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An assessment of "Micro-Weather Stations" Initiatives at Himalayan villages to monitor local weather variation and to assess the possible long-term climate change: Evaluating Impact on Livelihood

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Himalayan state like Uttarakhand is very sensitive and vulnerable to climate change. Many research data also indicate the climate variation in Himalaya region and its adverse effect on its climate. The present study is participatory evaluation of village micro weather station.
Micro- weather station is an initiative of Shramyog, Dehradun based organization. The station is basically a forum where village children learn about weather by collecting temperature and rain-fall data. In addition, the forum provides other tool to know their surrounding including biodiversity, night sky, weather prediction etc.In the present study we evaluated micro-weather stations of three villages of block Salt in Almora district of Uttarakhand for a period of one year from Jan 2016 to April 2017 and three months in the year 2017 at four villages. These micro weather stations have been established at Govt. schools located in these villages with the aid of a non-profit NGO 'Shramyog'. The trained school children (so called "BalManch") under the mentorship of a teacher and a member of Shramyog record the daily weather measurements temperature average. This report shows the variations of temperature for four months and the temperature variation is compared with Haldwani temperature model and the temp variation is in similar manner. The comparison shows remarkable similarity between observed temperature records and model climatologically.

Keywords: Micro-weather stations, Himalayan villages, Himalayan Rainfall

1-Introduction

Local weather is a key component of local living. People are affected from local environment by many ways, for example living, agriculture, socio-culture etc. is dependent on local climatic condition. If local people are well aware of their local environment, they can plan their living accordingly. In order to understand local weather and its impact on local life we studded four village's weather patterns (**Thanh Nguyen et al).** This paper presents the applications of Kriging spatial interpolation methods for meteorological variables, including temperature and relative humidity, in regions of Vietnam. Temperature, rainfall are two main meteorological variables which directly impacts physical and biological processes (C. Daly et al). Therefore, we primarily focused on temperature and rainfall pattern of the area. In addition, we collected primary data of the area including population, forest type, soil type, demography etc. to better understanding of the region. The development of a statistical modeling technique suitable for producing mean and interannual gridded climate datasets for a topographically varying domain is undertaken (Brown et al). The present study is the basic finding of the studded weather stations. The program of establishing micro-weather station in these remote Himalayan villages is still in its early phase and has been running for last one year only. The program started in Mid-2015, however, the proper data record started coming out only since Jan-2016. So far, the teams, so called "BalManch" have been established in 9 villages of "*Salt*" block of Almora district. "*Salt* "is the block of district Almora in the Kumaun division of Uttarakhand state, India. The district headquarters is at Almora. "*Salt*" is surrounded by Almora district to the east, Garhwal region to west. The present study involves analyzing the data for four villages for which the micro-weather stations were established earliest. Because the project is still in its infancy, the major data record that is regularly available are the daily maximum and daily minimum temperature. The three villages for which these daily minimum and maximum temperature data have been analyze

2-Methodology

The process of establishment of Micro-weather stations and Data Collection
The Shramyog members follow step-wise procedure to establish micro-weather stations in the villages.The Shramyog members get in touch with the villagers and school teachers. Discuss with them about the weather conditions and livelihood, how are these interlinked, suggesting idea of measuring weather at local level to help them improving their traditional knowledge system of weather. During the discussion, People get aware about their

geographical conditions and its link with extreme weather conditions or lack of weather conditions such as heavy rainfall, snowfall. During discussion, villagers share their experiences about how changing climatic conditions affect their livelihood. For example, some villages like Ghugati in Almora used to receive a good amount of snowfall till the year about 2003-04 but there has been no snowfall after that. Earlier, snowfall used to remove some root–eating insects helping villagers to protect crops. Snowfall also used to help in groundwater recharge. But lack of snowfall has seriously hit these processes severely affecting the agricultural production. Thus, livelihood have been found directly linked with changing climate conditions. The members also interact with the school students; create curiosity among them by asking questions about weather.

Then the idea of setting up a local weather information system is proposed which would be run by the help of the students. The format of this system is to introduce local people with their daily local weather information like rainfall, temperature, wind velocity etc. This might help the people to schedule their crop rotation, harvesting better. 6- A group of 10 to 12 creative children is made. This group interact among themselves and discuss about local weather conditions and its impact on local agriculture (e.g., cereals, vegetables etc.) and the biodiversity (e.g., pine tree, cactus, grass etc.).

The Shramyog members try to explain this impact while establishing a qualitative relation between last few months weather conditions and the local agricultural/biodiversity growth/decay in the same period.This enables them to understand the importance of having a record of local weather information. In general, the students show great interest and ask many questions about weather conditions and forecasting. Now the process of setting up thermometer and rain gauge in the village is started. The students and villagers are trained to measure it. They're also encouraged to anticipate about the impending weather based on current weather information. The group record the data on daily basis and then send the recorded data to Shramyog's Dehradun office every month by post. The daily record of the data triggers discussion among students about the local weather conditions and in the process, they start associating the relationship between variation of temperature with altitude and the altitudinal variation in the diversity of plants and vegetables. The discussion on daily data also motivates them to collect and keep the daily record of the data. This fulfills our purpose. This entire process of generating awareness and triggering discussion among students and villagers is very necessary otherwise the motivation for collection and keeping records of the data would be missing and the whole purpose might get defeated. The program was successful in the villages of Matwas, Saankar, Kathgodam and others.Then the program was scaled up and the awareness program has been taken up to about20villages so far.

The awareness program is also conducted on 5thJuneevery year and the students and villagers are invited with their village weather data to discuss with each other. This further trigger the discussion about the variation of weather patterns and accordingly decide upon the crop rotation. In such awareness programs, the people interact among themselves and also technically train each other about handling the instruments, the application of the instruments in their daily life.

In the awareness program, the students are encouraged to get pictures of clouds from internet and relate them to rainfall. Then they are taught about forecasting rainfall on the basis of visible clouds and comparing these clouds to the internet cloud pictures. The cloud data in association with wind velocity, temperature and rainfall data enables the trainees to make a qualitative forecast for the rainfall and they do succeed most of the times (about ~80% of the time according to their claim). These crude forecasts based on micro-weather stations of the villages are also compared with therefore casts issued by the IMD (Indian Metrological Department) branch of Mukteshwar, the nearest IMD station to the villages. The students and villagers are happy to note that most of the time these forecasts are actually comparable. The whole process described above has enabled us to get a good weather data record from these villages. The present study makes an assessment of the data of daily maximum and daily minimum temperature, thus collected from three villages Matwas, Saankar and Kathgodam, gigare

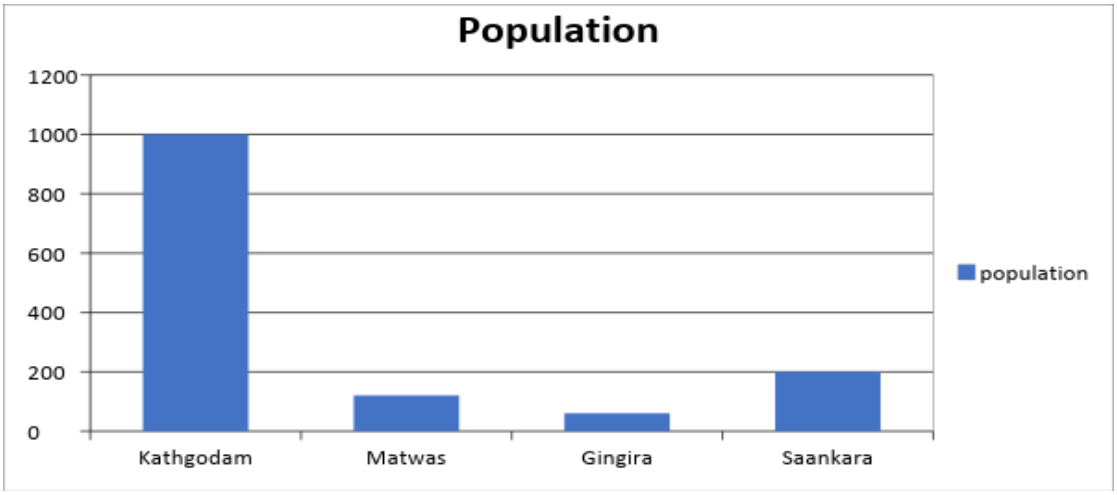

Fig 1 shows the population of the villages as survey by Shramyog

3-Result and Discussion

Fig 1 shows the population of the villages as survey by Shramyog. This reveals that Kathgodam has the highest population among the four villages, while Gigare have lowest population. The Kathgodam situated in plane region of the state while rests of the villages are in the hilly area of Uttarakhand. Mass migration has been taking place from the hilly Reason of Uttarakhand.
The data support state migration patterns.

Tale 1 – Minimum, Maximum and average temp. of four village

Months	Gigare	Matwas	Saankar	Kathgodam
January	Temp. Min.9ºc Max.16ºc Avg.12.5	Temp. Min.4ºc Max.10ºc Avg.7ºC	Temp. Min.7ºC Max.14ºC Avg.10.5ºC	Temp. Min.10ºC Max.17ºC Avg.13.5ºC
February	Temp. Min.10ºC Max.25ºC Avg.17.5ºC	Temp. Min.11ºC Max.20ºC Avg.15.5ºC	Temp. Min.13ºC Max.21ºC Avg.17ºC	Temp. Min.15ºC Max.23ºC Avg.19ºC
March	Temp. Min.14 Max.29 Avg.21.5	Temp. Min.20 Max.35 Avg.27.5	Temp. Min. Max. Avg.	Temp. Min.25 Max.32 Avg.28.5
April	Temp. Min.20.5 Max.30.8 Avg.25.65	Temp. Min. Max. Avg.	Temp. Min.25 Max.37 Avg.31	Temp. Min.27 Max.31 Avg.29

3.1 Temperature variation of four village in four months

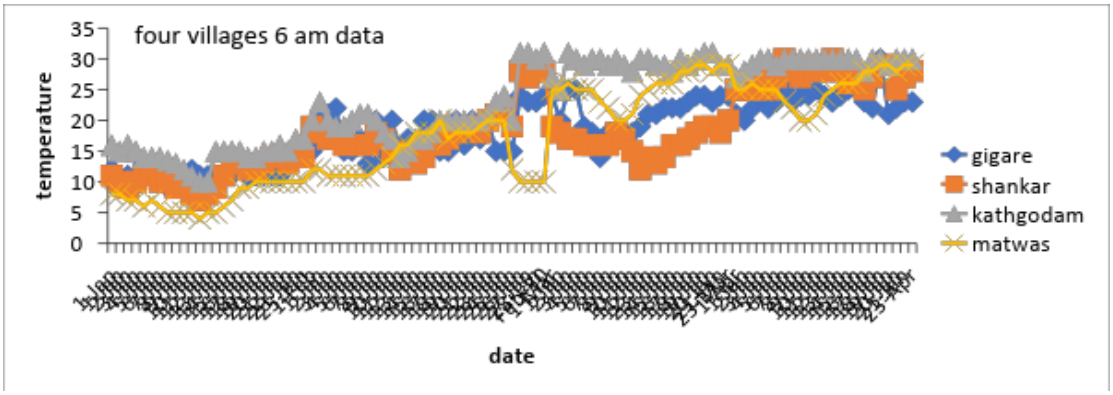

Fig:2- shows four village, four months 6AM temp. Data

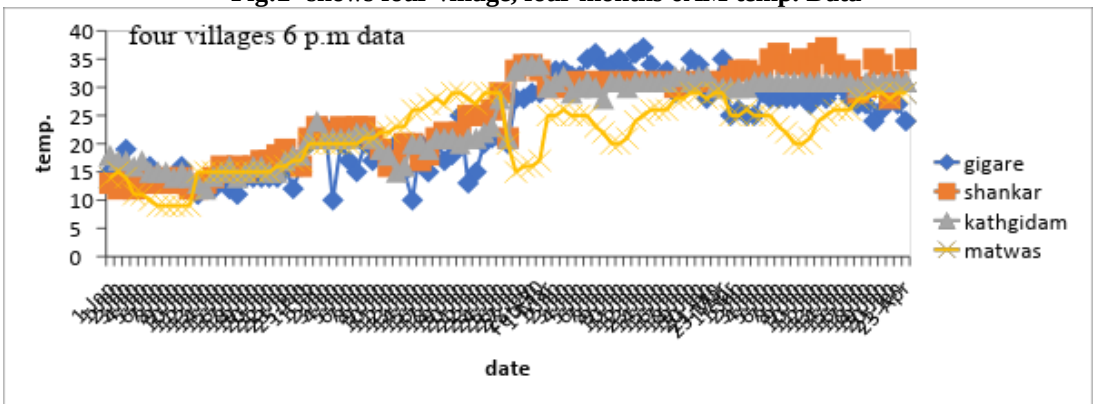

Fig 3-shows four villages, four months 6 pm temp. data

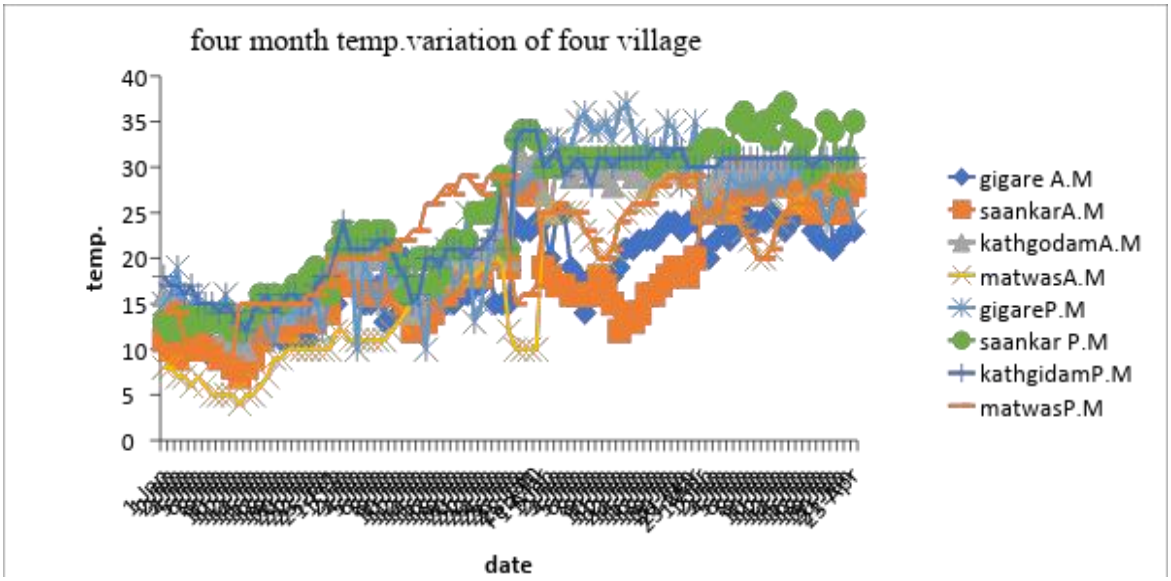

Fig 4: show the four-month temp.variation of four villages.

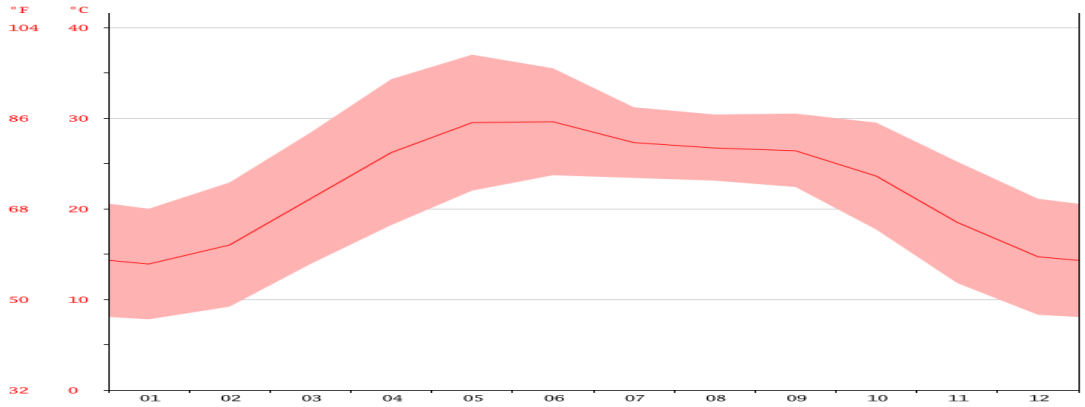

Fig 5: **Climatologically average record of temperature at Haldwani obtained from the "climate model"** (Source: https://en.climate-data.org/location/4074/). The shaded region shows the uncertainty given by the climate model.

A quick comparison of **graph 4** and **Fig 5** shows remarkable similarity of the model outcomes and the temperature records obtained by the school students and the villagers. All the observed temperature records are well within the uncertainty range of climate model output.

The comparison of observed temperature records and the climatologically records obtained from the climate model clearly demonstrates the potential of these data to be used for the evaluation of climatic conditions of this region. Their potential use of evaluation of future climate change if assimilated with the climate models properly. Hence, although these micro-weather stations are maintained by school students and the villagers, it holds great potential of being used operationally for the climate change evaluation, provided the support continues.

4-Conclusion

The study presents the temperature variation at three high altitude villages and one low altitude village of Himalayan region. The villages situated in high latitude show higher variation in the temperature, three villages are in different latitude and longitude but temp is not change according to latitude, so it is partially claim that hill region climate change. The result data found that the latitude not affected temperature sometime. It was a preliminary survey to check feasibility of micro weather station in salt block of Uttarakhand state. The main aim of this study was to get a glance about an operational mechanism of weather station by villagers and its technical reliability. Because of resources and time consternate it was not possible to go into deep technical details however, this study could give primary information about local level initiative of weather station and a base line data to go for further research. The present policy is based on centralized planning; there is no participation of local inhabitants in the planning process. In this research we discuss a concept, 'micro weather station' (MWS), with local people to introduce the concept among them and understand the process. This study has been designed for

primary information which may not help to bring big change. However, the knowledge which generated by this research can pave the way for further research. The temperature increase pattern is normal as it is lowest in January and highest in march There is no abnormal annual whether variation observed. River and forest cover affect the winter temperature. The overall concept is a good tool to engage local people in climate awareness. Explanatory and regress research need to be conducted to understand the hilly climate and weather.

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