Spread of Covid-19 in India: The Third Report [2.4.20; 12 mid-night]

Jyotsna Jalan & Arijit Sen*

The cut-off time for our Second Report was 31^{st} March mid-night. Our Third Report focuses on the stock of Novel Coronavirus infections in India starting from that point in time up to 2^{nd} of April mid-night. In this 48-hour window, the nature of the spread of Covid-19 in India has been *significantly disrupted and worsened* by the "Nizamuddin transmission (*N*-transmission)" that we mentioned in our Second Report. Specifically, up to the mid-night of April 2, the following six states – Andhra Pradesh, Delhi, Madhya Pradesh, Maharashtra, Tamil Nadu, and Telangana – had at least of 677 Covid cases arising from the *N*-transmissions so as to assign the *smallest possible value of the shock* to the system that has been caused by this single source of disease spread.]

In the aggregate, over the 48-hour time interval, there have been 807 new Covid afflictions in India, of which only 3% are primary cases (predominantly brought about by the repatriation of stranded Indian citizens in infected countries like Iran and Italy), and the rest are all cases arising out of (a few) intra-family and (mostly) extra-family transmissions. The disease, therefore, has "matured sufficiently" in the country.

Further, the data seems to indicate that the extent of disease spread is explained significantly by the *N*-transmissions. To investigate this issue more comprehensively, we carry out *separate analysis* of the six states heavily impacted by the *N*-transmissions and the rest of India. Tables 3.1 and 3.2 (presented at the end of this report) present district-level data (under quite analogous heads as in Tables 1 and 2 in our previous reports) for the six "*N*-afflicted states" and the "Rest of India" separately. [In this regard, we need to clarify the following: (i) In our second round of analysis, there were already 107 cases arising from the "early" *N*-transmissions, predominantly in the same six states. (ii) There are 52 cases of *N*-transmission in the Rest of India in the current round of analysis, but no single state in this cluster has more than 20 *N*-afflicted cases. (iii) We unfortunately do not have district-level data in the current round for Jammu and Kashmir and for Telangana, and are thus forced to settle at state-level analysis for them.]

From Tables 3.1 and 3.2, the following distinct features of disease spread in the *N*-afflicted states (containing 30% of India's population) and the Rest of India are worth noting.

[1] Over the 48 hours under consideration, the number of cases in the Rest of India rose by 26%, from 871 to 1101 (and spread to 16-18 "new" districts). In contrast, the number of cases in the six *N*-afflicted states have risen by 89%, from 757 to 1434 (and spread to 15-20 "new" districts).

[2] While 10% of the new cases in Rest of India were due to primary infections (Indians repatriated from afflicted countries), there were no primary cases in the six *N*-afflicted states.

[3] Among the already adversely affected western and southern states of India, while some states – Punjab, Rajasthan, Gujarat, Karnataka, and Kerala – haven't yet been seriously hit by *N*-transmission, four others states – Andhra Pradesh, Maharashtra, Tamil Nadu, and Telangana – have been hit to a significant extent (increase in disease load these last four states has been 81%).

[4] The two biggest metropolitan areas of India – Delhi and the national capital region, and greater

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Mumbai – have been seriously affected by the *N*-transmission. The growth in disease load in the municipal areas of Delhi and Mumbai have been 144% and 59% respectively.

Our current sense is that the full impact of *N*-transmission is yet to be realized. While this adverse shock has already worsened the situation in initially-impacted states like Maharashtra and Delhi, the three states of Andhra Pradesh, Tamil Nadu, and Telangana will likely see significant spread of Covid-19 in their rural as well as urban districts. Consequently, *N*-transmission will probably lead to *some dilution* in the phenomenon of "afflicted district clusters" that we have discussed in our previous reports, but possibly only in a few states.

We now turn our attention to the transmission indices – which are simply the ratio of "transmitted cases" (i.e., cases arising out of disease transmission from primary patients to other patients) to "total cases" in each district. The following four figures – Figures 3.1 - 3.4 – update Figures 1

Figure 3.1 Transmission Indices in the Rest of India

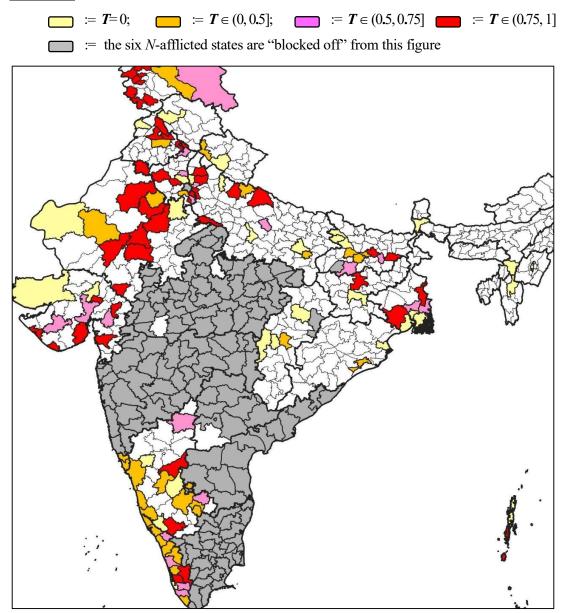
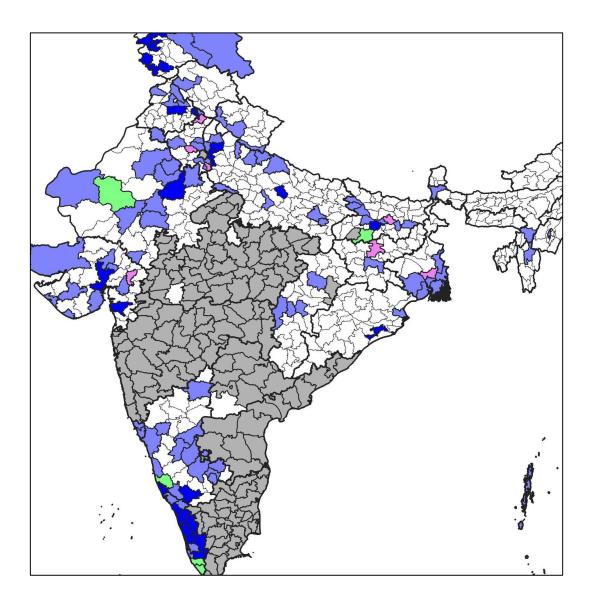


Figure 3.2 Change in Transmission Indices in the Rest of India



 \square := the six *N*-afflicted states are "blocked off" from this figure

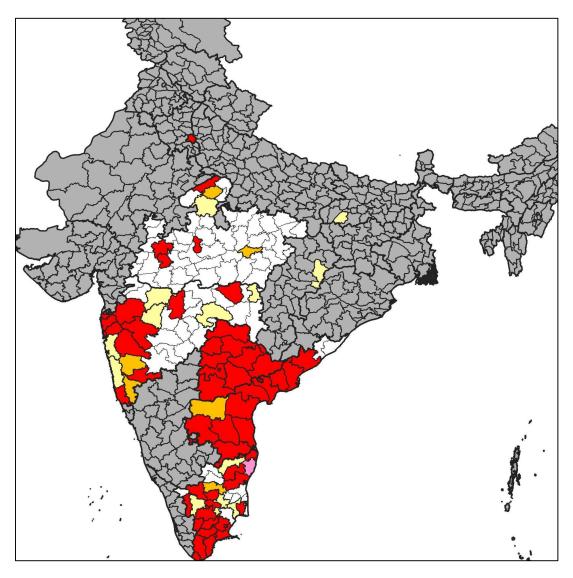


and 2 of our previous reports, by colour-coding the afflicted districts on the basis of the updated district-level transmission index T(3), and by documenting the district-level changes in the transmission indices: T(3) - T(2), separately for the six *N*-afflicted states and for the Rest of India.

The principal conclusions from these four figures (and the relevant data columns in Tables 3.1 and 3.2) are the following: In the already-afflicted districts of the Rest of India, the transmission index has remained unchanged in 68% of the districts, and has increased significantly in only 8% of the districts. In contrast, in the already-afflicted districts of the six *N*-afflicted states, the transmission index has remained unchanged in only 23% of the districts, while it has increased significantly in

Figure 3.3 Transmission Indices in the six *N*-afflicted states



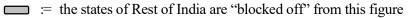


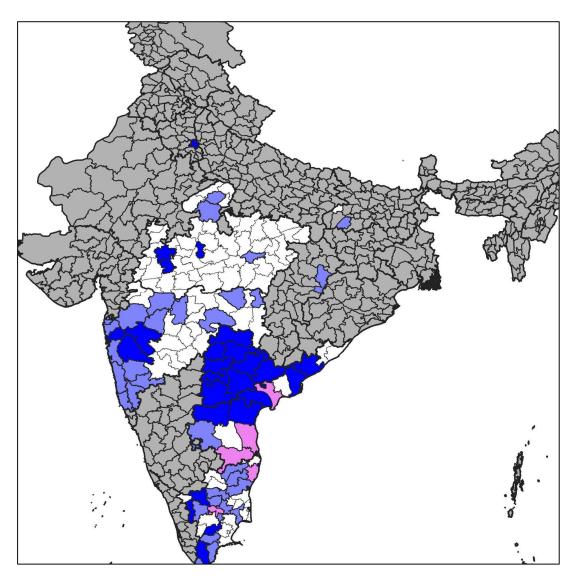
72% of the districts. This is one important sense in which the spread of Covid-19 in India has been significantly disrupted and worsened by *N*-transmission.

To help understand the extent of the adverse shock due to *N*-transmission, we now focus on the following counterfactual. Specifically, we address the following question: What would the disease load be in the six *N*-afflicted states had there been *no N*-transmission? The last three columns of Table 3.2 provide information in this regard. From the column reporting the [stock of total cases less those due to *N*-transmission], we note the following: If there had been no *N*-transmission, then the number of cases in the six *N*-afflicted states would have risen by 20%, from 757 to 908 (which

Figure 3.4 Change in Transmission Indices in the in the six *N*-afflicted states

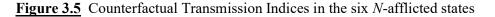




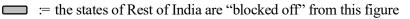


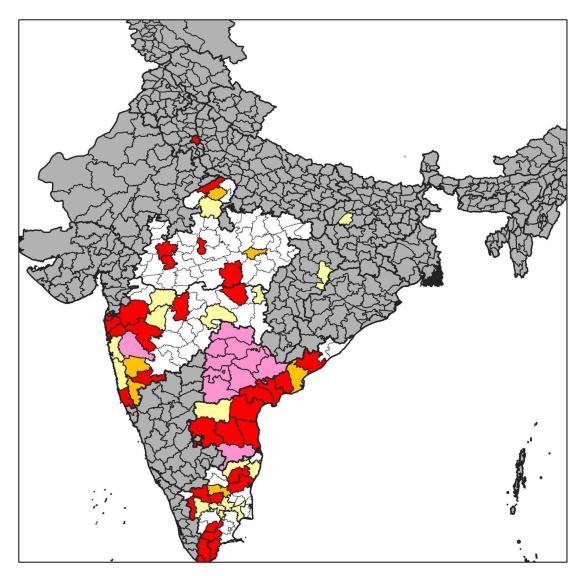
would have been quite comparable to the growth of disease load in the Rest of India).

Further, Figures 3.5 and 3.6 depict the district-level "counterfactual transmission indices" and their changes, if there had been no *N*-transmission in the six states. The data reveals the following: If there indeed had been no *N*-transmission in the six states, then in the already affected districts in these states, there would have been no change in the transmission index in 75% of the districts, and there would have been a significant increase in the transmission index in only 10.5% of the districts (again, these numbers would have been quite comparable to the district-level experiences in the rest of the country).







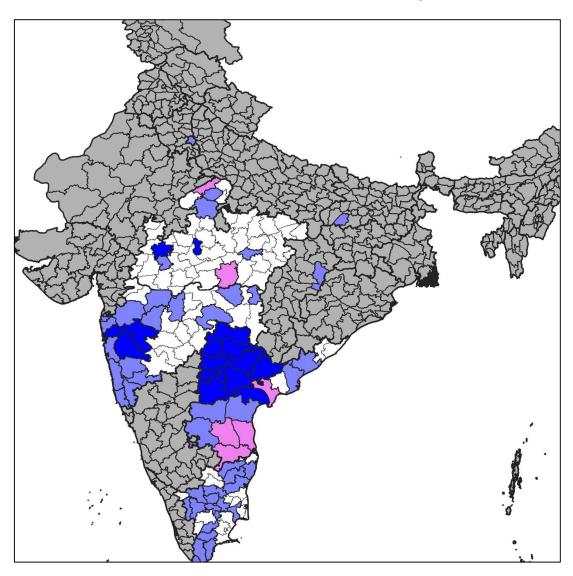


In summary, the data presented in our current report (based on the "raw information" available from <u>covid19india.org</u>) indicate that a single event that generated substantial *N*-transmission did indeed worsen the trajectory of the spread of Covid-19 in India. To determine the full magnitude of this shock, we will need to wait for a few more days to see whether the shock generates a cumulative worsening of disease spread in different specific parts of India, or whether the country is successful in containing subsequent waves of infection arising from the initial disease propagation. It is also to be seen whether, and to what extent, the substantial movements of migrant labour to different parts of the country worsen disease spread.

Figure 3.6 Change in Counterfactual Transmission Indices in the in the six *N*-afflicted states



= the states of Rest of India are "blocked off" from this figure



We hope that within the next few days, with the "stabilization" of the country-wide impact of *N*-transmission, it will become clearer whether the spatial spread of Covid-19 across India is becoming more or less uneven, and how the speed of disease progression is changing over time.

Affected Districts ARUNACHAL Lohit ASSAM Cachar	<u>Total Cases</u> 1 1 1 1 1 15	<u>cases</u>	cases 1 1	<u>cases</u>	cases		<u>in T</u>
Lohit ASSAM	1			1			[]
ASSAM			J	1	1 1		
	15				L		
Cachar			15	16	15		
				1		0.00	0.00
<u>Goalpara</u>	3		3	3	3	1.00	
<u>Jorhat</u>	8		8	8	8	1.00	
<u>Kamrup M</u>	4		4	4	4	1.00	
BIHAR	8	4	4	29	15		
Begusarai	1		1	1	1	1.00	
<u>Bhagalpur</u>				6	6	1.00	
Gaya	3	1	2	4	3	0.75	-0.25
Gopalgunj	2	2		3		0.00	0.00
Munger				3	2	0.67	0.00
Nalanda	1		1	2	1	0.50	0.50
Patna				4	2	0.50	0.00
<u>Saran</u>	1	1		1		0.00	
Siwan				5		0.00	0.00
CHATTISGARH				9	1		
Bilaspur				1		0.00	0.00
Durg				1		0.00	0.00
Korba				1		0.00	0.00
Raipur				5	1	0.20	0.00
Rajnandgaon				1		0.00	0.00
GOA				5	1	0.20	0.00
GUJARAT	14		14	84+4	62+4		
Ahmedabad	8		8	31	22	0.71	0.10
Bhavnagar	1		1	7	7	1.00	0.00
Gandhinagar				9	7	0.78	0.00
Gir Somnath				2	2	1.00	0.00
Kutch				1		0.00	0.00
<u>Mehsana</u>				1		0.00	0.00
Panchmahal	1		1	1	1	1.00	
Porbandar	2		2	3	3	1.00	0.00
Rajkot				9	6	0.67	0.00
Surat	2		2	11	9	0.82	0.04
Vadodara				9	5	0.56	0.00
HARYANA	6		6	49	28		
Ambala	2		2	49 3	20	0.67	0.67

Table 3.1: Data for the Rest of India

STATE /	Increase in	Increase in	Increase in	Stock of total	Stock of		Change
Affected Districts	Total Cases	primary cases	transmitted cases	cases	transmitted cases	<u>T(3)</u>	<u>in T</u>
Faridabad		<u>(d365</u>		6	5	0.83	0.00
Gurgaon				24	8	0.33	0.00
Hissar				1	1	1.00	0.00
Palwal	3		3	4	3	0.75	0.75
Panchkula				2	2	1.00	0.00
Panipat				4	3	0.75	0.00
<u>Rohtak</u>	1		1	1	1	1.00	
Sirsa				3	3	1.00	0.00
Sonipat				1		0.00	0.00
HIMACHAL	3		3	6	3		
Kangra				3		0.00	0.00
<u>Una</u>	3		3	3	3	1.00	
JHARKHAND			1	2	1		
Hazaribag	1		1	1	1	1.00	
Ranchi				1		0.00	0.00
KARNATAKA	23	3	20	124	64		
Bangalore	3	2	1	47	13	0.28	0.00
Bellary	1	_	1	4	4	1.00	0.00
Bidar	10		10	10	10	1.00	
Chikkaballapur				10	6	0.60	0.00
Chitradurga				1	-	0.00	0.00
Dakshina Kannada	1	1		8	1	0.13	-0.02
Davanagere				2	1	0.50	0.00
Dharwad				1		0.00	0.00
Kalaburagi	1		1	5	4	0.80	0.05
Kodagu				1		0.00	0.00
Mysuru	7		7	21	19	0.90	0.05
Tumakuru				2	1	0.50	0.00
Udupi				3	1	0.33	0.00
Uttara Kannada				9	4	0.44	0.00
KERALA	45	11	34	286	119		
Alappuzha				2		0.00	0.00
Ernakulam	3		3	23	8	0.35	0.10
Idukki	5		5	10	8	0.80	0.20
Kannur	3	2	1	48	13	0.27	0.00
Kasaragod	20	6	14	129	53	0.41	0.05
Kollam	2	1	1	5	3	0.60	-0.07
Kottayam				3	3	1.00	0.00
Kozhikode	1		1	7	2	0.29	0.12
Malappuram	3		3	13	4	0.31	0.21
Palakkad	1		1	6	2	0.33	0.13

		Increase in	Increase in		Stock of		
<u>STATE</u> /	Increase in Total Cases	primary	transmitted	Stock of total	transmitted	<u>T(3)</u>	Change
Affected Districts	Total Cases	<u>cases</u>	cases	<u>cases</u>	<u>cases</u>		<u>in T</u>
Pathanamthitta	1		1	13	7	0.54	0.04
Thiruvananthapuram	3	2	1	13	6	0.46	-0.04
Thrissur	3		3	11	8	0.73	0.10
Wayanad				3	2	0.67	0.00
MANIPUR	1		1	2	2		
Imphal West				1		0.00	0.00
Thoubal	1		1	1	1	1.00	
14170DANA							
MIZORAM				1		0.00	0.00
Aizawl				1		0.00	0.00
ODISHA	1		1	5	2		
Bhadrak				1		0.00	0.00
Khordha	1		1	4	2	0.50	0.17
PUNJAB	5		5	45+2	36+2		
Amritsar				2		0.00	0.00
Hoshiarpur	1		1	7	7	1.00	0.00
Jalandhar				5	4	0.80	0.00
Ludhiana	1		1	2	1	0.50	0.50
Ajit Singh Nagar	3		3	10	8	0.80	0.09
Bhagat Singh Nagar	3			19	16	0.84	0.00
				15	10	0.01	0.00
RAJASTHAN	38+2	4	34+2	131+2	94+2		
Ajmer				5	4	0.80	0.00
<u>Alwar</u>				1		0.00	0.00
Bharatpur	1		1	1	1		
Bhilwara				26	26	1.00	0.00
Churu	7		7	8	8	1.00	0.00
Dungarpur				3	3	1.00	0.00
Jaipur	20		20	41	35	0.85	0.14
Jaisalmer				10		0.00	0.00
Jhunjhunu	1		1	9	3	0.33	0.08
Jodhpur	5	4	1	19	6	0.32	-0.04
Pali				1	1	1.00	0.00
Pratapgarh				2	2	1.00	0.00
Sikar				1	1	1.00	0.00
Tonk	4		4	4	4	1.00	
UTTAR PRADESH	24		24	103+25	83+25		
Bulandshahar	2		2	2	2	1.00	1.00
Basti	4		4	4	4	1.00	1.00
Agra	5		5	15	15	1.00	0.00
Bagpat				1		0.00	0.00
Barelli				6	5	0.83	0.00

Only state-level dat			cases in West		a not find dis	strict-le	vei
		6 10 10 11					1
PUDUCHERRY Puducherry	2 2		2 2	3 3	2 2	0.67	0.67
	2		2				
Leh				11	7	0.64	0.00
Kargil				2	o 1	0.50	0.00
LADAKH				13	8		5.04
JAMMU KASHMIR ⁰	15		15	70	62	0.89	0.04
CHANDIGARH	3		3	18	13	0.72	0.06
South Andaman				9	8	0.89	0.00
N & M Andaman				1		0.00	0.00
ANDAMAN NICOBAR				10	8		
South 24 Parganas				1		0.00	0.00
Purba Medinipur				1		0.00	0.00
Paschim Medinipur				2	2	1.00	0.00
North 24 Parganas				4	3	0.75	0.00
Nadia				5	5	1.00	0.00
Kolkata	8	1	7	19	12	0.63	0.18
Kalimpong				1		0.00	0.00
Hoogly	2		2	3	2	0.67	0.67
Haowrah				1		0.00	0.00
WEST BENGAL	10+16	1	9+16	37+16	24+16		
Udham Singh Nagar	3		3	3	3	1.00	
Pauri Garhwal				2	_	0.00	0.00
Dehradun				4	1	0.25	0.00
UTTARAKHAND	3		3	9	4		
Varanasi				2	1	0.50	0.00
Pilibhit				2	1	0.50	0.00
Muzaffarnagar				2	2	1.00	0.00
Moradabad				1		0.00	0.00
Meerut	1		1	6	5	0.83	0.03
Lucknow	1		1	9	5	0.56	0.06
Lakhimpur Kheri				1	1	1.00	0.00
Kanpur Nagar				1		0.00	0.00
Jaunpur	2		2	3	2	0.67	0.67
Ghaziabad	1		1	6	4	0.67	0.07
Gautam Buddh Nagar	8		8	42	36	0.86	0.03
Affected Districts	<u>-10tal cases</u>	<u>cases</u>	<u>cases</u>		<u>cases</u>		<u></u>
<u>STATE</u> /	Increase in Total Cases	<u>primary</u>	transmitted	Stock of total cases	transmitted	<u>T(3)</u>	Change in T

<u>STATE</u> / Affected District	Increase in Total Cases	Increase in N- transmission cases	Increase in other cases	Stock of Total Cases	Stock of Transmit Cases	<i>T</i> (3)	Change in T(3) from T(2)	Stock of total cases less N-trans	T ^[-∿] (3)	Change in 7 ^[-N] (3) from 7(2)
ANDHRA	100	67	38	150	137			83		
Anantpur				2	2	1.00	0.00	2	1.00	0.00
Chittoor	8	6	2	9	8	0.89	0.89	3	0.67	0.67
East Godavari	5	5		9	7	0.78	0.28	4	0.50	0.00
Guntur	11	9	2	20	19	0.95	0.06	11	0.91	0.02
Krishna	17	5	12	22	18	0.82	0.62	17	0.76	0.56
Kurnool	1	1		2	1	0.50	0.50	1	0.00	0.00
Prakasam	9	9		20	19	0.95	0.04	11	0.91	0.00
SPS Nellore	20	3	17	21	20	0.95	0.95	18	0.94	0.94
Visakhapatnam	1	1		12	10	0.83	0.02	11	0.82	0.00
<u>West Godavari</u>	15	13	2	15	15	1.00		2	1.00	
<u>YSR</u>	18	15	3	18	18	1.00		3	1.00	1.00
MADHYA PRADESH	41	31	10	107+1	95+1			76+1		
Bhopal	5		5	10	9	0.90	0.10	10	0.90	0.10
<u>Chindwara</u>	1		1	1	1			1	1.00	1.00
Gwalior				2	1	0.50	0.00	2	0.50	0.00
Indore	31	31		75	74	0.99	0.01	44	0.98	0.00
Jabalpur				8	2	0.25	0.00	8	0.25	0.00
<u>Khargone</u>	1		1	1	1	1.00		1	1.00	1.00
<u>Morena</u>	2		2	2	2	1.00		2	1.00	1.00
Shivpuri				2		0.00	0.00	2	0.00	0.00
Ujjain	1		1	6	5	0.83	0.03	6	0.83	0.03
MAHARASHTRA	121	32	103	430	366			398		
Ahmednagar	11		11	20	18	0.90	0.12	20	0.90	0.12

Table 3.2: Data for the *N*-afflicted States

<u>STATE</u> / Affected District	Increase in Total Cases	Increase in N- transmission cases	Increase in other cases	Stock of Total Cases	Stock of Transmit Cases	7(3)	Change in T(3) from T(2)	Stock of total cases less N-trans	T ^[-N] (3)	Change in <i>T</i> ^[-N] (3) from <i>T</i> (2)
Aurangabad				1		0.00	0.00	1	0.00	0.00
Buldana	2		2	6	6	1.00	0.00	6	1.00	0.00
Gondia				1		0.00	0.00	1	0.00	0.00
Jalgaon				1		0.00	0.00	1	0.00	0.00
Kolhapur				2	1	0.50	0.00	2	0.50	0.00
Mumbai	90	30	90	242	214	1.01	0.19	212	1.01	0.19
Nagpur				16	14	0.88	0.00	16	0.88	0.00
Nasik				1	1	1.00	0.00	1	1.00	0.00
Palghar				2	2	1.00	0.00	2	1.00	0.00
Pune	13	2	11	62	47	0.76	0.06	60	0.75	0.06
Raigad				1		0.00	0.00	1	0.00	0.00
Ratnagiri				1		0.00	0.00	1	0.00	0.00
Sangli				25	21	0.84	0.00	25	0.84	0.00
Satara				2	1	0.50	0.00	2	0.50	0.00
Sindhudurg				1	1	1.00	0.00	1	1.00	0.00
Thane	5		5	42	40	0.95	0.01	42	0.95	0.01
Yavatmal				4		0.00	0.00	4	0.00	0.00
TAMIL NADU	185	184	1	309	282			125		
Chengalpattu	14	14		14	14	1.00		0		0.00
Chennai	21	20	1	50	39	0.78	0.16	30	0.63	0.01
Coimbatore	28	28		33	32	0.97	0.17	5	0.80	0.00
Dindigul	17	17		17	17	1.00		0		0.00
Erode	8	8		27	25	0.93	0.03	19	0.89	0.00
Kanchipuram	2	2		3	2	0.67	0.67	1	0.00	0.00
Kanyakumari				5	5	1.00	0.00	5	1.00	0.00
Karur	16	16		17	16	0.94	0.94	1	0.00	0.00

<u>STATE</u> / Affected District	Increase in Total Cases	Increase in N- transmission cases	Increase in other cases	Stock of Total Cases	Stock of Transmit Cases	<i>T</i> (3)	Change in T(3) from T(2)	Stock of total cases less N-trans	T ^[-ℕ] (3)	Change in <i>T</i> ^[-N] (3) from <i>T</i> (2)
Madurai	9	9		15	14	0.93	0.10	6	0.83	0.00
Namakkal				18	18	1.00	0.00	18	1.00	0.00
<u>Ramnathpuram</u>	2	2		2	2	1.00		0		
<u>Ranipet</u>	4	4		4	4	1.00		0		
Salem				6	2	0.33	0.00	6	0.33	0.00
<u>Sivaganga</u>	5	5		5	5	1.00		0		
Thanjavur				1		0.00	0.00	1	0.00	0.00
<u>Theni</u>	20	20		20	20	1.00		0		
<u>Thirupattur</u>	10	10		10	10	1.00		0		
<u>Thiruvallur</u>	1	1		1	1	1.00		0		
Thiruvannamalai	1	1		2	2	1.00	0.00	1	1.00	0.00
<u>Thiruvarur</u>	7	7		7	7	1.00		0		
Thoothukkudi	4	4		5	5	1.00	0.00	1	1.00	0.00
Tiruchirappalli				1		0.00	0.00	1	0.00	0.00
Tirunelveli	7	7		30	29	0.97	0.01	23	0.96	0.00
Tirupur				1		0.00	0.00	1	0.00	0.00
Vellore				2		0.00	0.00	2	0.00	0.00
Viluppuram				3	3	1.00	0.00	3	1.00	0.00
Virudhunagar	9	9		10	10	1.00	0.00	1	1.00	0.00
TELENGANA ⁰	57	47	10	149	113	0.76	0.15	102	0.65	0.04
DELHI	173	170	3	293	278	0.95	0.07	123	0.88	0.00