs: 20 interconnected actions to guide decision makers. Rome, Italy, https://doi.org/10.1061/(ASCE)MT.1943-5533.0001328.

FiBL-IFO (2021). Organics International 2021: The World of Organic Agriculture. Frick and Bonn, Germany

ICIMOD and MoAF (2018). Organic agriculture develoent strategies: Roadmap for 12th Five Year Plan and Beyond. Nepal, Kathmandu: ICIMOD.

Ministry of Agriculture and Forests. (2019). Bhutan Organic Guarantee System (BOGS). Bhutan, Thimphu: National Organic Progr.

Ministry of Agriculture and Forests. (2019). Bhutan Organic Standard (BOS). Bhutan, Thimphu: National Organic Progr.

Ministry of Agriculture and Forests. (2020). Training manual: Internal Control System (ICS). Bhutan,Thimphu: National Centre for Organic Agriculture.

Schaetzen de, S. (2019). Organic agriculture and the sustainable develoent goals: Part of the solution.

Scialabba, N. (Ed.). (2015). Training manual for organic agriculture. FAO, Italy, Rome.

Training Three: Community-Based Forestry for Conservation and Livelihoods

Course Director : Ugyen Dorji (ugyen.cnr@rub.edu.bt)
Duration : One week

Training overview

The week-long training on Community-based forestry for conservation and livelihoods is designed to provide participants with a comprehensive understanding of community-based forestry principles and practices including the best cases from Bhutan. The training will equip participants with the skills and knowledge to develop and implement community-based forestry for projects in their own countries or regions towards conservation and improvement of livelihoods.

Learning outcomes

On the completion of the training, participants will be able to:

1. Explain the principles of community-based forestry for conservation and livelihoods.
2. Analyze best cases from Bhutan community-based forestry and initiatives.
3. Design and implement community-based forest management.
4. Identify the key stakeholders in the develoent and implementation of plans and activities.
5. Identify appropriate tools, methods, and techniques to facilitate participation in community-based forest management.
6. Develop a plan to sustain and scale up the impact of community-based forestry projects.

Training content

Time	**Day 1: Introduction to community-based forestry management**	**Facilitator(s)**
08:45 –9:15	Registration and welcome, opening, setting the stage and participants introduction	Dr. Ugyen Dorji/ Dr. Yonten Dorji
09:15 –10:15	Introduction to community forestry	Dr. Ugyen Dorji/ Dr. Yonten Dorji
10:15 –11:45	Break	
10:45 –13:00	Overview of community forestry principles	Dr. Ugyen Dorji/ Dr. Yonten Dorji
13:00 –14:00	Lunch break	
14:00 –15:00	Overview of community forestry principles	Dr. Ugyen Dorji/ Dr. Yonten Dorji
15:00 –15:15	Break	
15:15 –15:15	Guest speaker session: experience sharing	Guest Speaker

	on community-based conservation and livelihoods projects	
15:15 –17:00	Discussion of the challenges and opportunities in community-based forestry	Participants

Time	**Day 2: Community forestry management plans**	
09:00 –9:15	Recap from the previous day and reflection on key insights	Dr. Ugyen Dorji/ Dr. Yonten Dorji
09:15 –10:15	Overview of community forestry management plans	Dr. Ugyen Dorji/ Dr. Yonten Dorji
10:15 –11:45	Break	
10:45 –12:00	Identification stage	Dr. Ugyen Dorji/ Dr. Yonten Dorji
12:00 –13:00	Planning stage	Dr. Ugyen Dorji/ Dr. Yonten Dorji
13:00 –14:00	Lunch break	
14:00 –15:00	Implementation stage including monitoring & evaluation	Dr. Ugyen Dorji/ Dr. Yonten Dorji
15:00 –15:15	Break	
15:15 –17:00	Financial and technical guidelines	Dr. Ugyen Dorji/ Dr. Yonten Dorji

Time	**Day 3: Experiential learning-visit and learn from local forestry management projects**	
08:00 –8:30	Report to the departure point	Dr. Ugyen Dorji/ Dr. Yonten Dorji
08: 30 –17:00	Visit to community forest and interacting with community management group in Punakha district	Participants

Time	**Day 4: Experiential learning-visit and learn from local forestry management projects**	
08:00 –8:30	Report to the departure point	
08: 30 –17:00	Visit to community forest and interacting with community management group in Tsirang district	Participants

Time	**Day 5: Developing community forestry management plans**	
09:00 –9:15	Reflection on key field visit to community forest	Dr. Ugyen Dorji/ Dr. Yonten Dorji
09:15 –10:15	Establishing the legal and institutional frework	Dr. Ugyen Dorji/ Dr. Yonten Dorji
10:15 –11:45	Break	

10:45 –13:00	Setting up a community forest management plan	Dr. Ugyen Dorji/ Dr. Yonten Dorji
13:00 –14:00	Lunch break	
14:00 –15:00	Setting up a community forest management plan	Dr. Ugyen Dorji/ Dr. Yonten Dorji
14:00 –15:15	Break	
15:15 –16:15	Developing an inventory of forest resources	Dr. Ugyen Dorji/ Dr. Yonten Dorji
16:15 –17:00	Developing a monitoring system	Dr. Ugyen Dorji/ Dr. Yonten Dorji

Time	**Day 6: Planning workshop-developing community forestry management plans**	
09:00 –9:15	Recap from the previous day and reflection on key insights	Participants
09:15 –10:15	Developing monitoring and evaluation	Dr. Thubten Son
10:15 –11:45	Break	
10:45 –12:00	Developing a conflict resolution mechanism	Dr. Thubten Son
12:00 –13:00	Developing a resource management system	Dr. Thubten Son
13:00 –14:00	Lunch break	
14:00 –15:00	Presentation	Participants
15:00 –15:15	Break	
15:15 –16:15	Presentation	Participants
16:15 –17:00	Farewell and certificate distribution closing	

Time	**Day 7: Cultural visit**	
09:00 –17:00	Cultural visit to nearby places	Dr. Ugyen Dorji/ Dr. Yonten Dorji

Materials/Resources required

1. College lecture theatre will be used as the space and facilities are adequate to accommodate participants, trainers, and equient.
2. Training materials required will include handouts, community-based conservation manuals, and other relevant training materials, including copies of case studies, regulations, and other reference documents.
3. Audio-visual equient will include projectors, screens, microphones, and speakers for presentations and group discussions.
4. Flip charts and markers will be needed to facilitate brainstorming and group activities.
5. Computers and Internet access will enable participants to conduct research and access online resources related to the training.
6. Evaluation forms will be made to assess the effectiveness of the training and obtain feedback from the participants.
7. Certificates will be awarded towards the end of training.

8. Refreshments such as snacks, meals, and beverages to sustain participants during the training.
9. Travel and accommodation for participants travelling from different locations, arrangements for their transportation and lodging will also be required.

Materials required

Materials
10. Training venue
11. Training materials
12. Audio-visual equient
13. Flip charts and markers
14. Computers and Internet access
15. Guest speakers
16. Evaluation forms
17. Certificates
18. Refreshments
19. Travel and accommodation

Reading Materials

Berkes, F. (1989). *Common property resources: Ecology and community-based sustainable develoent.* Belhaven Press with the International Union for Conservationof Nature and Natural Resources.

Department of Research and Develoent Services, MOAF. (2002). *Community-based natural resource management in Bhutan: A frework.* KuenselCorporation.

Means, K. and Josayma, C. (2002*). Community –based forest resource conflict management: A training package*. Food and Agriculture Organisation of the United Nations.

Menon, A., Singh, P., Shah, E., Lele, S., Paranjape, S. and Joy, K.J. (2007). *Community-based natural resource management: Issues and cases from South Asia*. Sage Publications India Pvt Ltd.

Sundar, K.V., Moni, M. and Jha, M.M. (2004). *Natural resources management and livelihood security: Survival strategies and sustainable policies*. Concept Publishing Company

Training Four: Biodiversity Conservation Techniques

Course Director : Ugyen Dorji (ugyen.cnr@rub.edu.bt)
Duration : One week

Training overview

A week-long training will focus on techniques for biodiversity conservation. The training will have a practical, hands-on approach and will cover various aspects of conservation science, including the use of modern techniques like cera traps, remote sensing, drones, and citizen science. The training will also cover the study of different wildlife species, including mmals, avian, herpetofauna, aquatic, and invertebrates and will include fieldwork to conduct surveys and collect data. Additionally, there will be a section on ethnobotany, which will involve field surveys and interviews with local communities to document traditional knowledge and use of plants.

Learning outcomes

On completion of the training, participants will be able to:

1. Explain the importance of biodiversity conservation and the challenges faced in protecting endangered species and their habitats.
2. Demonstrate filiarity with modern techniques used in conservation biology such as setting up cera traps, retrieving data, and analyzing data;
3. Identify the characteristics of different wildlife species, including mmals, avian, herpetofauna, aquatic, and invertebrates.
4. Demonstrate practical skills in conducting surveys and collecting data for different wildlife species.
5. Analyze the cultural significance of plants in local communities and interpret their role in rituals and traditions.

Training content

Time	Day 1: Fundentals and modern techniques	Facilitator(s)
08:45 –09:15	Registration and welcome, opening, setting the stage and participants introduction	Mr. Ugyen Dorji
09:15 –10:15	Introduction to biodiversity conservation	Dr. Dhan Bdr. Gurung
10:15 –11:45	Break	
10:45 –12:00	Modern techniques to conservation: cera traps	Dr. Dhan Bdr. Gurung
12:00 –13:00	Remote sensing	Dr. Dhan Bdr. Gurung
13:00 –14:00	Lunch break	

14:00 –14:30	Drones	Dr. Dhan Bdr. Gurung
14:30 –15:00	Citizen science	Dr. Dhan Bdr. Gurung
15:00 –15:15	Break	
15:15 –15:45	Molecular analysis	Dr. Dhan Bdr. Gurung
15:45 –16:15	Acoustic monitoring	Dr. Dhan Bdr. Gurung
16:15 –16:45	Transect	Dr. Dhan Bdr. Gurung
16:45 –17:00	Question and answer session	

Time	**Day 2: Conservation techniques for major biodiversity groups**	
Mmals		
09:00 –9:15	Recap from the previous day and reflection on key insights	Mr. Ugyen Dorji
09:15 –10:15	Live trapping and marking	Mr. Sangay Tshering/ Mr. Karma Sherub
10:15 –11:45	Break	
10:45 –12:00	Scat surveys	Mr. Sangay Tshering/ Mr. Karma Sherub
12:00 –13:00	Thermal imaging ceras	Mr. Sangay Tshering/ Mr. Karma Sherub
13:00 –14:00	Lunch break	
Avian		
14:00 –14:30	Conducting point counts	Mr. Sangay Tshering/ Mr. Karma Sherub
14:30 –15:00	Mist netting	Mr. Sangay Tshering/ Mr. Karma Sherub
15:00 –15:15	Break	
15:15 –15:45	Radio telemetry	Mr. Sangay Tshering/ Mr. Karma Sherub
15:45 –16:15	Bird banding	Mr. Sangay Tshering/ Mr. Karma Sherub
Aquatic		
16:15 –16:45	Fish spling methods	Mr. Ugyen Dorji
16:45 –17:30	Macroinvertebrate spling methods	Mr. Ugyen Dorji

Time	**Day 3: Conservation techniques for major biodiversity groups**	
09:00 –9:15	Recap from the previous day and reflection on key insights	Participants
Herpetofauna		
09:15 –10:15	phibian spling methods: visual surveys, traps, mark and recapture	Dr. Dhan Bdr. Gurung
10:15 –11:45	Break	
11:45 –13:00	Reptile spling methods: visual surveys,	Dr. Dhan Bdr. Gurung

	traps, mark and recapture	
13:00 –14:00	Lunch break	
Invertebrates		
14:00 –14:30	Pitfall trap surveys, sweep net, hand collecting	Mr. Karma Wangdi/ Mr. Ongpo Lepcha
14:30 –15:00	Baited trap, light trap surveys to collect nocturnal invertebrates such as moths and beetles and other methods	Mr. Karma Wangdi/ Mr. Ongpo Lepcha
15:00 –15:15	Break	
Ethnobotany		
15:15 –16:00	Field surveys	Dr. Dhan Bdr. Gurung
16:00 –17:00	Conducting interviews with local communities and participatory mapping	Dr. Dhan Bdr. Gurung
17:00 –17:30	Group discussion and field work briefing	Mr. Ugyen Dorji

Time	**Day 4: Experiential learning-field work on surveying major biodiversity groups**	
08:00 –8:30	Report to the departure point	Mr. Ugyen Dorji
08: 30 –17:00	Field work on specific group of biodiversity	Participants

Time	**Day 5: Experiential learning-field work on surveying major biodiversity groups**	
09:00 –17:00	Field work on specific group of biodiversity	Participants

Time	**Day 6: Experiential learning-field work on surveying major biodiversity groups**	
09:00 –17:00	Field work on specific group of biodiversity	Participants

Time	**Day 7: Discussion and wrap up**	
09:00 –9:15	Reflection on key field visit	
09:15 –10:15	Panel discussion with experts on major biodiversity	Field Experts
10:15 –11:45	Break	
10:45 –12:00	Panel discussion with experts on major biodiversity	Field Experts
12:00 –13:00	Group presentation on findings from field survey	Participants
13:00 –14:00	Lunch break	
14:00 –15:45	Group presentation on findings from field survey	Participants
15:45 –16:00	Break	
16:00 –16: 40	Certificate distribution and feedback/evaluation	Mr. Ugyen Dorji
16:40 –17:00	Closing ceremony	

Time	Day 8: Cultural visit	
09:00 –17:00	Cultural visit to nearby places	Mr. Ugyen Dorji

Materials/Resources required

1. College lecture theatre will be used as the space and facilities are adequate to accommodate participants, trainers, and equient.
2. Training materials required will include handouts, community-based conservation manuals, and other relevant training materials, including copies of case studies, regulations, and other reference documents.
3. Audio-visual equient will include projectors, screens, microphones, and speakers for presentations and group discussions.
4. Flip charts and markers will be needed to facilitate brainstorming and group activities.
5. Computers and Internet access will enable participants to conduct research and access online resources related to the training.
6. Evaluation forms will be made to assess the effectiveness of the training and obtain feedback from the participants.
7. Certificates will be awarded towards the end of training.
8. Refreshments such as snacks, meals, and beverages to sustain participants during the training.
9. Travel and accommodation for participants travelling from different locations, arrangements for their transportation and lodging will also be required.

Reading Materials

Buckland, S.T., Anderson, D.R., Burnh, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. (2001). *Introduction to Distance Spling: Estimating*. UK: Oxford University Press.

Caughly, G. and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. UK: Blackwell Scientific Publications, Oxford.

Kays, R. W., & Slauson, K. M. (2019). Remote ceras. In Cera traps in animal ecology (pp. 21-53). Springer, Ch.

Lindenmayer, D. B., & Likens, G. E. (2018). Effective ecological monitoring. CSIRO Publishing.

Morrison M.L., Block, W.M., Strickland, M.D., and Kendall, W.L. (2001). *Wildlife Study Design*. New York: Springer-Verlag,

Sinclair, A. R. E., J. M. Fryxell and G. Caughley. (2006). *Wildlife ecology, conservation and management*. Malden, MA: Blackwell Science.

Swann, D. E. (2015). Recommended guiding principles for reporting on cera trapping research. Biodiversity and Conservation, 24(1), 253-264.

Royal University of Bhutan

Training Five: Climate-smart Agriculture using Geospatial Technologies

Training Director : Dr. Ugyen Thinley (uthinley.cnr@rub.edu.bt)
Training duration **:** Ten Days

Training objectives

The 10-day training will focus on Climate-smart agriculture technologies and integrating geospatial technologies to make farms resilient and sustainable. The training will have an extended period of practical exercise on data collection, spatial analysis, and mapping of climate risks, vulnerabilities and opportunities. The practical exercise will also focus on land use planning.

Learning outcomes

At the end of the training, the participants will be able to:

1. Describe concepts and principles of CSA.
2. Explain different CSA technologies and practices.
3. Design CSA practices using Geographic Information System.
4. Acquire remotely sensed datasets from open sources such as Google Earth Engine, Earth explorer etc.
5. Carry out a CSA based project using GIS and remote sensing.

Training content

Time	**Day 1: Introduction to Climate-smart Agriculture**	**Facilator**
08:45 –09:15	Registration and welcome, opening, setting the stage and participants introduction	Son Tshering
09:15 –10:15	Impacts of climate change on agriculture	Dr. Son Tashi
10:15 –11:45	Break	
10:45 –12:00	Building farm resilience through Climate-smart agriculture practices	Dr. Son Tashi
12:00 –13:00	CSA practices in Bhutan	Dr. Son Tashi
13:00 –14:00	Lunch Break	
14:00 –16:45	CSA farm visit	Dr. Son Tashi
16:45 –17:00	Question and answer session	Dr. Son Tashi

Time	**Day 2: Integrating GIS in CSA**	Dr. Ugyen Thinley
09:00 –9:15	Introduction to GIS and ArcGIS software Interface (Inform participants about the project)	Dr. Ugyen Thinley
09:15 –10:15	Data Display and Data retrieval	Dr. Ugyen Thinley
10:15 –11:45	Break	
10:45 –13:00	Map symbolization-charts, dots, colour rp, etc.	Dr. Ugyen Thinley
13:00 –14:00	Lunch Break	
14:00 –17:00	Cartography-designing a printable map	Dr. Ugyen Thinley

Time	**Day 3: Data Processing using Geoprocessing Tools**	Mr. Ugyren Dorji
09:00 –10.15	Data processing-extraction, combination, and transformation	Mr. Ugyren Dorji
10:15 –11:45	Break	
11:45 –12:40	Feature Geometry Calculations-area, perimeter, volume and heights	Mr. Ugyren Dorji
12: 40 –13:00	3D Result visualization in ArcScence	Mr. Ugyren Dorji
13:00 –14:00	Lunch Break	
14:00 –17:00	3D Result visualization in ArcScence	Mr. Ugyren Dorji

Time	**Day 4: Geospatial Data Collection**	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
09:00 –9:15	Demonstration on GPS handset usage	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
09:15 –10:15	GPS survey within the cpus	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
10:15 –11:45	Break	
11:45 –13:00	GPS survey within the cpus cont.	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
13:00 –14:00	Lunch Break	
14:00 –17:00	GPS data integration to GIS	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
Time	**Day 5: Brief Introduction to Remote Sensing**	
09:00 –9:15	Concepts of Remote Sensing	Dr. Ugyen Thinley
09:15 –10:15	Supervised Landsat 8 Image Classification	Dr. Ugyen Thinley/ Mr. Ugyren Dorji

10:15 –11:45	Break	
11:45 –12:15	Supervised Landsat 8 Image Classification cont.	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
12:15 –13:00	Accuracy Assessment of Classified Image	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
13:00 –14:00	Lunch Break	
14:00 –05:00	Accuracy Assessment of Classified Image	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
Time	**Day 6: Introduction to GIS modelling Techniques**	
09:00 –9:15	Introduction to Weighted Overlay and its roles in Suitability Modelling	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
09:15 –10:15	Exercise on the Weighted Overlay using real data	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
10:15 –11:45	Break	
11:45 –13:00	Exercise on the Weighted Overlay using real data cont.	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
13:00 –14:00	Lunch Break	
14:00 –17:00	Introduction to Fuzzy Overlay and its roles in Suitability Modelling	Dr. Ugyen Thinley/ Mr. Ugyren Dorji

Time	**Day 7: Introduction to GIS modelling Techniques cont.**	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
09:00 –9:15	Introduction to Fuzzy Overlay and its roles in Suitability Modelling cont.	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
09:15 –10:15	Exercise on Fuzzy Overlay using real data	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
10:15 –11:45	Break	
11:45 –01:00	Exercise on Fuzzy Overlay using real data cont.	Dr. Ugyen Thinley/ Mr. Ugyren Dorji
13:00 –14:00	Lunch Break	
14:00 –17:00	Introduction to Predictive Modeling- Interpolation and Machine Learning Algorithms	Dr. Ugyen Thinley

Time	**Day 8: Implementation of CSA practices using GIS**	
09:00 –9:45	Exercise on Different Interpolation Techniques	Dr. Ugyen Thinley
09:45 –10:15	Exercise on Machine learning algorithm– Random Forest	Dr. Ugyen Thinley
10:15 –11:45	Break	

11:45 –12:10	Exercise on Machine learning algorithm– Random Forest	Dr. Ugyen Thinley
12:10 –13:00	Exercise on Machine learning algorithm– Support Vector Machine	Dr. Ugyen Thinley
13:00 –14:00	Lunch Break	
14:00 –17:00	Demonstration on Maxent-Maximum Entropy Model	Dr. Ugyen Thinley

Time	**Day 9: Implementation of CSA practices using GIS cont.**	
09:00 –10:15	Design CSA practice using a GIS modelling technique	Dr. Ugyen Thinley
10:15 –11:45	Break	
10:45 –12:00	Design CSA practice using a GIS modelling technique cont .	Dr. Ugyen Thinley
12:00 –13:00	Poster designing	Dr. Ugyen Thinley/Mr. Ugyen Dorji
13:00 –14:00	Lunch Break	
14:00 –15:45	Poster designing	
15:45 –16:00	Break	
16:00 –17: 00	Poster designing	Dr. Ugyen Thinley
Time	**Day 10: Implementation of CSA practices using GIS cont.**	
09:00 –10:15	Poster Presentation and Evaluation	Dr. Ugyen Thinley/Mr. Ugyen Dorji
10:15 –11:45	Break	
10:45 –13:00	Poster Presentation and Evaluation	Dr. Ugyen Thinley/Mr. Ugyen Dorji
13:00 –14:00	Lunch Break	
14:00 –15:45	Training Wrap-up	Dr. Son Tashi/Dr. Ugyen Thinley/Mr. Ugyen Dorji
15:45 –16:00	Break	
16:00 –16: 40	Training evaluation	
16:40 –17:00	Training Closure	

Materials/Resources required

ArcGIS software, QGIS software, GPS handsets, alkaline pencil batteries, satellite datasets (landsat, sentinel).

Reading Materials

Ahmad, F., Farooq, A., Goparaju, L., & Rizvi, J. (2020). The Geospatial Understanding of Climate-Smart Agriculture and REDD+ Implementation: Indian Perspective. *Ekológia* (Bratislava), 39(1), 72-87.

Faurès, J. M., Bartley, D., Bazza, M., Burke, J., Hoogeveen, J., Soto, D., & Steduto, P. (2013). *Climate smart agriculture sourcebook*. FAO, Rome, 557.

Kazemi Garajeh, M., Salmani, B., Zare Naghadehi, S., Valipoori Goodarzi, H., & Khasraei, A. (2023). *An integrated approach of remote sensing and geospatial analysis for modeling and predicting the impacts of climate change on food security*. Scientific Reports, 13(1), 1057.

Koley, M. S., & Jeganathan, C. (2030). *Geospatial Technology: the emerging global trend towards the new horizon of sustainable agriculture*.

Mathenge, M., Sonneveld, B. G., & Broerse, J. E. (2022). Application of GIS in Agriculture in Promoting Evidence-Informed Decision Making for Improving Agriculture Sustainability: A Systematic Review. *Sustainability*, 14(16), 9974.

Tenzin, J., Phuntsho, L., & Lakey, L. (2019). *Climate smart agriculture: Adaptation & mitigation strategies to climate change in Bhutan*. Climate Smart Agriculture: Strategies to Respond to Climate Change; Shrestha, RB, Boktiar, S., Eds, 37-61.