1 ### ***Original Research Article***

2 # Weather forecasting: Traditional knowledge of the

3 # people of Uttarakhand Himalaya

4

5 **ABSTRACT**

6

Aims: The objective of this study is to highlight and document indigenous weather forecasting knowledge of the people.

Study design: Based on interaction with the community members.

Place and Duration of Study: Four valleys in the state of Uttarakhand, India have been taken up for the study; Johar, Byans and Niti valleys together with upper reaches of Bhagirathi valley. The data was collected between June 2012 and January 2015.

Methodology: The present study is based on the response of the people of the selected 73 villages, recorded using a specially designed semi-structured questionnaire. Response of 871 persons was recorded and besides this, perception of the people was also recorded through focused group discussions, in-depth interviews and key informant interviews. Special care was taken to select elderly people for response as they have memories of longer time span. It was also attempted to have gender balance in the responses. Proportions of male and female respondents are 46 and 54 percent respectively. The age profile of respondents is; 35 - 40 years 24 percent, 41 - 45 years 14 percent, 46 - 50 years 11 percent, 50 - 55 years 13 percent, 55 - 60 years 11 percent and > 60 years 27 percent.

Conclusion: Traditional weather forecasting has been used for local level decision making in pursuits related to travel and agriculture and for capturing timely information related to likely hazardous events. It is perceived that the traditional knowledge of the people was based upon uniformity of weather pattern that has lately been disturbed by climatic changes and hence people are finding it increasingly difficult to use this knowledge for decision making. The people, especially elderly persons, however have faith in this knowledge and with their experience they are able to use more indicators with greater understanding of their individual reliability. Formal recognition is required to be given to these practices so that these could be better utilized in planning process and are acceptable to the masses. Integrating this knowledge with the modern science can help in better understanding of various climate related parameters and help in managing climate risks.

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11 **1. INTRODUCTION**

12 Weather forecasting, as we understand today, relates to capability of assessing the weather
13 conditions in advance. This is done presently by analyzing huge volume of meteorological data,
14 collected from across the globe on real time basis, using high end computing machines. Though
15 not equipped with scientific instrumentation and analytical techniques the local communities
16 across the globe developed the art of assessing weather conditions using their accumulated
17 knowledge of generations. It was largely based on close observation of various faunal, floral and
18 meteorological changes in their surroundings. Weather forecasting and climate prediction
19 ensured success of farming operations, with the exception of intermittent disasters [1].

20

21 From the very beginning weather conditions have a major influence on life and life support
22 strategy of the people of the study area. This mostly revolved around travelling for trade,
23 pastoralism and limited agriculture. The people of the study area were traditionally traders who

used to venture on long and difficult journeys traversing high altitude passes of Himalaya for furthering their trading interests. They thus used to traverse all through the Himalayan mountain range where vagaries of fast changing weather are still a major challenge. Judiciousness of the decision related to timing of movement was thus vital for the success of these journeys.

These journeys were physically demanding and only the fit ones could undertake these. Women, children and elderly, together with ill and weak persons, therefore stayed back in their summer homes in the higher reaches where they engaged in cultivation of some niche crops. Survival during the trading journey was largely dependent on the judiciousness of the assessment of weather conditions and therefore the people of the area developed an elaborate system of weather forecasting that they used for deciding the timing of initiating the travel or halting at safe places on the way. The precision of forecasting a fair or bad weather was important for them as a wrong decision could as well wipe out the trading expedition all together. Decisions related to travel plan and route were thus taken after thorough review of various signs of nature. The tradition thus evolved out of their instinct to survive in their trade related journeys.

These people used to stay in Tibet for business from July to October, returning in November to do further business in the lower valleys and plains of northern India. They travelled with goods, halting at various places and moving on at appropriate time. The traditional weather forecasting knowledge was in the form of bio - indicators and other physical factors that include wind direction, time of the year, colour of sky and position of starts.

Weather related knowledge was at the same time highly useful for farmers and shepherds. Shepherds depended on livestock for their sustenance and counted on their knowledge to decide the timing of movement and halt of the large herds during summers so that they could take advantage of the diverse grazing resources. Success of limited farming within short duration depended on timing of sowing, harvest and storage that was also traditionally decided upon by the knowledge of weather conditions.

1.1 People and economy of the study area

Bhotiya tribe constitutes majority population of the study area. Though agro – pastoralism is the major economic activity of the area trans-Himalaya trade used to be their traditional pursuit. For this they used to maintain large animal herds; particularly those of sheep and yak that were utilized for transporting various tradable commodities from terai, in the foothills of Himalaya that used to be their abode during harsh winter months, to Tibet traversing high-altitude passes and rugged Himalayan terrain.

Sugar, gur, misri, tobacco, spices, pulses, grain, coffee, vegetable oil, ghee and various miscellaneous consumable items constituted the package carried across and exchanged by these people in Tibet for borax, salt, raw wool, shawl wool (pashmina), gold dust, animals, yak tails, chhirbi (butter) and raw silk. These tradable commodities essentially included products bartered by these people on way with the local inhabitants. Local fairs of the region that coincided with the movement of these migratory traders ensured that the local producers fetch fair price. This ensured variety in the economy of the region and at the same time infused new vigour into the economy of this region.

The people of the area traditionally crossed over to Tibet through a number of identified passes. For the people of Johar valley it was Gonkhal Dhar, a ridge defining the eastern border of Milam village, where the traders were given a hearty send-off and accorded a warm welcome on their return. From there the route to Tibet was through Untadhura pass (5377 meters) that could be crossed between June and October.

People of Byans valley carried out trade through Lipulekh pass following the Kali valley and the importance of this route can well be assessed from the fact that Baz bahadur Chand, the king of Kumaun, personally supervised construction of this route [2]. En route Garbyang used to be a

79 major trading destination and the importance of the same can well be assessed from ornate
80 multistoreyed buildings of the area [3].
81
82 In the Garhwal region trans - border trade was carried out through Niti, Mana and the Nilang
83 passes. The way to Niti pass was along Dhauli Ganga, Mana pass was through the higher
84 reaches of the Alaknanda beyond Badrinath and Nilang pass was accessed through narrow
85 gorge of Jad Ganga beyond Harsil.
86
87 After the Sino-Indian war of 1962 the border was closed and this flourishing traditional commerce
88 was suddenly disrupted. This forced the people to pay attention towards settled agriculture for
89 supplementing their income from other sources.
90
91 Lipulekh pass of the study area is first Indian border post to be opened for trade with China in
92 1992. This was followed by the opening of Shipki La in Himachal Pradesh in 1994 and Nathu La
93 in Sikkim in 2006. Presently, Lipulekh pass is open for cross-border trade every year from June
94 through September and people of the area still engage in traditional cross border trade. Their
95 ethnic characteristics and linguistic skills together with traditional acumen to traverse difficult
96 terrain that is still largely traversed on foot help them dominate this trade.
97
98 Most people of the study area still resort to seasonal migration and live at high altitude in summer
99 (May - June to October - November) and migrate to lower altitudes around November till April.
100
101
102 **2. METHODOLOGY**
103 Johar, Byans and Niti valleys together with upper reaches of Bhagirathi valley are taken up for the
104 present study (Fig. 1). This area is largely populated by the people of Bhotiya tribe. 73 villages of
105 these valleys are covered by this study; 26 in the upper reaches of Bhagirathi river valley (Fig. 2),
106 16 in Niti valley (Fig. 3), 24 in Johar valley and 7 in Byans valley (Fig. 4).
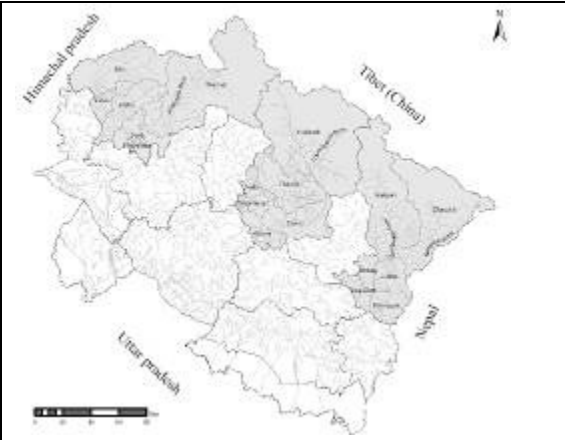107

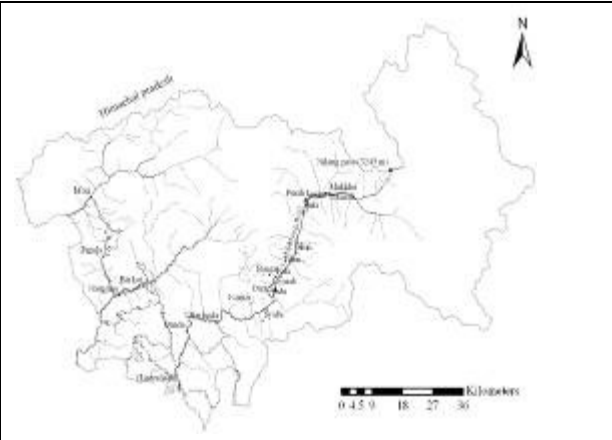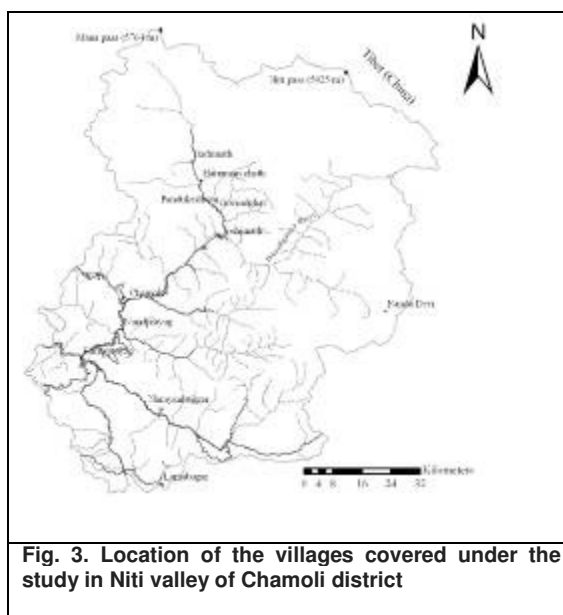| Fig. 1. Location of the four valleys taken up under the present study. | Fig. 2. Location of the villages covered under the study in Bhagirathi valley of Uttarkashi district. |

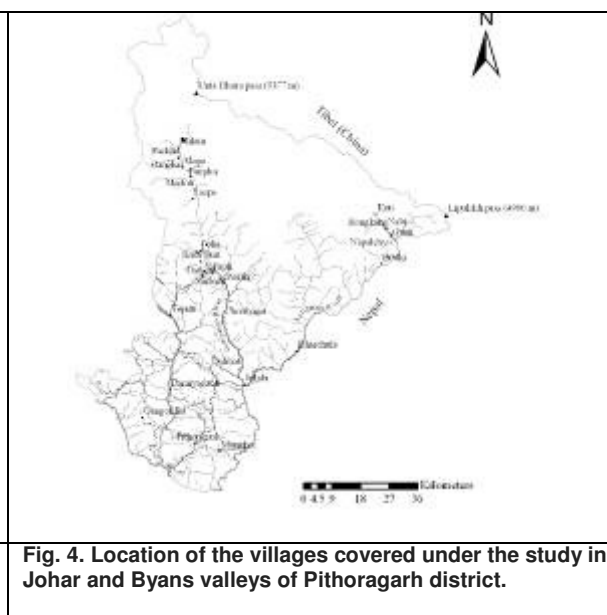| Fig. 3. Location of the villages covered under the study in Niti valley of Chamoli district | Fig. 4. Location of the villages covered under the study in Johar and Byans valleys of Pithoragarh district. |

108
109 Except for Bhagirathi valley were the selected villages are located in the altitudinal rage of 750 to
110 2620 meters above mean sea level (msl), all other villages are located between 2200 and 3600
111 meters.
112 The present study is based on the response of the people of the selected villages recorded using
113 a specially designed semi-structured questionnaire. Response of 871 persons was recorded and
114 besides this, perception of the people was also recorded through focused group discussions, in-
115 depth interviews and key informant interviews. Special care was taken to select elderly people for
116 response as they have memories of longer time span. It was also attempted to have gender
117 balance in the responses. Proportions of male and female respondents are 46 and 54 percent
118 respectively. The age profile of respondents is; 35 - 40 years 24 percent, 41 - 45 years 14
119 percent, 46 - 50 years 11 percent, 50 - 55 years 13 percent, 55 - 60 years 11 percent and > 60
120 years 27 percent (Fig. 5).
121
122 The objective of this study is to highlight and document indigenous weather forecasting
123 knowledge of the people. The word forecast often
124 refers to short term assessment of weather
125 conditions; up to one week. Traditional
126 knowledge is explained as the knowledge of a
127 group or a community from a particular area,
128 based on their environmental understanding,
129 interacting with nature and experiences within
130 their area [4&5]. As defined by De Boef and
131 others the term traditional knowledge is used
132 here as the knowledge of people of a particular
133 area based on their interactions and experiences
134 within that area, their traditions, and their
135 incorporation of knowledge emanating from
136 elsewhere into their production and economic
137 systems [5].

Fig . 5. Age group of the repondents in the four valleys.

138
139 **3. RESULTS AND DISCUSSION**
140
141 The prediction and bio- indictors were observed to be based on the longstanding familiarity of the
142 people with seasonal patterns of precipitation, temperature, wind and cloud pattern, position of
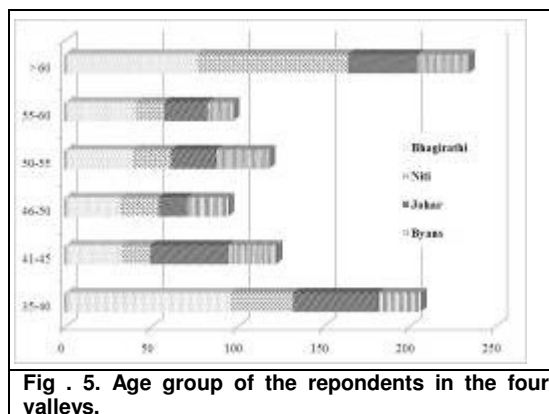
143 stars, behaviour of animals and birds and other similar indicators and observations. The
144 observations are grouped together based upon the parameters used for weather forecasting.
145

146 **i.** **Floral indicators**
147 • Blossoming peach (*Prunus persica*), apricot (*Prunus armeniaca*), fig (Ficus sp.) or
148 budding in other trees in the surrounding farms considered to indicate onset of spring.
149 Emergence and growth of new leaves indicates rising temperature is increasing and the
150 winter season is drawing to an end.
151 • Abundant blossoming of peach, apricot and other trees is considered an indicator of good
152 rainy season.
153 • Flourishing of mushrooms, both edible and wild, is considered to indicate imminent rain
154 as the same is associated with high humidity.
155 • Physical state and flexibility of pine (Pinus sp.) cones is traditionally utilized by the people
156 of the study area for assessing humidity in the atmosphere and predicting rainfall. The
157 pine cones generally tend to open up and become stiff in dry weather but in the presence
158 of high humidity these become flexible and often regain their original shape. It is this
159 variation in the state of pine cones with changing humidity that is utilized for assessing
160 humidity content in the air and predicting rainfall.
161 • Flowers of certain lower plants open up in fine weather. In case the petals of these plants
162 remain closed it is considered to indicate rain and bad weather.
163 • Appearance of young leaves and grass in the mountains, particularly in the pastures, is
164 considered to indicate good rains.
165 • Dropping of fruits or drying of flowers before maturity is considered to indicate
166 forthcoming very dry season.
167

168 **ii. Cloud colour and pattern**
169 • Dark clouds are considered to indicate heavy rainfall within a few hours.
170 • Dark clouds approaching from north are considered to bring rain.
171 • Red / pink clouds in the morning are considered to indicate the possibility of rain where
172 as red / pink clouds in the evening are considered to indicate that there would be no rain.
173 • Dark clouds preceding strong winds are considered to indicate thunderstorm in a few
174 hours.
175 • Wind getting fast with a particular colour and movement pattern of clouds is considered to
176 indicate rain.
177

178 **iii. Moisture**
179 • In villages elderly farmers usually carry a small bag of *tambaku* (tobacco)
180 for *hukka* (traditional smoking pipe). Moisture over the hukka is considered to indicate
181 rain.
182 • Moisture on dried chillies or tobacco leaves is considered to indicte high humidity and
183 imminent rain.
184

185 **iv. Other abiotic indicators**
186 • Red sky in the morning is considered to indicte rain, while red sky in the evening is
187 considered to indicte that there will be no rain.
188 • Shadow of the rainbow near the source of water is considered to indicte clear weather.
189 • Soil moisture is assessed by people by physically crumbling the soil with hand and
190 observing its structure and dryness. This is done before deciding the timing of sowing
191 and seed or seedling is introduced only when soil condition is observed to be favourable.
192 Otherwise farmers wait for rainfall.
193 • To check the soil moisture people turn over the stones near river or hill side or under the
194 shade of the tree. Moist soil under the stone during spring and summer season is
195 considered to indicate that the summer rain is approaching.

196   •   Bubbles in water during light rain are considered to indicate of more rain. In case the
197   bubbles appear during morning showers it is considered to indicate that the rain would
198   last the whole day.
199   •   If the water falls down while taking out for washing hands and legs it is considered to
200   indicate rain.
201

202 **v.**   **Spectrum/halo around the sun and the moon**
203   •   A ring around the moon and sun caused by light shining through sheet like high level
204   clouds is considered to indicate rainfall within the next two to three days. The description
205   of the clouds matches with cirrostratus clouds that consist of ice crystals and are
206   associated with warm fronts and high moisture.
207   •   If the spectrum around the sun has a larger diameter then rainfall is considered to be
208   assured. All the photometers are a luminous phenomenon produced by the reflection,
209   refraction, diffraction or interference of light from the *sun* or moon. The visible spectrum
210   of light around the sun or moon is called halo, or carona according to its distance from
211   the sun or moon. If the distance is more then it is called the halo phenomenon, which is
212   caused by a layer of thin veil of cirrus clouds i.e. non rain bearing clouds. But if the
213   distance is less, it is called corona phenomena produced by somewhat dense clouds
214   which may cause rainfall. The accuracy of this indigenous observation is as high as 50
215   per cent [6].
216

217 **vi.**   **Star constellation**
218   •   Pattern of stars and movement of stars from west to east at night under clear skies
219   indicate onset of rainfall in 2 - 3 days and similar patterns are also used to predict
220   cessation of rainfall.
221   •   The position of the starts is traditionally used to sense direction and time and if all
222   stars are out at night it is considered to indicate a nice day tomorrow.
223
224

225 **vii.**   In the study area people with arthritis were also observed to predict weather, based on
226   the level of their joint pain. If there is pain in the joints it is considered to indicate
227   imminent rain. This is assessed to be associated with the fact that certain weather related
228   factors can increase pain.
229

230 **viii.**   **Insect related indicators**
231   •   Appearance of ants and rapidly increasing size of anthills, which are moist, are
232   considered to indicate good rains. Variations in insect population have been shown to
233   exist throughout the year. Appearance of ants and the mushrooming of anthills mean
234   that the daily temperatures are warm enough for the ants to come out from
235   hibernation and roam around in / on the soil.
236   •   Appearance of ants and increase in the size of anthills is also considered to indicate
237   warming of weather and based on this observation people start to sow crops that are
238   sensitive to low temperatures.
239   •   If ants come out in large numbers and change place, it is considered to indicate rains.
240   •   Winged termites coming out of the soil after rainfall is considered to indicate fair
241   weather for some time.
242   •   Appearance of winged termites after a dry spell of some days is considered to
243   indicate rains.
244   •   If the spiders leave their webs, this is considered to indicate rains. Spiders generally
245   abandon their web and seek shelter with drop in atmospheric pressure and this
246   observation is utilized by the people for predicting rains.
247   •   Sound of crickets calling or chirping throughout the night is considered to indicate
248   change in weather.
249   •   When the bees come out of their hives it is considered a sign of clear weather.

250   • Sight of bees moving untimely and in large numbers towards their hives is considered
251   to indicate bad weather and rain.
252

253 **ix. Bird related indicators**
254   • Flock of small birds like common swallows (*Hirundo rustica*) together with proceeding
255   black clouds is considered to indicate rain.
256   • Birds taking dip in water is considered to indicate imminent rain.
257   • Sight of red billed chough (*Pyrrhocorax pyrrhocorax*) is considered to indicate that the
258   higher reaches have experienced snow and winter conditions are setting in.
259   • Crow spreading and moving its wings near river or source of water is considered to
260   indicate dry spell.
261   • Flocks of birds flying high in the sky is considered to indicate fair weather. If they fly
262   below their normal flight height this is considered to indicates rain or bad weather. Fall in
263   air pressure due to bad weather conditions causes discomfort in birds' ears and in order
264   to alleviate it they fly at lower elevations. Increase in humidity, at times of bad or wet
265   weather, draws insects to the surface and this is another reason for insect-seeking birds
266   to fly low.
267   • Flock of sparrows flying around the sky with scattered clouds is considered to indicate
268   rain in the afternoon.
269   • Ground nesting bird species making their nest on higher ground is considered to indicate
270   likely increase in water level of the water body (river / stream). The red-wattled
271   lapwing (*Vanellus indicus*) generally lays eggs on bare ground and never constructs a
272   nest. Laying of eggs by the lapwing on high ground is considered to indicate rise in water
273   level of streams and rivers.
274   • Migration and immigration of birds is considered an indicator changing season.
275   • Loud chirping of birds in group and taking dip in water is considered to indicate rain.
276   • Particular sound of the birds together with atmosphere becoming unusually calm is
277   considered to indicate rains.
278

279 **x. Animal behaviour**
280   • Grazing cows / yaks, juppu in local parlance, returning home early is considered to
281   indicate rains or bad weather.
282   • Well-fed cows/calves jumping in herd on their way home from mountain pastures is
283   considered to indicate rains or bad weather.
284   • Consumption of excess fodder by cattle is considered to indicate harsh weather or dry
285   conditions.
286   • Grazing cows returning home early with raised tails is considered to indicate rains.
287   • Croaking of frogs during afternoon is considered to indicate imminent rain during all
288   seasons.
289   • Sight of domestic hen/cocks searching food during rain is considered to indicate that the
290   rain would continue. But if these do not search for food during rain it is considered to
291   indicate that the rain would stop soon.
292   • If the goats do not graze it is considered to indicate snowfall.
293   • If burrowing animals like rats come out of their burrows and start to dig the ground it is
294   considered to indicate some natural calamity.
295   • Weeping like sound of animals is considered a bad omen and correlated with natural
296   calamities.
297

298 **xi. Appearance of reptiles:** Sight of certain snakes moving down the mountain is considered to
299   indicate good rains. Snakes generally come out of hibernation and proceed to downhill areas
300   in search for prey and mating partners so as to reproduce in early summer season, so as to
301   ensure that the eggs are hatched in time and baby snakes fatten their bodies in preparation for
302   the cold season when these resort to hibernation [7].

303 **xii.Earthquakes:** Although not falling in the category of weather forecasting, animals, birds and
304   insects are believed to sense the approaching earthquake waves well in advance. This is
305   believed to induce abnormal behaviour in these and the same is considered an indicator of
306   an imminent earthquake. It is also believed that a few minutes prior to the earthquake,
307   everything becomes completely still (no movement and no sound) e.g. birds chirping and
308   flying around. Insects cease to make noise and stop to move around and there is total
309   silence and stillness. This unusual calm is considered to indicate earthquake activity.
310   Seconds before the earthquake it is believed that the dogs start to howl and other animals too
311   become agitated and restless. After the earthquake has passed, similar silence is repeated
312   for a couple of minutes.
313
314   Animals and birds have also been known to leave an area or region up to 48 hours prior to a
315   major earthquake, not returning until well after the event [8].
316
317 ## 4. DISCUSSION
318
319 Traditional weather forecasting refers to the use of various indicators for assessing weather
320 conditions. Traditional forecasting mechanisms and indicators differ across communities, cultural
321 backgrounds and environments. In South Africa and Western Kenya, inhabitants use birds, toads,
322 and white ants to predict the summer season and onset of rains. Based on their observation they
323 at the same time can predict temperature variation in the range of 18° C to 26° C [9&10]. In the
324 northeastern Brazil appearance of crickets is used while in Tanzania forecast is made on the
325 basis of behavioral patterns of birds and mammals. Activities of arthropods, such as fleas,
326 cockroaches, houseflies, spiders and many others are considered to indicate arrival of the
327 summer season in Japan [11&12]. Similar indicators and forecasting methods are observed all
328 over the world.
329
330 The main advantage of traditional weather forecast is its simplicity and timeliness; a person can
331 make an independent observation without use of complicated instruments and make use of the
332 information when needed without resorting to complex analysis of the collected information.
333 There is no need for consultation with experts and in fact the indicators observed by people in
334 their immediate environment provide more accurate information than forecasts interpolated from
335 data of the weather stations located at distant places. This holds good for remote and
336 inaccessible terrains such as that of Uttarakhand where most metereological observatories are
337 restricted to district headquarters and the data from the same is extrapolated for making
338 predictions over large geographical areas. Remoteness of the places also hinders the
339 accessibility of the people to scientific weather forecasts through television, newspapers or radio.
340
341 Amongst others the challenges for the integration of this traditional knowledge with mainstream
342 science include the fact that observed environmental indicators lack sufficient scientific data for
343 validation. The knowledge is based on cultural belief system of the people and often varies with
344 different cultures and there is still no formal intergenerational transfer of knowledge amongst the
345 communities.
346
347 The indicators are based on ecological interactions and response of the indicator species, which
348 is being altered by climate change which is making these predictions increasingly less reliable.
349
350 ## 5. CONCLUSION
351 Bereft of external interventions the geo-environment around most local communities behaved as
352 a closed system with little faunal and floral changes. Moreover there were little variations in the
353 weather pattern. Though based upon intricate observation and recordkeeping of generations the
354 likelihood of the predictions being correct was at that time relatively high. Changed ground
355 realities and changes being introduced in weather conditions by climate change are however
356 making traditional weather forecasting tools increasingly unreliable. This is leading to mistrust
357 amongst masses regarding the efficacy of traditional indicators. The elderly people however have
358 faith in these and based upon their experience they resort to the use of multiple indicators for

effective and reliable predictions.In the changed ground the traditional art of weather forecasting is fast loosing ground and being transmitted through oral tradition this knowledge is sure to be lost soon as the community would be disinterested in putting in effort for transmitting irrelevant knowledge. This knowledge is however the product of in depth observation and detailed documentation of natural phenomenon over an appreciably long span of time and therefore detailed scientific documentation of this knowledge together with standardization of indicators that are still pertinent is a must. This if done in right spirit and results made available to the masses, could greatly empower local communities.

This effort would at the same time has scope of initiating an all together new line of research wherein modern weather forecasting skills could be further sharpened though the incorporation of real time inputs on the standardized indicators from the community.

Besides empowering the local communities this effort would be beneficial for the state as also others as improved weather forecasting would translate into better decision making, improved economic scenario and reduced loss from recurring disasters.

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