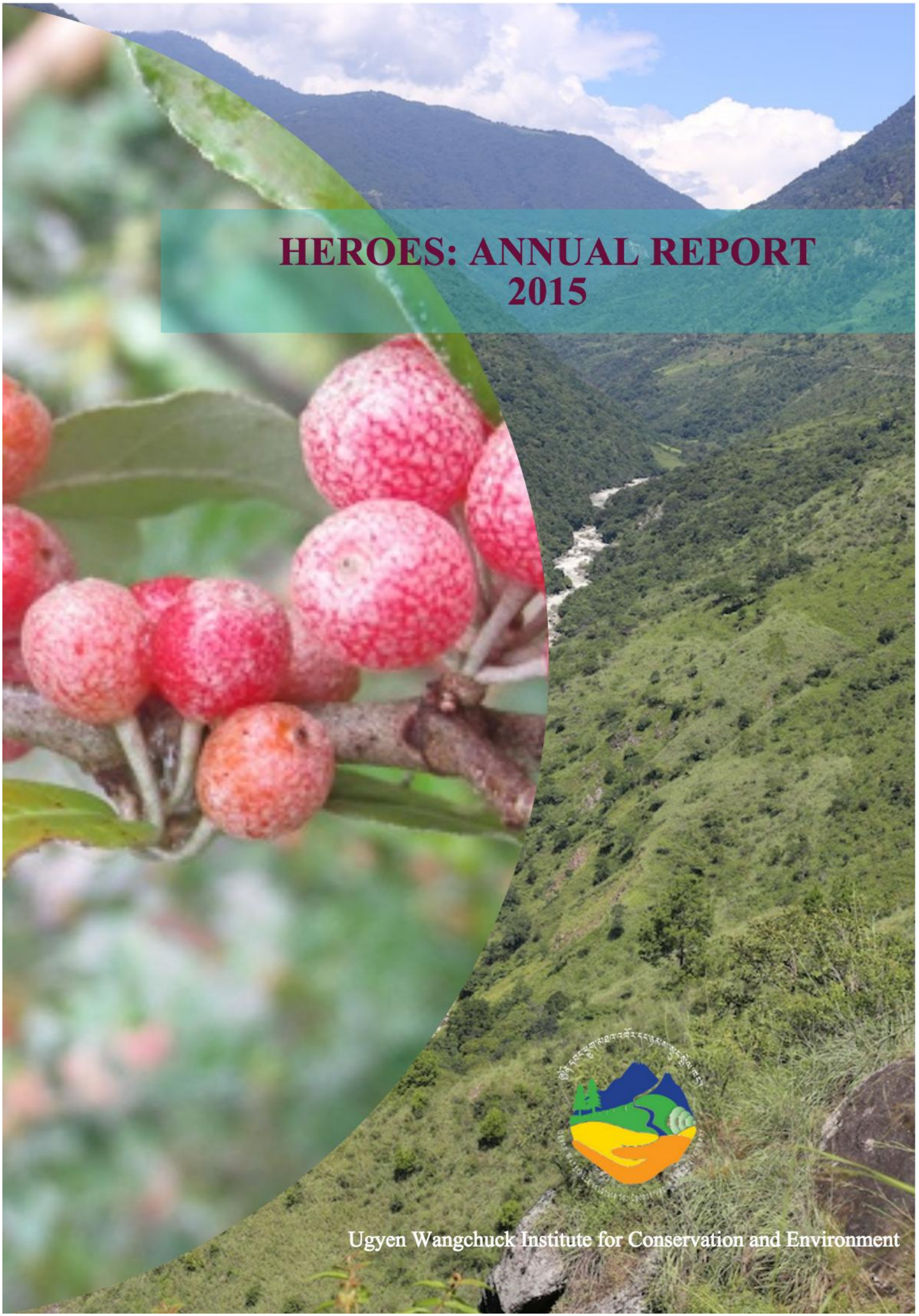

HEROES: ANNUAL REPORT 2015

Ugyen Wangchuck Institute for Conservation and Environment

Foreward

While it is too early to rate BPN's (Bhutan Phenology Network) success, significant progress has been made towards fulfilling its core objectives. In this annual report, it is with great excitement that I present progress made so far, challenges faced and our envisaged way forward.

I believe that educating youth on climate change and its impact will be one of our greatest contributions. Since its implementation in 2014, BPN has trained 34 teachers and 340 students on the science of phenology and its importance. It has stimulated significant interest both from schools and public. In particular, for the first time ever, phenology has been mainstreamed as one of the main topics in our high school curriculum. Starting 2016, students will learn about phenology and carry out basic observations as a part of their curriculum.

Bhutan still lacks good baseline data on the impacts of climate change on our biodiversity. To bridge this gap, serving as a data repository center, UWICE has received and stored 132,295 phenological data entries recorded by students on daily basis from 17 schools. In addition, weather stations from 17 sites also log climate data on a daily basis.

Most schools are deprived of adequate resources to facilitate exploratory learning of nature. Equipping them with necessary resources has created an enabling learning environment while also intensifying their interest and inquisitiveness about nature. What more can we expect? Each school has been supplied with a desktop computer, digital camera and internet services. In addition, as a part of climate monitoring system, weather stations have been deployed in each school.

Significant progress has been made. Yet, much remains to be done to establish BPN as a viable climate monitoring system. Given that understanding climate change requires years of data, effort must be sustained and attention paid to ensure the continuity of BPN.

The BPN team is grateful to our funders, the KARUNA FOUNDATION and the BHUTAN FOUNDATION. We are also grateful to the network of schools, teachers and students who are part of the Bhutan Phenology Network.

Nawang Norbu
Director

About the BPN

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Bhutan Phenology Network

BPN stands for Bhutan Phenology Network. BPN is group of individuals, organizations and institutions that monitor the impact of climate change on plants and animals in Bhutan. As a citizen science program, it engages students and teachers from schools across the country in observing and recording the seasonal lifecycle events of plants and animals.

BPN, at its core, is founded on a simple idea that ever plant and animal has a story to tell about its changing environment.Yet, in its simplicity, it provides an insightful information about the climate change and its impact on our environment. BPN, through its effort, promotes better understanding and appreciation of climate change and its impact on biodiversity. Among others, BPN:

1)Generate an yearly record of plants and animals life cycle events

2)Generate an yearly record of climate variables

3)Educate younger generation on impact of climate change on biodiversity and humans.

The status monitoring of plant and animal phenophases by students generate an yearly record of phenological events. In addition, with an establishment of weather station in each school, an yearly records of climate variables such as temperature, precipitation, solar radiation, soil moisture, wind speed and wind direction are generated.

As a monitoring site, each school also serves as a center for climate and phenological data that can be used for research and training in the field of environment and climate change. Being a common platform, BPN also fosters a mechanism to share information among researchers, educators, resource managers, and citizens on climate change and its impact.

BPN is a collaborative effort between Department of Forest and Park Services and Ministry of Education. And it is funded by US based Karuna Foundation through Bhutan Foundation.

1 Background

Phenology is the study of recurring plant and animal life cycle stages, specifically known as phenophases: budburst, leafing, flowering, fruiting, emergence of insects, migration of birds.

More simplistically, as per USA National Phenology Network (USAPN), phenology is defined as 'Nature's calendar'.

Each spring, as days get warmer, most plants exhibit leaf sprouts and open flowers. Birds migrate from the lower elevation to the higher elevation. This marks the end of winter and beginning of new spring season.In fact, phenological schedule as a seasonal cycle, is predominantely regulated by climatic conditions, particularly temperature and precipitation.

Globally, earlier spring and late autumn events are recorded by scientists and naturalists due to climate change. Intergovernmental Panel on Climate Change (IPCC), for example, has found that the spring onset has been advancing at a rate of between 2.3 and 5.2 days per decade since 1970's. IPCC, therefore, declared that phenology "is perhaps the simplest process to track changes in the ecology of species in response to climate change"

Consequently, such changes manifest as species range shift, changes in species phenological schedules and species extinction. But not all species response equally to climate change, leading to mismatch in ecosystem. Such mismatch could alter the existing interactions and processes in the ecosystem. As a result, this could have serious implications on our biodiversity and environment.

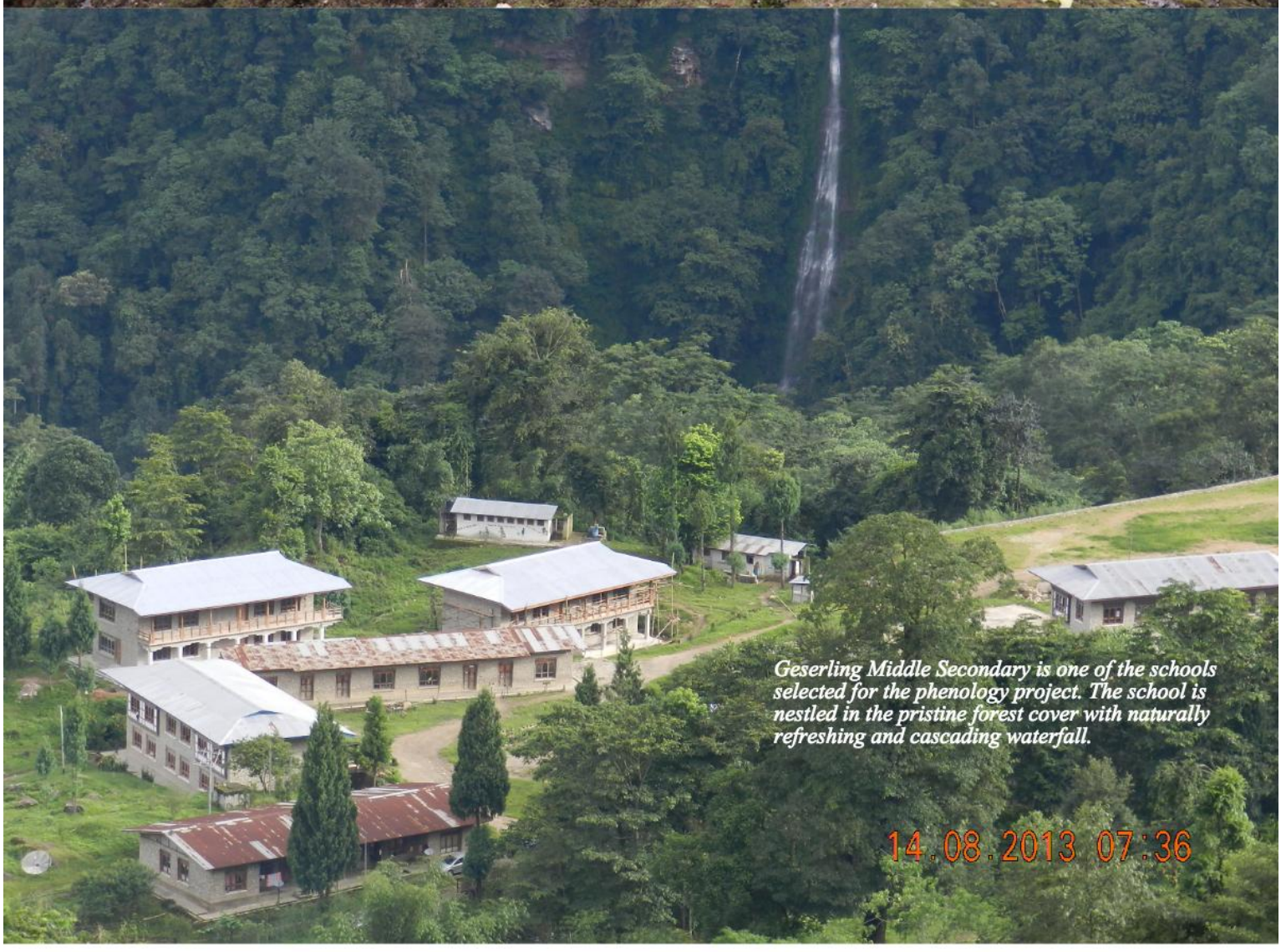
Knowing how plants and animals response to climate change will help us to determine and understand their ability to adapt, migrate or become extinct in the face of climate change. And accordingly, frame an appropriate adaptation and management strategies biodiversity conservation.

Across the globe, phenology has been used and proven to be cost effective and efficient tool to study the climate change and its impact. Its potential, however, is not yet explored in Bhutan. Moreover, in Bhutan, the baseline data on impact of climate change on biodiversity is scarce and undocumented(National Adaption Plan, NBC, 2010). Phenology, as a tool, has great potential to generate data and facilitate adaptation strategies.

Towards this effort, BPN has been conceptualized in 2013 and operationalised in 2014.

As a part of takin movement ecology, a weather station had been setup in one of the remotest location and at an altitude of 4955 m(amsl). It is monitored by one of the yak herder.

Pictutre courtesy: Takin research team, UWICE



Geserling Middle Secondary is one of the schools selected for the phenology project. The school is nestled in the pristine forest cover with naturally refreshing and cascading waterfall.

2
Network and Location

An important aspect considered while selecting schools as monitoring unit is cross-sites phenological monitoring of plants across wide geographic region,elevation gradient and vegetation zones.The sites or schools for phenology monitoring are located along different elevation gradient and vegetation zones. Besides elevation gradient, the geographic coverage has also been taken into consideration while selecting schools.

During the first phase, 17 schools from 16 dzongkhags were selected as the monitoring sites(Figure 1). Four more schools will be selected from the remaining dzongkhags during its next phase, brining the total monitoring sites to 20.Out of 17 schools, two schools fall in primary category, four schools fall in higher secondary and 10 schools fall in lower secondary category.

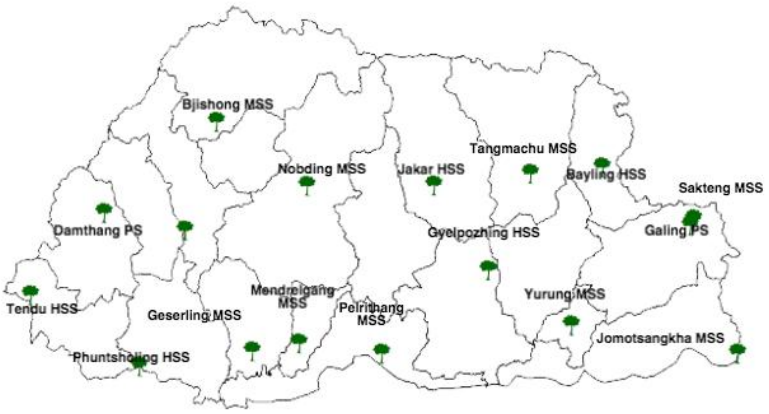


Figure 1. Location of school selected for phenology monitoring study

2.1.Elevation profile

Generally, air temperature at mountain regions decrease with increasing elevation at the lapse rate of about 0.6 ˚C every 100 m (Du et al. 2007). Therefore, with temperature gradient of 0.6 ˚C/100 m, our monitoring sites spreaded over 2902 m elevation range will experience mean temperature difference of 17.41˚C. Understanding the correlation between the temperature gradient and phenology gradient will be crucial for robust prediction of ecological responses to climate change in the region.

A drastic change in elevation within a short distance also provides an unique opportunity to study how phenological events change with elevation, and its impact due to climate change. Within this landscape, the species composition, duration of growing season, vegetation, etc differ due to changing environment condition and topography.

The elevation profile of selected schools are as shown in Figure 2. Pelrithang HSS, at an elevation of 199 m (amsl),is located at the lowest elevation. In the highest elevation, we have Damthang PS at an elevation of 3102 m(amsl). Selection of sites along elevation gradient is specifically important in places where phenological event changes along elevation gradient, with plants of same species flowering earlier at lower elevation than plants at higher elevation.

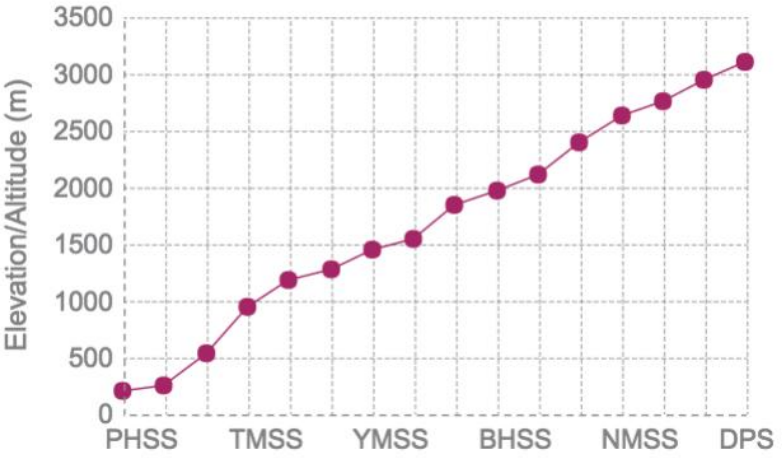


Figure 2.Elevation profile of schools selected for phenology project

2.2.Vegetation profile

All selected schools have good coverage of natural vegetation in and around its campus. The selected sites have the representation of major eco-floristic and geographic zones of Bhutan. With an elevation ranging from 200 m to 3500 m(amsl), it covers major vegetation types, ranging from subtropical forest to mixed conifer forest.

However, majority of schools fall in subtropical forest and cool broad-leaved forest, followed by chirpine and bluepine forest. Out of 17 schools,4 schools fall in sub-tropical forest, 2 schools fall in chiripine forest, 3 schools fall in warm broadleaved forest, 2 schools fall in bluepine forest, 4 schools fall in cool broadleaved forest, 1 school fall in mixed conifer and 1 school fall in fir forest.

More importantly, the vegetation profile as shown in Figure 3, depicts an adequate ecological representation for the study.

Table 1. Schools' vegetation zone

Sl	Vegetation Zopne	Elevation Range (m)	Schools	Count
1	Subtropical forest	200-1000	Tendu HSS, Phuntsholing HSS Pelrithang MSS, Jomotsangkha MSS	4
2	Chirpine forest	900-1800	Tangmachu MSS, Gyelpozhing HSS	2
3	Warm broadleaved forest	1000-2000	Geserling MSS, Mendrelgang MSS, Yurung MSS	3
4	Bluepine forest	2100-3000	Khasadrapchu MSS, Jakar HSS	2
5	Cool broadleaved forest	2000-2900	Bjishong MSS, Nobding MSS, Bayling HSS, Galing PS	4
6	Mixed conifer forest	2500-3100	Sakten MSS	1
7	Fir forest	3000-3800	Damthang PS	1

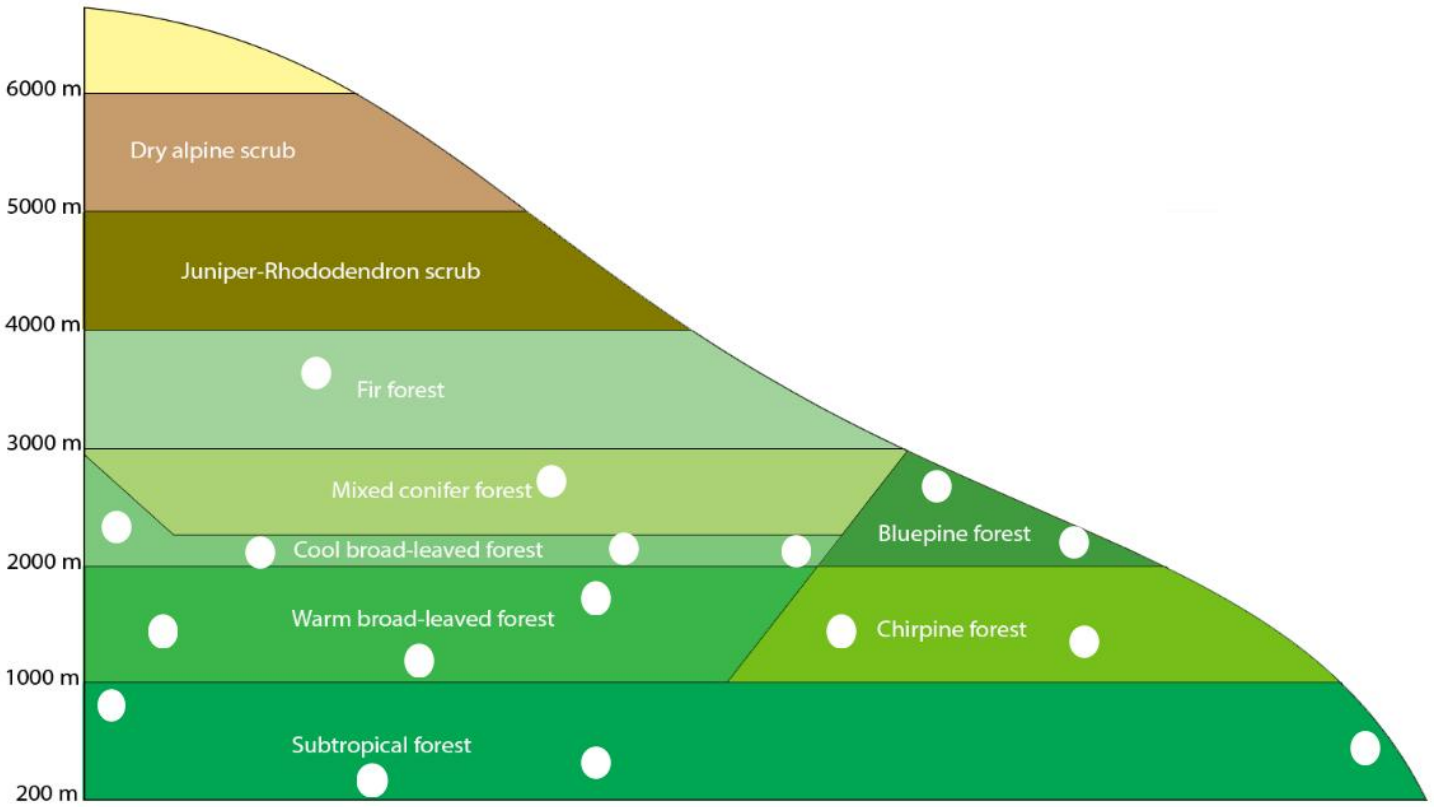


Figure 3.Vegetation profile along the elevation gradient and location of monitoring sites .

2.3.Weather stations siting

Altogether, 17 hobo weather stations had been setup in 17 schools(Figure 4).Weather stations had been setup in flat or gentle slope area with natural setting and are located away from building. Also, all the station have adequate open spaces to avoid any shading effect. The setting objective is to achieve the highest quality and the most representative data of the environment under study. Stations are located close to monitoring sites with different elevation gradient.For protection, the stations have been fenced and constantly monitored by schools.

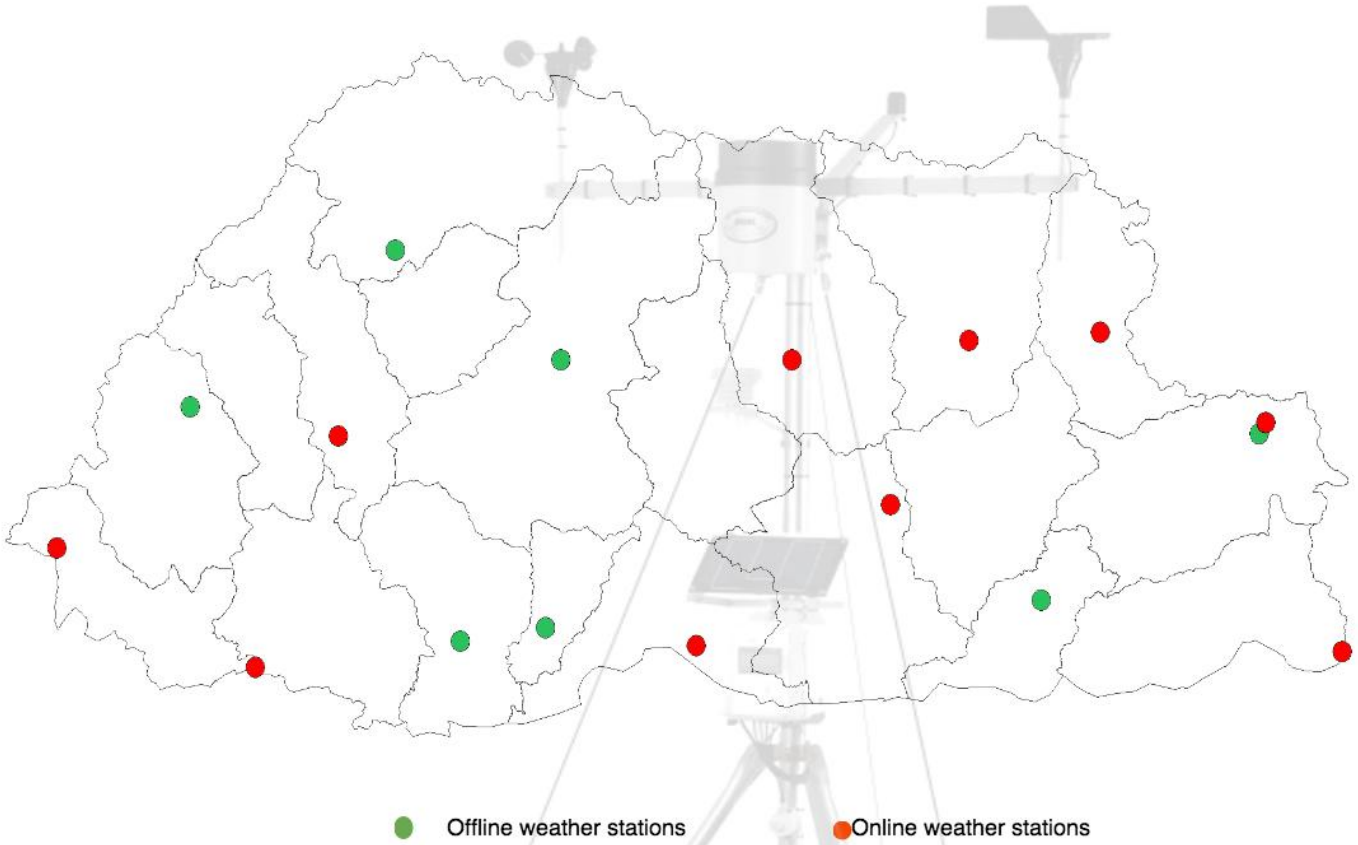


Figure 4.Weather sation sitting for the project

3
Species and Phenophases

3.1.Species

As per USANPN, species of plants for phenology observation can be broadly classified into four class: calibration species,cloned species, regional species and special project species. We have adopted USANPN approach in classifying plants selected for the project. Based on their distribution range and geographic coverage, we have identified 10 calibration species. Plants are considered as calibration plants if they are found in at least three schools with varying elevation. While some calibration species provide north-south spatial coverage, others provide east-west spatial coverage of the study area.

Along the southern belt, we have Bombax ceiba and Bidens pillosa, spreading all along the extreme south-east to south-west. In northern belt, we have Juglans regia, Primula denticulata and Fragaria nubicola as calibration species. Along central belt, we have Quercus grifithii, Eleagnus parviflora,Cymbidium hookerianum and Melia azederach as calibration species. The number of calibration species available in each monitoring sites or schools are as shown in the Figure 5. The number of calibration species per school ranges from 1 to 5; most schools have 3 calibration species.

While most of the remaining species falls under regional species class, some species like Aesandra byturacea, Rosa sericia, etc have been placed under special species due to their special ecological and cultural significance. However, as of now, we haven't incorporated any cloned plants in our monitoring sites.

The list of plants species observed by the respective schools are as shown in Table.In total, 45 tree species, 33 shrub species and 25 herb species are being observed by students of 17 schools.

Species classification

Calibration species
Wide range species with ecological and economic significance is referred to as calibration species as they facilitate calibration of phenological measurements in the study area. An incorporation of at least one calibration species is recommended if an objective is to integrate phenology data with climate variables. Calibration species can be either native species or introduced species.

Regional species
Species that have more localized distribution than calibration species is known as regional species.The regional species have economic, ecological and cultural importance in the locality or regions.

Cloned species
Species that are genetically identical are known as cloned plants.Since cloned plants have consistent genotype, they facilitate measurement of biological response to climate variation.

Special species
Species of plants that don't fit in calibration, regional or cloned plants, are placed in special species. Plants under this class have special ecological function such as source of nectar for bees,birds, etc. Also the plants with special research focus is placed under this category.

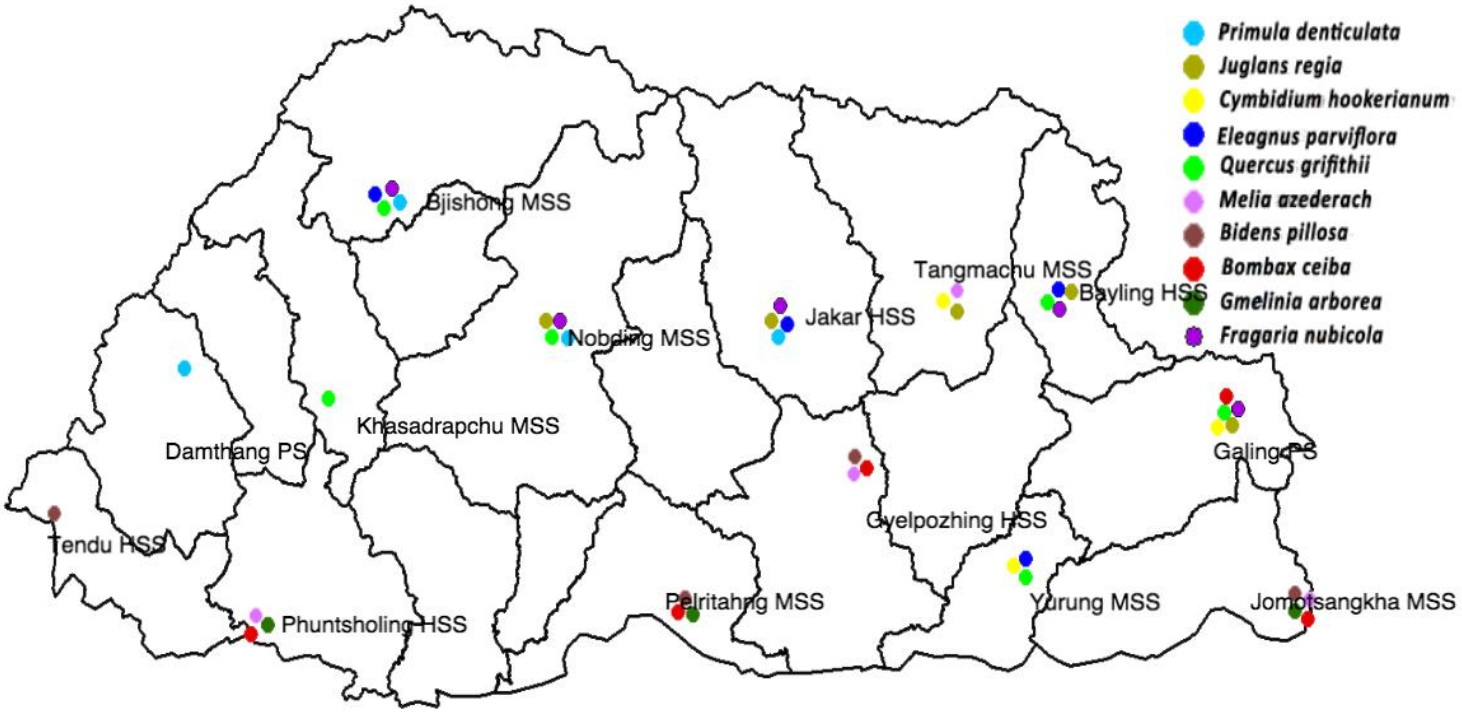


Figure 5. Species of plants selected for phenology study

3.2. Phenophases

Based on phenophase definition sheet, students identify phenophases of plants under observation. Students record whatever phenophases they see during their observation, starting from bud-burst to leaf fall. As per the observation protocols, students are required to observe and records following phenophases depending on the type of plants.

1) Vegetative phenophases: budburst, young leaf, leaf fall
2) Reproductive phenophases: flower bud, flower and pollen cones
3) Fruit/Seed phenophases: fruit, ripe fruit, and cones

Besides recording the observation, students also take pictures of phenophases of plants. However, as of now, there is no species specific phenophase definition guide. Given the diversity of plants and the ways in which phenophases manifest in each plants, general guidelines have serious limitations. The institute is still in the process of developing species specific guidelines.

Although there is considerable variation in how and when each species exhibit different phenophase stages, the generalized plant phenological sequences observed by students can be summarized as follows (Figure 6).

Figure 6. Phenological events of plants

General phenophase defination

Budburst
Leaf bud burst is stage when leaf tip is visible at the end of bud, but before first leaf has unfolded to expose leaf petiole or leaf base

Young leaf
Young and unfolded leaf is stage when its entire length has emerged from bud scale so its leaf stalk or petiole is visible at its point of attachment to stem, but before leaf has reached its full length or turn dark green or mature

Flower bud
Flower bud is a stage when one or more, fresh opened or unopened flower is visible on the plant, but before all flowers parts separate from each other revealing inner reproductive parts such as stamen and pistil

Open flower
Open flower is a stage when reproductive parts are visible between or within other floral parts (sepals and petals) or outer floral parts have separated revealing stamen and pistil

Young fruit
Fruit is considered as reproductive stage when it has not attained full maturity or reached full size, but before it has changed color on maturity or readily drops from tree.

Ripe fruit
Ripe fruit is reproductive stage when it has attained maximum size, has changed color from green to brown or yellow and readily drops from tree .

Leaf fall
Leaf fall is the stage when leaf is falling or has recently fallen from the plant, but not the one that has fallen due to disturbance or before it has reached the maturity. For evergreen tree, time of leaf fall is not distinct

1: Budburst

2: Young leaf

3: Flower bud

4: Open flower

5: Fruit

6: Ripe fruit

7: Leaf fall


DAY

4 Project Activities

4.1.Phenology observation

Given a diverse groups of students, it is necessary to have standard observation guidelines. Toward this effort, the institute developed standard observation guidelines and protocols detailing steps involved in setting up the site, observation, recording and submission of data using BPN website.

In total, 340 students from 17 schools participate in observing, recording and submitting the phenology data on daily basis. Usually, most of participating students are from nature club members. But, the members are not restricted to nature club members. Given their interest, any students can participate.

Each school observes 10 species of plants from wide taxonomic group and class. Generally, it consists of 5 trees, 3 shrubs and two herbs.

Two students observe one species of plant for an year with an understanding that if one student remains absent, one could carry out the observation without any interruption. Students observe and records the plants throughout the academic session.The observation is usually carried out during the lunch break or interval without an interruption to class session.

An observation protocols as shown in Fig 7 provides step by step instructions on how to implement the phenology observation in schools. Students collect the phenology data based on this guidelines and protocols.

Click to watch the video

(A glimpse of daily students' phenology observation activities of Sakteng MSS)

Figure 7. The observation protocols

4.2. Climate observation

The weather stations installed in schools consist of plug and play sensors for measuring temperature, precipitation, soil moisture, solar radiation, and wind speed and direction.The loggers were configured to log weather data after every 10 minutes.

Based on an availability of internet services in schools and site location, two types of weather stations were installed in schools: web based and stand alone(Figure 4). In total, 10 web based and 7 stand alone weather stations were installed.

Web based stations enable real-time, remote access to data through ethernet communications. After every one hours, the logged data are automatically transferred to web-based software from where an update on latest condition can be obtained in graphical or textual format. Students have an access to web link from where they get an update on latest weather condition of their school on real time basis (Figure)

However, stand alone stations require manual data downloading and submission through e-mail. The downloaded data can be graphed and viewed using hobo software. Everyday, phenology members carry out the data downloading using u-shuttle, an interface to relaunch, stop and download data from weather station.The downloaded data file in excel format is submitted to UWICE on weekly basis through e-mail.

For information for other students, the reading from weather stations are displayed on daily weather update board maintained by schools(Figure 8)

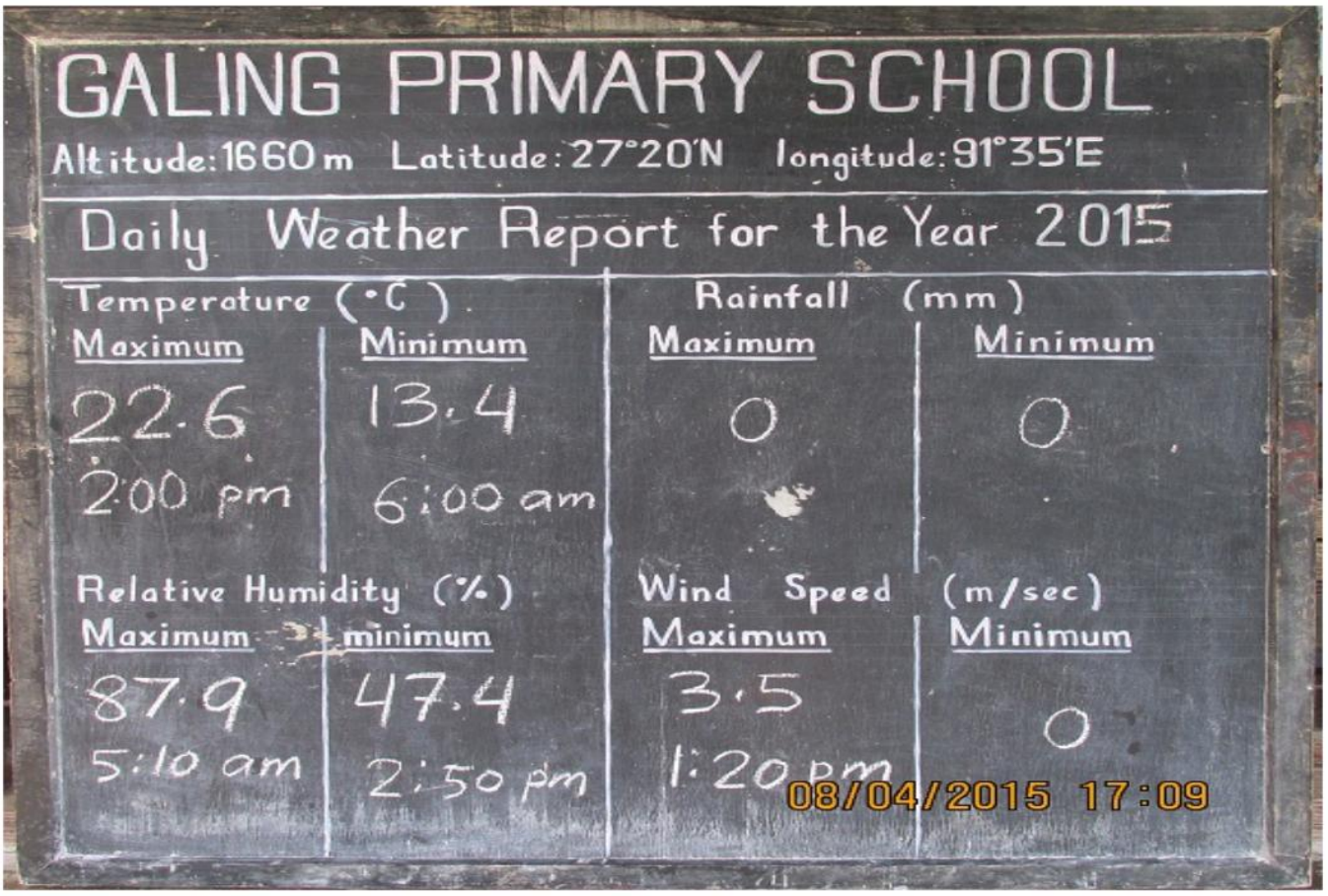


Figure 8. Weather bulletin in schools recorded from the hobo weather sation

Ugyen Lhamo, Nature Club Coordinator,Bayling High School

It has become very important for us to know the conditions of weather in a particular place and it is only the device called weather station /hobo station that serves the purpose. Our school is one of the fortunate schools in the country to receive a very much sophisticated weather studying device called hobo station this year. It gives us all the information of temperature, rainfall, humidity, wind direction and even the wind speed. The device is very much automated through sensors where we need not have to extract information manually.
Apart from updating us with the current weather conditions, it would also help students taking geography subjects to practically experience the concepts of weather through observations. Thus the establishment of hobo station in our school is a blessing

4.3. Capacity development

Focal teacher training

Prior to its implementation in February, 2014, the institute had trained principals and focal teachers from 17 schools on phenology observation protocols and operation of weather stations. As reinforcement training, three days workshop was conducted for focal teachers in February 2015. Back at schools, focal teachers trained students involved in phenology monitoring activities.

In February 2015, focal teachers from 17 school, accompanied by two project staff, were send for field excursion to learn about citizen science initiative in Bangkok.

Project staff training

In total, five staffs, who are responsible for implementing project activities were trained on Network and System Management, Geographic Information System, Satellite based phenology monitoring, and project management. However, the project is yet to send two candidates for long term study(Msc) as proposed in 2014. To avail any study/course abroad, candidate should have served minimum of three years(Civil Service Acts, Bhutan).
As our identified candidates didn't meet the requirements, the proposed Msc has to be postponed. However, Msc(Remote Sensing)for one of the candidate is scheduled for 2016. And another one for 2017-2018.

Student environmental expedition

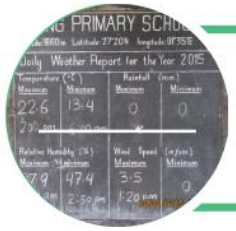
The environmental expedition has been proposed to promote performance based rewards for school that excel in implementing the project activities. Instead of monetary rewards, a reward in the form of expedition was promoted. In 2014, Gyelpozhing High School won the expedition with the submission of highest quantity and quality of phenology data. Also, students of Gyelpozhing HSS had scored highest in test.The ranking was based on overall score: Quality and quantity of data, and student's' aptitude test on phenology and climate change.

During the course of expedition, students were exposed to field botanization, bird watching, talks on environment, wildlife, conservation, etc.

For details, click the news link:

Students Environmental Expedition: Botanization activities

Among many, this is one of the fascinating image taken by students during their field observation, clearly depicting phenophases of Primula denticulata. More importantly, as per the date stamp on the image, this phenophase transition has taken place in less then one month time frame.



5 Outputs

5.1: Phenological data

Since its operation in February, 2014 , schools have been generating data through phenological observation and recording of plants. The phenology data have temporal scale of one day. Ideally, schools carry out the observation and data submission on daily basis. With an average six phenophses per plant, each school can generate sixty observation data on daily basis from 10 plants. This amounts to generation of about 1020 observations data entries in a day and 306000 data entries in a year.

However, in 2014, most of plants species were not yet finalized. Most schools were not able to carry out observation and data submission consistently. This lead to lower overall data turnover against our actual target of 306000 data entries per year.

As of December, 2014, the institute received 132,295 phenological observation data entries. Of which, 49051 data entries were on trees, 20756 data entries were on shrubs, 15028 data entries were on herbs and 1534 data entries were on conifers(Figures 9).

Among schools, Gyelpozhing Higher Secondary School has the highest data submission with 17856 entries,followed by Jomotshangkha MSS with 13937 entries and Jakar HSS with 13501 entries(Figure) Regionally, schools located in the eastern region have submitted more data compared to western and southern region.

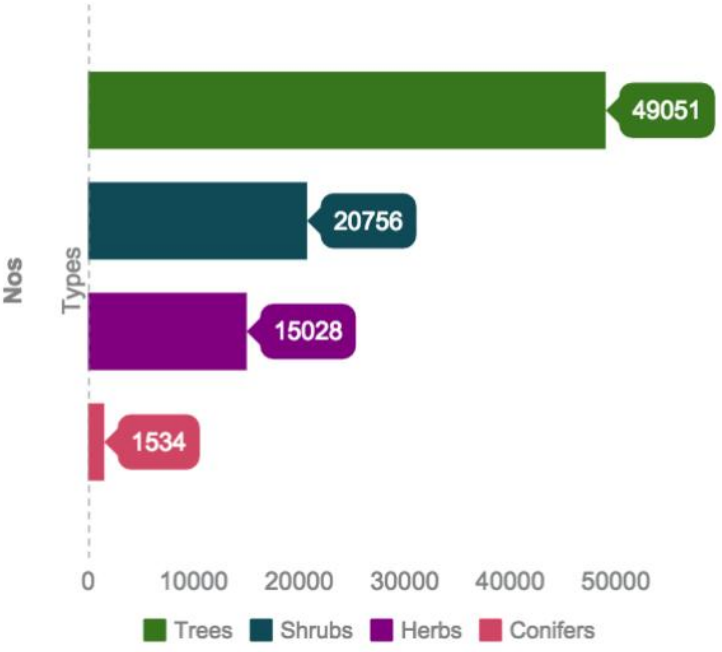


Figure 11. Data generated from 17 schools (December 2014)

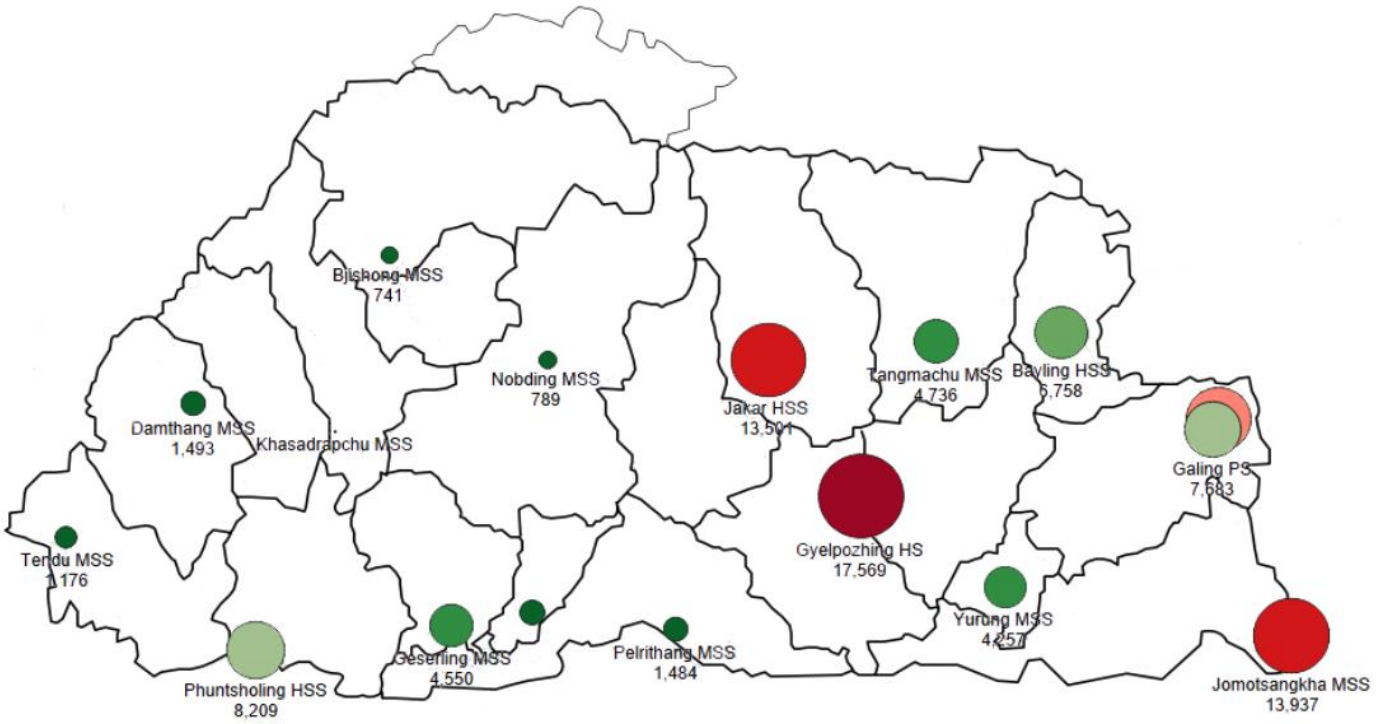
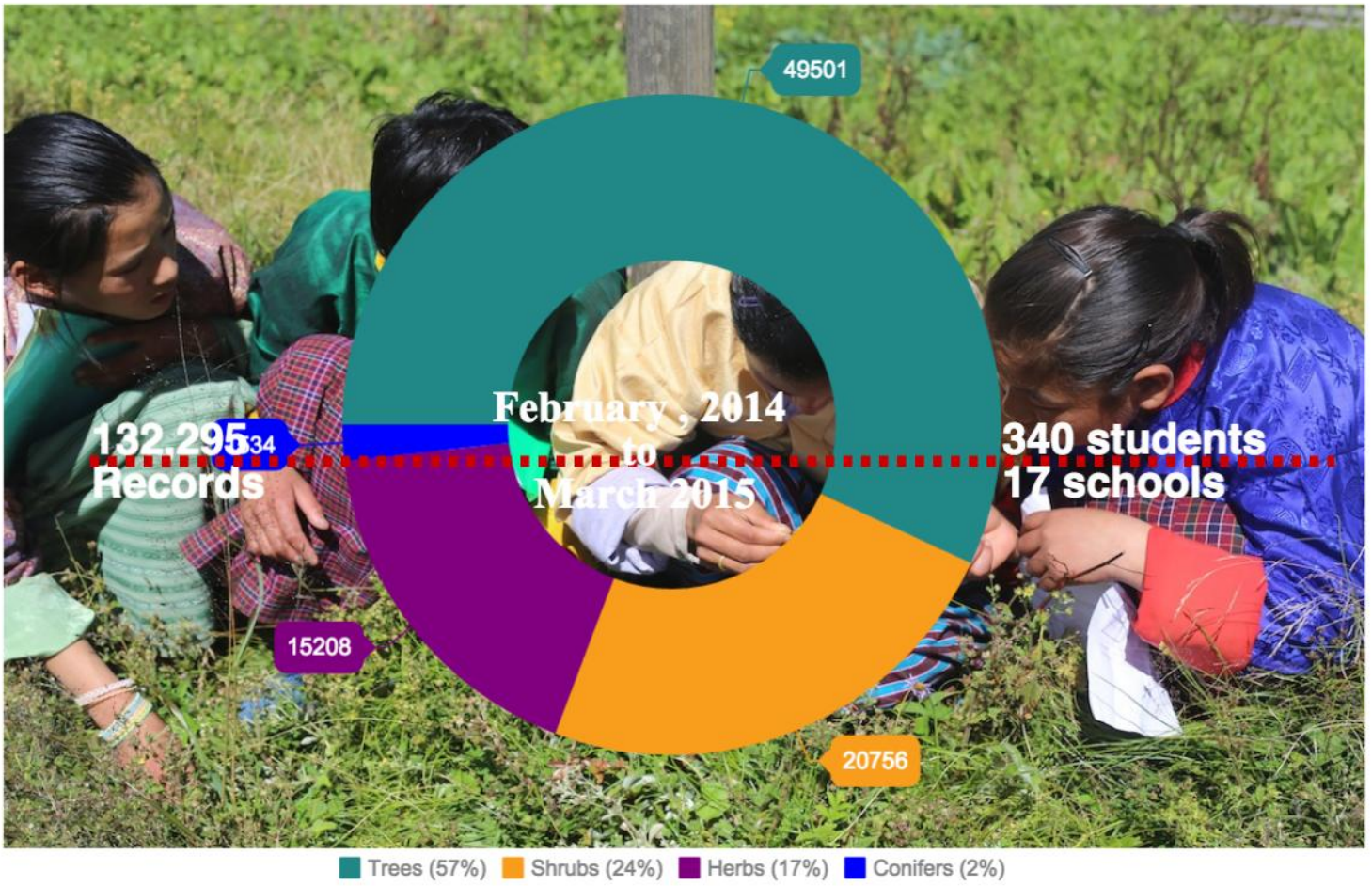


Figure 12. Data entries of phenophase observation by students



5.2: Climate data

Besides the phenological data, schools generate climate data at temporal scale of 10 minutes. Since August 2014, weather stations from 17 schools log and transmit data on temperature, rainfall, solar radiation, soil moisture, wind speed and wind direction at the resolution of 10 minutes. For web-based stations, data are downloaded from Hobolink, a web-based platform from where both current and historical data can be downloaded in excel format and view graphically.

As of August, 2015, one year weather data has been generated. However, from few stations, there is lack of data continuity due to station power drainage and technical malfunction. The structure of metadata and data generated from stations are as shown by Figure 13.

Before any analysis, climate data which have 10 minutes resolution have been averaged to daily and monthly data.

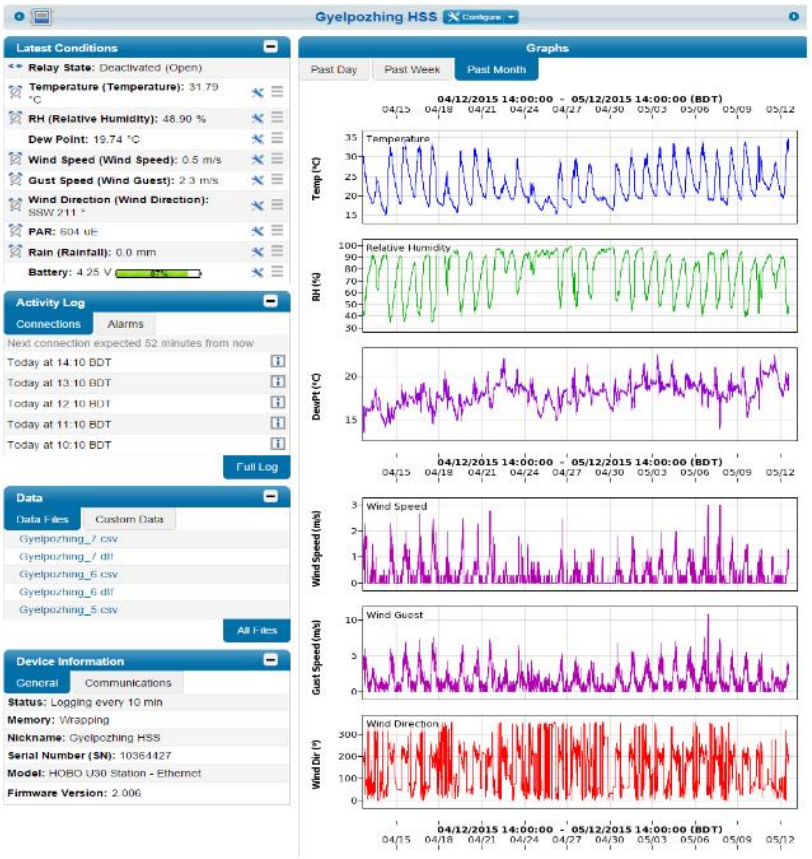


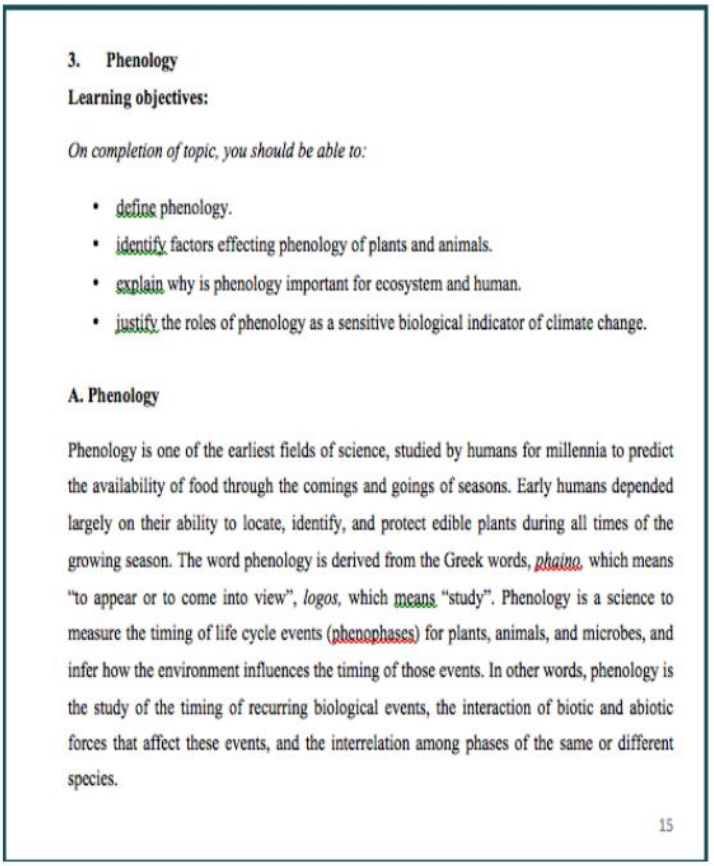
Figure 13.Online graphical interface for data visualisation (Hobolink)

5.3: Mainstreaming phenology in schools' curriculum

UWICE is closely working with Department of School Curriculum, Ministry of Education, in mainstreaming phenology in schools' curriculum.

Starting 2016's academic session, class 10 students from all over the country will learn about phenology and its importance in their environmental module. Also, as part of its practical component, students will be exposed to periodic phenology observation and creating phenology wheelscapes to illustrate their understanding and observation.

However, content for phenology topic for class 11 and 12 is yet to be finalized. For class 11 and 12, it will focus on data interpretation and analysis. On finalization of content, the curriculum will be implemented starting from 2016 academic session.



3. **Phenology**

Learning objectives:

On completion of topic, you should be able to:

- define phenology.
- identify factors effecting phenology of plants and animals.
- explain why is phenology important for ecosystem and human.
- justify the roles of phenology as a sensitive biological indicator of climate change.

A. Phenology

Phenology is one of the earliest fields of science, studied by humans for millennia to predict the availability of food through the comings and goings of seasons. Early humans depended largely on their ability to locate, identify, and protect edible plants during all times of the growing season. The word phenology is derived from the Greek words, *phaino*, which means "to appear or to come into view", *logos*, which means "study". Phenology is a science to measure the timing of life cycle events (phenophases) for plants, animals, and microbes, and infer how the environment influences the timing of those events. In other words, phenology is the study of the timing of recurring biological events, the interaction of biotic and abiotic forces that affect these events, and the interrelation among phases of the same or different species.

15

5.4: Schools equipment and services

17 schools were supplied with hobo weather station, desktop computer and camera each. Also, all schools selected for phenology project were provided with internet services throughout the year.While schools that already have internet services were provided monthly internet charges, schools that don't have access to internet facilities were provided new internet connection and monthly recharge amount.

Also, the data cards were provided to schools where it is not feasible to provide internet connection due to long distance and the prohibitive cost.

Sl.no	Equipment	Nos supplied/school	Total nos(purchased)	Remarks
1	Hobo weather stations	1	20	17 weather sations inslatted in schools , 3 stations installed at alpine meadow
2	Desktop computers	1	20	17 Desktop Computer supplied to 17 schools, 3 Desktop computers will be supplied to three new schools during in 2016.
3	Digital Cameras	1	20	17 cameras supplied to 17 schools, 3 cameras will be supplied to three new schools during in 2016.
4	Internet services	1	17	

Figure 14.Equipment supplied to schools for phenology observation and data entry

5.5: GIS lab set at the Institute

GIS lab was set up to facilitate GIS training at the Institute. Every year the Institute conducts GIS training for the forestry and conservation field staff.Given the importance of GIS in forestry and conservation, there was a need to set up well equipped GIS lab. The field staff from the front line conservationist for Department of Forest, Bhutan. So, it is crucial for them to know how to use GPS to track illegal activities, map biodiversity, etc.

Since its establishment in July, 2015, GIS lab has been used up for not only conducting GIS training, but also for other training. Already, two training have been conducted. And two more GIS training are in pipeline for this year.

GIS lab at UWICE

Human Resources Management traning

Wildlife photographic training

5.6: Conservation Drone

Since its first flight during ISC, drone was operated for few times to map research sites. Also, few fight were carried out to map the cultural sites. In between, for couple of months, Drone has encountered some technical problem and it was send for repair to Switzerland.

A major setback is getting an approval to operate the flight. An approval has to be sought from couple of agencies and its takes months to get an approval. However, an flight operation plans has been made and approval under process.

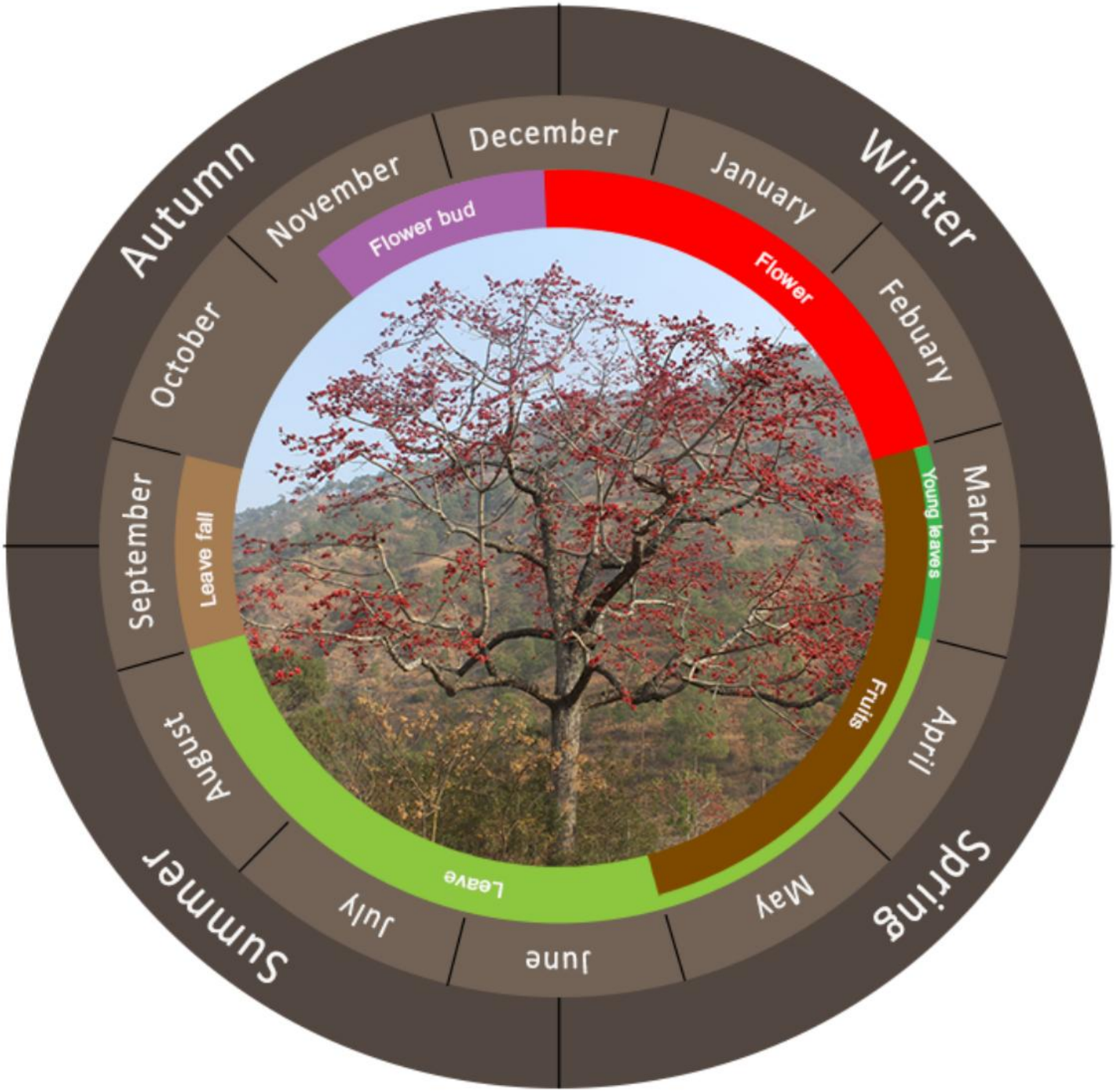
Once the flight operation is approved, following activities will be carried out: Generation of 3D of Sacred Sites of Bhutan, Wildlife Habitat Mapping and Hydropower Dam Mapping.

Bird eye view of UWICE's campus captured by drone

Bird eye view of Thimphu City, Thimphu, captured with drone

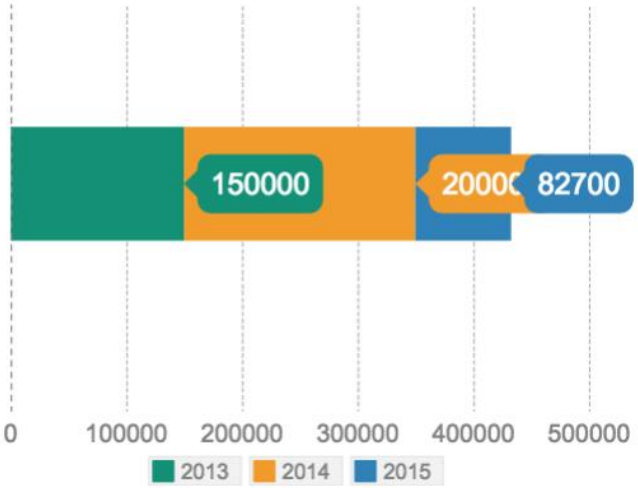
Bird eye view of Chamkhar Town, Bumthang, taken with Drone

Thermal image of research site located at Trashigang Goenpa, Thimphu, captured with drone

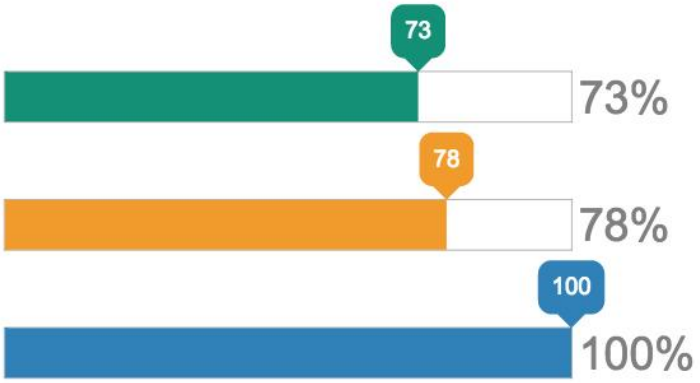

Autumn
Winter
Sprinb
Summer
December
January
Febuary
March
April
May
June
July
August
September
October
November
Flower bud
Flower
Young leaves
Fruits
Leave
Leave fall

6 Finance

Overall budget released

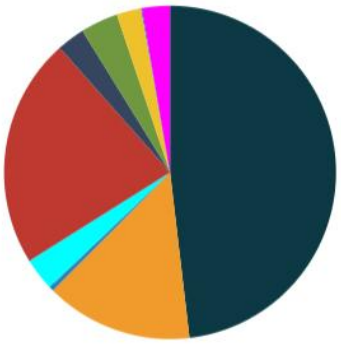


Overall budget utilised



2013: Budget status

Hobo weather stations	:$ 52802.00
Computers and peripherals	:$ 15725.94
Camera	:$ 502.10
Training	:$ 24498.05
Workshop	:$ 2977.35
Software	:$ 3479.07
Consultantancy	:$ 2985.04
Travel and transportation	:$ 5599.26
Banner and poster	:$ 87.20
Total	**: $108684.62**



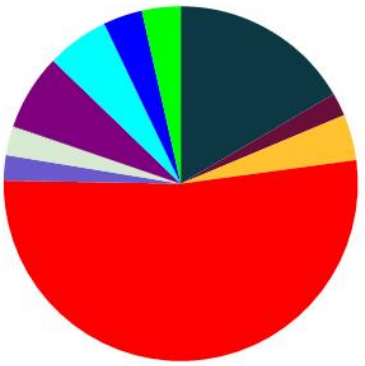
Expenses

2014: Budget status

2014

$156512.25 | $43487.75 | 78%

Training	:$ 82030.53
Drone and accessories	:$ 25953.00
Workshop	:$10,846.31
Fencing	:$ 8914.47
Camera	:$ 6550.22
Internet and netwok	:$ 5586.79
Datbase and website	:$ 5538.13
Travel and transportation	:$ 4098.63
Consultantancy	:$ 3608.34
Computers and peripherals	:$ 3298.22
Banner and poster	:$ 87.25
Total	**: $156512.25**



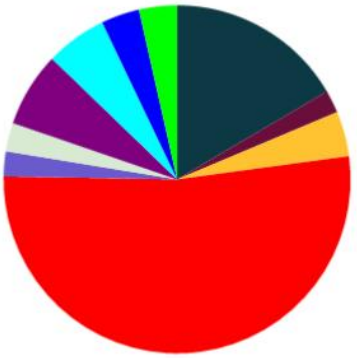
Expenses

2015: Budget status

2015

$82700+9801.00 | 100%

Computers and peripherals	:$ 46789.59
Workshop and expidition	:$ 18789.74
Training	:$ 17051.50
Website and software	:$ 4905.32
Travel and transportation	:$ 3457.25
Hobo weather stations	:$ 1866.10
Internet and network	:$ 1455.44
Total	**: $92501.99**



Expenses

Budget Summary

1.Overall Budget(2013-2015): $432700.00

2.Overall Expences(2013-2015): $357698.86

3.Overall Balance: $75001.14 (As of August,2015)

7 Wayforward

Upscaling BPN

Currently, phenology observation is limited to wild plants. To broaden its applicability, BPN will include observation of agricultural and horticultural crops during its next phase of project implementation.

In addition, as citizen science program, the system is expected to bring in an voluntary public engagement in monitoring phenological events of plants and animals. For this, BPN will establish a system and application where general public can report phenology observation of plants and animals from their mobile phone.

Satellite and aerial-photo based phenology observation will be used to upscale both spatial and temporal coverage of ground based phenology monitoring and its applicability.

From phenology research to application

The data generated from BPN will be used in developing application such as phenology calendar of key plants species. Apart from this, data can also be used for studying visitation pattern of pollinators and crop production.

In addition, the data generated from BPN will be shared with researcher and other institute. An online data sharing portal will be developed from where anyone can have an access to phenology and climate data.

With an incorporation of agricultural and horticultural crops, framing based phenology application tool will be developed.

Drone engagement

Drone will be used to map sacred site like Tasktang and generate 3 D view for the tourist and cultural information. Also, drone will be used to map tiger habitat at Royal Manas National Park. In addition, within this year, we have a plan to map forest cover around hydropower plants and generate land use change maps for assessing ecosystem value. A few attempt has been made to map FMU(Forest Management Unit), but failed due to poor GPS coverage and technical failure. However, very soon, we will use the drone to identify potential FMU in Bhutan.

On larger time frame, we plan to use drone for mapping snow cover and see how it has changes over time. In addition, drone will be used to map land-use change in Bhutan.

Mainstreaming phenology in schools curriculum

Among others, educating youth on climate change and impacts is one of the main objective of BPN. As part of its program, phenology will be incorporated as one of the topic in schools' environmental curriculum. For class 10, the content had been approved and incorporated in the curriculum to be implemented in 2016.
UWICE is closely working with Department of School Curriculum, MoE, in developing the content and activities on phenology topic for class 11 and 12.

The mainstreaming of phenology in schools' curriculum will not only play vital role in promoting an understanding and appreciation of nature, but also will also broaden their career prospect.

Phenology toolkit

Towards promoting phenology as tools to study climate change, an online interactive phenology toolkit will be developed. The toolkit will have an online interface from where:

1) Basic overlay analysis on onset of phenophase and climate variables can be done intereacticely from web interface

2) An online interactive course on basic phenology observation and recording can be taken up anyone interested in phenology study.

3) Phenology calendar of key plant species can be generated using online queries and infographic interface

Project activities

Training and site setup




Students

Field activities




Gyelposhing Higher Secondary School

Scientific Name	Family	Common Name	Category	Type
Callistemon phoeniceus	Myrtaceae	Bottle brush	Trees	Broadleaved Evergreen
Leucaena leucocephala	Leguminaceae	White lead tree	Trees	Broadleaved Evergreen
Melia azedarach	Meliaceae	China Berry	Trees	Broadleaved Decidious
Pinus roxburghii	Pinaceae	Chirpine	Trees	Conifer
Syzygium cumini	Myrtaceae	Jamun	Trees	Broadleaved Evergreen
Jatropa carcus	Euphorbiaceae	Purging nut	Shrubs	Evergreen
Osyris lanceolata	Santalaceae	African sandalwood	Shrubs	Evergreen
Searsia tomentosa	Anacardiaceae	Wild curran	Shrubs	Evergreen
Bidens pilosa	Asteraceae		Herbs	Annual
Parthenium hysterophorus	Compositaceae	Whitetop weed	Herbs	Annual

Jakar Higher Secondary School

Scientific Name	Family	Common Name	Catego-ry	Type
Juglans regia	Juglandaceae	Walnut	Trees	Broadleaved Decidious
Larix grifithii	Pinaceae	Larch	Trees	Conifer
Prunus persica	Rosaceae	Peach	Trees	Broadleaved Decidious
Salix babylonica	Salicaceae	Weeping Willow	Trees	Broadleaved Decidious
Cotoneaster microphyllus	Rosaceae	Rockspray	Shrubs	Evergreen
Elaegnus parvifolia	Elaegnaceae	Silver berry	Shrubs	Decidious
Rubus ellipticus	Rosaceae	Rasp berry	Shrubs	Decidious
Rosa sericea	Rosaceae	Wild rose	Shrubs	Decidious
Cosmos bipinnatus	Asteraceae	garden cosmos	Herbs	Annual
Fagopyrum esculatum	Polygonaceae	Buckwheat	Herbs	Annual

Jomotshangkha Middle Secondary School

Scientific Name	Family	Common Name	Category	Type
Aesandra butyracea	Sapotaceae	Indian Butter Tree	Trees	Broadleaved Decidious
Bombax ceiba	Bombacaceae	Red Cotton Tree	Trees	Broadleaved Decidious
Gmelina arborea	Verbenaceae	White teak	Trees	Broadleaved Evergreen
Melia azedarach	Meliaceae	China Berry	Trees	Broadleaved Decidious
Terminalia bellirica	Combretaceae		Trees	Broadleaved Evergreen
Citrus limon	Rutaceae		Shrubs	Decidious
Cassia occidentalis	Leguminosae		Shrubs	Evergreen
Ziziphus mauritiana	Rhamnaceae		Shrubs	Decidious
Bidens pilosa	Asteraceae		Herbs	Annual
Dendrobium densiflorum	Orchidaceae	Pinapple orchid	Herbs	Epiphytic

Khasadrapchu Middle Secondary School

Scientific Name	Family	Common Name	Category	Type
Cupressus corneyana	Coniferae	Cypress	Trees	Conifer
Prunus persica	Rosaceae	Peach	Trees	Broadleaved Decidious
Pinus wallichiana	Coniferae	Bluepine	Trees	Conifer
Quercus griffithii	Fagaceae	Oak	Trees	Broadleaved Decidious
Rhus chinensis	Rosaceae		Trees	Broadleaved Decidious
Cotoneaster bacillaris	Rosaceae		Shrubs	Decidious
Rosa sericea	Rosaceae	Wild rose	Shrubs	Decidious
Bidens pilosa	Asteraceae		Herbs	Annual
Cannabis sativa	Cannabaceae		Herbs	Annual
Rumex nepalensis	Polygonaceae		Herbs	Perrinial

Mendrelgang Middle Secondary School

Scientific Name	Family	Common Name	Category	Type
Alnus nepalensis	Leguminosae		Trees	Broadleaved Decidious
Erythrina stricta	Fabaceae		Trees	Broadleaved Decidious
Pyrus pashia	rosaceae	Pear Tree	Trees	Broadleaved Decidious
Saurauia napaulensis	Actinidiacea		Trees	Evergreen
Schima wallichii	Theaceae		Trees	Broadleaved Decidious
Hibiscus rosasinensis	Malvaceae		Shrubs	Decidious
Maesa chisa	Myrsinaceae		Shrubs	Decidious
Duchesnea indica	Rosaceae		Herbs	Annual
Geranium wallichianum	Gereniaceae		Herbs	Annual
Viola bhutanica	Violaceae		Herbs	Annual

Nobding Lower Secondary School

Scientific Name	Family	Common Name	Category	Type
Alnus nepalensis	Leguminosae		Trees	Broadleaved Decidious
Erythrina arborescens	Leguminosae		Trees	Broadleaved Decidious
Juglans regia	Juglandaceae	Walnut	Trees	Broadleaved Decidious
Michelia kisopa	Magnoliaceae	Yellow jade orchid tree	Trees	Broadleaved Evergreen
Quercus griffithii	Fagaceae	Oak	Trees	Broadleaved Decidious
Berberis angulosa	Beriberida-ceae	Large Flow-ered Berry	Shrubs	Decidious
Rhododendron arboreum			Shrubs	Decidious
Fagopyrum esculatum	Polygonaceae	Buckwheat	Herbs	Annual
Fragaria nubicola	Rosaceae	Strawberry	Herbs	Perrinial
Primula denticulata	Primulaceae	Primrose	Herbs	Perrinial

Pelrithang Middle Secondary School

Scientific Name	Family	Common Name	Category	Type
Bombax ceiba	Bombacaceae	Red Cotton Tree	Trees	Broadleaved Decidious
Erythrina arborescens	Leguminosae		Trees	Broadleaved Decidious
Gmelina arborea	Verbenaceae	White teak	Trees	Broadleaved Evergreen
Mangifera indica	Anacardaceae	Mango	Trees	Broadleaved Evergreen
Tamarindus indica	Leguminosae		Trees	Broadleaved Evergreen
Citrus aurantifolia	Rutaceae		Shrubs	Evergreen
Tabernaemontana divaricata	Apocynaceae		Shrubs	Evergreen
Ziziphus mauritiana	Rhamnaceae		Shrubs	Decidious
Ageratum conyzoides	Asteraceae		Herbs	Annual
Bidens pilosa	Asteraceae		Herbs	Annual

Phuentsholing Higher Secondary School

Scientific Name	Family	Common Name	Category	Type
Melia azedarach	Meliaceae	China Berry	Trees	Broadleaved Decidious
Gmelina arborea	Verbenaceae	White teak	Trees	Broadleaved Evergreen
Erythrina arborescens	Leguminosae		Trees	Broadleaved Decidious
Duabanga grandiflora	Sonnerateceae		Trees	Broadleaved Evergreen
Delonix regia	Leguminaceae	Gulmohar	Trees	Broadleaved Evergreen
Tabernaemontana divaricata	Apocynaceae		Shrubs	Evergreen
Solanum viarum	Solanaceae	Tropical soda apple	Shrubs	Decidious
Lantana camara	Verbenaceae	Wild sage	Shrubs	Evergreen
Oxalis stricta	Oxalidaceae		Herbs	Perrinial
Girardinia diversifolia	Urticaceae		Herbs	Annual

Sakten Lower Secondary School

Scientific Name	Family	Common Name	Category	Type
Abies densa	Pinaceae		Trees	Conifer
Daphne bholua	Thymelaeaceae		Trees	Broadleaved Evergreen
Quercus semecarpifolia	Fagaceae		Trees	Broadleaved Evergreen
Salix alba	Salicaceae		Trees	Broadleaved Decidious
Cotoneaster microphyllus	Rosaceae	Rockspray	Shrubs	Evergreen
Rhododendron arboreum	Ericaceae	Rhododendron	Shrubs	Decidious
Fragaria nubicola	Rosaceae	Strawberry	Herbs	Perrinial
Potentilla lineata	Rosaceae		Herbs	Perrinial

Tangmachu Middle Secondary School

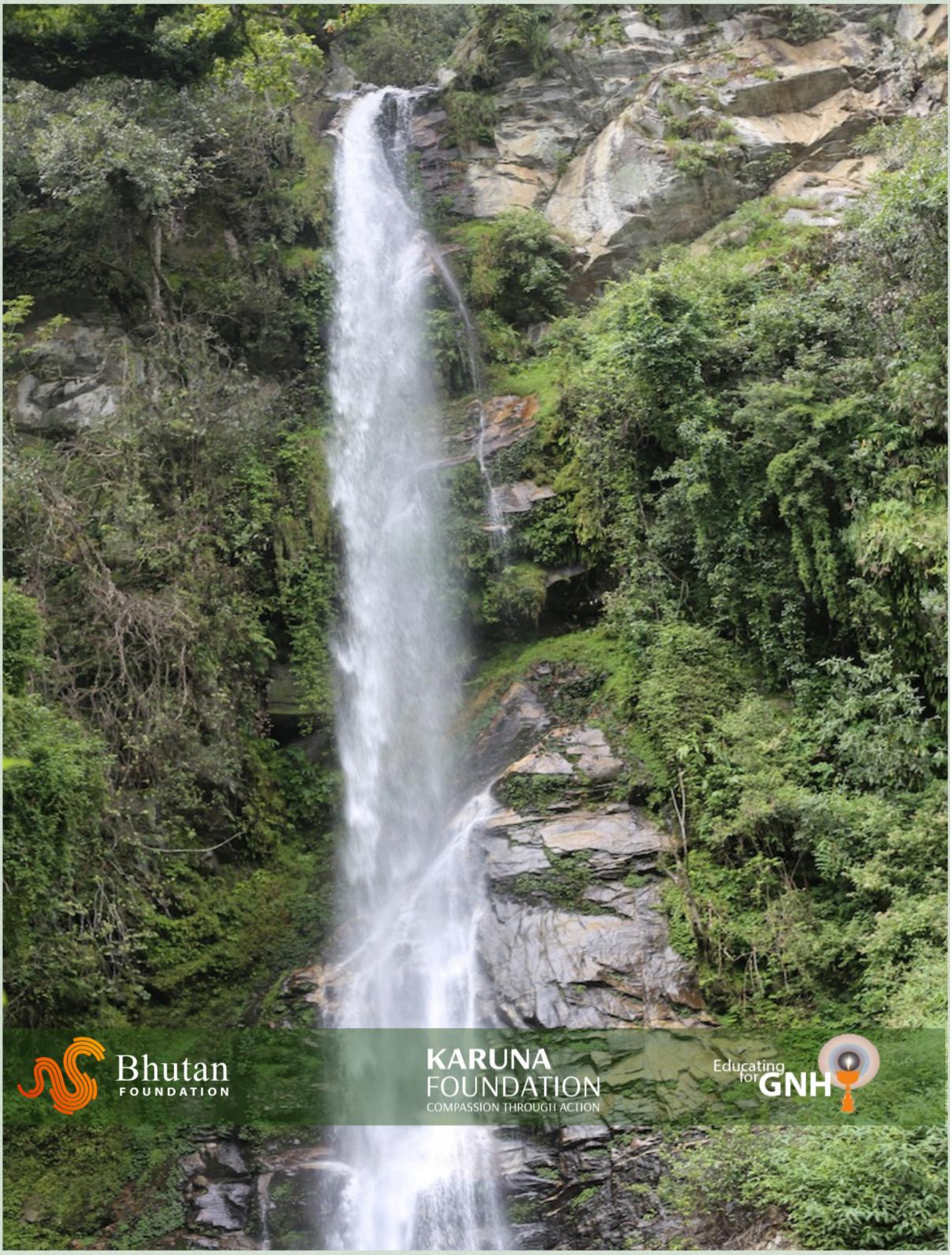
Scientific Name	Family	Common Name	Category	Type
Docynia indica	Rosaceae	Assam Apple	Trees	Broadleaved Decidious
Juglans regia	Juglandaceae	Walnut	Trees	Broadleaved Decidious
Melia azedarach	Meliaceae	China Berry	Trees	Broadleaved Decidious
Michelia kisopa	Magnoliaceae	Yellow jade orchid tree	Trees	Broadleaved Evergreen
Pinus roxburghii	Pinaceae	Chirpine	Trees	Conifer
Desmodium elegans	Leguminosae		Shrubs	Decidious
Indigofera indica	Fabaceae		Shrubs	Decidious
Osyris arborea	Santalaceae		Shrubs	Evergreen
Cymbidium hookerainum	Orchidaceae	Hookers Orchid	Herbs	Epiphytic
Cymbopogon khasianus	Graminae	Lemon grass	Herbs	Annual

Tendu Middle Secondary School

Scientific Name	Family	Common Name	Category	Type
Ailanthus integrifolia	Simaroubaceae		Trees	Broadleaved Evergreen
Albizzia procera	Fabaceae	Albizia	Trees	Broadleaved Evergreen
Citrus reticulata	Rustaceae		Trees	Broadleaved Evergreen
Duabanga grandiflora	Sonnerateceae		Trees	Broadleaved Evergreen
Mangifera indica	Anacardaceae	Mango	Trees	Broadleaved Evergreen
Callistemon citrinus	Myrtaceae		Shrubs	Evergreen
Ricinus communis	Euphorbiaceae		Shrubs	Evergreen
Ageratina adenophora	Asteraceae		Herbs	Perrinial
Acmella uliginosa	Asteraceae		Herbs	Annual
Bidens pilosa	Asteraceae		Herbs	Annual

Yurung Higher Secondary School

Scientific Name	Family	Common Name	Category	Type
Myrica esculenta	Myricaceae		Trees	Broadleaved Evergreen
Michelia kisopa	Magnoliaceae	Yellow jade orchid tree	Trees	Broadleaved Evergreen
Quercus griffithii	Fagaceae	Oak	Trees	Broadleaved Decidious
Saurauia napaulensis	Actinidiacea		Trees	Evergreen
Schima wallichii	Theaceae		Trees	Broadleaved Decidious
Clearodendrum viscosum	Lamiaceae		Shrubs	Evergreen
Elaegnus parvifolia	Elaegnaceae	Silver berry	Shrubs	Decidious
Cymbidium hookerainum	Orchidaceae	Hookers Orchid	Herbs	Epiphytic
Elettaria cardamomum	Zingiberaceae	Cardamom	Herbs	Perrinial


Bhutan
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KARUNA
FOUNDATION
COMPASSION THROUGH ACTION
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