# Scientific Analysis of Correlation between Natural Factors and Annual Festivals Around the Globe

Bal Ram Singh and Kalyan Chakravarthi

Center for Indic Studies, University of Massachusetts Dartmouth, Dartmouth, MA 02747

Annual festivals are part of numerous cultures throughout the world. The occurrence of the festivals in a given culture varies with the type of calendar followed in that tradition. While some of the American holidays are celebrated based on the Gregorian calendar, many other traditions, including Indian traditions follow lunar calendar. Since traditions are long-lasting by definition, and are associated with cycle in the natural conditions (weather, crop, etc.), we decided to analyze several natural parameters (temperature, day length, moon light length, etc.) examine a correlation between annual festivals and natural factors. Results suggest significant correlation between selective natural parameters and annual festivals.

## Introduction

Celebrations are part of human experience, which transcends culture, ethnicity, geography, or politics.

Festivals are the most comprehensive celebrations involving all sections of a society.

Virtually all the festivals are celebrated based on a calendar, which are generally based on lunar, solar, or a combination of lunar and solar positions. Most of the modern Western world has been following the Gregorian calendar, whereas Arabic, Chinese, Jewish, and Indian calendars use lunar calendar, and a culture like India follows a more sophisticated calendar that combines solar, lunar, and solar, lunar, along with star (*nakshatra*) positions.

What is the role of lunar, solar, or star positions on human celebrations? Are these just to keep track of calendars so that the events such as festivals are repeated yearly or monthly? Is there some connection between calendars in human behavior? Are those behaviors materialistic things related to crops and climate, or is there an influence of stars, moon, and Sun on the human behavior either through day light, moon light, and temperature, pressure, humidity, etc.?

Answers to such questions are not clearly understood even if these have been attempted. Many of the questions have not been even posed well. Answering such questions would be helpful in creating a better understanding amongst different cultures, and has potential for uniting the humanity in their quest to learn from the nature.

In this report, we have attempted to begin to examine some of these questions by employing some preliminary approaches.

Festivals are recurring events, and many consider them seasonal. We have therefore examined a possible correlation between the date of festivals with natural factors such as temperature, daylight, moonlight, and other similar parameters.

## Approach

Natural parameters such as temperature, pressure, daylight and moonlight were recorded for the past 10 years on days of the festivals, and also on control days.

Moonlight times for the above festivals dates were also recorded to examine a constancy between the festivals and this natural parameter.

Mean temperatures of previous 12 years for Holi (Hindu), Diwali (Hindu), Muharram (Muslim), and Rosh Hashanah (Jewish) were recorded, along with daylight time and moonlinght time.

Variations calculated as standard deviations in mean values of temperature were divided by the standard deviations observed for the mean values of the daylight times. The ratio of variation in temperature per variation in the daylight time (VTVD ratio). This ratio was used as a parameter to compare different festivals.

## Observations

The position of sun determines the daylight and temperature on various parts of the Earth. Temperature in turn is known to dramatically affect human behavior (Anderson, 1998).

Day length and the mean temperatures recorded for several cities (e.g., New Delhi) in India and the United States are shown in Table 1. The temperatures recorded are the average of minimum and maximum temperatures.

Table 1. Daylight period and temperature records of 12 years on March 1, March 28, October 12, and on days of Holi recorded for New Delhi.

Ratio of temperature to daytime was calculated for each year, and mean of this ratio was tabulated. Standard deviations of the mean of daylengths, temperatures, and their ratios were calculated. A relative change in the temperature with respect to variation in day length was calculated for March 1, March 28, and the day of Holi that occurred on days between March 1 and March 28, between 1990 and 2001.

Similar calculations were made for Diwali for days between October 18, and November 13, Rosh Hashana (generally in September and October), and Muharram (occurs throughout the year) occur throughout the year.

| New Delhi | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **1-Mar** | **Temp** | **Ratio** | **28-Mar** | **Temp** | **Ratio** | **Holi** | **Day Len.** | **Temp** | **Ratio** | **18-Oct** | **Temp** | **Ratio** |
| | | | | | | | | | | | | | |
| **1990** | 11.34 | 59 | 5.20282 | 12.21 | 68 | 5.56921 | | | | | 11.26 | 84 | 7.46004 |
| **1991** | 11.34 | 60 | 5.29101 | 12.21 | 72 | 5.89681 | *1-Mar-91* | 11.34 | 60 | 5.29101 | 11.26 | 83 | 7.37123 |
| **1992** | 11.35 | 67.5 | 5.94714 | 12.22 | 74 | 6.05565 | *19-Mar-92* | 12.06 | 73 | 6.05307 | 11.26 | 82.5 | 7.32682 |
| **1993** | 11.34 | 67 | 5.90829 | 12.21 | 70.5 | 5.77396 | *8-Mar-93* | 11.46 | 65 | 5.6719 | 11.26 | 81.5 | 7.23801 |
| **1994** | 11.34 | 70 | 6.17284 | 12.21 | 85 | 6.96151 | *28-Mar-94* | 12.21 | 85 | 6.96151 | 11.26 | 78 | 6.92718 |
| **1995** | 11.34 | 66.5 | 5.8642 | 12.21 | 79 | 6.47011 | *17-Mar-95* | 12.01 | 68 | 5.66195 | 11.27 | 79.5 | 7.05413 |
| **1996** | 11.34 | 78 | 6.87831 | 12.21 | 82 | 6.71581 | *5-Mar-96* | 11.42 | 72.5 | 6.34851 | 11.26 | 78 | 6.92718 |
| **1997** | 11.34 | 75 | 6.61376 | 12.21 | 77.5 | 6.34726 | *24-Mar-97* | 12.14 | 72 | 5.93081 | 11.25 | 75 | 6.66667 |
| **1998** | 11.33 | 64.5 | 5.69285 | 12.22 | 73 | 5.97381 | *13-Mar-98* | 11.54 | 63 | 5.45927 | 11.26 | 77 | 6.83837 |
| **1999** | 11.34 | 74 | 6.52557 | 12.22 | 87 | 7.11948 | *2-Mar-99* | 11.35 | 76.5 | 6.74009 | 11.26 | 78 | 6.92718 |
| **2000** | 11.33 | 64.5 | 5.69285 | 12.21 | 85 | 6.96151 | *20-Mar-00* | 12.07 | 73 | 6.04805 | 11.26 | 84 | 7.46004 |
| **2001** | 11.34 | 64 | 5.64374 | 12.21 | 69 | 5.65111 | *9-Mar-01* | 11.88 | 72 | 6.06061 | 11.26 | 81 | 7.19361 |
| | | | | | | | | | | | | | |
| **Mean** | **11.3392** | **67.5** | **5.95278** | **12.2125** | **76.8333** | **6.29135** | | **11.77091** | **70.9091** | **6.02062** | **11.26** | **80.125** | **7.11587** |
| **Std Dev** | **0.00515** | **5.83874** | **0.51442** | **0.00452** | **6.70255** | **0.54859** | | **0.347432** | **6.84404** | **0.51182** | **0.00426** | **2.96284** | **0.26233** |
| **R. SDEV** | | | **1133.89** | | | **1481.99** | | | | **19.6989** | | | **694.847** |

Results of temperature and day length analysis from New Delhi and Boston (Figs. 1 and 2) suggest significant correlation between selective natural parameters and annual festivals of those civilizations whose calendars are based on lunar changes. There is a significant constancy between the day of the festival and the moonlight time, of course, because of their fixed day of the lunar calendar. In our analysis, there is also a common observance of very low VTVD ratio for three different cultural festivals, showing a commonality of physical parameters.

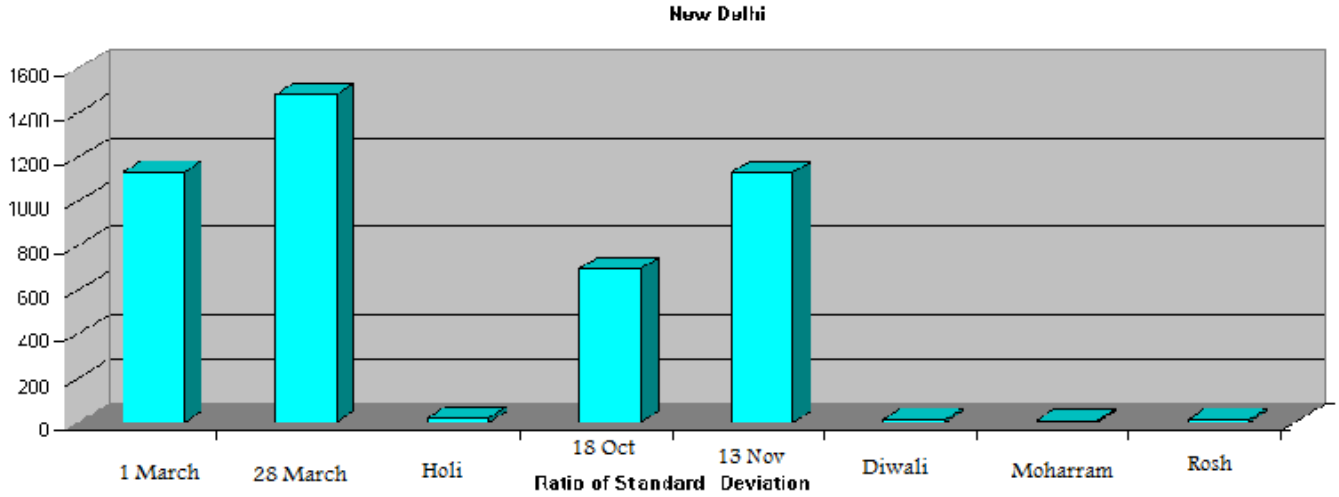


**Figure 1.** Ratio of standard deviations in temperature and day length in New Delhi over 12 years, corresponding to either different festivals or a given date in the Gregorian calendar.

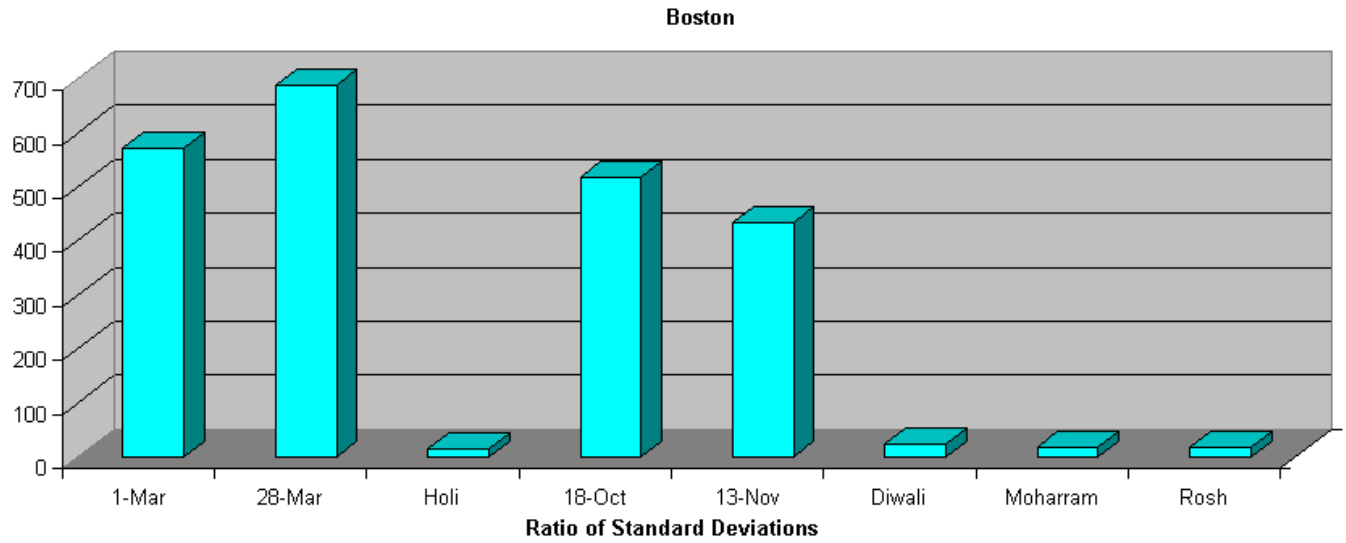


**Figure 2.** Ratio of standard deviations in temperature and day length in Boston over 12 years, corresponding to either different festivals or a given date in the Gregorian calendar.

We also checked the pressure values in New Delhi (**Fig. 3**) and Washington, DC, and found not much differences in their variations for a fixed date of the Gregorian calendar (e.g., October 18) or a festival like Holi or Diwali. Similar results were obtained for humidity records (data not shown).

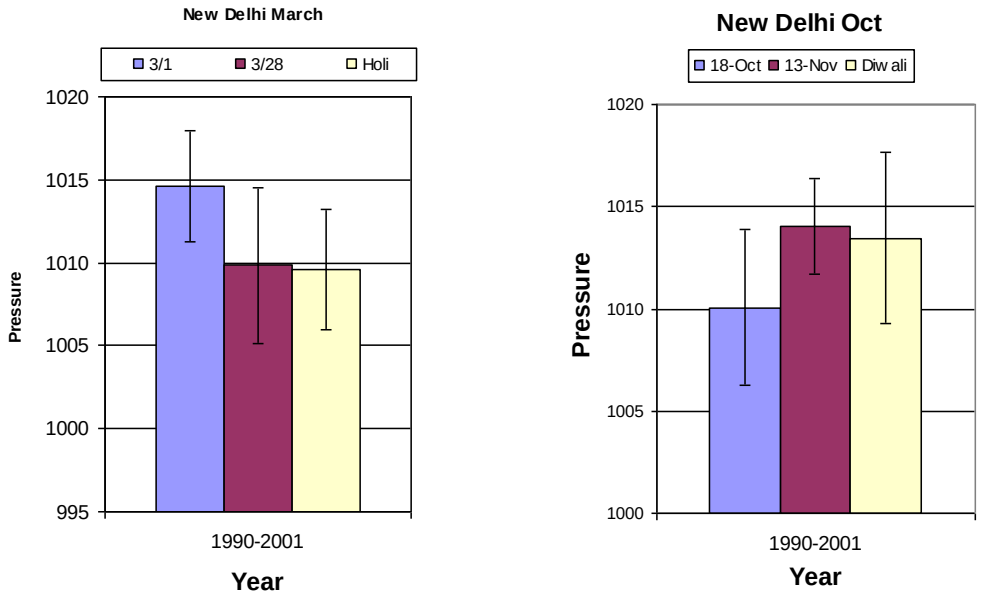


**Figure 3.** Average values of pressure in New Delhi in March and October/November, and on the days of Holi and Diwali. Variations in average values are represented by the vertical bars representing the standard deviations.

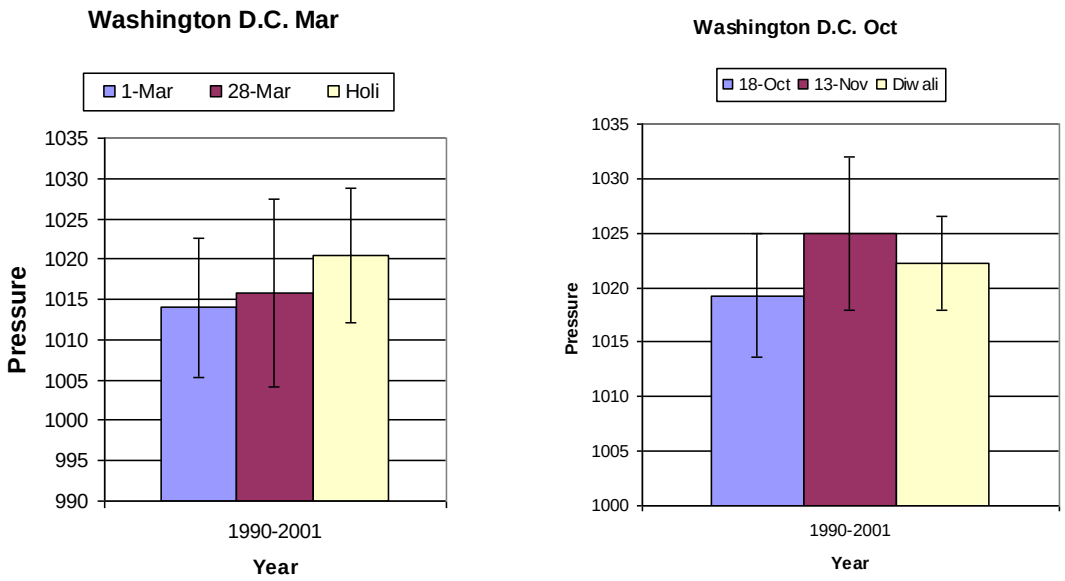


**Figure 4.** Average values of pressure in Washington, DC, in March and October/November, and on the days of Holi and Diwali. Variations in average values are represented by the vertical bars representing the standard deviations.

Observations from these analyses can be made as follows:

1. There is a clear distinction in the temperature and day light patterns in the Gregorian calendar based dates of festivals compared to those based on the lunar calendar (Table 1). The day length on March 1 or any other date is least varied as the Sun's position is fairly fixed on an annual basis. On the other hand the day light changes for festivals based on the lunar calendar, whose dates vary within about a month period. The temperature variations are not dependent on the lunar or solar calendar although the Sun's position could lead to a uniform amount and period of sunlight.

2. The standard deviations in the day light of a fixed Gregorian calendar is fairly low, but temperature variation (standard deviation) is fairly significant, leading to relatively high VTVD ratio (Figs. 2&3). However, it is notable that this ratio is substantially lower in Boston than in New Delhi for the same date on Gregorian calendar (Figs. 2&3), suggesting a greater variation in the temperature in New Delhi than in Boston on a given date of the year.

3. The VTVD ratio was the highest for a given date on the Gregorian calendar, owing primarily to the least changes in the day length. On the other hand, VTVD ratio for all the festivals which are based on the lunar calendar – Holi, Diwali, Muharram, and Rosh Hashanah – was extremely low, owing to significant variation in both the temperature

and day length because of changing days within a month period of the Gregorian calendar.

**Explanations and conclusions**

Calendar and moon phases:

The position (phase) of the moon is a very common determining factor of festivals seasons in many cultures throughout the world. However, there is major a contradiction in the perception of moonlight among different cultures. For example, in the Western world, lunacy is associated with full moon as a negative attribute (de Castro and Pearcey, 1995; Vance, 1995; Owen et al., 1998; Barr, 2000). In India, on the other hand, full moon is considered an auspicious occasion. *Chandra* in Sanskrit for moon is a commonly used name both for males and females, thus having no negative connotation.

Gregorian calendar currently in use worldwide is a derivative of the Julian calendar started by Julius Caesar in 46 BC with a simple formula of dividing 365 days by 12 months and adjusting for an extra day in February every four years. The Gregorian calendar was initiated on February 24, 1582 by a decree of Pope Gregory XIII. The calendar is most convenient and consistent for keeping record of days and plans. However, it may not provide awareness of the most subtle changes in our environment, such as changes in the moonlight period. The moonlight is least relevant to the city life today and perhaps part of the reason the solar calendar makes more sense in the modern world.

At the same time, there is a major effort to renew the knowledge of the role moon phases play in human life. One example has been the re-establishment of age-old moon gardening, even in the Western world (Roach, 2003).

Moon light and nature link:

In an article in National Geographic John Roach (2003) quotes RJ Harris, the head gardener at a private estate near Cornwall, England, and author of a book on the subject: "Lunar gardening is the oldest form of gardening known to man".

The practice centers on the moon's gravitational effect on the flow of moisture in soil and plants and, to a lesser degree, the effect of moonlight on seed germination.

Harris has gardened in tune with the lunar cycle since the 1950s, a practice he learned from his father and grandfather.

"Ever since prehistoric times, long before man ever had a watch on his wrist or a calendar on his wall, everything was governed by the phases of the moon," said Harris.

Harris notes that the moon not only controls ocean tides but influences the groundwater tables beneath our feet. Understanding the latter effect, and timing gardening chores accordingly, is the basis of moon gardening.

Harris gives the example that the best time to turn over a garden is during the last quarter of the moon because that is when the water table has dropped to its lowest point. "It means less moisture is within the soil. It is far easier to turn soil over when there is less moisture in it," said Harris, as quoted in Roach's article in National Geographic.

Coming from a farmer's family myself I remember our family starting many of the farming related actions, including sowing seeds and harvesting based on the *tithis* (dates) and *pakshas* (the dark and moonlight fortnights). It is, however, doubtful that the farmers make these decisions based on the scientific analysis of light, temperature, or gravity. This issue has also not been examined systematically even in the Western world, although quite possible to carry out (Roach, 2003).

Moon phases and human health:

The positions of sun and moon are likely to have major influence on the human body and physiology. The position of moon and sun are well known to affect ocean tides. Human body weight with over 50-60% water is bound to be affected. In 1980, Thakur et al. examined the incidence of acute poisoning cases on poorinma (full moon day) and non-poornima days between 1976 and 1979 at Patna medical college. They concluded that there was substantially larger number of cases were recorded on poornima days.

Similar studies by others have provided only inconclusive results. For example, Butler et al. (2003) carried out retrospective analysis of 2416 referrals to the Department of Oral and Maxillofacial Surgery, St. Bartholomews and The Royal London Hospital, London, over a 16-month period (17 lunar months). Frequency distributions were used to assess emergency workload during the week of the full moon. There was a rise in referrals in the latter part of the 7-day period surrounding the full moon. There was a persistent reduction in emergency workload in the 3-day period leading up to the full moon. The results approached but did not reach significance, but the effect of the moon on oral and maxillofacial referrals could not be proven. Thakur et al. (1980) posit that correlation to chronic diseases are difficult because it is difficult to establish their onset.

In another study, Buckley et al. (1993) carried out a study on self poisoning to determine whether there were significant circadian, weekly or lunar variations in self-poisoning presentations and whether patients' names or dates of birth had an influence on the likelihood of self-poisoning by analysing biorhythms, numerology and star sign in Hunter Valley, Australia. Consecutive adult patients admitted with self-poisoning between January 1987 and June 1993 were examined. There were 2215 patients admitted. There was a marked circadian variation. Over 6% of all admissions occurred in each of the hours between 6 p.m. and 1 a.m. compared with less than 2% per hour between 5 a.m. and 9 a.m. There was a small but statistically significant sex difference in presentations analysed by lunar phases. At the new moon 60% of self-poisonings were in women, compared with 45% when the moon was full. The mean illumination of the moon at the time of overdose was 50.63% +/- 0.91% for men, compared with 47.45% +/- 0.85% for women ($P = 0.014$). The circadian cycle (but not weekly, yearly or mystical

cycles) should be taken into account when determining staffing levels for poison information and casualty services. The full moon was protective for women.

Recently, Polychronopoulos et al. (2006) retrospectively reviewed all neurologic records of an emergency unit from 1999 to 2003 to identify a potential association between lunar phases and seizure occurrence. Overall 859 patients admitted for seizure occurrence were divided into the four quarters of the synodic month according to moon phases. A significant clustering of seizures around the full moon period was observed, supporting the ancient belief of periodic increased seizure frequency during full-moon days.

Nevertheless, several studies carried out even for animal bites and emergency admission have only provided contradictory results, and the issue remains unresolved (Roach, 2004). Other studies have been carried out on conception of male and female babies, and it has been shown that further studies are obviously needed.

However, contrary to the traditional belief that more cardiopulmonary resuscitations occur during the full moon, Alves et al. (2003) were unable to identify a significant effect during full moon days. However, they observed on average 6.5% fewer cardiopulmonary resuscitations during new moon days than other days.

Moon phase and human behavior:

It has also been investigated if full moon and no moon have any effect on the birth of male and female offsprings (Sarkar and Biswas, 2005). The study involving Indian couples of the age group 20 to 40 years revealed that 42 wives who were conceived within 24 hours of ovulation at full moon gave birth of 40 male and 2 female babies. On the other hand 40 women conceived on the day of ovulation 3 days prior to full moon gave birth of 13 male and 27 female babies. But only 5 women conceived on no moon, all of them gave birth of female babies. It was also observed that vaginal pH of the ovulated women during full moon was alkaline (pH 8.7 +/- 0.4) while pH was weak acidic in women ovulated 3 days prior to full moon and no moon (pH 6.4 +/- 0.5; 6.2 +/- 0.5). The basal body temperature (BBT) was increased 0.7 degrees F to 1.3 degrees F during the ovulation period when compared with women during the absence of ovulation. But there is an increase in temperature 0.5 degrees F more in women ovulated in full moon than no moon. Together, these results indicated that alkaline vaginal fluid medium and more rise of BBT during full moon favor conception of male babies. Such results provide very strong evidence to suggest human physiology is significantly affected by the lunar phases.

Temperature and human behavior

In addition to moon phases, studies have also shown that high temperatures also influence human behaviors, particularly aggressive behavior (Anderson, 1989). Therefore, the temperature values observed may have some connection to festivals or festival related behavior. However, it is unlikely the temperatures at different places such as New Delhi

and Boston can help with the behavior prediction. Relative changes in temperatures at a given place may be more relevant.

Analysis of temperature and day length data clearly establishes a distinction between festivals based on lunar calendar (Hindu, Jewish, and Muslims) and Gregorian calendar (Christian and many modern government initiated festivals such as independence day or republic day, etc.). Festivals based on lunar calendar provides a subtle way of learning of the lunar phases by the general populace so that they can become aware of a critical factor which could affect their physiology and mental conditions.

Calendar and culture

A culture like India where most of the population still lives in the villages, it is more convenient to follow the moon phases not only to keep track of time but also to plan the use of night time work based on the moon light. It also helps them to remain attached with the nature, an important aspect in promoting sustainability and preservation of environment. The Gregorian calendar has taken people particularly the educated class living in the cities, which has contributed maximally to the environmental exploitation resulting into current climatic changes and global warming.

A recent study by Pergams and Zaradic (2008) has shown a disturbing trend of significant decline in outdoor activities of people within the past 20 years. While lack of the lunar based activity may not be a main culprit for such observations as opposed to the use video for entertainment, it clearly does not help to not use a more nature-based calendar for daily life.

Conclusions

In conclusion, it is important to develop scientific analysis of many of the human traditions so that their time-tested values remain relevant in the modern time.

## References

Alves, D. W., Allegra, J. R. Cochrane, D. G. and Cable, G. (2003) Effect of lunar cycle on temporal variation in cardiopulmonary arrest in seven emergency departments during 11 years. Eur J Emerg Med. 10, 225-228.

Anderson, C. A. (1989) Temperature and aggression: ubiquitous effects of heat on occurrence of human violence. Psychol Bull. 1989 106, 74-96.

Barr,W. (2000) Lunacy revisited. The influence of the moon on mental health and quality of life. J Psychosoc Nurs Ment Health Serv. 38, 28-35

Buckley, N. A., Whyte, I. M. and Dawson, A. H. (1993) There are days ... and moons. Self-poisoning is not lunacy. Med. J. Aust. 159, 786-789.

Butler, S., Songra, A., Hardee, P. and Hutchison I. (2003) The moon and its relationship to oral and maxillofacial emergencies. Br J Oral Maxillofac Surg. 41, 170-172.

Owen, C., Tarantello, C, Jones, M. and Tennant C. (1998) Lunar cycles and violent behaviour Aust NZJ Psychiatry 32, 496-499

de Castro, J. M. and Pearcey,S. M. (1995) Lunar rhythms of the meal and alcohol intake of humans. Physiol. Behav. 57, 439-444.

Pergams, O. R. and Zaradic, P. A. (2008) Evidence for a fundamental and pervasive shift away from nature-based recreation. Proc Natl Acad Sci U S A. 105. 2295-2300.

Polychronopoulos, P., Argyriou, A. A., Sirrou,V., Huliara, V., Aplada,M., Gourzis, P., Economou, A., Terzis, E., and Chroni, E. (2006) Lunar phases and seizure occurrence: Just an ancient legend? Nerurology 66:1442–1443

Roach, J. (2003) Age-old moon gardening growing in popularity. National Geographic, July 10 issue.

Roach, J. (2004) Full Moon Effect On Behavior Minimal, Studies Say. National Geographic, February 4 issue.

Sarkar, M. and Biswas, N. M. (2005) Influence of moonlight on the birth of male and female babies. Nepal Med. Coll. J. 7, 62-64.

Thakur, C. P., Sharma, R. N. and Akhtar, H. S. M. Q. (1980) Full moon poisoning. British J. 281, 1684.

Vance, D. E. (1995) Belief in lunar effects on human behavior. Psychol. Rep.76, 32-34.