MONITORING PADDY RESIDUE BURNING IN NORTH INDIA USING SATELLITE REMOTE SENSING DURING 2018

End-of-Season Summary Report for 2018 (Final)

MONITORING PADDY RESIDUE BURNING IN NORTH INDIA USING SATELLITE REMOTE SENSING DURING 2018

- Paddy residue burning is practiced in the states of Punjab, Haryana and Uttar Pradesh (UP) after crop harvest. During 2018, a Central scheme was implemented in these states by providing subsidy to farmers' to provide suitable machinery and other interventions, coordinated through State Agriculture Departments. On behalf of ICAR, spatio-temporal monitoring of the active fires due to paddy residue burning was carried out in real- time for all the three states from 1- Oct to 30-Nov 2018 on daily basis and their comparison was made with events during 2017 and 2016. Thermal image from seven satellites acquired at the ICAR -IARI satellite ground station were used for the detection of fires for both day and night passes. Daily bulletin of fire events were prepared and fire locations were put on ICAR KRISHI Geoportal (http://geoportal.icar.gov.in:8080/geoexplorer/composer/) for visualization as maps. The intensity of fires detected by satellites were used for modelling the emissions of pollutants i.e. green-house gases (CO2, CO, NOx, CH4) and particulate matter (PM2.5, PM 10) at tehsil, district and state levels.

- Besides, in order to map the paddy area planted and the areas which practiced open burning of residue, multiple high resolution satellite images at 20m were acquired for pre-burning and post-burning in 20 districts of Punjab and 10 districts Haryana during 2018 which dominantly grow rice. The total planted area and burnt area statistics were used to estimate paddy straw burnt at tehsil, district and state level.

- Overall for the three states, burning events detected were 127774, 88948, and 75563 in the years 2016, 2017 and 2018, respectively. About 15% and 41% reduction in number of burning events were observed in current year (2018) as compared to that in 2017 and 2016, respectively. Of the 75563 burning events detected in the three States between 01-Oct-2018 and 30-Nov-2018, these were distributed as 59695 (79%), 9232 (12%) and 6636 (9%) in Punjab, Haryana and UP, respectively. The majority of burning happened between 27-Oct and 09-Nov in the three states. There was significant correlation (above 0.9) between number of burning events detected by thermal remote sensing and burnt area estimated by high resolution remote sensing.

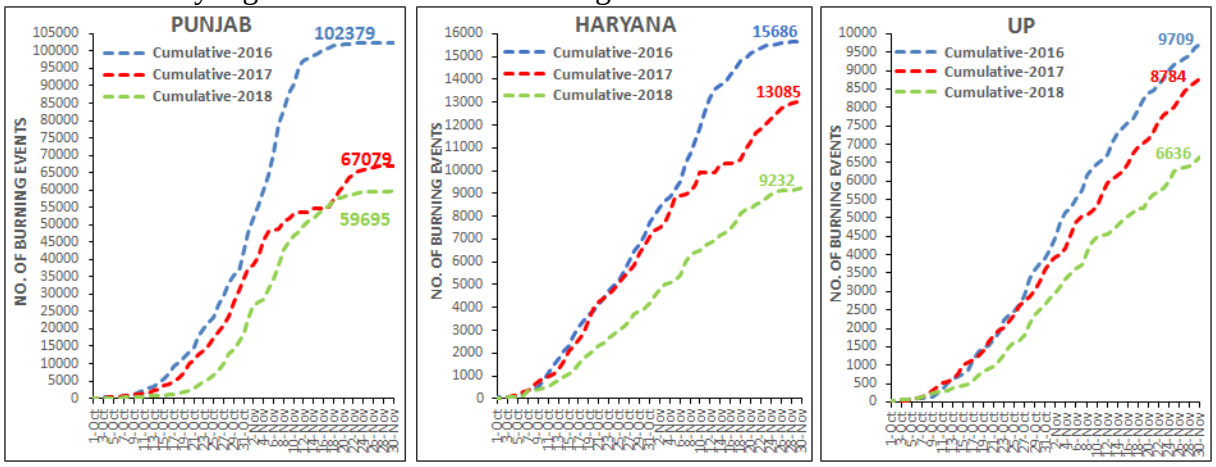

Fig 1 Comparison of paddy residue burning events of 2018 with 2017 and 2016 in the three states of Punjab, Haryana and UP over 1-Oct to 30-Nov period.

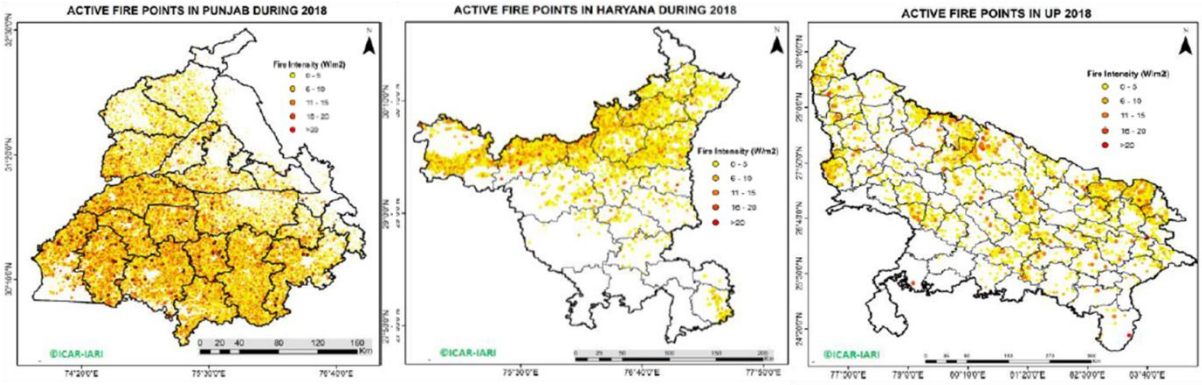

Fig 2 Maps showing paddy residue burning event detected by satellites during 1-Oct to 30-Nov-2018 in the three states of Punjab, Haryana and UP. Each dot represents burning event and color represents the fire intensity (Yellow is low and Red is high).

- Overall for the three states, about 23 Million tons of GHGs (Green House Gases) and Particulate matter (PM) was estimated to be emitted from paddy residue burning in the three states in 2018. Of the 23 Million tons of GHG and PM emission in 2018, Punjab contributed 83%, Haryana contributed 11% and UP contributed 7%. Of the total emissions, CO_2 contributed 93.7% of the pollutants. The total pollutants emitted by burning paddy residue during 2017 were about 28 Million tons which signifies an 18.3% reduction in pollution in 2018 over 2017.

('000 ton)	2017				2018			
GHG/PM	PUNJAB	HARYANA	UP	TOTAL	PUNJAB	HARYANA	UP	TOTAL
CH4	36.89	7.12	3.04	**47.05**	31.99	4.33	2.13	**38.45**
NOX	0.96	0.18	0.08	**1.22**	0.83	0.11	0.06	**1.00**
CO2	20699.47	3997.89	1704.05	**26401.41**	17950.65	2428.24	1194.67	**21573.56**
CO	1257.00	242.78	103.48	**1603.25**	1090.07	147.46	72.55	**1310.08**
PM 2.5	53.29	10.29	4.39	**67.96**	46.21	6.25	3.08	**55.54**
PM 10	27.46	5.30	2.26	**35.03**	23.82	3.22	1.59	**28.62**
TOTAL	**22075.06**	**4263.57**	**1817.29**	**28155.92**	**19143.57**	**2589.61**	**1274.06**	**23007.24**

Table 1 Comparison of pollutants emitted in 2017 and 2018 from paddy residue burning

(1) PUNJAB

- The burning events detected in Punjab were 102379, 67079, and 59695 in the years 2016, 2017 and 2018, respectively. About 11.01% and 41.69% reduction in number of burning events were observed in current year (2018) as compared to that in 2017 and 2016, respectively. No change in the intensity of burning was detected in Punjab in 2018 over that in 2017.
- For the 20 major paddy growing districts of Punjab, remote sensing estimated 2.96 Mha area planted, out of which 1.51 Mha area was burnt in 2018 i.e about 51% of the paddy planted area reported burning in 2018. Remote sensing estimated 25.48 Mt of paddy straw produced on dry weight basis in these 20 districts, out of which 11.81 Mt was burnt in 2018. About 46.4% of paddy straw was burnt in 2018.

- Firozpur, Sangrur and Muktsar districts reported highest paddy area burnt and highest burning events in 2018. Bhatinda, Firozpur, Muktsar, Mansa, Fazilka and Faridkot districts reported burning in more than 70% of their paddy area in 2018.
- About 19.41 Mt of pollutants were emitted by burning in 2018 while 22.1 Mt pollutants were emitted in 2017, representing a 13.3% reduction in 2018 over 2017.

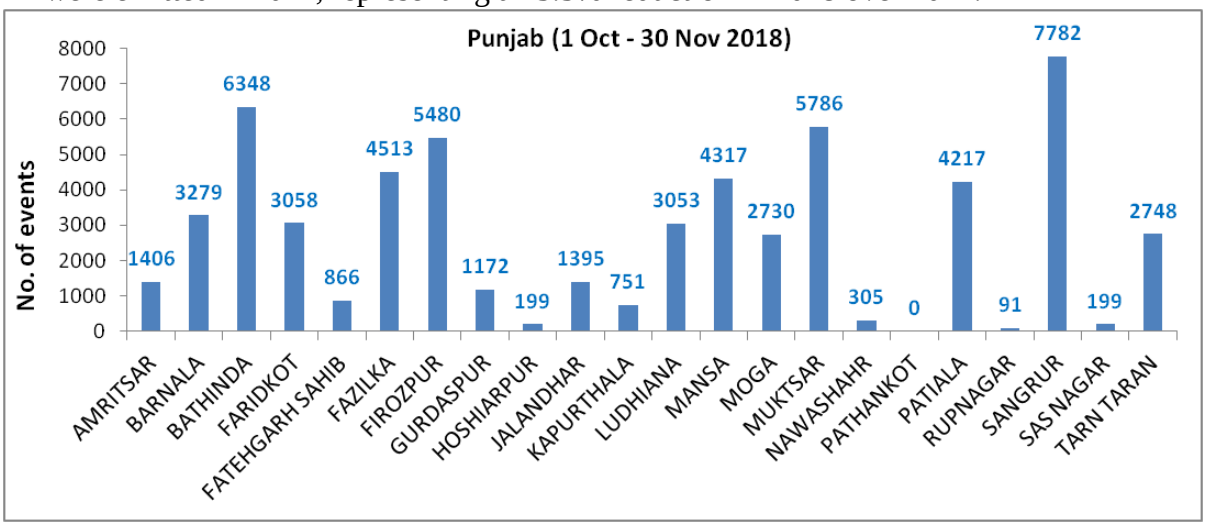

Fig 3 Districtwise distribution of paddy residue burning events detected by thermal satellite remote sensing during 2018 in Punjab

District	Paddy area by RS ('000 ha)	Paddy Area Burnt by RS ('000 ha)	Percent Burnt Area by RS (%)	Straw production on dry wt basis ('000 tons)	Straw Burned on dry wt basis ('000 tons)	Straw Burned (%)
AMRITSAR	186.76	33.72	18.06	1228.99	199.30	16.22
BARNALA	118.42	66.99	56.58	1125.88	572.04	50.81
BATHINDA	154.91	121.18	78.22	1449.35	1018.08	70.24
FARIDKOT	116.25	84.42	72.63	976.27	636.75	65.22
FATEHGARH SAHIB	81.88	36.18	44.19	795.92	315.84	39.68
FAZILKA	103.96	78.56	75.57	755.85	512.93	67.86
FIROZPUR	189.11	147.48	77.99	1651.04	1156.23	70.03
GURDASPUR	181.17	35.90	19.81	1190.18	211.77	17.79
JALANDHAR	166.27	75.73	45.55	1411.07	577.16	40.90
KAPURTHALA	118.02	62.09	52.61	997.06	471.05	47.24
LUDHIANA	255.71	101.52	39.70	2541.12	905.94	35.65
MANSA	111.40	84.49	75.85	986.67	672.05	68.11
MOGA	152.01	82.35	54.17	1438.34	699.73	48.65
MUKTSAR	186.58	142.17	76.19	1556.01	1064.67	68.42
NAWASHAHR	65.76	12.22	18.59	588.19	98.17	16.69
PATIALA	231.49	92.67	40.03	2026.47	728.50	35.95
RUPNAGAR	34.56	6.19	17.92	322.85	51.94	16.09
SANGRUR	290.37	143.14	49.30	2921.20	1293.15	44.27
SAS NAGAR	32.56	2.13	6.54	242.80	14.27	5.88
TARN TARAN	187.58	100.38	53.51	1278.05	614.15	48.05
HOSHIARPUR						
PATHANKOT						
TOTAL	**2964.69**	**1509.51**	**50.92**	**25483.26**	**11813.72**	**46.36**

Table 2 Districtwise statistics for Punjab showing paddy area planted, area burnt, straw produced and straw burnt in 2018.

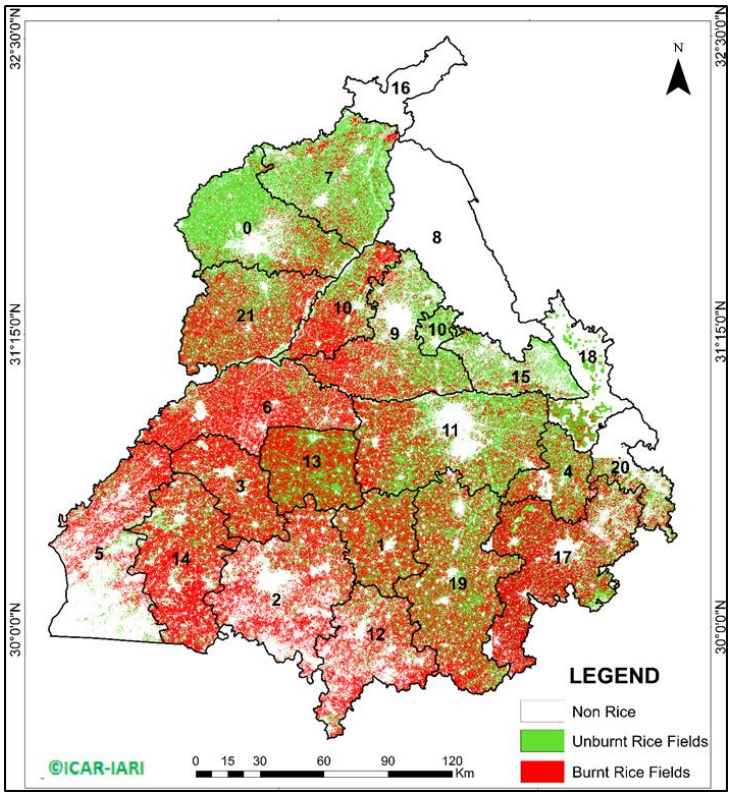

Fig 4 Maps showing paddy area planted, paddy area unburnt (green color) and paddy area burnt (red color) in Punjab in 2018.

(2) HARYANA

- The burning events detected in Haryana were 15686, 13085, and 9232 in the years 2016, 2017 and 2018, respectively. About 29.45% and 41.15% reduction in number of burning events were observed in current year (2018) as compared to that in 2017 and 2016, respectively. About 5.5% of fire event's intensity in current year changed from very high to low as compared to 2017, signifying shift towards partial burning of residue implying lower emission of particulate matter.
- For 10 major paddy growing districts of Haryana, remote sensing estimated 1.04 Mha area planted, out of which 0.23 Mha area was burnt in 2018 i.e. about 22.12% of the paddy planted area reported burning in 2018. For the 10 major paddy growing districts, remote sensing estimated 7.55 Mt of paddy straw produced on dry weight basis, out of which 1.60 Mt was burnt in 2018 i.e. About 21.2% of paddy straw was burnt in 2018.
- Fatehabad and Sirsa districts reported highest paddy area burnt in 2018 and their paddy area burnt was 70.6% and 61.6%, respectively.
- About 2.59 Mt of pollutants were emitted by paddy residue burning in 2018 while 4.26 Mt pollutants were emitted in 2017, representing a 39.3% reduction in emitted pollutants in 2018 over 2017.

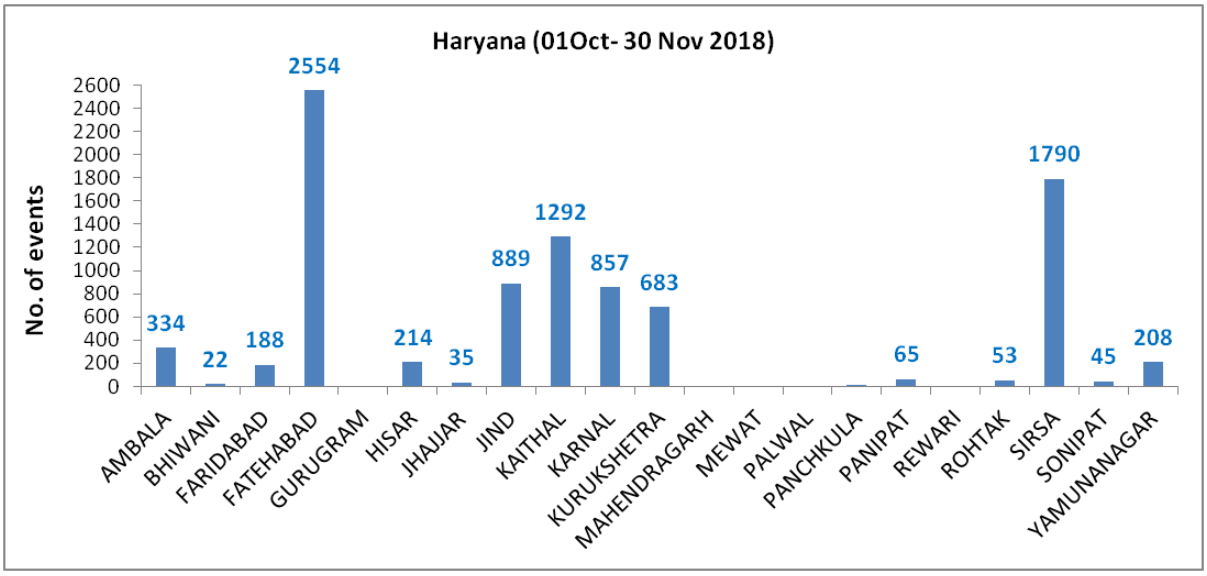

Fig 5 Districtwise distribution of paddy residue burning events detected by satellite thermal remote sensing during 2018 in Haryana

District	Paddy area by RS ('000 ha)	Paddy Area Burnt by RS ('000 ha)	Percent Burnt Area by RS (%)	Straw production on dry wt basis ('000 tons)	Straw Burned on dry wt basis ('000 tons)	Straw Burned (%)
AMBALA	84.05	3.15	3.75	693.88	23.39	3.37
FATEHABAD	98.70	69.65	70.57	814.89	516.38	63.37
HISAR	46.63	12.93	27.73	303.42	75.56	24.90
JIND	137.00	29.23	21.34	791.78	151.70	19.16
KAITHAL	169.44	29.35	17.32	1224.03	190.38	15.55
KARNAL	160.16	23.55	14.70	1183.37	156.25	13.20
KURUKSHETRA	120.98	21.32	17.63	1037.19	164.16	15.83
PANIPAT	78.91	0.30	0.38	488.58	1.68	0.34
SIRSA	67.70	41.71	61.60	551.27	304.96	55.32
SONIPAT	80.74	2.89	3.58	465.05	14.97	3.22
BHIWANI						
FARIDABAD						
GURGAON						
JHAJJAR						
MAHENDRAGARH						
MEWAT						
PALWAL						
PANCHKULA						
REWARI						
ROHTAK						
YAMUNANAGAR						
Total	1044.31	234.08	22.42	7553.45	1599.43	21.17

Table 3 Districtwise statistics for Haryana showing paddy area planted, area burnt, straw produced and straw burnt in 2018.

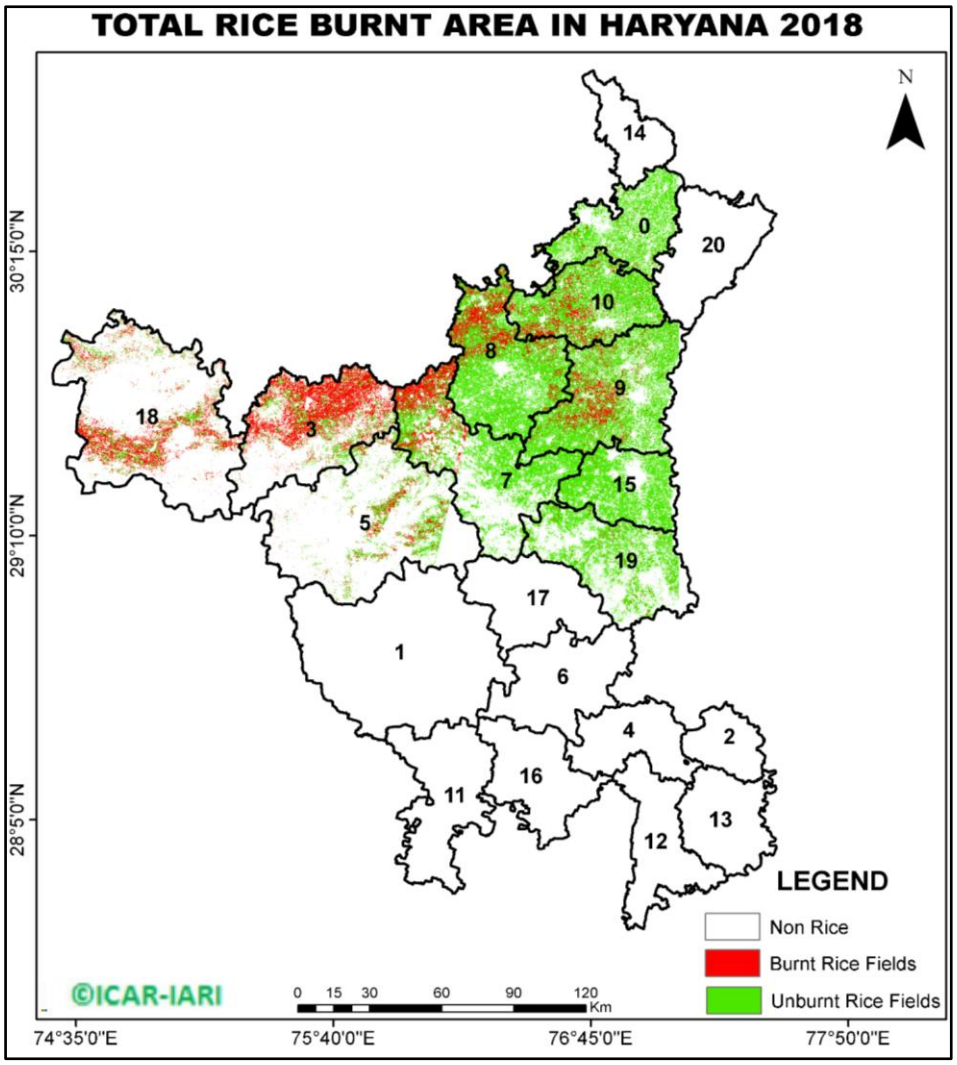

Fig 6 Maps showing paddy area planted, paddy area unburnt (green color) and paddy area burnt (red color) in Haryana in 2018.

(3) UTTAR PRADESH

- The burning events detected in UP were 9709, 8784, and 6636 in the years 2016, 2017 and 2018, respectively. About 24.45% and 31.65% reduction in number of burning events were observed in current year (2018) as compared to that in 2017 and 2016, respectively.
- About 4.6% of fire event's intensity in current year changed from very high and high to low as compared to 2017, signifying shift towards partial burning of residue implying lower emission of particulate matter.
- Maharajganj and Mathura districts reported highest number of burning events in 2018.
- About 1.27 Mt of pollutants were emitted by burning in 2018 while 2.82 Mt of pollutants were emitted in 2017, representing 29.89% reduction in 2018 over 2017.

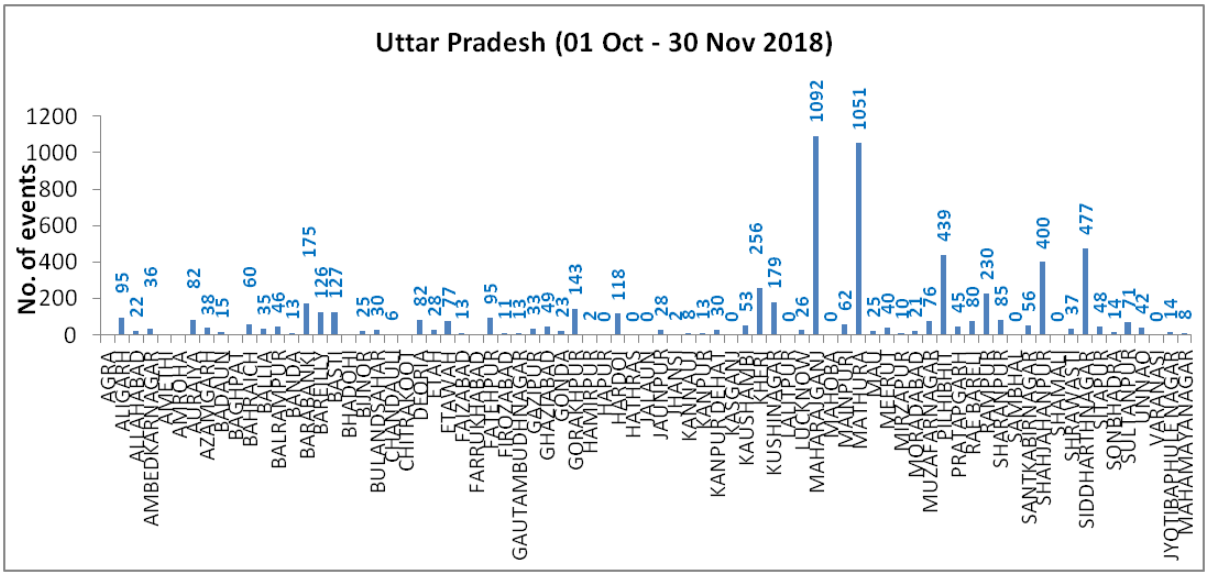

Fig 7 Districtwise distribution of paddy residue burning events detected by satellite thermal remote sensing during 2018 in Uttar Pradesh.