COVID-19: Has Karnataka stemmed the tide? Three tell-tale signs

In the current analysis, we present three tell-tale signs indicating that the State of Karnataka appears to have stemmed the Covid tide. The analysis is based on the MoHFW data from March 10 to April 13 in terms of the number of cases every day and cumulatively. It follows the same methodology used earlier in analysing the data from Kerala (see https://bit.ly/Covid19-India-District-DataVizualization).

To begin with, it is worth examining whether new cases as fraction of the total cases have been on the rise or have these slowed down. This is done because it is the nature of exponential growth that the new cases Δn is proportional to N. As the number of new cases on a given day are subject to day-to-day statistical fluctuation, we take the ratio of the new cases of past 7 days as percentage of the total cumulative cases.

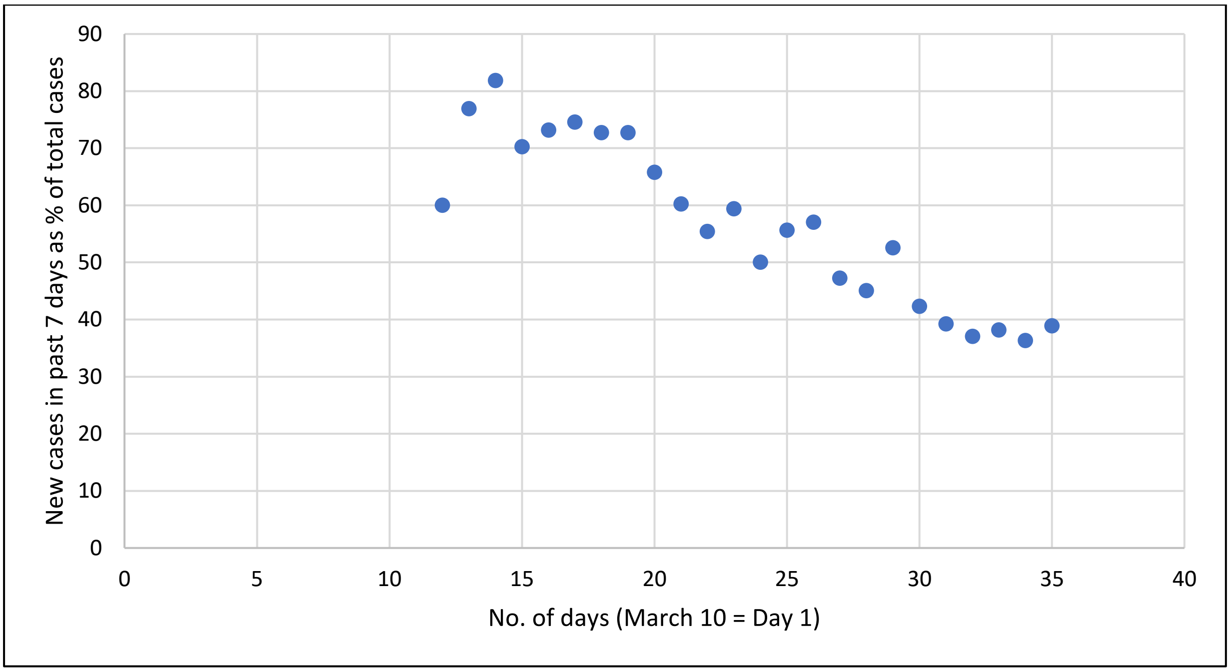

Figure 1: Karnataka: New cases (past 7 days) as % of total cases (March 21- April 13)

The graph above shows an unmistaken trend that the new cases as a fraction of the total cases have come down from 26th March to 12th April, and it has been on a steady decline, with some occasional small spikes.

Considering an exponential growth curve, the number of cases can be represented as:

$y = Ae^{Kx}$ (y is the number of cases, x the number of days and K is a constant).

Lower the value of K the better. For India, the exponential growth is given by the equation

$y = 41.37e^{0.1608x}$ with a value of $R^2 = 0.99$.

While for Karnataka the equation is

$y = 2.8717e^{0.1479x}$ with a value of $R^2 = 0.95$ (as of 13th April).

When we examine the exponential equation on an ongoing basis, the value of K has shown a clear turn around starting from March 28th with a steady reduction thereafter.

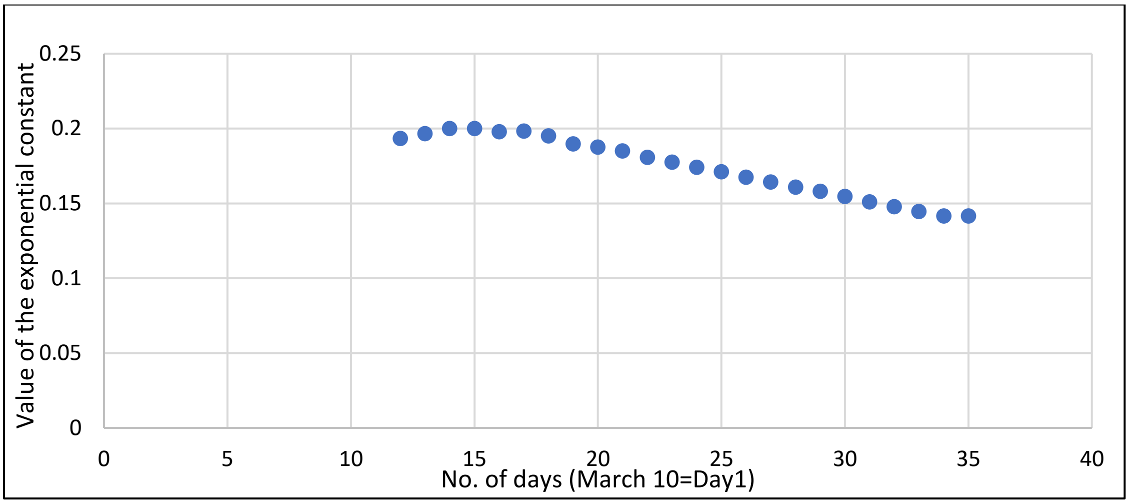

Figure 2: Karnataka- Changing nature of the exponential curve (March 21- April 13)

An equally interesting corroboration of these two trends is provided by the best fit for Karnataka through a polynomial curve. We restrict ourselves to the cubic equation i.e. use x, x^2 and x^3 of the type,

$\mathbf{y = Y_0 + Ax + Bx^2 + Cx^3}$ where y is the number of cases, x the number of days y_0 is the number of cases on day zero and A, B and C are coefficients of x, x^2 and x^3 . Where the coefficient of a term is positive it will mean that the cases will go up as x increases, when it is negative the cases will decrease with time. .

For India, the relation between the number of cases y and the number of days is represented by:

$\mathbf{y = 0.4532x^3 - 10.768x^2 + 93.962x - 114.6}$, $R^2 = 0.99$

While for Karnataka, it is represented by:
$\mathbf{y = -0.002x^3 + 0.3322x^2 - 2.6449x + 8.5}$, $R^2 = 0.99$ (as of 13th April)

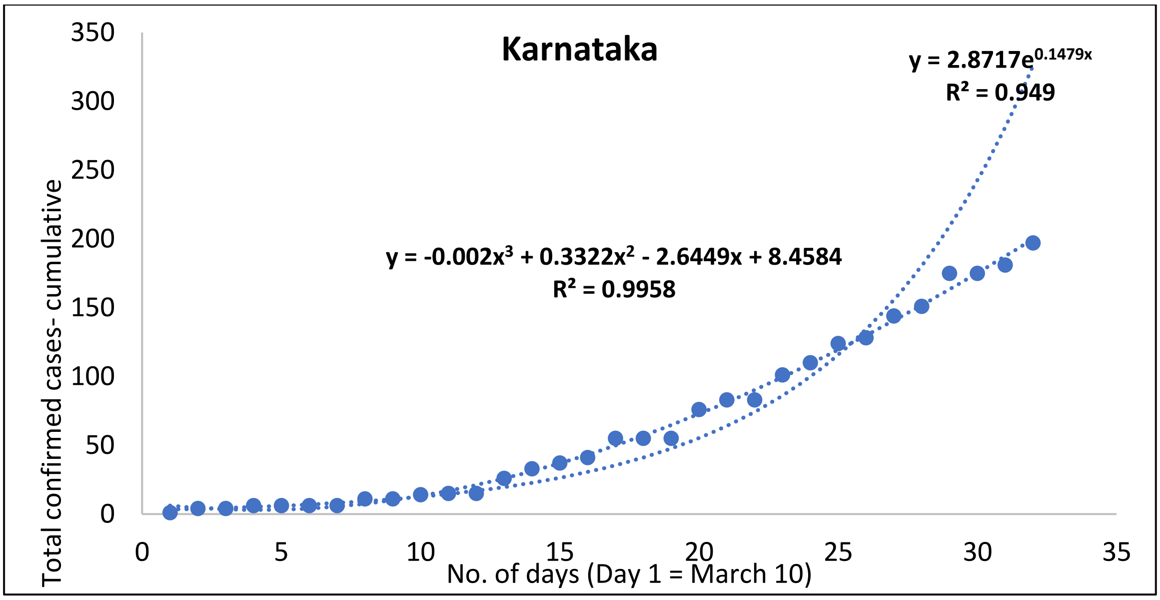

Figure 3: COVID-19 cases in Karnataka

In the figure above, one can clearly see the move away from exponential trend from 4th April, if not before. The table below provides the cubic equations for every day beginning from March 21.

Table 1: Case-study of COVID-19 in Karnataka

Date	Day	Cases	Exponent	R-Sq (Exp)	Cases of last 7 days as % of the total cases	Polynomial Fit (X=3)	R Sq (Poly)
10-Mar	**1**	1				Notice the coefficient of the x and the x^3 terms increasing, coming down closer to zero and then turning negative and continuing to do so.	
11-Mar	**2**	4					
12-Mar	**3**	4					
13-Mar	**4**	6					
14-Mar	**5**	6					
15-Mar	**6**	6					
16-Mar	**7**	6					
17-Mar	**8**	11					
18-Mar	**9**	11					
19-Mar	**10**	14					
20-Mar	**11**	15					
21-Mar	**12**	15	0.19	0.819	60	$y = -0.0001x^3 + 0.0452x^2 + 0.7004x + 1.3$	0.94
22-Mar	**13**	26	0.20	0.855	77	$y = 0.0262x^3 - 0.4178x^2 + 2.9216x - 1.2$	0.94
23-Mar	**14**	33	0.20	0.883	**82**	$y = 0.0342x^3 - 0.5681x^2 + 3.6924x - 2.1$	0.96
24-Mar	**15**	37	0.20	0.903	**70**	$y = 0.0269x^3 - 0.4216x^2 + 2.8922x - 1.1$	0.97
25-Mar	**16**	41	0.20	0.917	**73**	$y = 0.0172x^3 - 0.2126x^2 + 1.6815x + 0.5$	0.98
26-Mar	**17**	55	0.20	0.930	**75**	$y = 0.0208x^3 - 0.2954x^2 + 2.1887x - 0.22$	0.98
27-Mar	**18**	55	0.20	0.937	**73**	$y = 0.0112x^3 - 0.0653x^2 + 0.7024x + 1.9$	0.98
28-Mar	**19**	55	0.19	0.930	73	$\underline{\mathbf{y = 0.0003x^3 + 0.2115x^2 - 1.1771x + 4.9}}$	0.97
29-Mar	**20**	76	0.19	0.950	66	$y = 0.0055x^3 + 0.0737x^2 - 0.1956x + 3.3$	0.98
30-Mar	**21**	83	0.19	0.950	60	$y = 0.0059x^3 + 0.0625x^2 - 0.1124x + 3.1$	0.98
31-Mar	**22**	83	0.18	0.951	**55**	$y = 0.0011x^3 + 0.202x^2 - 1.1986x + 5.02$	0.98
01-Apr	**23**	101	0.18	0.953	**59**	$y = 0.0025x^3 + 0.1597x^2 - 0.8552x + 4.4$	0.99
02-Apr	**24**	110	0.17	0.950	**50**	$y = 0.0025x^3 + 0.1597x^2 - 0.855x + 4.4$	0.99
03-Apr	**25**	124	0.17	0.956	**56**	$y = 0.0032x^3 + 0.1354x^2 - 0.6414x + 4.0$	0.99
04-Apr	**26**	128	0.17	0.956	**57**	$y = 0.0014x^3 + 0.1958x^2 - 1.1925x + 5.1$	0.99
05-Apr	**27**	144	0.16	0.956	**47**	$y = 0.0014x^3 + 0.1962x^2 - 1.1959x + 5.1$	0.99
06-Apr	**28**	151	0.16	0.955	**45**	$y = 0.0003x^3 + 0.2363x^2 - 1.5884x + 5.9$	1.00
07-Apr	**29**	175	0.16	0.955	**53**	$y = 0.0016x^3 + 0.1867x^2 - 1.087x + 4.8$	1.00
08-Apr	**30**	175	0.15	0.953	**42**	$y = 0.0003x^3 + 0.241x^2 - 1.6547x + 6.12$	1.00
09-Apr	**31**	181	0.15	0.951	**39**	$y = -0.0014x^3 + 0.3097x^2 - 2.3948x + 7.9$	1.00
10-Apr	**32**	197	0.15	0.950	**37**	$y = -0.002x^3 + 0.3322x^2 - 2.6449x + 8.5$	1.00
11-Apr	**33**	207	0.14	0.950	**38**	$y = -0.0025x^3 + 0.3563x^2 - 2.9217x + 9.1$	0.99
12-Apr	**34**	226	0.14	0.950	**36**	$y = -0.0022x^3 + 0.3442x^2 - 2.7793x + 8.8$	0.99
13-Apr	**35**	247	0.14	0.950	**39**	$y = -0.0015x^3 + 0.3082x^2 - 2.3431x + 7.6$	0.99

Initially the coefficients of x and x^3 are positive. One can gradually notice the unmistakable reversal of sign of the coefficient of x first (becoming negative on 28th March), followed by the coefficient for x^3 (becoming negative from 9th April). The value of the coefficient of x^3 steadily decreased henceforth.

There are thus clear signs that Karnataka has turned the tide and the trend has been consistent. Barring an episodic spike, one can expect Karnataka to continue the trend.

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