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Wildlife Institute of India

Identification of human- leopard conflict hotspots for prioritizing the mitigation measures in Junnar Forest Division, Pune, Maharashtra

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Report Title	**Identification of human- leopard conflict hotspots for prioritizing the mitigation measures in Junnar Forest Division, Pune, Maharashtra**
Project Details	Understanding Population Dynamics, Space Use, Movement and Diet of Leopards in Junnar Taluka, Maharashtra for Human Leopard Conflict Mitigation
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Contents

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List of Tables

List of Figures

Annexure Details

Executive Summary

Mitigation of human-carnivore conflict became a priority to wildlife managers for the conservation of large carnivores and human livelihood. Hence, for the effective mitigation measure, it is necessary to identify the priority human-carnivore conflict hotspots. In India, the growing human population, infrastructure development, and land modification are affecting the large carnivore population leading to human-carnivore conflict. Among human-carnivore conflict, human-leopard conflict is common in different geographical regions due to the adaptability of species across a different environmental gradient in India.

Human-leopard conflict records of 20 years (1999-2018) were collected from the different ranges of the Junnar Forest Department (JFD) in the Pune district. The area is known for the human-leopard conflict for the past three decades. The records show an abrupt surge of human-leopard conflict after the year 2014. Using these records, spatio-temporal clusters of the hot spots and cold spots were identified using optimized hotspot analysis tool in ArcGIS. Also, five different categories of hot spots in the study area namely, new hot spots, consecutive hot spots and sporadic hot spots of human- leopard conflict through emerging hot spot analysis in ArcGIS were identified.

It is suggested that different management approaches and strategies focusing on the different categories of hotspots are required to deal with human-leopard conflict for effective mitigation measures. Villages have been highlighted as the new conflict hotspots i.e. which has emerged in recent years. Immediate actions like intensive night patrolling and awareness in the villages to control will help in reducing human-leopard conflict.

Introduction

In Anthropocene, the escalating demand for space and resources because of the increasing human population is causing habitat loss for carnivores worldwide (Graham *et al.* 2005; Karanth *et al.* 2013). The substantial carnivore attack on humans and vice-versa became a major threat for the conservation of large carnivore and human livelihood (Miller 2015). The human-carnivore conflict includes carnivore attacks and its related threat to human life, economic security or recreation, also the retaliatory killing of carnivore by humans (Broekhuis *et al.* 2017; Meena *et al.* 2014; Sidhu *et al.* 2017). Human-carnivore conflict is attributed to several factors like environment, species (carnivore and prey) human infrastructure, management interventions, the large home range of carnivores and their protein-rich dietary requirement (Treves and Karanth 2003; Linnell *et al.* 2001; Macdonald and Sillero-Zubiri 2002). These factors are certainly drawing carnivores to human-dominated landscape causing intermittent competition with humans due to similar needs (Treves and Karanth 2003; Loveridge *et al.* 2010; Athreya *et al.* 2013).

India has a good hold of large carnivore populations outside the protected areas which have often been loggerhead with the growing human population, particularly leading to frequent human-carnivore interaction (Madhusudan and Karanth 2002; Athreya *et al.* 2007). Among the large carnivores, leopards are known for their adaptability to different environmental gradient and wide distribution (Vijayan and Pati 2000; Daniel 2009; Athreya *et al.* 2013). Leopards can flourish near the human settlement by feeding on livestock and domestic dogs and can thrive in agriculture dominating landscapes, plantations, tea and coffee estates (Goyal *et al.* 2000; Sidhu *et al.* 2015, Kshettry *et al.* 2017; Naha *et al.* 2017). These adaptabilities of leopard to coexist in human-dominated landscape by depredating on livestock is unfortunately leading to human-leopard conflict in different geographical regions of India (Daniel 2009). Large numbers of leopards are killed because of the real and perceived threat they pose to livestock; hence it became a challenge for its conservation (Karanth *et al.* 2012; 2013; Athreya *et al.* 2013; Mondal *et al.* 2013).

Globally, it became a necessity to identify the priority human-carnivore conflict sites for effective mitigation measures for the conservation of large carnivores (Miller 2015; Broekhuis *et al.* 2017). In recent years spatial statistical approaches like predation risk modeling and hotspot analysis have emerged as key tools to identify the hotspots for the carnivore-conflict. These tools have the potential to provide information pertaining to livestock management and carnivore conservation in such conflict areas (White and Ward 2011).

Maharashtra state is known for the human-leopard conflict. From 1999-2005 where forest department reports 902 human injuries and 201 human deaths were reported (Athreya *et al.* 2011). In this report, the spatial distribution of human-leopard conflict in different years of the north-western corner of Pune District in Western Maharashtra was examined. The area has a history of human-leopard conflict for last three decades (Athreya 2004; Shingote and Schuett 2013). By using forest department records of leopard attacks on human and livestock in the last 20 years, we used spatio-temporal hot spot analysis to assess significant clusters of human-leopard conflict in environmental space.

Study Area

Junnar Forest Department (JFD) (18°27'51.48" - 19°24'03.6" N and 73°31'18.84" -74°35'09.24" E) has a geographical area of 4360 km^2 and is in proximity to the Western Ghats one of the biogeographical regions of India. There are two protected areas adjacent to this forest division - Bhimashankar Wildlife Sanctuary in West and Kalsubai Harishchandragad Wildlife Sanctuary in north-west. JFD has four administrative blocks *(talukas)* Junnar, Ambegaon, Khed, and Shirur. The area is mosaics of hills, human

settlements with high population density and agriculture dominating landscapes in which the sugarcane is the major crop (Athreya *et al.* 2004). It has approximately 8% of forest cover and is historically supported by dry-deciduous forest (Champion and Seth 1968). The area has a good number of cattle, buffalo, domestic dogs, and pigs. Because of the nomadic shepherd community, sheep are also abundant in the area during the different cropping seasons. The area is drained by rivers like Bhima and Ghond with their tributaries Kukdi, Puspawati and Mina which support seven irrigation projects. Apart from leopards, there are records of predators like hyena, wolf, and jackal. The area also harbours the sparse population of wild pig, Indian porcupine, and hare.

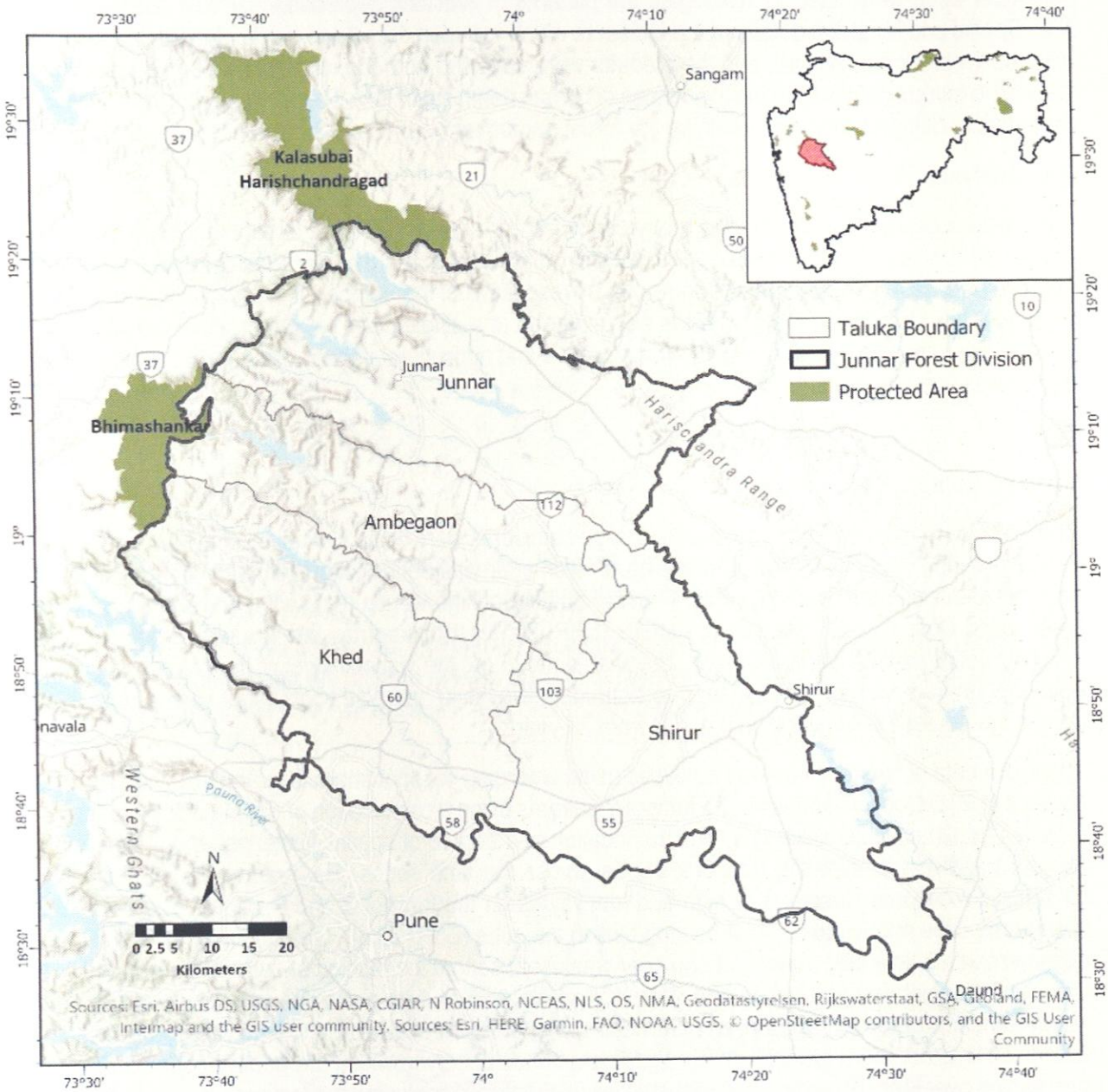


Figure 1: Map of Junnar Forest Division, Maharashtra, India with respect to protected areas

Methodology

Data collection:

The Maharashtra Forest Department financially compensates for livestock depredation, human death, and injury caused by carnivores. The livestock owner should report the kill and locate the carcass to the forest department official within 48hrs of incidence. After verification by Forest Department officials, livestock owners (or immediate family member with respect to human death and injury) receive compensation as per the rules of the scheme. The compensation records from January 1999 to December 2018 were used to investigate the patterns of livestock depredation by wild animals in the JFD. Spatial and temporal details of the incidents which included the village name, date and time of the incident, livestock depredated, and the predator were collected from the records. The same format was followed to extract details from the incidences of human death and injury. The verified records of livestock depredation, human injury, and death by the forest department were used for further analysis.

Data Analysis:

The livestock depredation and human injury/death records at seven different forest range from the years 1999-2018 formed the main dataset of this study. It is to be noted that each incident (with village as location) as a data point for analysis were used, irrespective of the number of livestock killed in a single incidence. It is considered that conflict is not governed at a single point but rather attributed with other features like human population density, infrastructure and agricultural pattern. Therefore, the village as a feature was used for the analysis.

Mapping Conflict Hot Spot:

Livestock depredation incidents attributed to large carnivores were used, to analyse long term spatial and temporal trends of conflict. Conflict mapping of each year was done using optimized hot spot analysis This tool identifies statistically significant spatial clusters of high values (hot spots) and low values (cold spots using Getis-Ord Gi* statistic in ArcGIS (ESRI 2019). It aggregates the incidents point data into weighted features for a particular year. This was done to get the visual insight of the change of conflict hot spots (the area where leopard tend to depredate livestock) and cold spots (area where leopard do not tend to depredate livestock) in the JFD from 20 years.

The entire data of twenty years was analysed using emerging hot spot analysis in ArcGIS. The emerging hot spot analysis tool evaluates spatio-temporal patterns using a combination of two statistical measures: i) Getis-Ord Gi* statistic which identifies the location and degree of spatial clustering, and ii) the Mann-Kendall trend test to evaluate temporal trends across the time series (Harris *et al.* 2017). Getis-Ord Gi*statistic measures clustering of high and low values (in the form of Z and P values) in a bin of the space-time cube relative to its neighbouring bins in the cube (ESRI 2019).The end time as the time step alignment with a time step interval of one year was used; so that the binning of data will be initiated with the last data point and go back in one year increments until all data points fall within a time step. The Mann-Kendall statistic (an application of Kendall's rank-order correlation test to time series) was used to determine whether there are statistically significant trends observed which are persistent, increasing, or decreasing over time. Emerging hot spot analysis tool helps in analysing the temporal trends in the data by comparing each time step in the data with the next one (Harris *et al.* 2017); these pairs were compared over the 20-year series along with the z-score and p-value for each bin. The tool provides cluster and trend results in the form of seventeen different categories of hot or cold spots depending upon the data.

Results

A total of 4648 incidents of livestock depredation, human injury and death were reported from 1999 to 2018. Leopard (n=4495) was the main carnivore species reported in the conflict cases, along with sporadic cases of wolves (n=99), hyenas (n=22) and unidentified wild animals (n=32) in the records. Since 1999 there have been consistent cases of leopard attacks on humans and livestock (Figure 2). A pattern observed in the attacks on humans leading to injuries or death shows a peak in years between 2000-03 and 2008-10 (Figure 3). Among livestock, goats (56.9%) were reported to have the highest depredation followed by cattle (primarily calves; 21.2%) and sheep (15.6%).

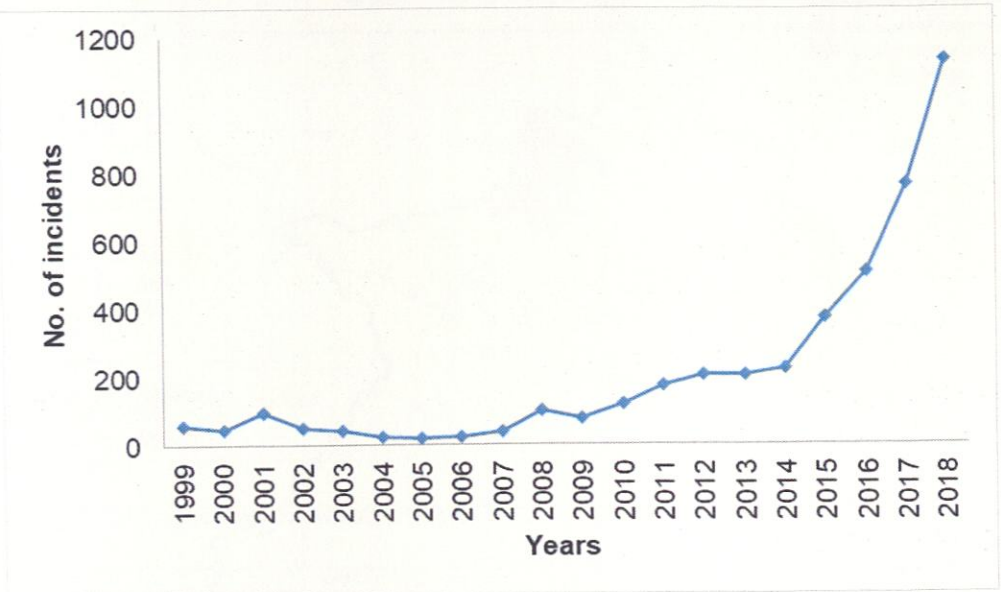


Figure 2: Number of human-leopard conflict incidences from years 1999 to 2018 in Junnar Forest Division, Maharashtra, India

JFD comprises of 638 villages across four talukas. Records suggest out of 638 villages, 323 villages have experienced a conflict with the leopard at least once in the last two decades. Most of the villages report only a single case in the past two decades; only one village reported a high incident (n=460) in total.

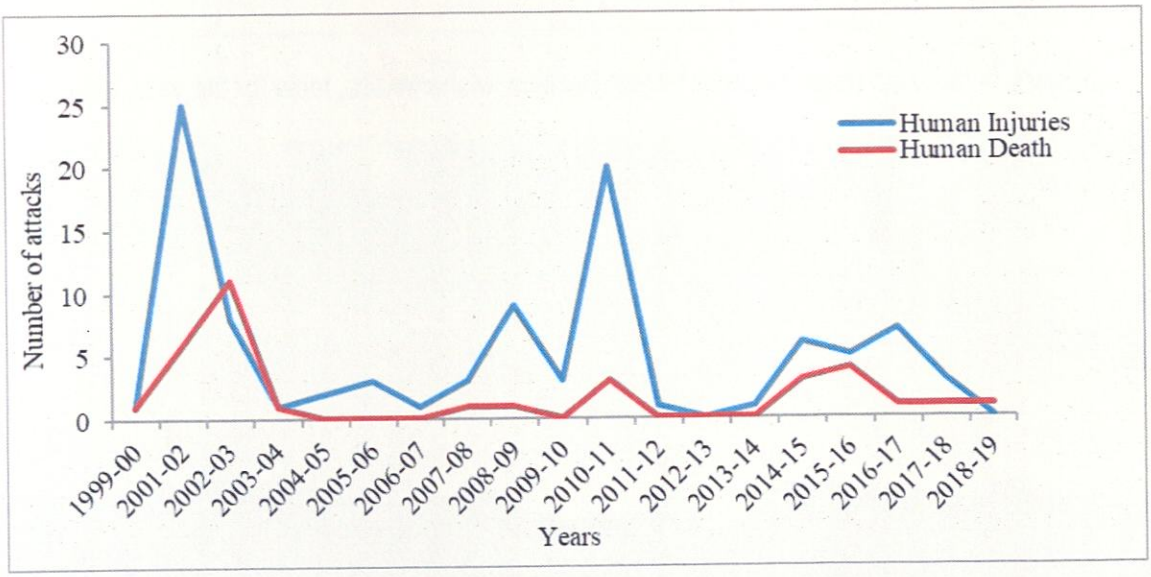


Figure 3: Human injuries and death by leopards in Junnar Forest Division, Maharashtra, India from 1999 to 2018

Hot Spot Analysis

Spatially significant clusters were identified using optimized hot spot analysis. Here the focus was on plotting the presence or absence of the incidents in villages under JFD for every single year between years 1999 to 2018. Through this hot spot and the cold spots were identified in JFD. The conflict hot spots were in and around to Junnar *taluka* from the year 1999 to 2007 subsequently, it expanded in the year 2008 and then reduced in the year 2011. After the year 2012 new conflict hot spots appeared in Shirur *taluka*. The analysis also showed us a pattern that detected the year (2016 & 2017) had no specific pattern of hot spots or cold spots.

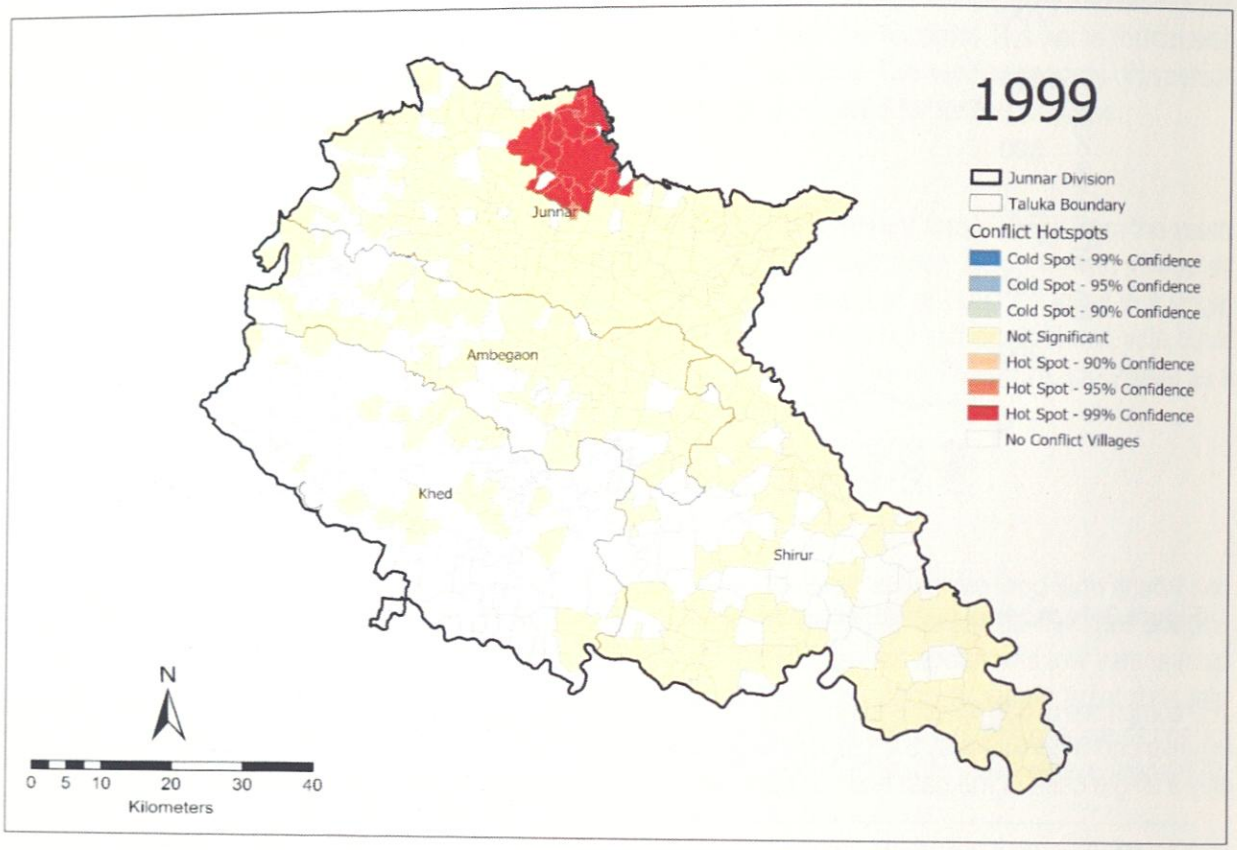
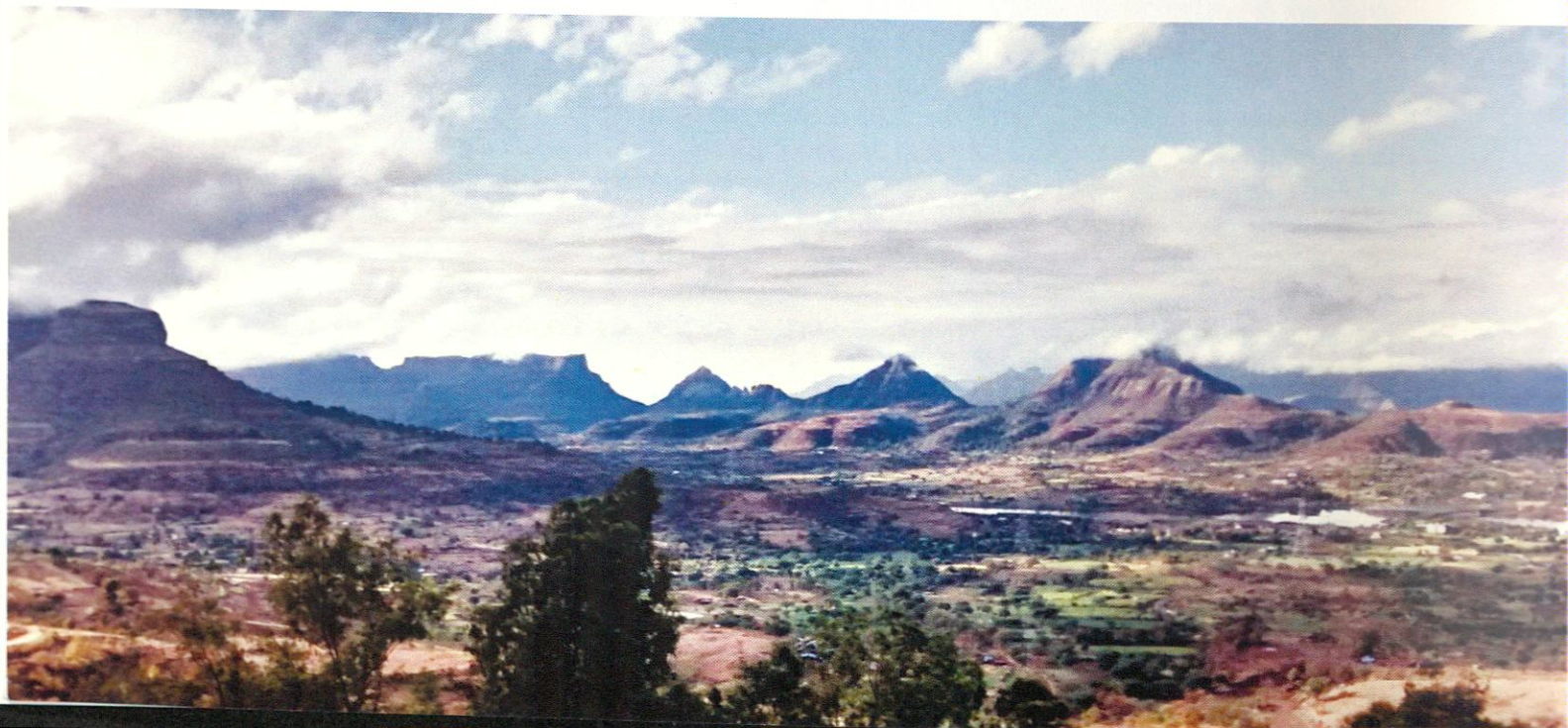


Figure 4: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 1999



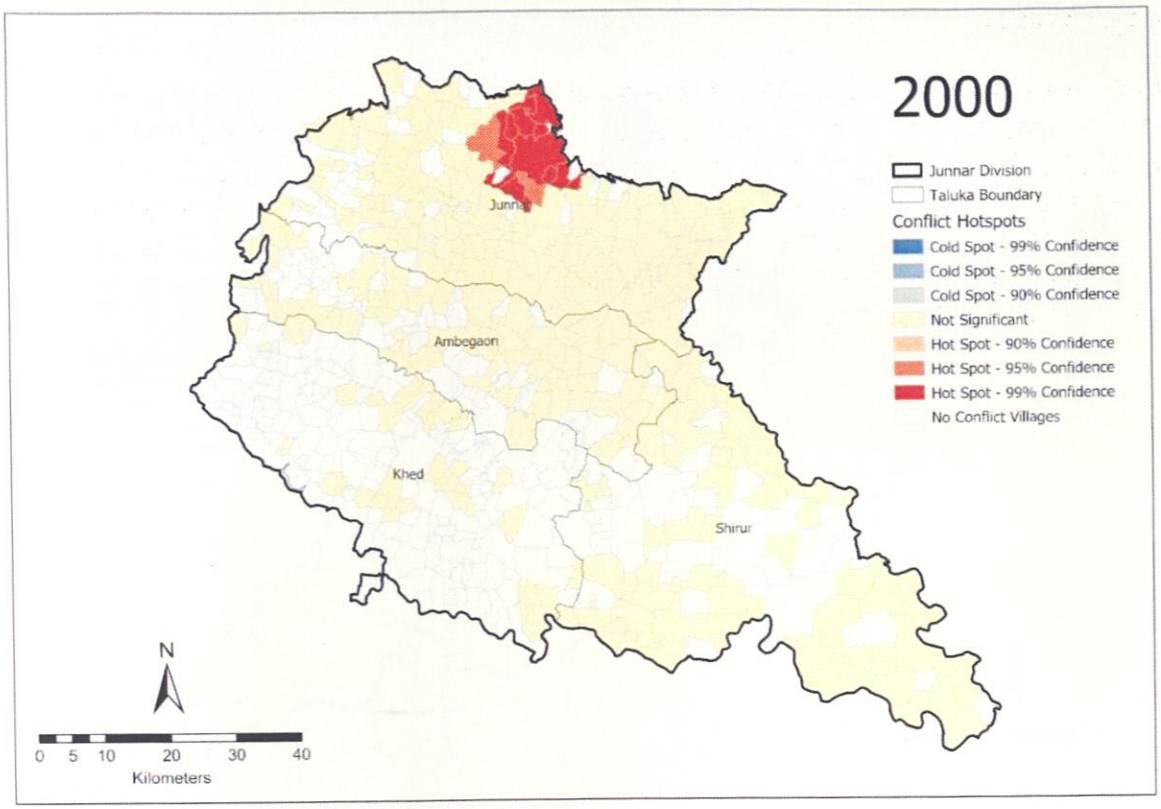


Figure 5: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2000

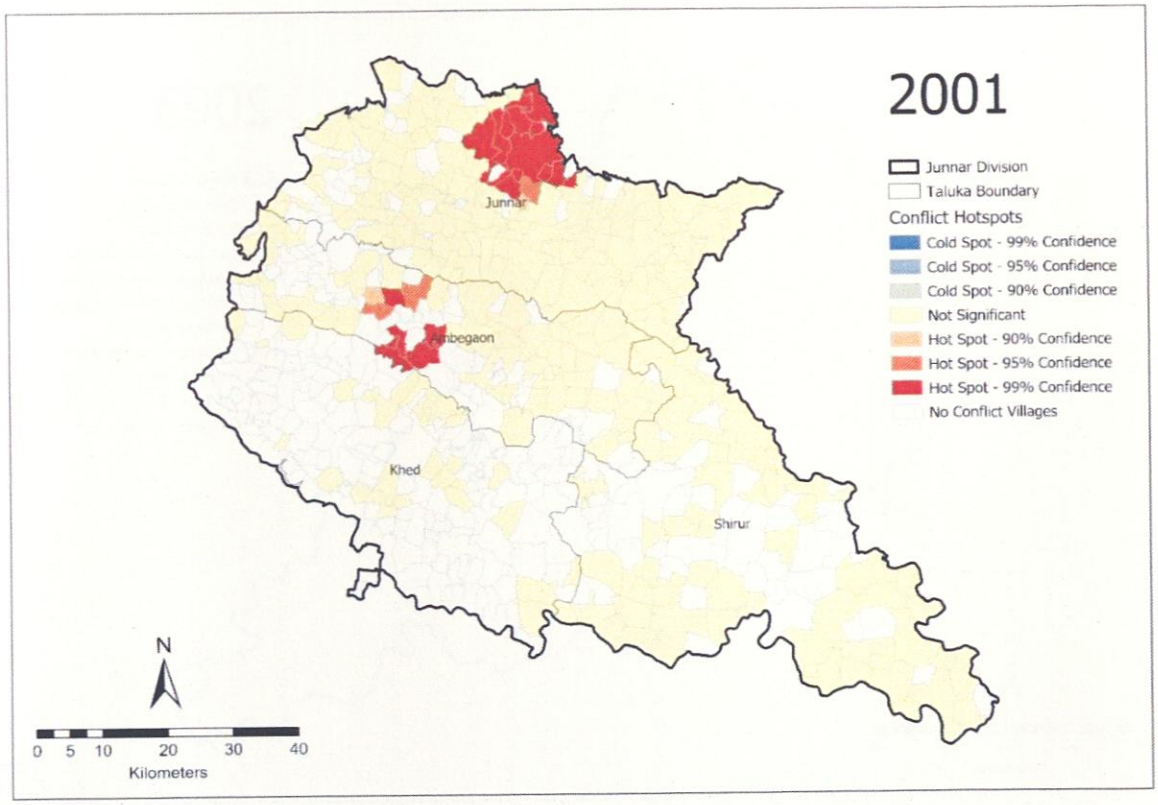


Figure 6: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2001

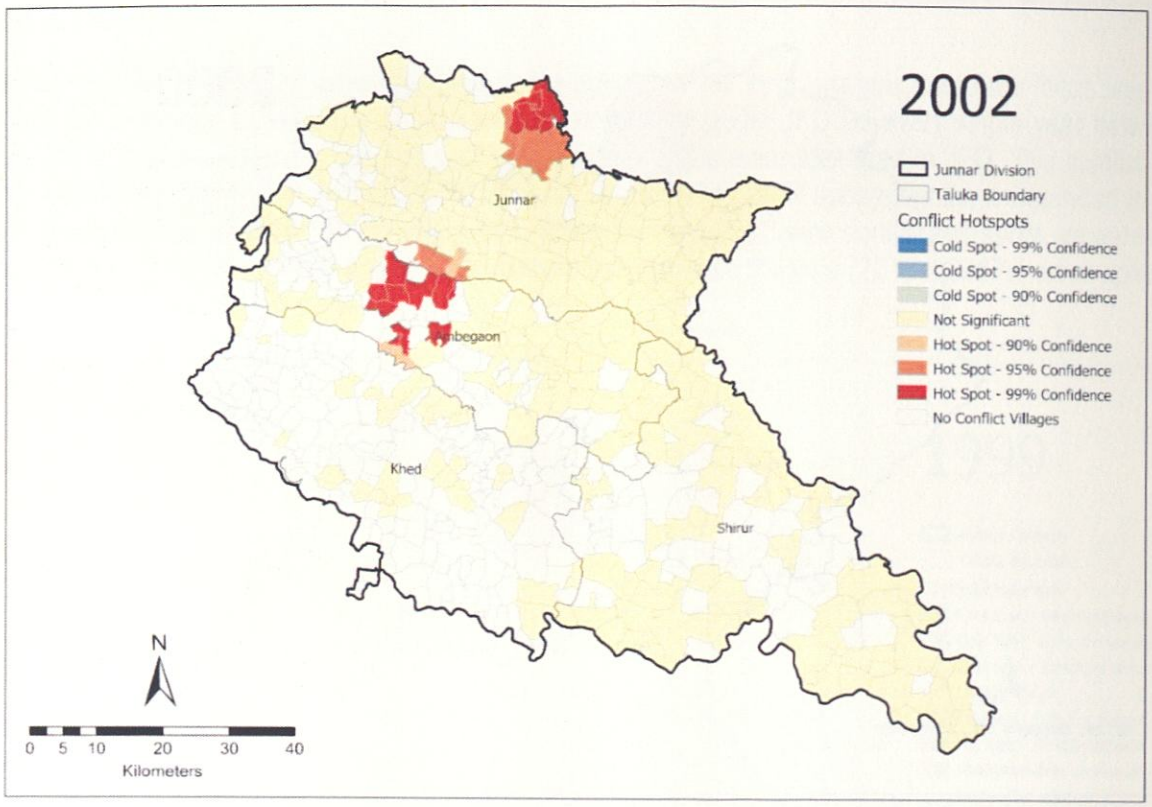


Figure 7: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2002

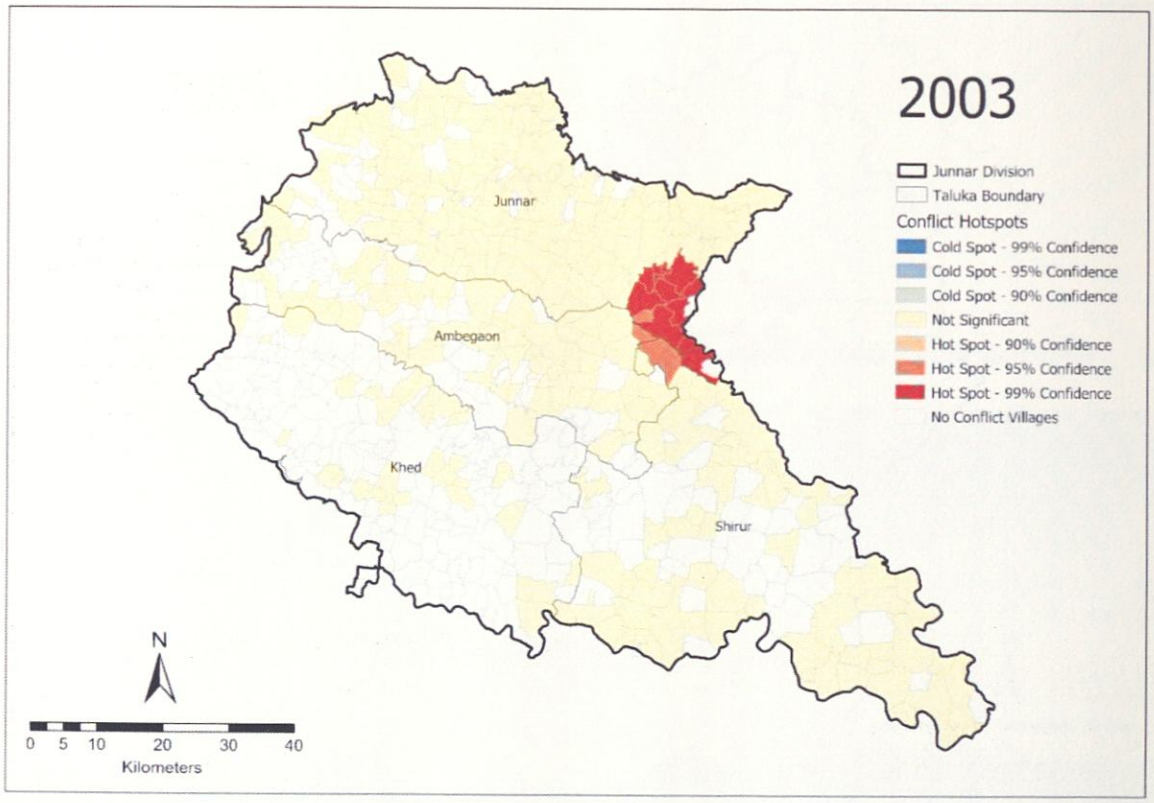


Figure 8: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2003

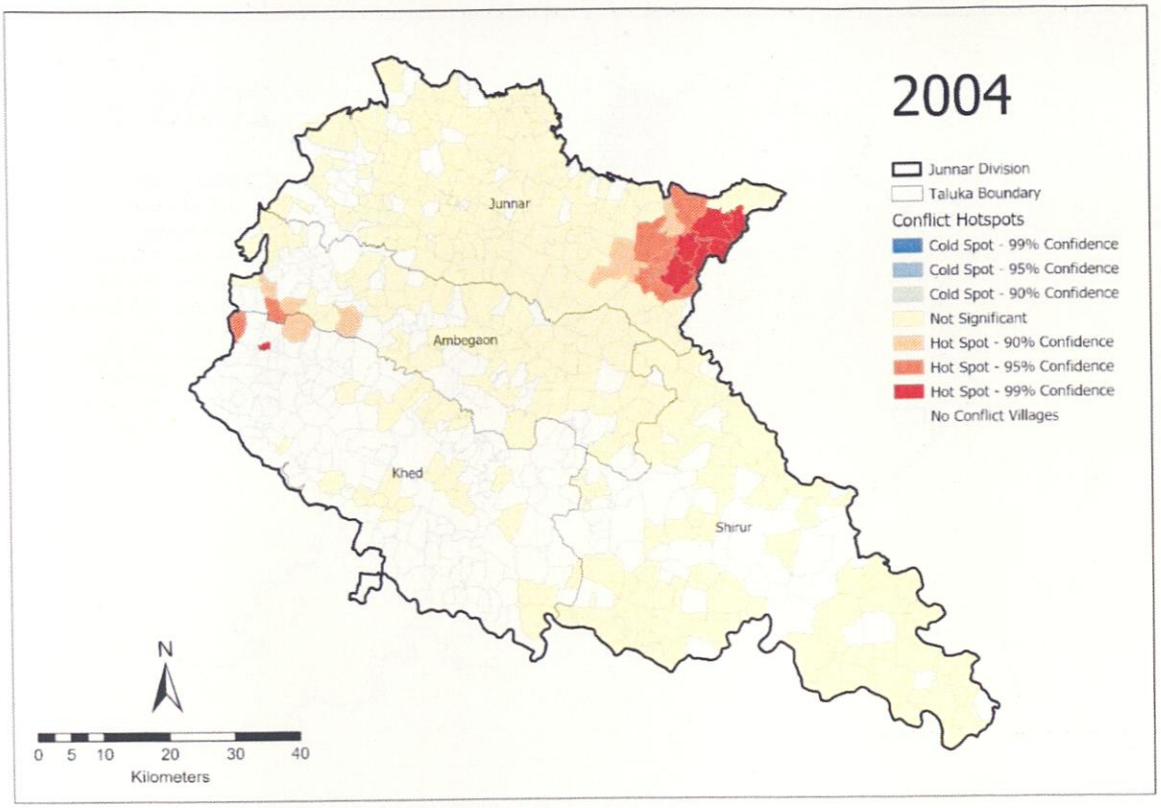


Figure 9: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2004

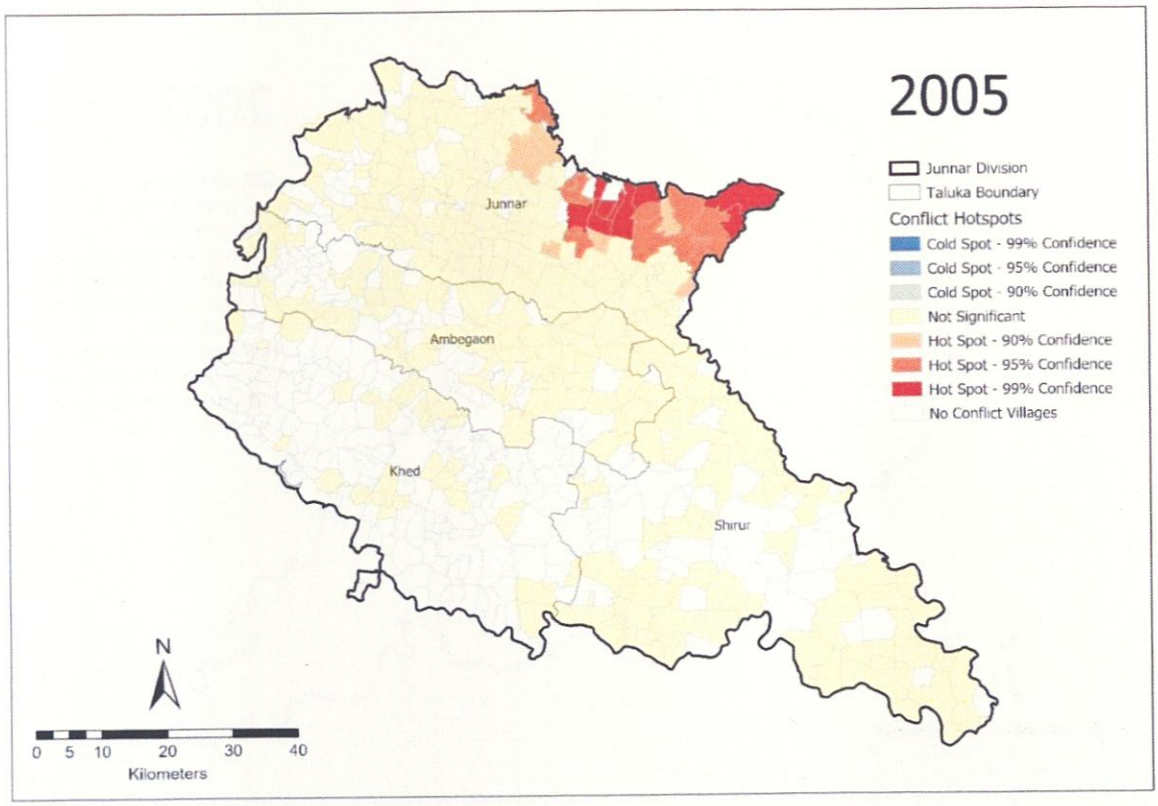


Figure 10: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2005

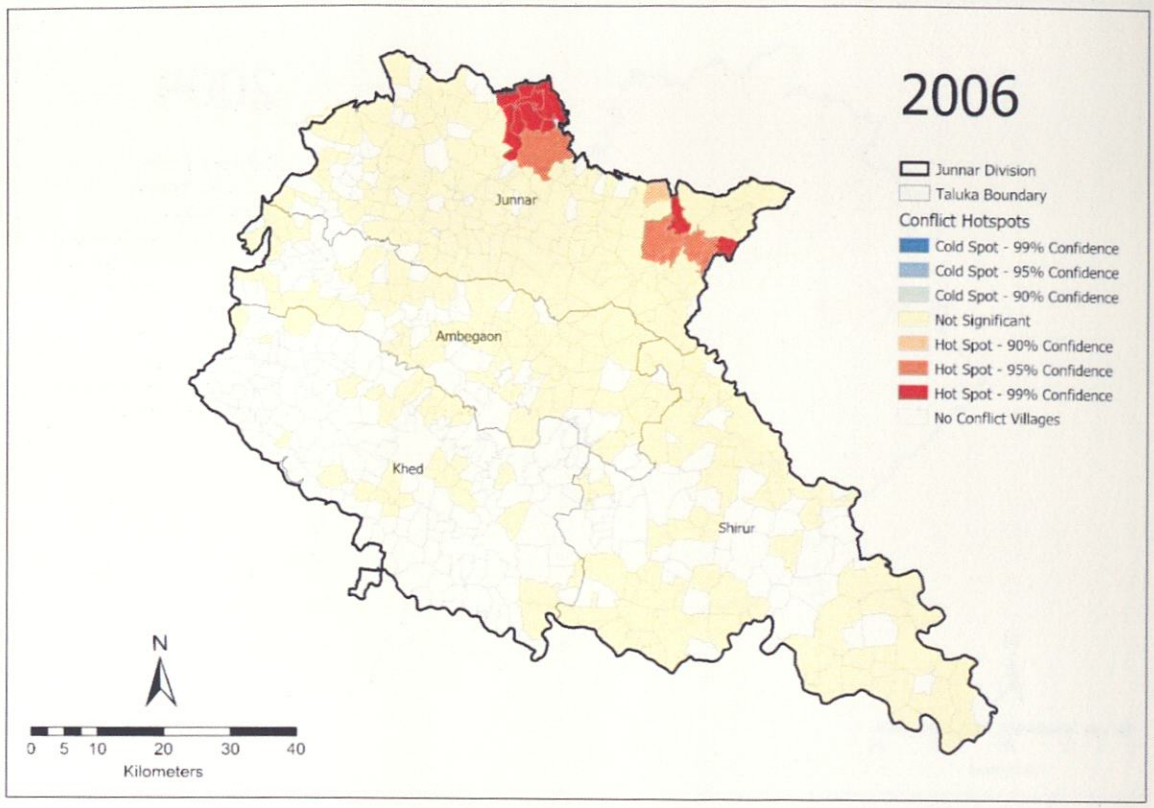


Figure 11: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2006

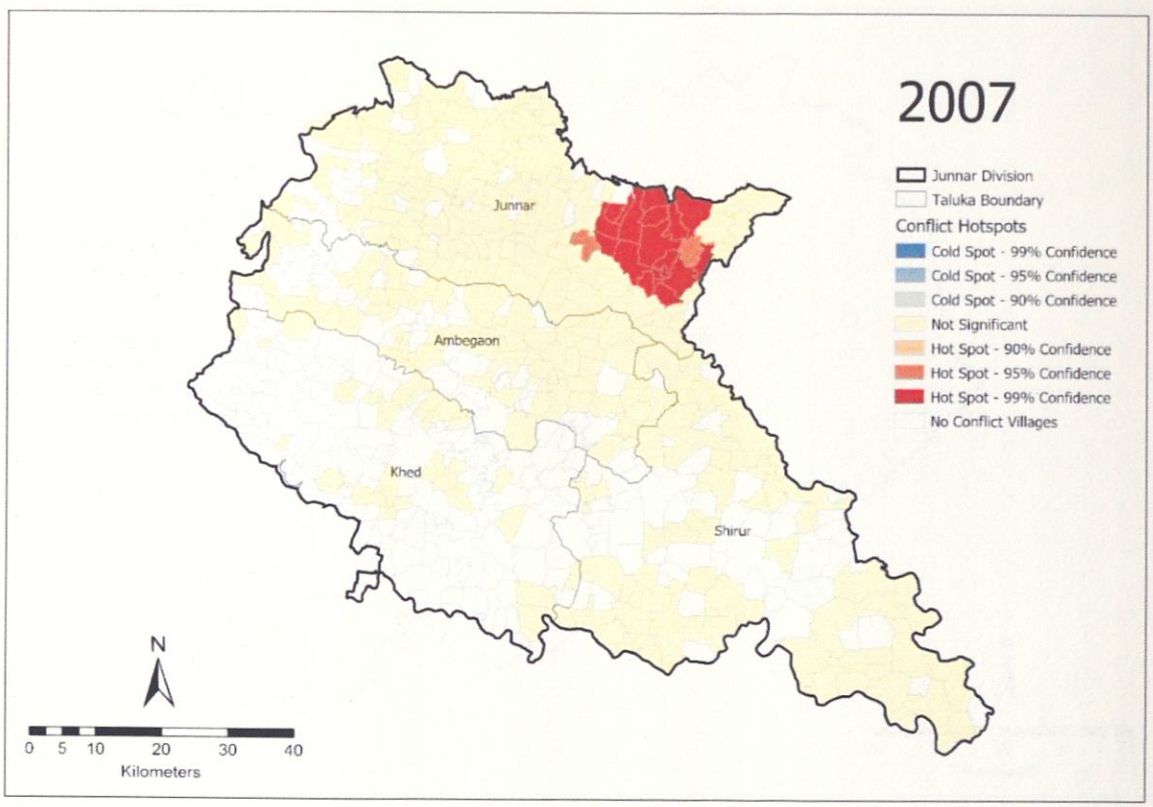


Figure 12: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2007

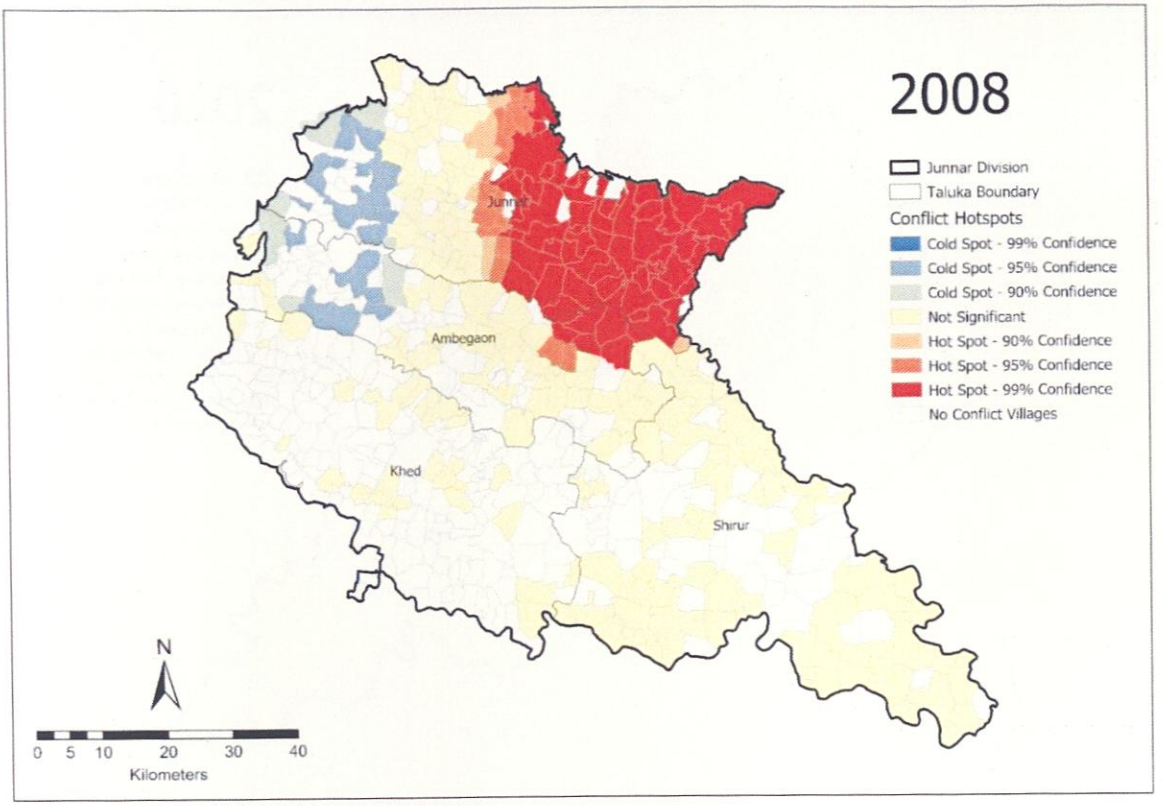


Figure 13: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2008

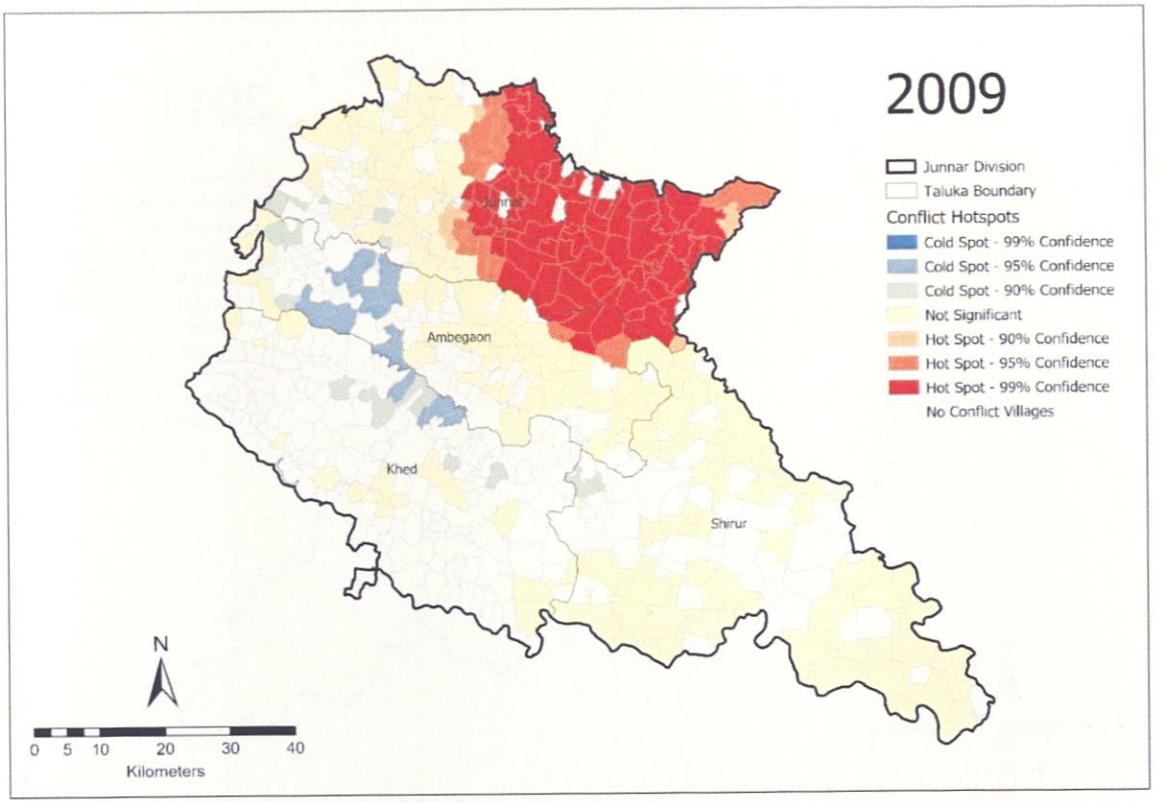


Figure 14: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2009

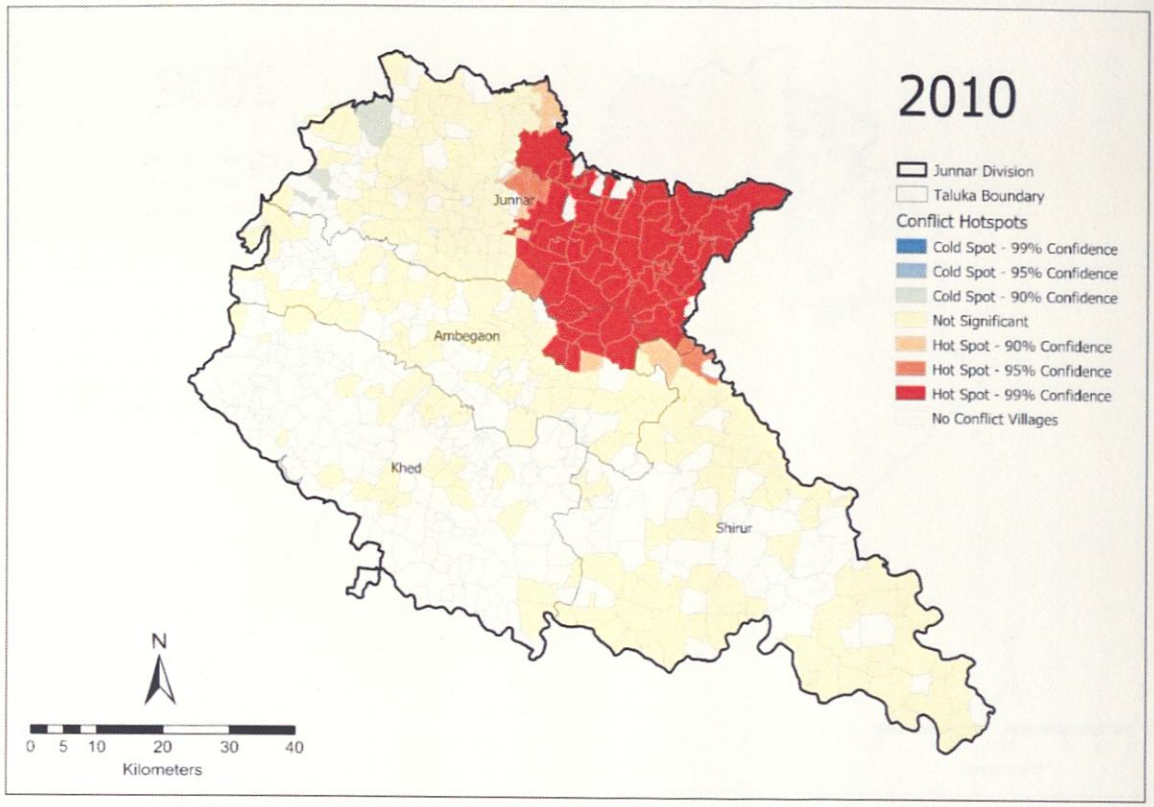


Figure 15: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2010

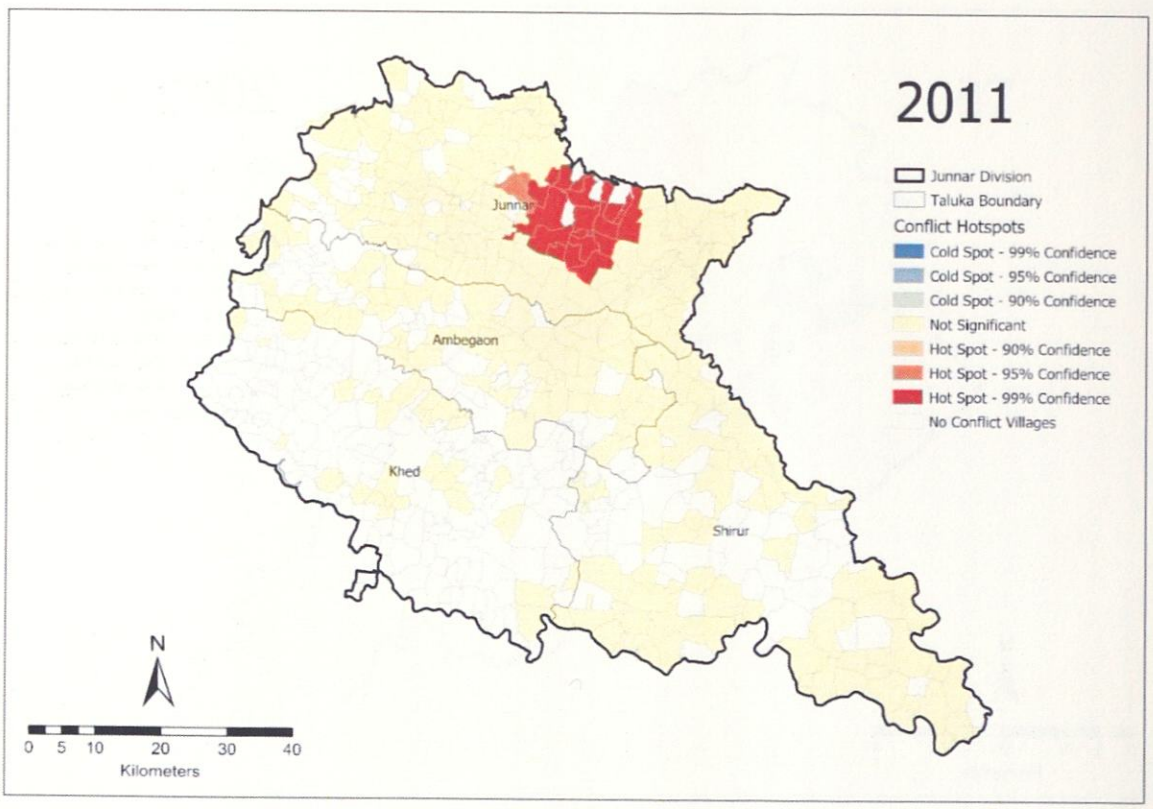


Figure 16: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2011

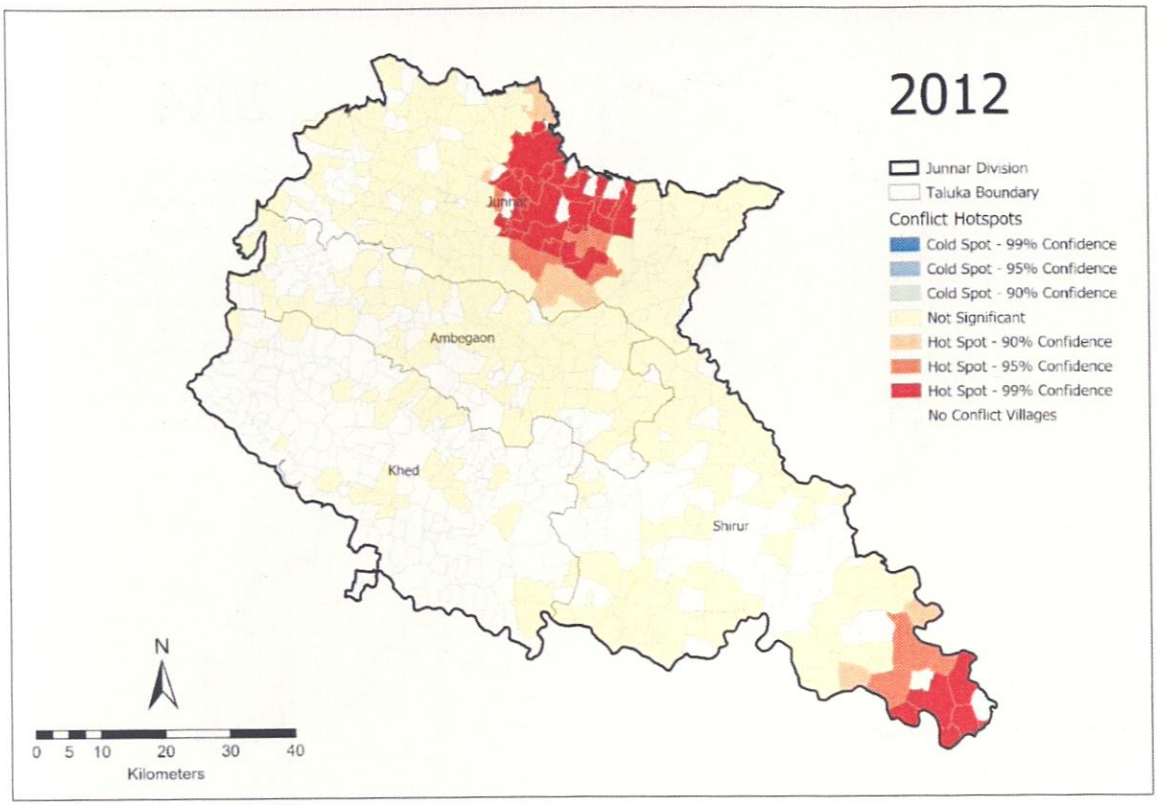


Figure 17: Hot spot map of Junnar Forest Division, Maharashtra, India for the year 2012

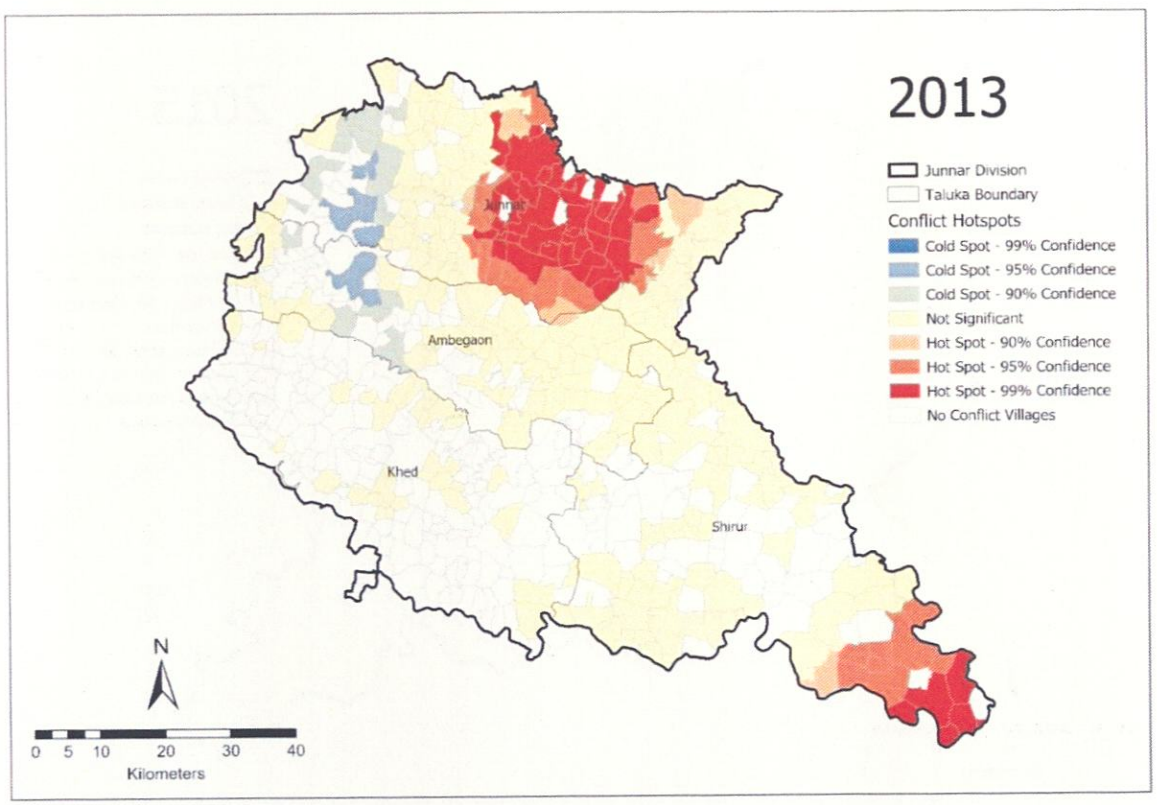


Figure 18: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2013

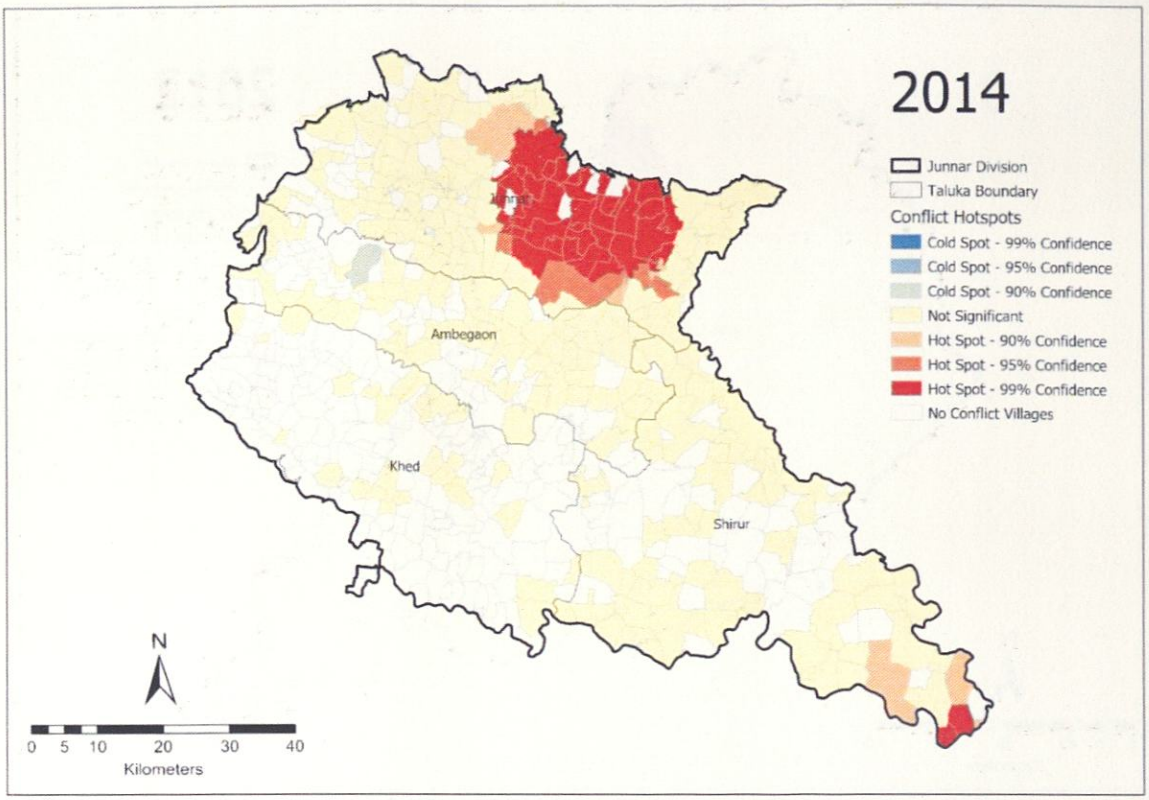


Figure 19: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2014

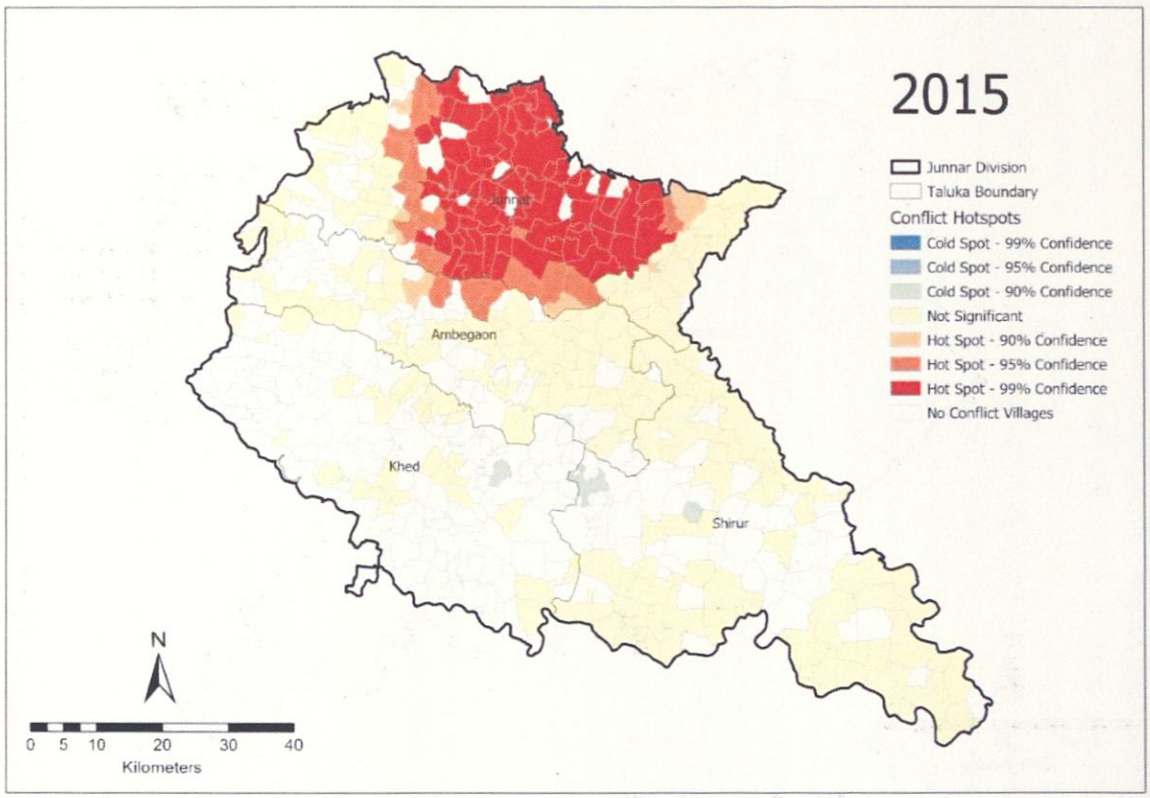


Figure 20: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2015

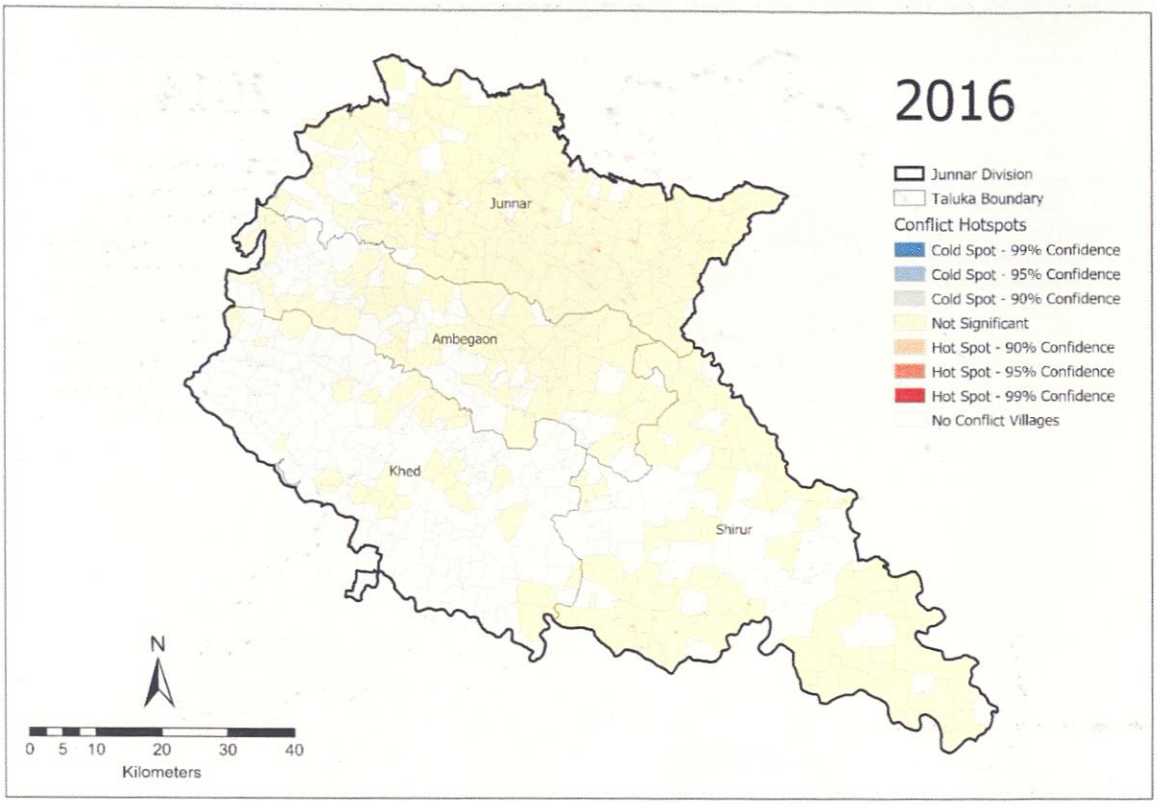


Figure 21: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2016

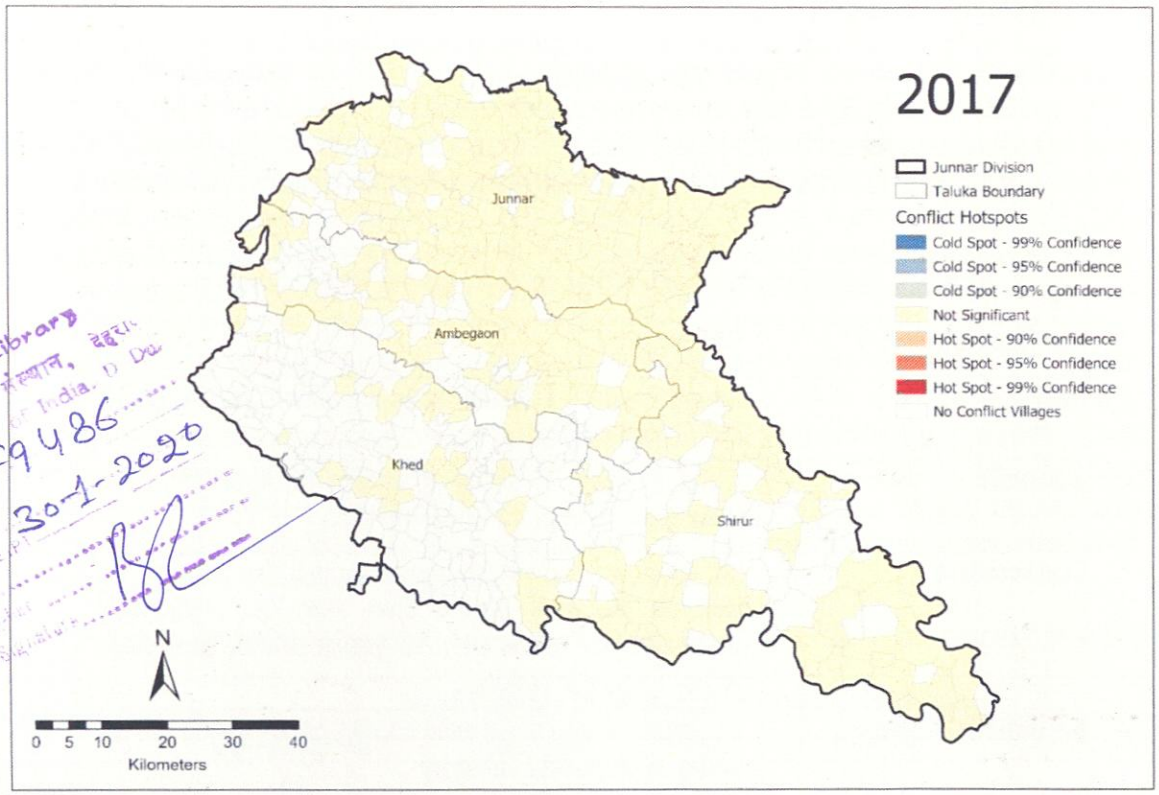


Figure 22: Hot spot and Cold Spot map of Junnar Forest Division, Maharashtra, India for the year 2017

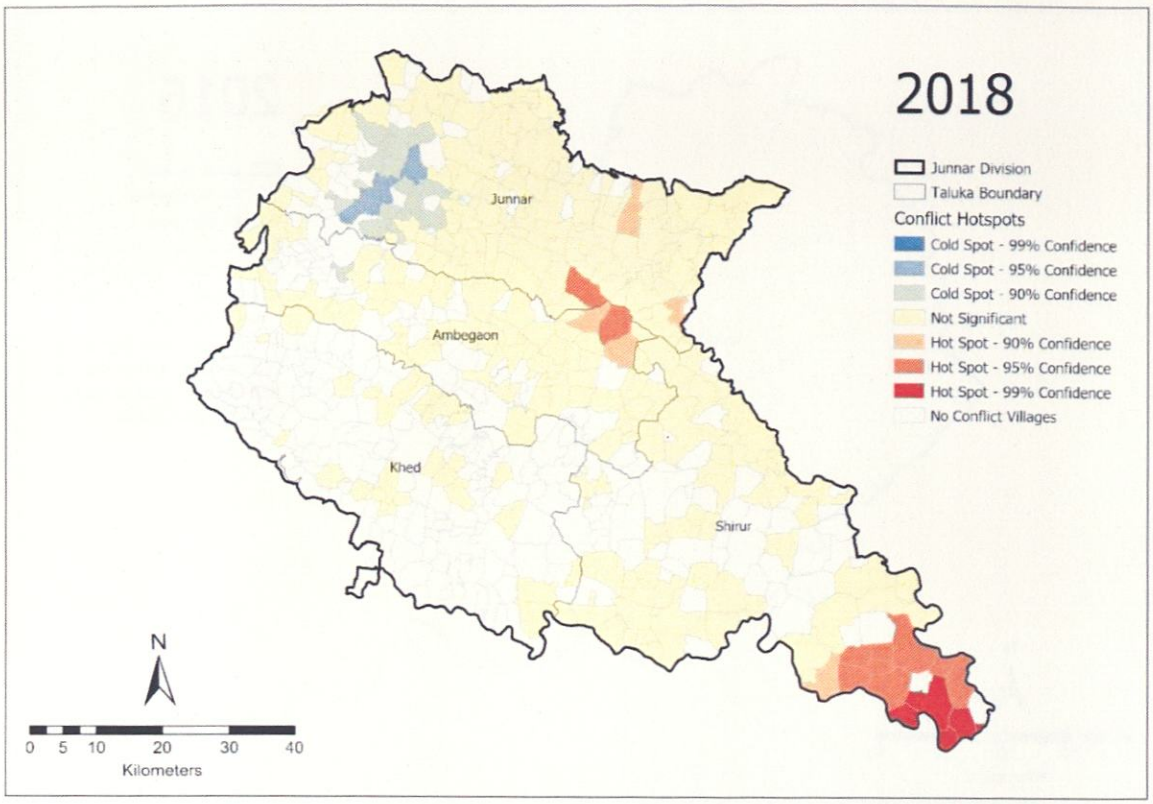


Figure 23: Hot spot and Cold spot map of Junnar Forest Division, Maharashtra, India for the year 2018

4.2. Emerging Hotspot analysis

The aggregation of 431 conflict villages was completed using ArcGIS for understanding the current scenario of conflict hot spots. By default, emerging hot spot analysis categorizes every bin into one of the seventeen hot spots (or cold spot) categories, each reflecting a characteristic disposition. To avoid the cluttering of insignificant categories, we have reported only five categories (Figure 5) relevant to this study (Table 1).

Table 1: Identified categories of hot spots in Junnar Forest Division

Hot Spot Category	Definition
New	Location which is statistically significant for the years 2017 and/or 2018
Sporadic	Location which is an on-again and off-again hot spot. Less than 18 years of this time step
Consecutive	Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption
No pattern detected	Locations where there exist conflict cases but do not fall under any specific category

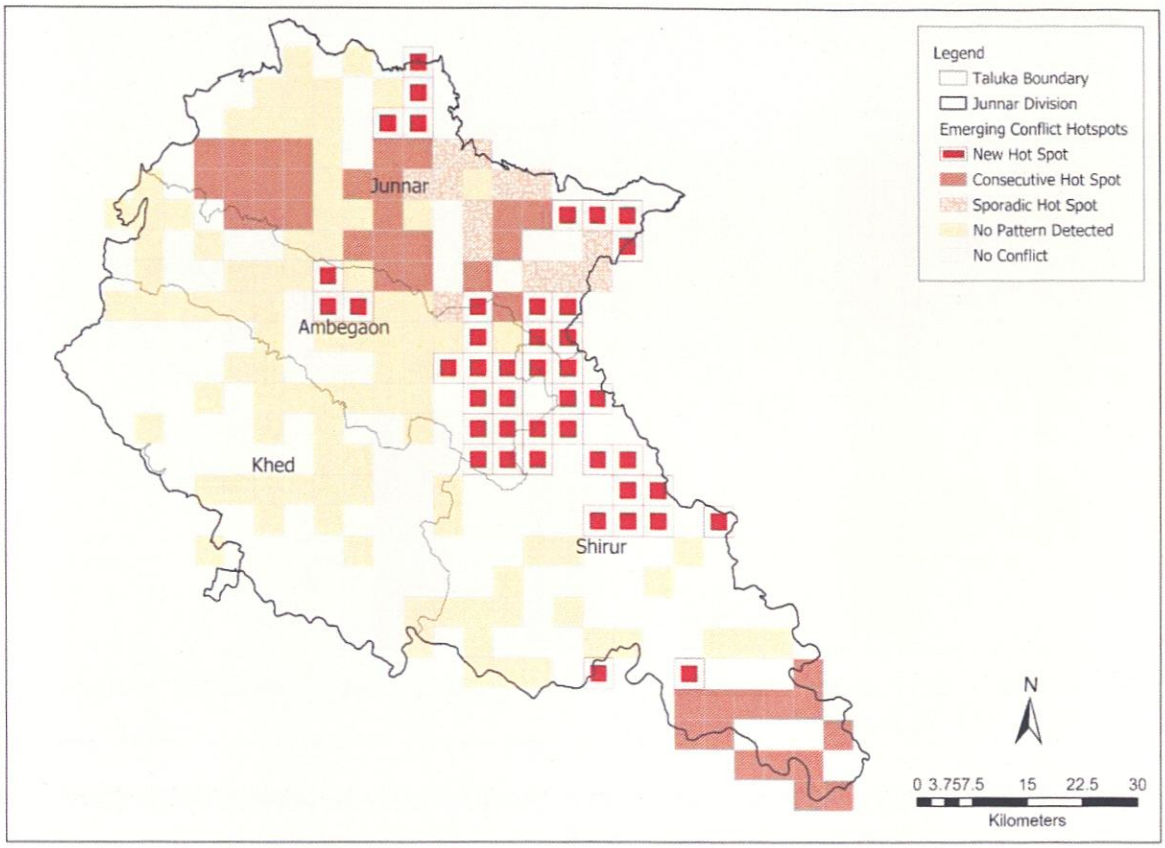


Figure 24: Map of Junnar Forest Division showing new, consecutive, sporadic hot spots based on data from 1999 to 2018

Each cluster shown is an area that is significantly different from the surrounding area. It is to be noted that in this tool, conflict village solely does not form a part of the analysis, but rather is an amalgamation of neighbouring conflict villages. Figure 24 shows five distinct clusters of conflict hotspot villages. The *taluka-wise* list of villages is given in Annexures 1 – 8. Junnar *taluka* has recorded conflict for a long time and now boasts a strong network of wildlife rescue volunteers representing different village clusters. Whereas Ambegaon *taluka* which comprises more hilly patches shows a recent rise in leopard rescue/livestock depredation. During our visits to range offices, preliminary interaction with the officials suggested that in recent times, there have been frequent rescue operations in Ambegaon and Shirur *taluka*. Creating awareness and conducting training sessions for forest officials with respect to leopard interactions has been a primary focus in these areas of new hot spots. Despite scattered conflict reports, there was no specific pattern observed in the remaining 231 villages across all four *talukas.* and 206 villages reported no conflict. This resulted in assigning a zero value against these village bins, which are represented under the 'no conflict' category.

Table 2: *Taluka-wise* percentages of villages in different categories of hot spots across 1999 -2018

Talukas	% of Villages in different hot-spot categories				
	Consecutive	Sporadic	New	No pattern	No Conflict
Junnar	41	12	14	28	5
Ambegaon	0	1	20	53	26
Shirur	14	0	21	29	36
Khed	0	0	0	35	65

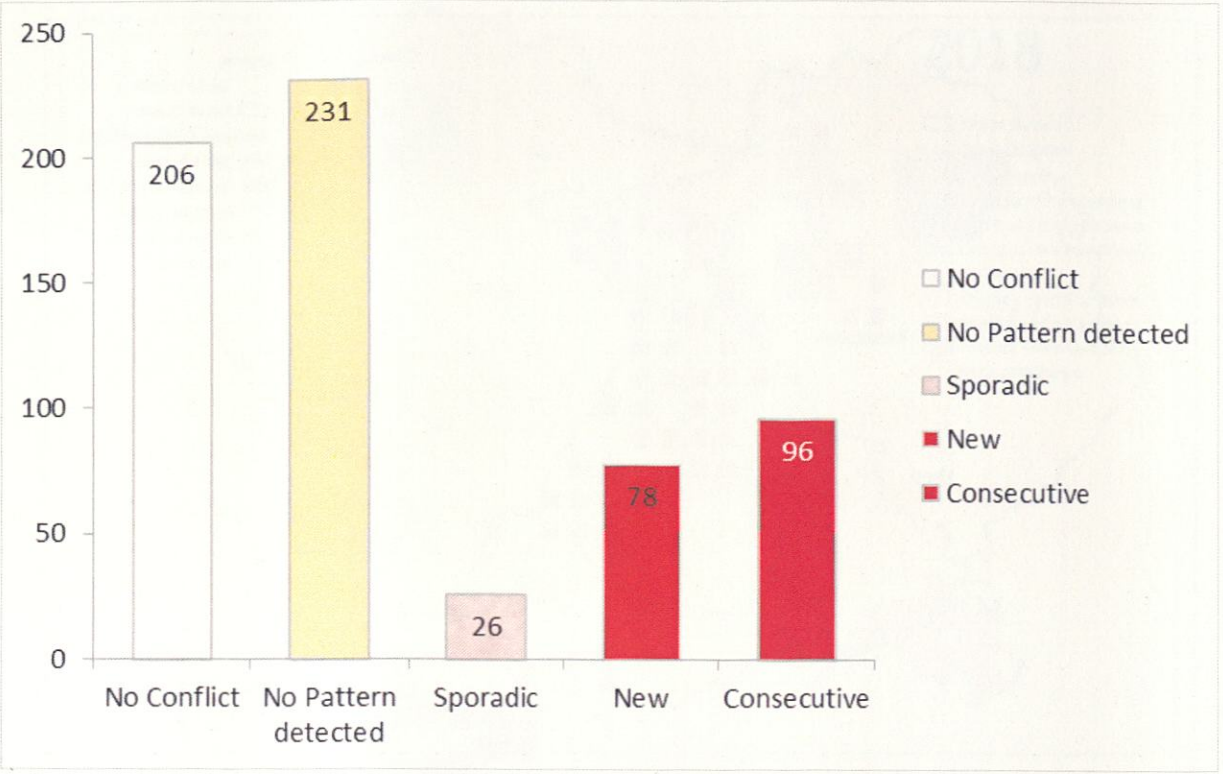


Figure 25: Number of villages in different categories of hot spots in Junnar Forest Division from 1999 to 2018

Human-wolf conflict in JFD

JFD has other large carnivores like wolf and hyena. During data sorting, it was identified that there is human-carnivores conflict in JFD other than Human-leopard conflict. The mapping of human-wolf conflict in JFD was done based on the records of the forest department from the year 1999-2018. It includes both livestock depredation and attacks on humans by the wolf. The number of incidences (n=99) is comparatively low in JFD and most of the incident occurred before the year 2010. Hence, it is not possible to identify the hot spots of the human-wolf conflict. Village centroid was used to map the human-wolf conflict in JFD.

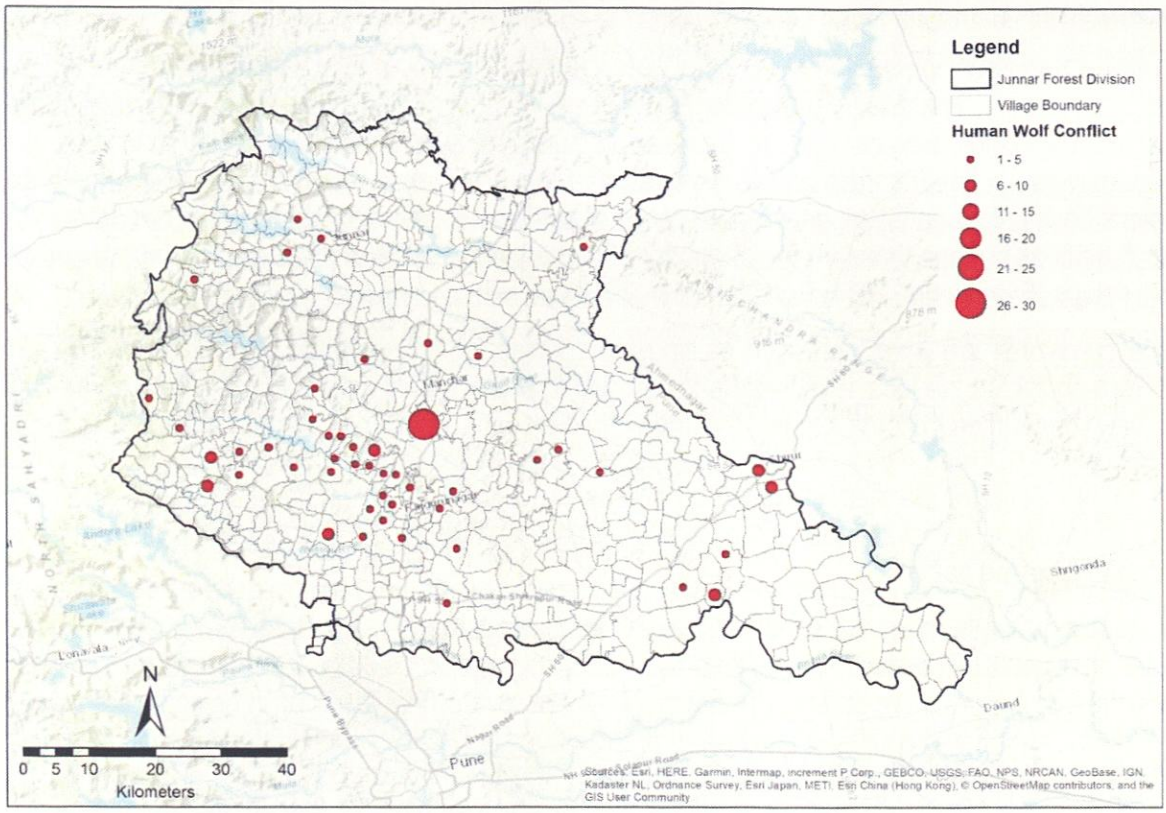


Figure 26: Spatial distribution of wolf conflict record for Junnar Forest Division from 1999 to 2018

Discussion

JFD has a history of human-leopard conflict with a parallel change in land use patterns (Athreya *et al.* 2004; 2007; 2011). The area is witnessing a change in cropping pattern due to the more availability of water from irrigation projects and an increase in human-population density which is leading to an exponential rise in linear infrastructure. As a result of this, the human aided subsidies and numbers of livestock have unfortunately triggered more cases of conflict. Large carnivores may not live permanently in such settings but can thrive on the periphery of human settlements and can be occasional guests to these setups (Evans *et al.* 2014; Bombieri *et al.* 2018).

Large carnivores are often portrayed as flagship species for conservation (Linnell *et al.* 2000), but carnivore-conflict at the local level results in damage to property and loss of human life (Treves 2009). The forest department records suggest that the human-leopard conflict has abruptly increased in the past five years in JFD. There are several factors attributed to the increase in human-carnivore conflict (Treves *et al.* 2014). Some of the factors include a decrease in distance to forest cover (Azevedo and Murray 2007), reduction in the availability of wild prey (Sidorovich *et al.* 2003), lack of human attendance and change in cropping pattern.

On agricultural lands, large carnivores are known to compete with humans for space and resources, resulting in conflict worldwide (Sangay & Vernes, 2002, Ogada *et al.* 2003). JFD has patchy forest cover concentrated in the western corner. Our hotspot analysis reveals that the conflict hotspots are mainly in the eastern, central and south-eastern corner of the study area which is dominated by agriculture fields. These areas are dominated by sugarcane crops along with intermittent crops like Jowar *Sorghum bicolar* and Bajra *Pennisetum glaucum*. Sugarcane and Jowar cropping in across the landscape have significantly increased in the last two decades.

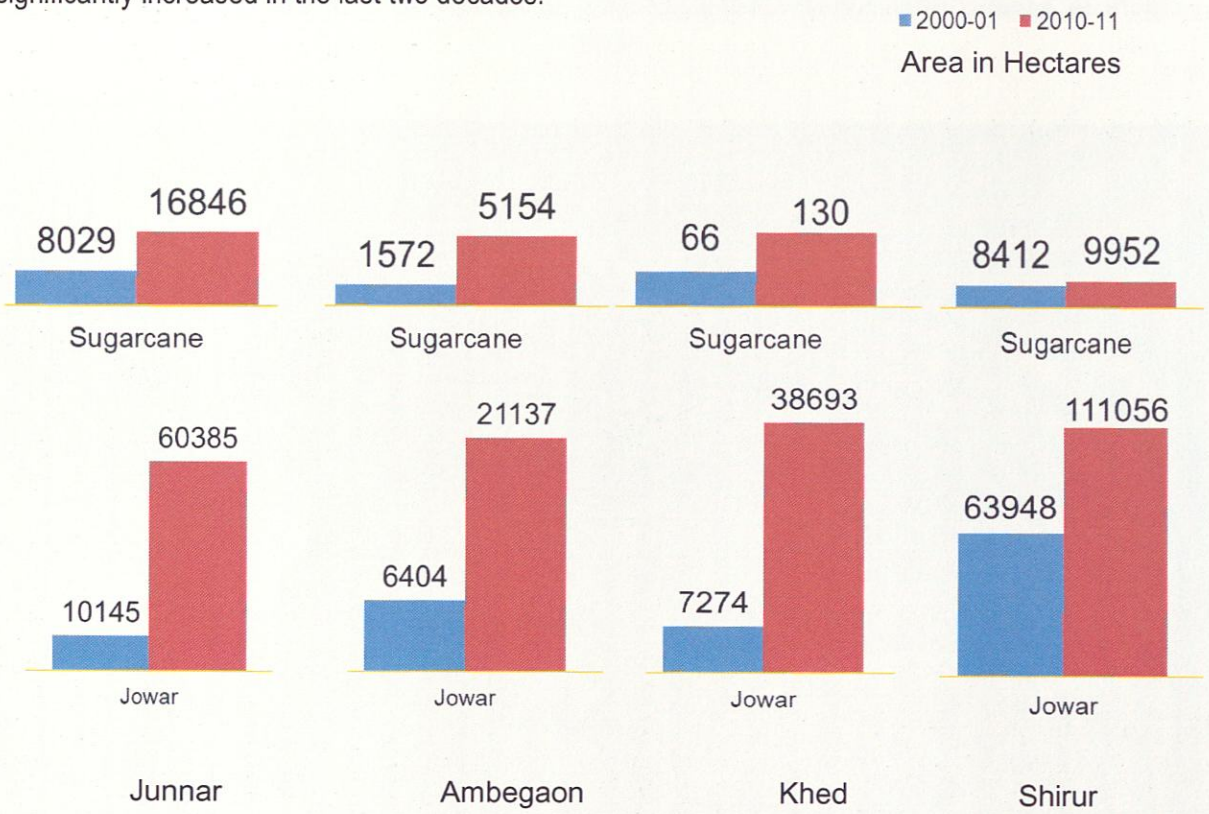


Figure 27: Change in area under different crop types in Junnar Forest Division across 2001-02 to 2010-11 (Source: Agriculture Census 2011)

Sugarcane is a cash crop that requires more amount of water. The area under sugarcane has increased in the past couple of decades due to more availability of water from the irrigation projects. We assume that here, the high density of sugarcane is helping leopard to take cover whereas, other tall crops are facilitating the movement of leopard in the study area.

There are several policies linked to the mitigation of human-leopard conflict in India like *ex-post-facto* compensation schemes, capture and translocation of problematic animals, and sometimes lethal measures under the jurisdiction of Wildlife protection Act 1972 (Fontúrbe and Simonetti 2011; Athreya *et al.* 2011). Maharashtra Forest Department has an excellent compensation scheme where compensation is given after a systematic reporting of conflict cases. People are getting financial support for economic loss, and somehow it is helping increase the tolerance level of people towards the human-leopard conflict in JFD. A study conducted by (Athreya *et al.* 2011) suggests that translocation is ultimately causing more conflict cases in JFD. After the translocation programme in the year 2001-03, the number of human deaths increased from an average of four to 17 per year. A Leopard Rescue center in Manikdoh was established in the year 2002 to reduce human-leopard conflict and distressed individuals who are injured or accidentally caught in an emergency. These efforts focus on curative or temporary solutions to mitigate conflict. There has been no study in the area which addresses the basic ecology of leopards, like its population estimates, tenure-ship, turn-over rate, spatio-temporal use and movement pattern, which will facilitate a scientific understanding of the species in JFD and thus provide better mitigation strategies.

This study highlighted the use of the model to identify different degrees of hot spots and the cold spots of human- leopard conflict which will facilitate better, area-specific management strategies to mitigate human-leopard conflict in JFD. Based on the different categories of identified hot spot it is suggested that intensive patrolling and awareness workshops should be conducted in villages categorised under new hotspots where there is a stronger chance of a rise in human-leopard conflicts in upcoming years. Replicating rescue volunteer groups to other villages and training them for preventive measures will help avoid conflict incidents. As a part of the awareness workshops, villagers should be encouraged to build predator-proof fences to protect their livestock.

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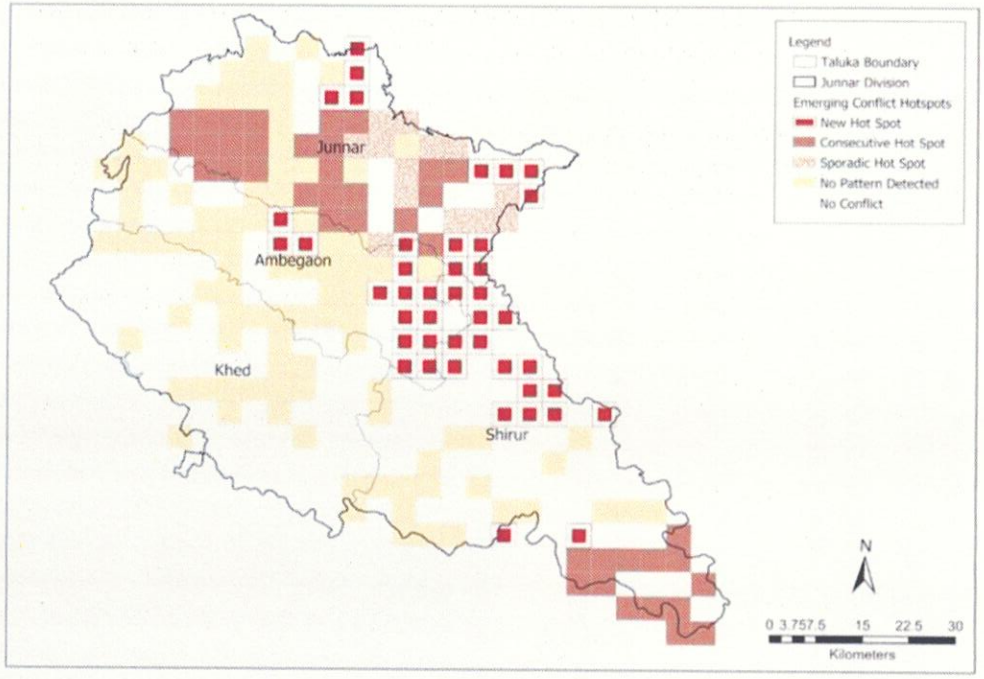
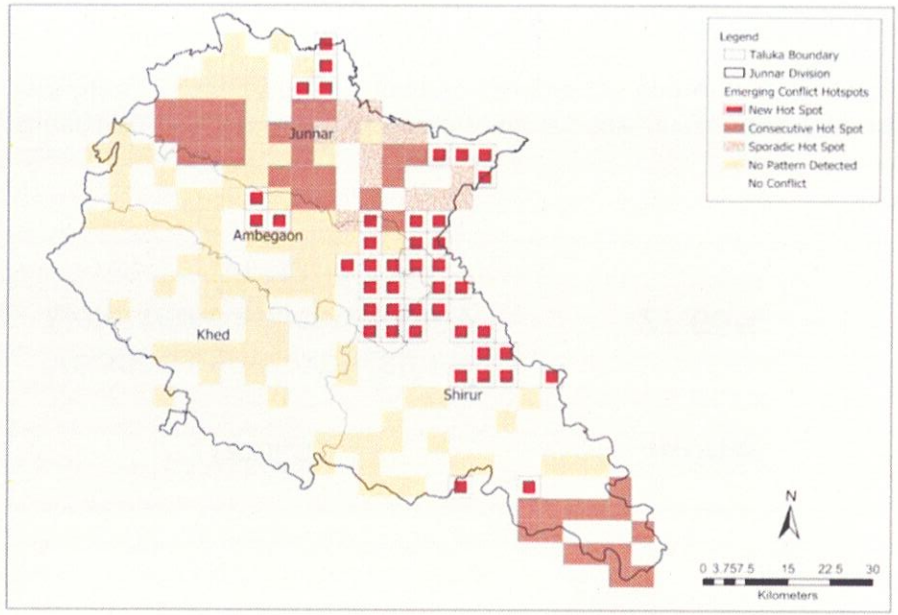


Taluka	**Junnar**
Villages under *Consecutive* conflict category (in %)	**41.48%**

Emerging Hot Spot **Consecutive** Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

Sr. No.	Village Name	Sr. No.	Village Name
1	Agar	40	Kusur
2	Ale	41	Malwadi (N.V.)
3	Alefata (N.V.)	42	Manikdoh
4	Ambe	43	Mankeshwar
5	Amboli	44	Narayangaon
6	Amrapur	45	Netwad
7	Aptale	46	Nirgude
8	Arvi	47	Otur
9	Aurangpur	48	Pangari Tarf Otur
10	Ballalwadi	49	Phagul Gavhan
11	Basti	50	Pimparwadi
12	Belsar	51	Pur
13	Bhatkalwadi (N.V.)	52	Rajur
14	Bhivade Bk.	53	Rajuri
15	Bhivade Kh.	54	Ralegan
16	Bhorwadi	55	Shinde
17	Bori Kh.	56	Shiroli Bk
18	Botarde	57	Shiroli Kh
19	Chalakwadi (N.V.)	58	Shiroli Tarf Kukadneher
20	Chawand	59	Shivali
21	Datkhilwadi	60	Somatwadi
22	Dhalewadi Tarf Haveli	61	Sonawale
23	Dhalewadi Tarf Minher	62	Surale
24	Ghangaldare	63	Tambe
25	Golegaon	64	Tejewadi
26	Gunjalwadi	65	Tejur
27	Hadsar	66	Tikekarwadi
28	Hapus Baug (N.V.)	67	Uchhil
29	Hivare Tarf Minher	68	Udapur
30	Ingaloon	69	Umbraj
31	Junnar (M Cl)	70	Undekhadak
32	Kale	71	Vadgaon Kandali
33	Keli	72	Vadgaon Sahani
34	Kewadi	73	Vighnahat (N.V.)
35	Khamgaon	74	Wadgaon Anand
36	Khamgaon	75	Wanewadi
37	Khilarwadi	76	Warulwadi
38	Kumshet	77	Yedgaon
39	Kuran	78	Yenere



Taluka	**Junnar**
Villages under *Sporadic* conflict category (in %)	**12.23%**
Villages under *New* conflict category (in %)	**13.82%**

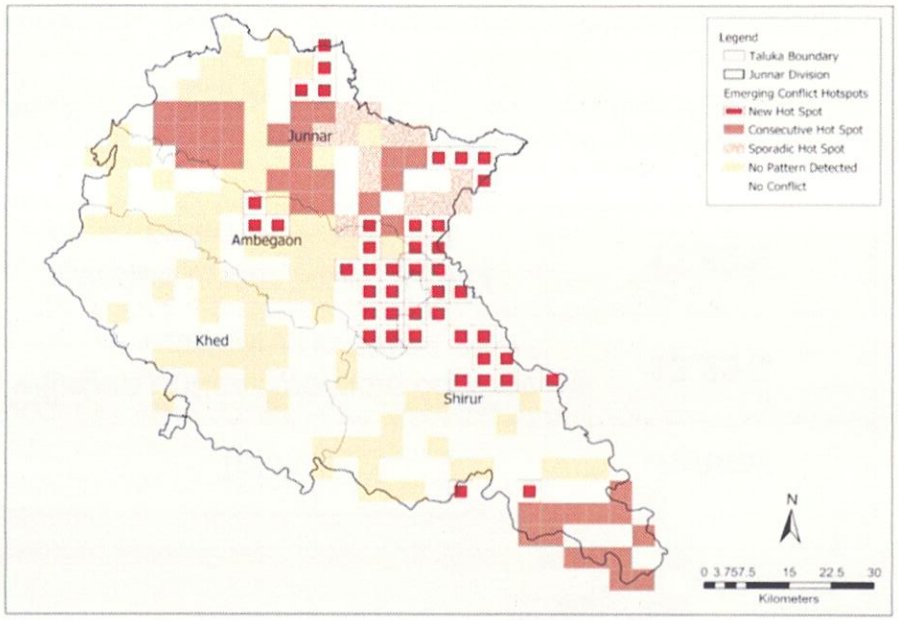
Emerging Hot Spot	**Sporadic**	Location which is an on-again and off-again hot spot. Less than 18 years of this time step
Emerging Hot Spot	**New**	Location which is statistically significant for the years 2017 and/or 2018

Sporadic Hot Spot Villages

Sr. No.	Village Name	Sr. No.	Village Name
1	Bangarwadi	13	Kandali
2	Belhe	14	Khamundi
3	Bhorwadi	15	Kombadwadi
4	Bori Bk.	16	Nagadwadi
5	Dholwad	17	Navalewadi (N.V.)
6	Dumbarwadi	18	Padirwadi (N.V.)
7	Gaymukhwadi (N.V.)	19	Pimpalwandi
8	Gulunchwadi	20	Santwadi
9	Gunjalwadi	21	Tambewadi
10	Hivare Bk	22	Vaishakh Khede
11	Hivare Kh	23	Yadavwadi
12	Jadhav Wadi		

New Hot Spot Villages

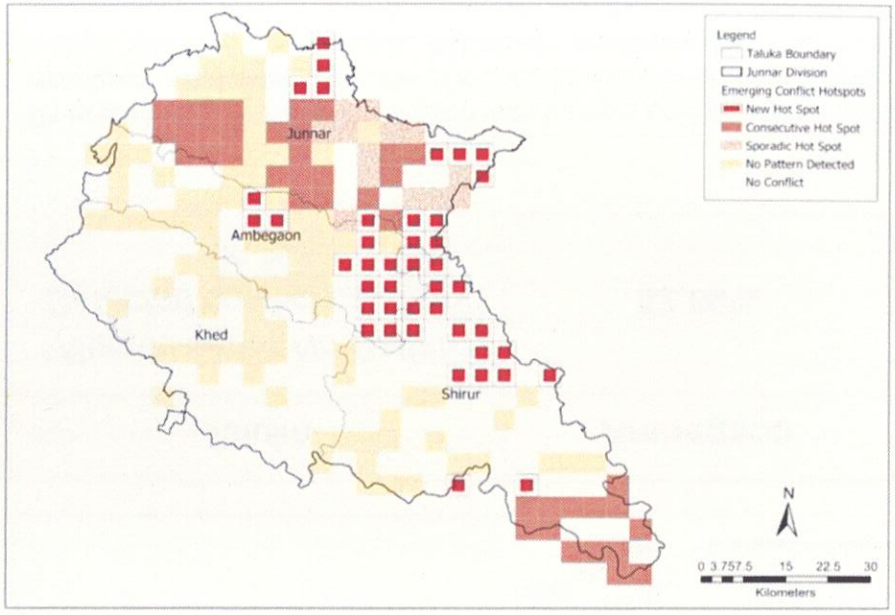
Sr. No.	Village Name	Sr. No.	Village Name
1	Ahinavewadi	14	Nimgaon Sawa
2	Ambe Gavhan	15	Pachgharwadi (N.V.)
3	Anandwadi	16	Pargaon Tarf Ale
4	Ane	17	Pemdara
5	Chilhewadi	18	Pimpri Kawala
6	Dingore	19	Ranmalawadi
7	Khodad	20	Rohkadi
8	Kolwadi	21	Sakori T Belhe
9	Mandarne	22	Shindewadi
10	Mangrul	23	Shiroli T Ale
11	Manjarwadi	24	Sultanpur
12	Nalawane	25	Unchkhadakwadi
13	Nimdari	26	Zap (N.V.)



Taluka	**Junnar**
Villages under *No Pattern Detected* conflict category (in %)	**27.65%**

Emerging Hot Spot	**No Pattern Detected**	Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

Sr. No.	Village Name	Sr. No.	Village Name
1	Agar	27	Khanapur
2	Ajanawale	28	Khatkale
3	Alame	29	Khireshwar
4	Aldare	30	Kolhewadi
5	Alu	31	Kopare
6	Bagadwadi (N.V.)	32	Madh
7	Baglohare	33	Mandave
8	Barav	34	Muthalne
9	Bhoirwadi (N.V.)	35	Nimgaon Tarf Mahalunge
10	Buchakewadi	36	Nimgiri
11	Chincholi	37	Ozar
12	Devale	38	Padali
13	Dhamankhel	39	Pangari Tarf Madh
14	Dhangarwadi	40	Pargaon Tarf Madh
15	Godre	41	Parunde
16	Hatban	42	Pimpalgaon Joga
17	Hatvij	43	Pimpalgaon Siddhanath
18	Hirdi	44	Pimpalgaon T Narayangaon
19	Hivare Tarf Narayangaon	45	Pimpri Pendhar
20	Jalwandi	46	Sanganore
21	Jambhulpad (N.V.)	47	Sawargaon
22	Jambhulshi	48	Sitewadi
23	Karanjale	49	Taleran
24	Katede	50	Usran
25	Khadkumbe	51	Vadaj
26	Khaire	52	Watkhale



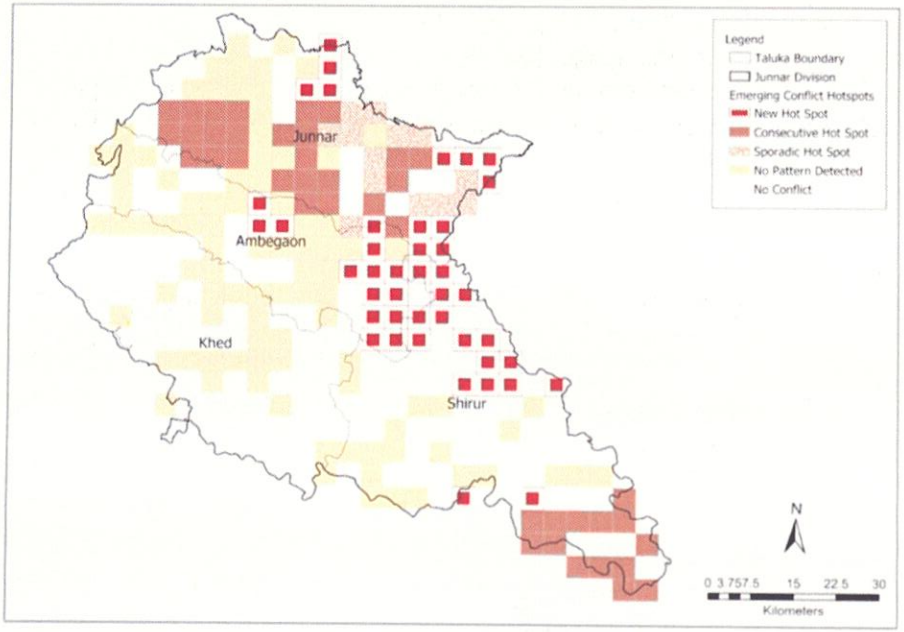
Taluka	**Ambegaon**
Villages under *Sporadic* conflict category (in %)	**1.44%**
Villages under *New* conflict category (in %)	**19.56%**

Emerging Hot Spot **Sporadic** — Location which is an on-again and off-again hot spot. Less than 18 years of this time step

Sr. No.	Village Name
1	Jadhavwadi (Ranjani) (N.V.)
2	Ranjani

Emerging Hot Spot **New** — Location which is statistically significant for the years 2017 and/or 2018

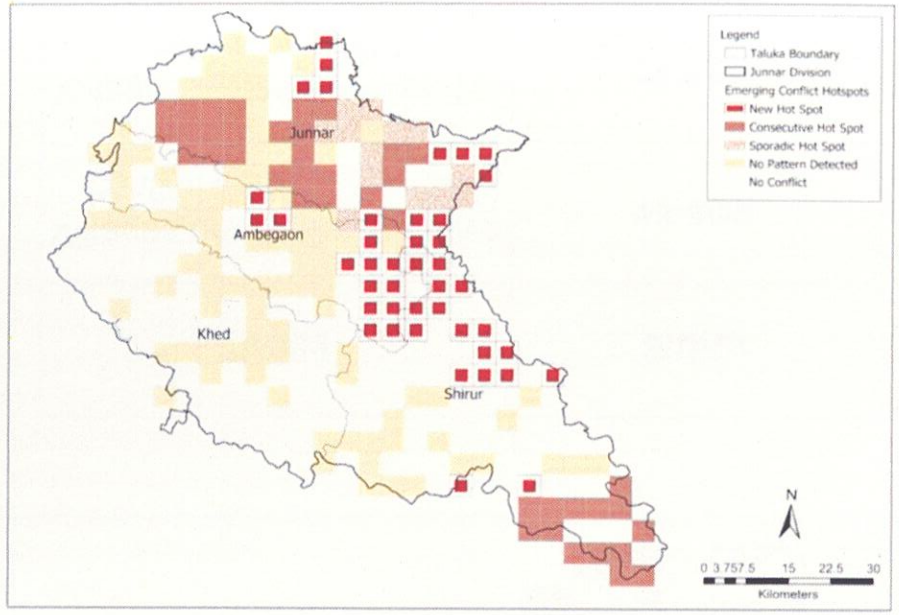
Sr. No.	Village Name	Sr. No.	Village Name
1	Bharadi	15	Malawadi
2	Chas	16	Mengadewadi
3	Chincholi	17	Mondalewadi
4	Dhamani	18	Nagapur
5	Girawali	19	Nirgoodsar
6	Jarkarwadi	20	Pargaon Tarf Awasari Bk.
7	Jawale	21	Pondewadi
8	Kadewadi	22	Ramwadi (N.V.)
9	Kathapur Bk.	23	Ranmala
10	Khadaki	24	Shingave
11	Khadakwadi	25	Thakar Wadi
12	Lakhangaon	26	Thakarwadi
13	Loni	27	Valati
14	Mahalunge Padawal		



Taluka	**Ambegaon**
Villages under *No Pattern Detected* conflict category (in %)	**52.89%**

Emerging Hot Spot	**No Pattern Detected**	Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

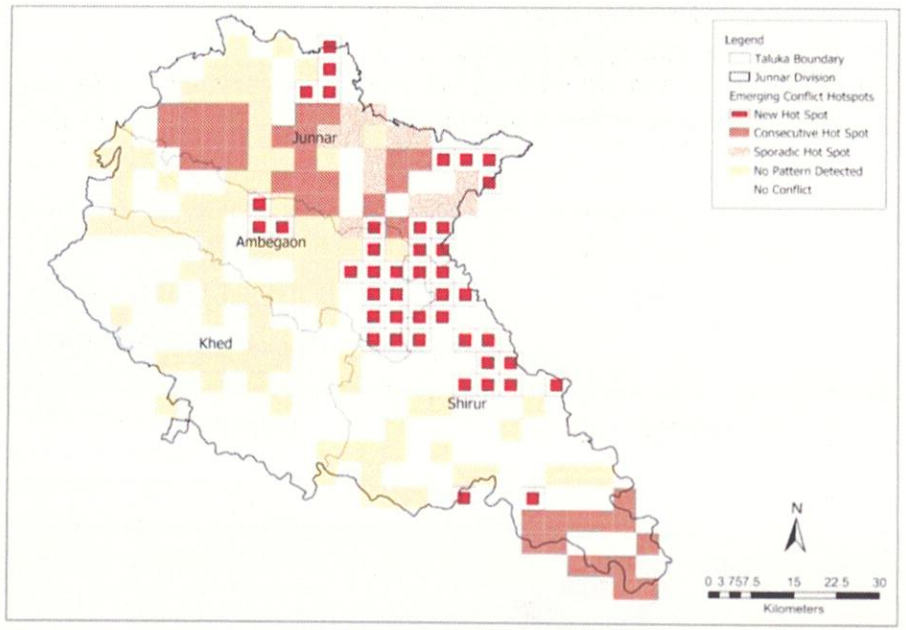
Sr. No.	Village Name	Sr. No.	Village Name
1	Amade	38	Malin
2	Ambedara	39	Manchar (CT)
3	Ambegaon	40	Nanavade
4	Amondi	41	Nandur
5	Asane	42	Narodi
6	Awasari Bk.	43	Nhaved
7	Awasari Kh	44	Nighutwadi
8	Bhagadi	45	Panchale Bk.
9	Bhorwadi	46	Panchale Kh.
10	Borghar	47	Pargaon Tarf Khed
11	Chandoli Bk.	48	Phalode
12	Chandoli Kh.	49	Phulvade
13	Chikhali	50	Pimpalgaon Tarf Mahalunge
14	Chinchodi	51	Pimpari
15	Dhakale	52	Pinglewadi Landewadi
16	Dimbhe Kh.	53	Pokhari
17	Don	54	Pokharkarwadi (N.V.)
18	Eklahare	55	Sakore
19	Falakewadi (N.V.)	56	Sal
20	Gangapur Bk.	57	Savarli
21	Gangapur Kh.	58	Shindemala
22	Gavdewadi	59	Shinoli
23	Ghodegaon	60	Sultanpur
24	Gohe Bk.	61	Supedhar
25	Gohe Kh.	62	Takewadi
26	Kalamb	63	Tale Ghar
27	Kalambai	64	Talekar Wadi
28	Kanase	65	Tamblemala
29	Karegaon	66	Tavharewadi
30	Khadakamala	67	Thorandale
31	Kolharwadi	68	Thugaon
32	Kolwadi Kotamdara	69	Tirpad
33	Kondhare	70	Vachalmala
34	Kushire Bk.	71	Vachape
35	Lauki	72	Vadgaon Kashimbeg
36	Mahalunge Tarf Ambegaon	73	Vitthalwadi
37	Mahalunge Tarf Ghoda		



Taluka	**Khed**
Villages under *No Pattern Detected* conflict category (in %)	**34.71%**

Emerging Hot Spot	**No Pattern Detected**	Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

Sr. No.	Village Name	Sr. No.	Village Name
1	Adgaon	35	Mandoshi
2	Anavale	36	Manjarewadi
3	Arudewadi	37	Markal
4	Askhed Bk.	38	Mirjewadi
5	Bahirwadi	39	Mohakal
6	Bahul	40	Naiphad
7	Bhivegaon	41	Nimgaon
8	Bibi	42	Pacharnewadi
9	Bursewadi	43	Papalwadi
10	Chakan (CT)	44	Pur
11	Chandoli	45	Rakshewadi
12	Darakwadi	46	Raundhalwadi
13	Devoshi	47	Sabalewadi
14	Dhamane	48	Sakurdi
15	Dhorewadi	49	Sandbhorwadi
16	Donde	50	Satkarsthal
17	Gundalwadi	51	Sayagaon
18	Holewadi	52	Shelu
19	Jaidwadi	53	Shinde
20	Jaulke Kh.	54	Shirgaon
21	Kadadhe	55	Shiroli
22	Kahu	56	Siddhegavhan
23	Kalechiwadi	57	Takalkarwadi
24	Kaman	58	Tekavadi
25	Kanhewadi Bk.	59	Tokavade
26	Karkudi	60	Vadgaon Tarf Khed
27	Khalchi Bhamburwadi	61	Varchi Bhamburwadi
28	Kiwale	62	Vetale
29	Kohinkarwadi	63	Wada
30	Koregaon Bk.	64	Waghu
31	Koregaon Kh.	65	Wajavane
32	Koyali Tarf Chakan	66	Waki Bk
33	Koyali Tarf Wada	67	Waki Tarf Wada
34	Kurkundi		



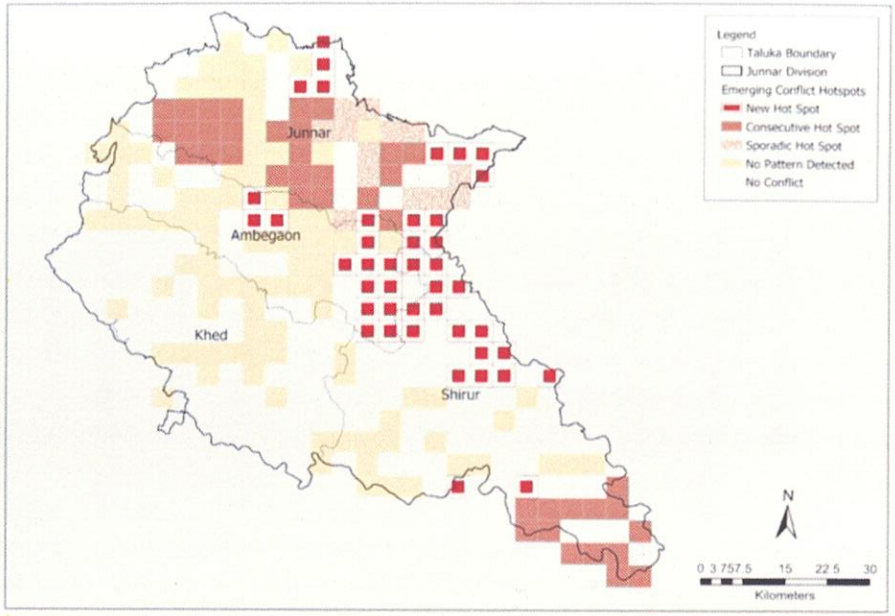
Taluka	**Shirur**
Villages under *Consecutive* conflict category (in %)	**14.40%**
Villages under *New* conflict category (in %)	**21.18%**

Emerging Consecutive Hot Spot Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

Sr. No.	Village Name	Sr. No.	Village Name
1	Alegaon Paga	10	Nagargaon
2	Andhalgaon	11	Pimpalsuti
3	Bambhulsar Bk.	12	Rakshewadi
4	Chinchani	13	Ranjangaon Sandas
5	Ganegaon Dumala	14	Sadalgaon
6	Inamgaon	15	Shirasgaon Kata
7	Kolgaon Dolas	16	Tandali
8	Kuruli	17	Vadgaon Rasai
9	Mandavgan Farata		

Emerging New Hot Spot Location which is statistically significant for the years 2017 and/or 2018

Sr. No.	Village Name	Sr. No.	Village Name
1	Amdabad	14	Nhavara
2	Annapur	15	Nimgaon Bhogi
3	Chandoh	16	Nimgaon Dude
4	Dongargan	17	Pimparkhed
5	Echakewadi	18	Ravadewadi
6	Fakate	19	Saradwadi
7	Jambut	20	Savindane
8	Kardilwadi	21	Shirur
9	Kathapur Kh.	22	Shirur (M Cl)
10	Kawathe	23	Takali Bhima
11	Lakhewadi	24	Takali Haji
12	Malthan	25	Vadner Kh.
13	Mhase Bk.		



Taluka	**Shirur**
Villages under *No Pattern Detected* conflict category (in %)	**28.81%**

Emerging Hot Spot	**No Pattern Detected**	Location with a single uninterrupted run of analysis towards the end of the time step i.e. statistically significant for more than 18 years of this time step, without an interruption

Sr. No.	Village Name	Sr. No.	Village Name
1	Apti	18	Pabal
2	Babhulsar Kh.	19	Parodi
3	Darekarwadi	20	Pimpale Jagtap
4	Dhanore	21	Pimpale Khalsa
5	Dingrajwadi	22	Saradwadi
6	Futanwadi Akharimal	23	Shikrapur
7	Gunat	24	Shindodi
8	Hivare	25	Shingadwadi
9	Jategaon Bk.	26	Shivtakrar Mahalungi
10	Jategaon Kh.	27	Talegaon Dhamdhere
11	Kanhur mesai	28	Thitewadi
12	Karandi	29	Varude
13	Kondhapuri	30	Vitthalwadi
14	Koregaon Bhima	31	Wadhu Bk.
15	Malwadi Agarkarwadi	32	Waghale
16	Nimgaon Mhalungi	33	Wajewadi
17	Nimone	34	Zodagewadi