



HEROES AN ANNUAL REPORT 2018



Letter from the Director

HEROES has made significant contribution in terms of building climate change study facilities in schools, building capacity of teachers and students, and generating climate data. Twenty one schools are well equipped with weather station, desktop computer and camera to facilitate climate change study in school. Also, due to yearly phenology workshop, more than fifty teachers were trained on phenology observation protocols and climate change study. In addition, around 1500 students were actively involved in studying climate change impact in their respective school. Four years' phenology and climate data from 17 schools were already archived in the central data repository maintained by UWICER. Phenology, as school's curriculum, has already been mainstreamed in class 10, 11 and 12 Environmental Science (ES) Curriculum. As of now, 110 schools across the country are implementing ES curriculum.



For HEROES, the generation of scientifically rigorous data and education of youth are our priorities. However, we also genuinely feel the need to enhance our data products and tools to support decision making and scientific discovery. Without such effort, we would have serious setback in realizing the potential of HEROES. We believe this could be achieved by building the capacity of staff in data analysis and interpretation. Our focus, this year, will be on data analysis, interpretation and product development. While its important to sustain our effort in data generation, we also feel the need to expand our scope and relevancy. In 2019, as part of HEROES program, we will be launching monitoring initiative called "Flower for Wild Bees". This initiative is expected to document the foraging behavior of wild bees in Bhutan.

As the flagship project, HEROES certainly has many opportunities to contribute to climate science of Bhutan. We look forward for sustained and collective effort to make HEROES as a viable climate monitoring system. **WE ARE GRATEFUL TO THE FUNDER, KARUNA FOUNDATION AND BHUTAN FOUNDATION.**

(Director)
UWICER

An aerial view of school implementing HEROES (drone footage)



Location of plants under observation



Location of weather station



Location of cardamom field under observation

Yurung Middle Secondary School is one of the schools implementing HEROES since 2014. The above aerial view shows location of plants and weather station that are being monitored by students on daily basis. Besides wild plants, the school also monitor the cash crop such as Cardamom. They correlates how variation in climate parameters effect the cardamom's lifecycle and production in the school campus.

420

Students involved in the project every year

110

Environment teachers trained on phenology monitoring protocol

57

People send for ex-country short term training from the project fund

21

Focal teachers and schools involved in the project

3

Level of curriculum incorporates phenology in the Environmental Science Curriculum

HIGHLIGHTS

0.13 M

Phenology records submitted till date

103

Plants observed by students every year

21

Weather stations log weather data every 10 minutes

10

Months of phenology observation carried out every year

3

Reports published using HEROES data

ADVANCE SCIENCE

Cotoneaster microphyllus, a shrubby plant, is being observed in four schools ; Jakar High Schools, Damthang Primary School, Bayling High School and Khasadrapchu Middle Secondary School.

Since 2016, Khasadrapchu Middle Secondary School has noticed that most of the plants in its school campus are being extensively defoliated at very early stage of its seasonal life-cycle. Curious, Mrs.Tashi Yangzom, the focal teacher of the school, embarked on to study what causes an untimely defoliation of this plant. On close observation, she found out that most of the plants are being infected by aphids. According to her, such infestations were not seen before. She believes that plants are defoliated by early appearance of aphids. She reasoned that aphid might have appeared early due to warmer climate, causing its eggs to hatch early. But, its predator might not have responded that well to the warming climate, leading to difference in timing of aphid appearance and its predator. However, she doesn't want to limit her understanding based on her speculation. Instead, she wants to find out if such things are happening with other schools as well.

HEROES, as repository of observation data collected from 21 schools, can provide valuable data to any citizens wishing to carry out any research related to climate change impact on biodiversity. While other data becomes absolute with time, this time series observation data only becomes more valuable with time. It is the only means and ways to get the firsthand insight into impact of climate change on plants and animals life-cycle.

Using HEROES' data and with inquiry from other focal teachers, she investigated plants of similar species in other three schools. She found out that plants in other schools are not affected by aphids and thus, not defoliated. Though far from conclusive, her investigation certainly induced a heightened sense of inquisitiveness in the school. She further wants to look into the correlation of climate variables to an outbreak of aphids in *Cotoneaster microphyllus* for longer time frame. This, among others, is just one incident that has been reported to HEROES. Likewise, many more schools are reported to have initiated their own investigation.



INFORM DECISION

Cannabis sativa, commonly known as Cannabis, is widely distributed and invasive plant species found by the side of road or crack in the sidewalks. The Narcotic Drugs, Psychotropic Substance and Substance Act of Bhutan (NDPSSA) classifies cannabis under schedule I of the Act, describing it as narcotic drugs.

In Bhutan, although no serious case of abuse has been reported, the trend of cannabis abuse is on the rise. Abuse, especially among students, is reported to be rampant and increasing. This has been attributed to abundant availability of plants in and around schools campus. The school-based survey found out that one in every five students used cannabis (Kuensel, 28 June, 2017). As control measures, every year, mass uprooting of Cannabis is carried out throughout Bhutan. However, despite the aggressive control effort, more areas gets colonized by this plant. This has been attributed to the fact that the Cannabis plants are uprooted only after seed dispersal has already taken place. This greatly hinders the measures to prevent and control substance abuse derived from this plant.

HEROES, as school based phenology monitoring program, provides life-cycle information about plants. Such phenology information could greatly aid in management of invasive plants which has adverse impact on socio-economic aspect on our societies.

Understanding the phenological characteristics of plants will greatly help in controlling spread of this plant. By targeting uprooting activities within the window between leaf flush and seed development, the efficacy of its control program can be maximized. This will have huge impact on reducing number of substance abuse, especially among youths.

Some schools implementing HEROES has already started observing plants and their phenological characteristics. Based on seasonal characteristics of plant such as timing for its seed maturity, schools and other communities can plan an annual uprooting campaign and thereby increase an effectiveness of substance abuse measures. This could avoid the need to carry out repeated uprooting campaign in the same place year after year. In doing so, substantial amount of that is being spent in the campaign could be saved.



CAPACITY DEVELOPMENT



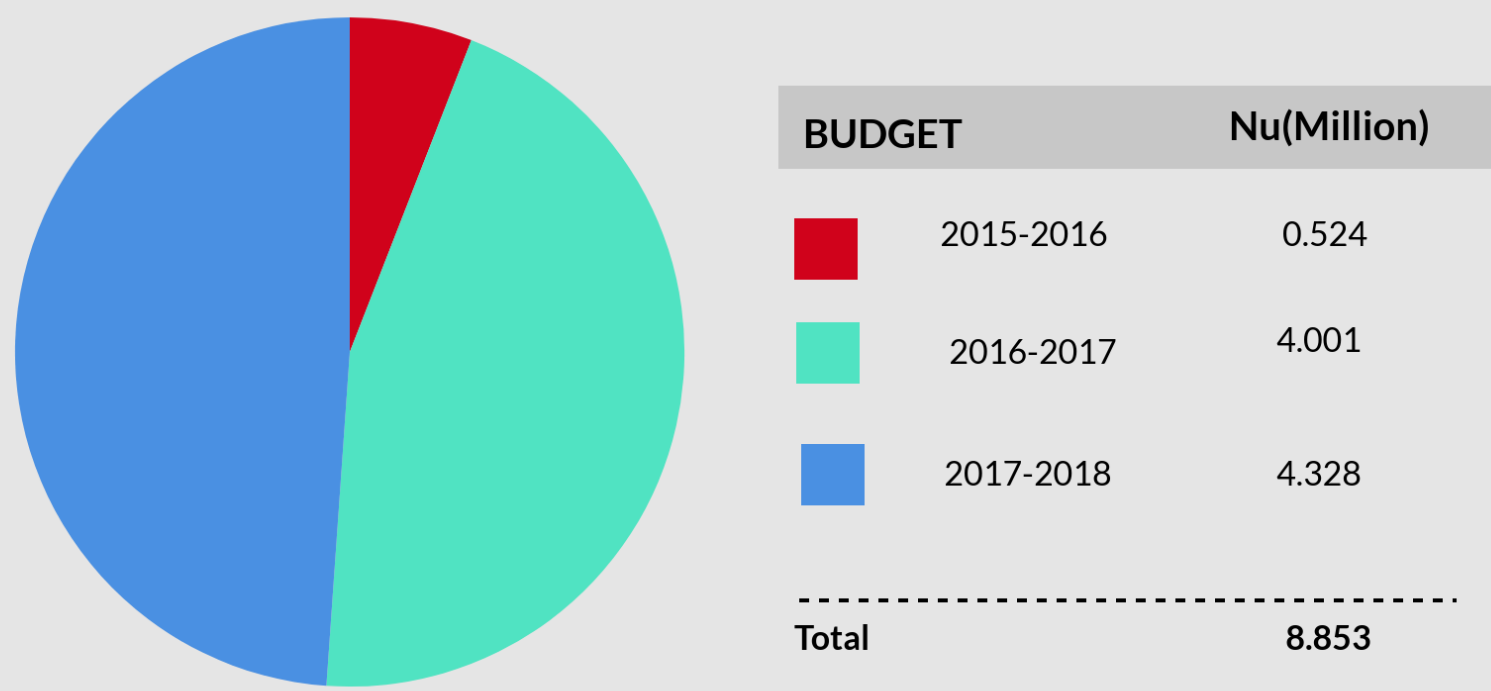
Capacity development plays critical role in advancement of HEROES as applied scientific research on climate change and its impact on biodiversity. Every year, 21 focal teachers are being trained on phenology observation protocols, basic data analysis and interpretation. Back in schools, focal teachers mentor students to carry out basic climate change research in their school backyard.



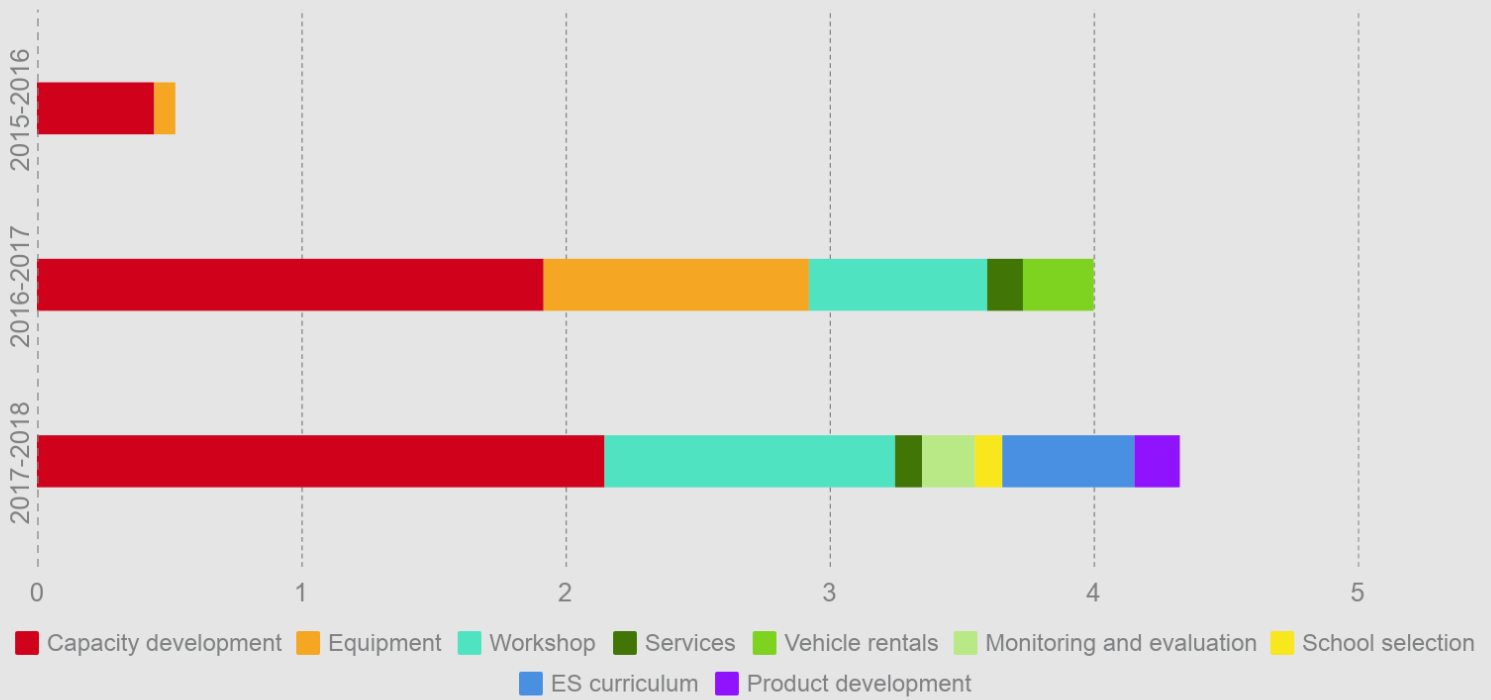
RESOURCES

Budget release and the expences status

Since 2014, HEROES was funded by KARUNA FOUNDATION through Bhutan Foundation. Untill 2015, the fund was directly released to UWICER. However with the signing of MoU between Bhutan Foundation, GNHC and UWICER in 2016, the fund was routed through GNHC. This report, therefore, only present the overall financial standing from 2015 onward. However, the year wise reporting, both financial and physical, had already been submitted to Bhutan Foundation through GNHC.



EXPENCES in Nu (Million)



IMPLEMENTATION

Activities and their status

Most of the activities during 2016 and 2017 FY have been implemented. However, some of the activities had been cancelled and fund reallocated to other activities related to HEROES. Whenever such changes were deemed necessary, the concerned funding agencies had been apprised and necessary approval sought. Activities that had been proposed and the secured fund are as shown herein:

Sl	Project Activity	Status
1	Phenology workshop for 17 schools	Organized
2	Short term training on drone operation and image analysis	Trained
3	Purchase antivirus software for 17 schools desktop computers	Completed
4	Purchase internet equipment for remote schools (Airmux, network equipment, etc)	Reconciled
5	Release first half-yearly internet services packages to 17 schools implementing HEROES	Completed
6	Purchase power backup/lightening arrester for project equipment	Purchased
7	Purchase replacement/maintenance parts of project equipment	Replaced
8	Short term training on phenology and climate database management and application development	Trained
9	Short term training on phenology data analysis and interpretation	Trained
10	Hiring of vehicle for visit to schools for presentation and talk on phenology	Hired
11	Phenology talk and presentation in schools (DSA/TA): 17 schools	Conducted
12	Purchase equipment: Cameras for project staff	Purchased
13	Database Server Purchase and Installation	Completed
14	Release second-half yearly internet recharge allocation to schools	Provided
15	Send one staff for Msc. In GIS and RS	Undergoing Msc
16	Purchase network/internet equipment for 4 new schools	Purchased
17	Purchase of network tool kit and weather station kits	Purchased
18	Phenology Conference/Workshop	Reconciled
19	Hiring of vehicle for new school selection field visit	Hired
20	Selection of 4 more new schools for the project: field visit to school	Selected
21	Installation of hobo station in 4 new selected schools	Installed
22	Hiring of one vehicle for phenology monitoring and evaluation Phenology monitoring and evaluation exercise (DSA/TA)	Hired
23	Phenology monitoring and evaluation exercise (DSA/TA)	Conducted
24	Short term training on phenology data visualization tools development	Reconciled
25	Annual phenology report publication	Published

PARTNERS

Funder and implementer

Partners are key to the success of HEROES. Together with partners, HEROES has made significant progress towards fulfilling its core objectives.

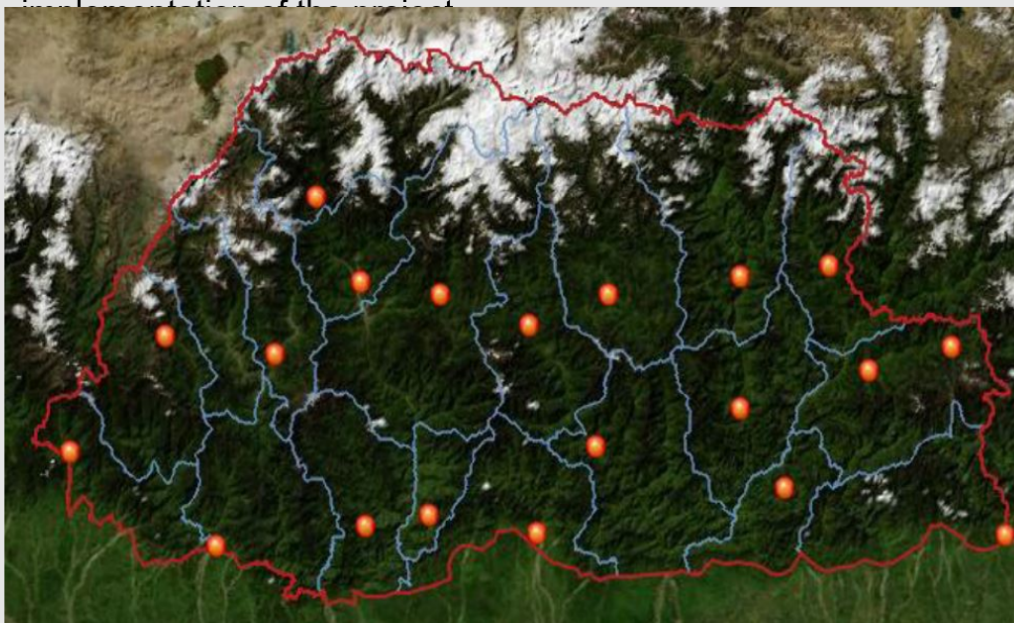
HEROES team is grateful to our funders, the KARUNA FOUNDATION and the BHUTAN FOUNDATION. Without their committed support, HEROES wouldn't have materialized.

We are also grateful to the network of schools, teachers and students who are part of the Bhutan Phenology Network. Their hard work and enthusiasm has not only helped to establish the baseline data for climate change study, but also set the benchmark of climate literacy in Bhutan.

As part of mainstreaming HEROES in school's curriculum, Royal Education Council (REC) has played a critical role in facilitating incorporation of phenology as one of the topic in Environmental Science Curriculum. We would like to thank REC for all the support.

Implementation of activities wouldn't have been possible without timely release of fund. We are also grateful to GNHC for making the fund available on time and the guidance during the overall implementation of the project.

**KARUNA
FOUNDATION**
COMPASSION THROUGH ACTION



Location of schools implementing HEROES



APPENDICES

Report and book chapter



Bhutan Phenology Network

Environmental Science

3. Phenology

Learning objectives:

On completion of topic, you should be able to:

- define phenology.
- identify factors effecting phenology of plants and animals.
- explain the importance of phenology.
- justify the roles of phenology as a sensitive biological indicator of climate change.

The environment is a changing world under the influence of various factors and conditions. The biotic components of an ecosystem respond to these changes in order to survive and reproduce. Organisms demonstrate morphological and physiological changes with the changing physical conditions of the environment.

A. What is 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 the phases of same or different species.

Periodic biological phenomena such as sprouting and flowering of plants in the spring; changing of colour of plants in the fall; birds migrating; insect hatching and animals hibernating, are examples of phenological events.

The timing of phenological events is sensitive to environmental conditions. For example, in a particularly warm and dry spring, leaf bud bursts and first flower occurs weeks earlier than usual; whereas, in an exceptionally cool and wet spring, they are delayed. As a result, the timing of phenophases tends to vary in between years based on patterns of weather, climate and resource availability. Phenological observations are therefore integrative measures of the condition of the physical,

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STEM Olympiad 2017

Analysis of the temperature and precipitation variation pattern under climate change in Khasadrapchu

Executive Summary

The study was undertaken to identify the change in climate of Khasadrapchu. The research focused on discovering the variation in the pattern of the mean annual temperature and precipitation at Khasadrapchu for the last three years. The study correlates the variables such as precipitation and temperature as the influencing factors for the change in climate at Khasadrapchu.

The problem under study is indispensable as Climate Change is likely to cause a series of shifts in Bhutan's temperature and precipitation patterns and lead extreme climate shock.

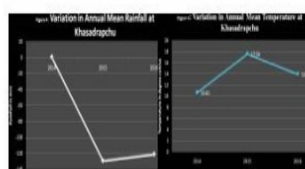
Methodology

The adopted research design for the paper is Scientific Method of Research as the research is done in the discipline of Science. Furthermore, the scientific method is a standardized way of making observations, gathering data, forming theories, testing predictions, and interpreting results. The research design is apt for ethical justifications. In addition the results and findings deduced through the research design of Scientific Method would be reliable and valued upon in the scientific world.

The selection of the research design was encouraged by Pridar (2017). The researcher supports the Scientific Method to be orderly and systematic processes. Scientists attempt to control external factors that are not under direct investigation. Their findings are based on the empirical evidences. Findings of scientific methods can be generalized, which means that they can be used in situations other than the one under study.

Findings

The research has found out that in the year 2014 the mean annual temperature of Khasadrapchu was 16.61°C. In 2015 it rose to 17.54 °C with an increase of 6.93 °C and the year 2016 recorded 13.91° C. The annual mean temperature of 2016 showed a decrease of 3.63 °C.



It was found out that the annual mean precipitation in the year 2014 was 0.06 mm. In 2015, it dropped down to -129.68 mm and in 2016 it was -421.38mm. The amounts of precipitation in the last 3 years have been minimal.

The comparative analysis of the varying data for the three years confirms an increase of 3.3°C at Khasadrapchu. The research has found out that there has been extreme reduction in the long term precipitation in the monsoon season at Khasadrapchu. Furthermore, the area has received minimal amount of precipitation.

Therefore, the research paper concludes that the Climate is changing at Khasadrapchu. Due to frequent extreme climate shocks Khasadrapchu will experience an increase in immediate precipitation. The mean temperature in both the seasons of summer and winter at Khasadrapchu is expected to increase in the years to come. The area will experience extreme reduction in the long term precipitation during the monsoon season.

Conclusion

- The mean temperature in both the seasons of summer and winter at Khasadrapchu show an increase.
- There had been a reduction of the long-term precipitation in particular during the monsoon season.

The data pattern for both temperature and precipitation is inconsistent over the three years.

Lety Gyam, Student,
Khasadrapchu AMES



Climate is one of the most important factors that affects the wellbeing of all life forms on the Earth. Slight change in the components of the Earth (atmosphere, hydrosphere, cryosphere, lithosphere and biosphere) causes huge changes in climate. Emission of greenhouse gases (GHG) through various anthropogenic activities is one of the main causes of climate change. Climate change today has become a global concern.

The change in climate affects natural resources, disturbs fragile ecosystem and threatens the existence of living organisms. Numerous studies show the climate change results in the change of phenological events of plants and animals. Therefore, in order to sustain life on the Earth, it has become crucial to adopt courses of action to mitigate the problems of climate change or adapt to it.

Shrub 1: *Jatropha carcus* (Purging nut)



Tree 5: *Callistemon phoeniceus* (Bottle brush)

