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# Estimation of Indian Time Zone Via Fuzzy Clustering Approach

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**Abstract:-**
Timeplaysaverycrucialroleinourlives;hence,thetimezonescameintoexistence.Therearenumeroustimezonesallacrosstheglobe.Allthe workirrespectiveoftheirtypeisdependentontime.Somecountries havetwoormorethantwo timezones.India follows the Indian Standard Time (IST). It is the primary time standard with +5.30UTC ahead of UTC and followed in Indian subcontinent. India,beingavastcountryafter the independence is facing a problem with its own time zone; mainly, the people belonging to North East India. So, in this paperwe madeanapproachviafuzzyclusteringbyfuzzycmeansalgorithmand calculating the problem by the observation of sunrise and sunset of different cities ofIndia.

**Keywords:** *Time zone, Coordinated Universal Time (UTC) , Indian Standard Time (IST), fuzzy clustering and fuzzy c-mean clustering etc..*

## 1. INTRODUCTION

Time zone is the biggest issues in all over the world especially in the country in which area is large. Most of the developed countries adopted two or more than two time zone according to the requirement. India is also the one of the larger country of the world but in India only one time zone is followed. For this a lot of states in India are facing the problem especially educational institution, government organizations and many other; mainly the north east India. In Guwahati When the working day starts in the upper east on thelongestdayoftheyear,thesunhighinthesky and the warmth is nearing its pinnacle on the grounds that tickerscrosswiseoverIndiaaresettothathour.Arunachal Pradesh's Chief Minister Pema Khandu reiteratednortheasternstatesdecades'olddemandforaseparate time zone. Leaders from that region argue that aseparate time zone would increase daylight savings andefficiency.

Coordinated Universal Time (UTC) is the primary time standard by which the world regulates clock andtime.Timezonesarecalculatedasperthelongitudeoftheglobe. Consideringearthasasphere.Longitudinallydividingtheglobeinto 4 equal parts of each 90°. Since, a day equals to24hours.It is calculated as follow :( 90×4) ÷24=15.Hence,15°sweepsanhourwhichresembles1°sweeps4mins.So,there are24timezonesontheglobe. Following map shows the standard time zone of the world.

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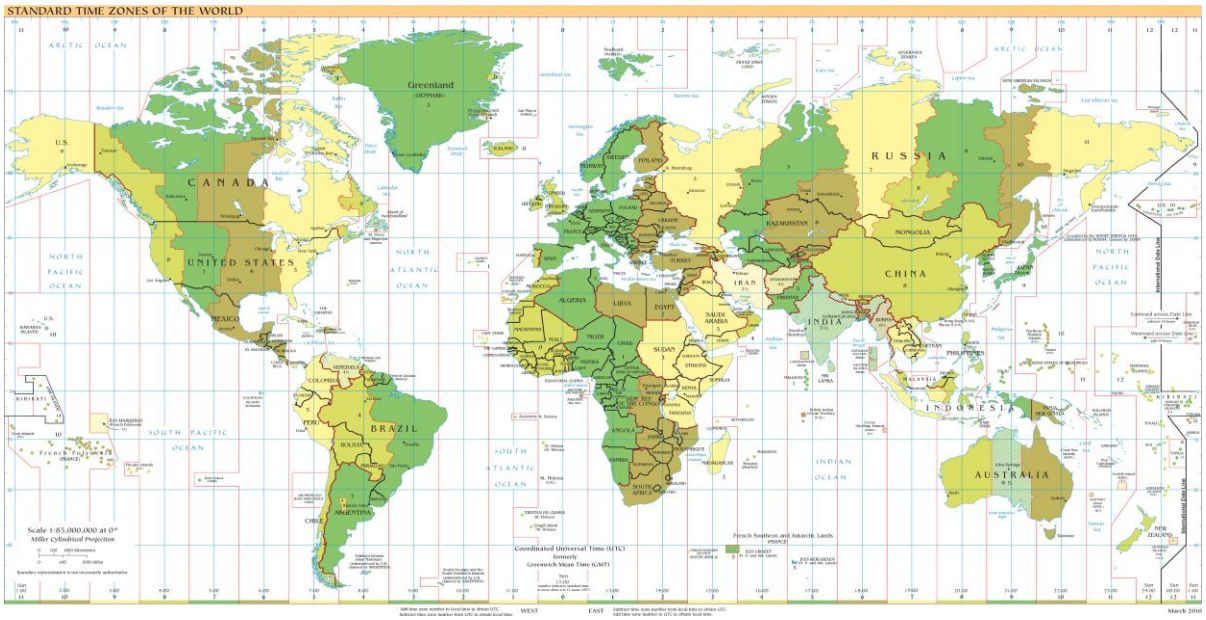


**Figure 1.1**: Show the standard time zone of the World

Australia follows three time zones as there are two longitudespasses through the subcontinent dividing the time into three zones namely AustralianWesternTime+08:00*UTC*,AustralianCentralStandard Time+09:30*UTC*,AustralianEasternStandardTime+10:00*UTC*. Similarly, Russia has 11 time zones, the USA and Canada each has six, Brazil has four. These countries strengthen their clocks throughout the summer, so that evenings have more daylight and mornings have less. Many European nations additionally use this exercise to utilize maximum sunlight hours. An exquisite exception but to this sample is China, which to begin with had 5 time zones, however presently has best a single time area, mainly due to political motives. India followed the Indian Standard Time (IST).It is the primary time standard with +5.30UTC ahead of UTC and followed in Indian subcontinent. From the mentioned figure 1.2we canclearlyobservethattherearethreedifferentstandardtimezones dividedby 2l attitudepassingthroughthesubcontinenti.e. 75˚and90˚and the mean of the time zones on the latitude is applied as the IST. 75˚represents+05:00*UTC*90˚represents+06:00*UTC*meanofboth the above mentioned time zone is+05:30*UTC*

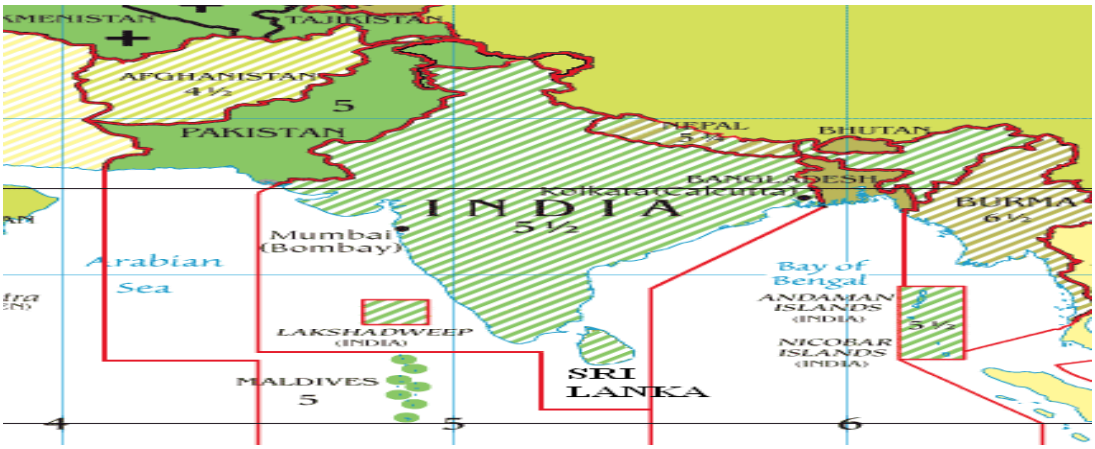

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**Figure 1.2**: Shows the Indian Standard Time (IST)

Clustering is the unaccompanied categorization of the objects into homogeneous relevant groups called clusters, so that objects in the same group become more comparable to one another than objects in various groups according to certain defined measures of comparison.The threshold between clusters is properly defined in the crisp clustering process. Nonetheless, the thresholds between clusters cannot be clearly defined. Certain objects might be included in more than one group. The fuzzy clusteringKinkuchi approach provides a better and more efficient way to cluster such objects in these situations. In this paper we suggested the fuzzy c- mean clustering algorithms (FCM) to find the suitable time according to the particular regions.

## 2.Literature Review

Many researchers discussed the advantage of different time zones. Kinkuchi at el. [1]and T.Kikuchi[2]discussed the problem in the monopoly of the completion in the two country service business model that reflects the role of differences in the time zone as a determinant of business patterns. In [3] show that the impact of time zones in commercial service trading depends on the ICT infrastructure level. If the time zone of trading nations do not overlap then the production, trade volumes can increase and the utilization of the time zone variations[4], also indicates that it increases the welfare and ensure accumulation of capital. Y. Matsuoka and M. Fukushima [5]were creating a business models with two same countries in different time zones and one industry with transitional specialized good produced in two consecutive stages. Also, implementing a change in disutility in terms of work that increases the night salaries.In [6] demonstrate that children in areas where sunsets occurs later have poorer outcomes because of the negative relationship between sunset and sleep and the consequent impacts on sleep deprivation performance.In this, paper[7] formulates a financial model that presents the issues of the time zones and technological revolution in communication together to show that skilled workers are helping with these innovations. M.Manjunath and Keith Peres Da Costa [8]evaluate the capacity of the process in the multi zones through learning in different countries, implementing incentives, barriers to solutions, energy effects, power consumption and evaluating a related field study.As with the required competence and knowledge, the analytical CSIR-NPL may try to implement the two time zones within the nation. The article[9] suggested two time zone, namely IST-I(UTC+5:30h) and IST-II(UTC+6:30h)

The purpose of traditional clustering is to precisely assign a single cluster to each data setprecisely.But the fuzzy clustering gives different levels of satisfaction, where membership of a possible level is divided between different clusters.It offers more detailed and comprehensive partitioning solutions which provide more decision-making options.The fuzzy clustering has its origins in a fuzzy logic in a particular field of computing that indicates the possibility and degree of data sets that is part of a number of categories. So inpaper[10] concentrates on the analysis of fuzzy clustering structures in different cases.The paper[11] present the application of fuzzy

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clustering for a relationship between temperature, humidity and PM10.It [12]provides a number of modeling examples, including a human control action model and qualitative model to describe the patterns of stock price data in time series.This paper[13]presents an optimized clustering method of 48 substations for the static load characteristics of the human domain power network. In paper [14][15], various distance methods in clustering algorithms were proposed in order to find the optimal locations for facility location problems.

## 3. METHODOLOGY

### FUZZY C-MEAN CLUSTERING

Fuzzy clustering is a mathematical technique in which experimental data sets are classified according to similarities[16].FCM is the clustering approach that permits the inclusion of one set of data in two or more clusters.Dunn developed this method in 1973[17] and Bezdak enhanced it in 1981[18] and also frequently used to recognize a pattern.

Due to the fact the data set $y_k$ is clustered to N clusters by FCM algorithm [16]. Clustering is centers $c_j$ and $\tau_{jk}^m$ partitioning by minimizing the cost function.

$$min\ z_{fcm} = \sum_{k=1}^{N}\sum_{j=1}^{c} \tau_{jk}^m \left\|y_k - c_j\right\|^2 \qquad (3.1)$$

Where $\tau_{jk}^m$ shows the membership grade of $y_k$ to the $n^{th}$ clusters,$\|\ .\ \|$ is distance metric, such as the Euclidean distance and $c_j$ is the $c^{th}$ cluster centers. The $m > 1$ fuzzification parameter governs the softness of the membership.In [17] higher mask estimation capability for m=2 was recognized. Therefore in this effort the fuzzificationor is the set to (3.2) until asuitableterminate standard is not met.

$$c_j = \frac{\sum_{k=1}^{n} \tau_{jk}^m y_{jk}}{\sum_{k=1}^{n} \tau_{jk}^m} \qquad c \in N \qquad (3.2)$$

$$\tau_{jk}^m = \begin{cases} \left[\sum_{i=1}^{c} \left( \frac{\|y_k - c_j\|}{\|y_k - c_i\|}\right)^{\frac{2}{r-1}}\right]^{-1} & \text{if } \|y_k - c\| > 0\ , \forall\ j \\ 1 & if\ \|y_k - c\| = 0 \\ 0 & if\ \exists\ i \neq j \quad \left\|y_k - c_j\right\| = 0 \end{cases} \qquad (3.3)$$

The calculation is based on such steps:

- The cluster center is initialized.Calculate the distance to the centers from each data set. The equation (3.1) and (3.2) uses Euclidean distance.

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- The sum for all points of membership grade is equal to 1 and the membership grade shall be determined by each point from each center.
- The new centers for each cluster were calculated based on the estimated membership grade (3.3).
- Emphasize these means until the contrast between$z_{fcm}$ ,$c_j$, or $\tau_{jk}$ from the prior stage and existing stage under ∈. ∈is alluded as the controller of fluffiness, which varies in cases, it could be an instinctive modest number or an earlier .

## 4. Experimental Result

The table below shows the time of sunrise and sunset of capital and central cities of various states of India according to geographic for the months of February, March and April for a specific day.

| State | City | Sunrise | Sunset |
|---|---|---|---|
| **Arunachal Pradesh** | Itanagar | 05:02 | **17:34** |
| **Nagaland** | Kohima | 05:01 | **17:31** |
| **Manipur** | Imphal | 05:02 | **17:31** |
| **Mizoram** | Aizawl | 05:08 | **17:36** |
| **Tripura** | Agartala | 05:14 | **17:42** |
| **Meghalaya** | Shillong | 05:10 | **17:40** |
| **Andaman And Nicobar** | Port Blair | 05:14 | **17:31** |
| **Assam** | Dispur | 05:10 | **17:41** |
| **Sikkim** | Gangtok | 05:22 | **17:54** |
| **West Bengal** | Kolkata | 05:26 | **17:53** |
| **Bihar** | Patna | 05:37 | **18:07** |
| **Jharkhand** | Ranchi | 05:37 | **18:05** |
| **Odisha** | Bhubaneswar | 05:37 | **18:02** |
| **Andhra Pradesh** | Vijaywada | 05:59 | **18:21** |
| **Tamil Nadu** | Chennai | 06:02 | **18:20** |
| **Telangana** | Hyderabad | 06:08 | **18:30** |
| **Chattisgarh** | Raipur | 05:53 | **18:19** |
| **Kerala** | Thiruvananthapuram | 06:18 | **18:32** |
| **Karnataka** | Bengaluru | 06:13 | **18:31** |
| **Goa** | Panaji | 06:27 | **18:47** |
| **Maharashtra** | Mumbai | 06:29 | **18:53** |
| **Madhya Pradesh** | Bhopal | 06:09 | **18:37** |
| **Uttar Pradesh** | Lucknow | 05:53 | **18:25** |
| **Uttarakhand** | Dehradun | 06:03 | **18:38** |
| **Himachal Pradesh** | Shimla | 06:06 | **18:42** |
| **Punjab** | Ludhiana | 06:11 | **18:47** |
| **Haryana** | Chandigarh | 06:07 | **18:44** |
| **Jammu And Kashmir** | Srinagar | 06:13 | **18:54** |
| **Gujarat** | Gandhinagar | 06:28 | **18:26** |
| **Rajasthan** | Jaipur | 06:14 | **18:45** |
| **LakshaDweep** | **Kavaratti** | **06:34** | **18:50** |

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**Table 4.1:** Shows the Sunrise and Sunsets w.r.t 3th April 2019

Hence, it is analyzed that by applying FCM algorithms the sunrise and sunset of 3th April 2019,considering sunrise and sunset along x-axis and y-axis respectively. We figure out three cluster Centre's as follows: $C_1$**(5.10, 17.39),** $C_2$ **(5.46, 18.13) and** $C_3$**(6.14, 18.40)**

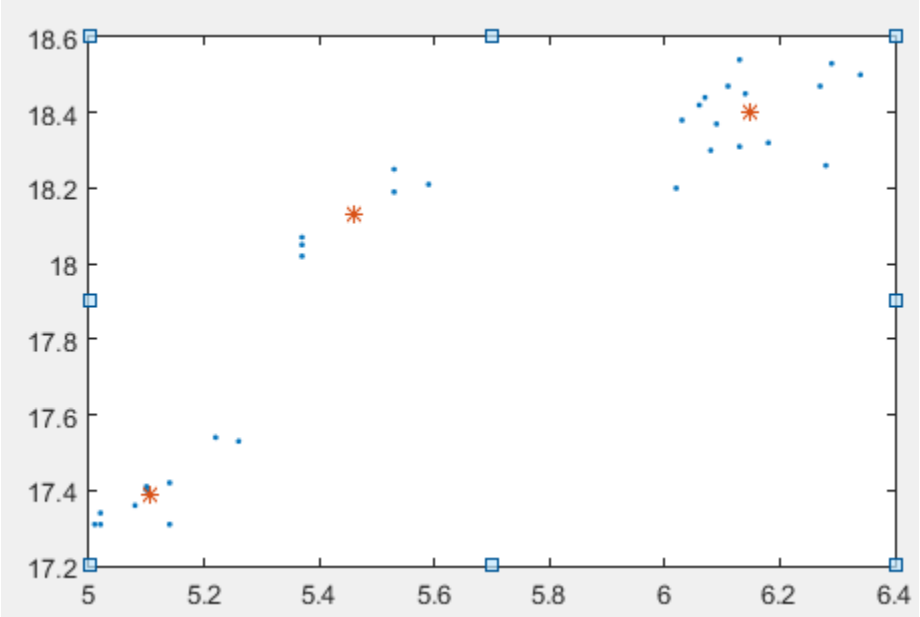


**Figure 4.1**Show the cluster center's w.r.t 3th April 2019

| State | City | Sunrise | Sunset |
|---|---|---|---|
| **Arunachal Pradesh** | Itanagar | 05:36 | **17:19** |
| **Nagaland** | Kohima | 05:33 | **17:18** |
| **Manipur** | Imphal | 05:34 | **17:19** |
| **Mizoram** | Aizawl | 05:38 | **17:24** |
| **Tripura** | Agartala | 05:44 | **17:30** |
| **Meghalaya** | Shillong | 05:42 | **17:27** |
| **Andaman And Nicobar** | Port Blair | 05:33 | **17:29** |
| **Assam** | Dispur | 05:43 | **17:27** |
| **Sikkim** | Gangtok | 05:59 | **17:39** |
| **West Bengal** | Kolkata | 05:55 | **17:42** |
| **Bihar** | Patna | 06:09 | **17:54** |
| **Jharkhand** | Ranchi | 06:07 | **17:54** |
| **Odisha** | Bhubaneswar | 06:04 | **17:53** |
| **Andhra Pradesh** | Vijaywada | 06:23 | **18:15** |
| **Tamil Nadu** | Chennai | 06:23 | **18:18** |
| **Telangana** | Hyderabad | 06:32 | **18:24** |
| **Chattisgarh** | Raipur | 06:21 | **18:10** |
| **Kerala** | Thiruvananthapuram | 06:35 | **18:33** |
| **Karnataka** | Bengaluru | 06:24 | **18:26** |

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| | | | |
|---|---|---|---|
| **Goa** | Panaji | 06:50 | **18:43** |
| **Maharashtra** | Mumbai | 06:55 | **18:45** |
| **Madhya Pradesh** | Bhopal | 06:39 | **18:26** |
| **Uttar Pradesh** | Lucknow | 06:27 | **18:10** |
| **Uttarakhand** | Dehradun | 06:40 | **18:20** |
| **Himachal Pradesh** | Shimla | 06:44 | **18:23** |
| **Punjab** | Ludhiana | 06:49 | **18:29** |
| **Haryana** | Chandigarh | 06:45 | **18:25** |
| **Jammu And Kashmir** | Srinagar | 06:55 | **18:31** |
| **Gujarat** | Gandhinagar | 06:58 | **18:45** |
| **Rajasthan** | Jaipur | 06:47 | **18:31** |
| **LakshaDweep** | **Kavaratti** | **06:53** | **18:50** |

**Table 4.2:** Shows the Sunrise and Sunsets w.r.t 7th March 2019

Similarly, for the cluster center's for7th March 2019 are as follow:

**$C_1$ (5.41, 17.27),$C_2$ (6.07,17.55) and $C_3$ (6.41,18.29)**

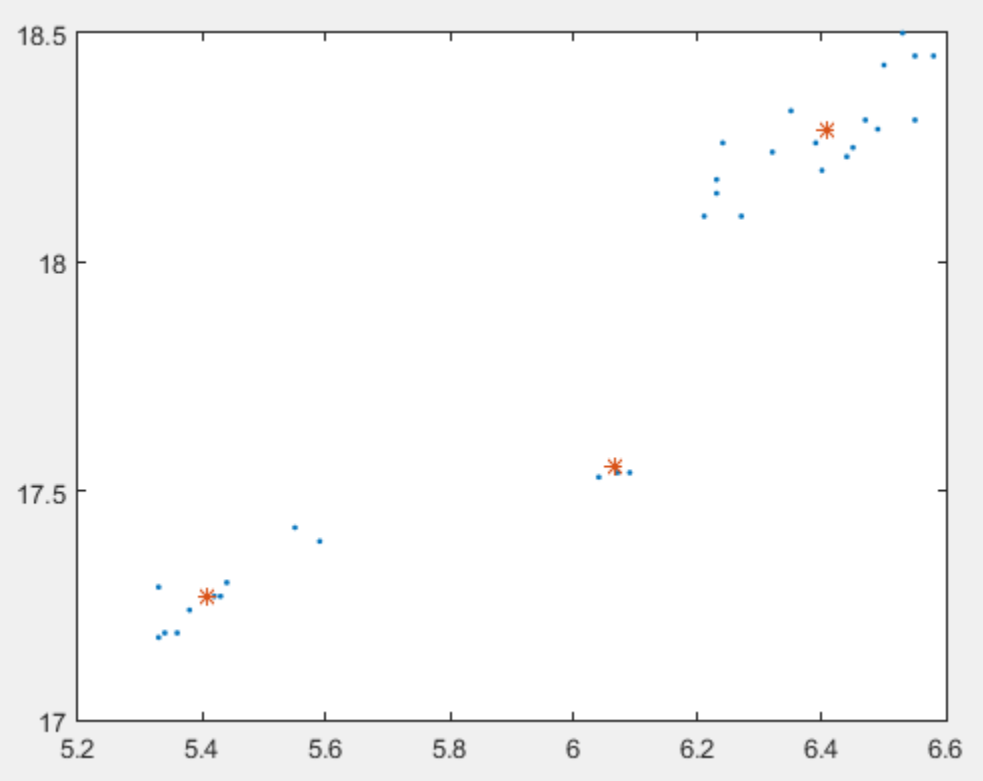


**Figure 4.2**Show the cluster center's w.r.t 7th March 2019

| State | City | Sunrise | Sunset |
|---|---|---|---|
| **Arunachal Pradesh** | Itanagar | 06:00 | **17:01** |
| **Nagaland** | Kohima | 05:56 | **17:01** |
| **Manipur** | Imphal | 05:56 | **17:03** |
| **Mizoram** | Aizawl | 05:59 | **17:09** |

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| | | | |
|---|---|---|---|
| **Tripura** | Agartala | 06:05 | **17:15** |
| **Meghalaya** | Shillong | 06:05 | **17:10** |
| **Andaman And Nicobar** | Port Blair | 05:44 | **17:23** |
| **Assam** | Dispur | 06:06 | **17:10** |
| **Sikkim** | Gangtok | 06:20 | **17:21** |
| **West Bengal** | Kolkata | 06:15 | **17:28** |
| **Bihar** | Patna | 06:32 | **17:37** |
| **Jharkhand** | Ranchi | 06:28 | **17:39** |
| **Odisha** | Bhubaneswar | 06:22 | **17:41** |
| **Andhra Pradesh** | Vijaywada | 06:38 | **18:06** |
| **Tamil Nadu** | Chennai | 06:36 | **18:12** |
| **Telangana** | Hyderabad | 06:48 | **18:14** |
| **Chattisgarh** | Raipur | 06:40 | **17:57** |
| **Kerala** | Thiruvananthapuram | 06:44 | **18:30** |
| **Karnataka** | Bengaluru | 06:46 | **18:23** |
| **Goa** | Panaji | 07:04 | **18:35** |
| **Maharashtra** | Mumbai | 07:12 | **18:34** |
| **Madhya Pradesh** | Bhopal | 07:00 | **18:11** |
| **Uttar Pradesh** | Lucknow | 06:50 | **17:52** |
| **Uttarakhand** | Dehradun | 07:07 | **17:59** |
| **Himachal Pradesh** | Shimla | 07:12 | **18:01** |
| **Punjab** | Ludhiana | 07:17 | **18:07** |
| **Haryana** | Chandigarh | 07:13 | **18:03** |
| **Jammu And Kashmir** | Srinagar | 07:26 | **18:06** |
| **Gujarat** | Gandhinagar | 07:19 | **18:30** |
| **Rajasthan** | Jaipur | 07:11 | **18:13** |
| **LakshaDweep** | **Kavaratti** | **07:03** | **18:45** |

**Table 4.3:** Shows the Sunrise and Sunsets w.r.t 7th February 2019

Similarly, for the cluster center's for7th February 2019are as follow:

**$C_1$ [6.37, 17.17], $C_2$ [6.43,18.08] and $C_3$ [7.11,18.14]**

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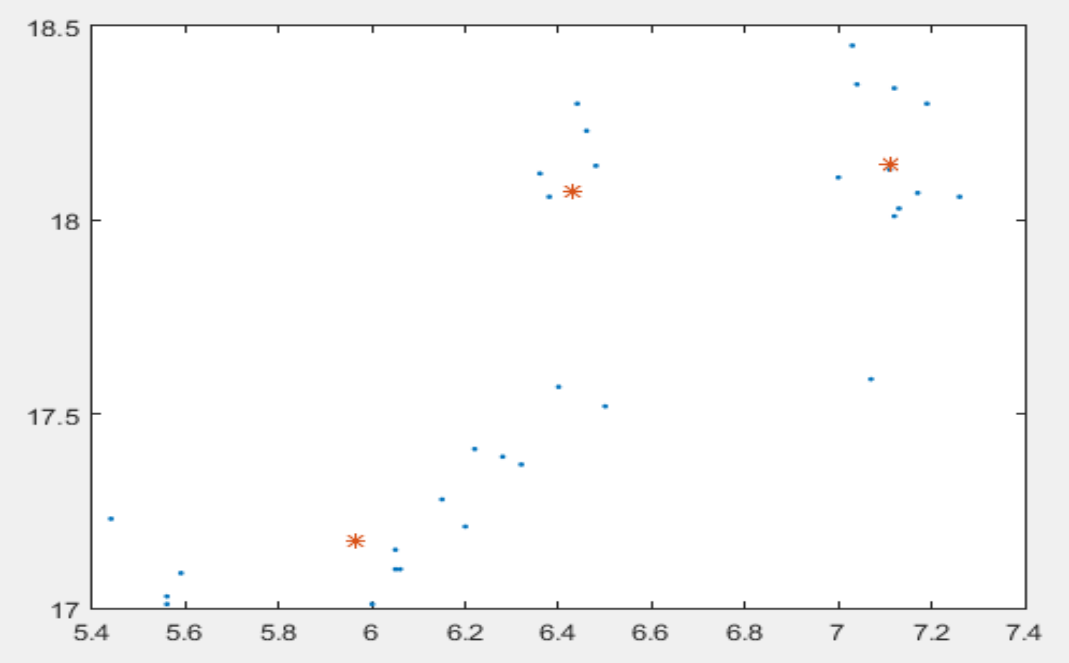


**Figure 4.3**Show the cluster center's w.r.t 7th February 2019

## Observation AndConclusion

From all the tables we observe that there is a huge time gap between theIndiancitiesrangingfromeasttowest.Consideringthecity offarthestnortheastIndianstate.i.e.Itanagarweobservethesunrises (05 : 02, 05 : 36, 06 : 00) and sunset (17 : 34, 17 : 19, 17 : 01) ,and if we compare this with the city of farthest west state .i.e. Gandhinagar weobservethesunrise(06:28,06:58,07:19)andsunset(18:26,18: 45,18:30),wetendtoseethehugetimegap.Ifweconsideraperson travelsfromItanagartoGandhinagarviaflightthenthatpersonwillbe atfirstatUTC+05:30andthenwhenhewillflyoverBangladesh thenhewillexperienceUTC+06:00andthenagainwhenhewillflyover India he will be back at UTC+05 : 30 . So, clearly the person movesaheadintimeandthenagaintravelsbackintimewhichseemsto beincorrect.Soafterviewingsuchproblemswemakeanapproach viafuzzycmeanssothat we canviewtheneedofanothertimezone.
Weresemblethedatafromconsecutivelythreemonthsandtheaverage isdepictedviathefourclusterswiththeirrespectivecenters.Sincethe

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ISTmeridianpassesoverAllahabadsowewillconsiderthesunriseand sunsettimeofthisplacesontherespectivedays:

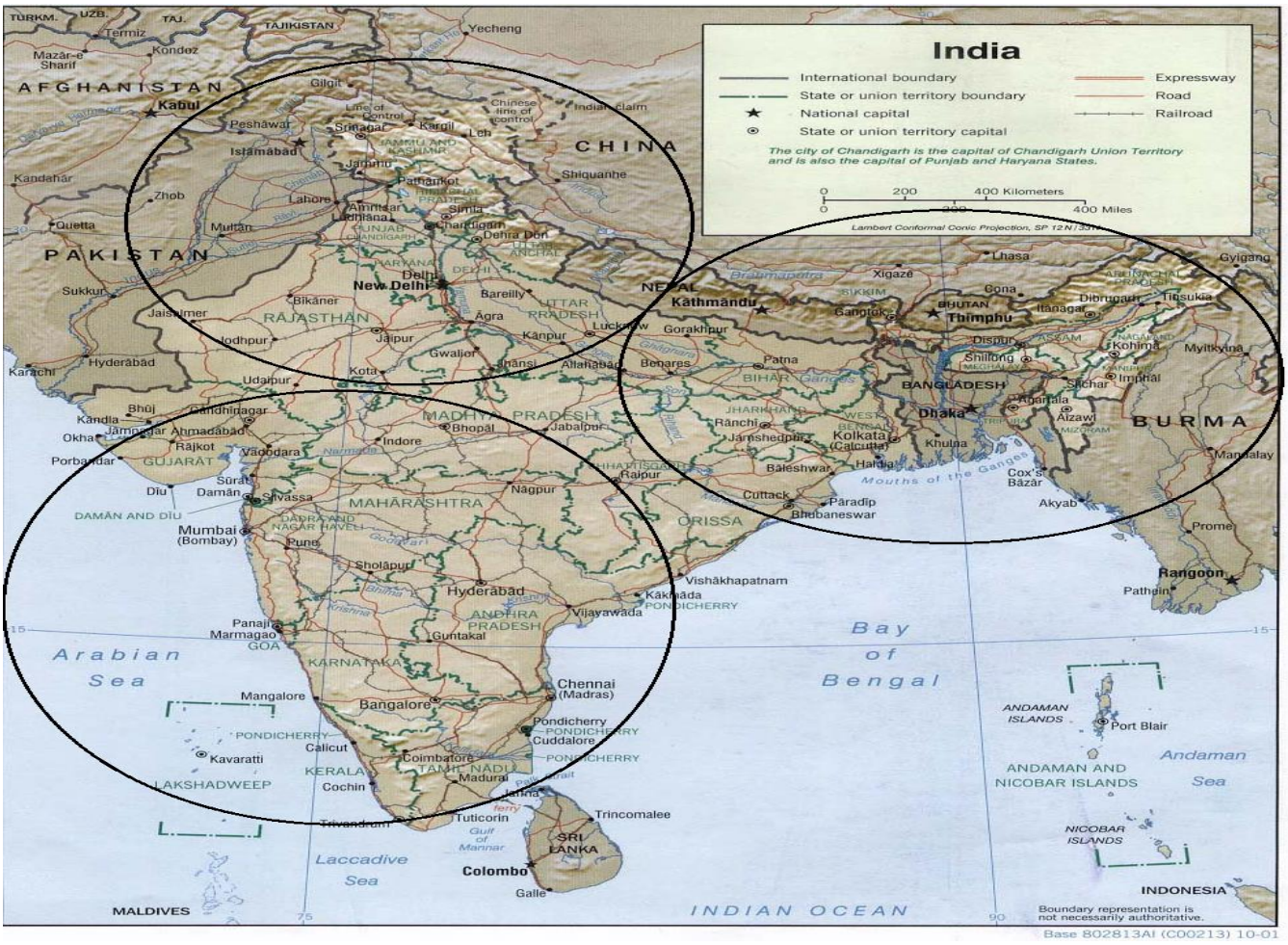


**Figure 5.1** Show the three clusters according to region

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| Date | Sunrise | Sunset | Center(from fuzzy c means) |
|---|---|---|---|
| 3rd April 2019 | 05:54 | 18:20 | (5:41, 18:22) |
| 7th March 2019 | 06:22 | 18:07 | (6:24, 18:01) |
| 7th February 2019 | 06:45 | 17:50 | (6:30, 17:47) |

We can now clearly observe that our calculated center differs from that of the IST in both the aspects of sunrise and sunset. Taking the greatestdifferenceofthesunriseweshouldaddanothertimezoneto the IST making two time zones for India .i.e. UTC+05 : 30hrs and UTC+05:45hrs.Thiswillbenefitbotheastandwestofthecountry. As,citizenslivingattheplaceswillsuffernolossesintime.Moreover, the demand of another time zone by the people north east India will benefit them in time keeping, saving electricity, performingdifferent workloads.

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