SARS-CoV2 Simulations for India including Vaccinations

Computation Decision Science Laboratory*
Illinois Institute of Technology
https://sars-covid-tracker-india.herokuapp.com;
e-mail:kapoor@iit.edu

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Current Projections comparing Vaccination rates

Vaccination rates are considered in these projections. The vaccination rate is applied uniformly across Indian states and applied to the susceptible population that is present in our compartment model (based on the SEIR model) which has asymptomatic, hospitalized and death compartments and incorporates lockdown impacts for predictive modeling of virus sprread in Indian states and an India aggregate model from individual states model. The analysis is based on an initial release of population in the early part of 2021 to provide for rise in susceptible population. The current projections below are based on data until June 1st, 2021. We will quantify the release relative to the susceptible population that was computed during February-March 2021 when restrictions were removed. We consider two type of release from lockdown. The removal of lockdown starts at 6/30/2021 and the population returns to the status in February/March in 60 and 90 days. We compare the number of cases and deaths under the current vaccination rate and in the case when the vaccination rate is doubled.

Parameters

- Current Vaccination rates: 2.0M (20 Lakhs)/day or approximately 0.15%/day.
- Projected vaccination rate: 4.0M (40 Lakhs)/day or approximately 0.3%/day
- Start date of projected vaccination rate: 6/15/2021
- Lockdown removal date: 6/30/2021 and Lockdown release rate:
  (a) 100% over 60 days
  (b) 100% over 90 days

Discussion

Our simulation shows that doubling the current rate of vaccination will reduce the number of cases and deaths by

- 14% Total cases and 12% Total deaths in the case of release over 60 days. The reduction in total cases is 3.9M. and deaths are reduced by 64K. The anticipated number of cases are 26.5M and 22.6M

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- In the case of a extended period of release (90 days) the improvements are 20% and 16%, respectively. The reduction in total cases is 4.8M and deaths are reduced by 76K. The anticipated number of cases are 24.7M and 19.9M
- In the case of a longer extended period of release (180 days) the improvements are 40% in total number of cases and 32% in total deaths. The reduction in number cases jumps to 8M and 137K reduced deaths.The anticipated number of cases are 20.2M and 12.2M

This indicates benefits of a slow release of population over 180 days to reduce likelihood of a high third peak, along with possible increase in vaccination rates to more than double. Other steps available are stricter contact tracing and testing. These would help substantially.

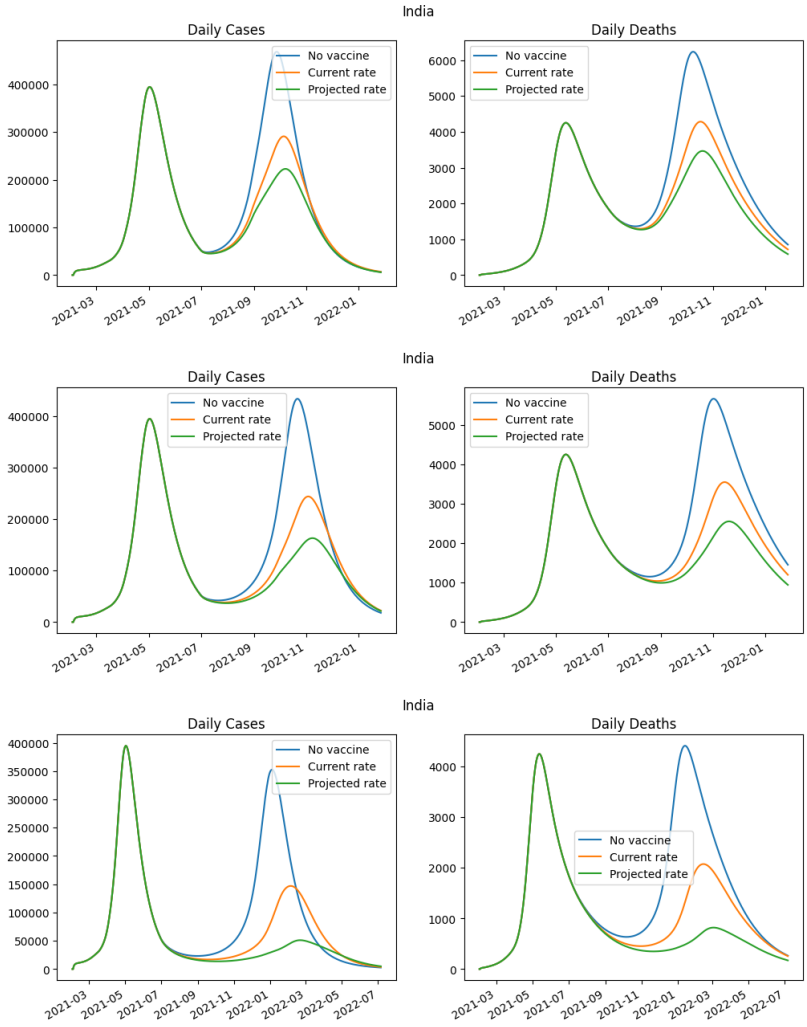

Figure 1: Comparison of three scenarios: releasing population from lockdown over 60, 90 and 180 days

Appendix: Statewide Analysis with increased vaccination rates

We present the improvements state-wise in the three scenarios, i.e. the release of population over 60, 90 and 180 days starting on June 30th, 2021. The figures and tables illustrating the benefits follow:

State	Reduction in Cases	Improvement in Cases	Reduction in Deaths	Improvement in Deaths
India	3765604	14.3%	64232	12.0%
Andaman and Nicobar	181	7.2%	17	4.0%
Andhra Pradesh	253653	16.0%	1332	15.1%
Arunachal Pradesh	3177	7.3%	29	6.7%
Assam	76157	10.2%	1159	9.5%
Bihar	85727	18.1%	781	16.3%
Chandigarh	6493	13.3%	82	11.9%
Chhattisgarh	136140	19.1%	1979	18.7%
Daman and Diu	646	8.9%	0	8.6%
Delhi	89732	11.6%	1576	11.1%
Goa	19680	16.6%	387	15.8%
Gujarat	139645	19.8%	1456	19.5%
Haryana	71708	13.8%	852	12.7%
Himachal Pradesh	37258	18.5%	639	17.7%
Jammu and Kashmir	47685	17.8%	666	16.4%
Jharkhand	26273	12.4%	490	12.1%
Karnataka	261801	12.0%	3402	10.3%
Kerala	3543	1.0%	16	0.4%
Ladakh	4032	14.7%	26	13.0%
Lakshdweep	1148	10.7%	15	6.7%
Madhya Pradesh	140539	21.0%	1175	20.2%
Maharastra	1043936	19.9%	20050	15.2%
Manipur	10143	8.2%	263	7.9%
Meghalaya	10790	13.7%	266	13.0%
Mizoram	2723	7.8%	12	7.5%
Nagaland	2711	16.7%	133	13.7%
Odisha	58944	6.3%	163	5.5%
Puducherry	18431	14.7%	321	13.2%
Punjab	110774	15.7%	2660	15.0%
Rajesthan	112521	16.7%	1089	15.8%
Sikkim	3061	8.8%	49	8.4%
Tamil Nadu	646390	12.2%	19768	9.6%
Telangana	26648	7.6%	166	7.4%
Tripura	7307	14.2%	61	13.2%
Uttar Pradesh	43003	4.0%	500	3.7%
Uttarakhand	40237	15.4%	948	14.0%
West Bengal	222767	14.1%	1703	13.0%

Table 1: Improvement when population is released over 60 Days

State	Reduction in Cases	Improvement in Cases	Reduction in Deaths	Improvement in Deaths
India	4789111	19.9%	76076	16.0%
Andaman and Nicobar	237	10.1%	20	5.1%
Andhra Pradesh	331520	22.8%	1740	21.6%
Arunachal Pradesh	3673	9.3%	33	8.4%
Assam	83536	12.6%	1257	11.6%
Bihar	116077	26.1%	1081	24.2%
Chandigarh	8444	18.0%	108	16.4%
Chhattisgarh	183541	27.9%	2688	27.6%
Daman and Diu	862	12.6%	0	12.2%
Delhi	115243	15.4%	2035	14.9%
Goa	26199	23.4%	521	22.5%
Gujarat	184609	27.8%	1937	27.6%
Haryana	94537	19.1%	1142	17.8%
Himachal Pradesh	49474	26.1%	853	25.1%
Jammu and Kashmir	62905	25.3%	883	23.5%
Jharkhand	34830	17.1%	653	16.9%
Karnataka	349915	17.2%	4564	14.8%
Kerala	3102	0.9%	14	0.3%
Ladakh	5059	20.3%	32	17.9%
Lakshdweep	1202	12.8%	15	7.2%
Madhya Pradesh	186812	29.8%	1589	29.2%
Maharastra	1328858	28.0%	23074	20.4%
Manipur	11231	10.0%	290	9.6%
Meghalaya	14305	19.7%	353	18.7%
Mizoram	3122	9.8%	13	9.4%
Nagaland	3636	24.1%	180	19.9%
Odisha	75298	8.7%	206	7.4%
Puducherry	23742	20.8%	411	18.6%
Punjab	143244	21.6%	3454	20.7%
Rajesthan	150099	23.5%	1480	22.6%
Sikkim	3205	10.3%	51	9.7%
Tamil Nadu	751736	15.9%	20982	11.7%
Telangana	34748	10.7%	216	10.4%
Tripura	9871	20.6%	82	19.2%
Uttar Pradesh	60299	5.8%	706	5.4%
Uttarakhand	54167	21.9%	1294	20.3%
West Bengal	279775	19.7%	2122	18.1%

Table 2: Improvement when population is released over 90 Days

State	Reduction in Cases	Improvement in Cases	Reduction in Deaths	Improvement in Deaths
India	8044790	39.8%	136813	31.7%
Andaman and Nicobar	420	20.3%	46	11.1%
Andhra Pradesh	578492	48.5%	3045	45.1%
Arunachal Pradesh	5430	16.5%	50	14.8%
Assam	117891	22.2%	1807	20.3%
Bihar	209577	56.0%	1928	49.5%
Chandigarh	14493	35.2%	182	30.9%
Chhattisgarh	318302	56.8%	4645	55.2%
Daman and Diu	1503	24.6%	1	23.7%
Delhi	197046	29.3%	3461	27.9%
Goa	46660	49.0%	921	46.2%
Gujarat	335781	61.3%	3509	60.1%
Haryana	164938	37.9%	1962	34.3%
Himachal Pradesh	92690	59.4%	1592	56.2%
Jammu and Kashmir	110653	53.7%	1552	48.6%
Jharkhand	59370	32.7%	1107	32.0%
Karnataka	623072	35.2%	8156	29.5%
Kerala	2613	0.8%	12	0.3%
Ladakh	8251	41.5%	53	35.6%
Lakshdweep	1378	19.2%	19	10.7%
Madhya Pradesh	335206	65.2%	2818	62.0%
Maharastra	2210321	55.8%	45210	40.3%
Manipur	15622	16.8%	407	16.1%
Meghalaya	25620	42.7%	632	40.1%
Mizoram	4547	17.1%	20	16.4%
Nagaland	6625	53.1%	329	41.5%
Odisha	131340	17.6%	364	14.7%
Puducherry	41292	43.5%	724	37.9%
Punjab	243136	43.4%	5845	41.0%
Rajesthan	269251	49.3%	2619	46.0%
Sikkim	3869	15.3%	62	14.3%
Tamil Nadu	1111193	29.9%	36031	22.8%
Telangana	61080	21.4%	381	20.6%
Tripura	18443	45.9%	154	42.1%
Uttar Pradesh	104215	10.7%	1208	9.9%
Uttarakhand	97273	45.8%	2303	41.1%
West Bengal	477199	40.7%	3660	36.9%

Table 3: Improvement when population is released over 180 days

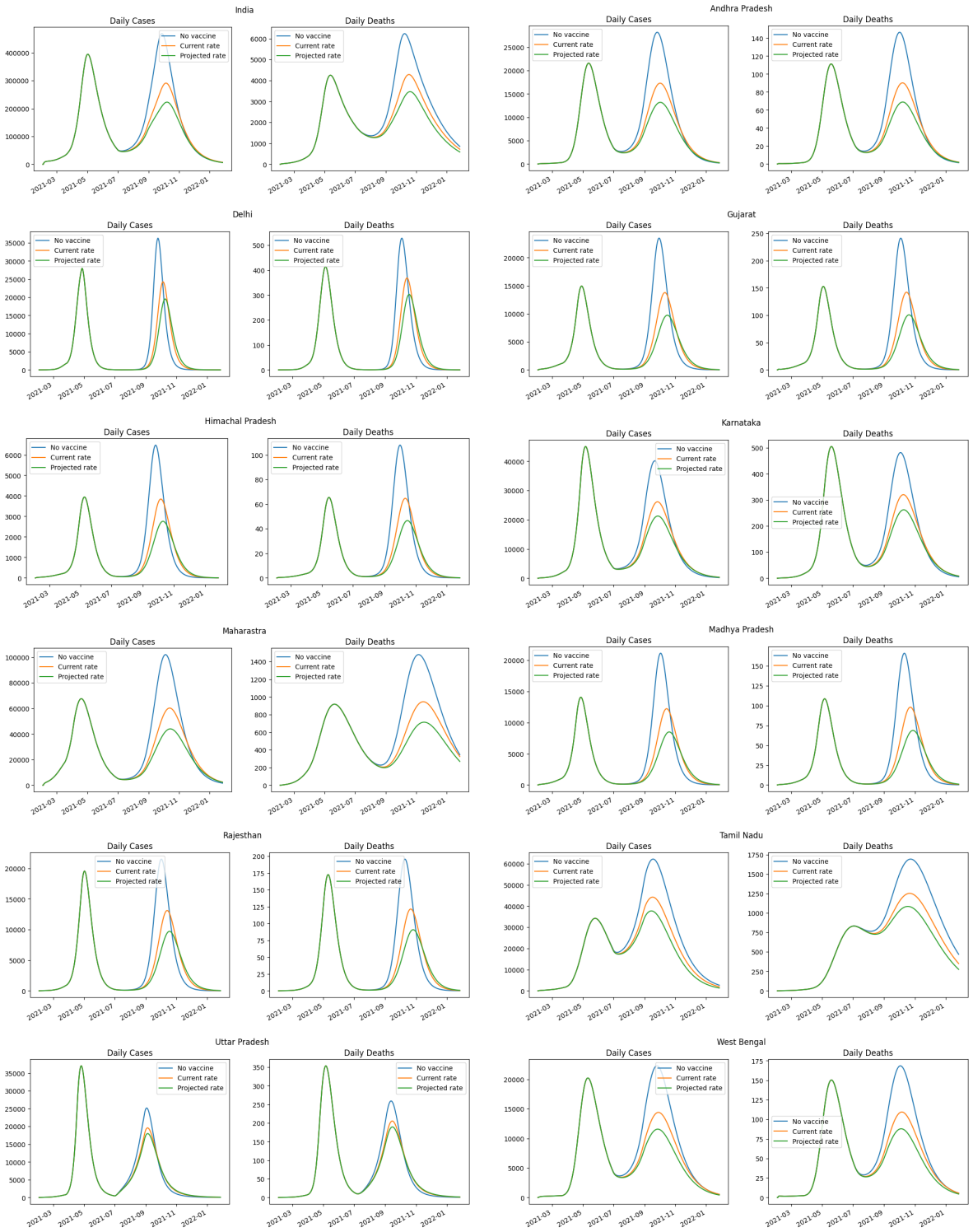

Figure 2: Projection with population release over 60 days

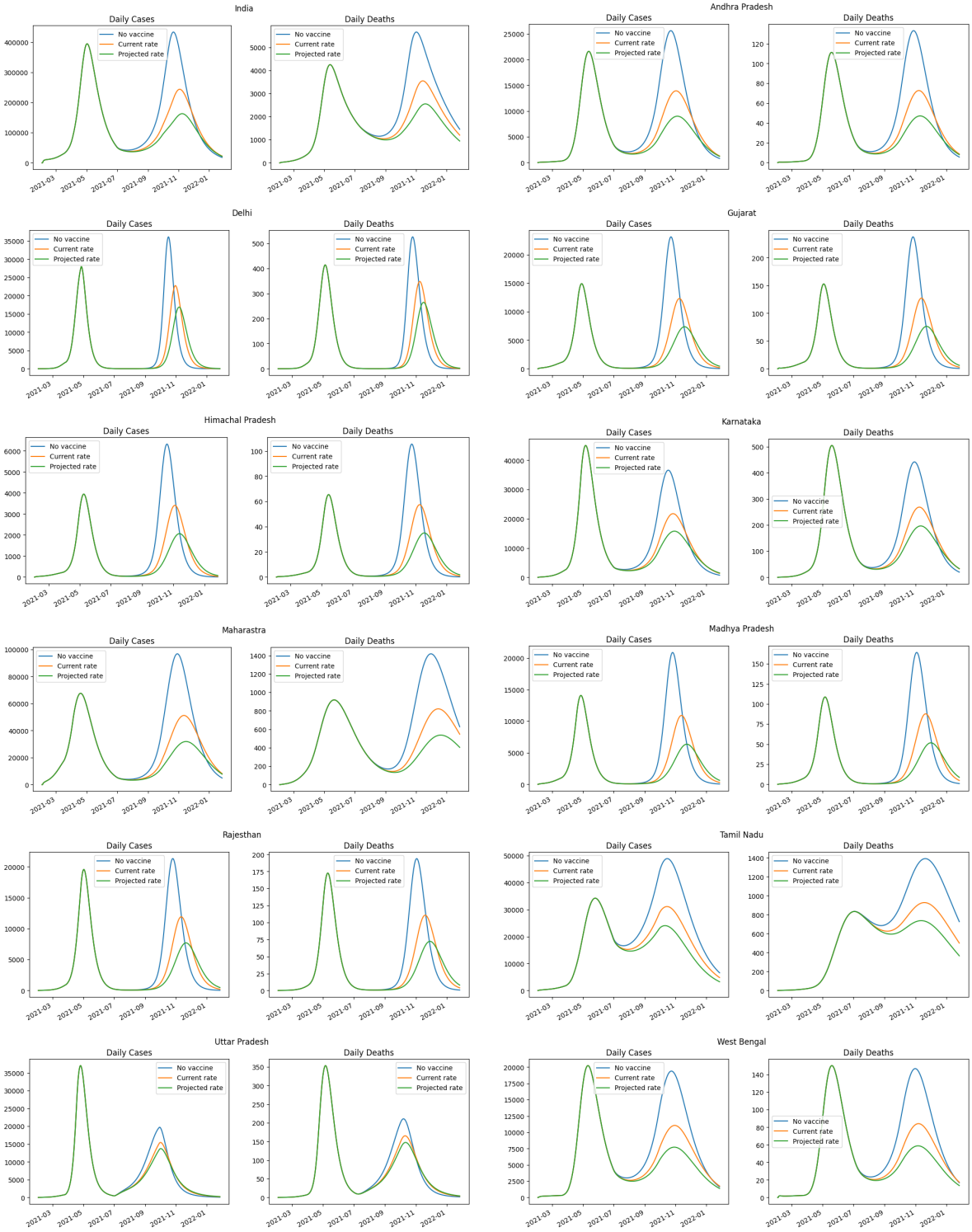

Figure 3: Projection with population release over 90 days

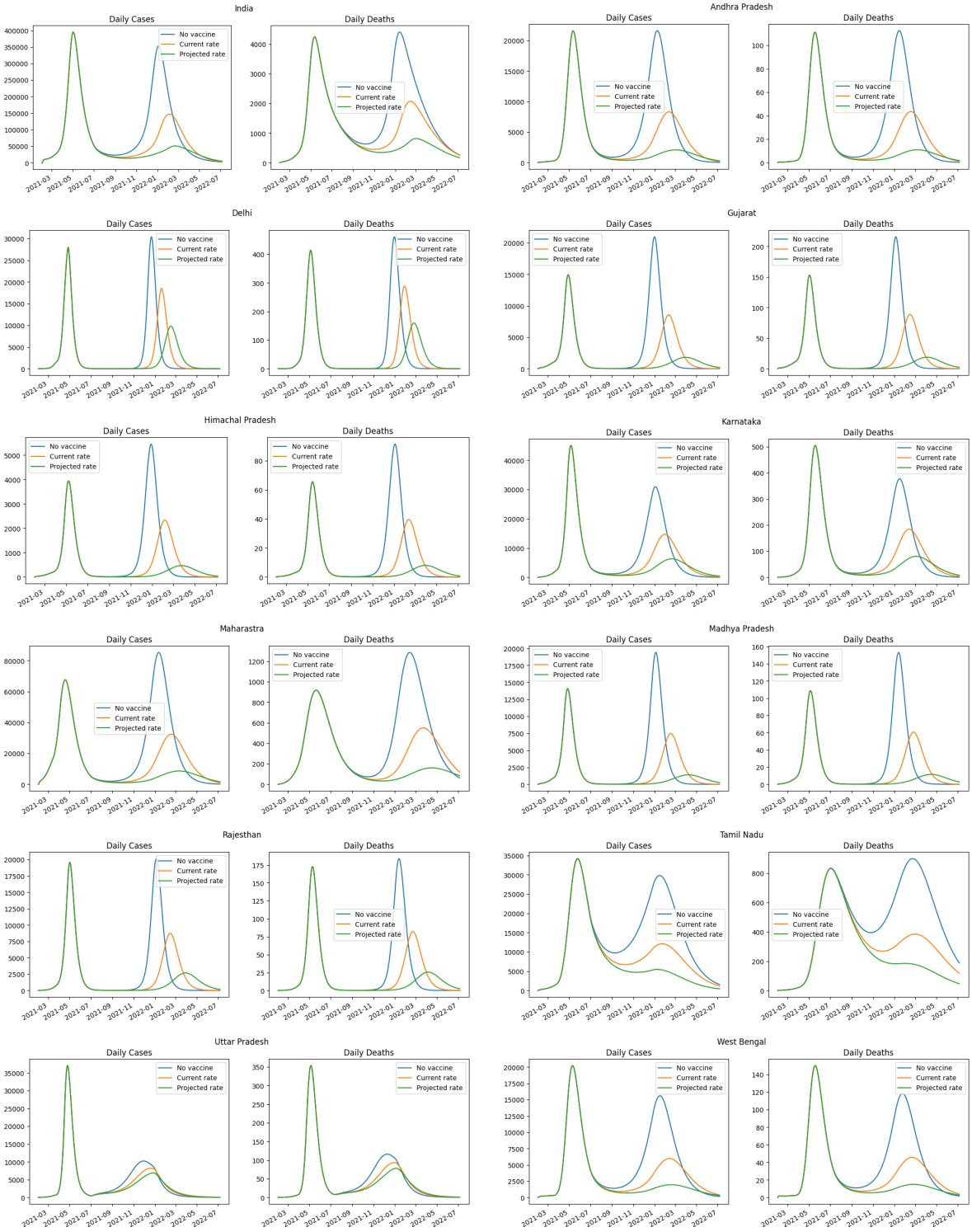

Figure 4: Projection with population release over 180 days