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Daily report 05-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Situation report 52

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With the financial support of: MINISTERIO DE CIENCIA E INNOVACIÓN "la Caixa"

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ *a*: the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ *K*: the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to data-points. We also discuss a specific issue every day.

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PJC and MC received funding from "la Caixa" Foundation (ID 100010434), under agreement LCF/PR/GN17/50300003; CP, DL, SA, MC, received funding from Ministerio de Ciencia, Innovación y Universidades and FEDER, with the project PGC2018-095456-B-I00;

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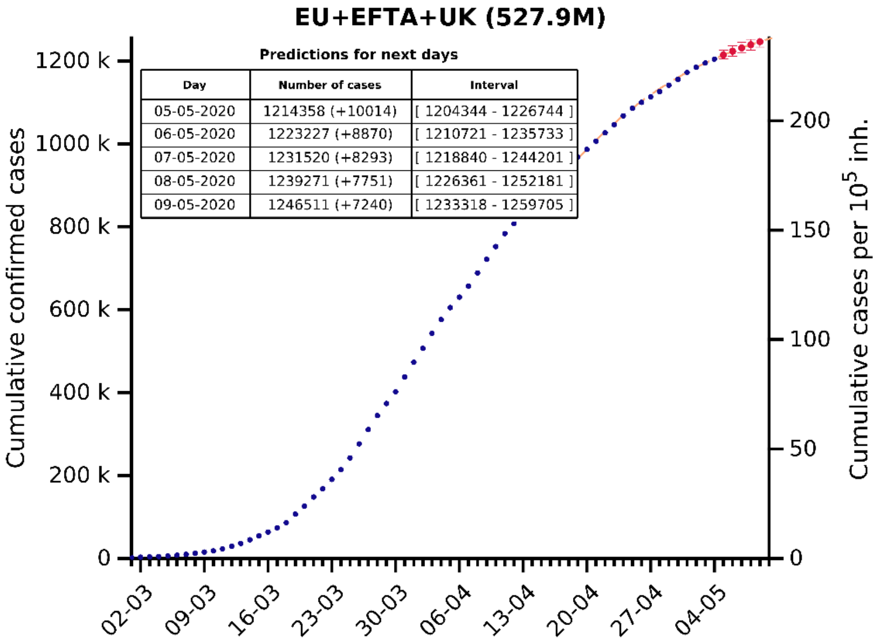
(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs



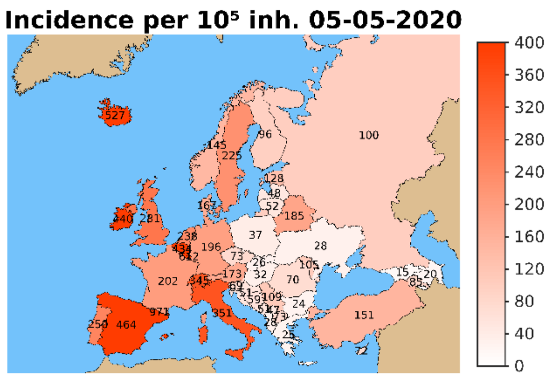
Good news for EU+EFTA+UK, since pandemic seems to be under control in most states. Only UK is resisting to confirm the slowing down clearly. **We are probably at the beginning of a new stage: coexisting with Covid-19 in a sustainable way**. This coexistence requires the rapid control of possible outbreaks in order to prevent uncontrolled growth. This is not an easy challenge, given that necessary surveillance mechanisms are only partially available for many countries. It is therefore time to work in this direction, trying to ensure that all countries can carry out proper surveillance. Logistical collaboration between European states is absolutely appropriate because, if the epidemic grows again in one of the states, it can drag many others. It is a joint challenge.

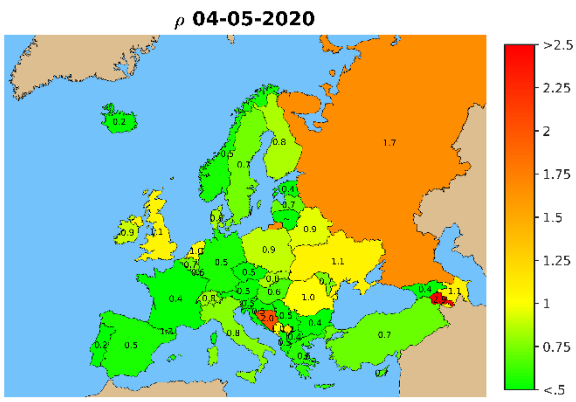
It is also time to look at other continents, since Europe is socially and economically linked to many other states. The pandemic is growing dangerously especially in North and Latin America. We need to look back and follow the evolution of the pandemic in these countries. Appendix 2 includes the risk diagrams of a few non-European countries and of the states in USA. Note that the situation in some US states is worse than the worst we have seen in Europe. La Rioja, with 317,000 inhabitants, reached a 14-day attack rate of almost 650 per 100,000 inhabitants. New York, with a population of 19.4 million people, almost reached a value of 700.

The analysis section discusses reliability of long-term predictions for cumulative cases and deaths, and presents the results for most affected countries.

Trends for specific countries

If we average new cases in the last five days, we see that EU+EFTA+UK countries are globally at the level of 9,700 daily cases. The vast majority of them, 84% of the total, corresponds to only 7 states: **UK** (3,866), **Italy** (1,295), **Germany** (948), **Spain** (915), **Belgium** (350) and **Sweden** (326). Controlling the spread in these 7 states is therefore very important for the whole continent. We see that 40% of daily new cases are currently being diagnosed in the UK.





Situation and trends per country

Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) form worst (red) situations according to each of the variables. **New!** Last column (**EPG_{EST}**) indicates EPG assessed with **estimated real 14-day attack rate** (see report from 22/04 for details). **EPG_{REP}** is calculated with **data reported by countries**. EPG_{REP} and EPG_{EST} **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

	Reported data						Indexes		
Country	Cumulative cases	Attack rate /10^5 inh.	Cumulative deaths	Mortality /10^5 inh.	Active cases (last 14 days)	14-day attack rate /10^5 inh.	ρ_7 (1)	EPG_{REP} (2)	EPG_{EST} (3)
Spain	218,011	470.4	25,428	54.9	26,848	57.9	0.65	37	437
Italy	211,938	356.6	29,079	48.9	30,710	51.7	0.77	40	551
United Kingdom	190,584	286.9	28,734	43.2	65,841	99.1	1.05	104	1,720
Germany	163,860	200.0	6,831	8.3	20,403	24.9	0.71	18	80
France	131,863	203.7	25,201	38.9	17,206	26.6	0.67	18	348
Belgium	50,267	442.6	7,924	69.8	10,284	90.5	0.62	57	957
Netherlands	40,770	240.0	5,082	29.9	7,365	43.4	0.70	30	392
Switzerland	29,898	348.9	1,476	17.2	2,072	24.2	0.74	18	92
Portugal	25,524	246.1	1,063	10.2	4,661	44.9	0.52	24	105
Sweden	22,721	231.0	2,769	28.1	7,944	80.7	0.91	73	1,123
Ireland	21,722	459.6	1,319	27.9	6,070	128.4	0.63	81	535
Austria	15,621	179.3	600	6.9	838	9.6	0.85	8	32
Poland	14,006	36.6	698	1.8	4,413	11.5	0.88	10	62
Romania	13,512	68.3	803	4.1	4,576	23.1	0.91	21	145
Denmark	9,670	169.3	493	8.6	2,155	37.7	0.84	32	170
Norway	7,847	146.2	208	3.9	734	13.7	0.72	10	27
Czech Republic	7,819	73.7	252	2.4	905	8.5	0.80	7	23
Finland	5,327	96.8	240	4.4	1,459	26.5	0.88	23	123
Luxembourg	3,828	664.6	96	16.7	270	46.9	0.87	41	NA
Hungary	3,065	31.4	363	3.7	967	9.9	0.86	9	122
Greece	2,632	23.5	146	1.3	387	3.5	0.81	3	16
Croatia	2,101	49.9	80	1.9	220	5.2	0.57	3	NA
Iceland	1,799	493.9	10	2.7	26	7.1	0.53	4	NA
Estonia	1,703	129.8	55	4.2	168	12.8	0.53	7	NA
Bulgaria	1,652	23.2	78	1.1	723	10.1	0.74	8	NA
Slovenia	1,439	69.2	97	4.7	104	5.0	0.54	3	NA
Lithuania	1,419	48.8	46	1.6	69	2.4	NA	NA	NA
Slovakia	1,413	26.0	25	0.5	240	4.4	0.47	2	NA
Latvia	896	45.5	16	0.8	157	8.0	0.83	7	NA
Cyprus	874	74.7	20	1.7	102	8.7	1.06	9	NA
Malta	480	111.9	4	0.9	49	11.4	NA	NA	NA
Liechtenstein	83	215.3	1	2.6	1	2.6	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
Best	Best	Best	Best	Best	Best	0.0	0	0

(1) ρ_3 is the average of 7 consecutive ρ, but can still fluctuate. (2) EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10^5 inhabitants (i.e. density of cases) by ρ_3 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10^5 inhabitants by ρ_3.

Highlights for countries with highest number of reported cases

- ✓ For 22 days, the UK has not been able to clearly reduce the number of new cases per day, remaining at about 4,000 cases per day, more than 5 cases per 100,000 inhabitants, and with a ρ_7 of 1.1. The number of deaths reported in the UK is 28,446, it could surpass Italy (with 28,884) in a few days

Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per 10^5 inhabitants (only for countries that have overtaken this threshold).

Countries	Days since the first 50 cases	Time interval between 1 and 10 cases / 105 inh. (days)	Time interval between 10 and 100 cases / 105 inh. (days)
Italy	73	11	16
France	67	10	20
Germany	67	12	17
Spain	65	7	12
United Kingdom	63	11	19
Norway	62	9	24
Switzerland	62	9	12
Netherlands	61	11	20
Sweden	61	10	28
Austria	60	10	14
Belgium	60	11	14
Greece	59	18	NA
Iceland	59	5	15
Denmark	57	4	30
Czech Republic	56	11	NA
Finland	55	12	NA
Portugal	55	9	15
Slovenia	55	6	NA
Ireland	54	8	18
Romania	54	15	NA
Estonia	53	5	30
Poland	53	17	NA
Bulgaria	51	25	NA
Luxembourg	51	6	7
Slovakia	51	24	NA
Croatia	50	12	NA
Latvia	49	12	NA
Cyprus	48	12	NA
Hungary	48	20	NA
Malta	47	8	34
Lithuania	46	9	NA
Liechtenstein	41	9	11

Analysis: Predicting hospitalizations and ICUs (I)

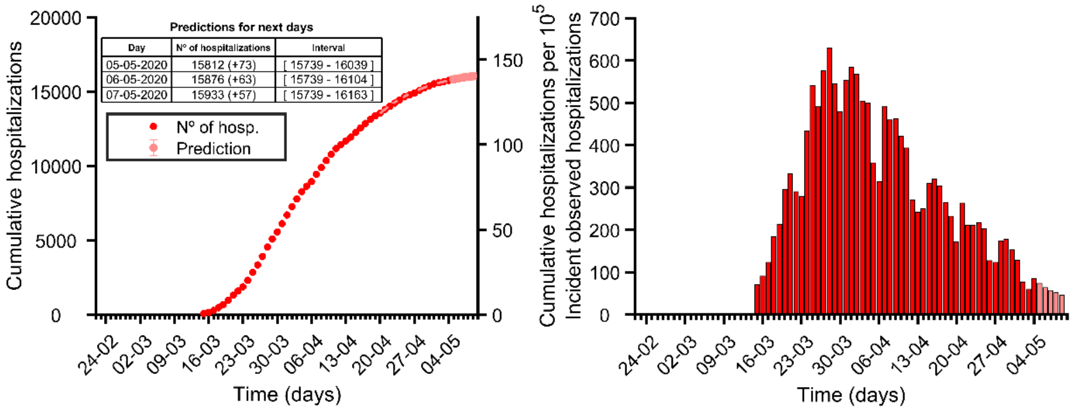
Hospital's capacity and availability of critical care points have been **major concerns of authorities for the management of the epidemic**. Several governments have requested advice from modelers in an attempt to find a way to predict occupation. Nevertheless, there has not been a proper reporting of data from governments and institutions regarding past hospitalizations and ICUs or, at least, in most of the cases, it is difficult to access it via public data portals.

Gompertz fits have shown usefulness for predicting hospitalizations and ICUs, when data were available. They require these data to be cumulative rather than prevalence, since prevalence depends on both admissions and discharges, so its dynamics is masked by the balance between both quantities.

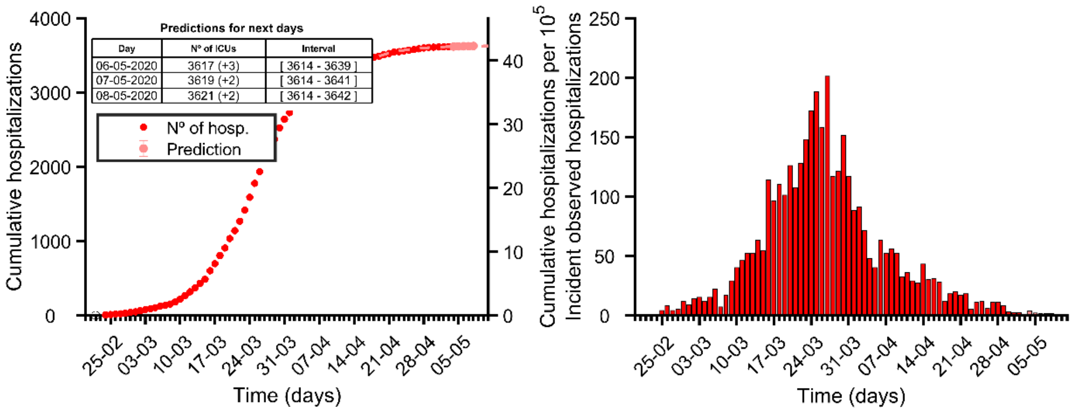
During the last weeks, we have been able to provide **short-term predictions** for Sweden (only ICUs), Switzerland (only hospitalizations), Belgium and its regions (only hospitalizations, since ICU data are reported as prevalence), and most Spanish regions (both hospitalizations and ICUs). Spain could not be analyzed as a whole because some of the regions have been reporting prevalence series until a few days ago. Italy also provides data, but only regarding prevalence. Therefore, predictions with Gompertz are not possible for this country.

The next figures show some examples of **hospitalizations** fittings and predictions. As seen, the higher the level of incidence, the smoother the curve, since noise is reduced.

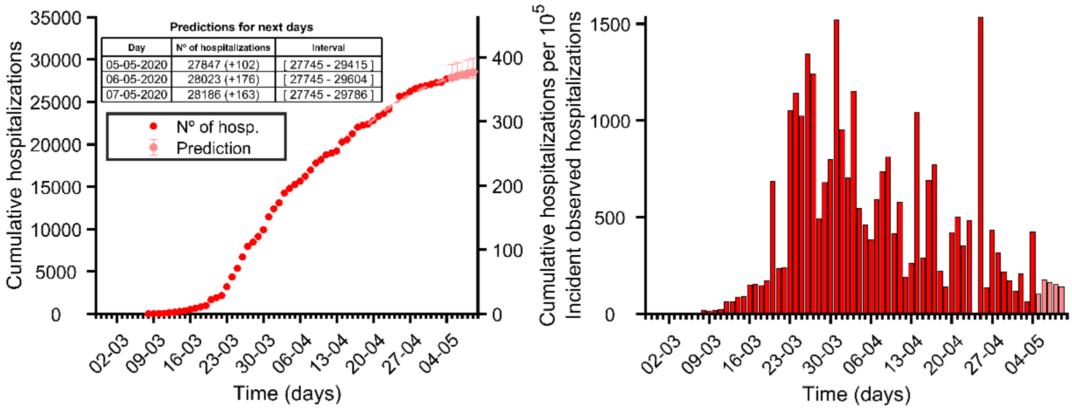
Belgium



Switzerland

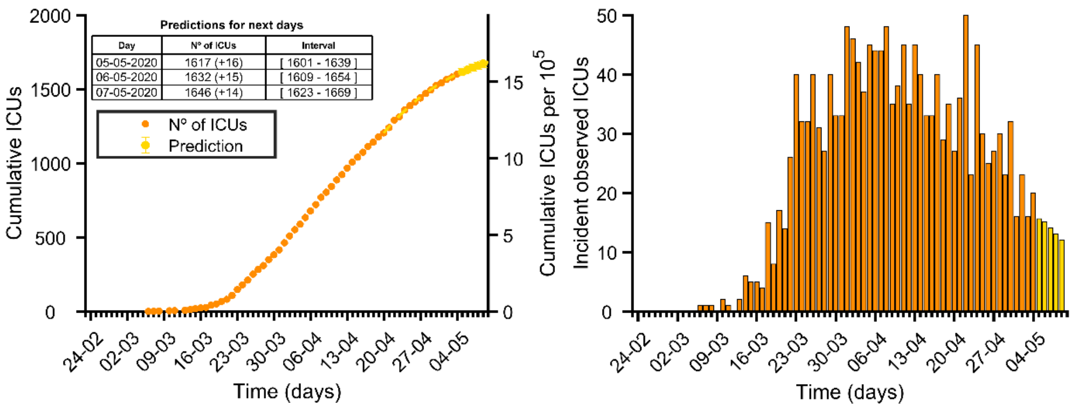


Catalunya (Spanish region)

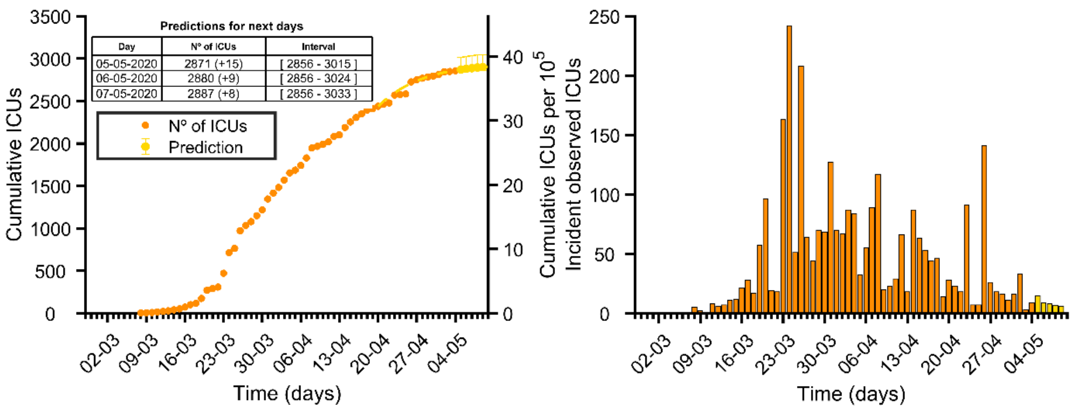


Next figures show some examples Gompertz fittings to **ICUs data**. Although numbers are lower, fittings and predictions are still reliable.

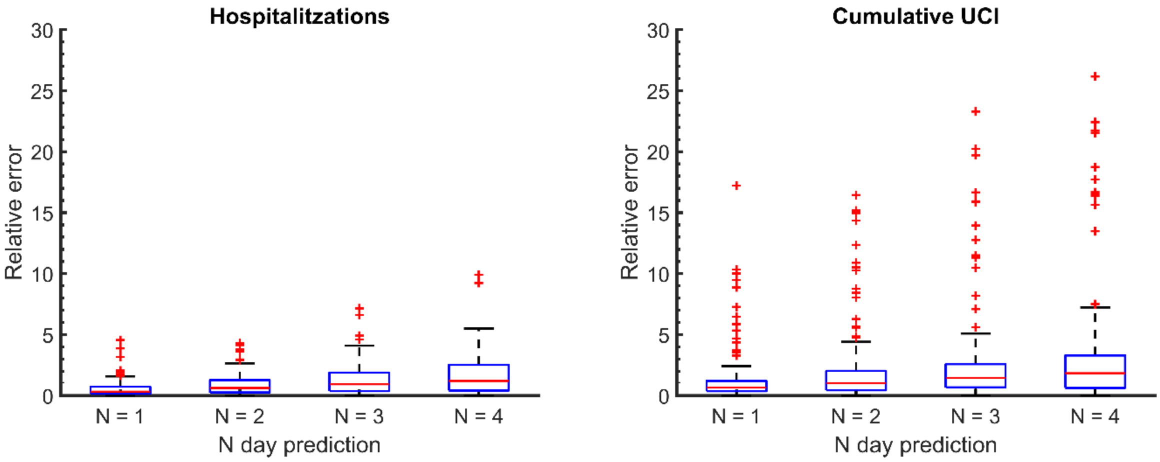
Sweden



Catalunya (Spanish region)

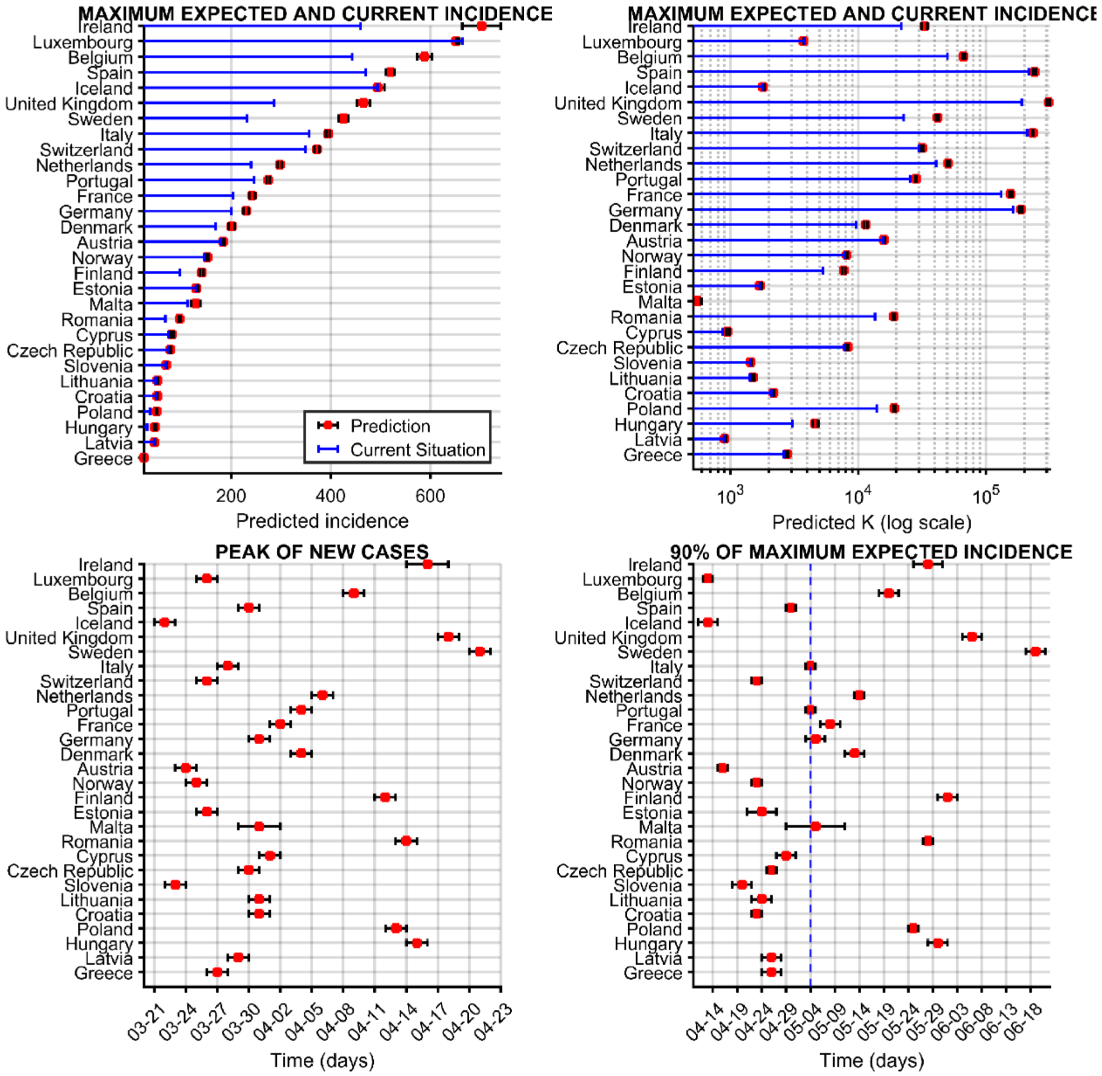


We have evaluated the **percentage of error in these predictions**. In the following figure, the error of predictions at 1, 2, 3, and 4 days is shown for both variables. In both cases, the mean error is under 5 %, although the size of the sample is quite limited (n≈130). In any case, it shows that this tool may be useful for management purposes. It should be appropriate to work at the lowest scale as possible, in order to delimit **predictions for regions that depend on a single or a few hospitals**. This would require detailed data availability, and would be only possible if noise does not mask the dynamics. If numbers are too low, the **scale should be increased to wider regions until a good balance between results' applicability and reliability is achieved**.

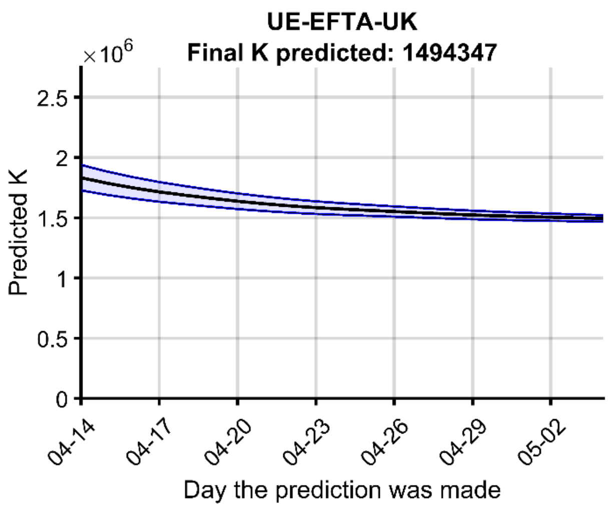

Hospitalitzations
Relative error
30
25
20
15
10
5
0
N = 1
N = 2
N = 3
N = 4
N day prediction
Cumulative UCI
Relative error
30
25
20
15
10
5
0
N = 1
N = 2
N = 3
N = 4
N day prediction

Long-term predictions

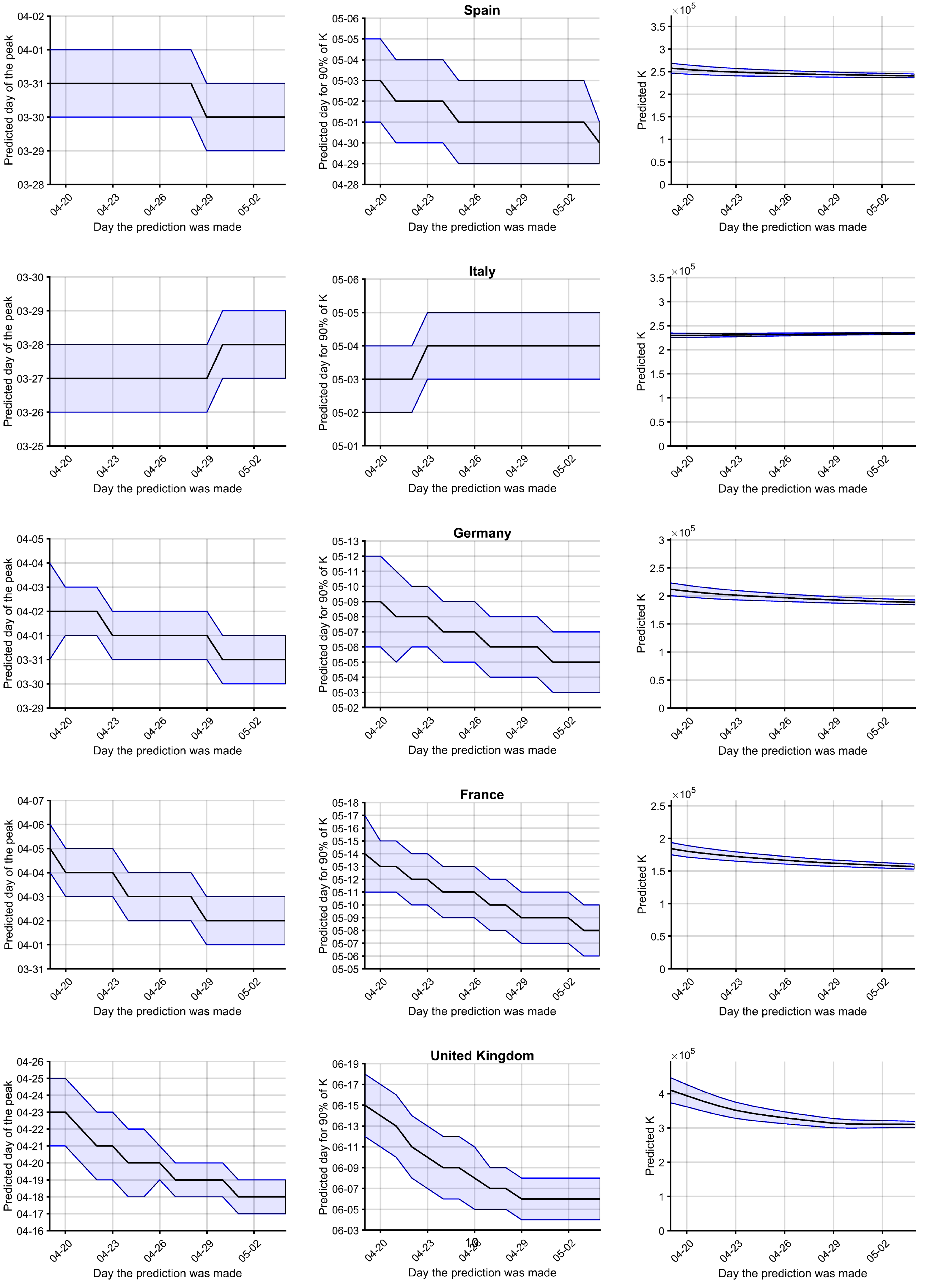
Long-term predictions, evaluated with the **whole historical series** and without weighting last 3 points. Up-left: Predictions of maximum incidences per country (total final expected attack rate per 10^5 inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



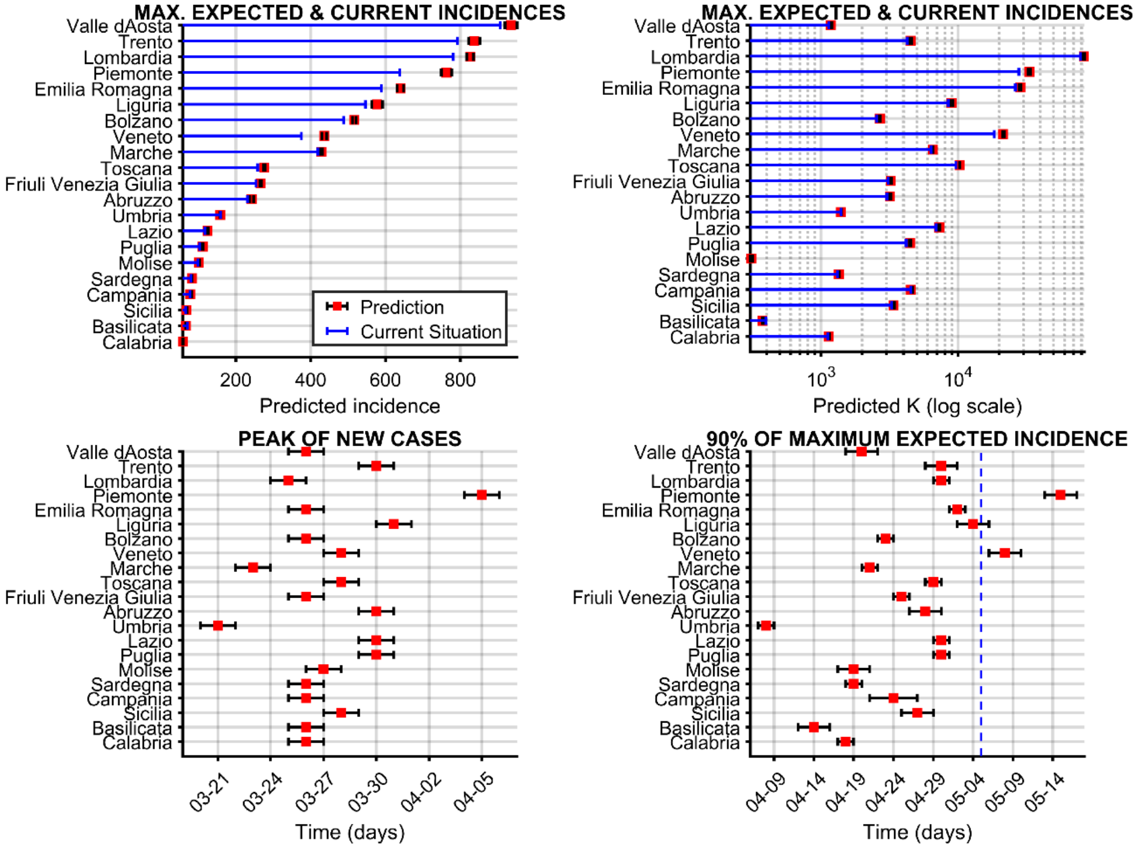
Final expected K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown in title.



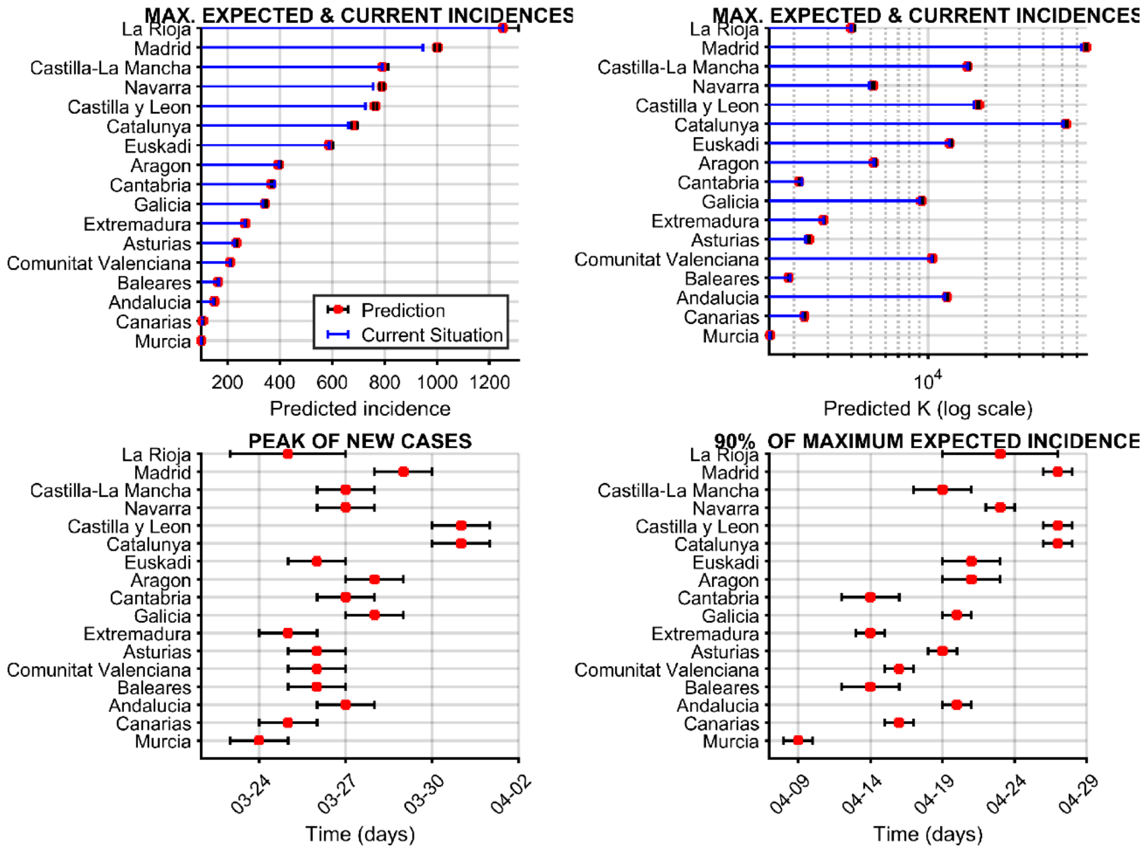
2020-05-04


Spain
Italy
Germany
France
United Kingdom
Predicted day of the peak
Predicted day for 90% of K
Predicted K
×10^5
Day the prediction was made

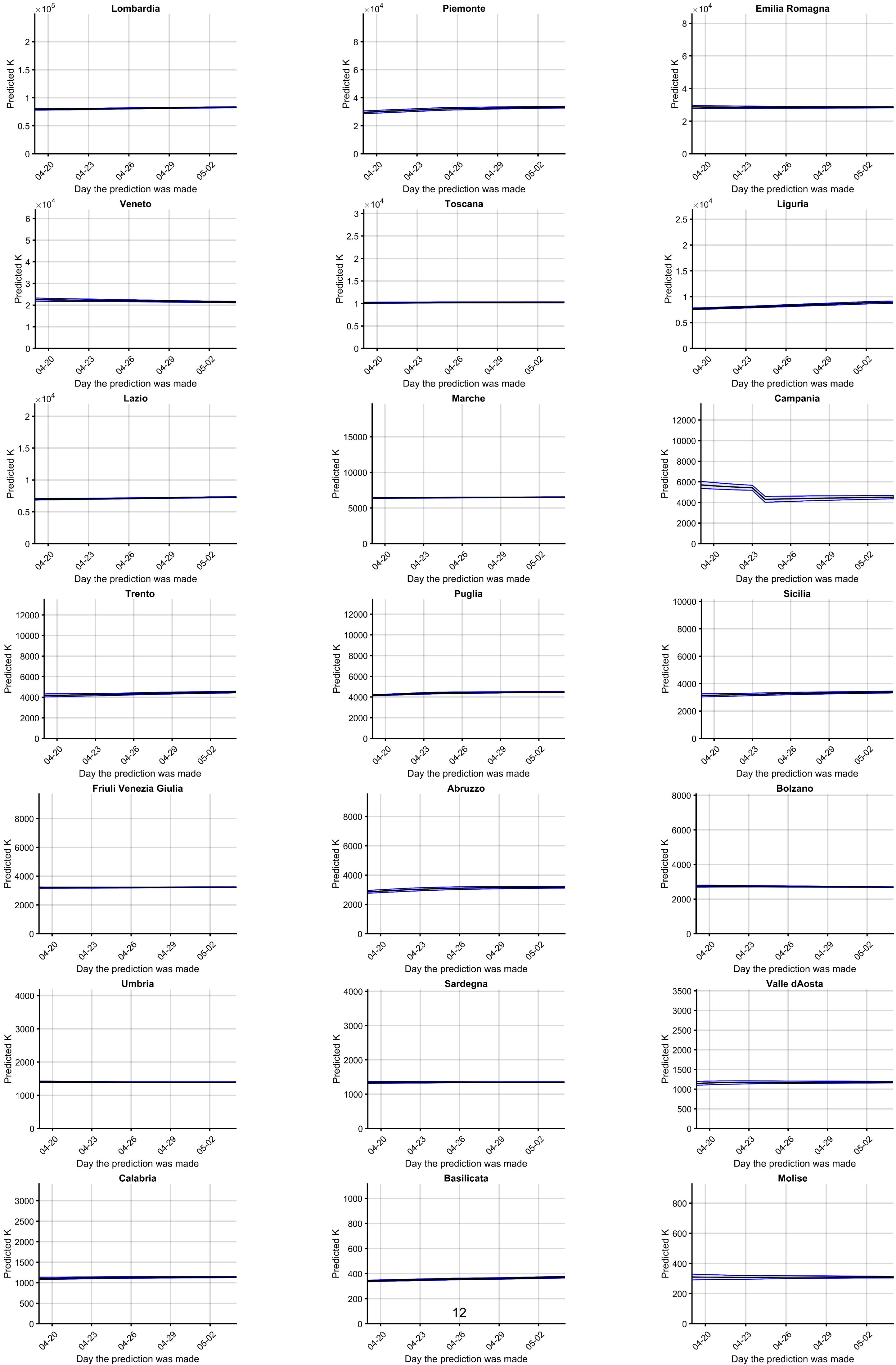
Italian regions



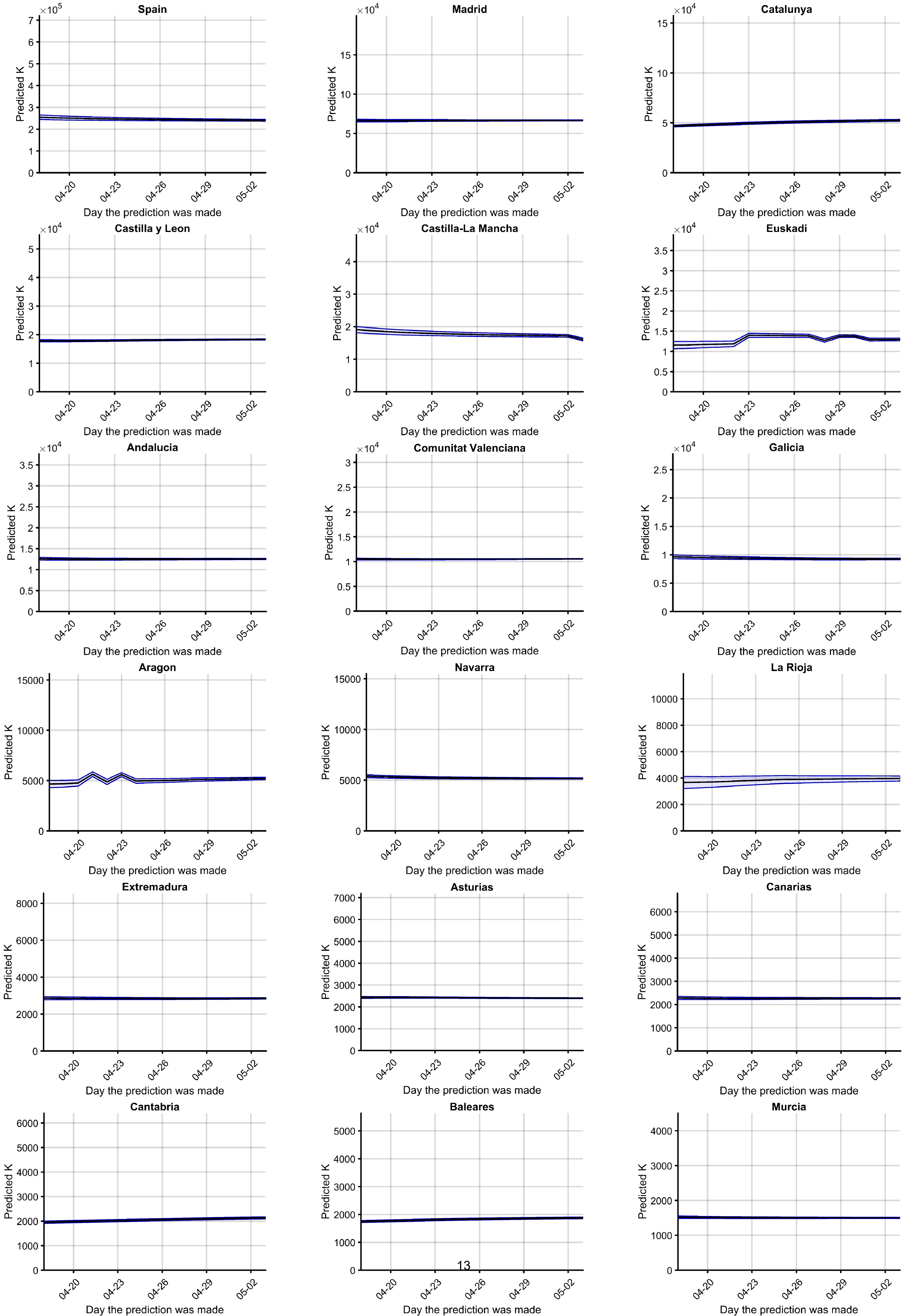
Spanish regions



2020-05-05


Lombardia
Piemonte
Emilia Romagna
Veneto
Toscana
Liguria
Lazio
Marche
Campania
Trento
Puglia
Sicilia
Friuli Venezia Giulia
Abruzzo
Bolzano
Umbria
Sardegna
Valle dAosta
Calabria
Basilicata
Molise
Predicted K
Day the prediction was made
04-20
04-23
04-26
04-29
05-02

2020-05-04



Spain
Madrid
Catalunya
Castilla y Leon
Castilla-La Mancha
Euskadi
Andalucia
Comunitat Valenciana
Galicia
Aragon
Navarra
La Rioja
Extremadura
Asturias
Canarias
Cantabria
Baleares
Murcia
Predicted K
Day the prediction was made
04-20
04-23
04-26
04-29
05-02

Situation and trends in Italian and Spanish regions

Italy

	Reported data						Indexes		
Country	Cumulative cases	Attack rate / 10^5 inh.	Cumulative deaths	Mortality / 10^5 inh.	Active cases (last 14 days)	14-day attack rate / 10^5 inh	ρ_7 (1)	EPG_{REP} (2)	EPG_{EST} (3)
Lombardia	78.605	782,8	14.389	143,3	10.674	106,3	0,75	80	1.493
Piemonte	27.774	637,5	3.216	73,8	5.819	133,6	0,79	106	1.262
Emilia Romagna	26.275	589,2	3.705	83,1	3.183	71,4	0,84	60	862
Veneto	18.402	375,1	1.545	31,5	1.998	40,7	0,74	30	265
Toscana	9.631	258,2	889	23,8	1.028	27,6	0,73	20	197
Liguria	8.475	546,5	1.232	79,5	1.711	110,3	0,79	88	1.315
Lazio	6.914	117,6	534	9,1	1.019	17,3	0,82	14	115
Marche	6.392	419,1	936	61,4	515	33,8	0,77	26	390
Campania	4.518	77,9	369	6,4	383	6,6	0,69	5	38
Trento	4.261	397,4	433	40,4	647	60,3	0,71	43	882
Puglia	4.170	103,5	433	10,7	548	13,6	0,78	11	109
Sicilia	3.267	65,3	247	4,9	432	8,6	0,65	6	45
Friuli Venezia Giulia	3.085	253,9	303	24,9	293	24,1	0,62	15	148
Abruzzo	3.025	230,6	335	25,5	358	27,3	0,74	20	229
Bolzano	2.542	2.366,1	286	266,2	132	122,9	0,56	69	165
Umbria	1.400	158,7	70	7,9	47	5,3	1,14	6	NA
Sardegna	1.318	80,4	119	7,3	82	5,0	0,77	4	36
Valle dAosta	1.143	910,0	139	110,7	50	39,8	1,45	58	720
Calabria	1.119	57,5	88	4,5	72	3,7	0,55	2	NA
Basilicata	396	70,4	25	4,4	46	8,2	NA	NA	NA
Molise	301	98,5	22	7,2	19	6,2	0,39	2	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	0,0	0	0

Spain

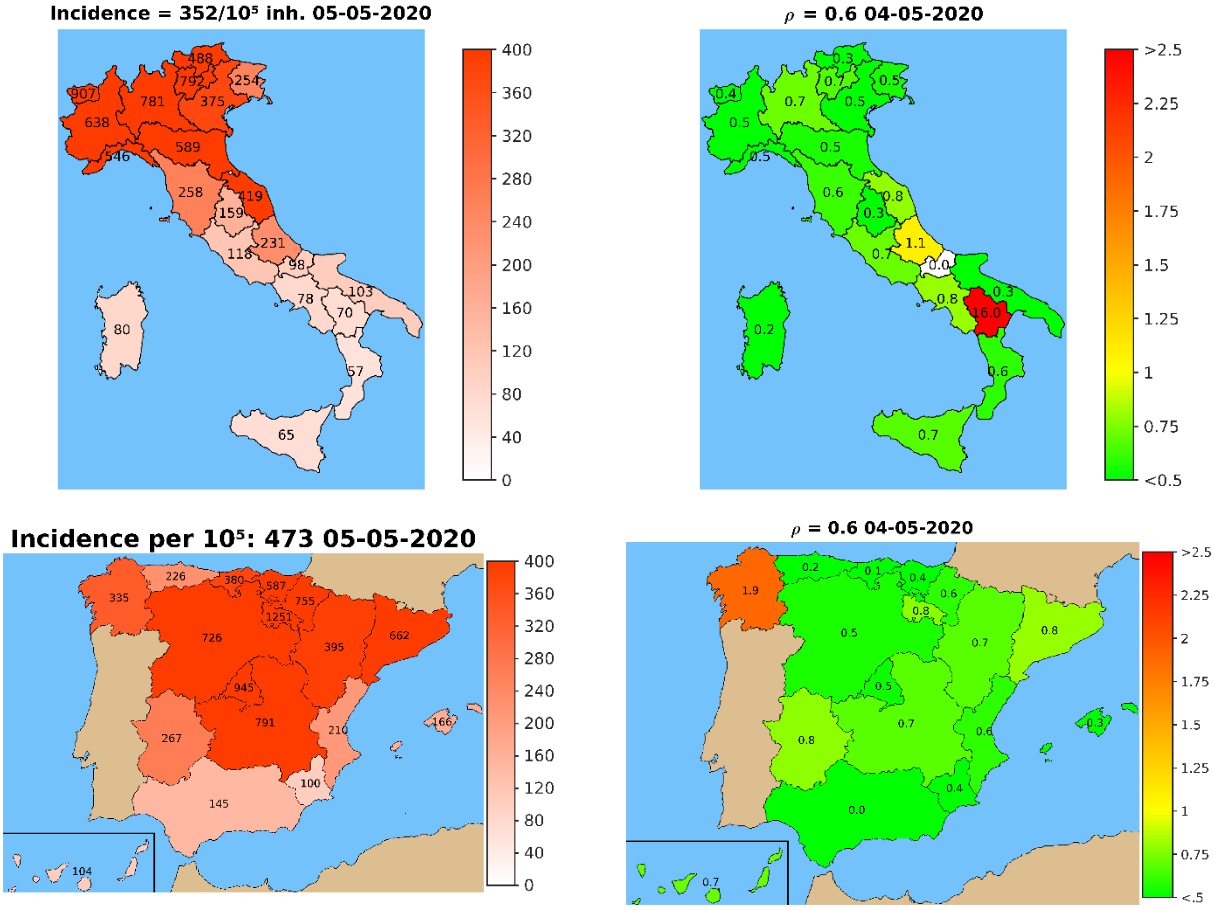
	Reported data						INAexes		
Autonomous regions	Cumulative cases	Attack rate /10^5 inh.	Cumulated deaths	Mortality rate /10^5 inh.	Active cases (last 14 days)	14-day attack rate /10^5 inh.	ρ_7 (1)	EPG_{REP} (2)	EPG_{EST} (3)
Madrid	62.989	948,5	8.420	126,8	7.664	115,4	0,75	87	1.181
Catalunya	50.771	671,1	5.270	69,7	7.659	101,2	0,6	64	699
Castilla y Leon	17.429	723,8	1.832	76,1	2.478	102,9	0,62	64	688
Castilla-La Mancha	16.080	790,0	2.616	128,5	1.144	56,2	0,6	34	575
Euskadi	12.965	595,3	1.353	62,1	1.358	62,3	0,58	36	382
Andalucia	12.210	144,9	1.267	15,0	1.071	12,7	0,44	6	60
Comunitat Valenciana	10.500	211,1	1.279	25,7	750	15,1	0,68	10	126
Galicia	9.051	335,2	573	21,2	714	26,4	1,54	41	272
Aragon	5.207	394,2	770	58,3	523	39,6	0,75	30	445
Navarra	4.936	759,4	471	72,5	461	70,9	0,71	51	496
La Rioja	3.967	1.265,1	336	107,1	283	90,2	0,44	40	340
Extremadura	2.852	267,7	462	43,4	160	15,0	1,60	24	400
Asturias	2.308	225,8	284	27,8	116	11,3	1,11	13	156
Canarias	2.231	101,1	142	6,4	146	6,6	0,49	3	22
Cantabria	2.207	379,4	198	34,0	209	35,9	0,82	29	284
Baleares	1.910	160,8	198	16,7	143	12,0	0,57	7	75
Murcia	1.496	100,6	136	9,1	51	3,4	0,84	3	26
Melilla	119	140,5	2	2,4	14	16,5	NA	NA	NA
Ceuta	101	119,0	4	4,7	1	1,2	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	0,0	0	0

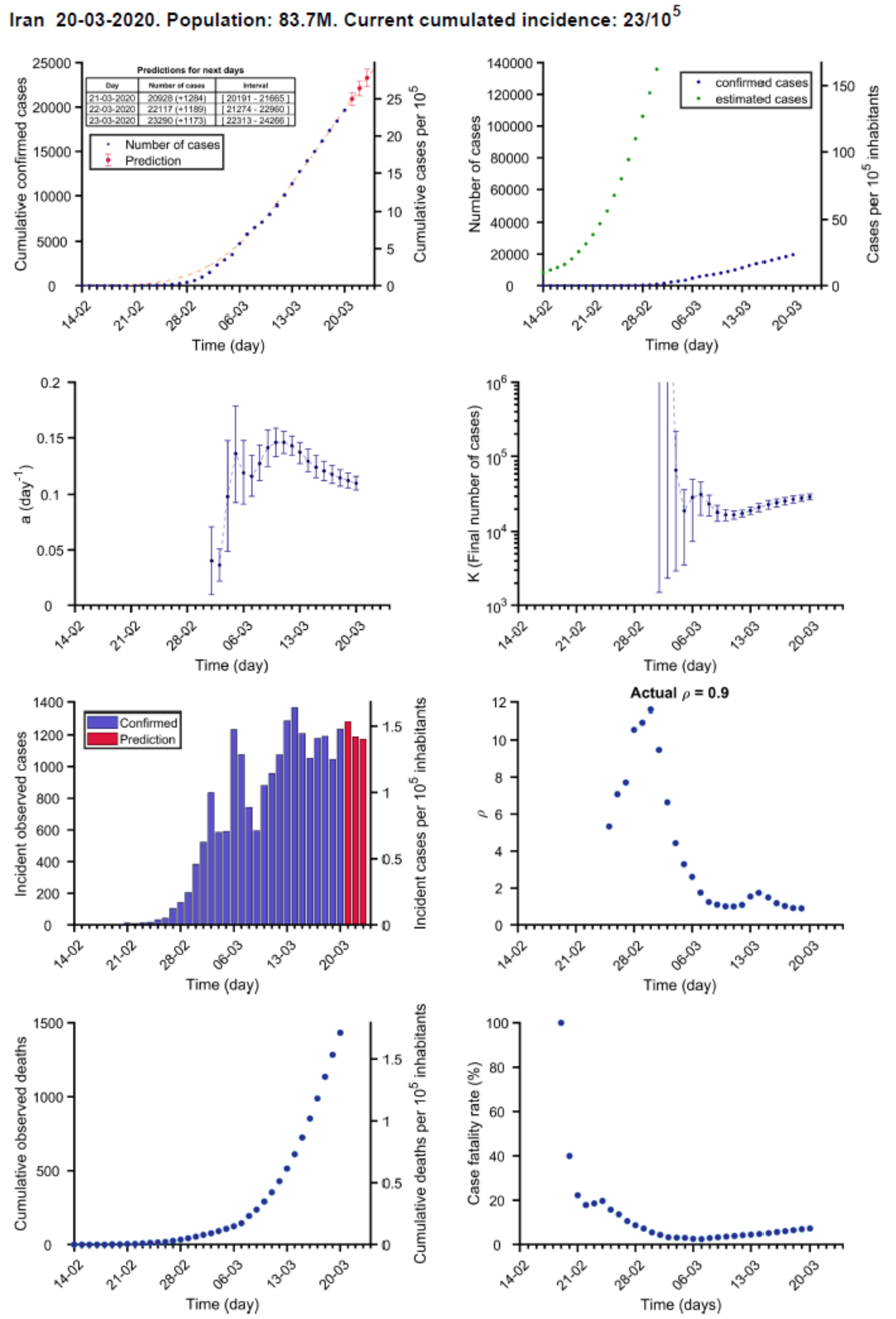
(1) ρ_3 is the average of 7 consecutive ρ, but can still fluctuate. (2) EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10^5 inhabitants (i.e. density of cases) by ρ_3 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10^5 inhabitants by ρ_3.

Maps of Italian and Spanish regions

Cumulative incidence and spreading rate (ρ) in Italian and Spanish regions.



Legend: Countries' reports details



Confirmed cases: data (blue), model fitted (dashed line), predictions (red points and table)

Estimated cases using death rate (see Methods)

Fitted *a* value using points prior to each date

Fitted *K* value using points prior to each date

Reported and predicted new cases

Evolution of *ρ*, a parameter related with Reproduction number (see Methods)

Reported deaths

Deaths / cumulated reported cases

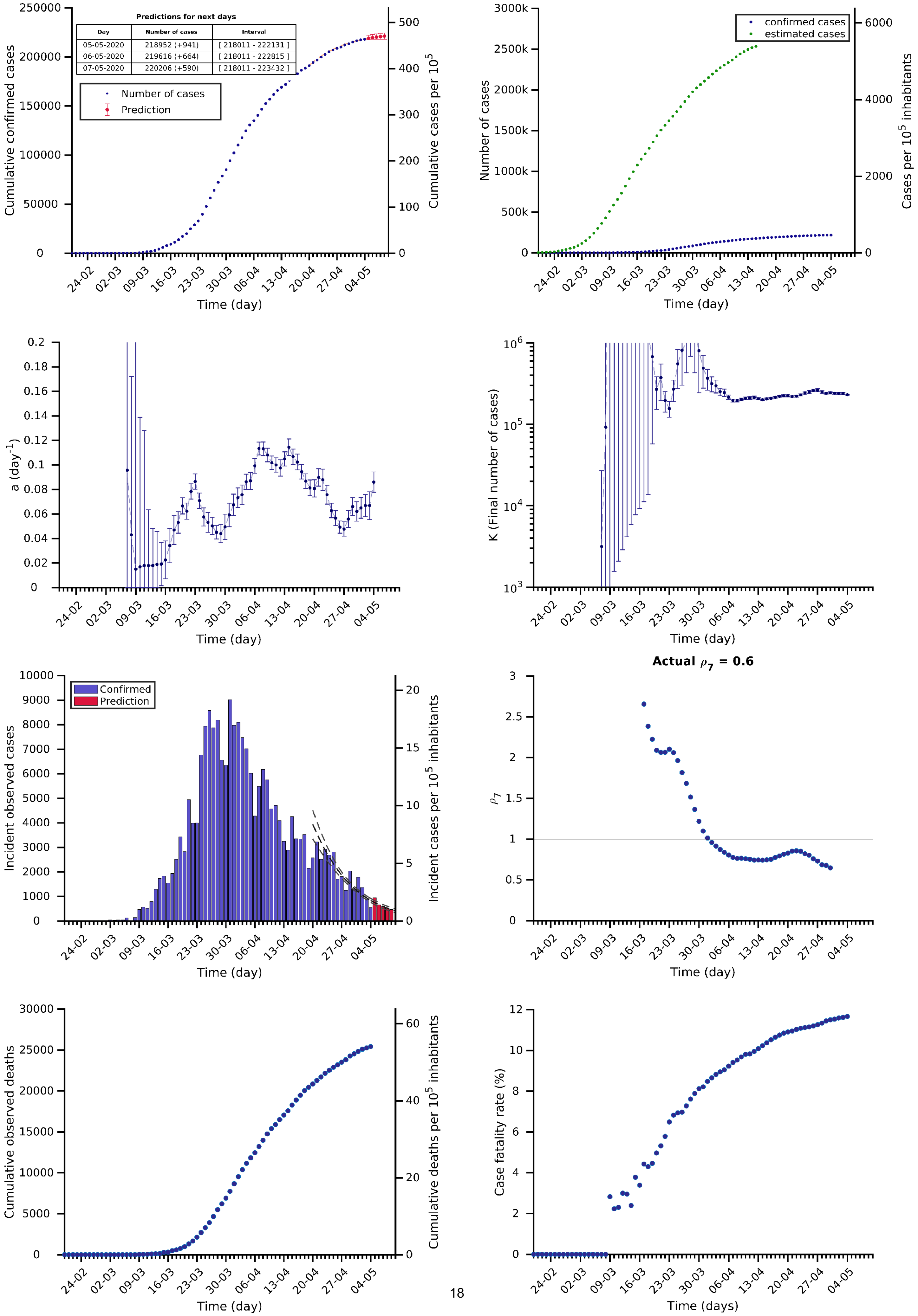
(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

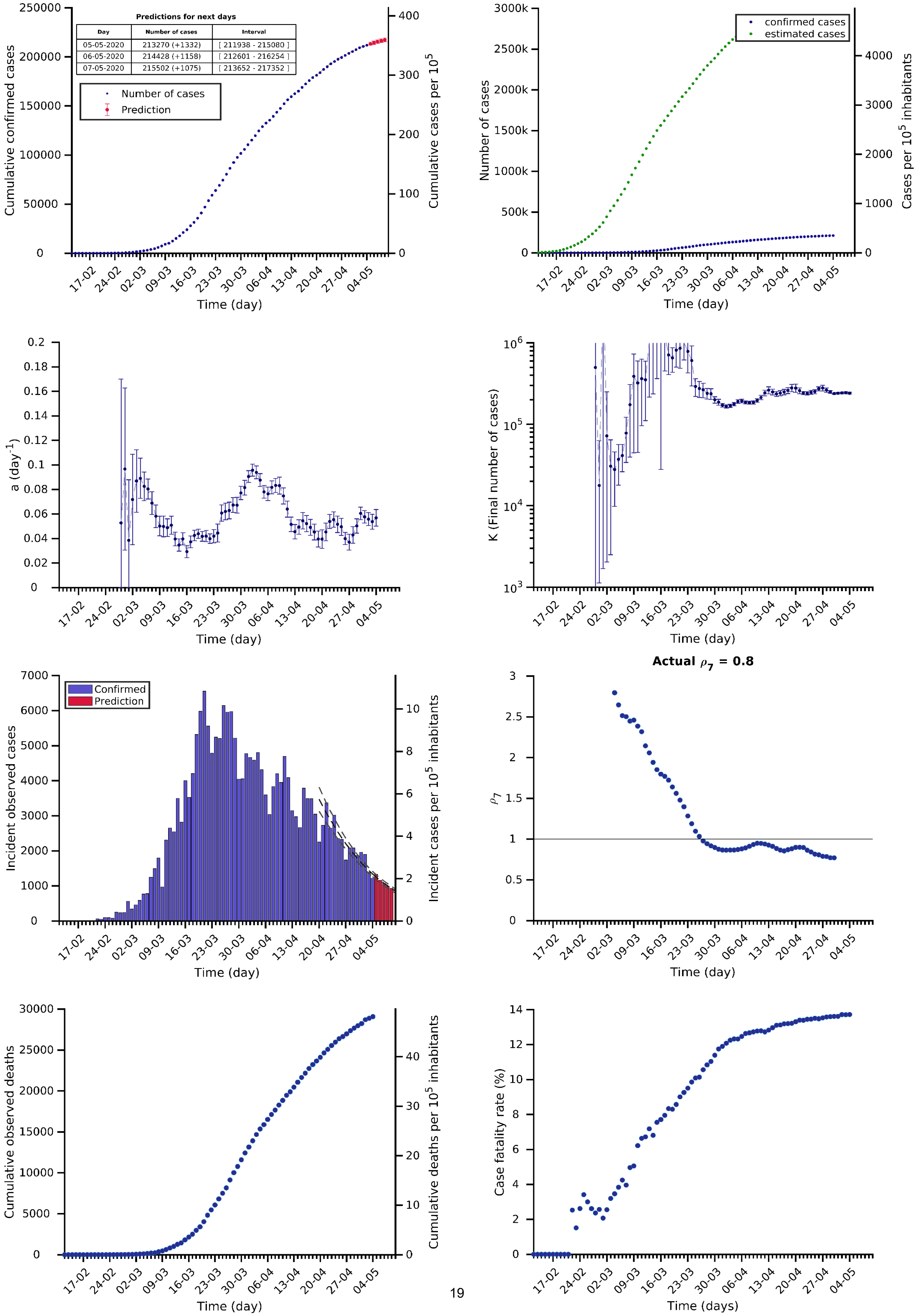
Spain 04-05-2020. Population: 47.0M. Current cumulated incidence: 464/10^5

Predictions for next days

Day	Number of cases	Interval
05-05-2020	218952 (+941)	[218011 - 222131]
06-05-2020	219616 (+664)	[218011 - 222815]
07-05-2020	220206 (+590)	[218011 - 223432]

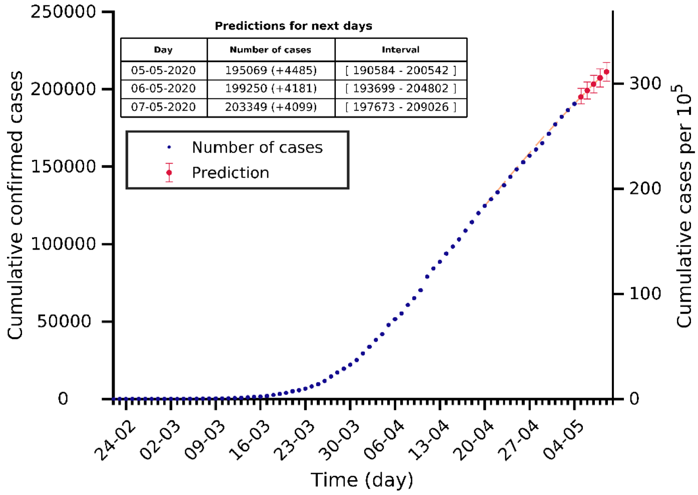


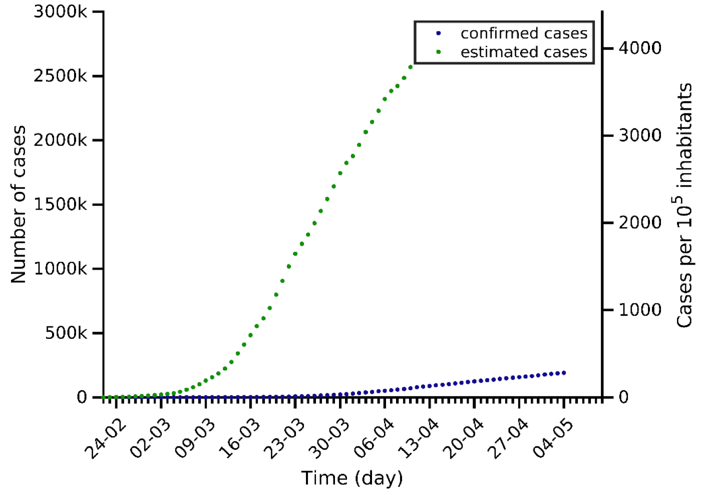
Italy 04-05-2020. Population: 60.5M. Current cumulated incidence: 351/10^5

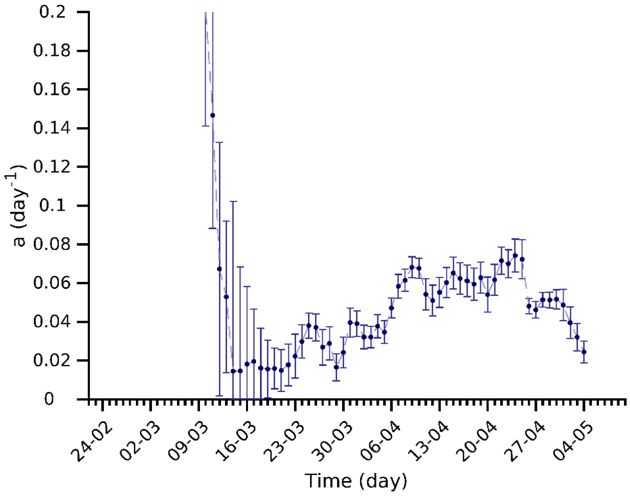


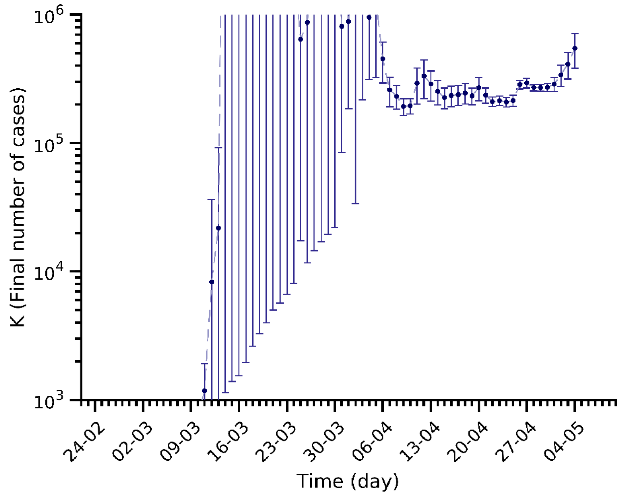
Day	Number of cases	Interval
05-05-2020	213270 (+1332)	[211938 - 215080]
06-05-2020	214428 (+1158)	[212601 - 216254]
07-05-2020	215502 (+1075)	[213652 - 217352]

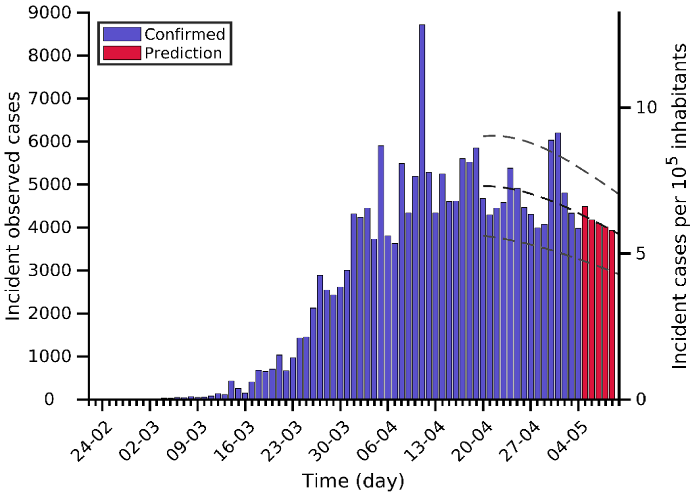
UK 04-05-2020. Population: 67.9M. Current cumulated incidence: 281/10⁵

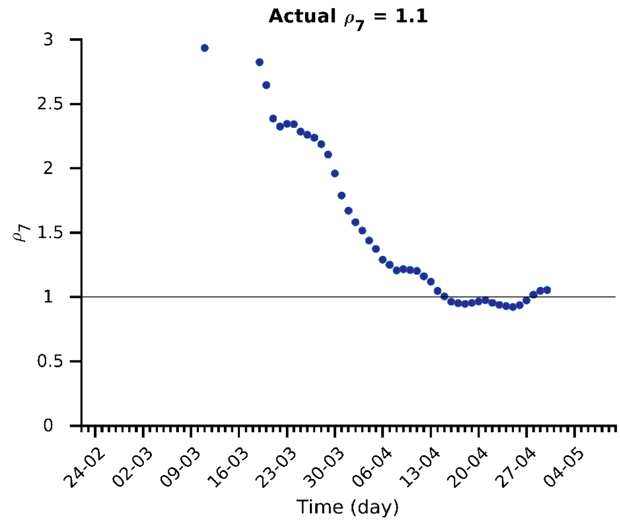


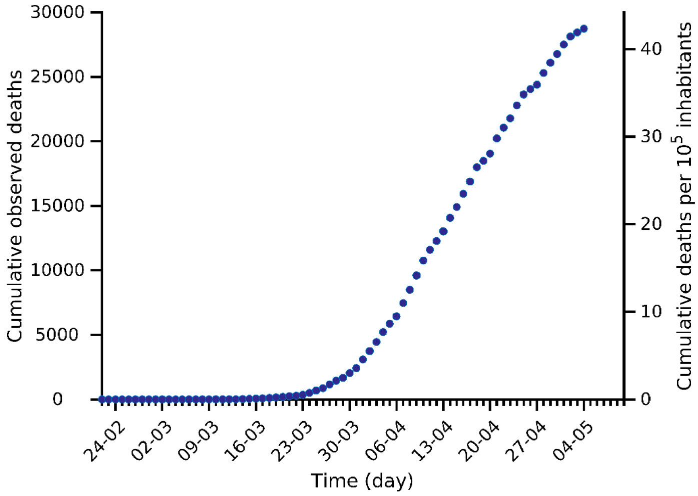


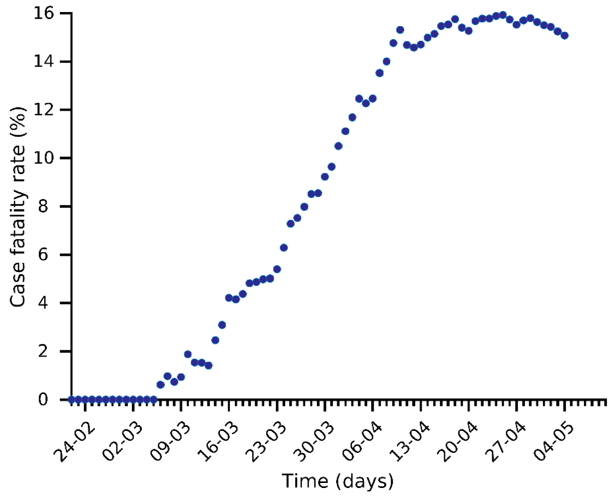




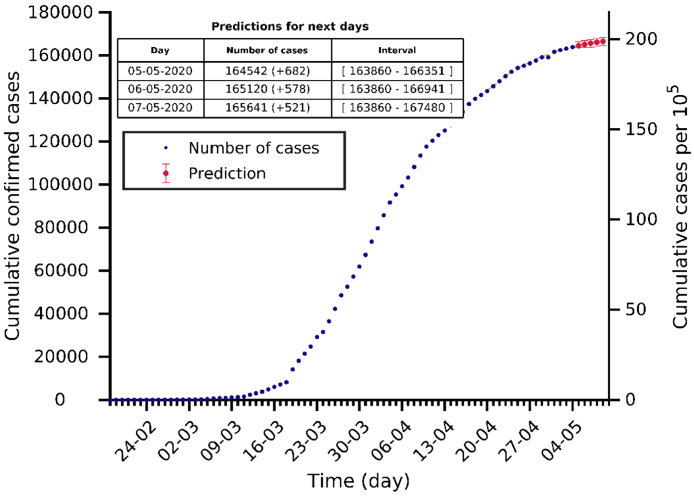




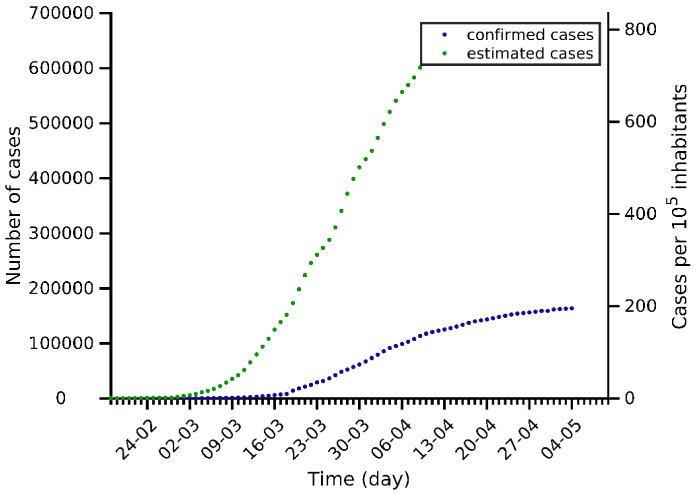


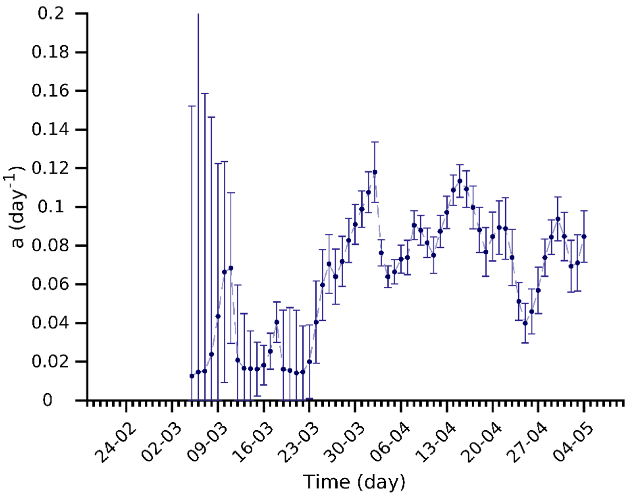


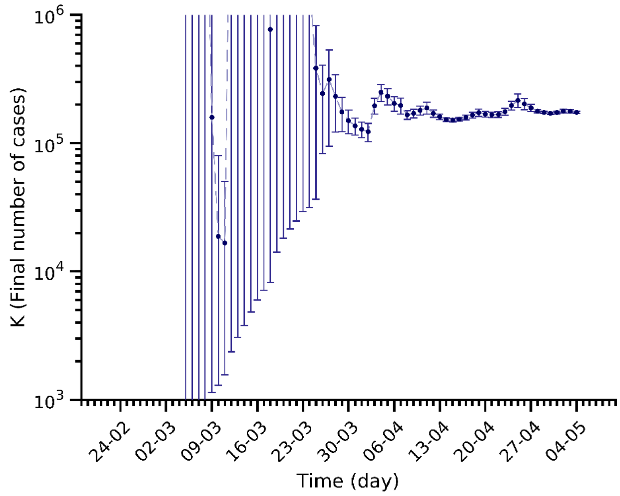
Germany 04-05-2020. Population: 83.8M. Current cumulated incidence: 196/10⁵

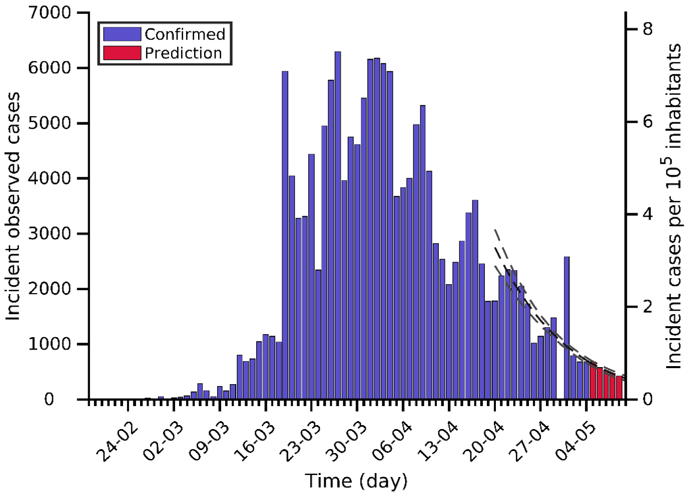


Day	Number of cases	Interval
05-05-2020	164542 (+682)	[163860 - 166351]
06-05-2020	165120 (+578)	[163860 - 166941]
07-05-2020	165641 (+521)	[163860 - 167480]

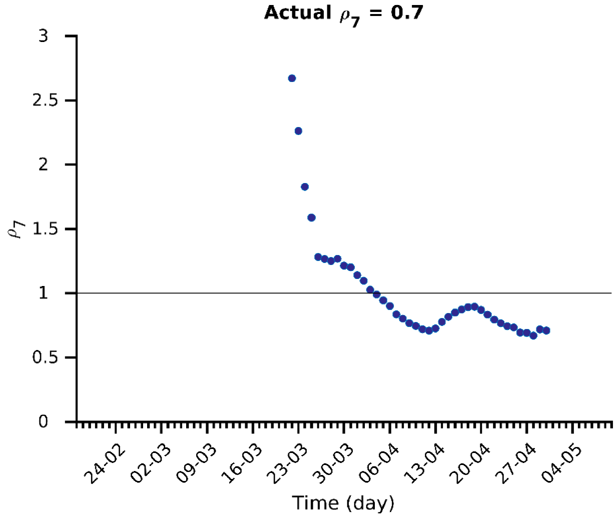


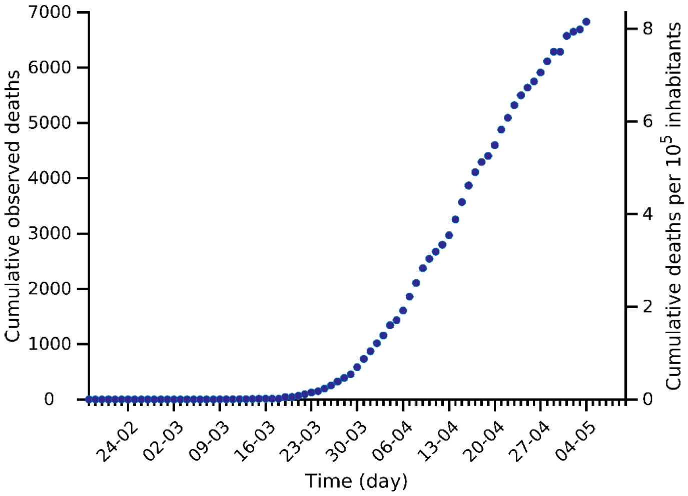


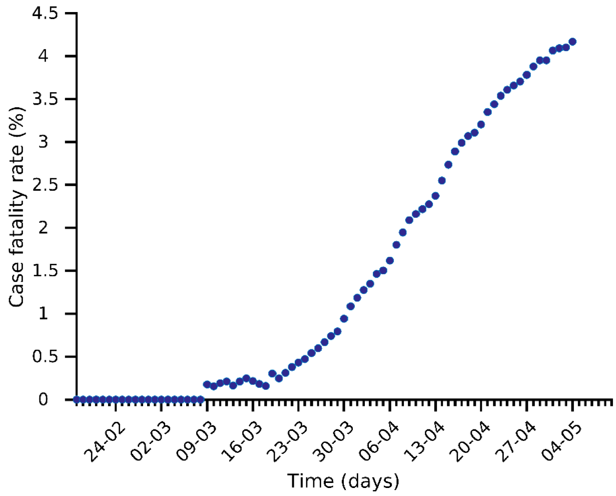




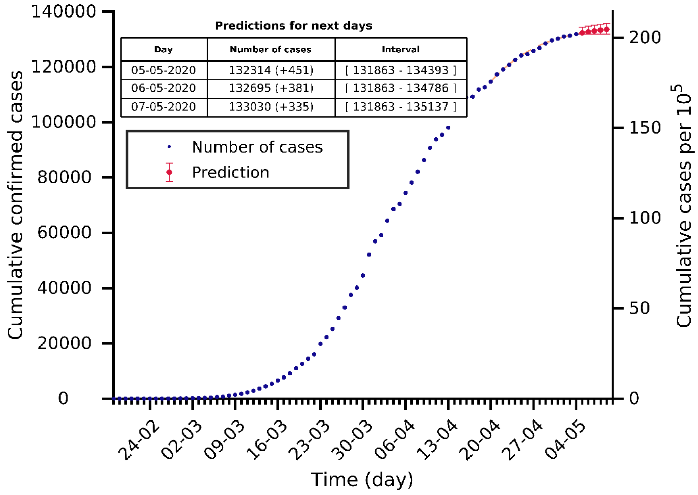
Actual ρ_7 = 0.7

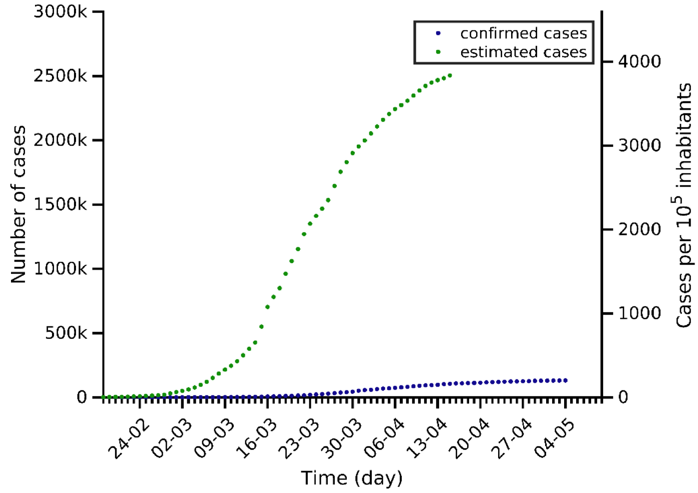


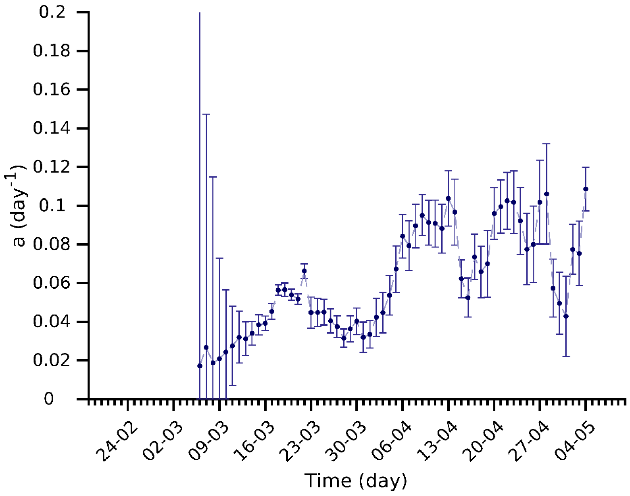


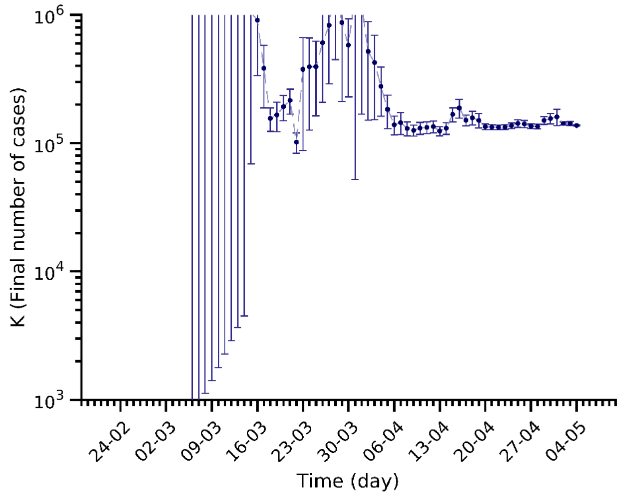


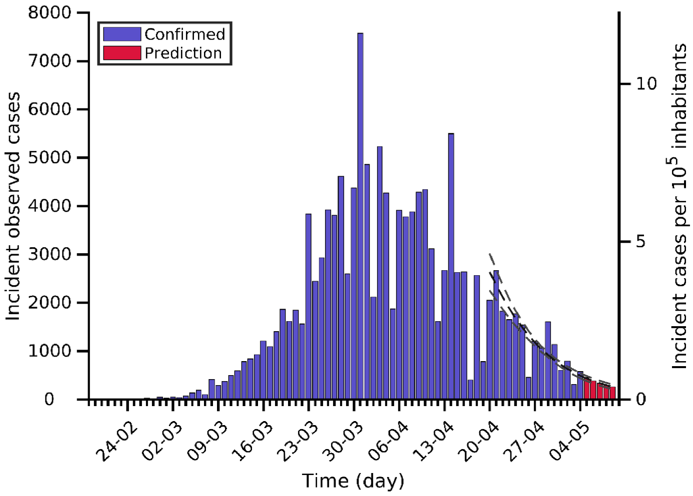
France 04-05-2020. Population: 65.3M. Current cumulated incidence: 202/10^5

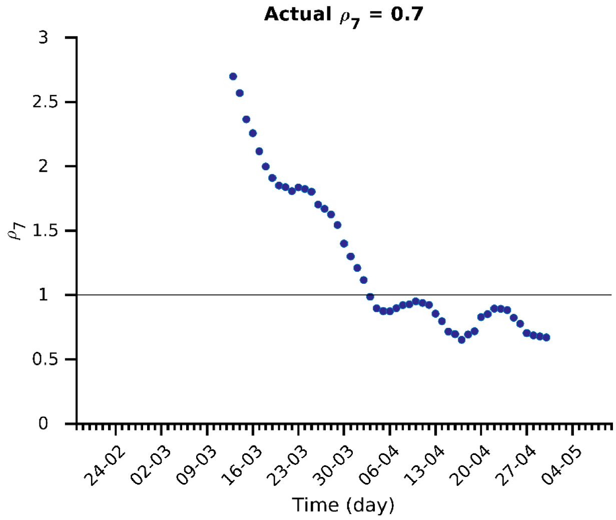


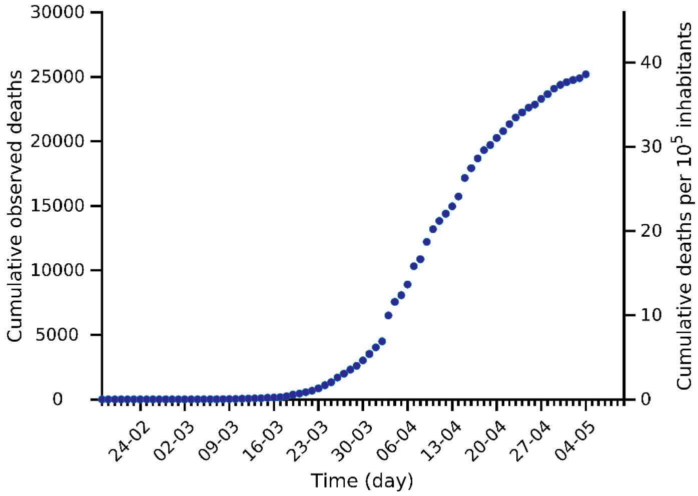


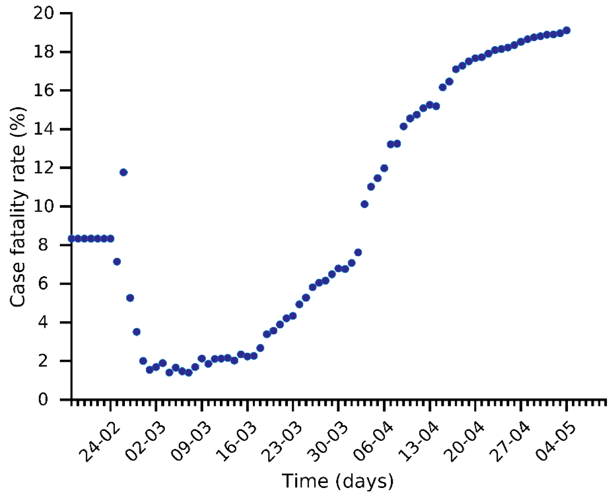




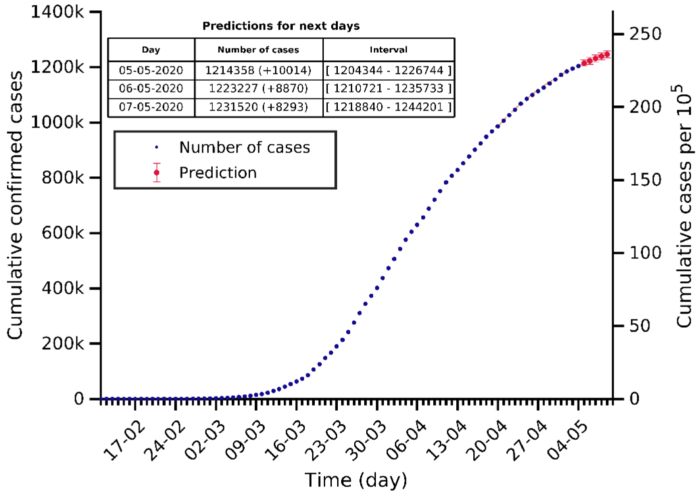


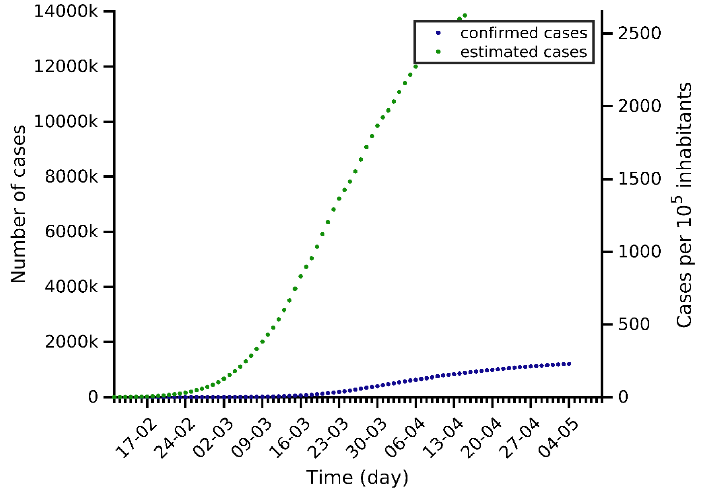


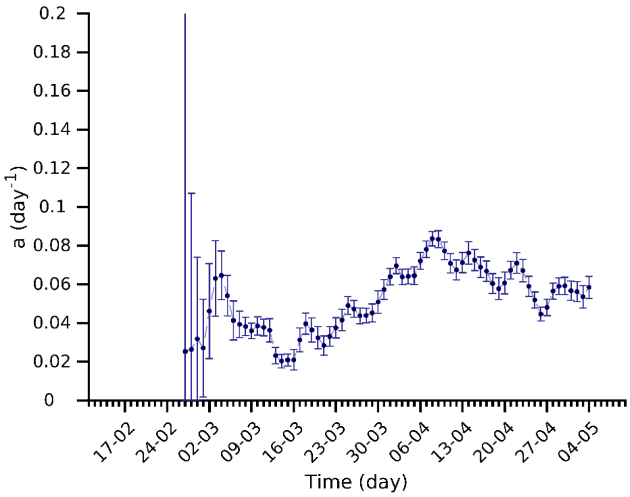


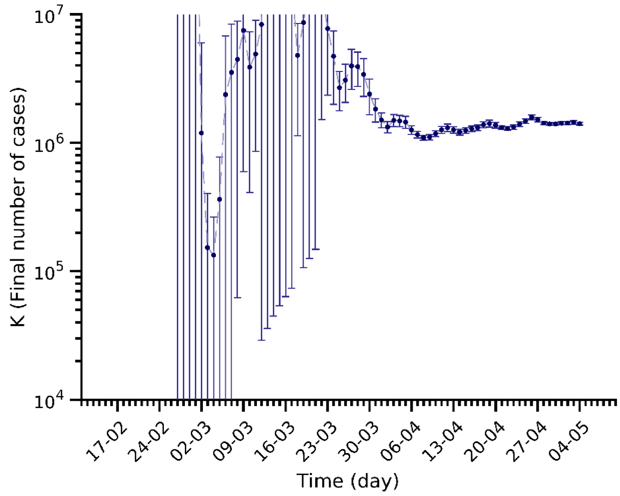


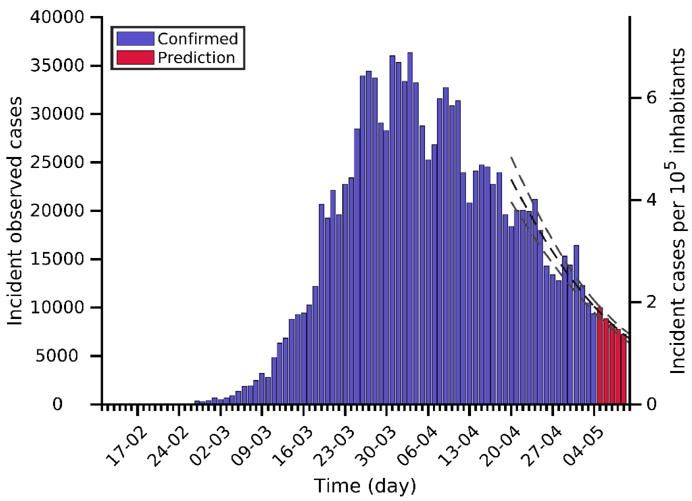
EU+EFTA+UK 04-05-2020. Population: 527.9M. Current cumulated incidence: 228/1

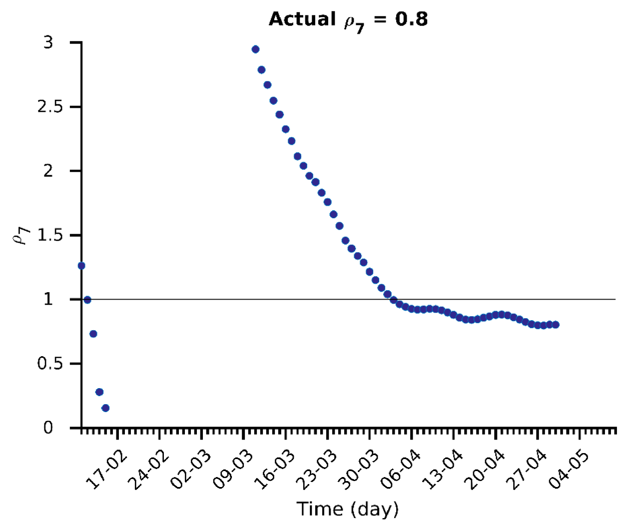


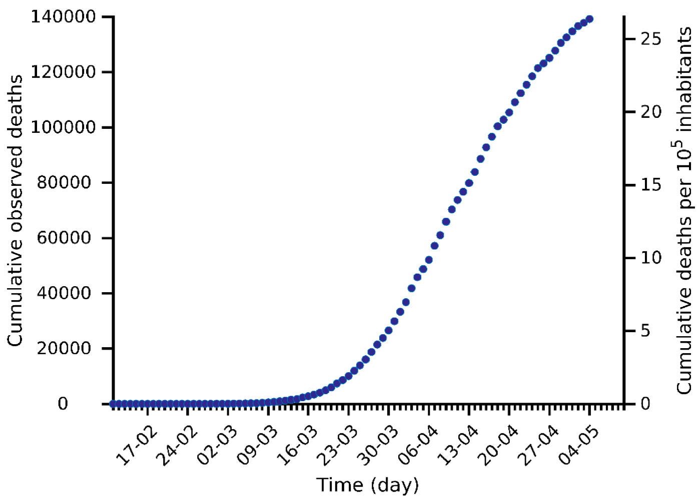


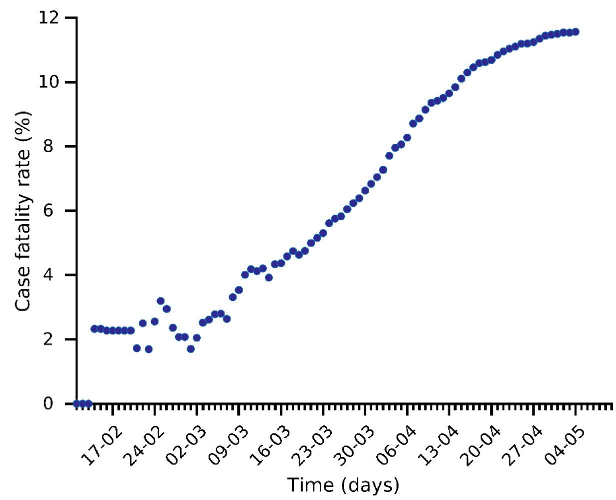




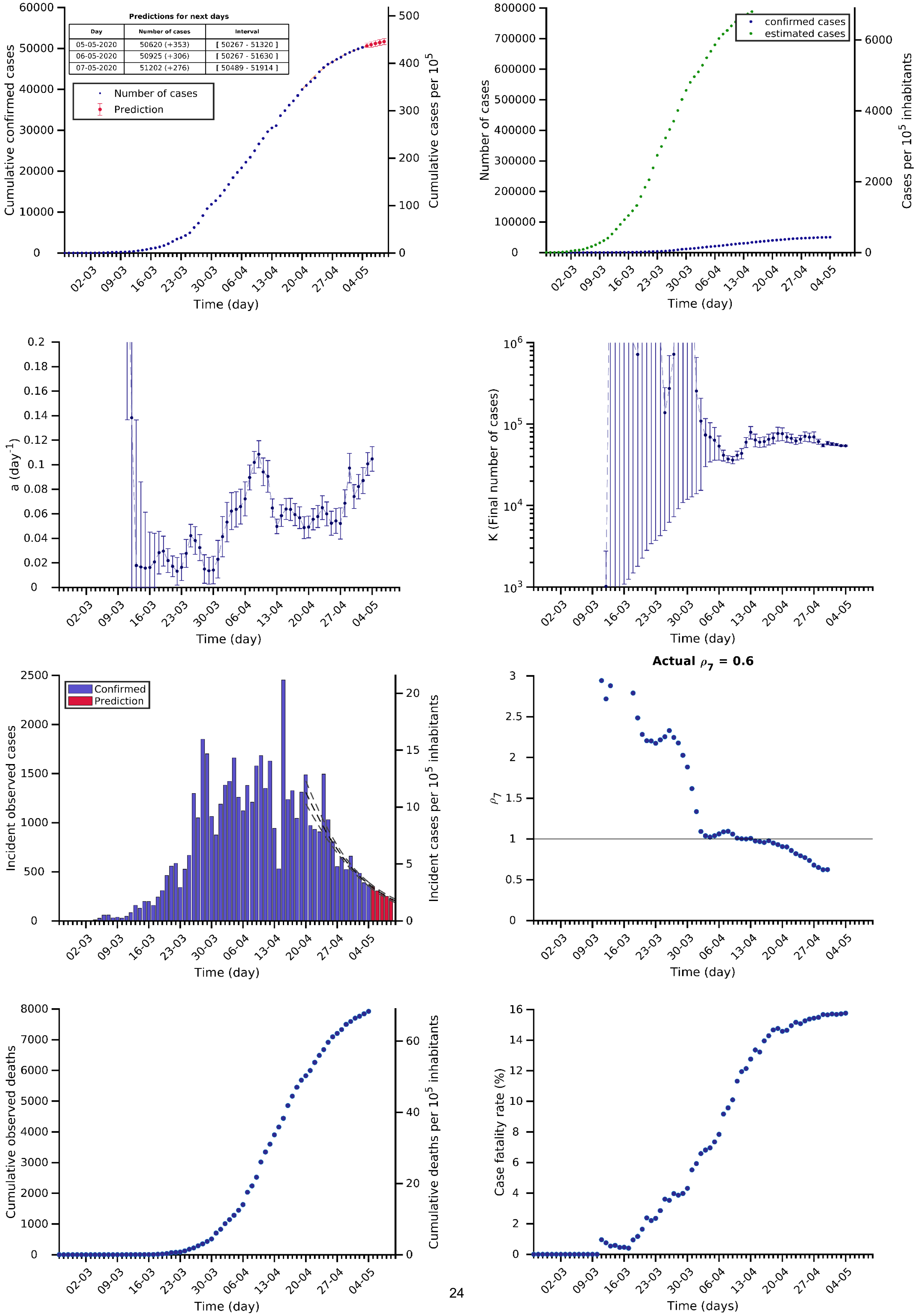




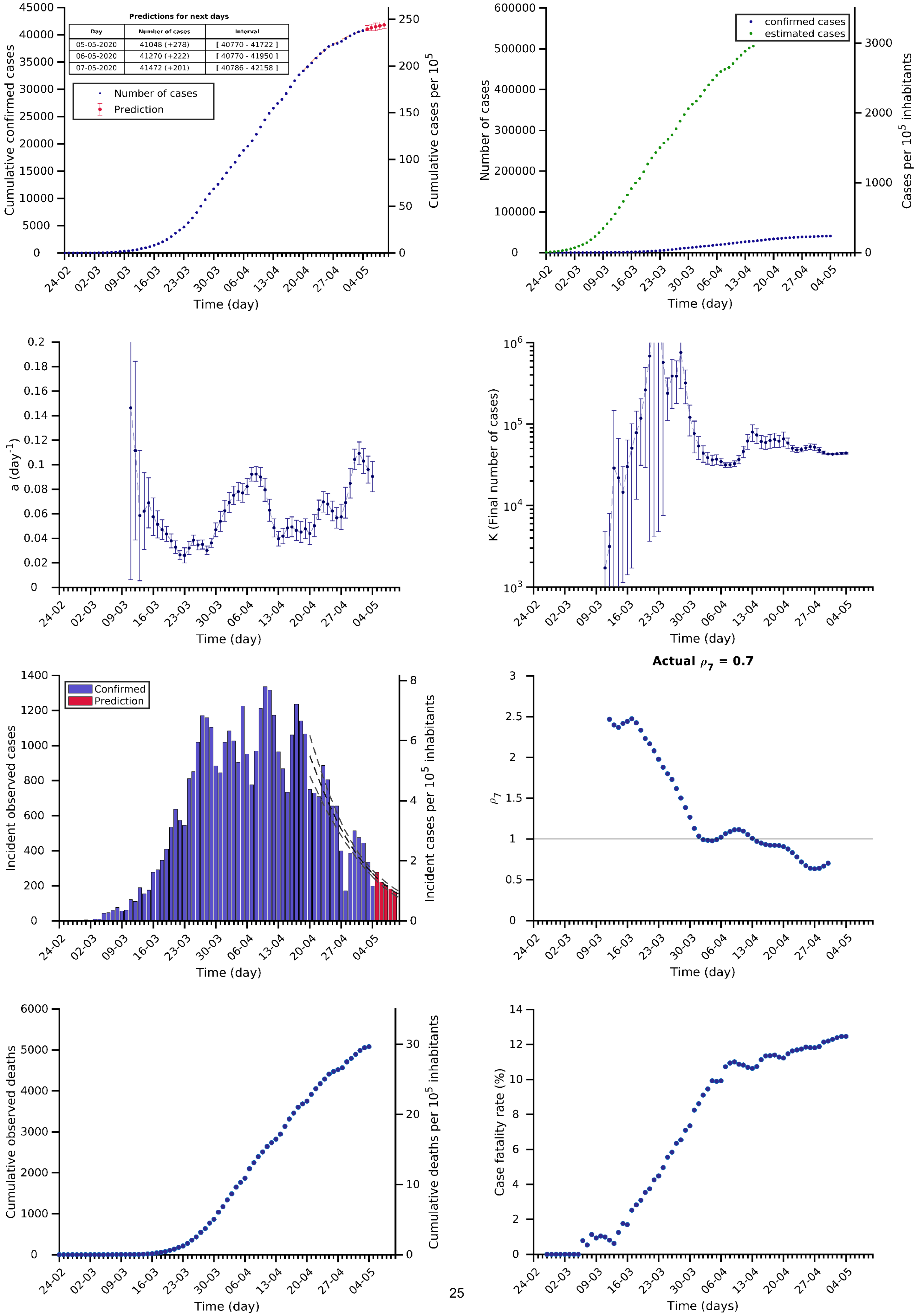




Belgium 04-05-2020. Population: 11.6M. Current cumulated incidence: 434/10^5



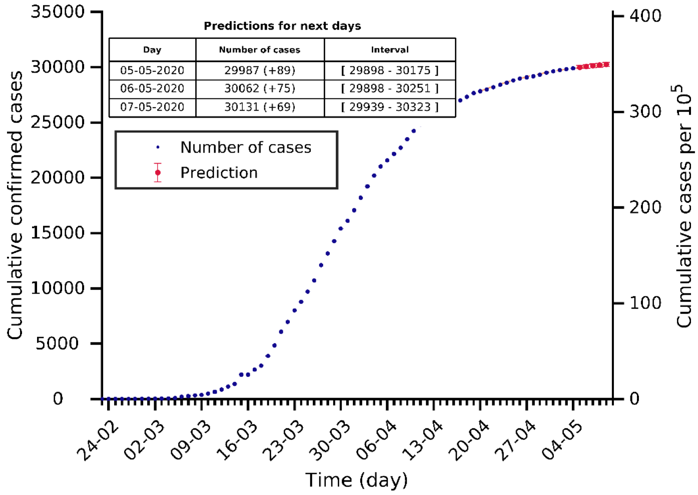
Netherlands 04-05-2020. Population: 17.1M. Current cumulated incidence: 238/10^5



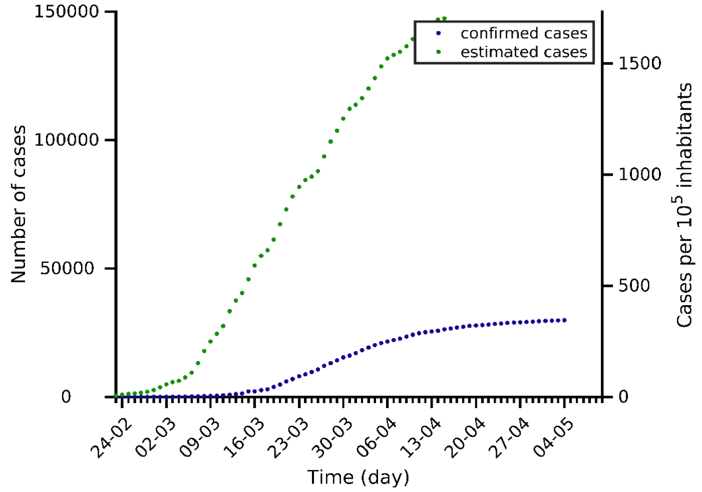
Predictions for next days

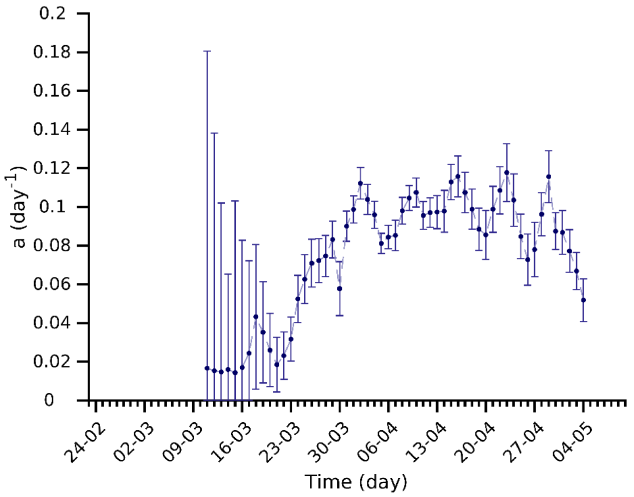
Day	Number of cases	Interval
05-05-2020	41048 (+278)	[40770 - 41722]
06-05-2020	41270 (+222)	[40770 - 41950]
07-05-2020	41472 (+201)	[40786 - 42158]

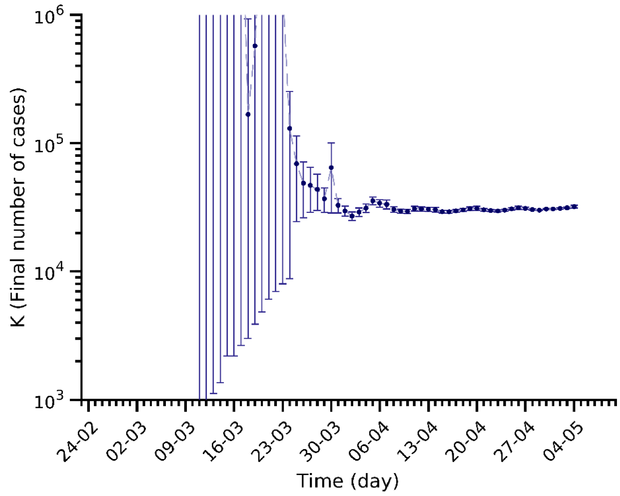
Switzerland 04-05-2020. Population: 8.7M. Current cumulated incidence: 345/10⁵

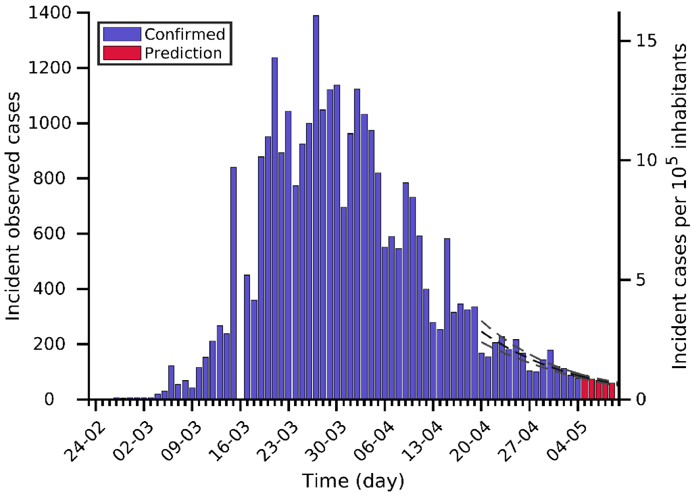


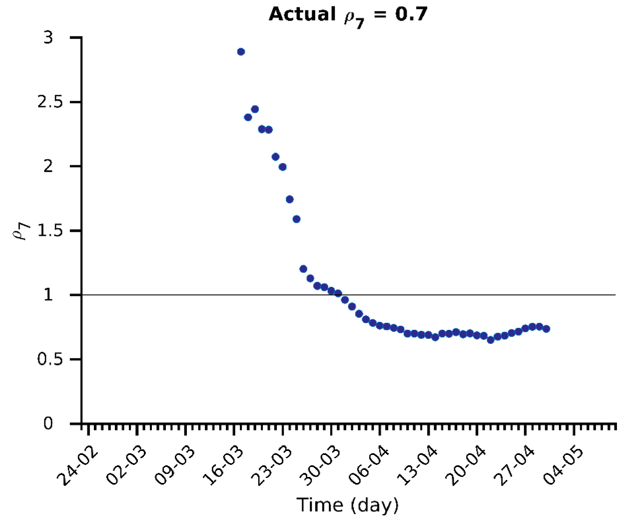
Day	Number of cases	Interval
05-05-2020	29987 (+89)	[29898 - 30175]
06-05-2020	30062 (+75)	[29898 - 30251]
07-05-2020	30131 (+69)	[29939 - 30323]

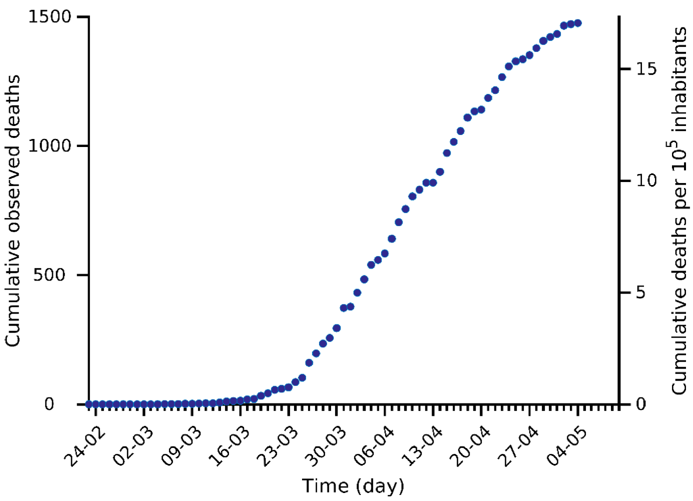


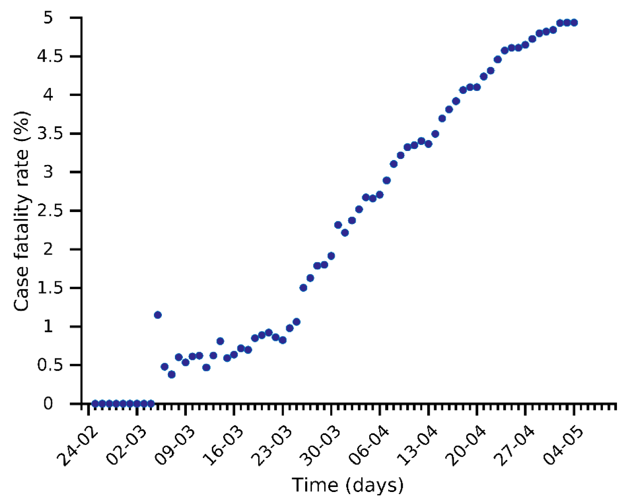




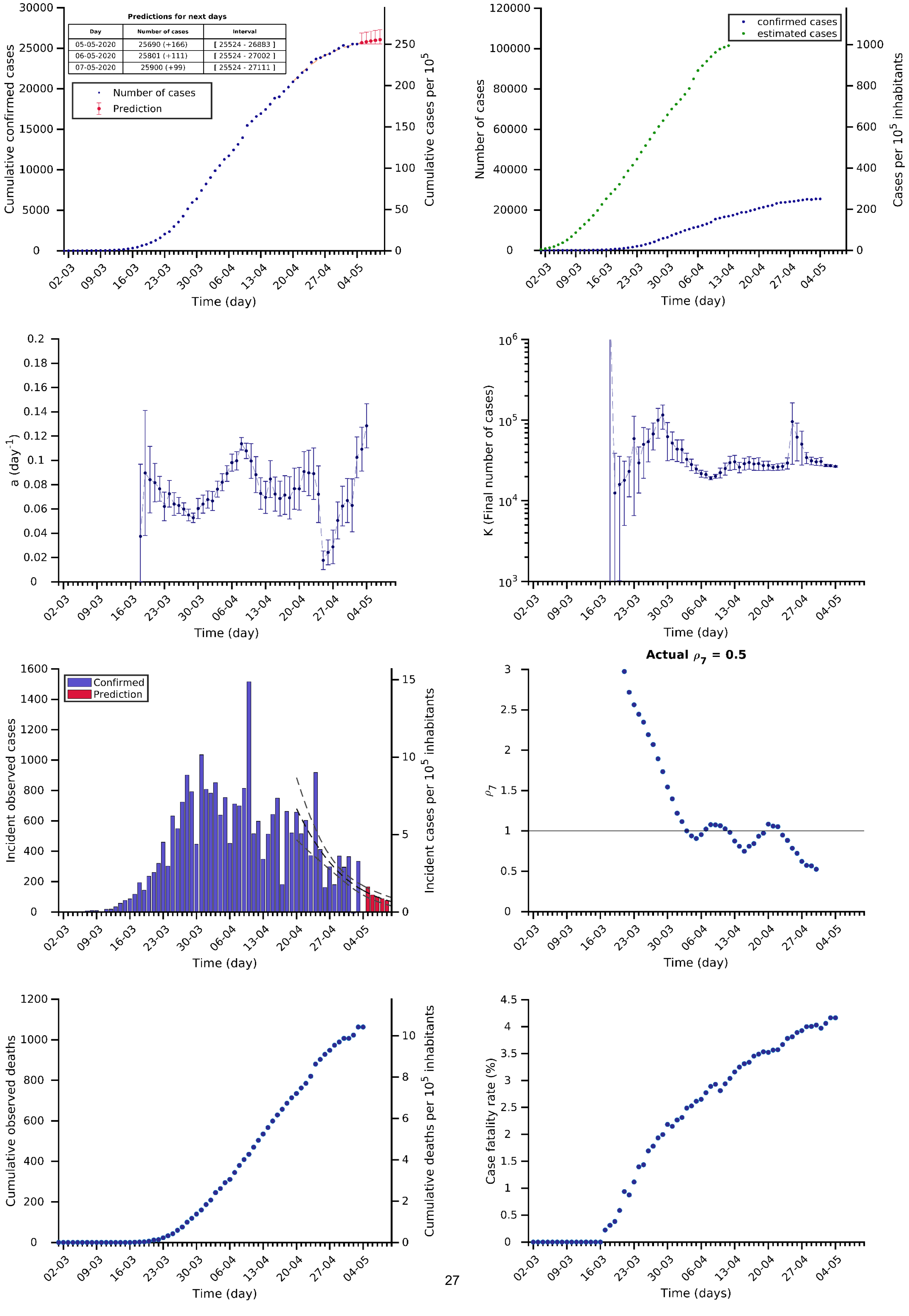




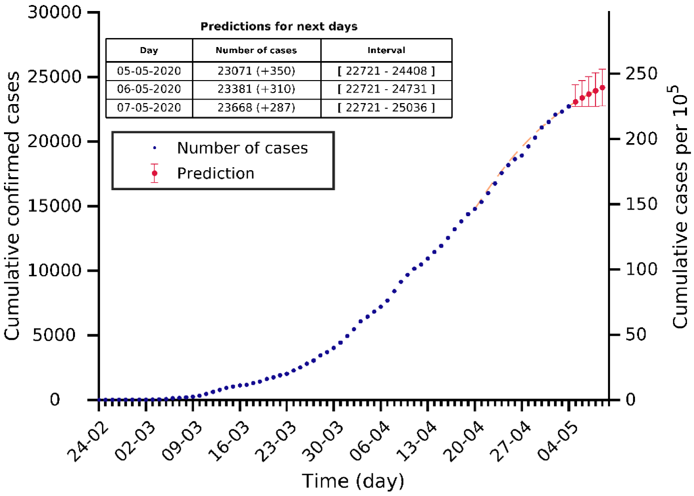


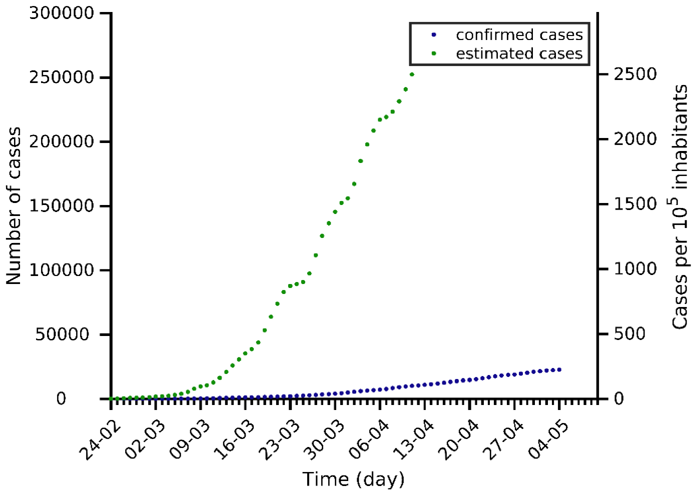


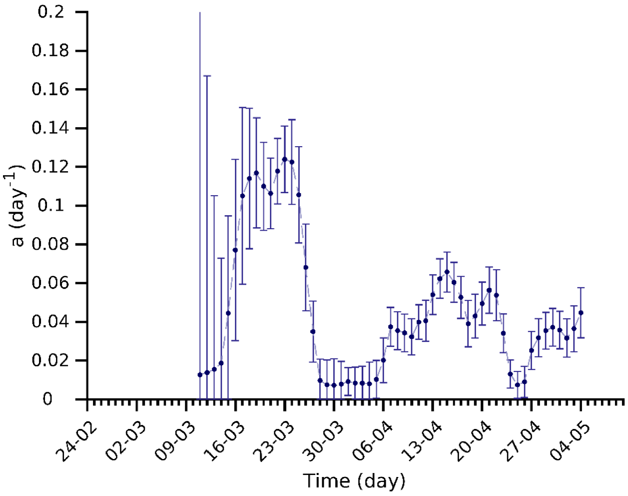
Portugal 04-05-2020. Population: 10.2M. Current cumulated incidence: 250/10^5

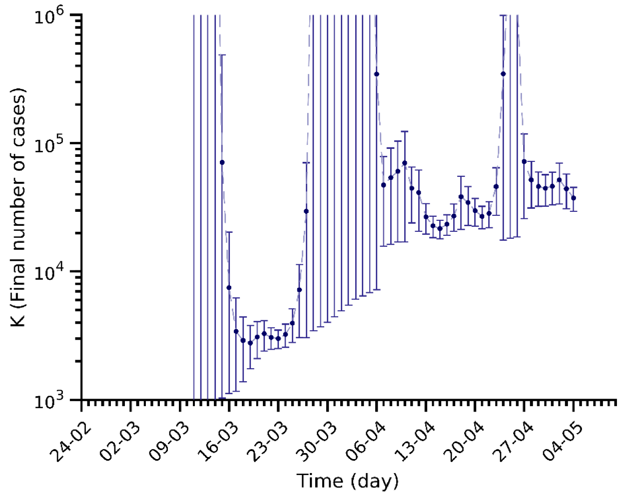


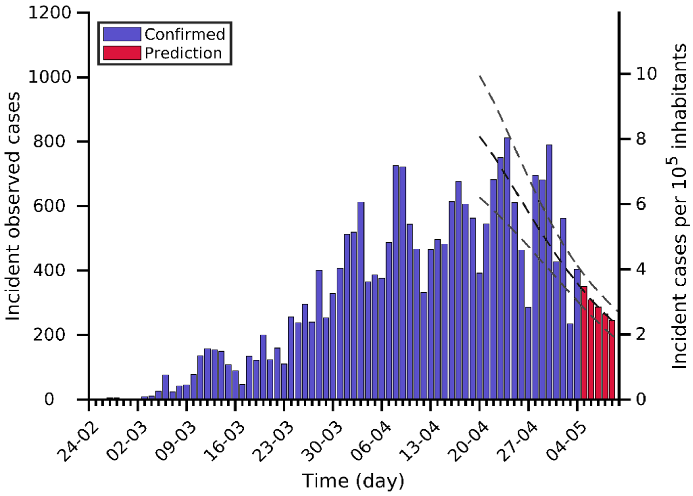
Sweden 04-05-2020. Population: 10.1M. Current cumulated incidence: 225/10⁵

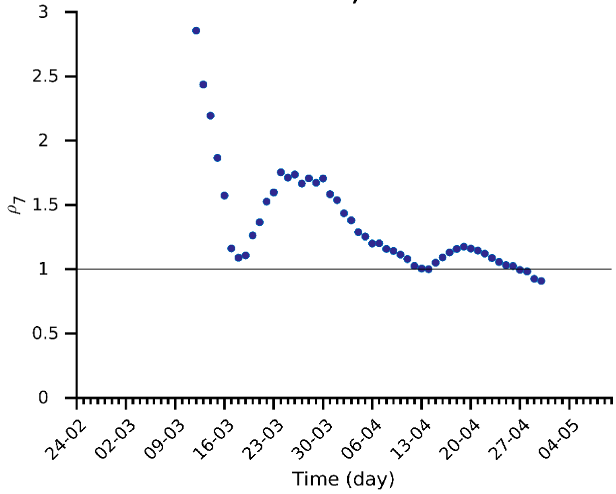


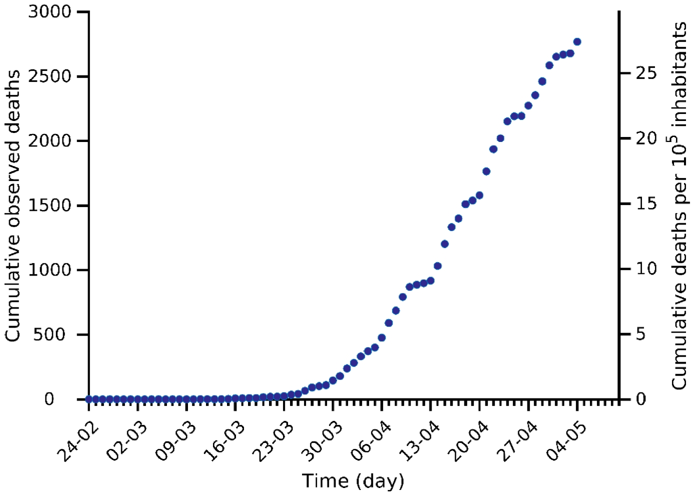


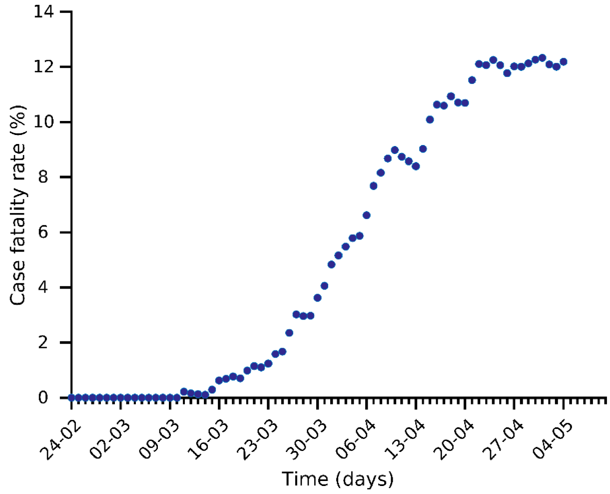




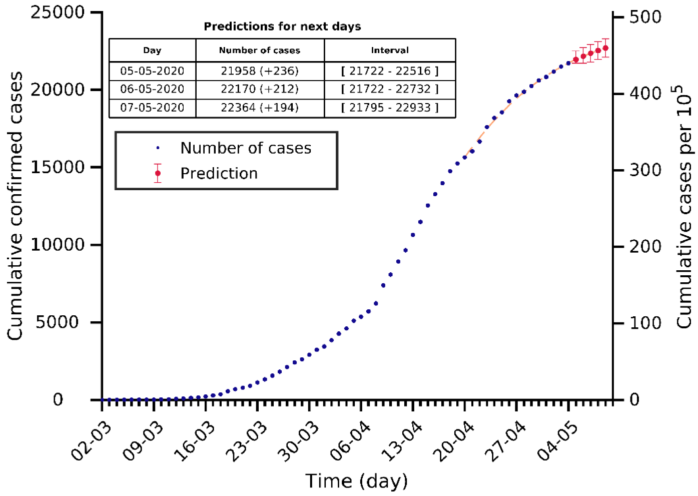


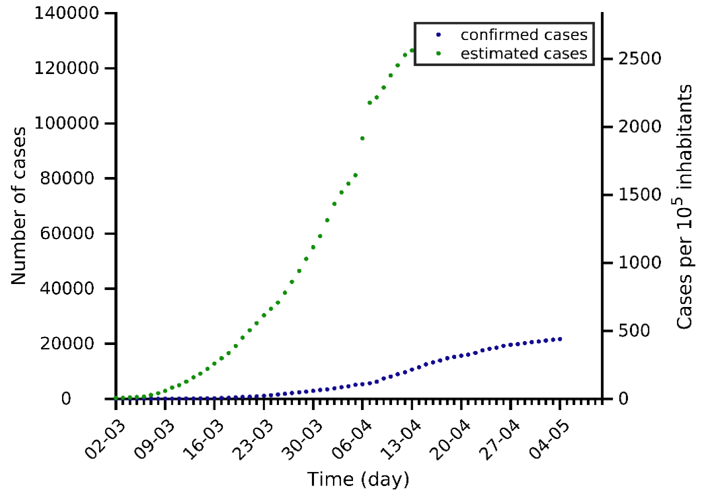


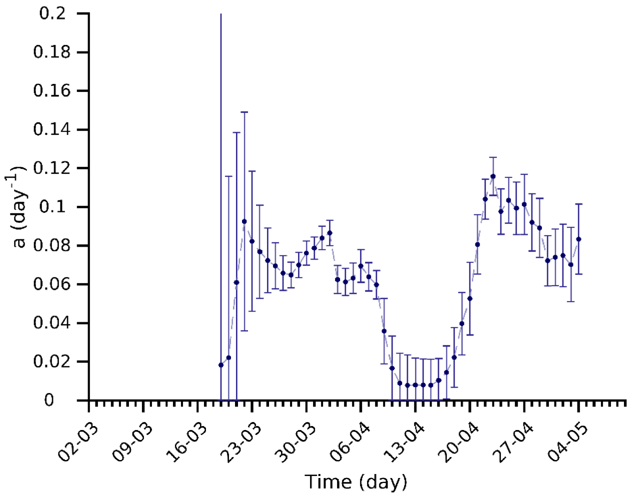


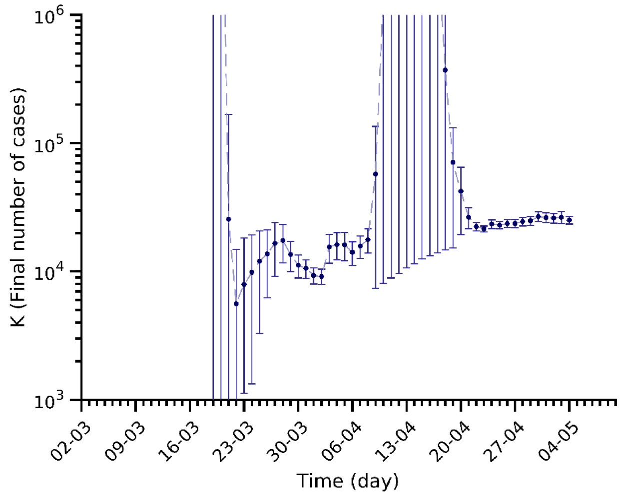


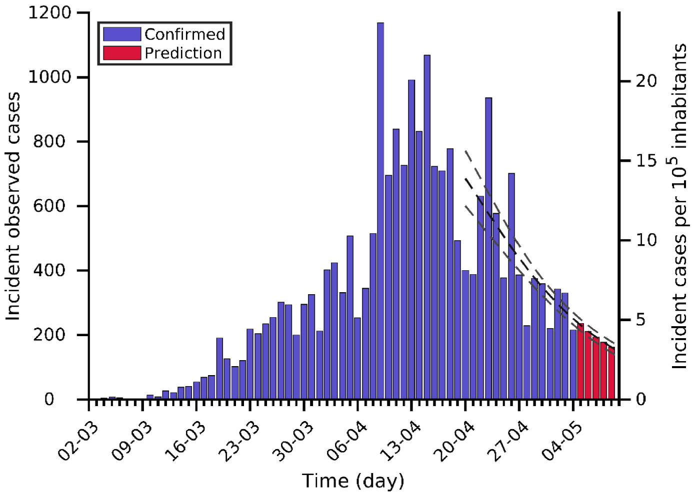
Ireland 04-05-2020. Population: 4.9M. Current cumulated incidence: 440/10^5

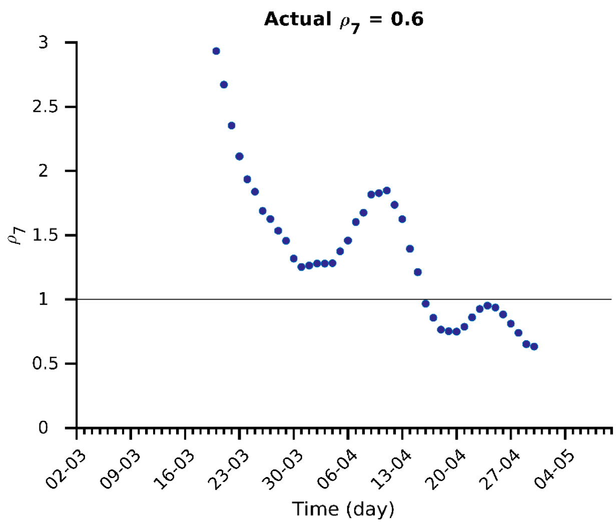


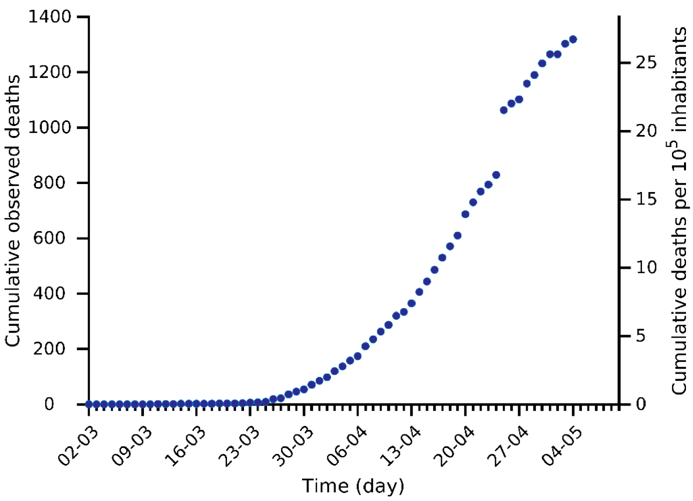


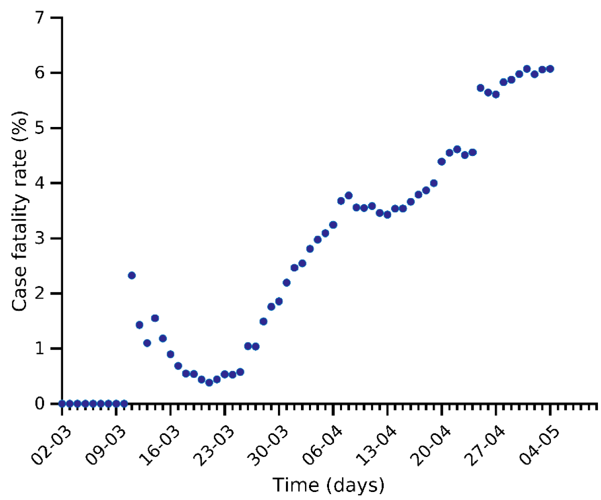




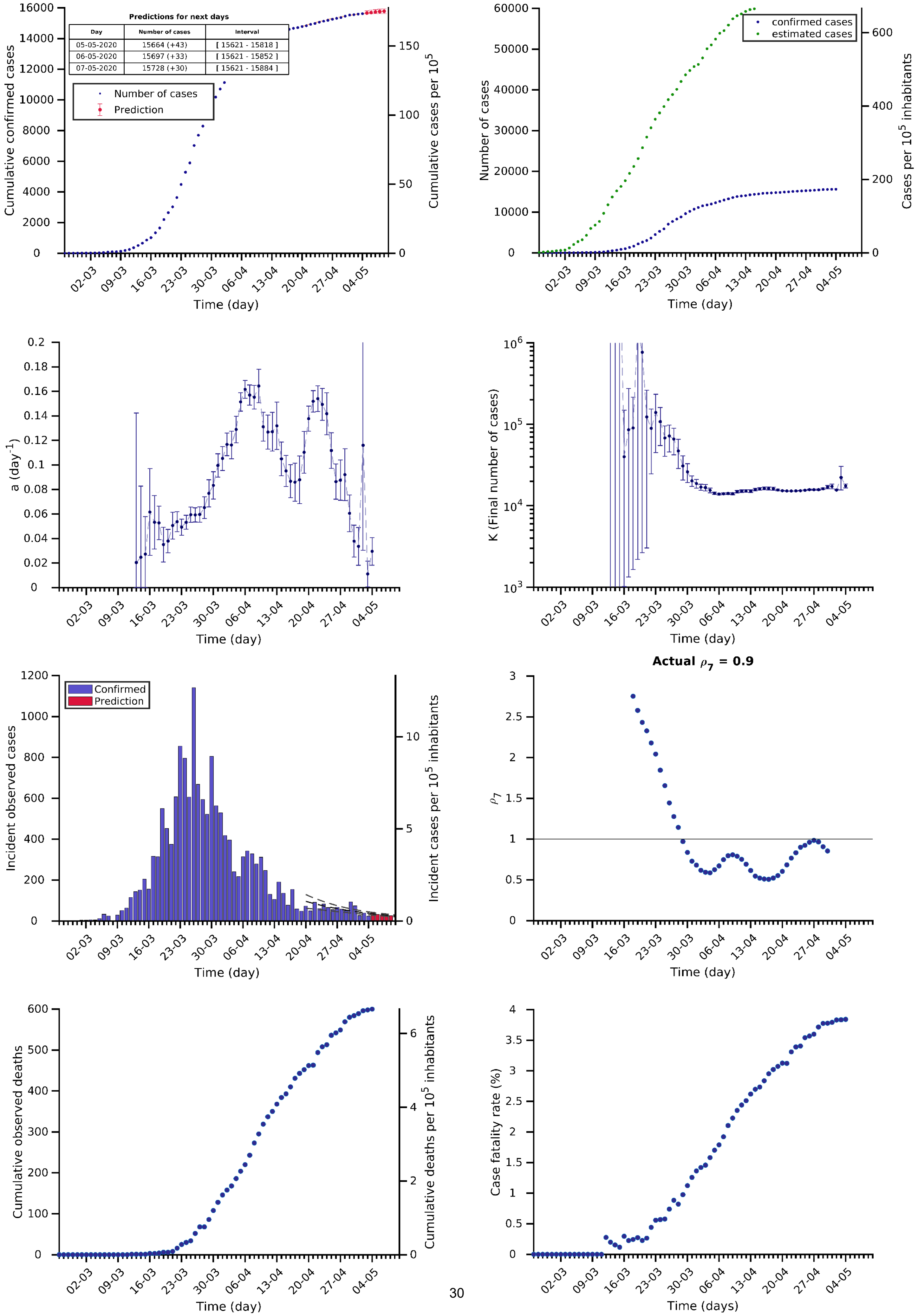




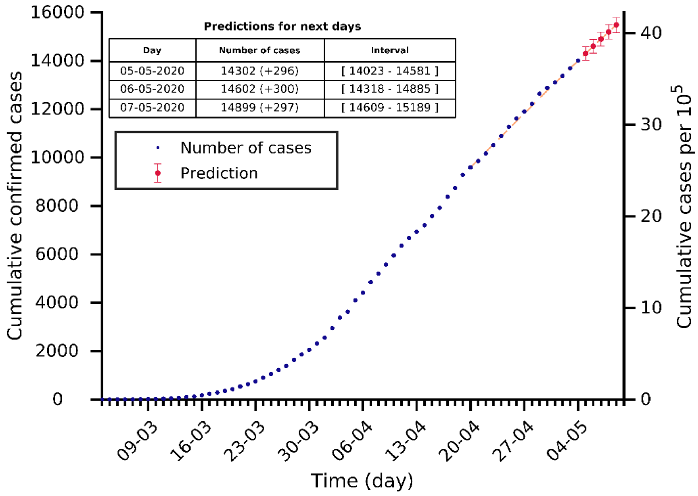


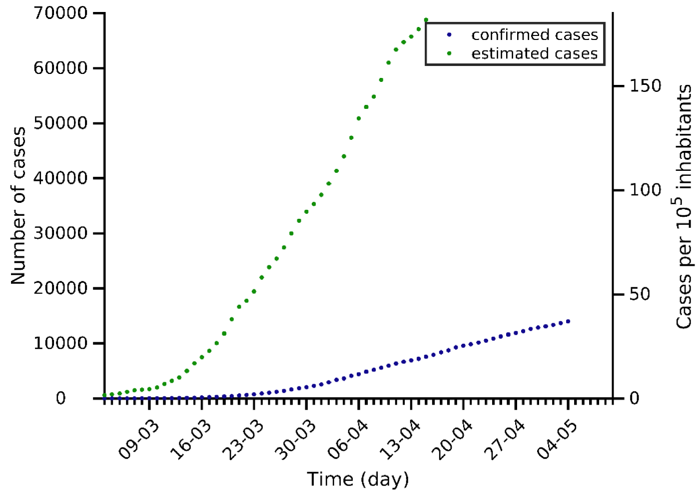


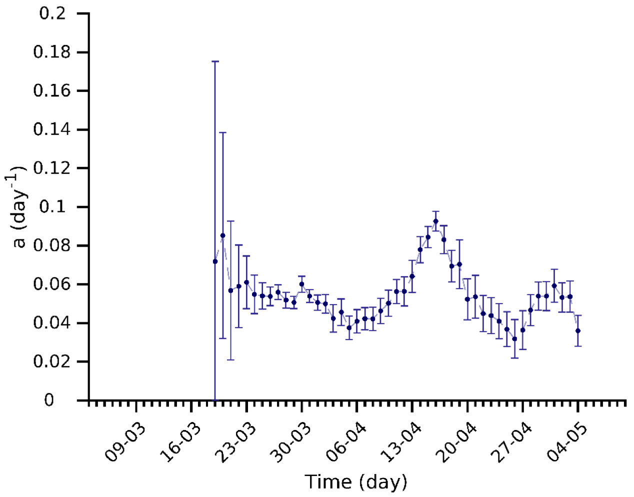
Austria 04-05-2020. Population: 9.0M. Current cumulated incidence: 173/10⁵

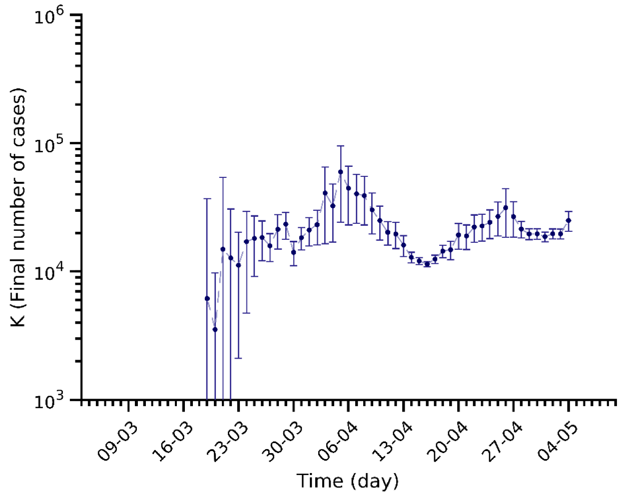


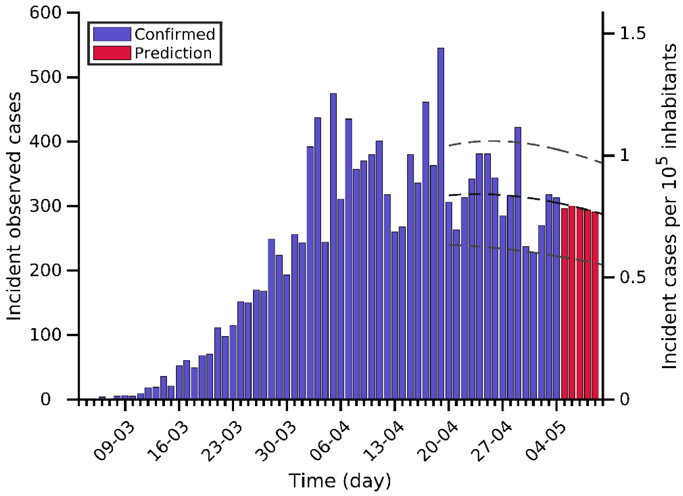
Poland 04-05-2020. Population: 37.8M. Current cumulated incidence: 37/10⁵

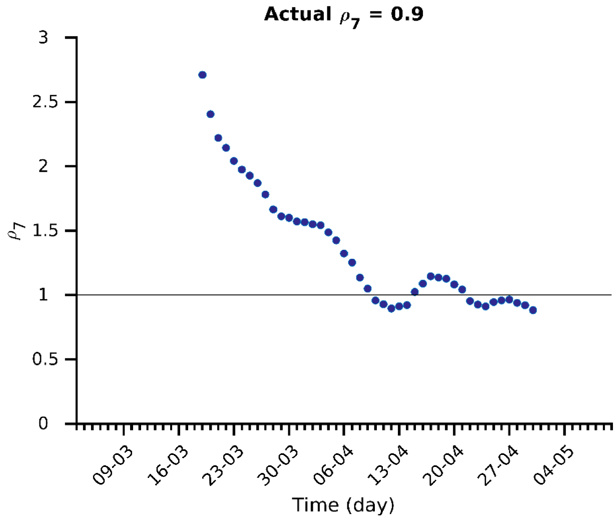


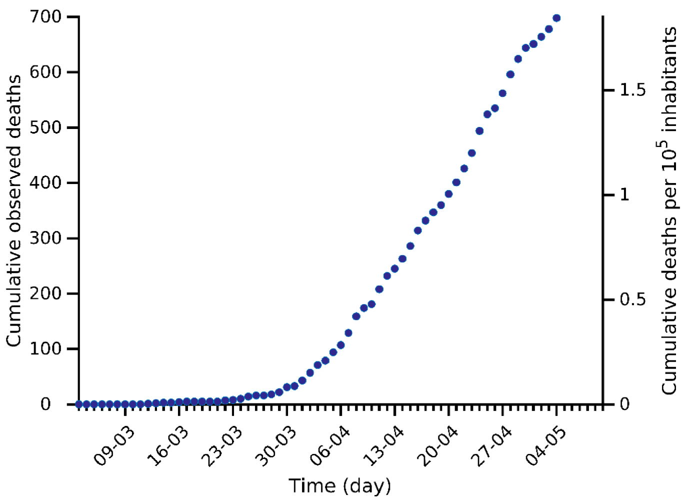


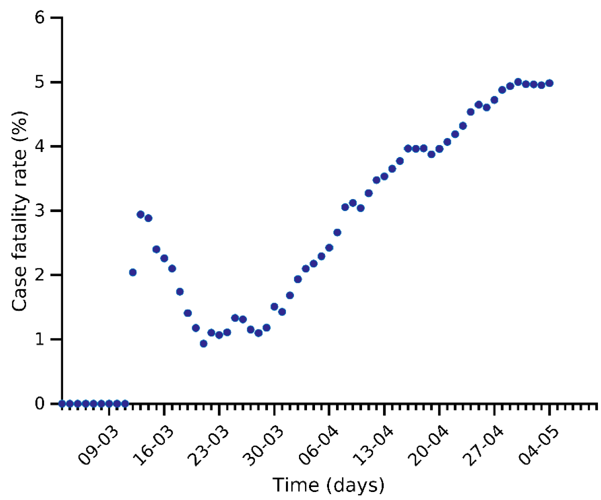




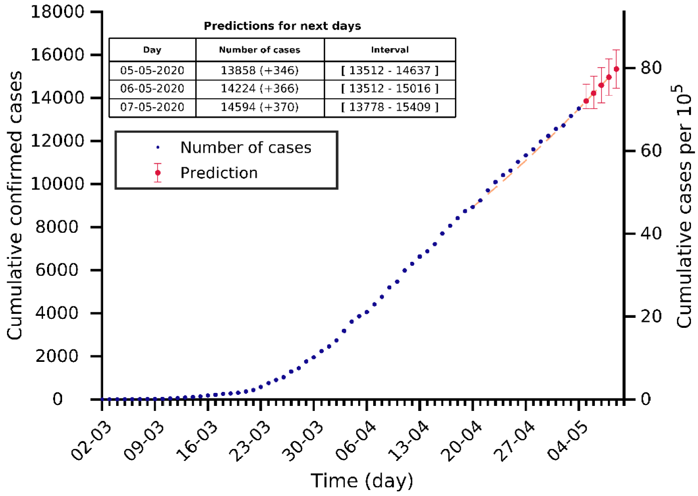


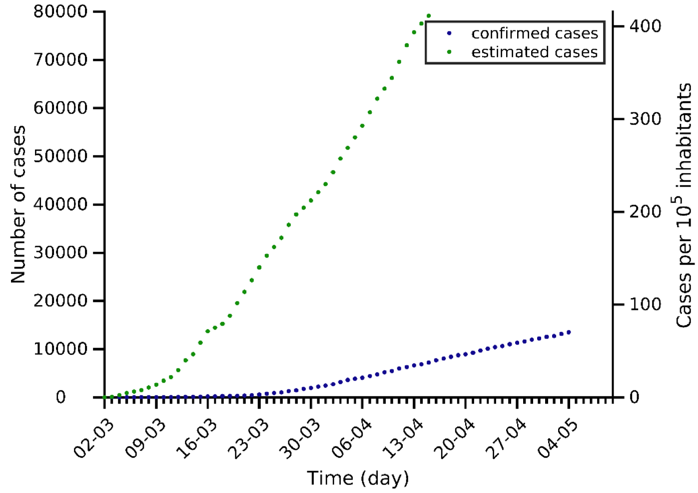


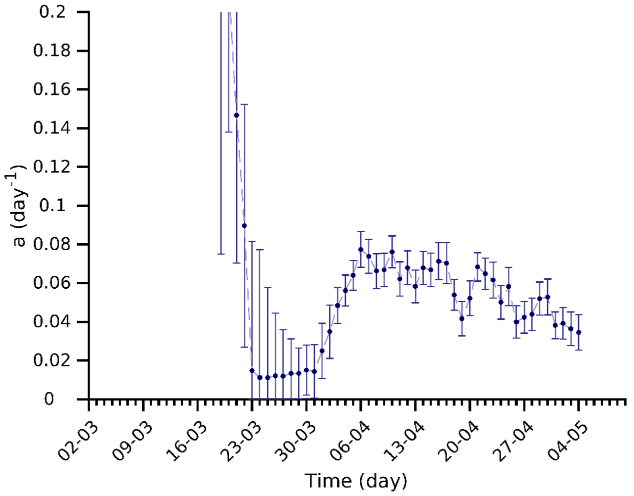


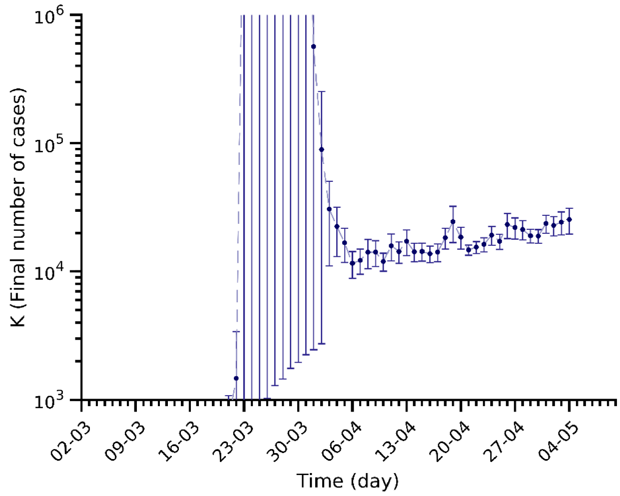


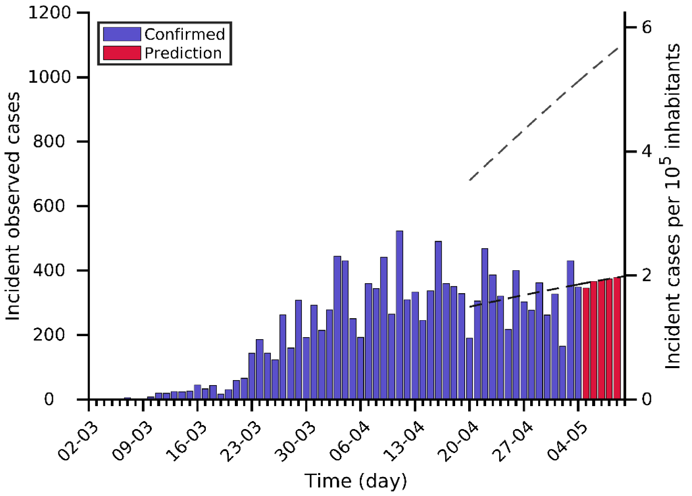
Romania 04-05-2020. Population: 19.2M. Current cumulated incidence: 70/10⁵

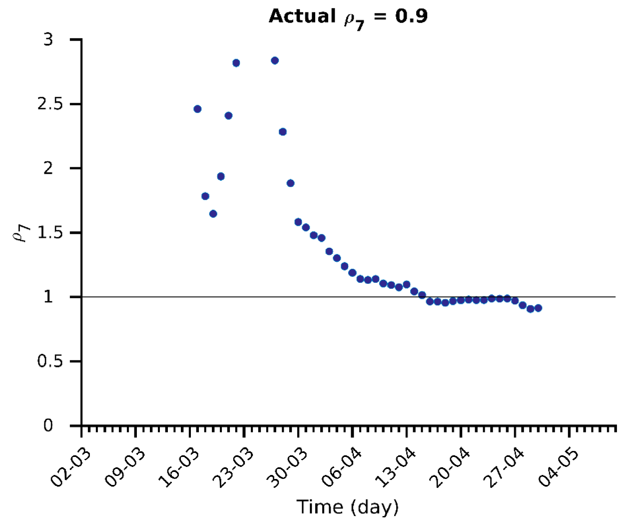


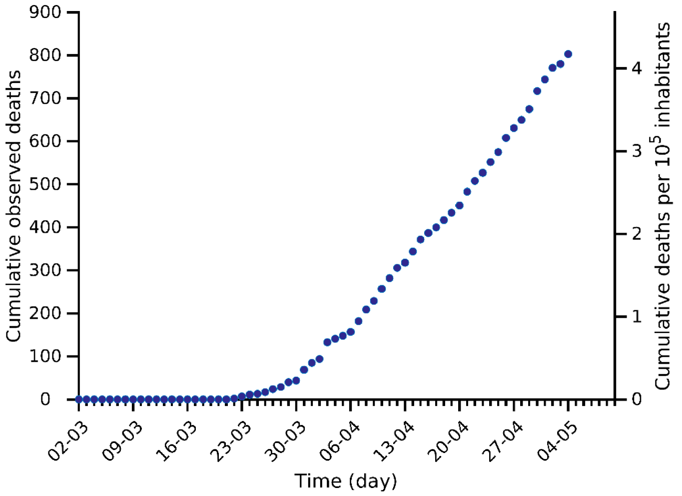


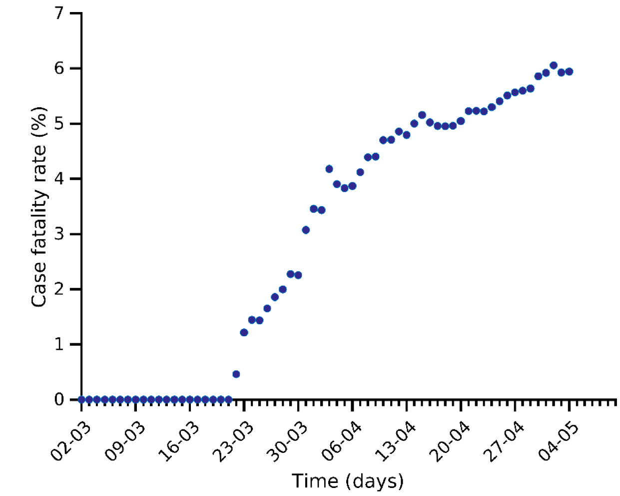




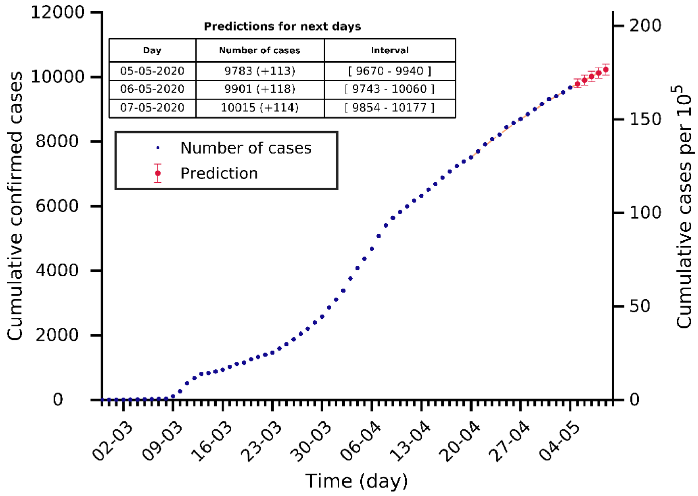




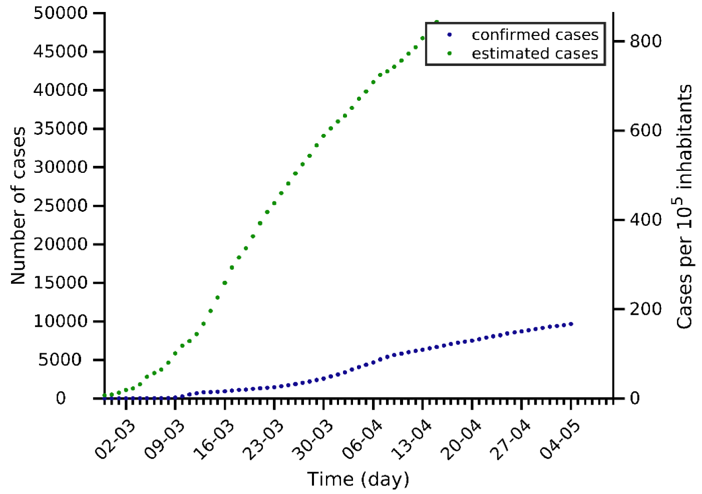


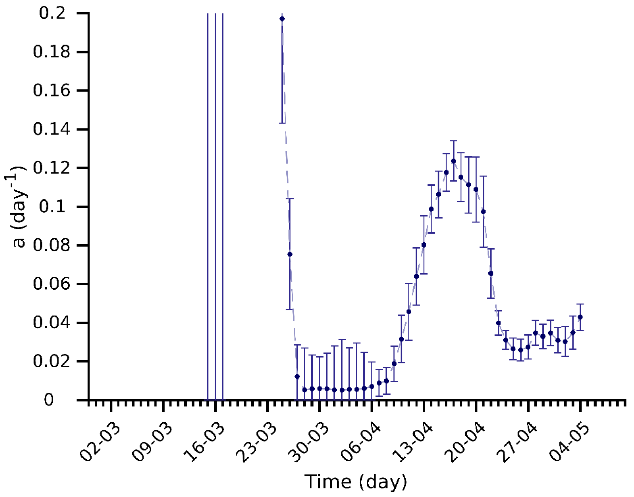


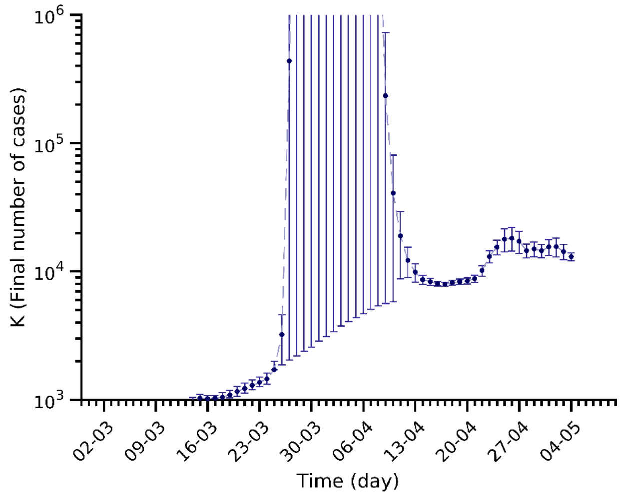
Denmark 04-05-2020. Population: 5.8M. Current cumulated incidence: 167/10⁵

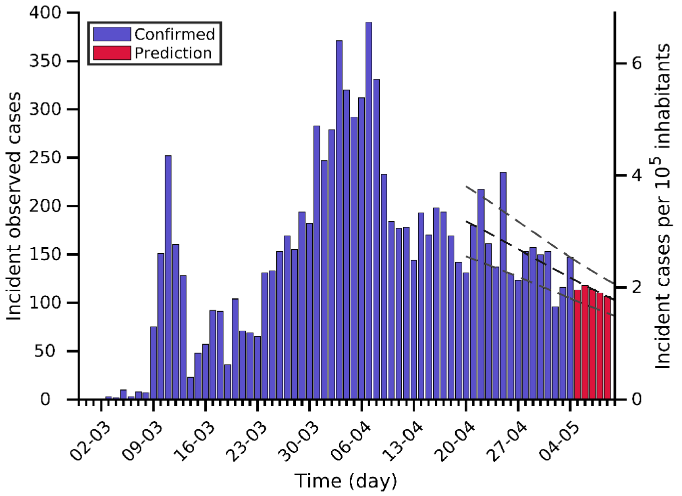


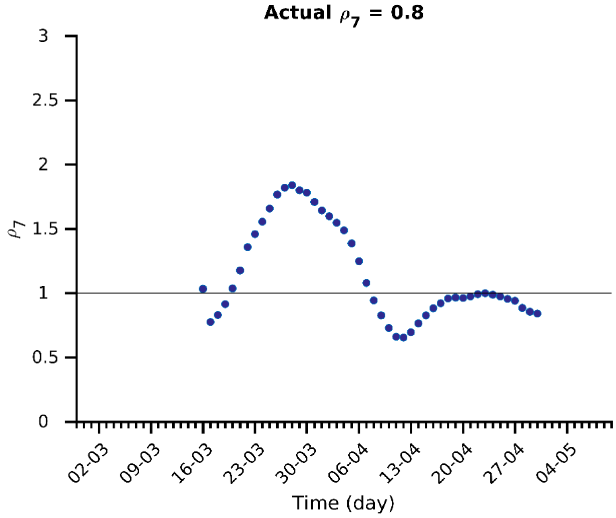
Day	Number of cases	Interval
05-05-2020	9783 (+113)	[9670 - 9940]
06-05-2020	9901 (+118)	[9743 - 10060]
07-05-2020	10015 (+114)	[9854 - 10177]

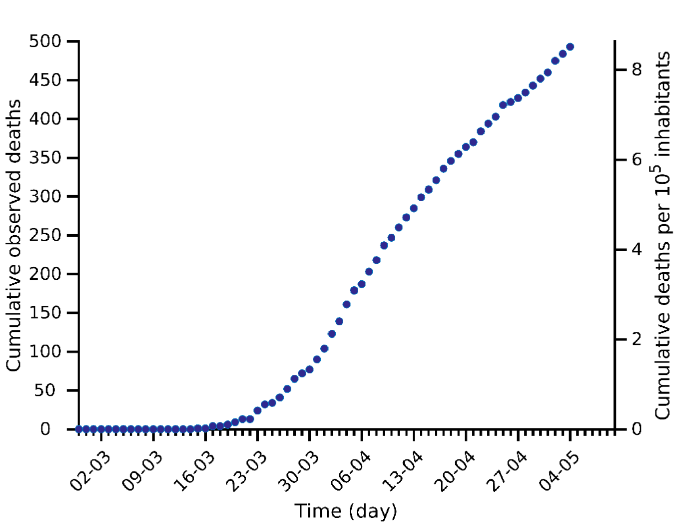


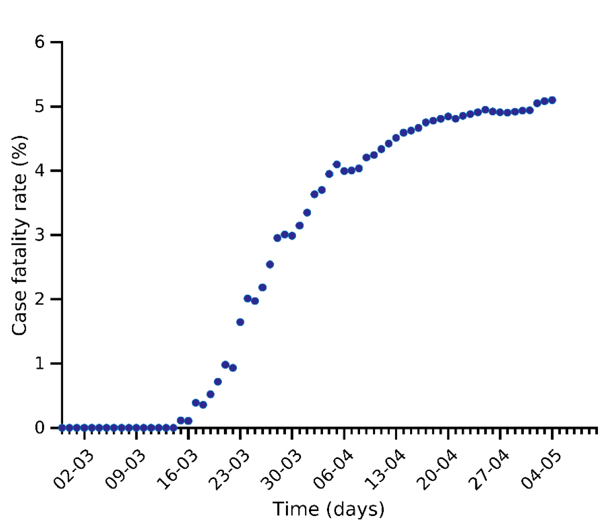




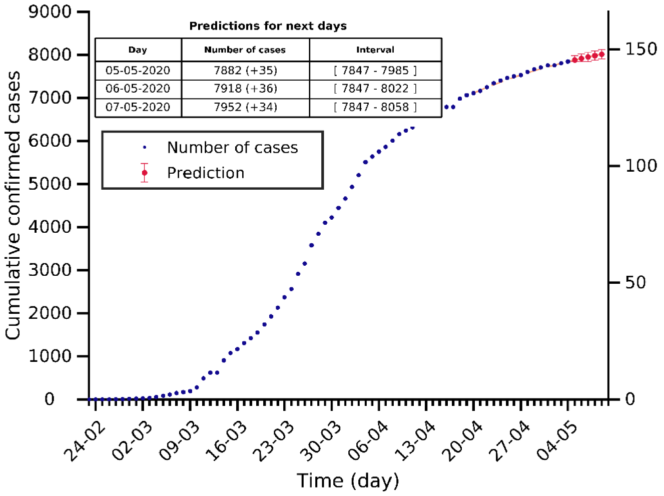


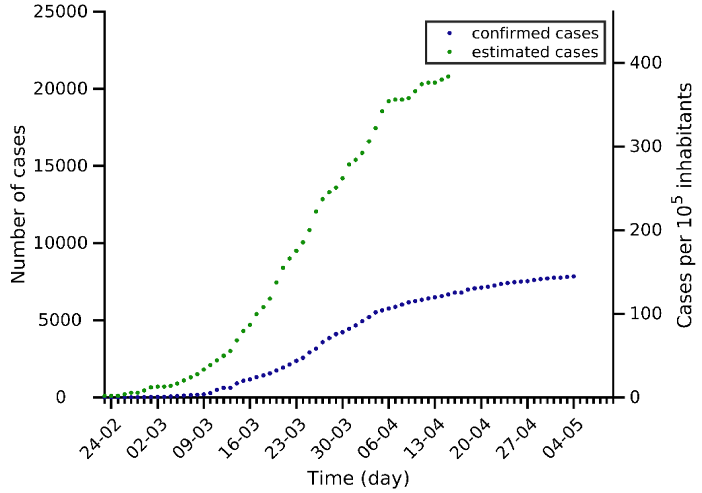


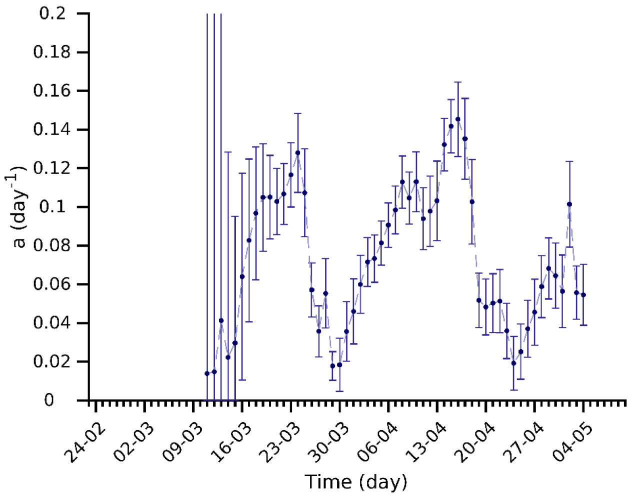


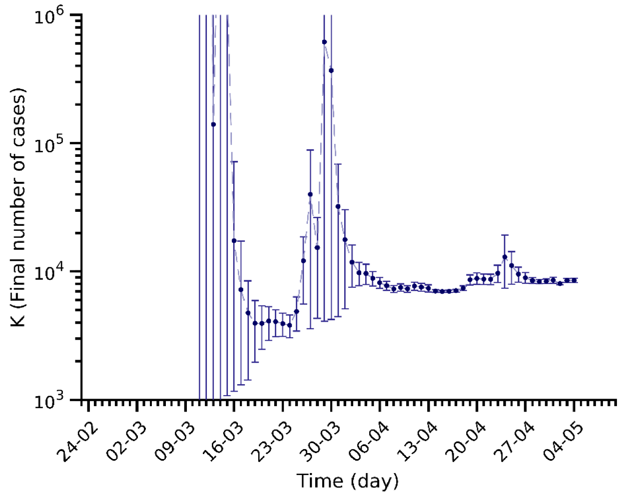


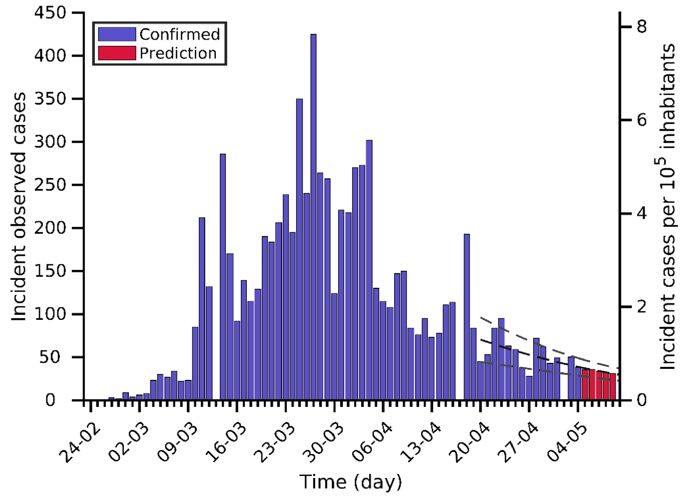
Norway 04-05-2020. Population: 5.4M. Current cumulated incidence: 145/10^5

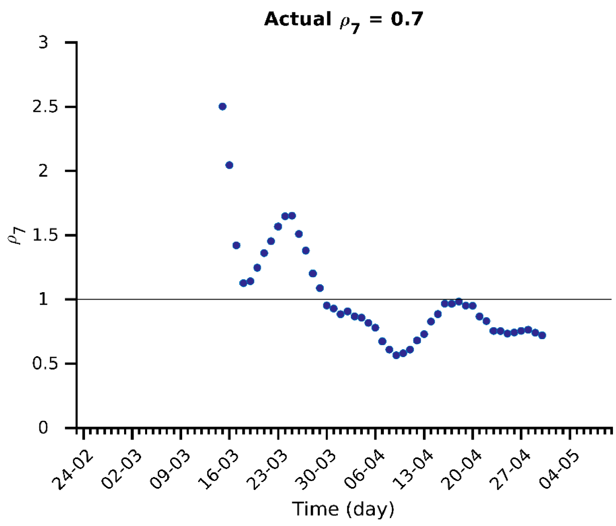


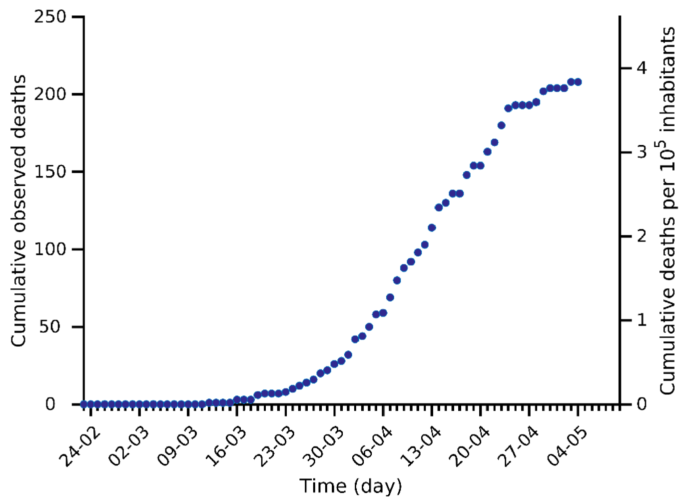


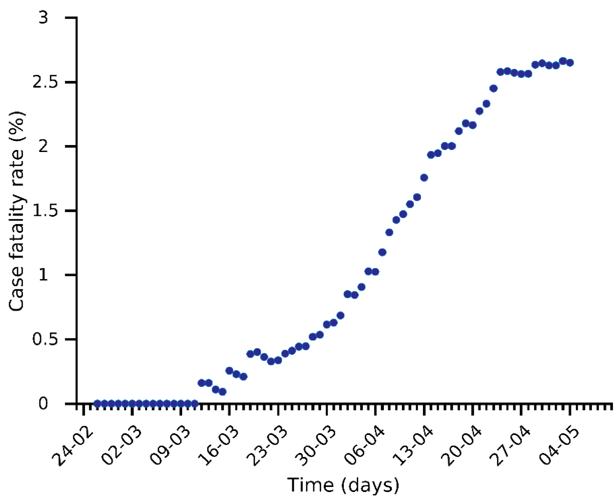




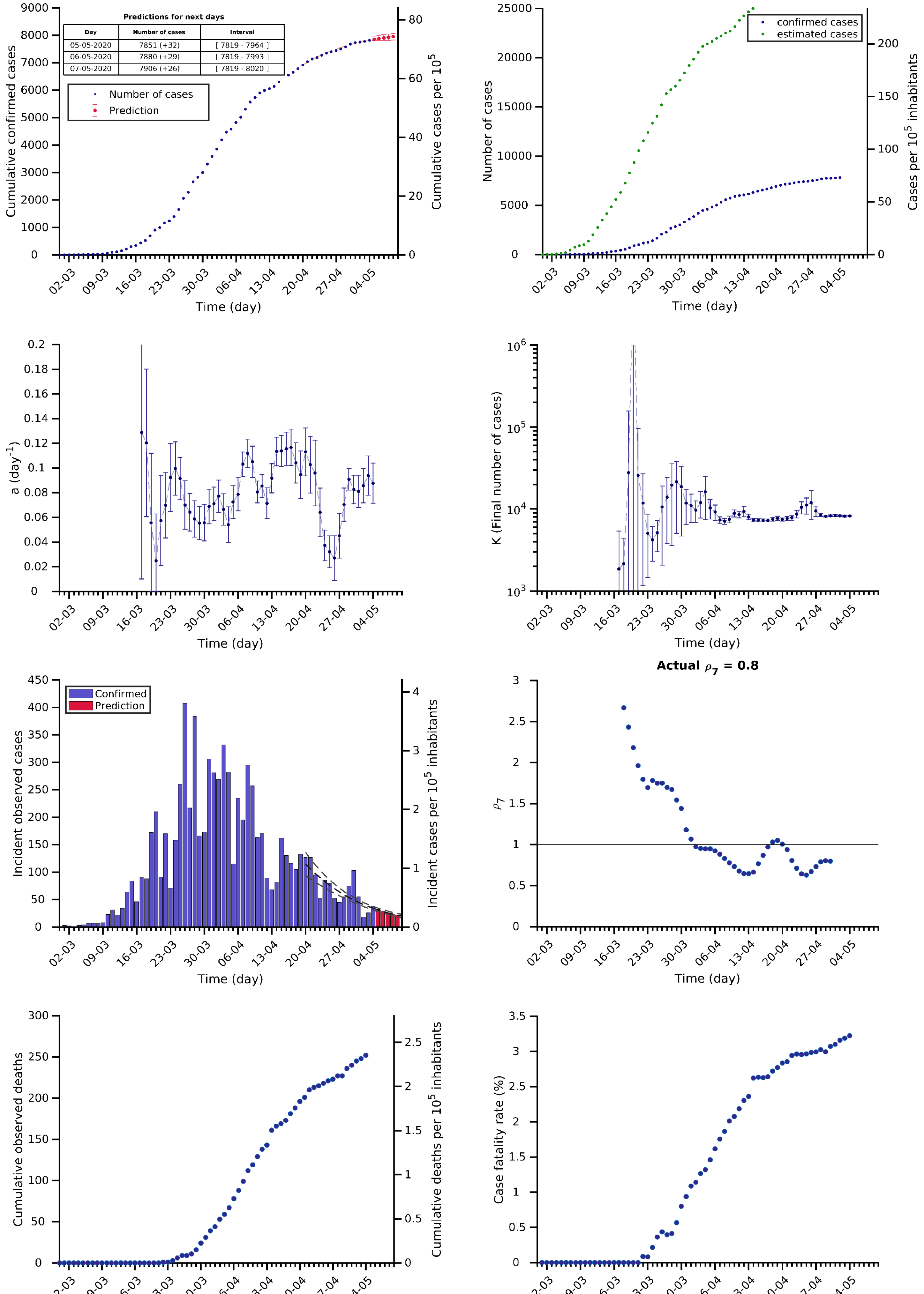




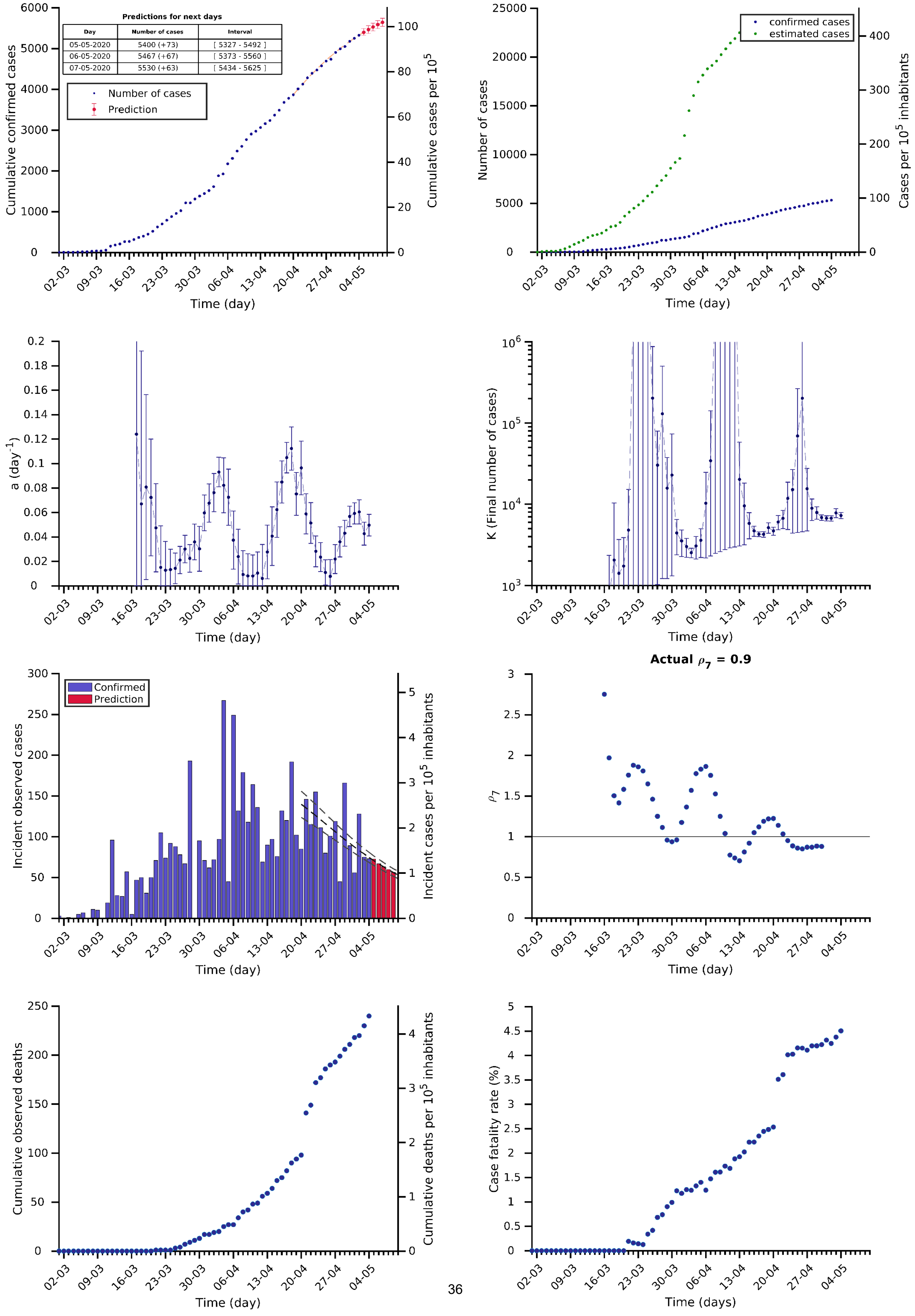




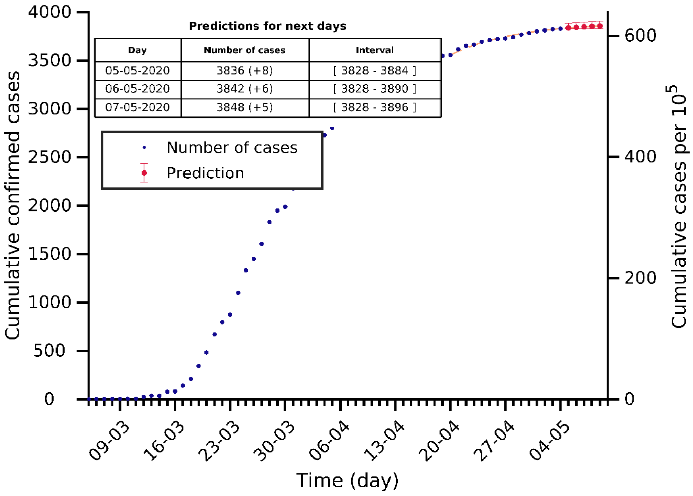
Czech Rep 04-05-2020. Population: 10.7M. Current cumulated incidence: 73/10⁵



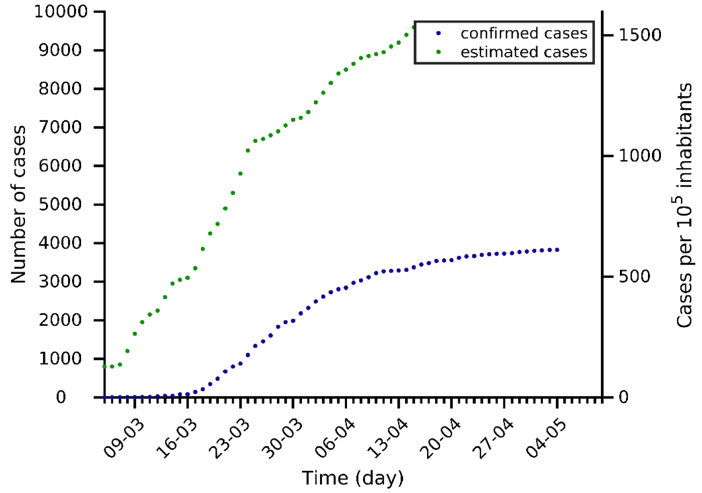
Finland 04-05-2020. Population: 5.5M. Current cumulated incidence: 96/10⁵

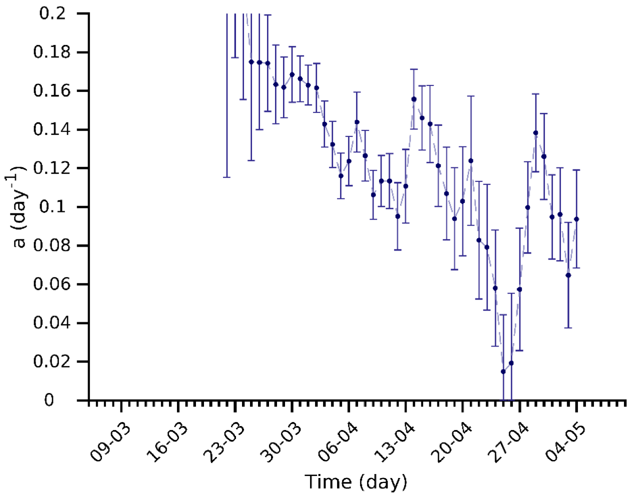


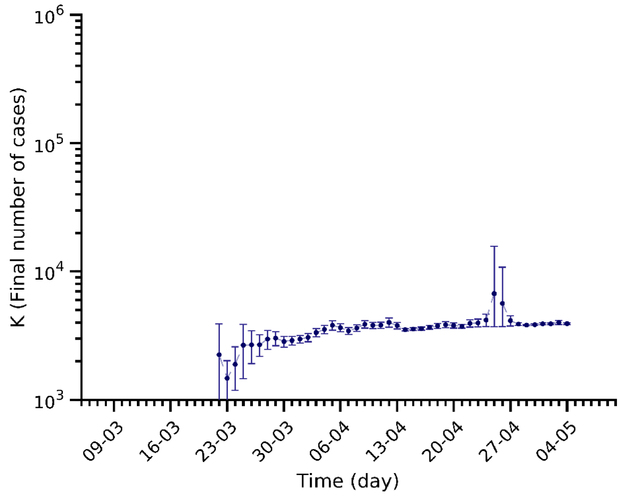
Luxembourg 04-05-2020. Population: 0.6M. Current cumulated incidence: 612/10⁵

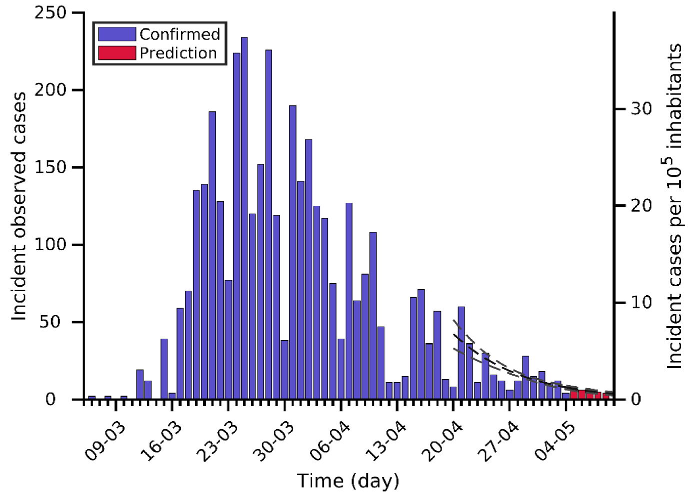


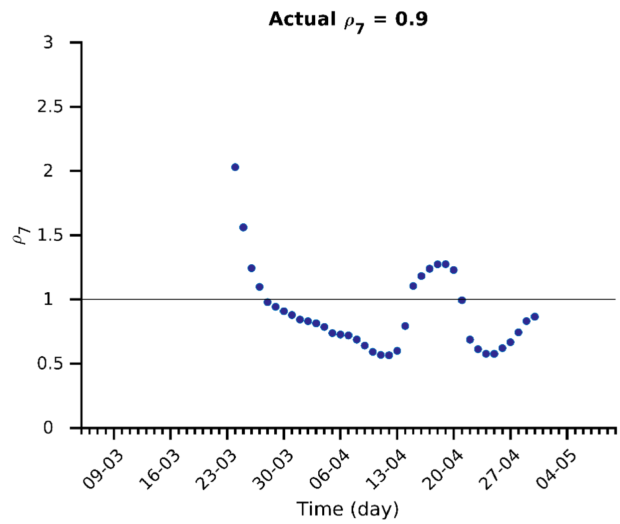
Day	Number of cases	Interval
05-05-2020	3836 (+8)	[3828 - 3884]
06-05-2020	3842 (+6)	[3828 - 3890]
07-05-2020	3848 (+5)	[3828 - 3896]

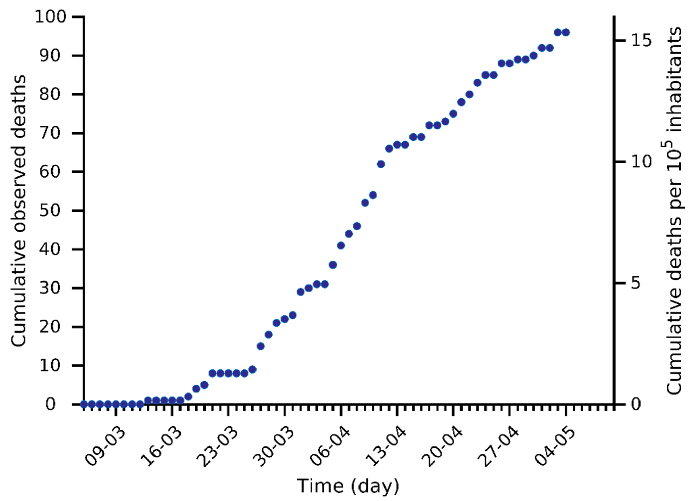


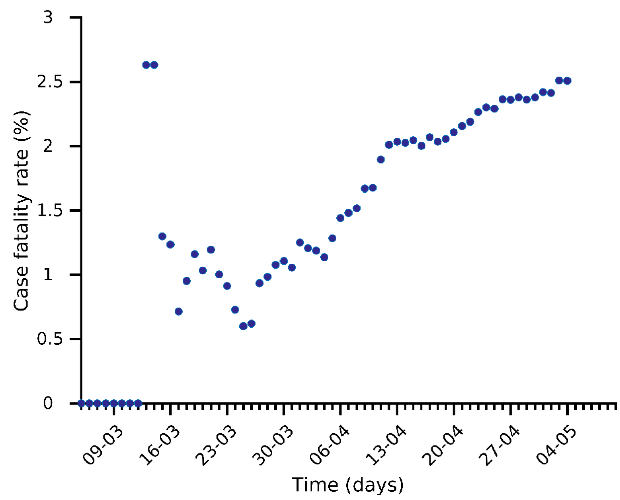




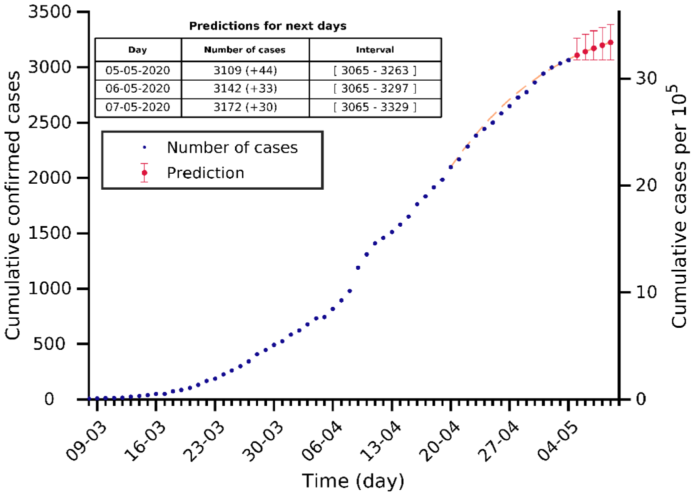


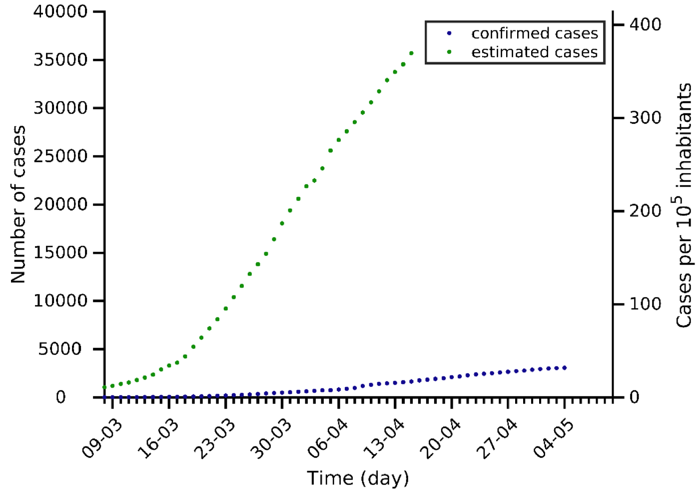


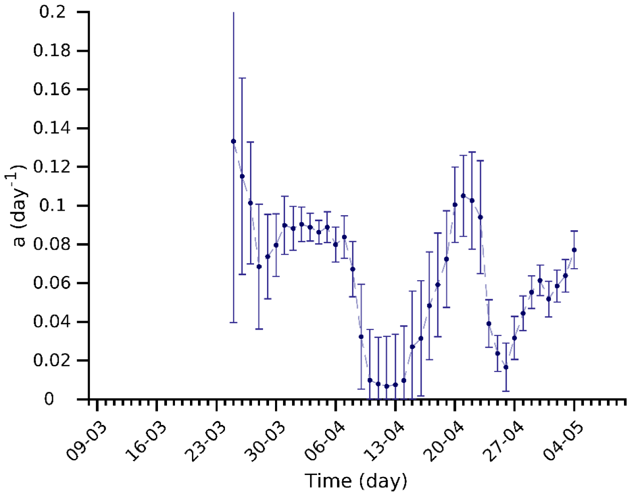


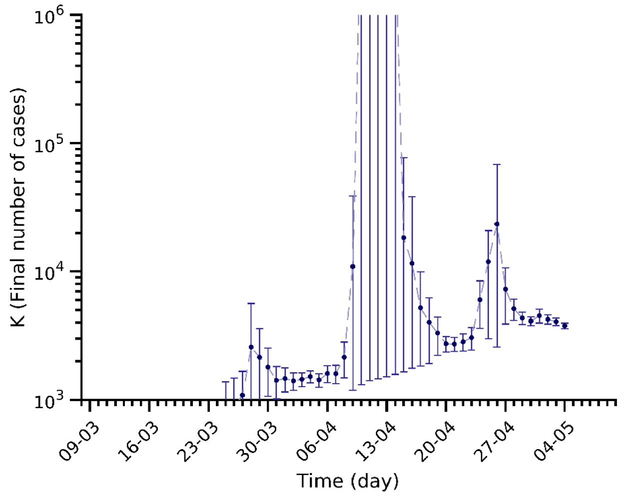


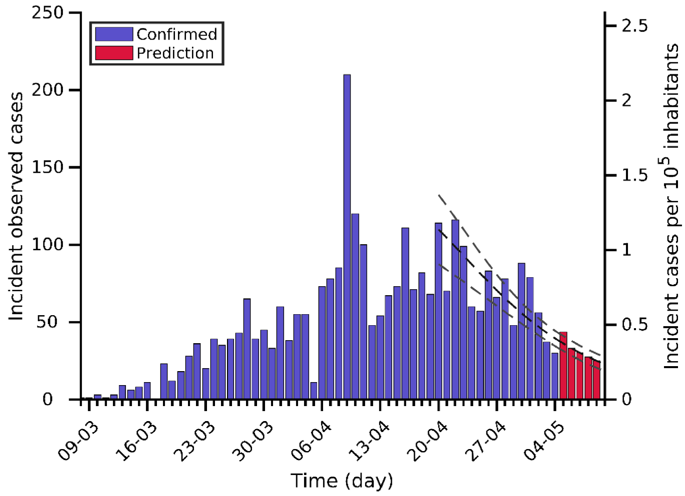
Hungary 04-05-2020. Population: 9.7M. Current cumulated incidence: 32/10⁵

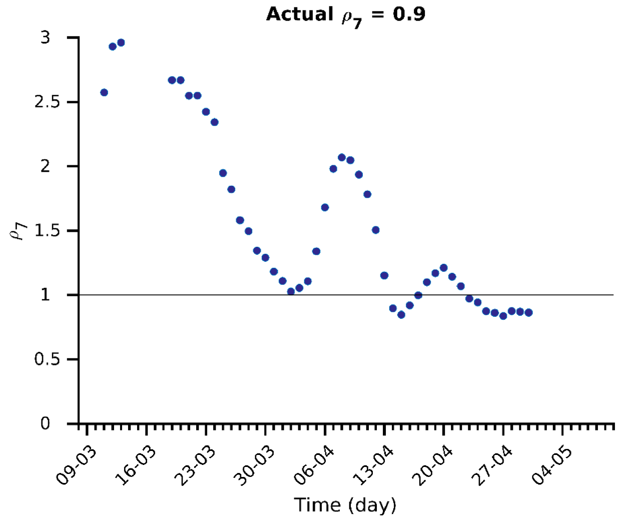


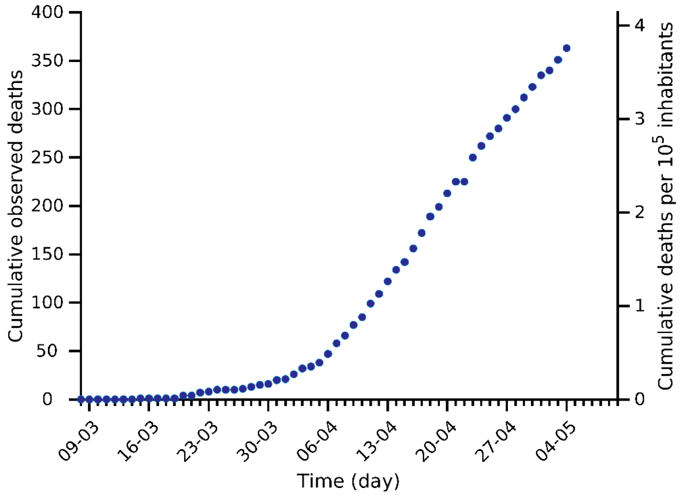


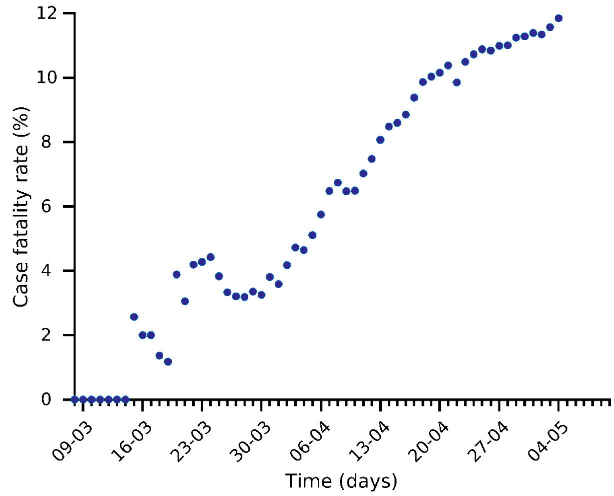




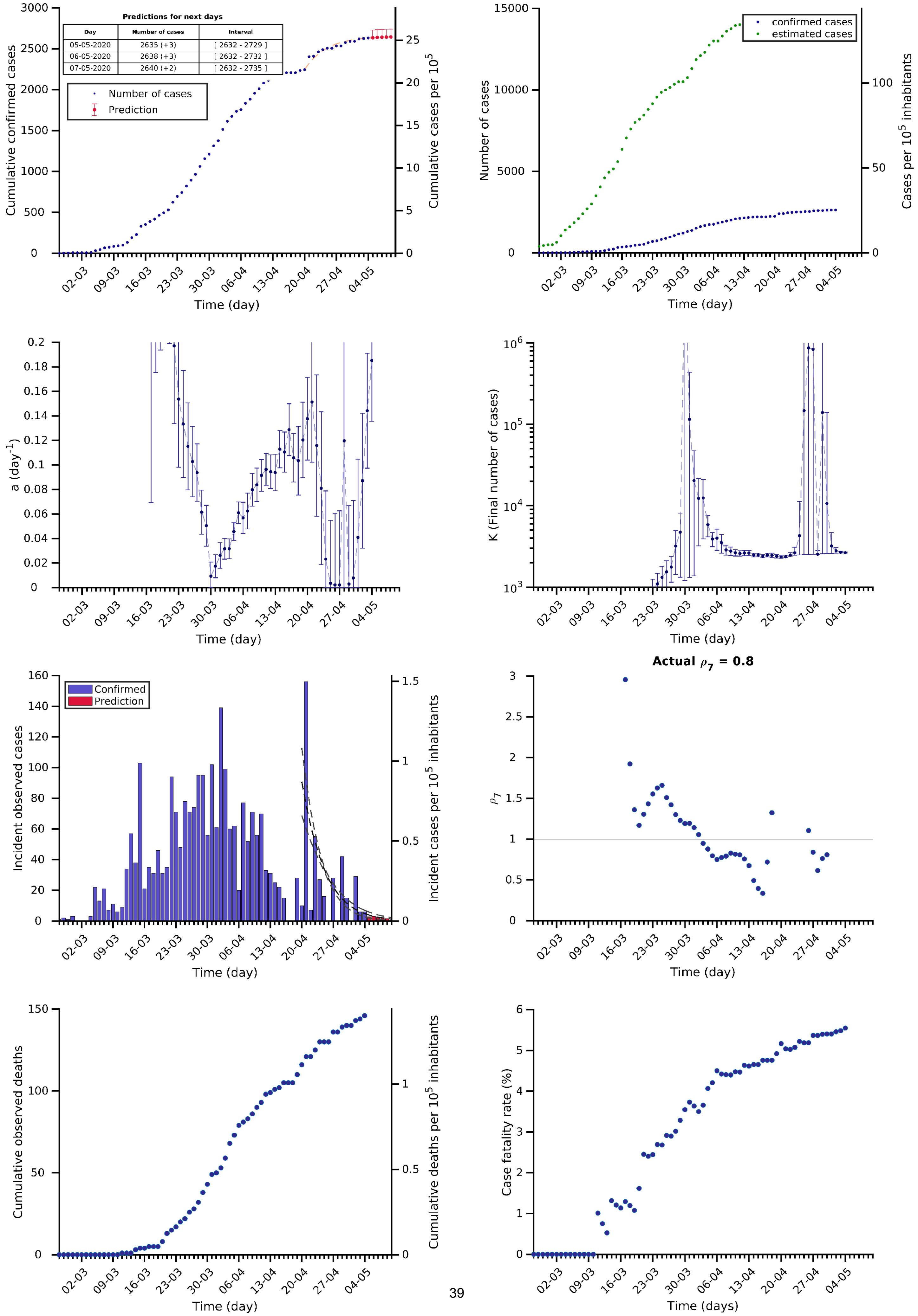




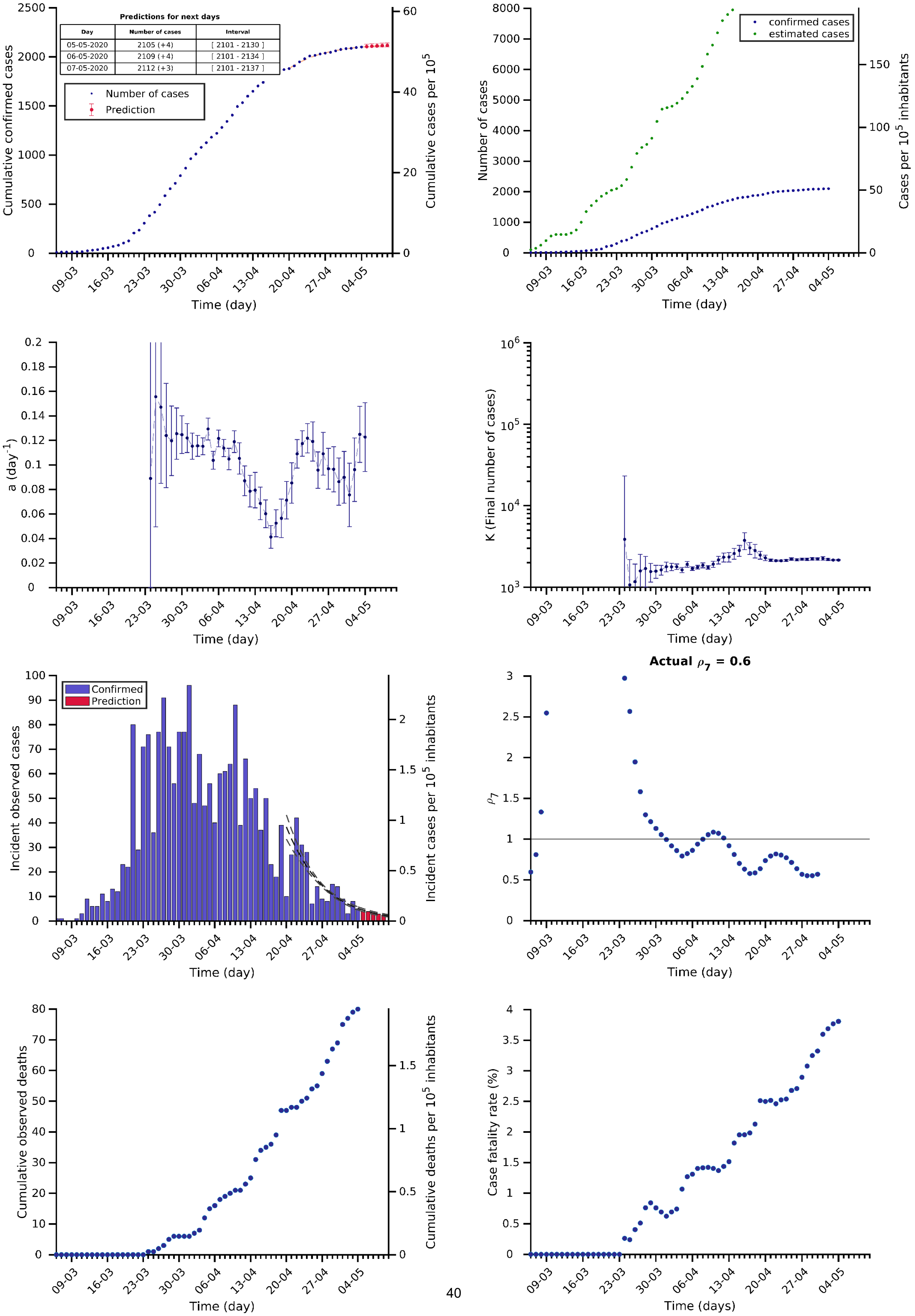




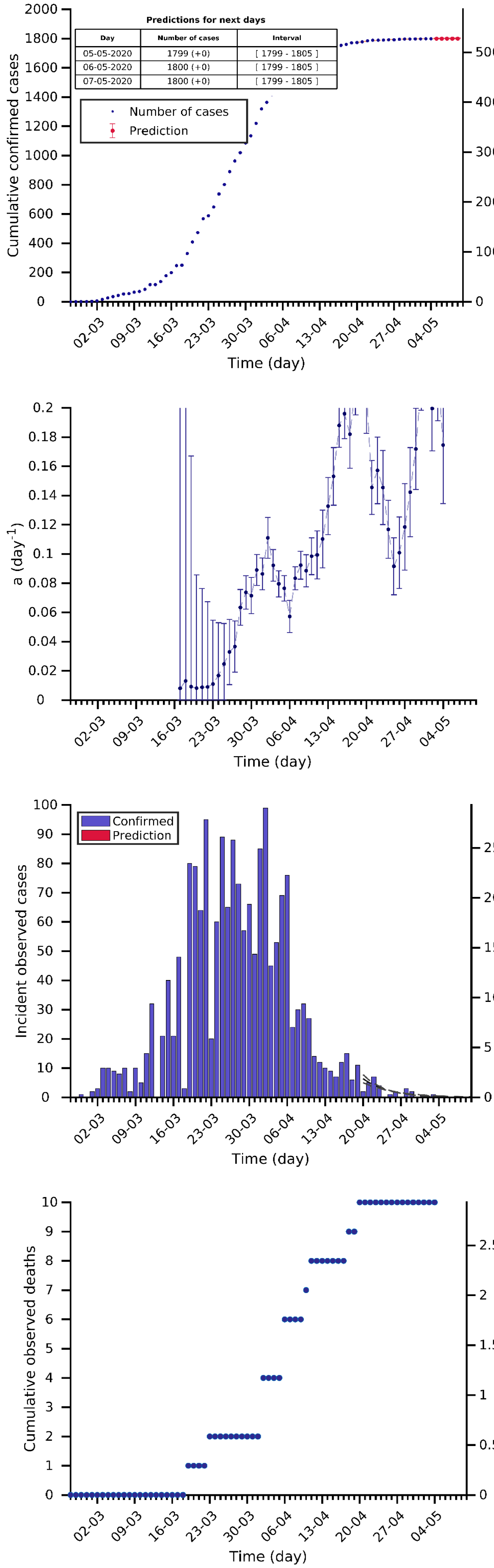
Greece 04-05-2020. Population: 10.4M. Current cumulated incidence: 25/10⁵

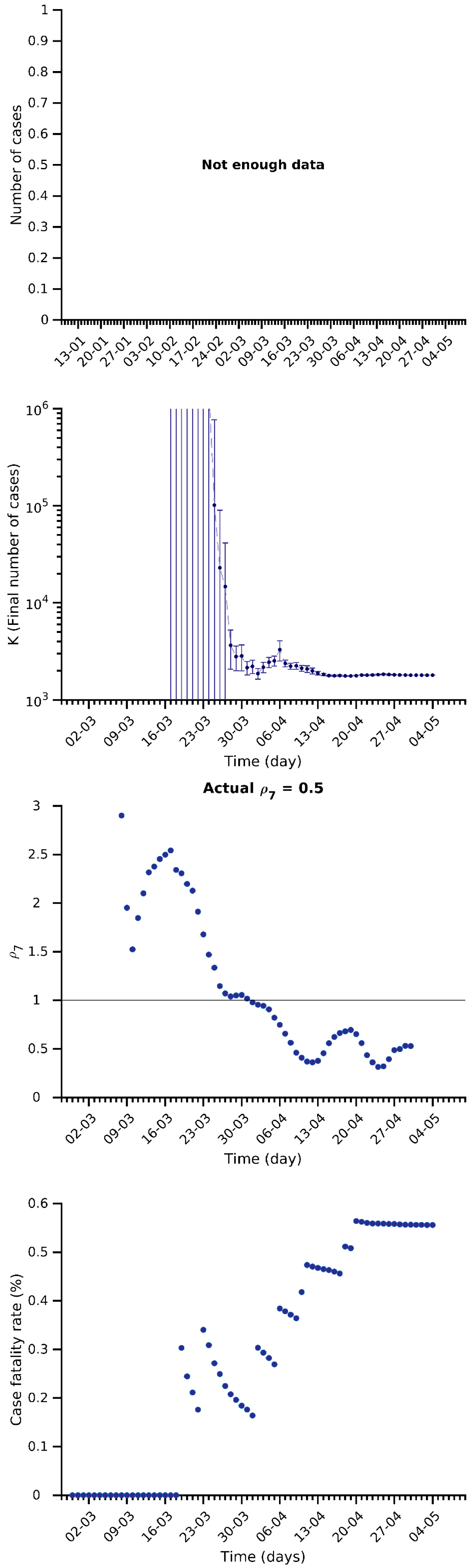


Croatia 04-05-2020. Population: 4.1M. Current cumulated incidence: 51/10^5

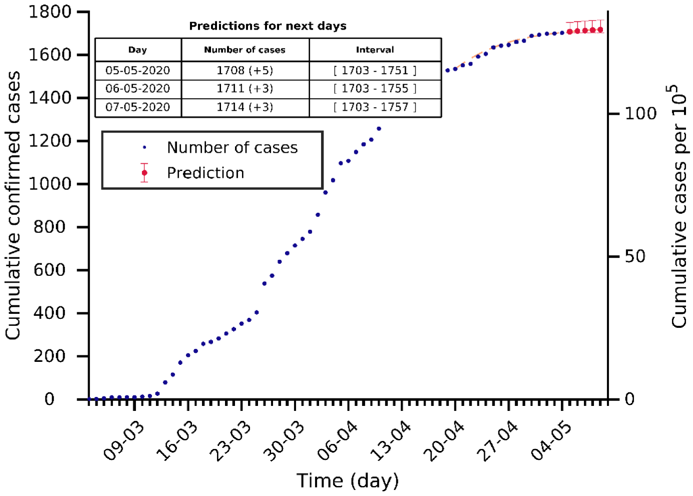


Iceland 04-05-2020. Population: 0.3M. Current cumulated incidence: 527/10⁵

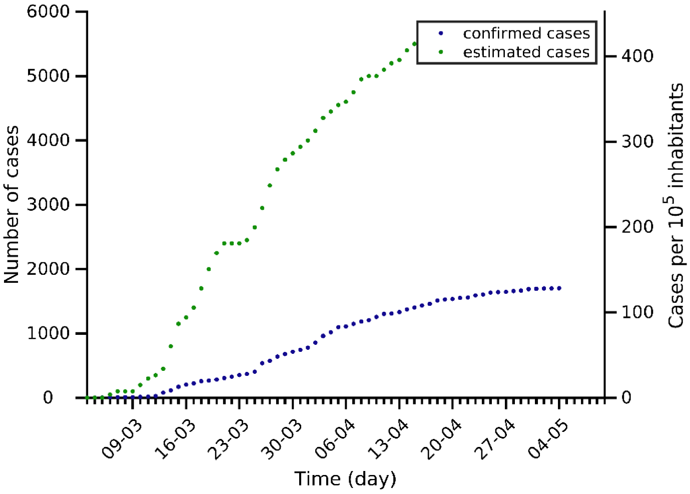


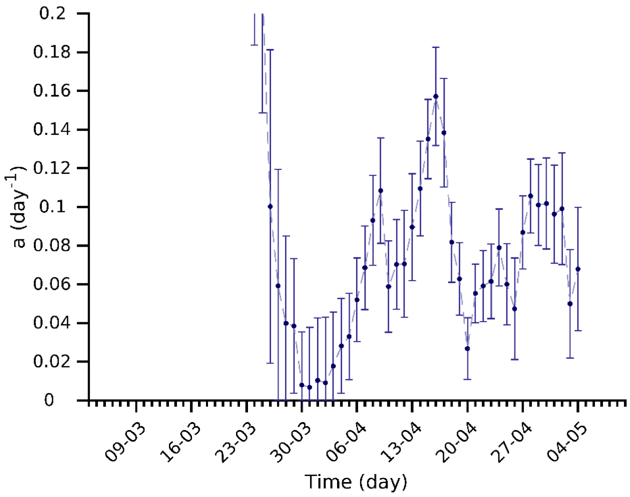


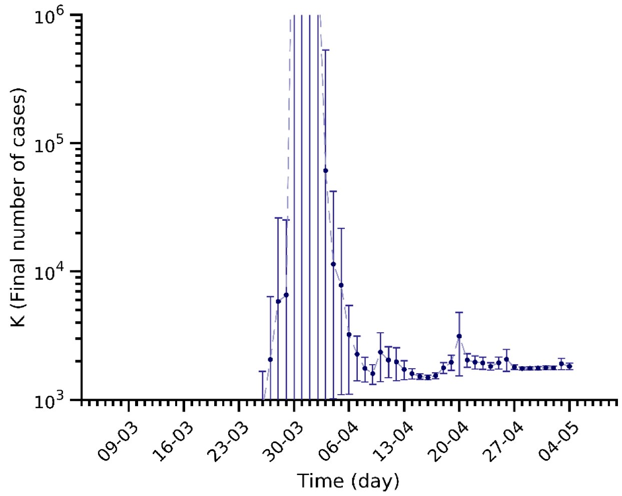
Estonia 04-05-2020. Population: 1.3M. Current cumulated incidence: 128/10^5

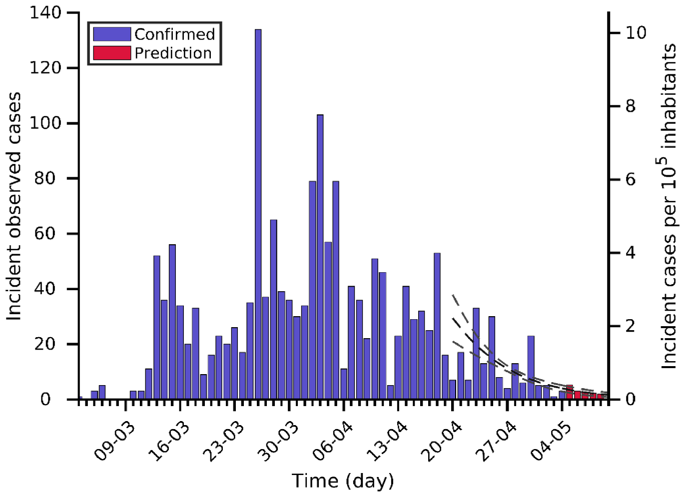


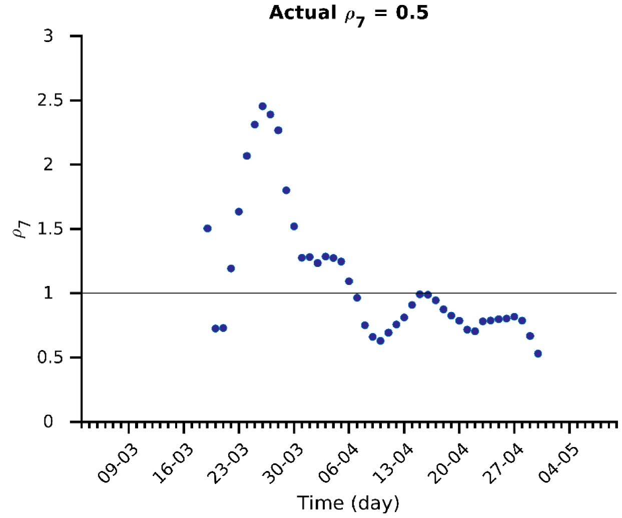
Day	Number of cases	Interval
05-05-2020	1708 (+5)	[1703 - 1751]
06-05-2020	1711 (+3)	[1703 - 1755]
07-05-2020	1714 (+3)	[1703 - 1757]

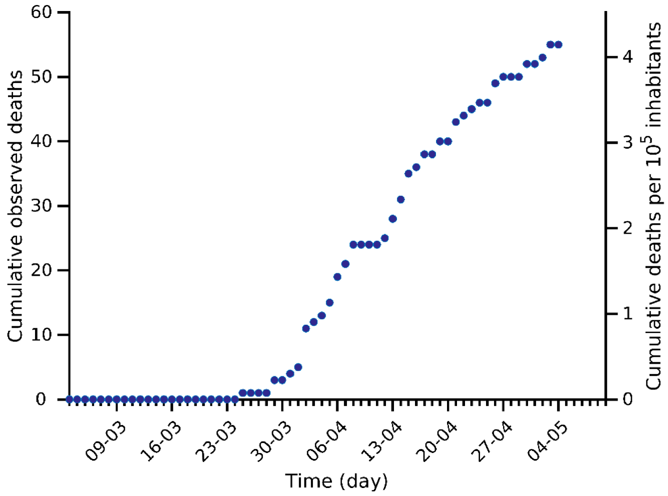


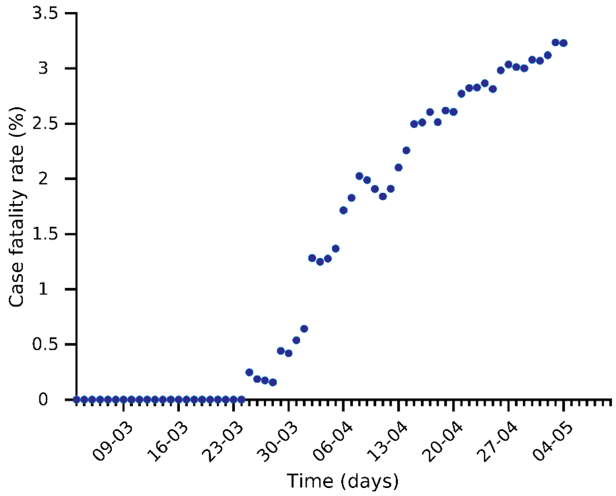




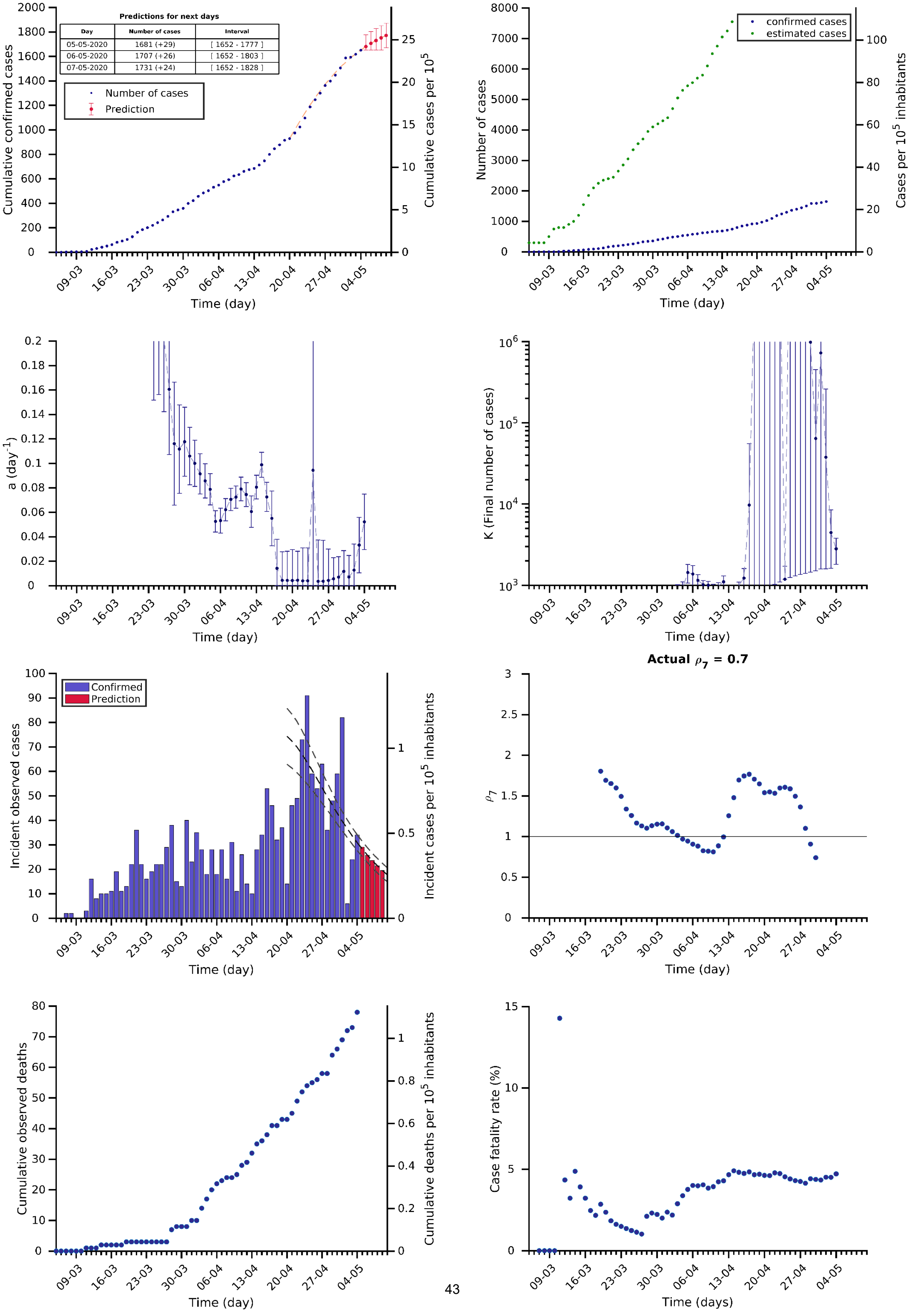




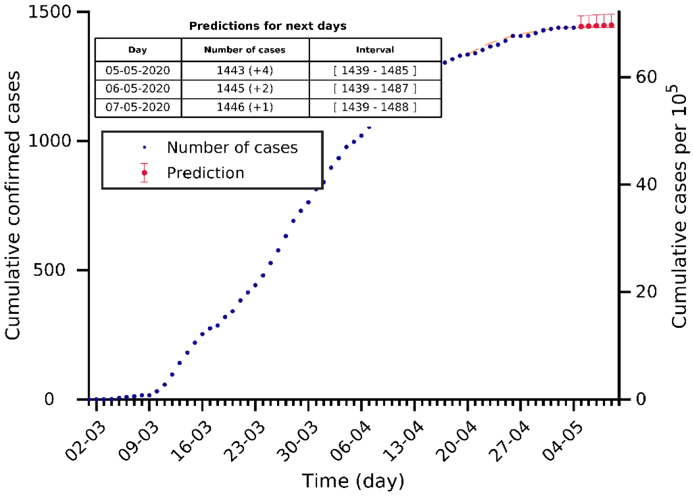




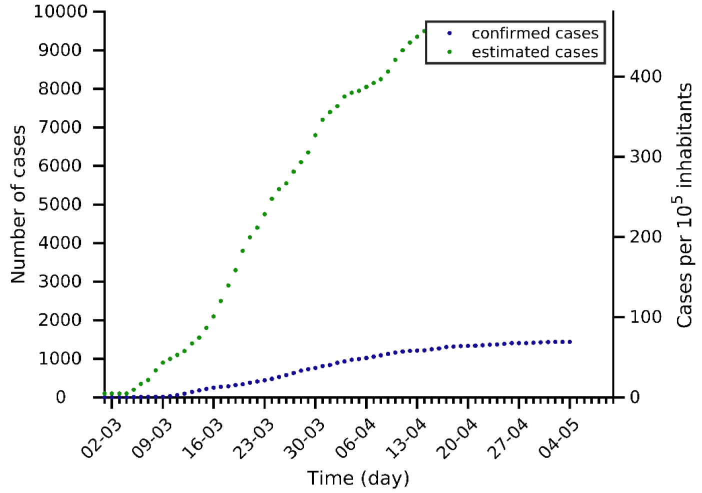
Bulgaria 04-05-2020. Population: 6.9M. Current cumulated incidence: 24/10⁵

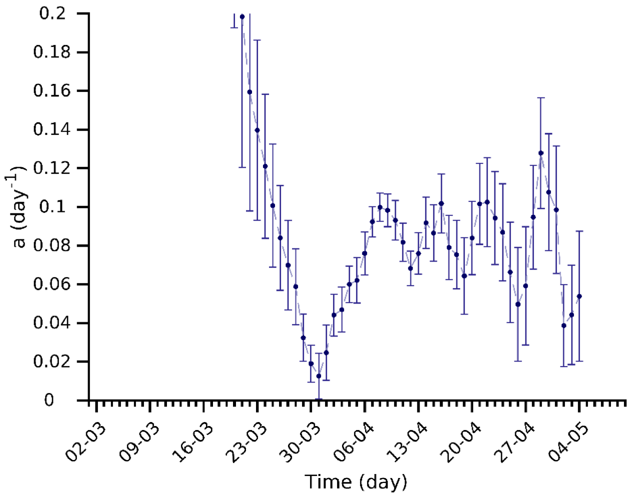


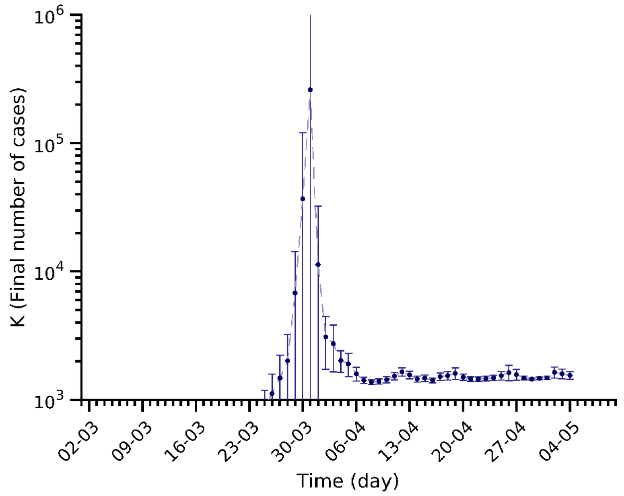
Slovenia 04-05-2020. Population: 2.1M. Current cumulated incidence: 69/10⁵

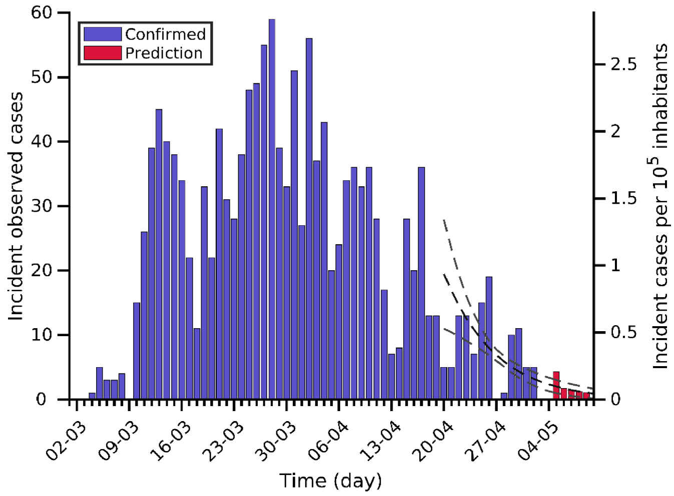


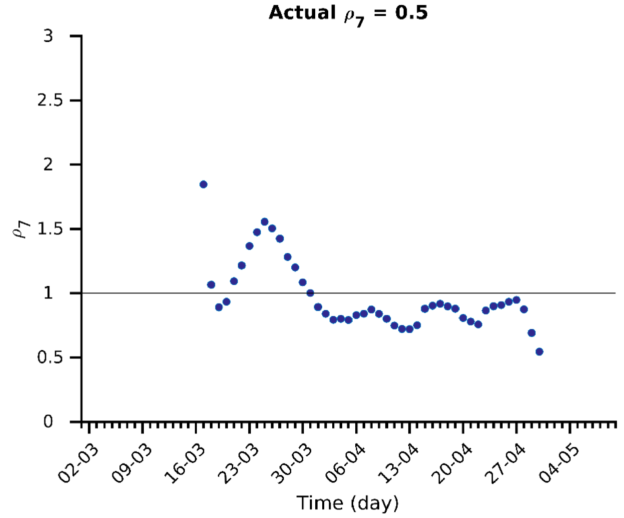
Day	Number of cases	Interval
05-05-2020	1443 (+4)	[1439 - 1485]
06-05-2020	1445 (+2)	[1439 - 1487]
07-05-2020	1446 (+1)	[1439 - 1488]

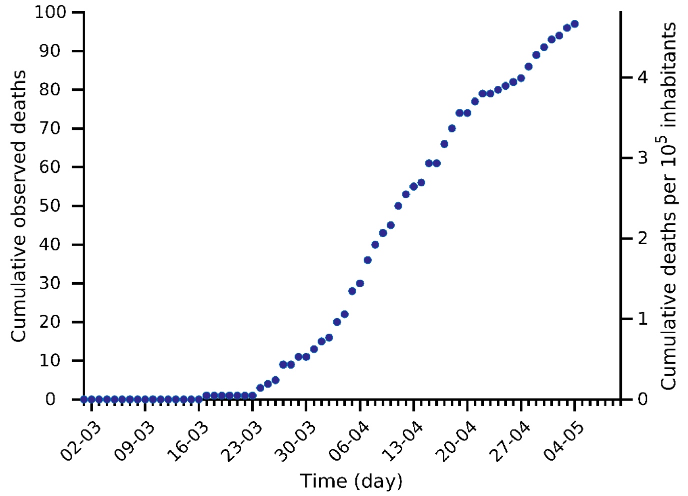


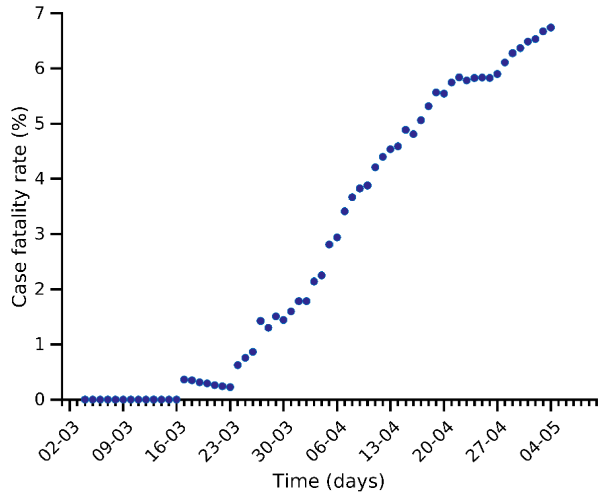




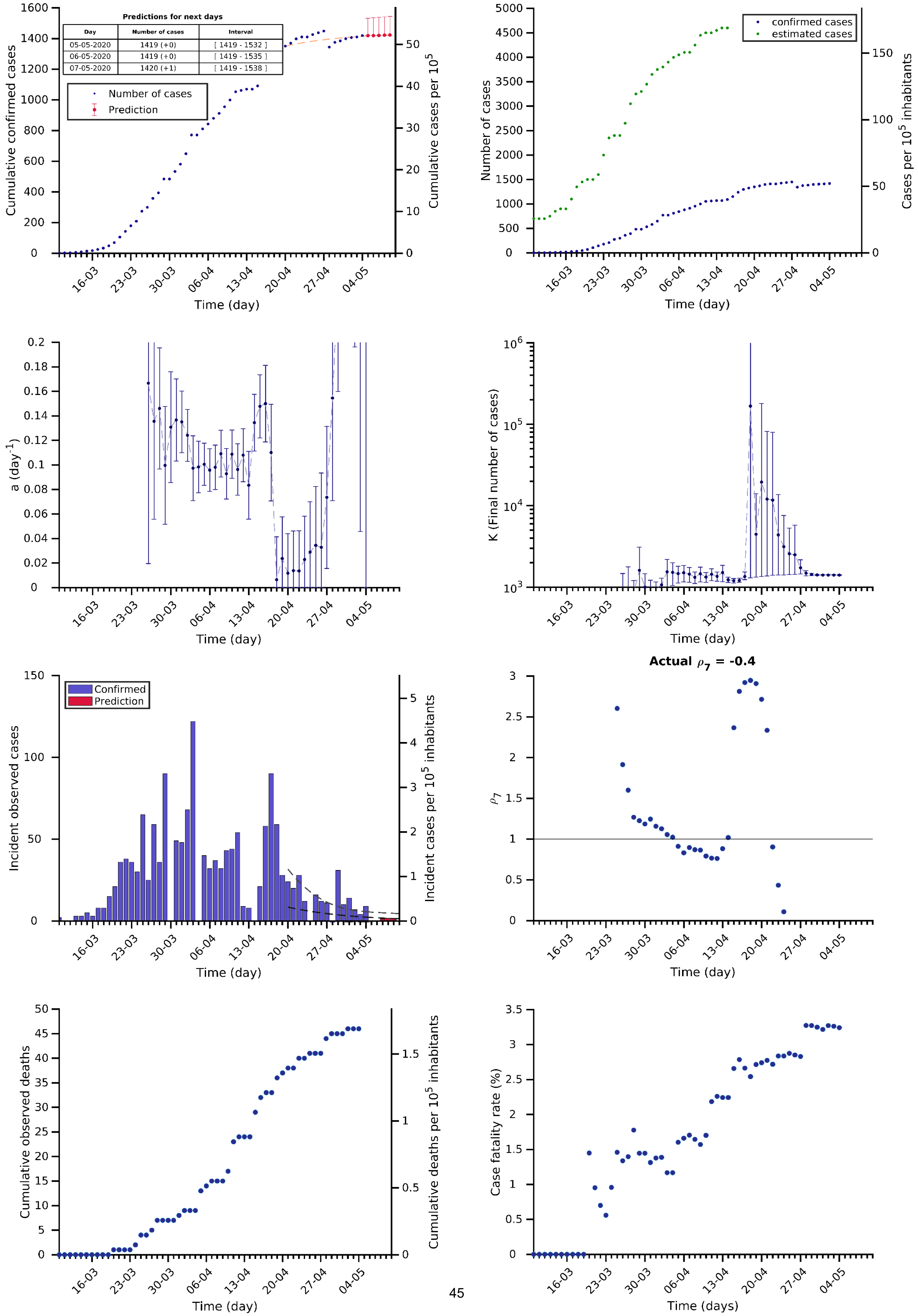




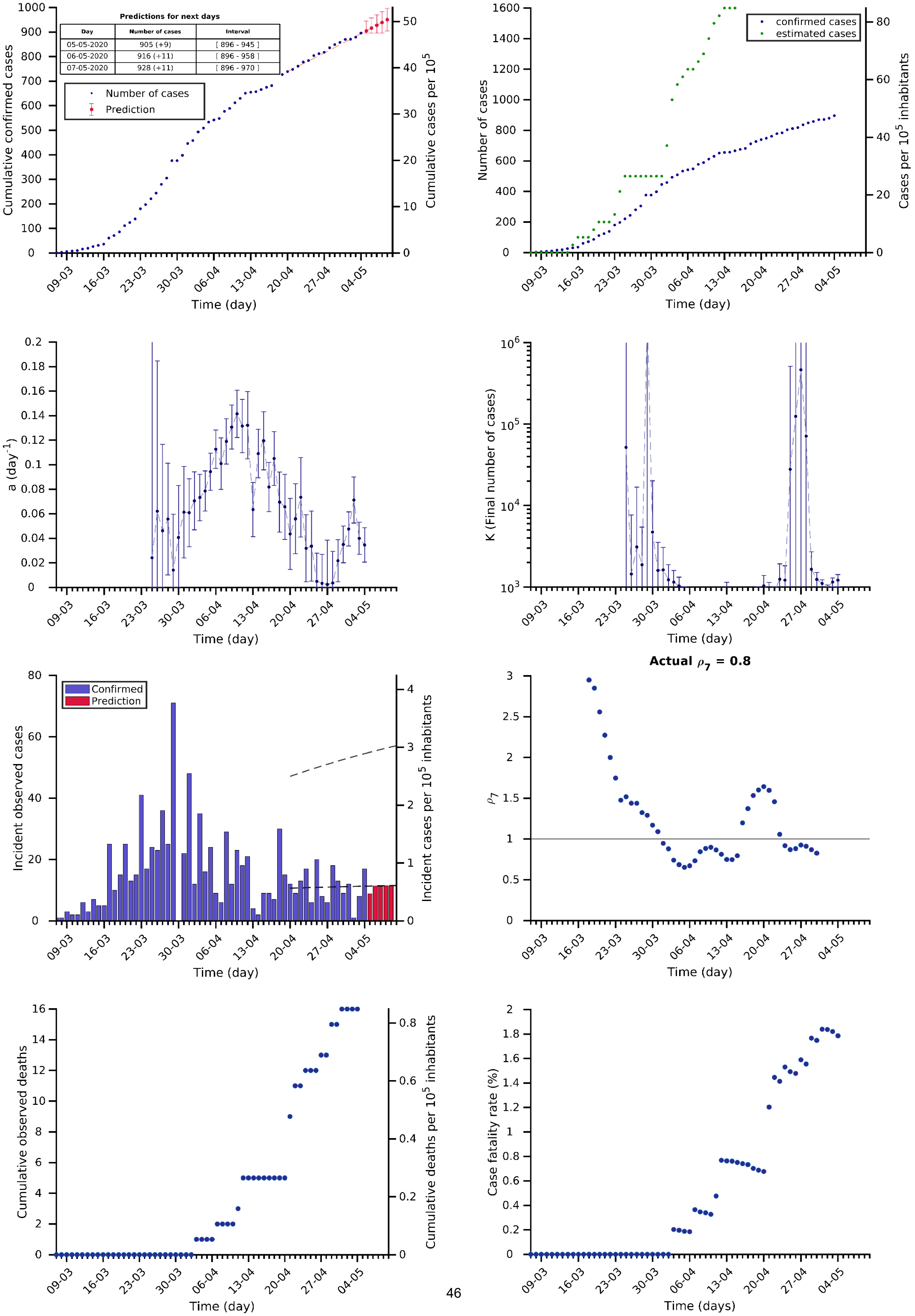




Lithuania 04-05-2020. Population: 2.7M. Current cumulated incidence: 52/10⁵

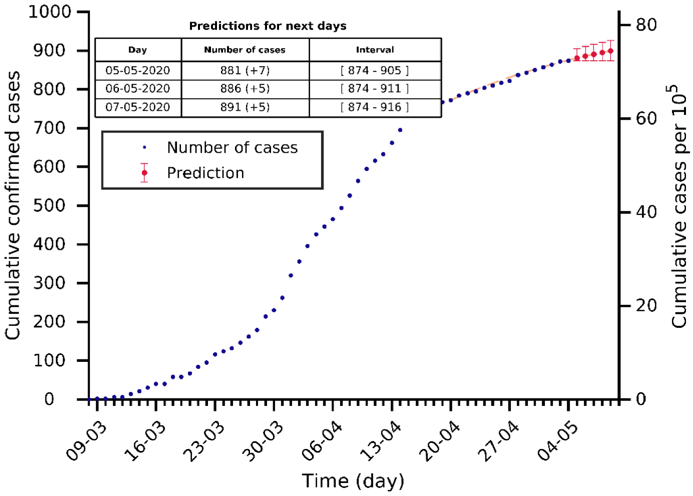


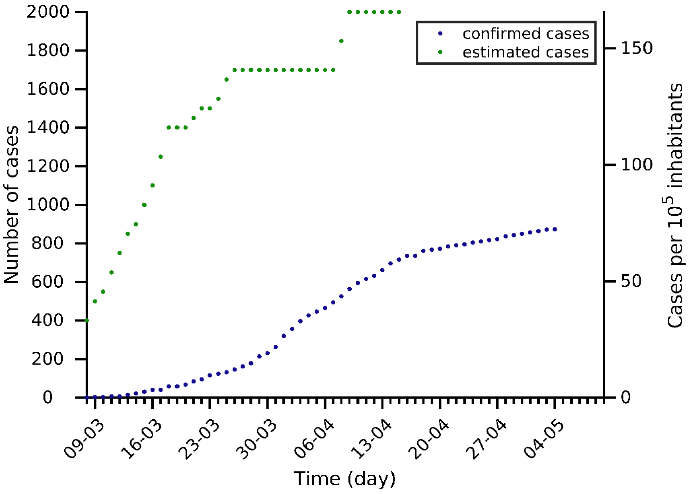
Latvia 04-05-2020. Population: 1.9M. Current cumulated incidence: 48/10⁵

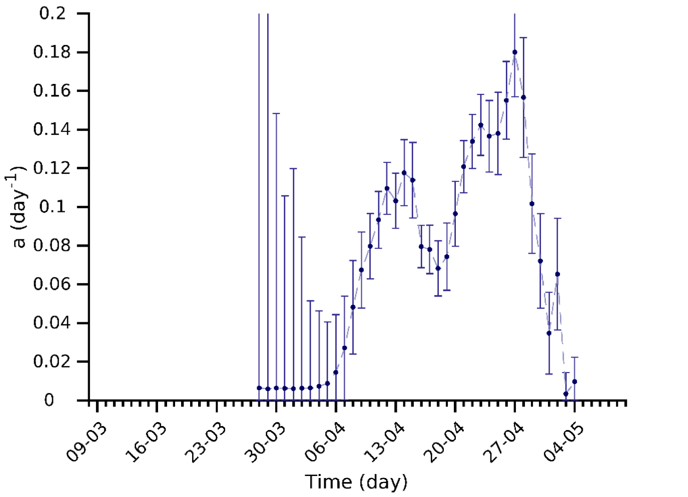


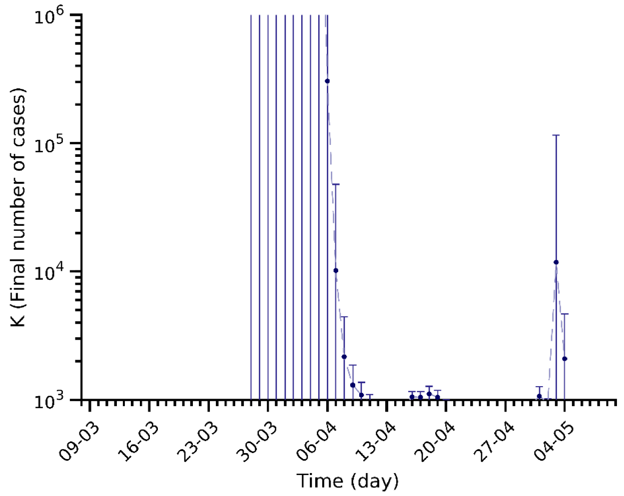
Day	Number of cases	Interval
05-05-2020	905 (+9)	[896 - 945]
06-05-2020	916 (+11)	[896 - 958]
07-05-2020	928 (+11)	[896 - 970]

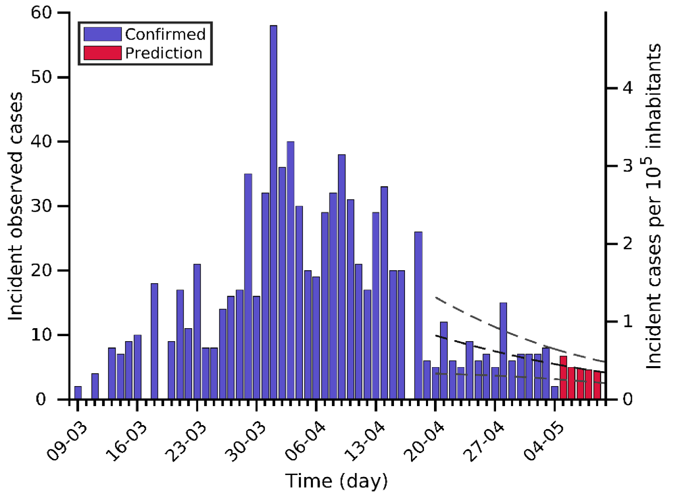
Cyprus 04-05-2020. Population: 1.2M. Current cumulated incidence: 72/10⁵

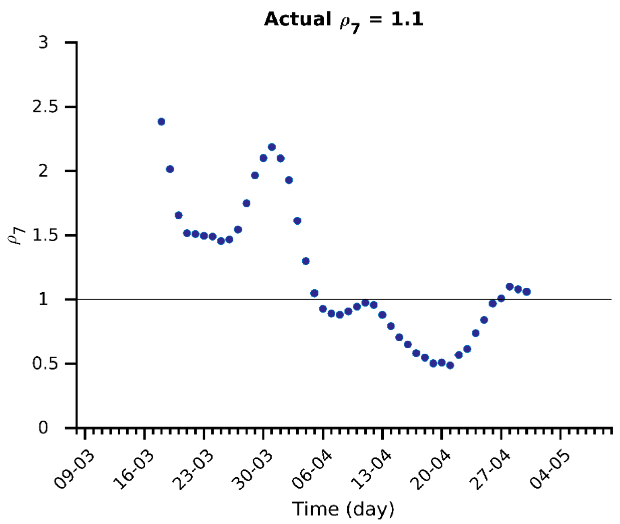


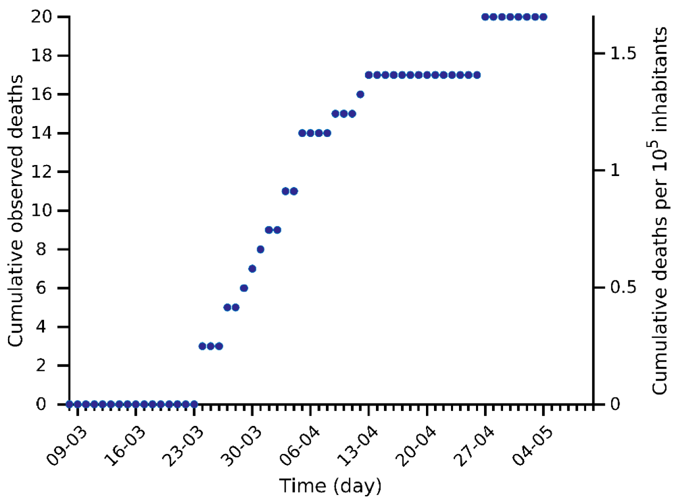


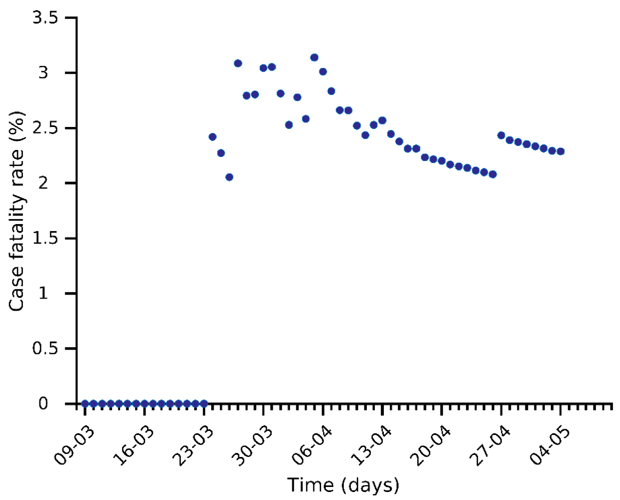




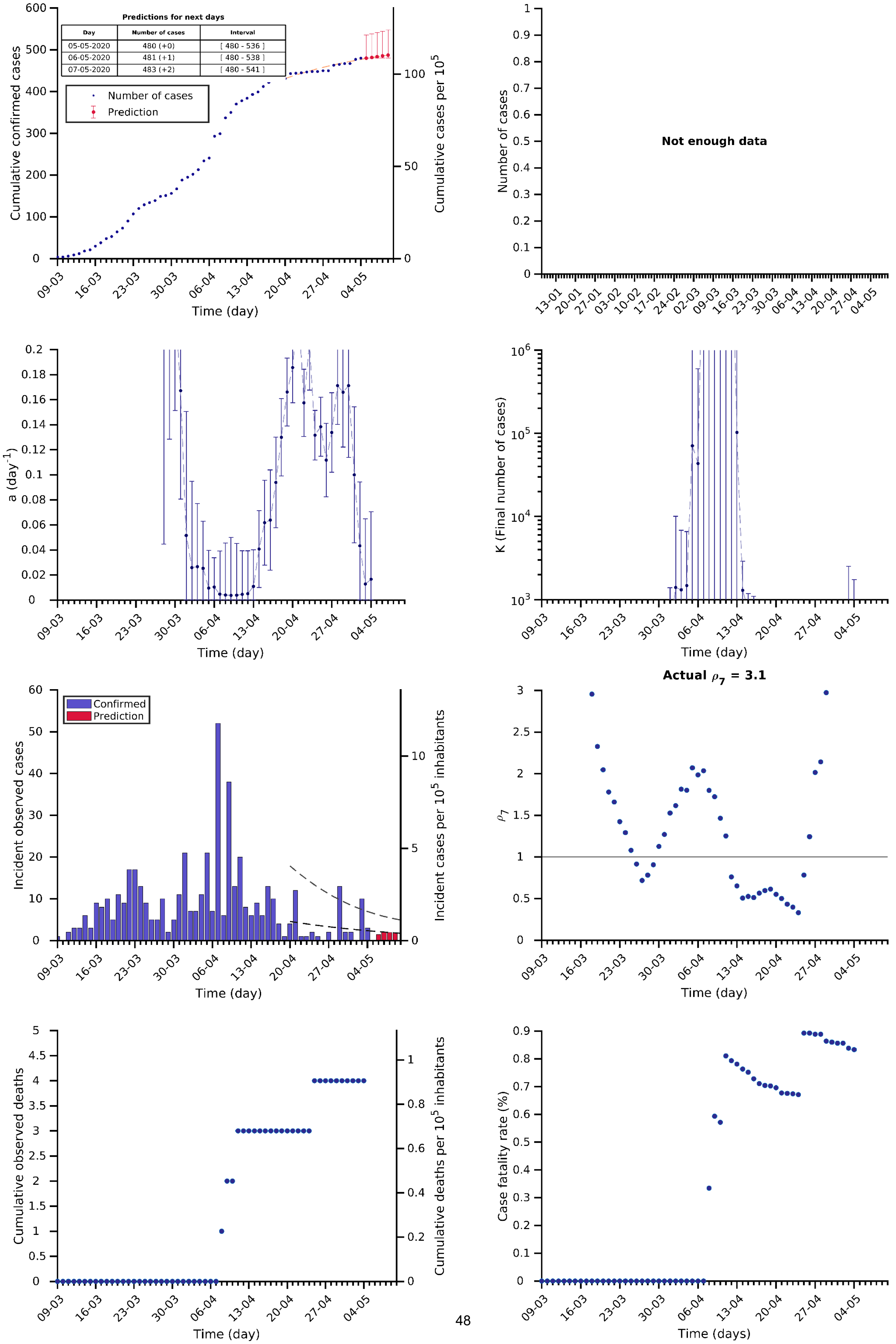








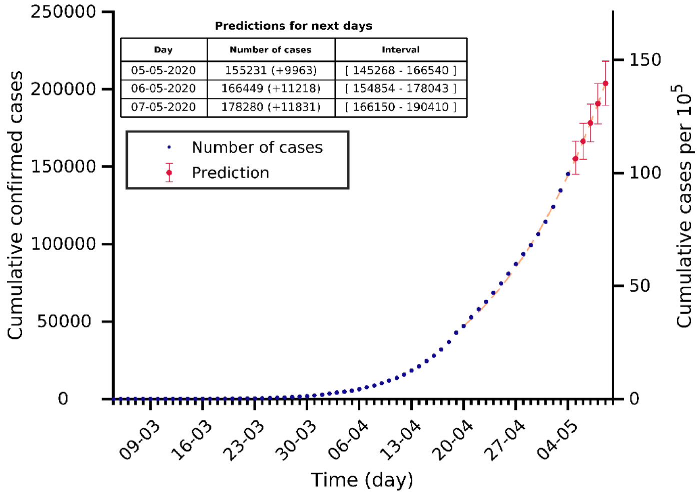
Malta 04-05-2020. Population: 0.4M. Current cumulated incidence: 109/10⁵



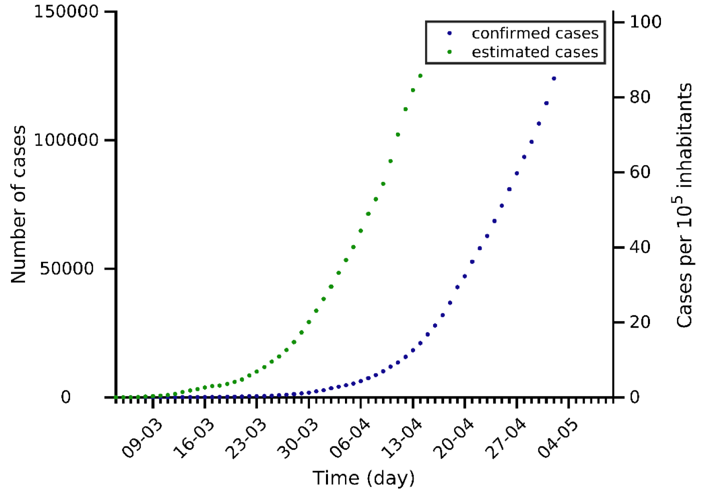
(2) Analysis and prediction of COVID-19 for other countries

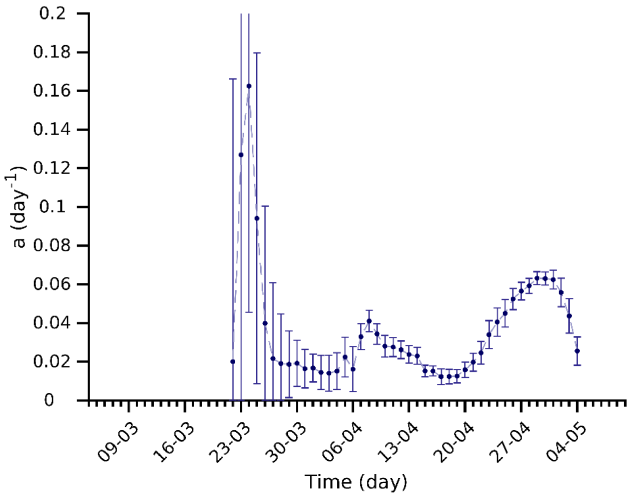
Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

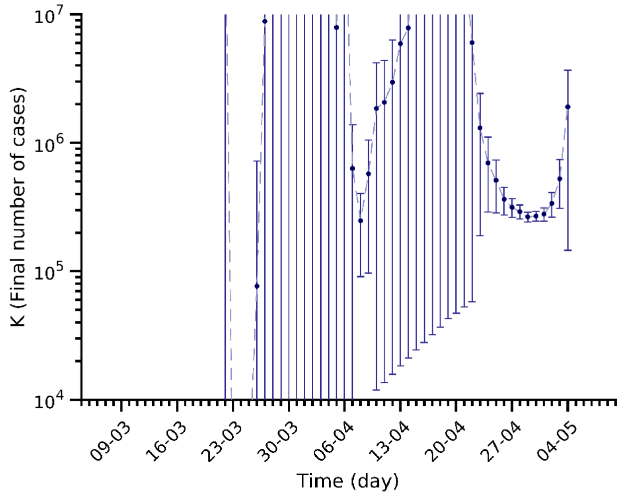
Russia 04-05-2020. Population: 145.9M. Current cumulated incidence: 100/10⁵

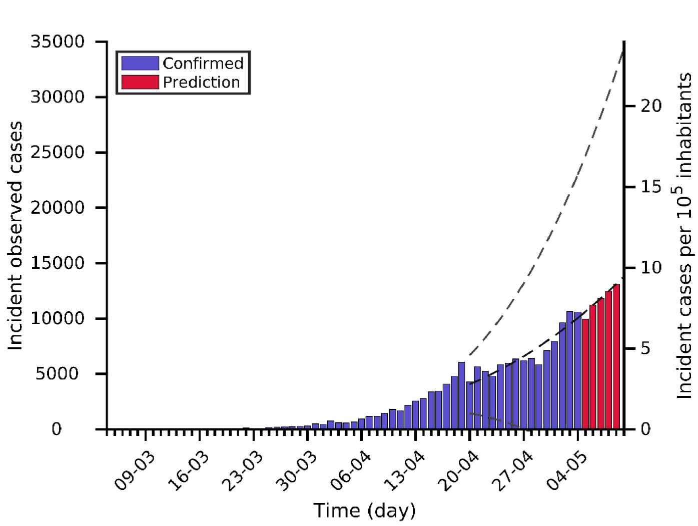


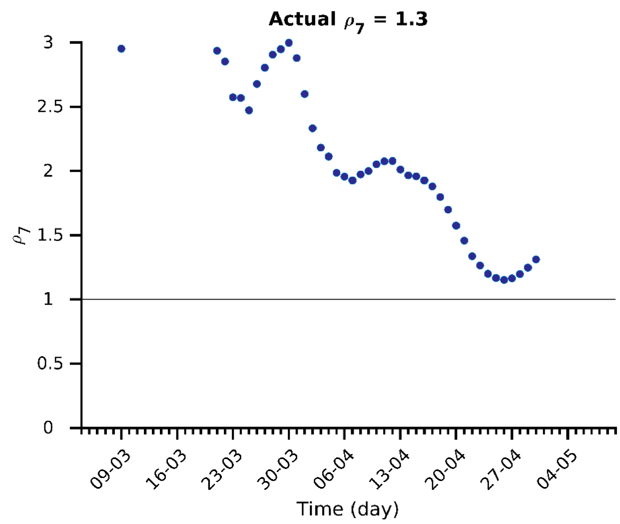
Day	Number of cases	Interval
05-05-2020	155231 (+9963)	[145268 - 166540]
06-05-2020	166449 (+11218)	[154854 - 178043]
07-05-2020	178280 (+11831)	[166150 - 190410]

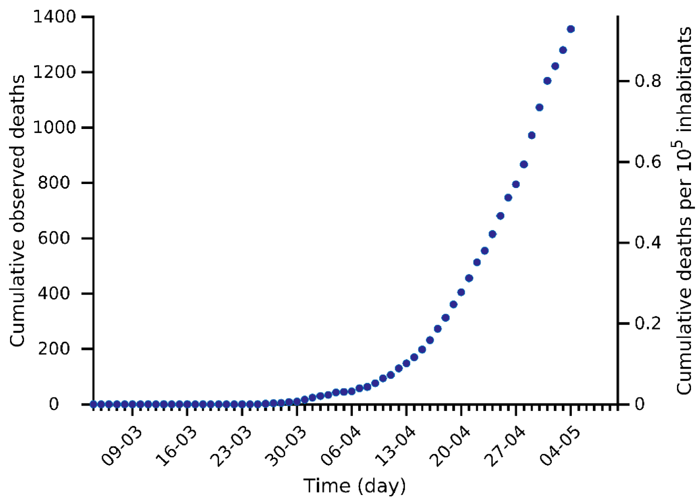


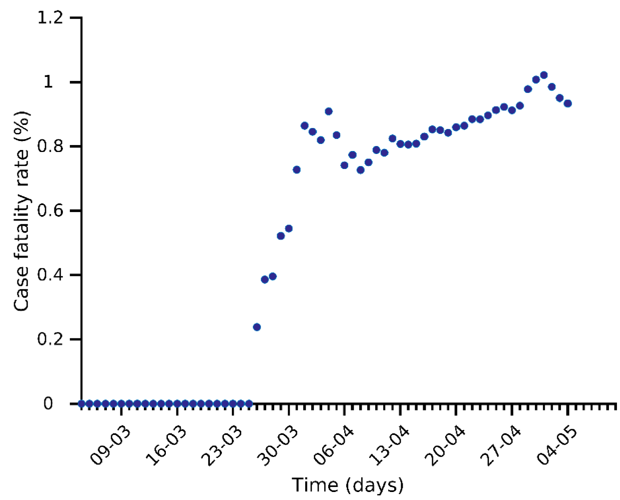




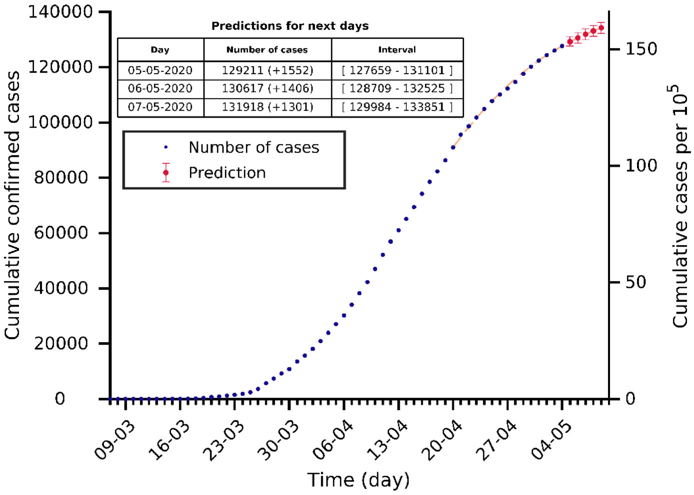




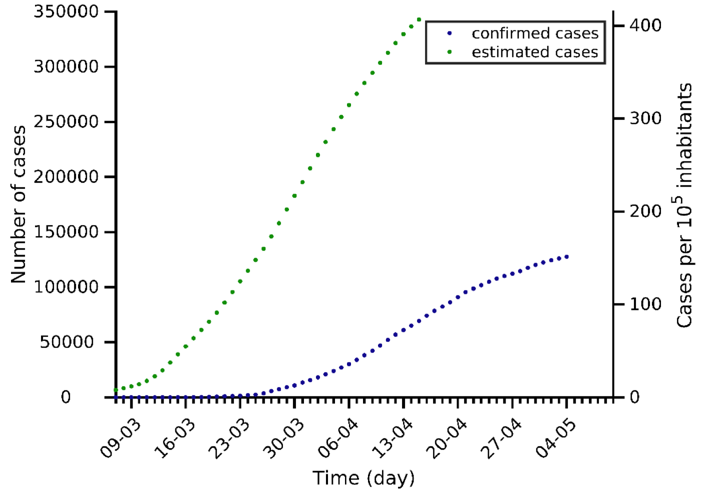


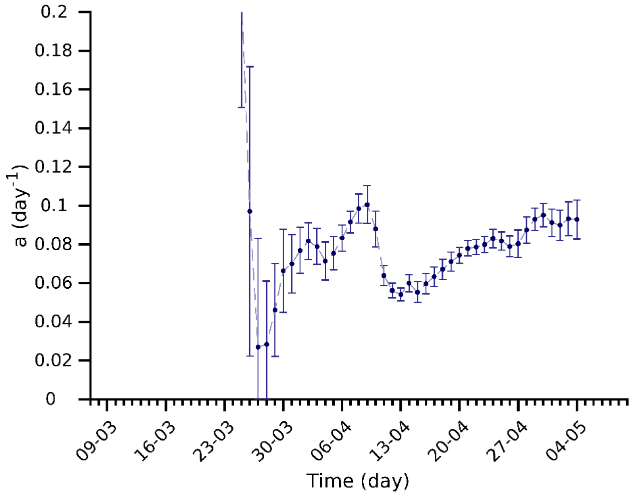


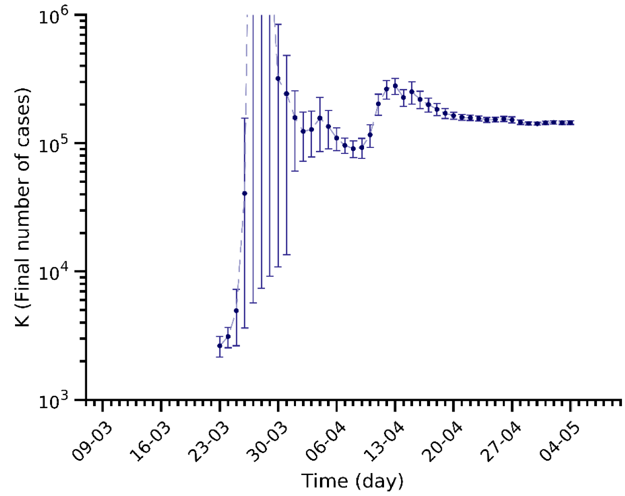
Turkey 04-05-2020. Population: 84.3M. Current cumulated incidence: 151/10⁵

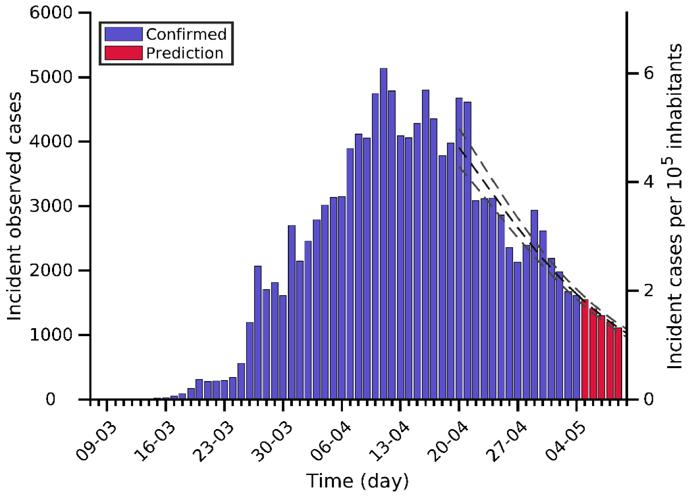


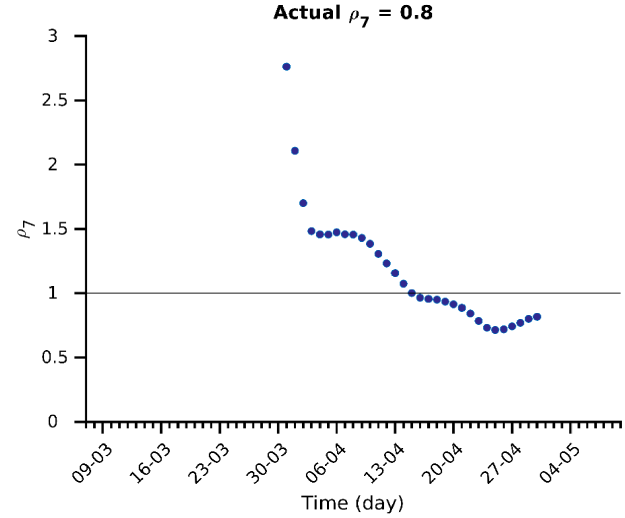
Day	Number of cases	Interval
05-05-2020	129211 (+1552)	[127659 - 131101]
06-05-2020	130617 (+1406)	[128709 - 132525]
07-05-2020	131918 (+1301)	[129984 - 133851]

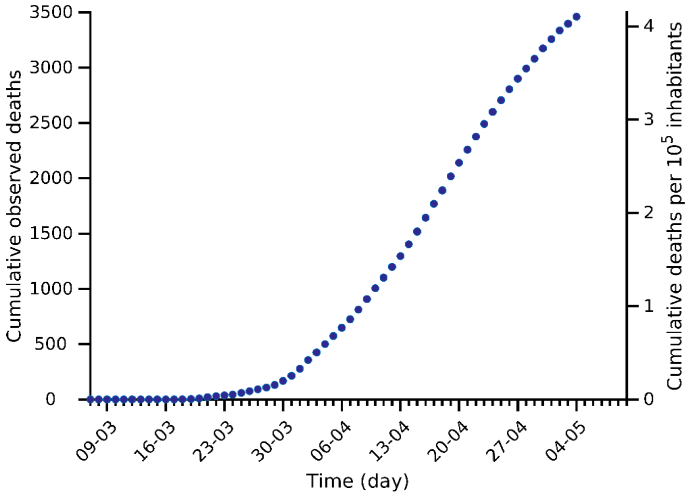


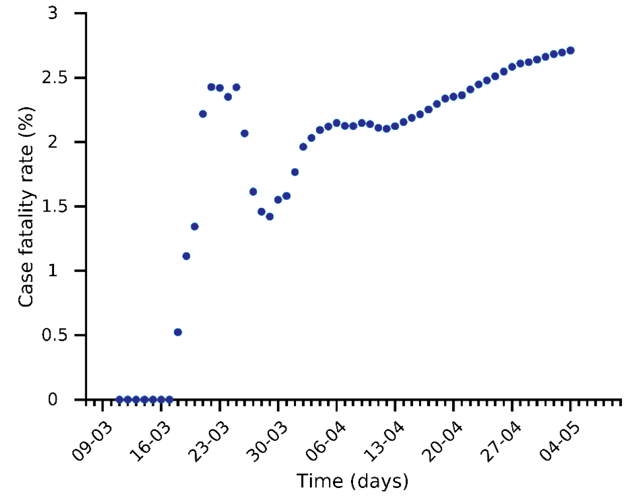




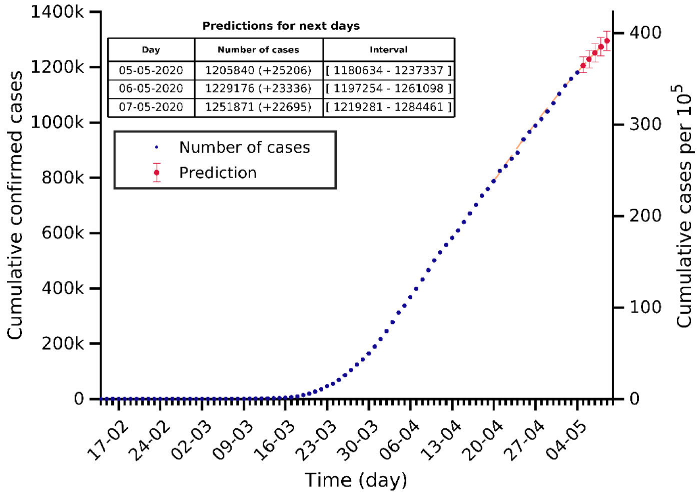




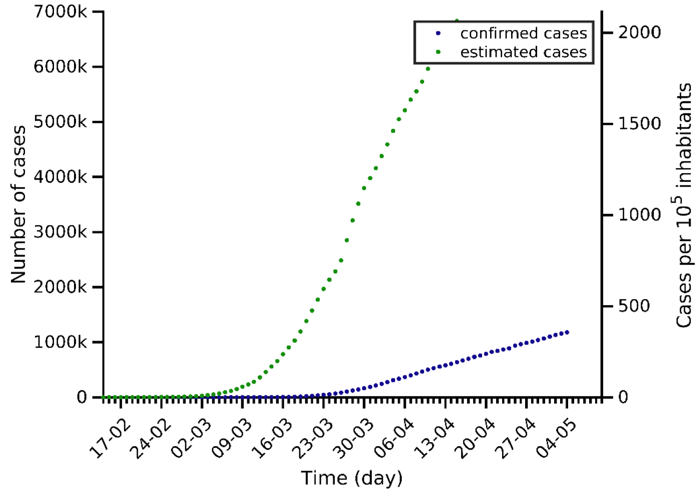


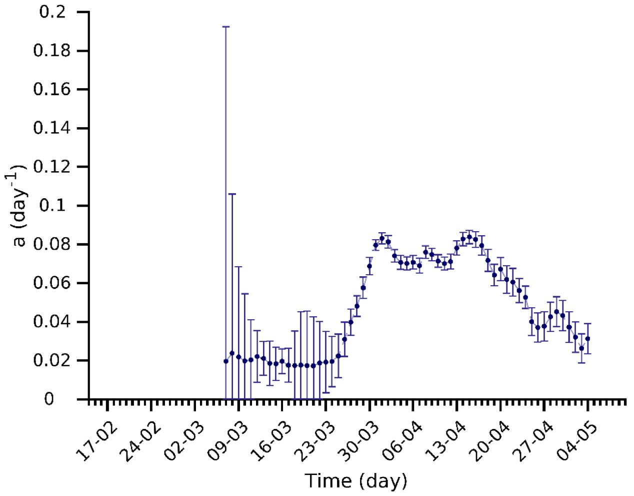


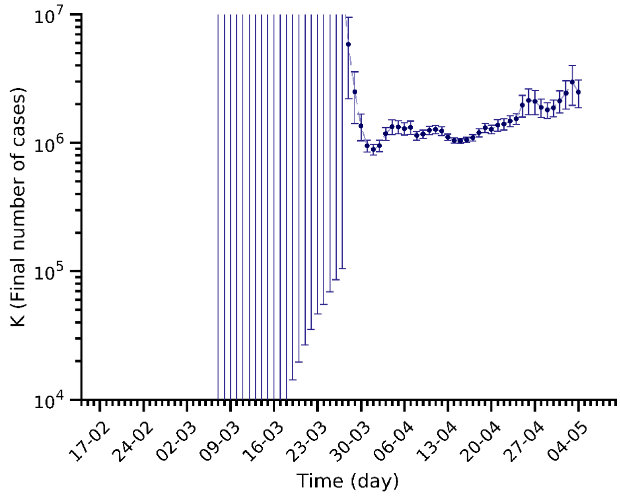
USA 04-05-2020. Population: 331.0M. Current cumulated incidence: 357/10^5

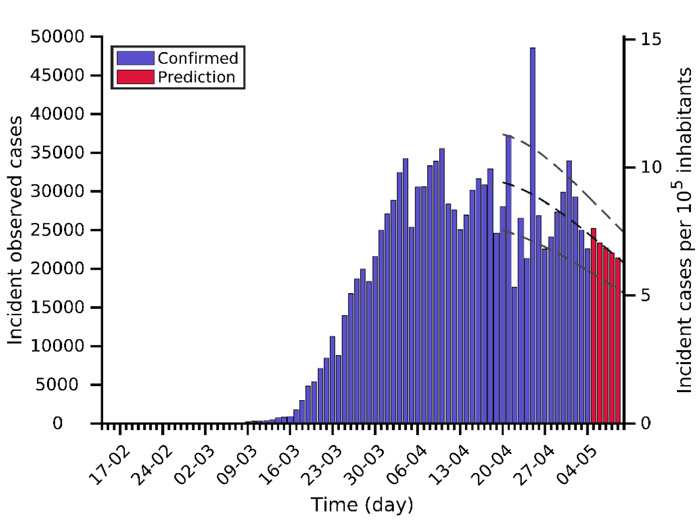


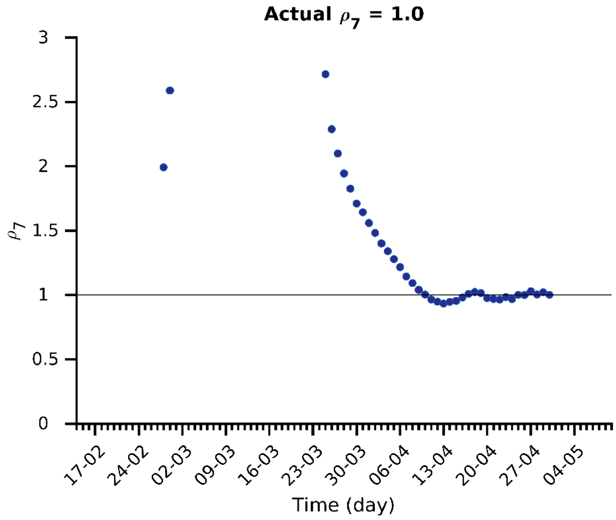
Day	Number of cases	Interval
05-05-2020	1205840 (+25206)	[1180634 - 1237337]
06-05-2020	1229176 (+23336)	[1197254 - 1261098]
07-05-2020	1251871 (+22695)	[1219281 - 1284461]

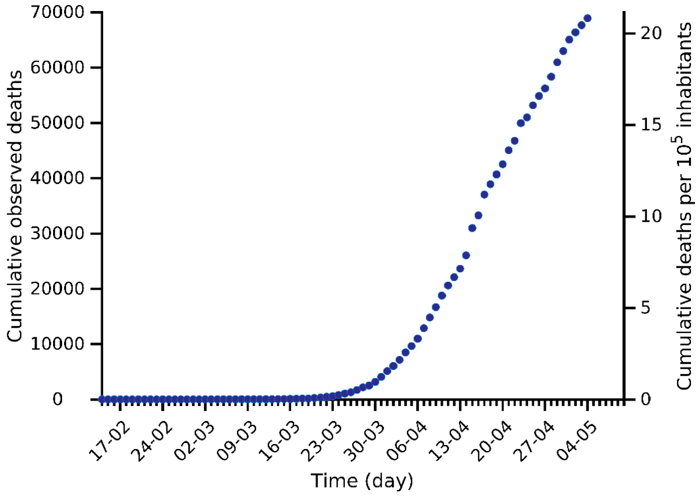


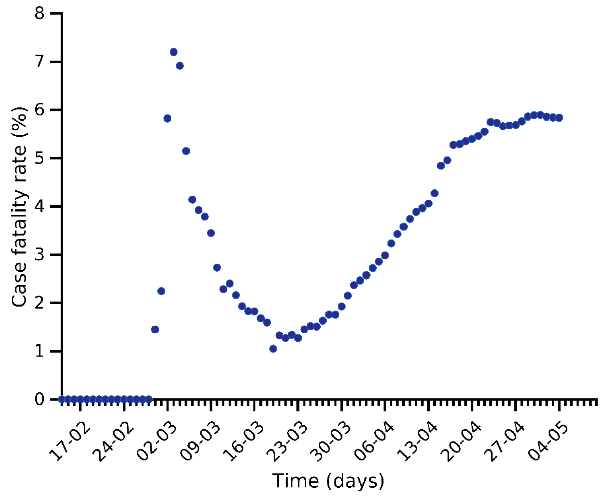




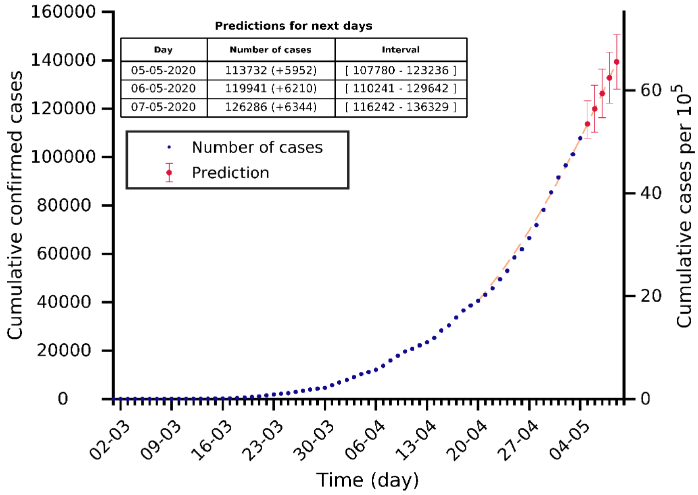


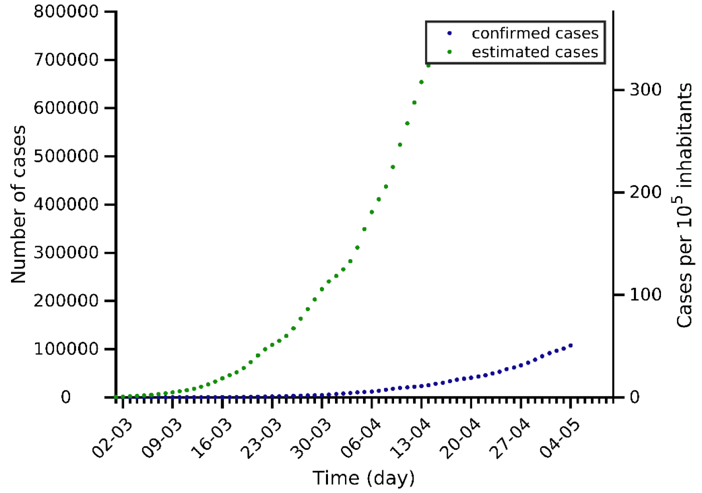


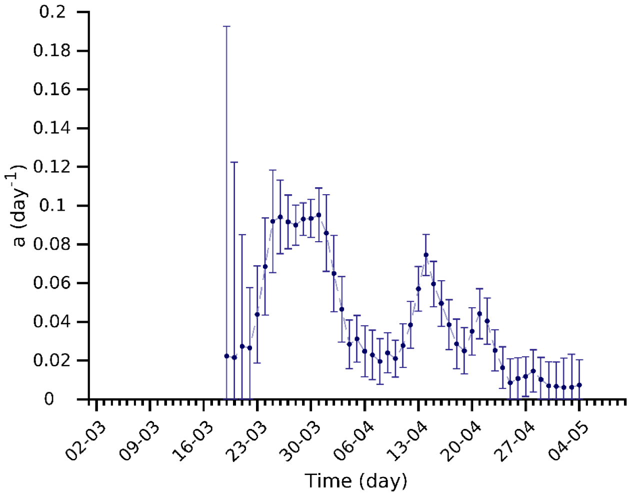


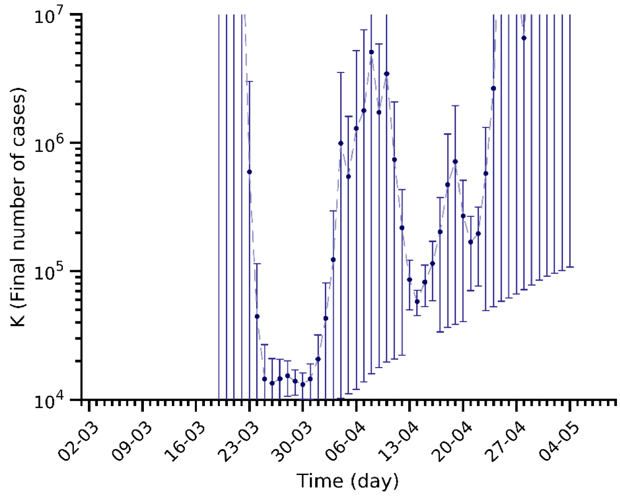


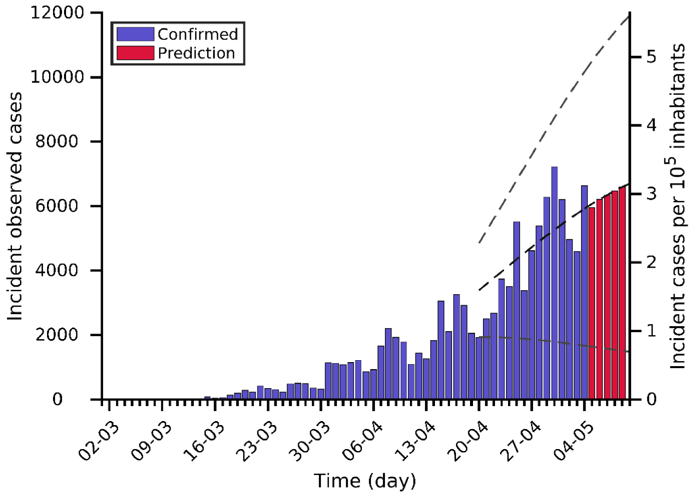
Brazil 04-05-2020. Population: 212.6M. Current cumulated incidence: 51/10⁵

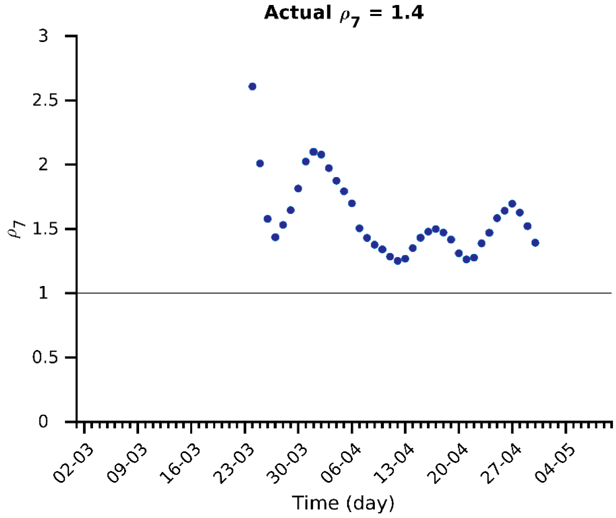


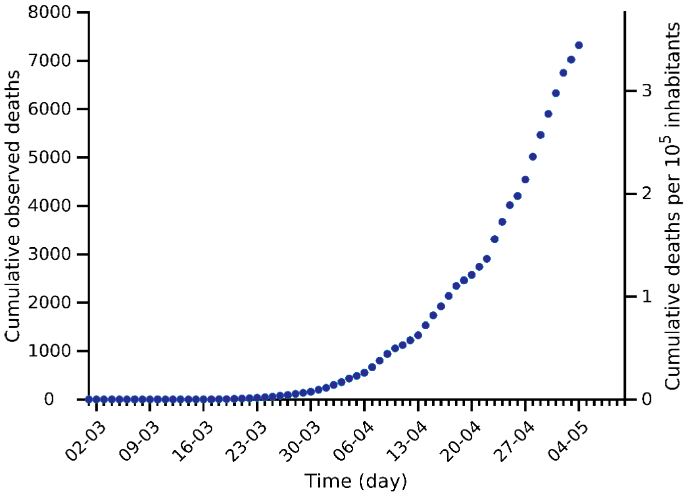


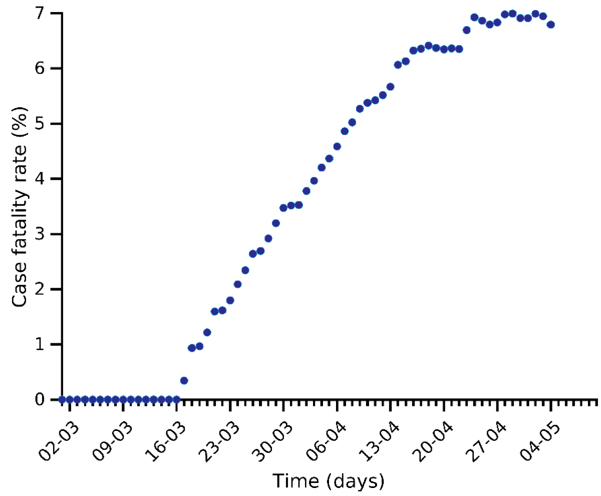




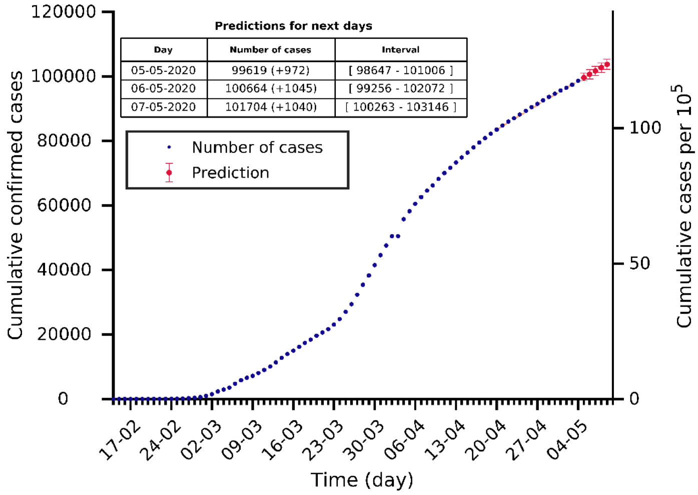


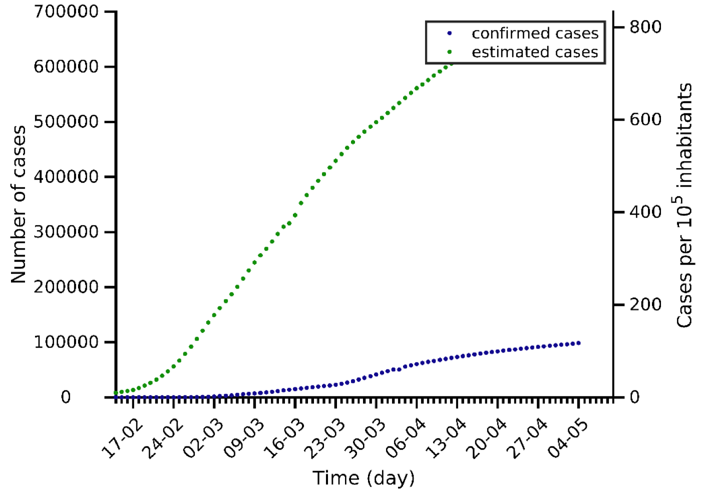


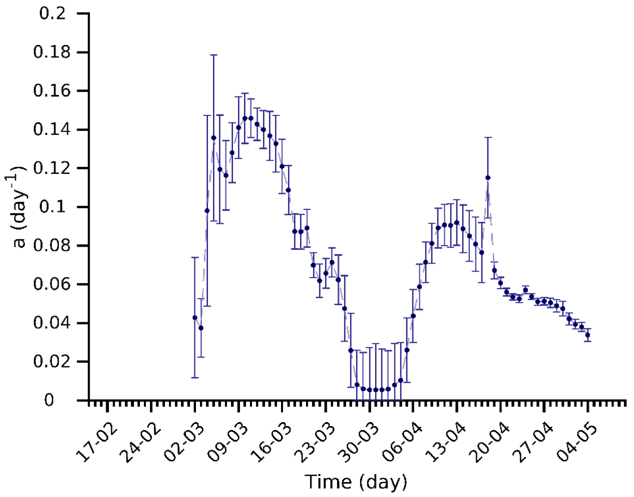


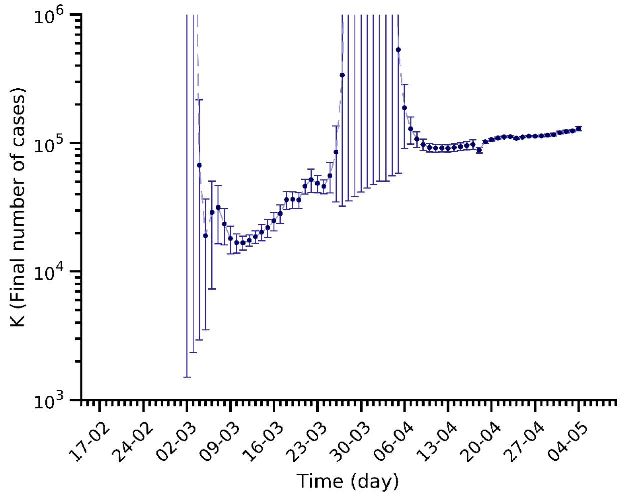


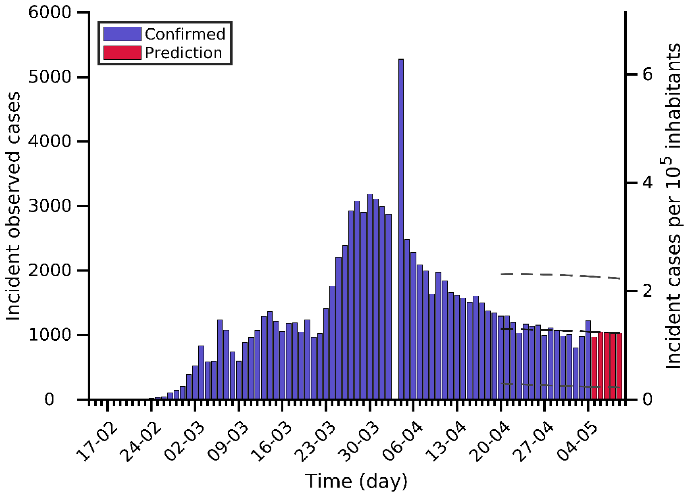
Iran 04-05-2020. Population: 84.0M. Current cumulated incidence: $117/10^5$



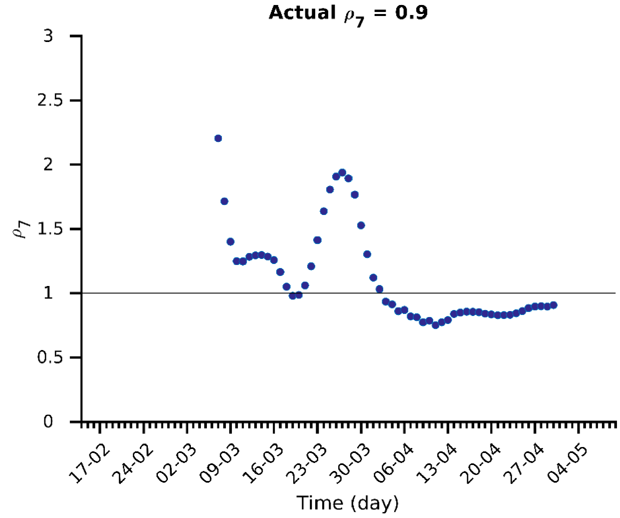


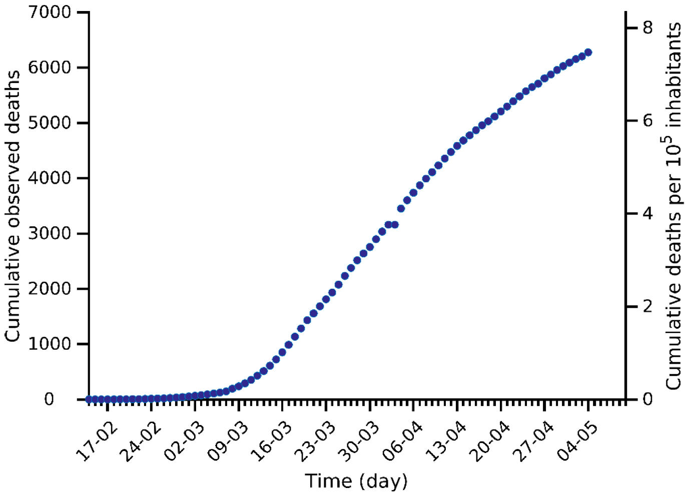


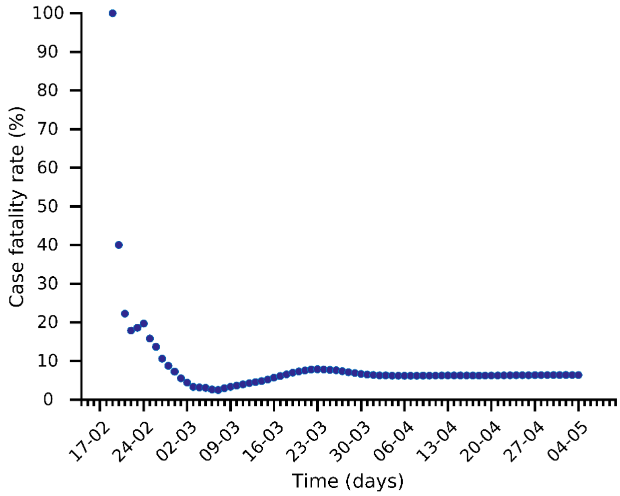




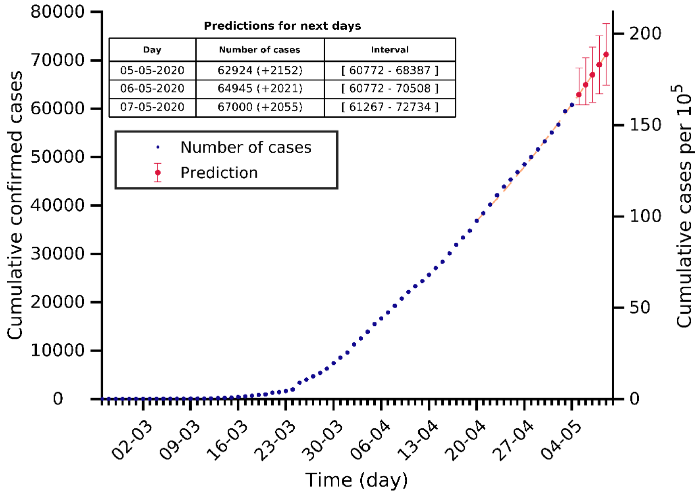
Actual ρ_7 = 0.9

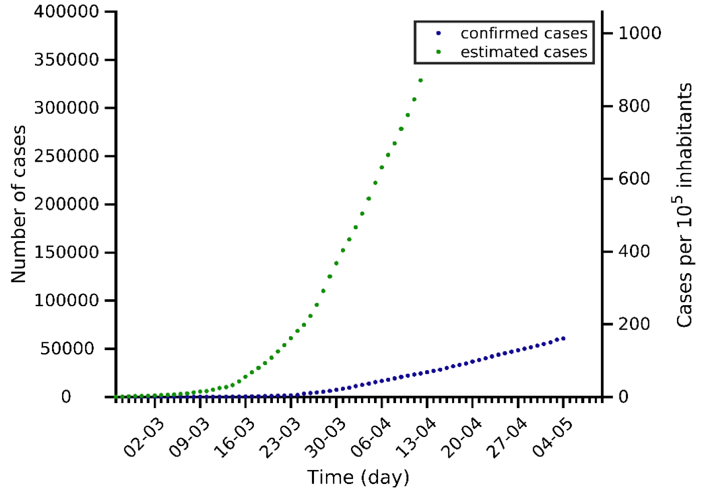


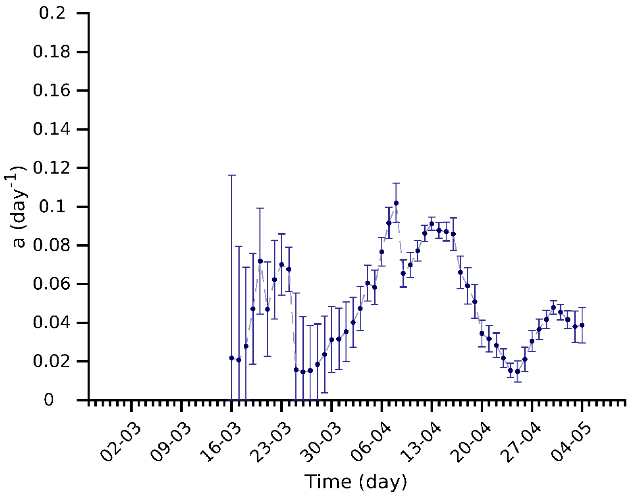


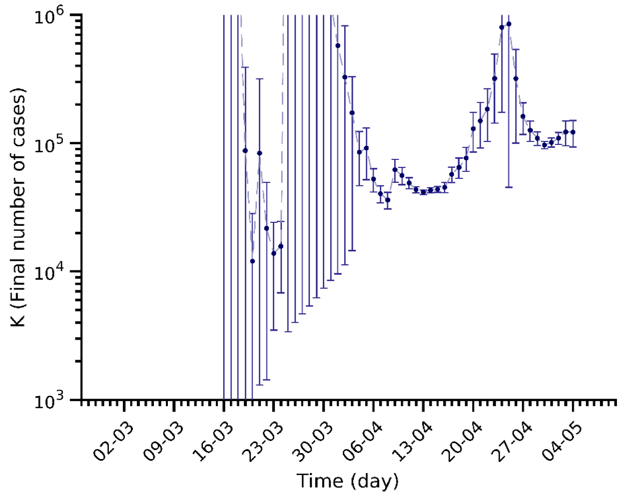


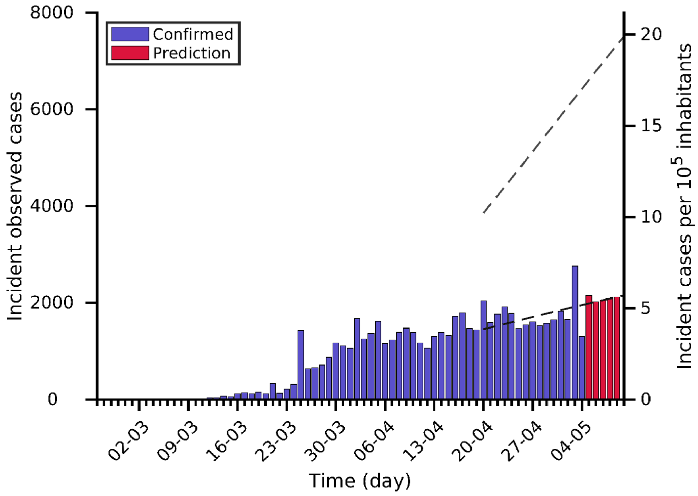
Canada 04-05-2020. Population: 37.7M. Current cumulated incidence: 161/10⁵

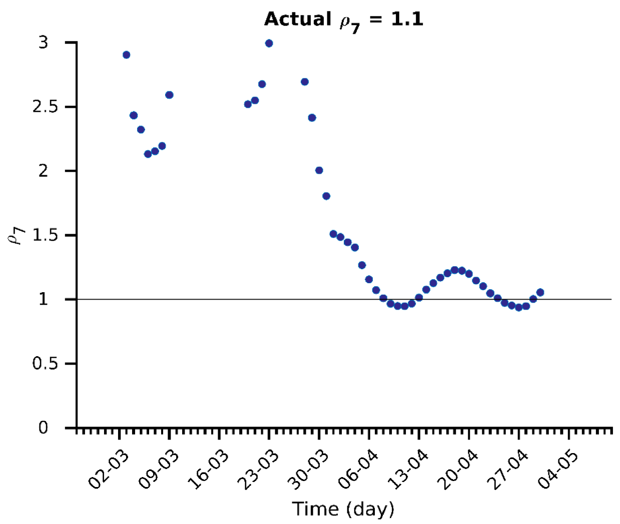


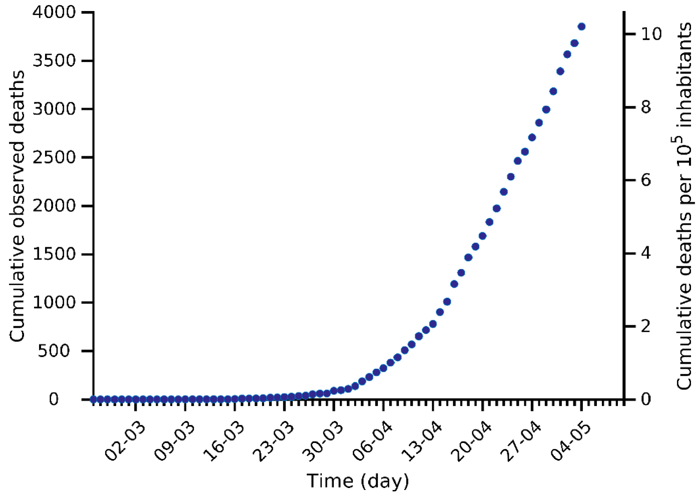


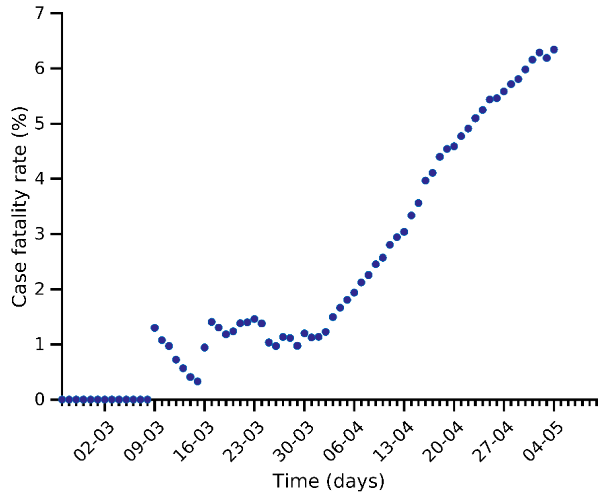




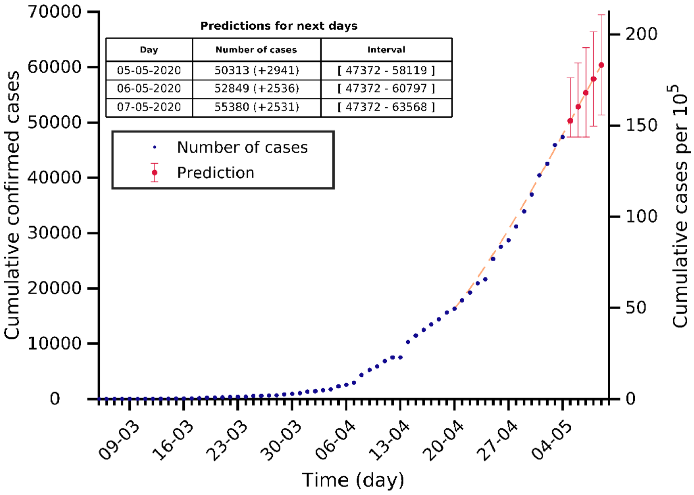




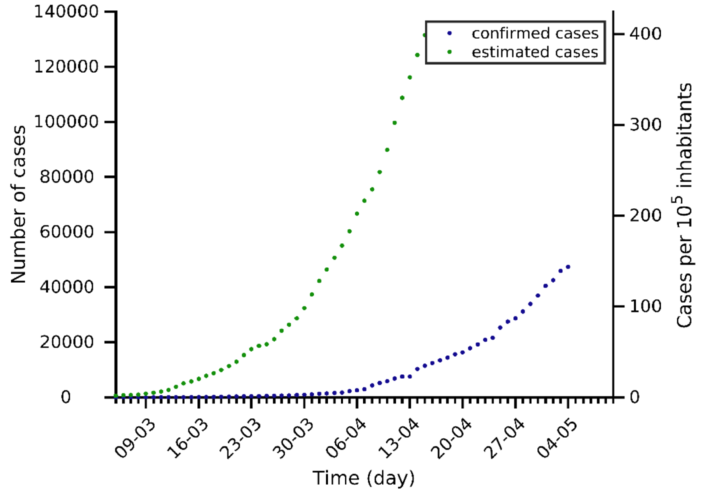


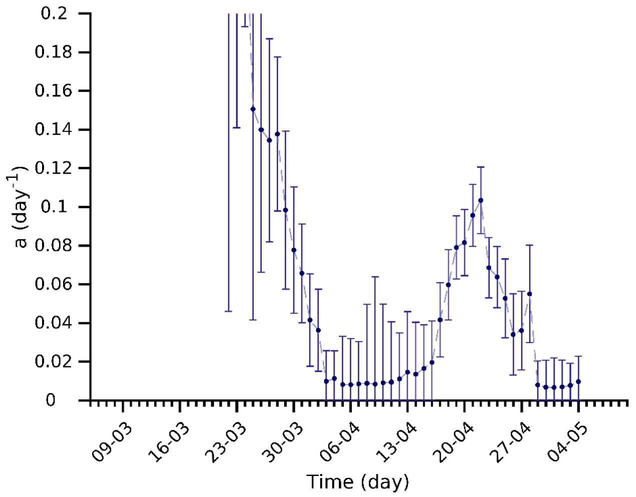


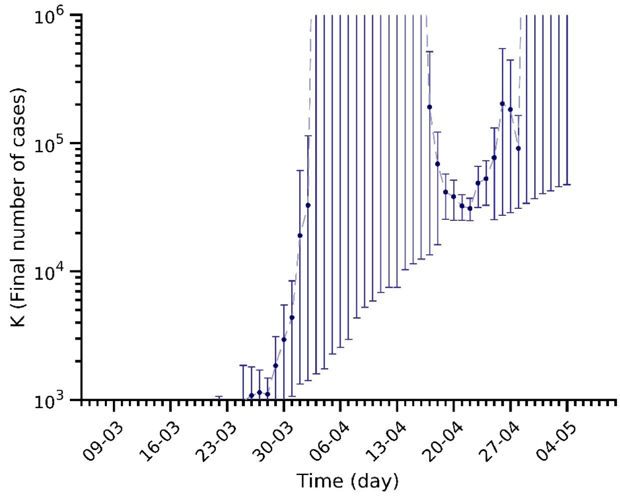
Peru 04-05-2020. Population: 33.0M. Current cumulated incidence: 144/10⁵

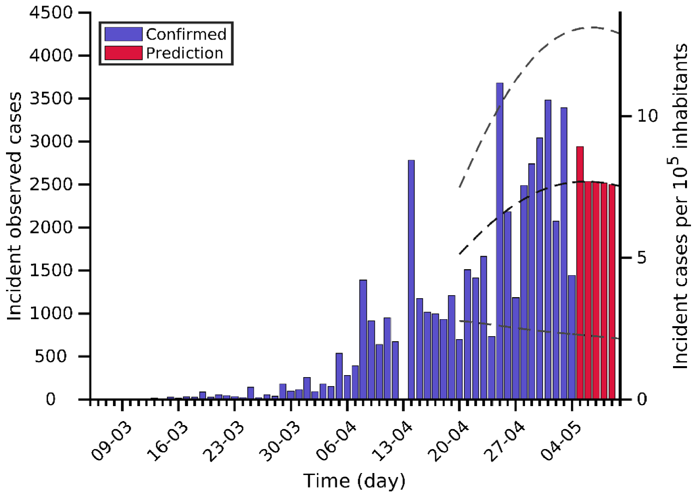


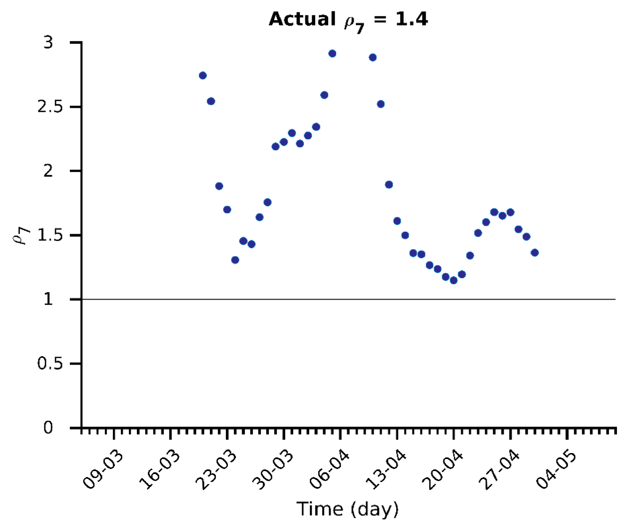
Day	Number of cases	Interval
05-05-2020	50313 (+2941)	[47372 - 58119]
06-05-2020	52849 (+2536)	[47372 - 60797]
07-05-2020	55380 (+2531)	[47372 - 63568]

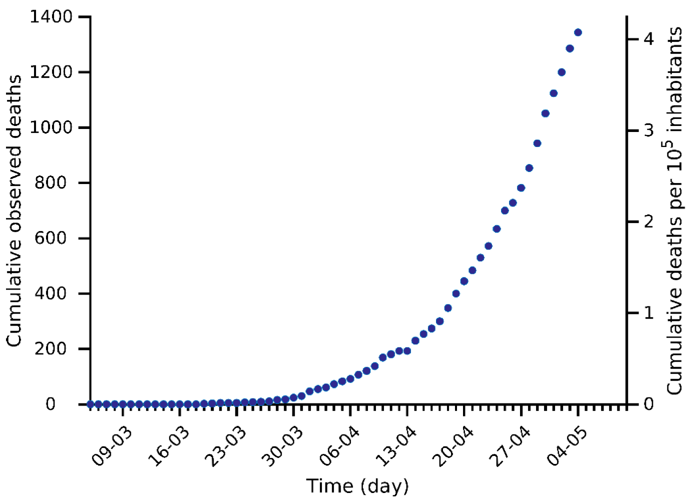


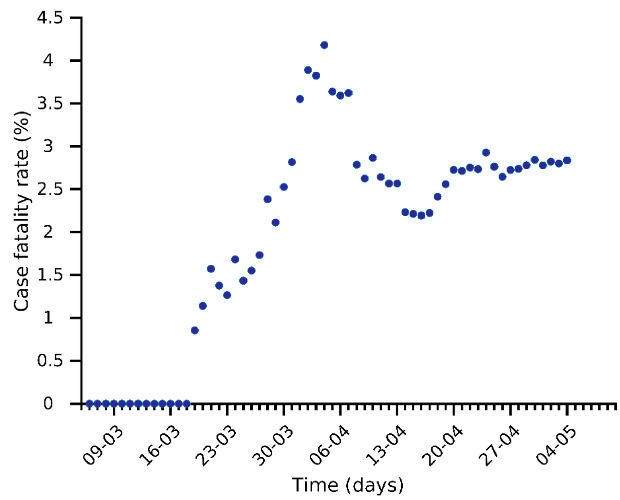




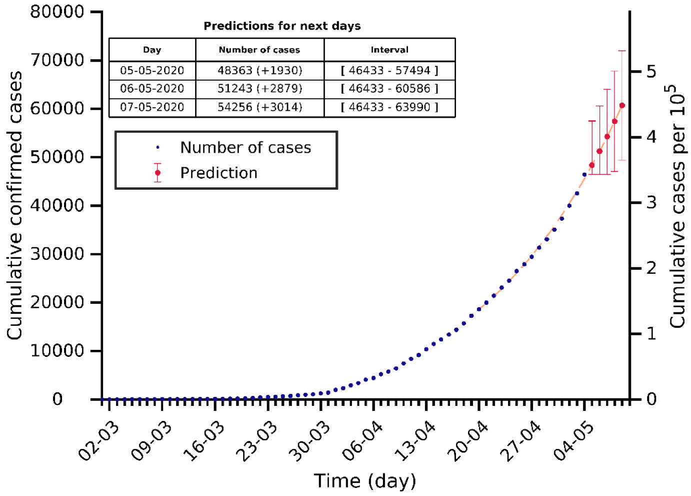


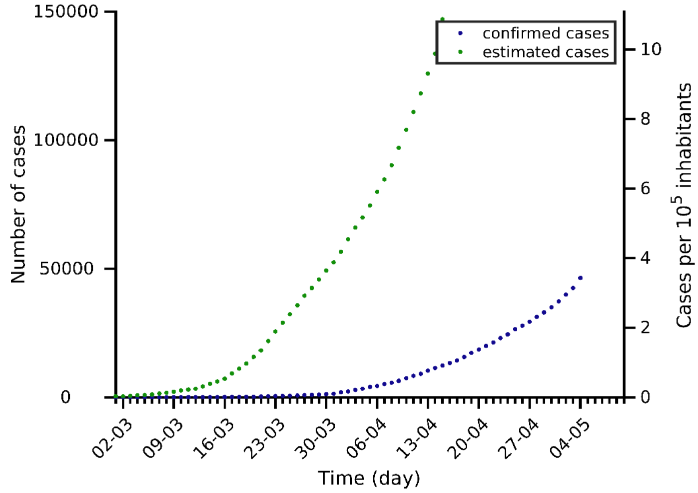


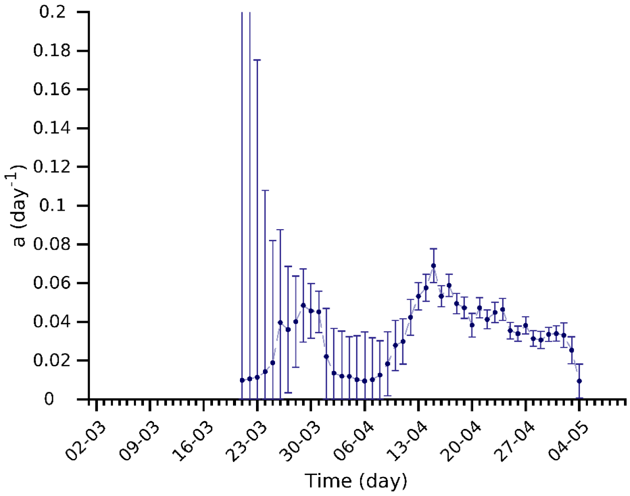


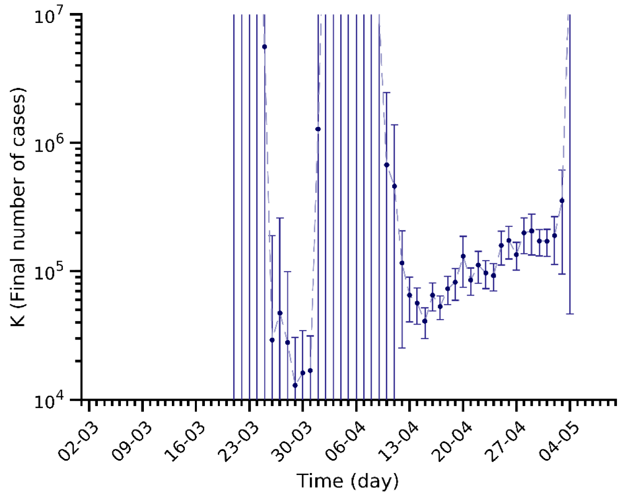


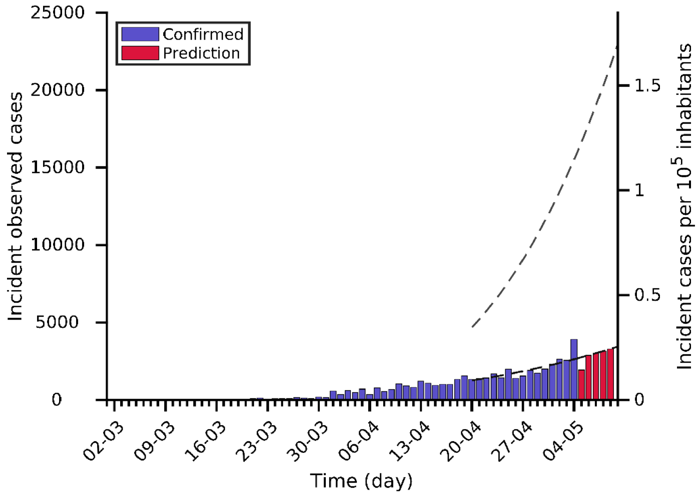
India 04-05-2020. Population: 1353.0M. Current cumulated incidence: 3/10⁵

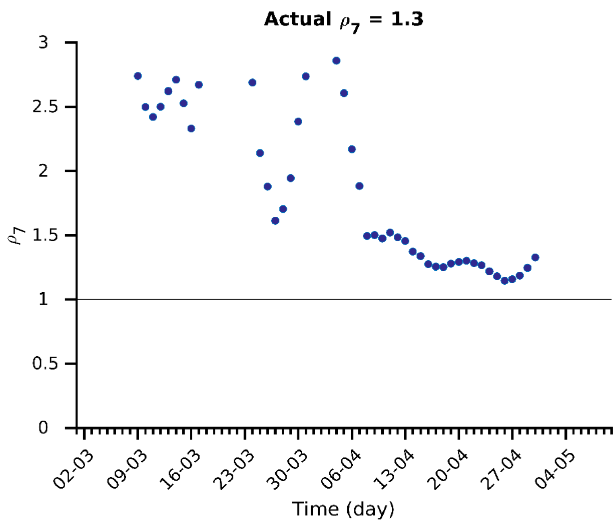


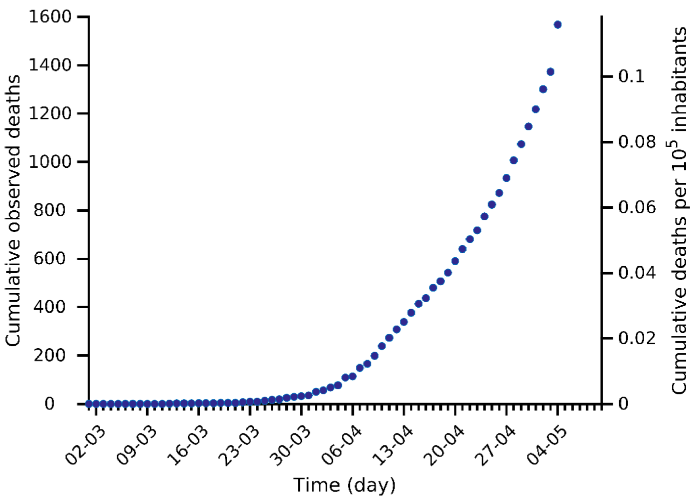


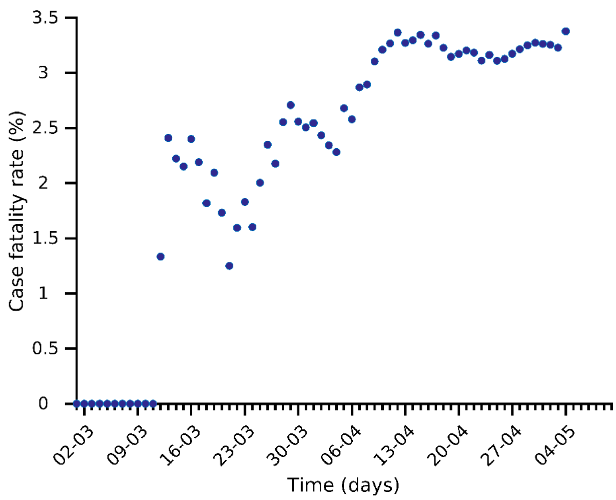




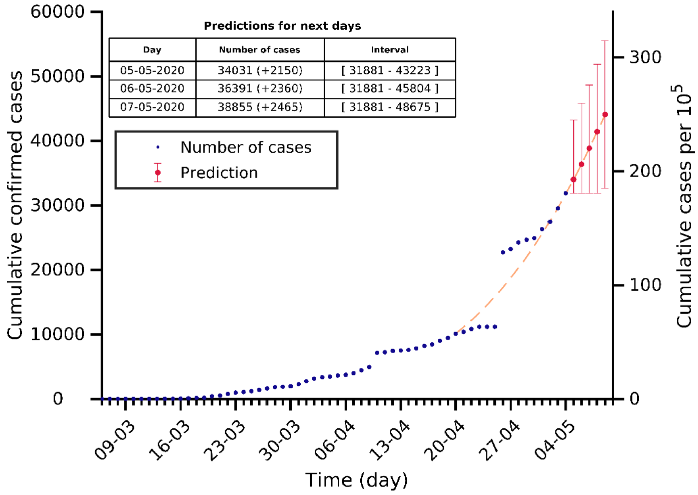




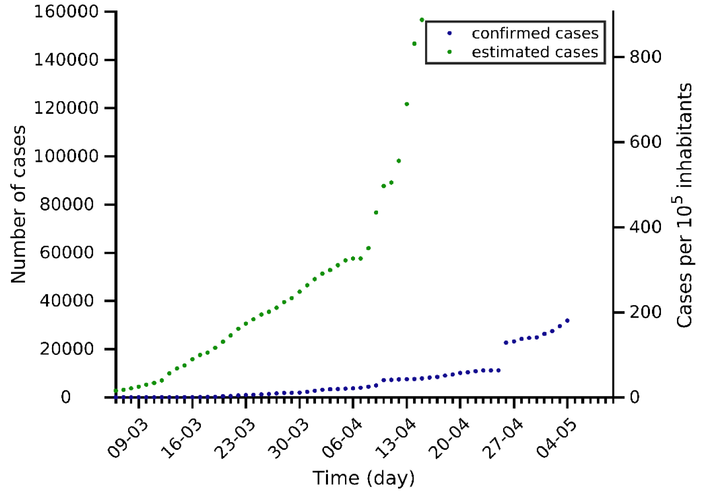


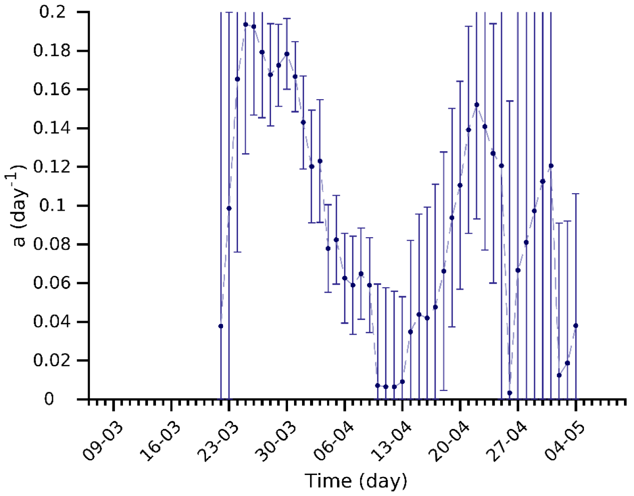


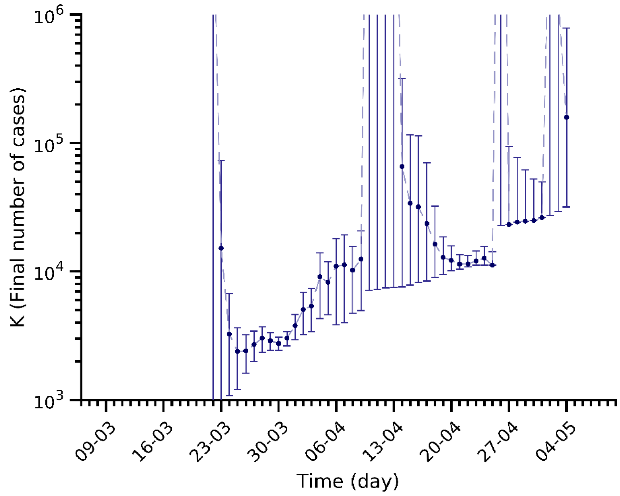
Ecuador 04-05-2020. Population: 17.6M. Current cumulated incidence: 181/10⁵

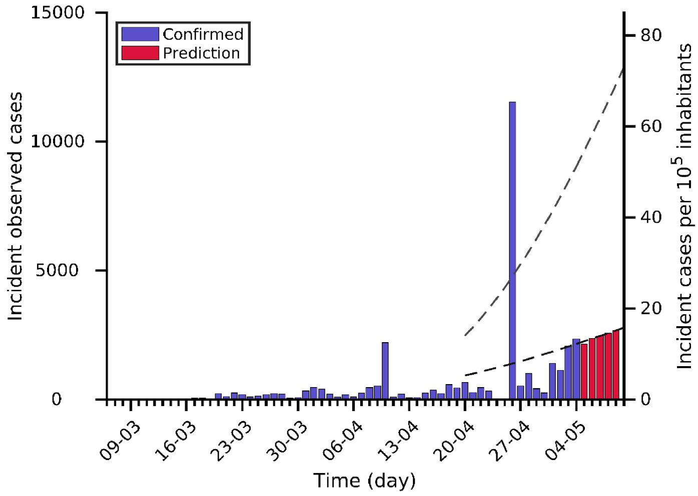


Day	Number of cases	Interval
05-05-2020	34031 (+2150)	[31881 - 43223]
06-05-2020	36391 (+2360)	[31881 - 45804]
07-05-2020	38855 (+2465)	[31881 - 48675]

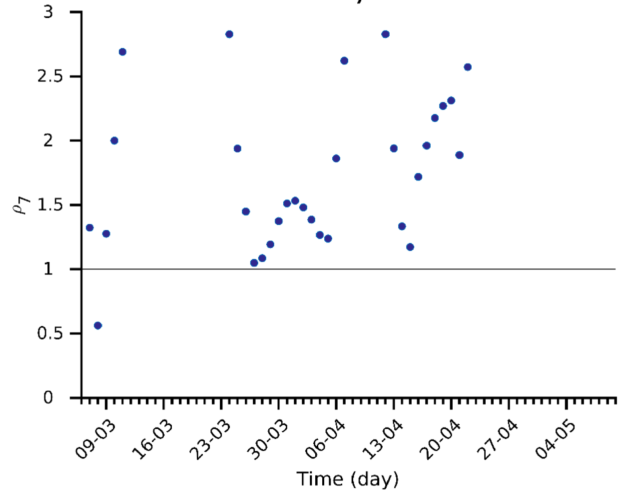


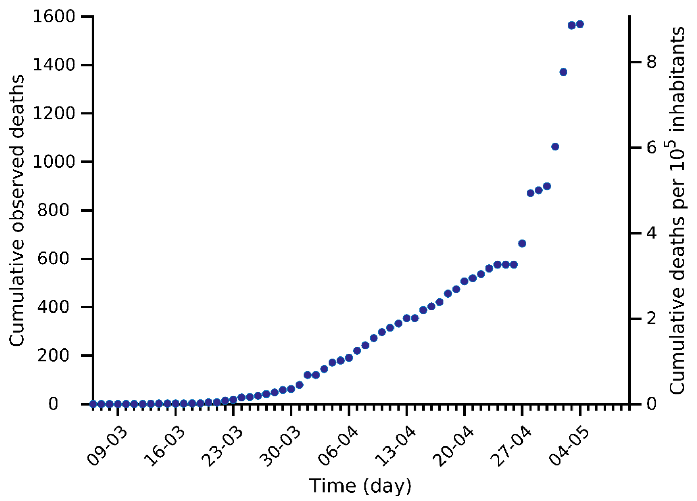


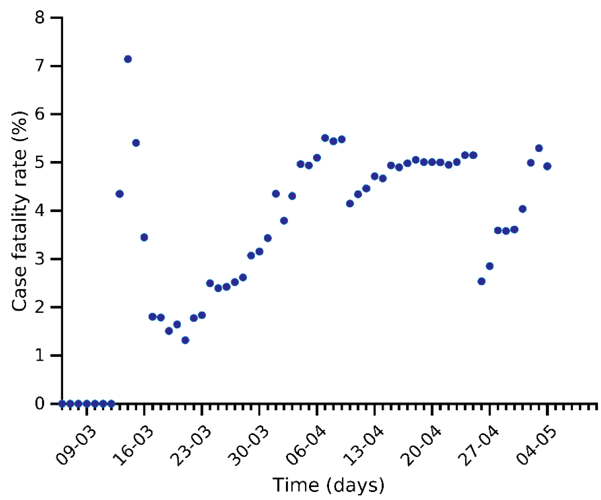




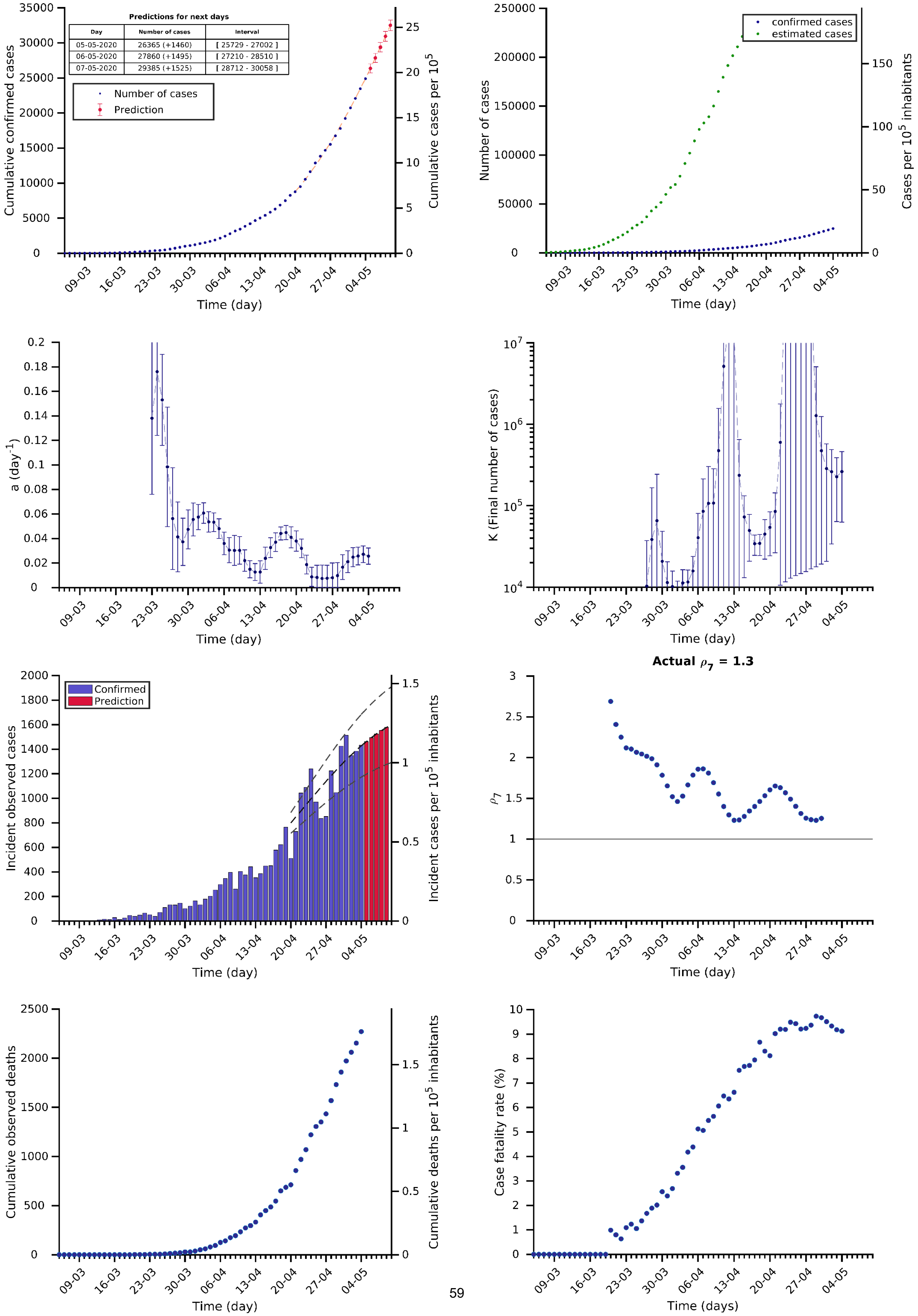
Actual ρ_7 = 3.4





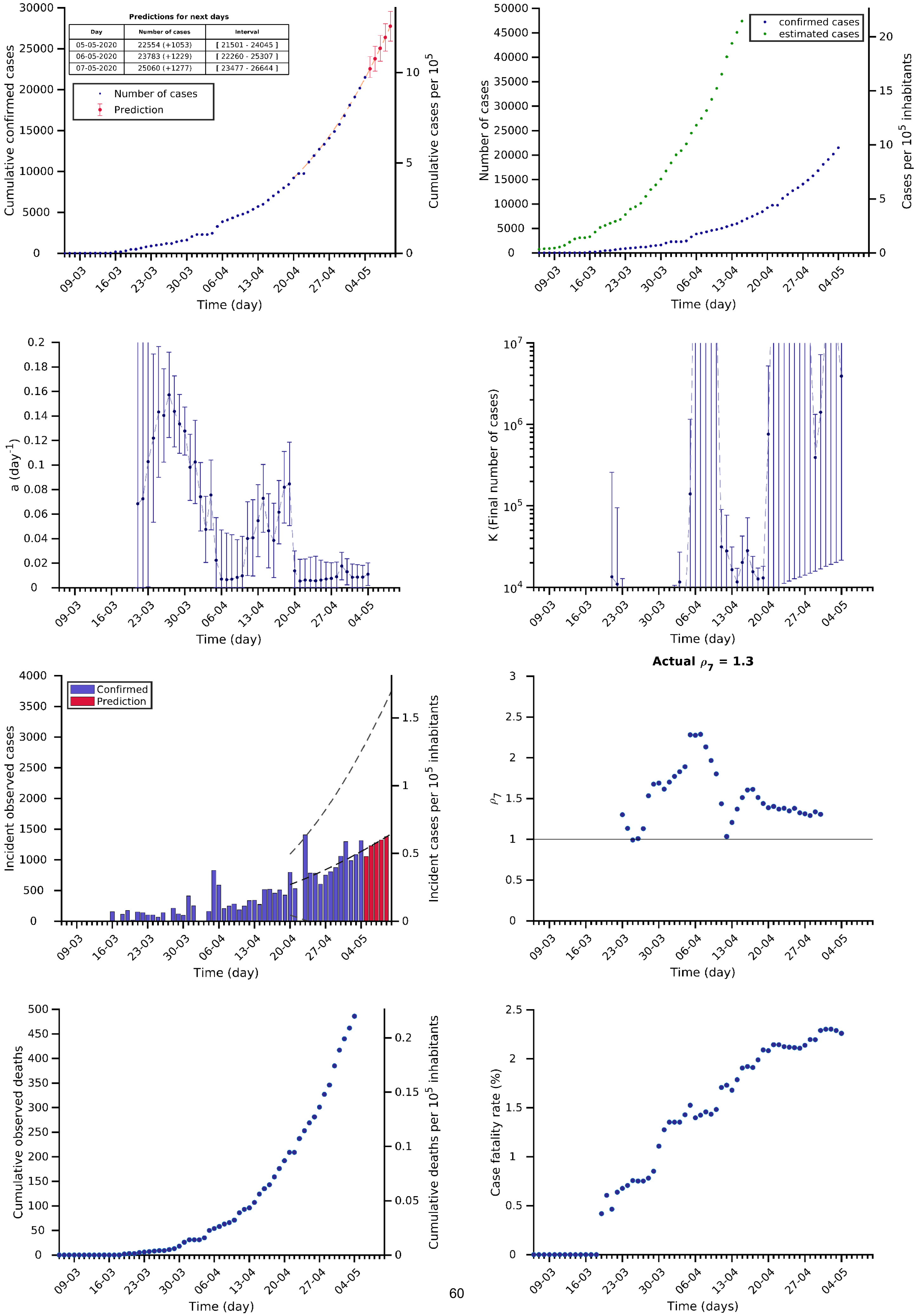


Mexico 04-05-2020. Population: 128.9M. Current cumulated incidence: 19/10⁵

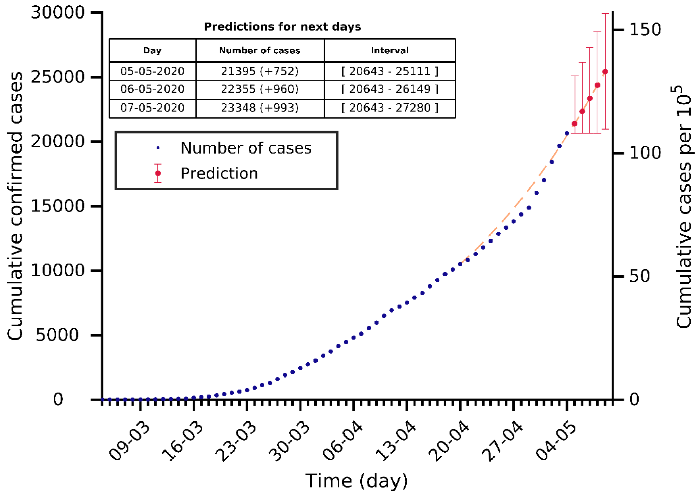


Day	Number of cases	Interval
05-05-2020	26365 (+1460)	[25729 - 27002]
06-05-2020	27860 (+1495)	[27210 - 28510]
07-05-2020	29385 (+1525)	[28712 - 30058]

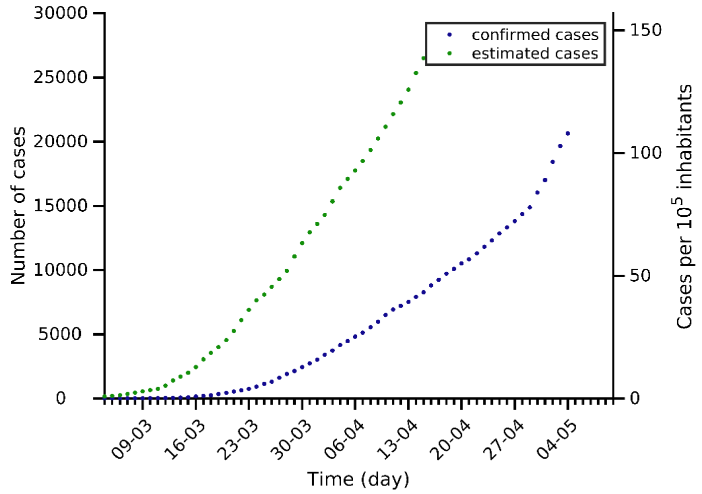
Pakistan 04-05-2020. Population: 220.9M. Current cumulated incidence: 10/10⁵

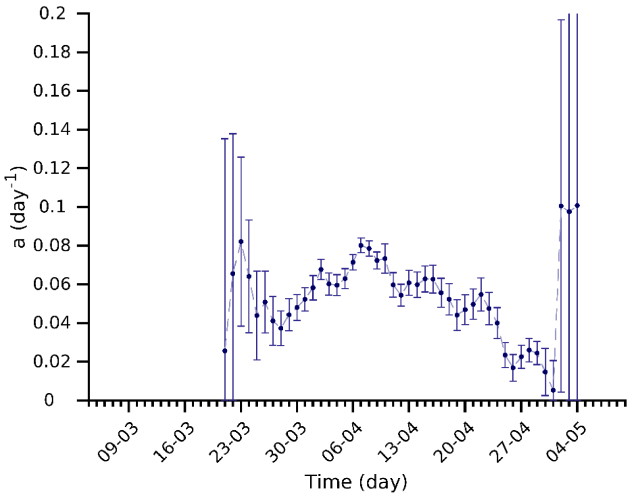


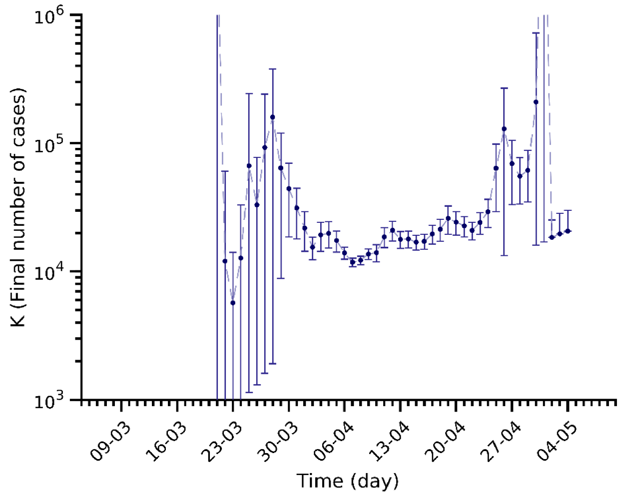
Chile 04-05-2020. Population: 19.1M. Current cumulated incidence: $108/10^5$

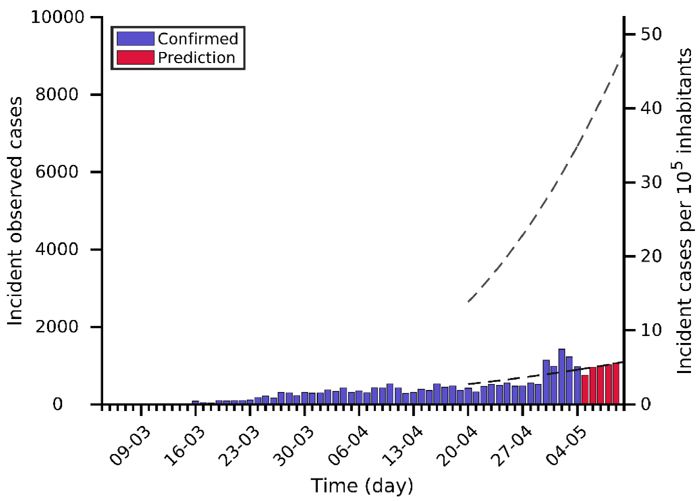


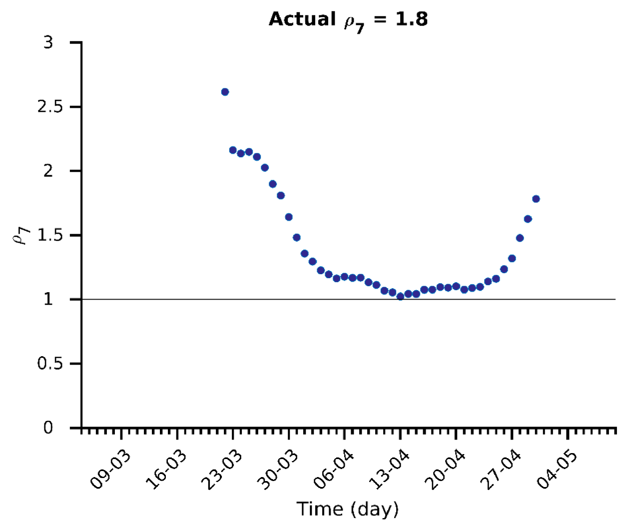
Day	Number of cases	Interval
05-05-2020	21395 (+752)	[20643 - 25111]
06-05-2020	22355 (+960)	[20643 - 26149]
07-05-2020	23348 (+993)	[20643 - 27280]

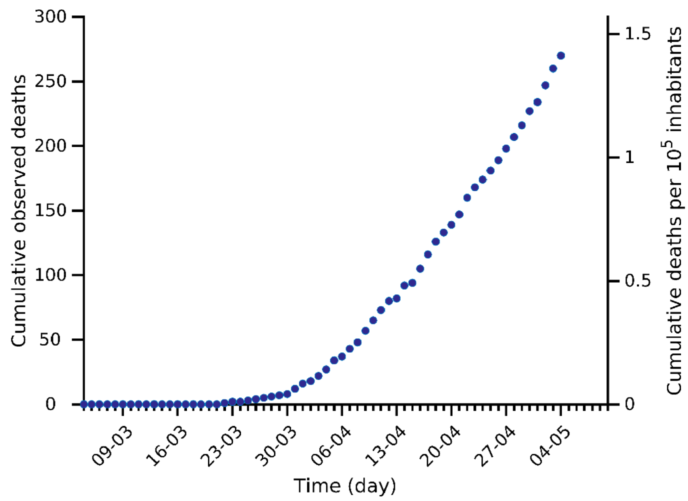


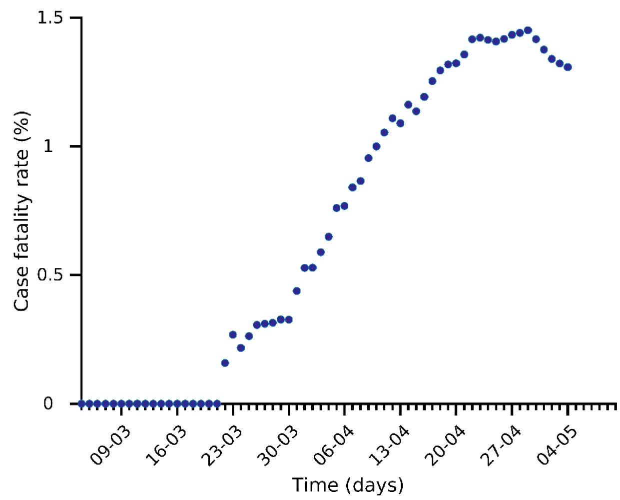




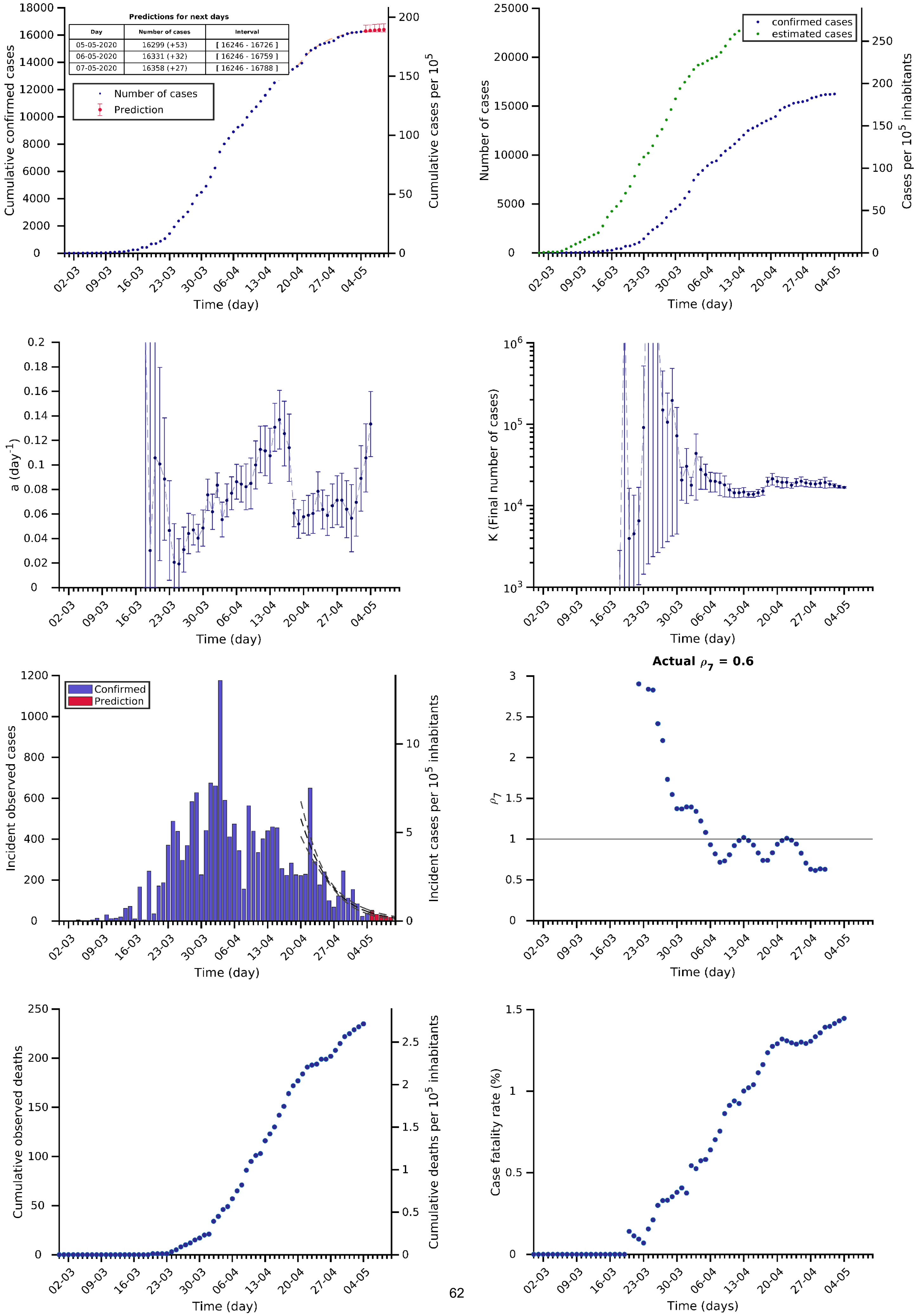




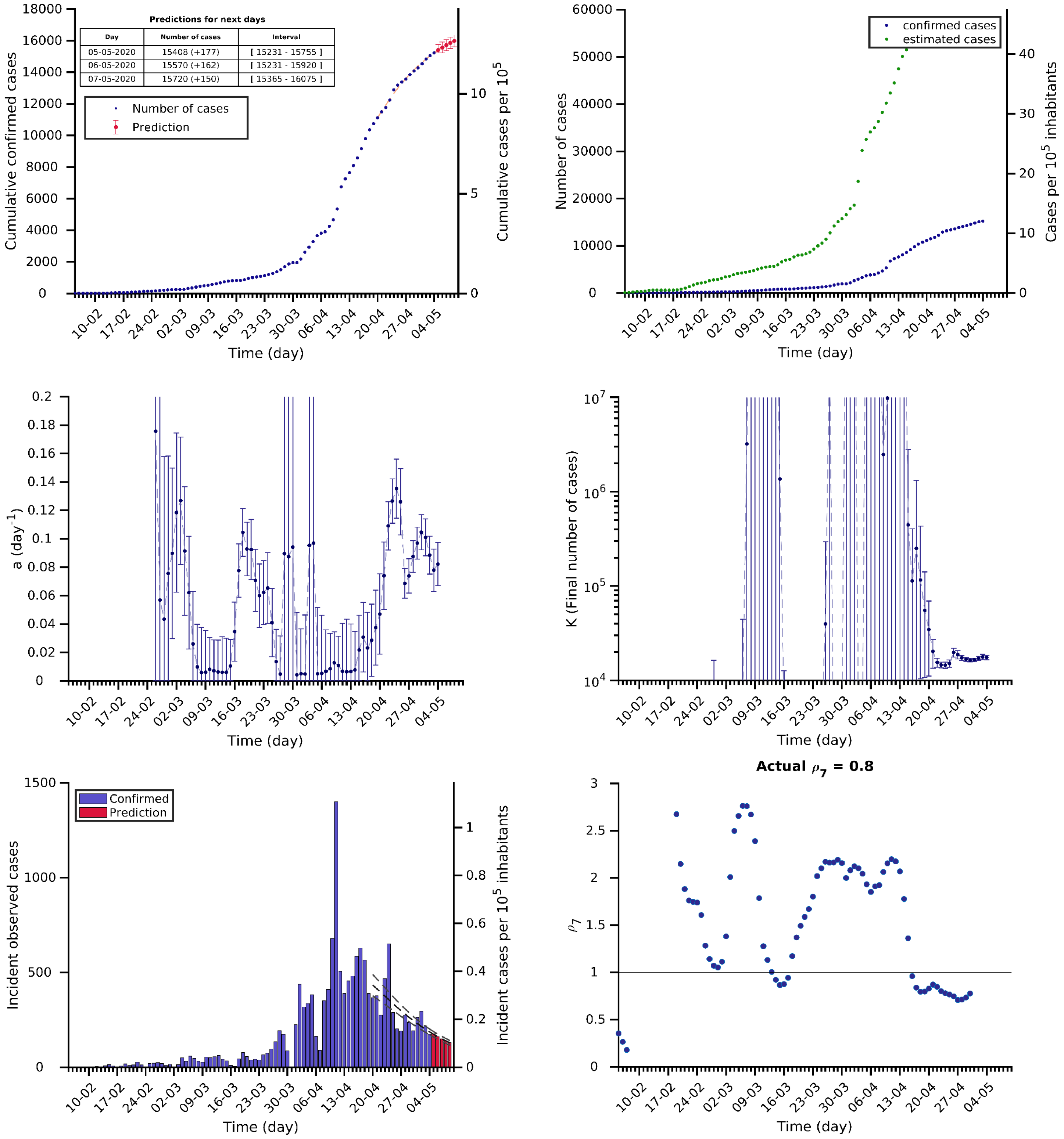




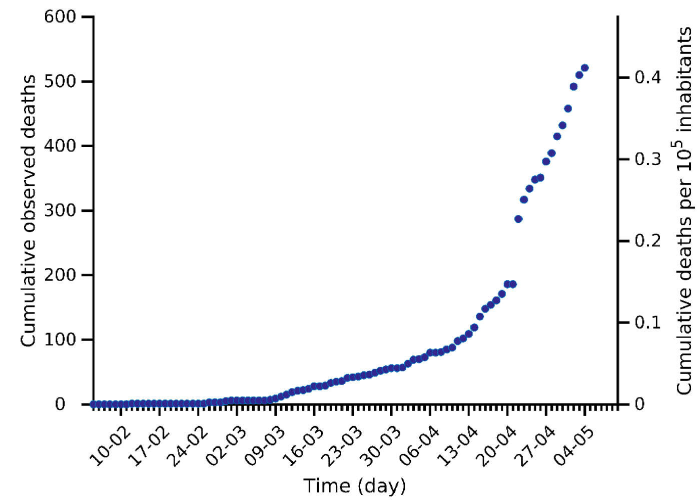
Israel 04-05-2020. Population: 8.7M. Current cumulated incidence: 188/10⁵

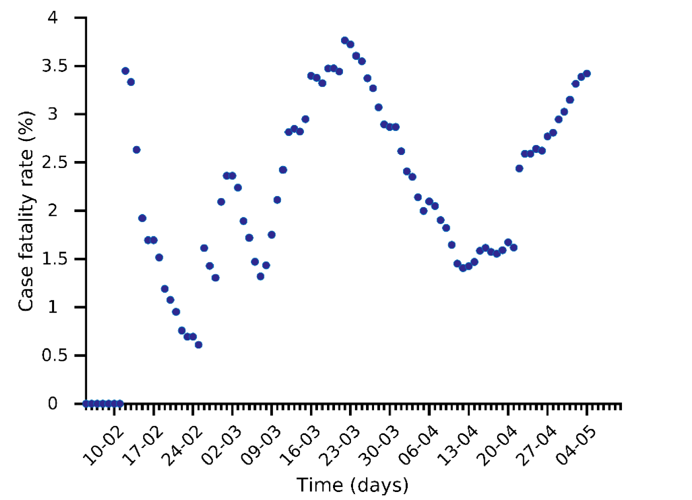


Japan 04-05-2020. Population: 126.5M. Current cumulated incidence: 12/10⁵

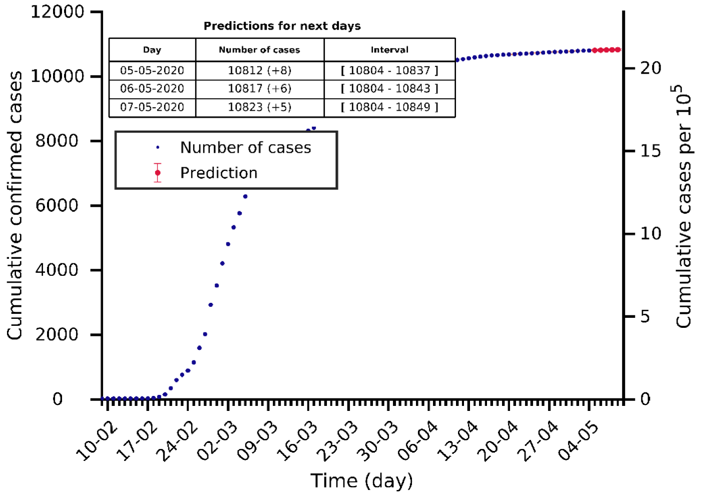


Day	Number of cases	Interval
05-05-2020	15408 (+177)	[15231 - 15755]
06-05-2020	15570 (+162)	[15231 - 15920]
07-05-2020	15720 (+150)	[15365 - 16075]

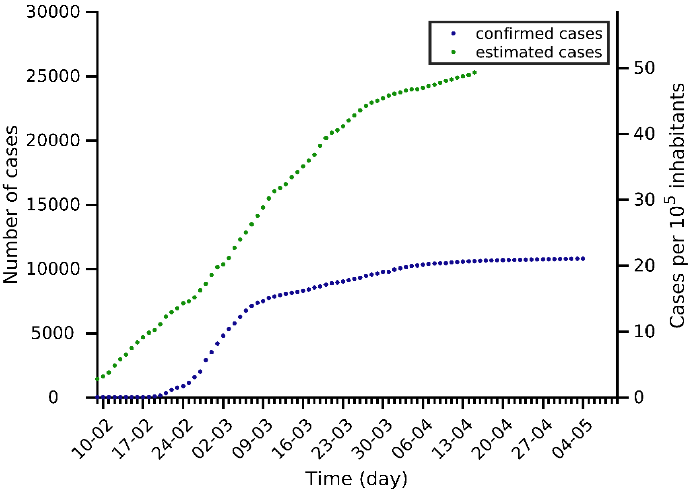


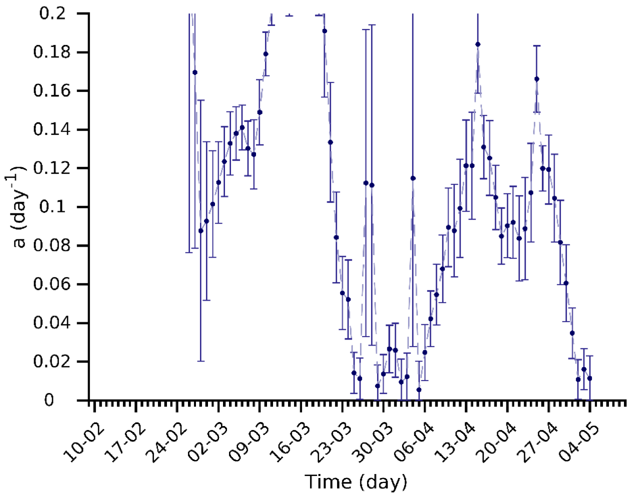


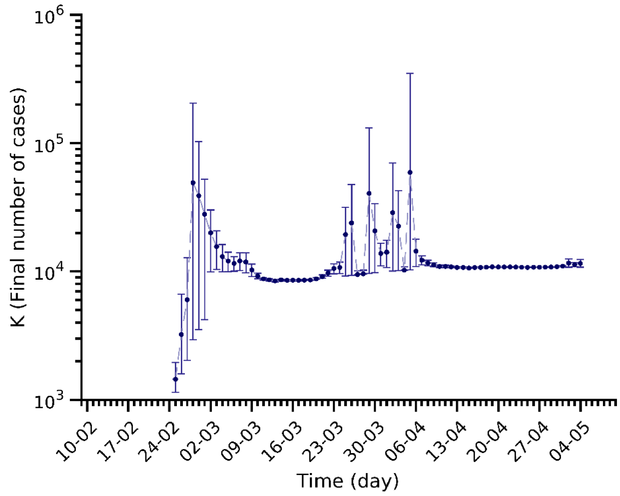
South Korea 04-05-2020. Population: 51.3M. Current cumulated incidence: 21/10⁵

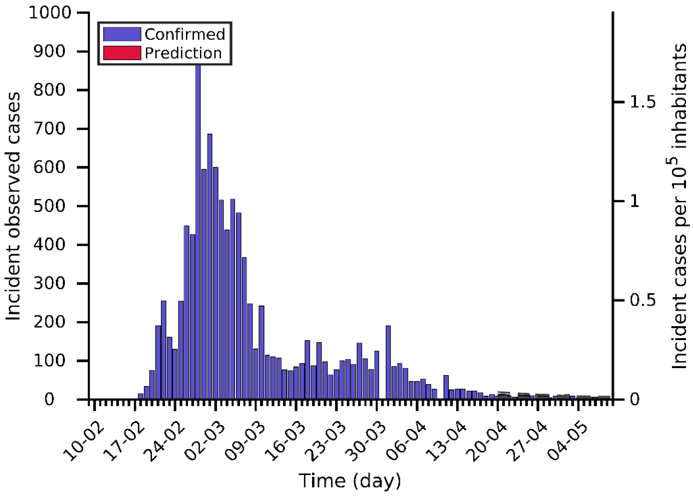


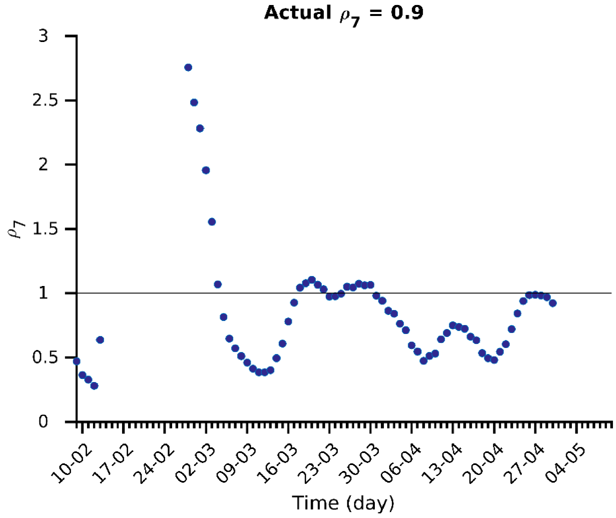
Day	Number of cases	Interval
05-05-2020	10812 (+8)	[10804 - 10837]
06-05-2020	10817 (+6)	[10804 - 10843]
07-05-2020	10823 (+5)	[10804 - 10849]

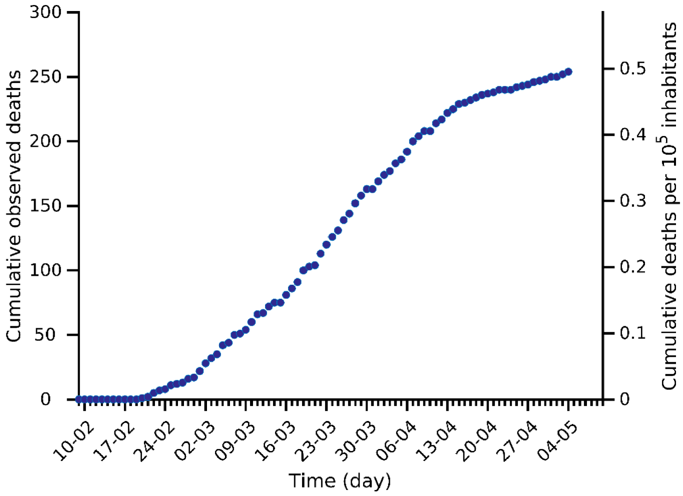


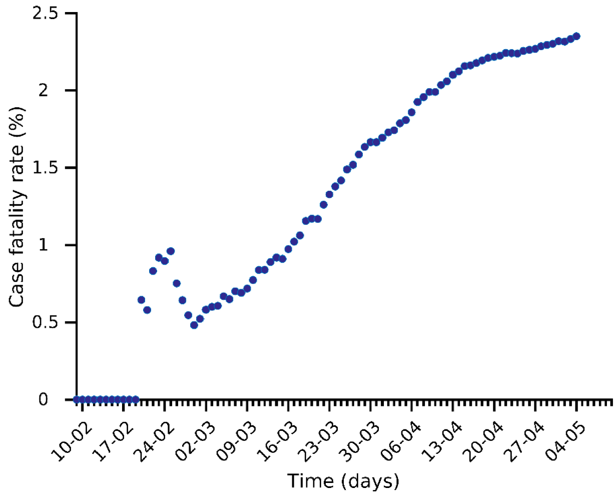




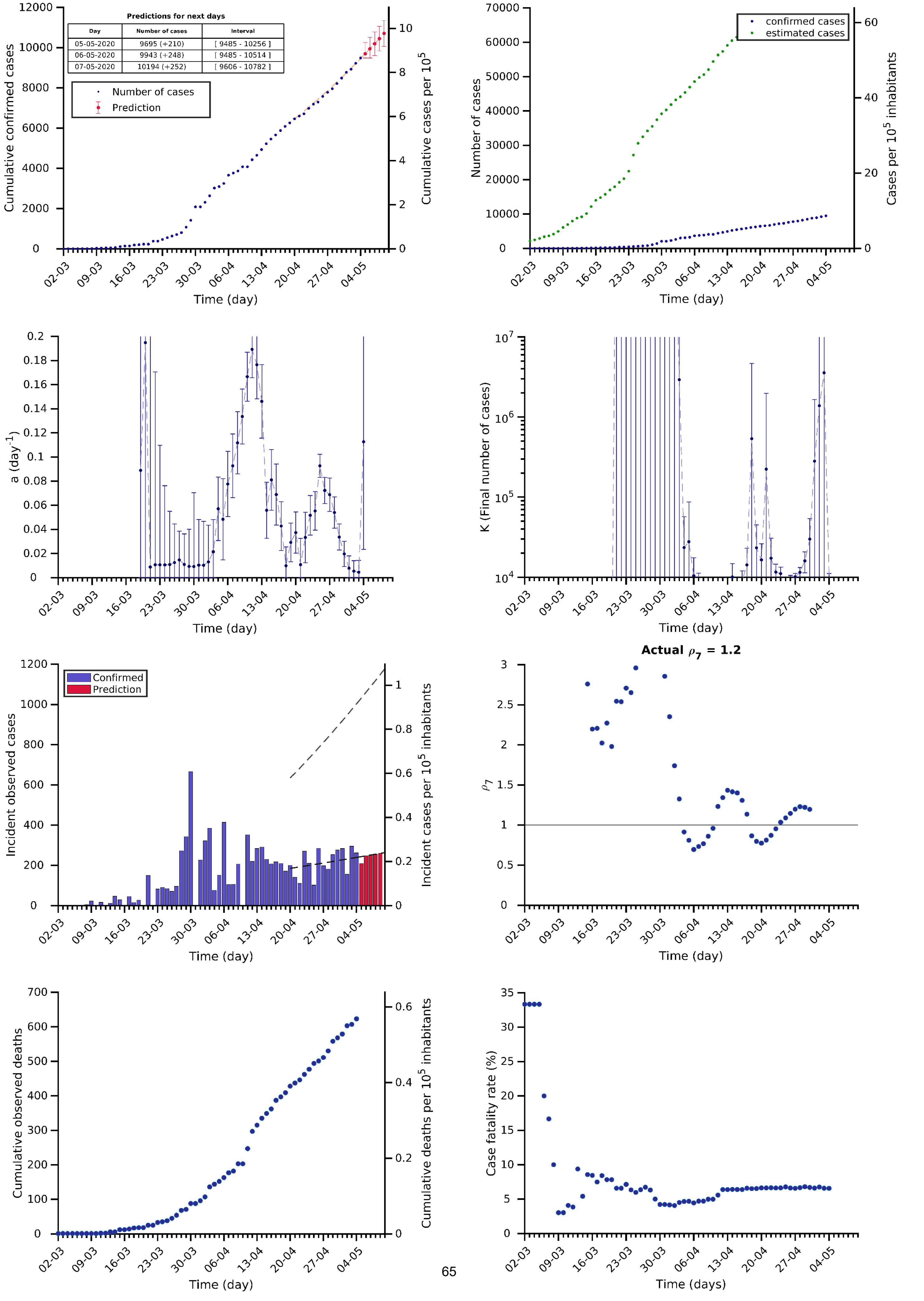






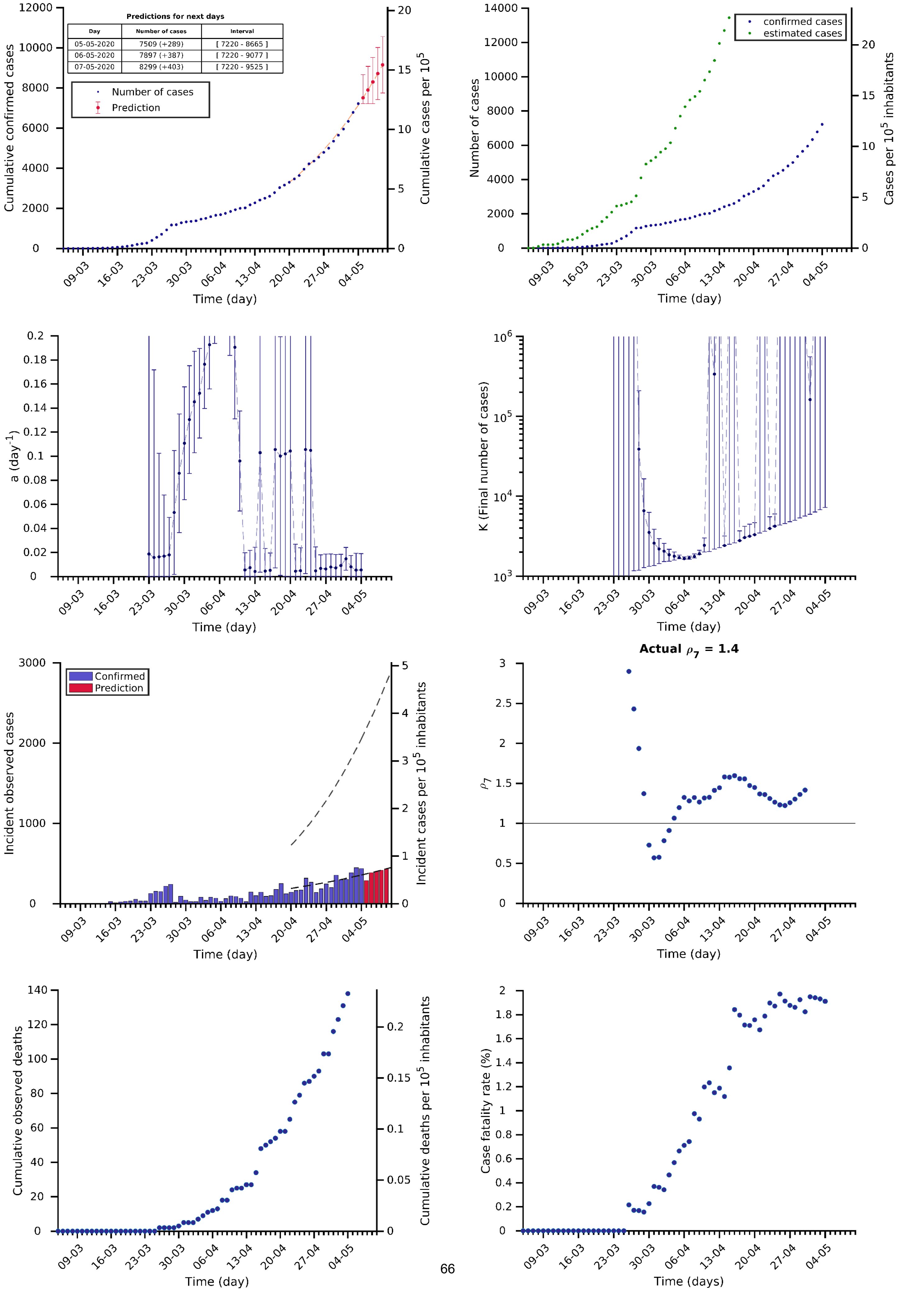


Philippines 04-05-2020. Population: 109.6M. Current cumulated incidence: 9/10^5

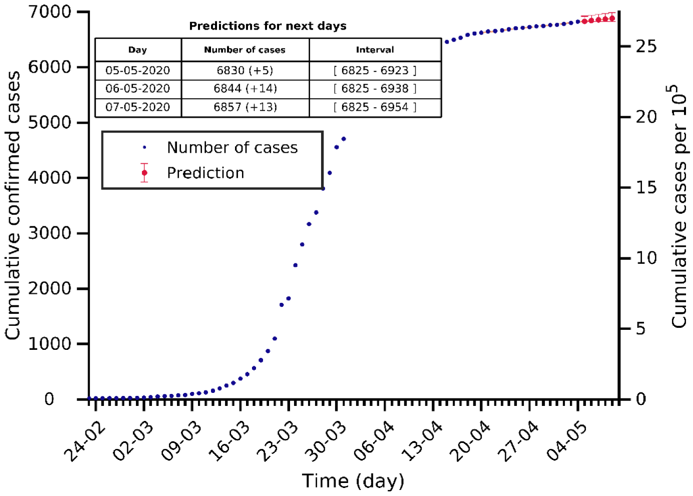


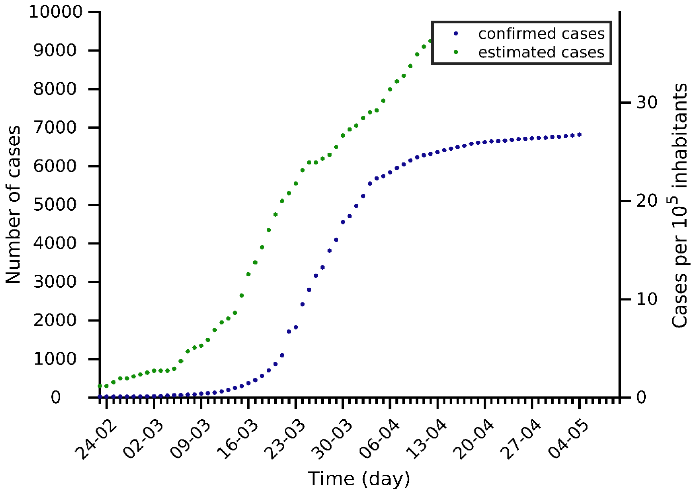
Day	Number of cases	Interval
05-05-2020	9695 (+210)	[9485 - 10256]
06-05-2020	9943 (+248)	[9485 - 10514]
07-05-2020	10194 (+252)	[9606 - 10782]

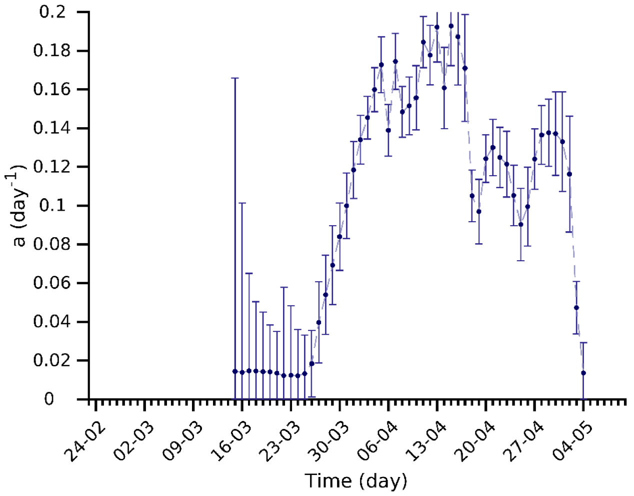
South Africa 04-05-2020. Population: 59.3M. Current cumulated incidence: 12/10⁵

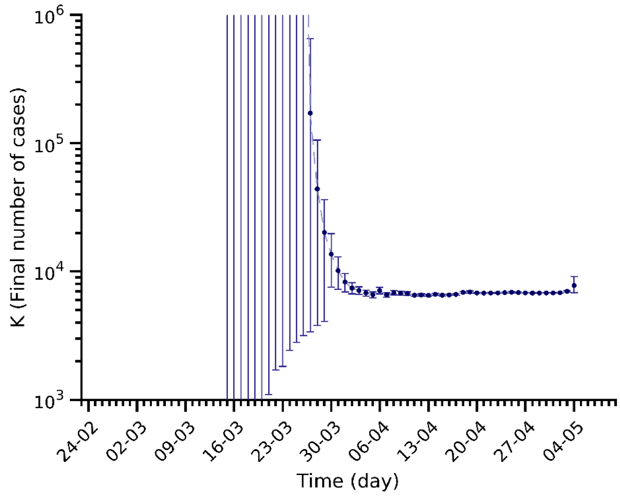


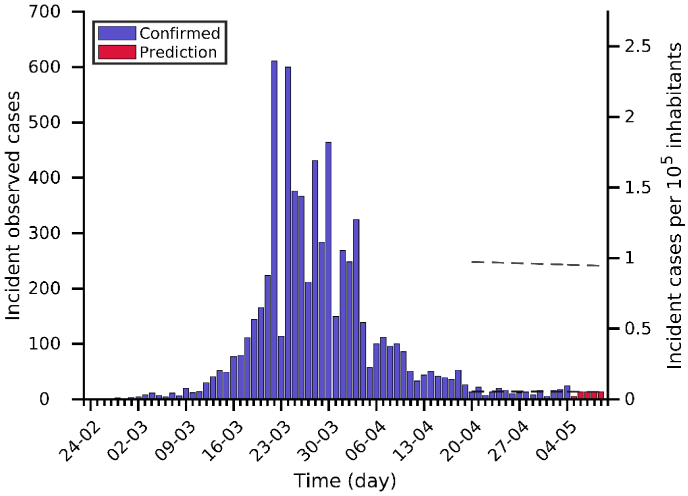
Australia 04-05-2020. Population: 25.5M. Current cumulated incidence: 27/10⁵

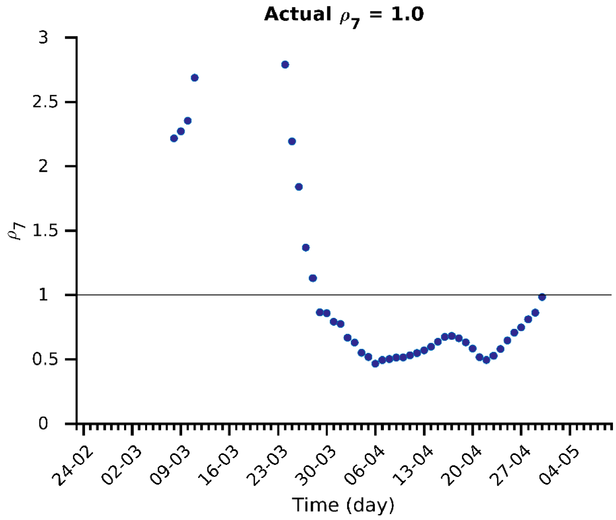


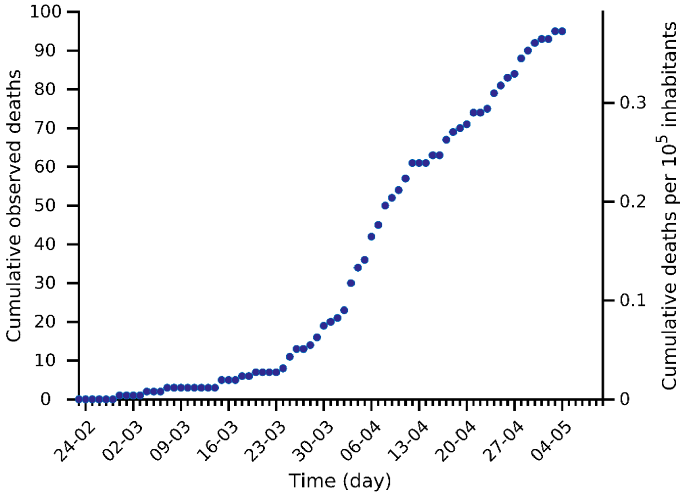


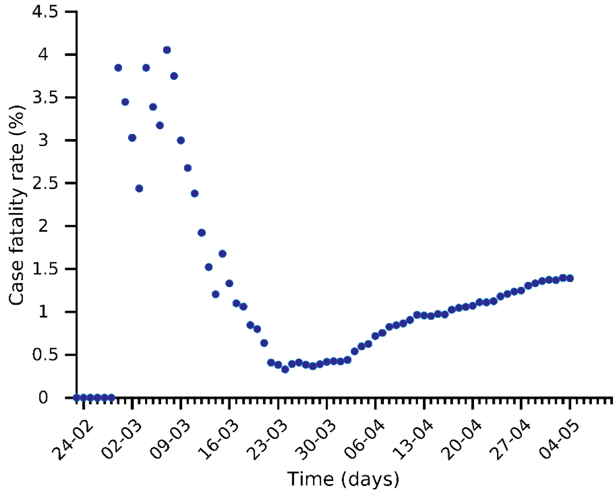




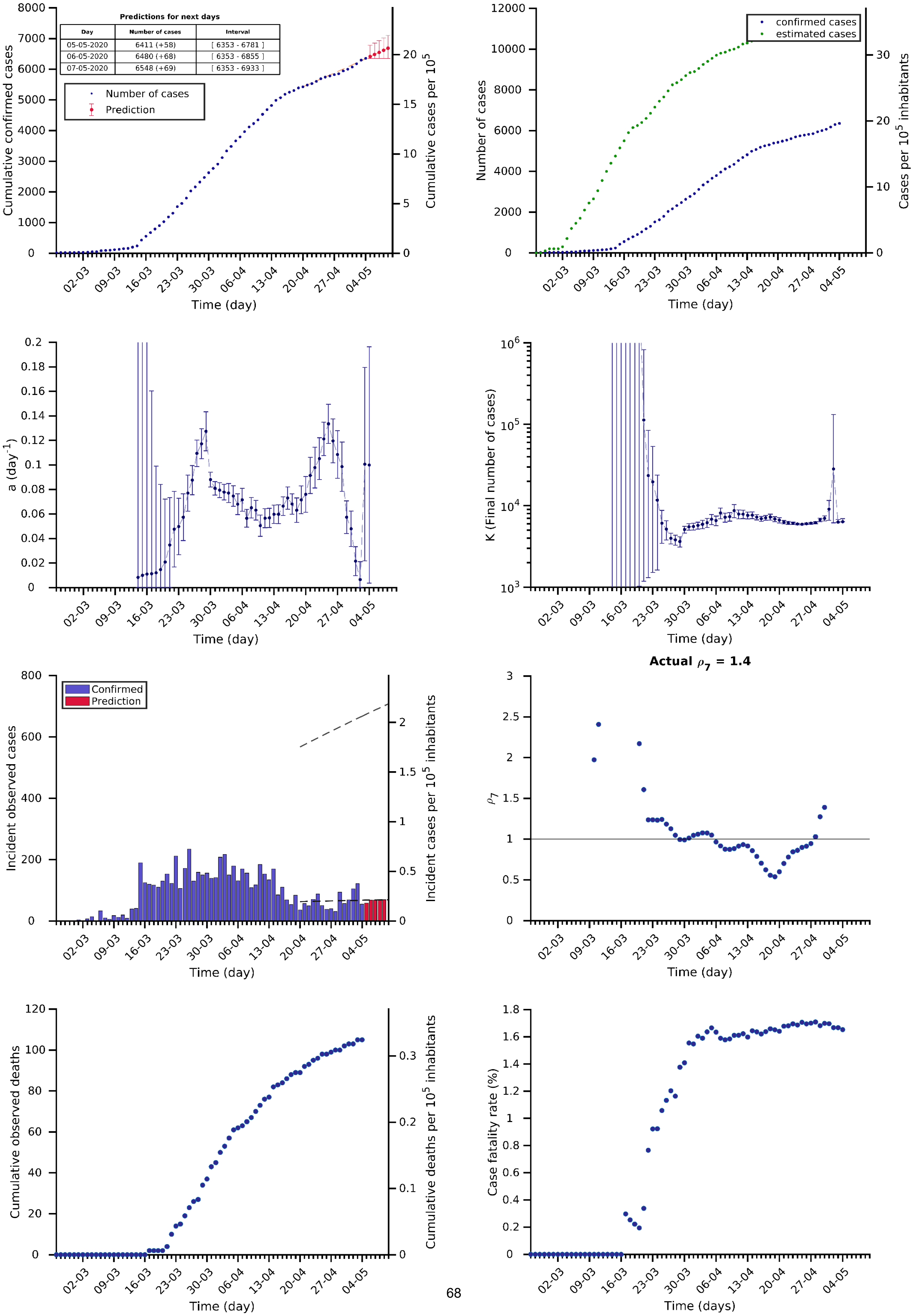








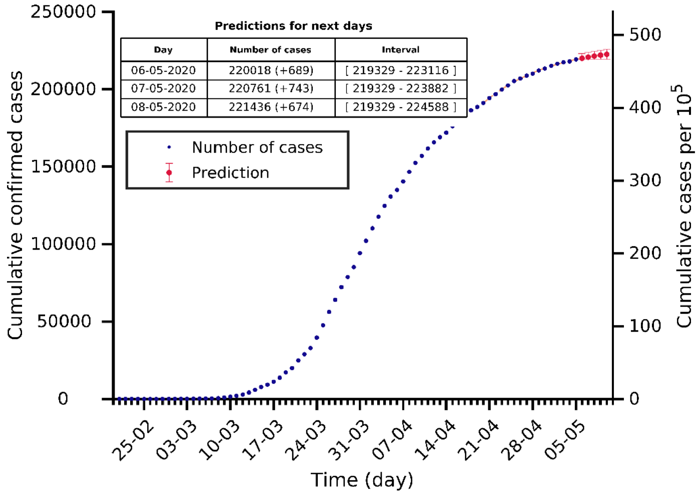
Malaysia 04-05-2020. Population: 32.4M. Current cumulated incidence: $20/10^5$

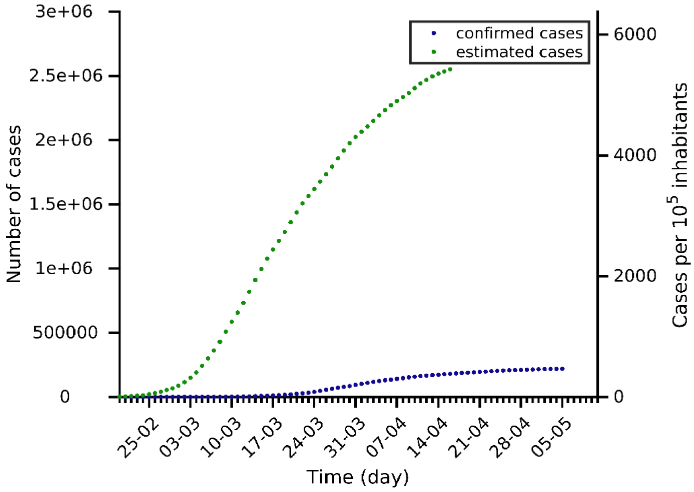


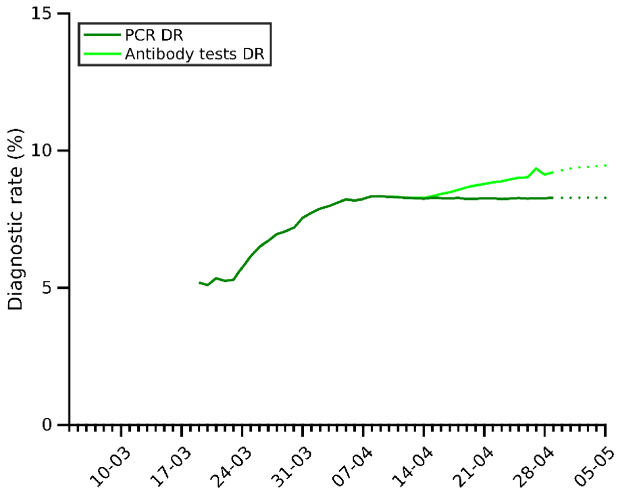
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

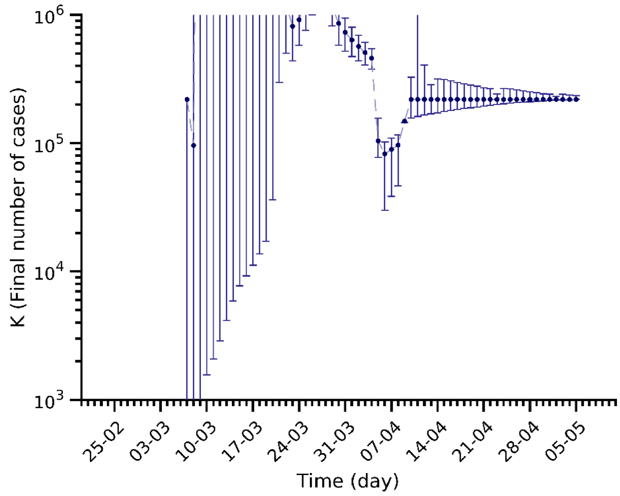
Data obtained from https://github.com/datadista/datasets/tree/master/COVID%2019 and https://covid19.isciii.es/

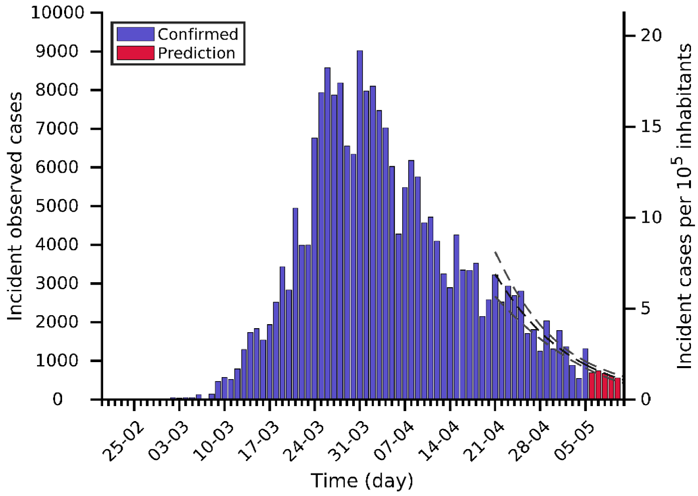
Spain 05-05-2020. Population: 47.0M. Current cumulated incidence: 466/10⁵

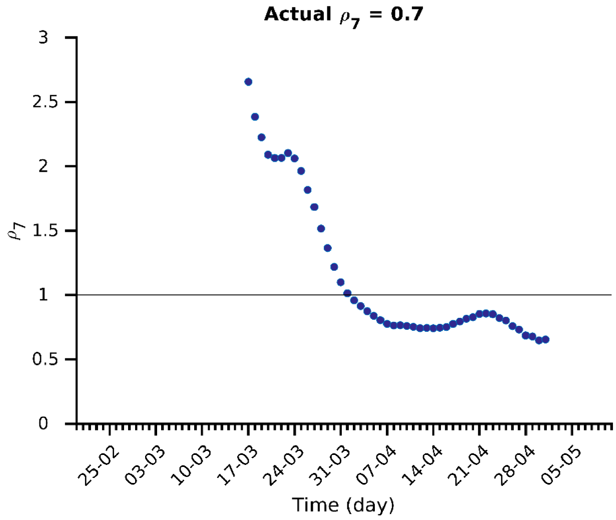


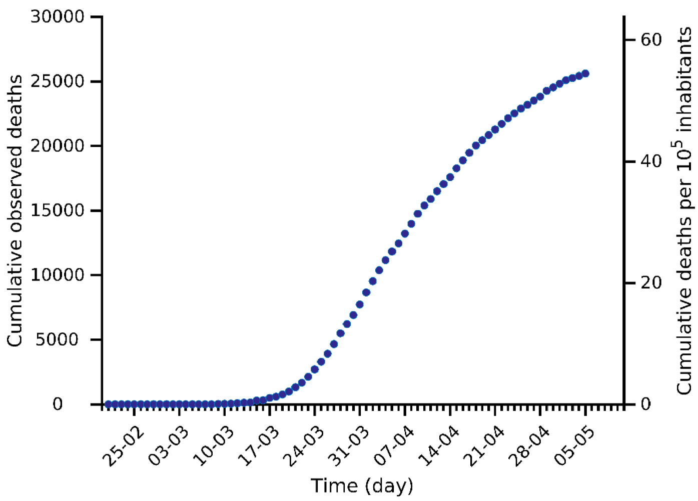


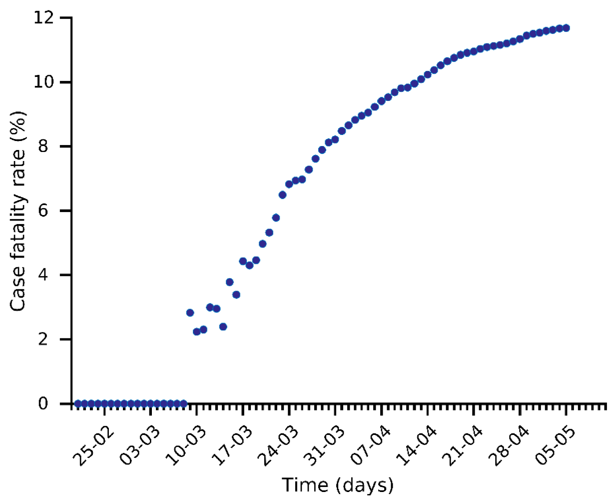




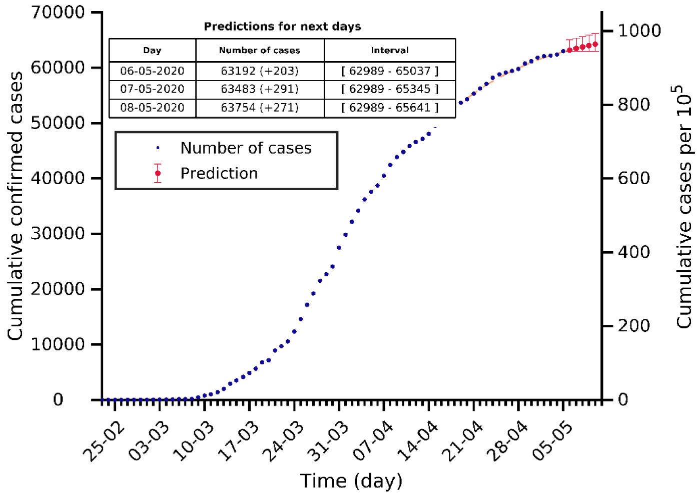


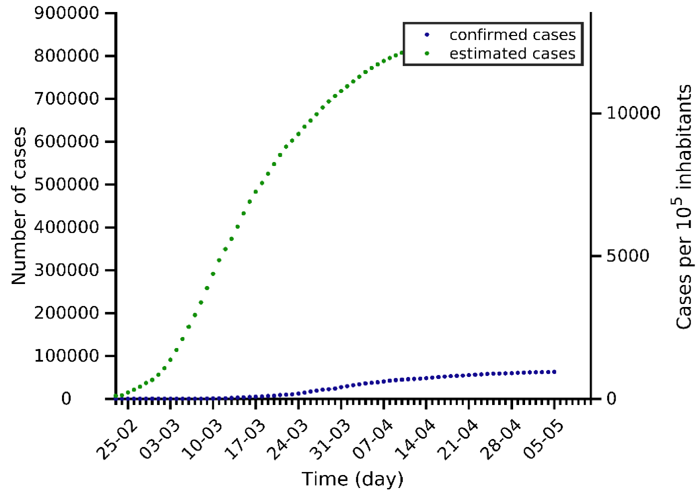


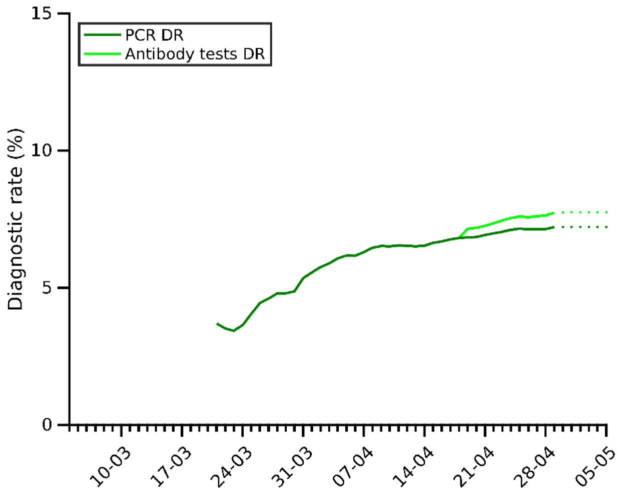


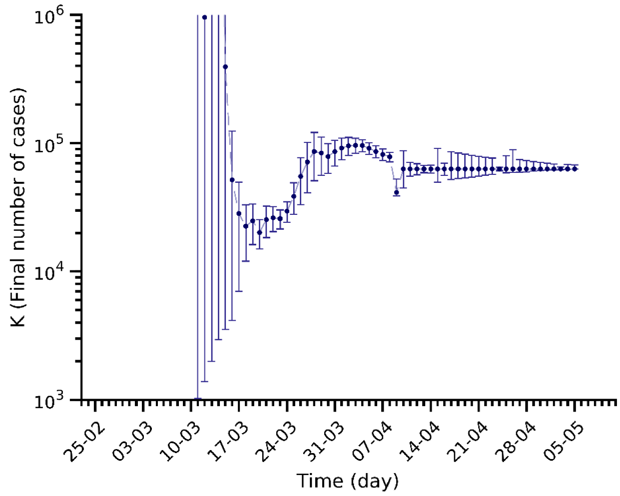


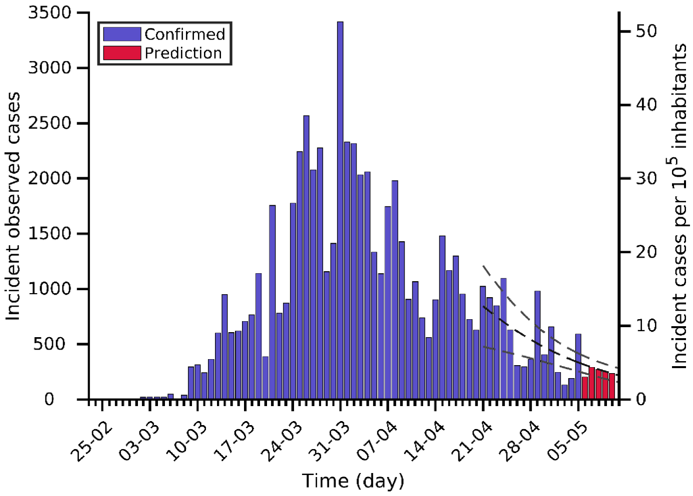
Madrid 05-05-2020. Population: 6.7M. Current cumulated incidence: 945/10^5

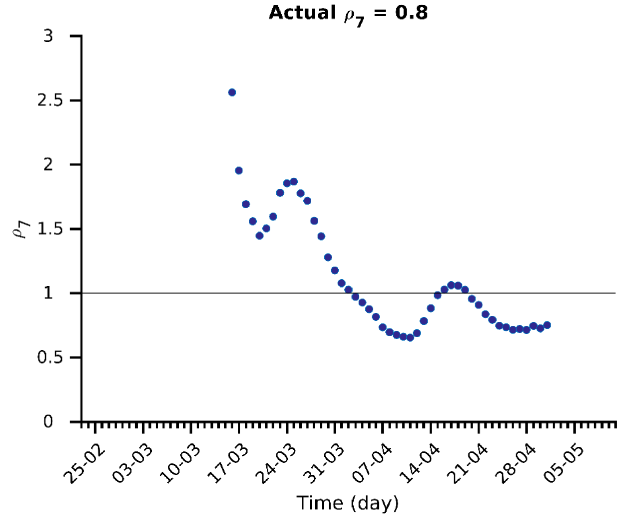


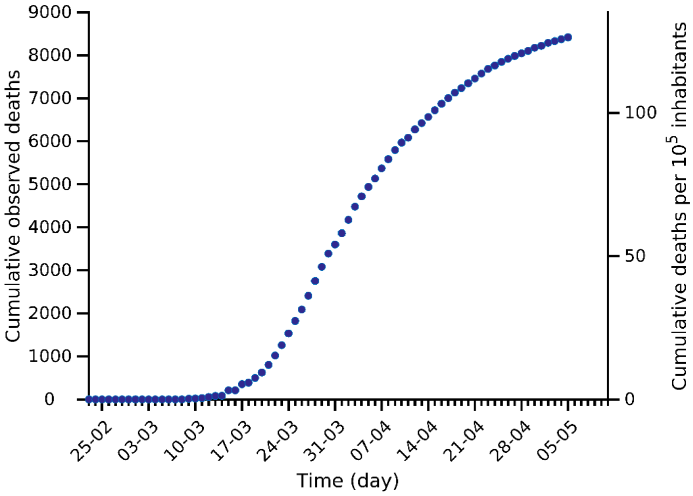


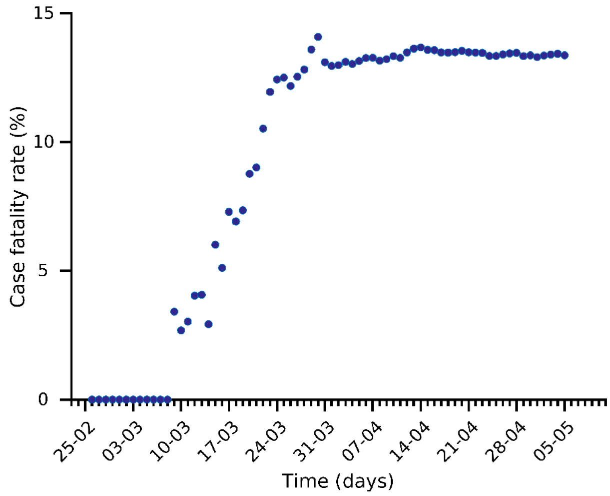




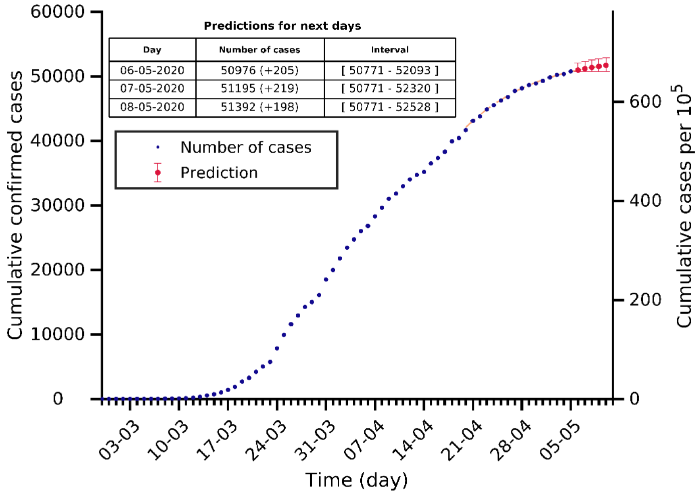


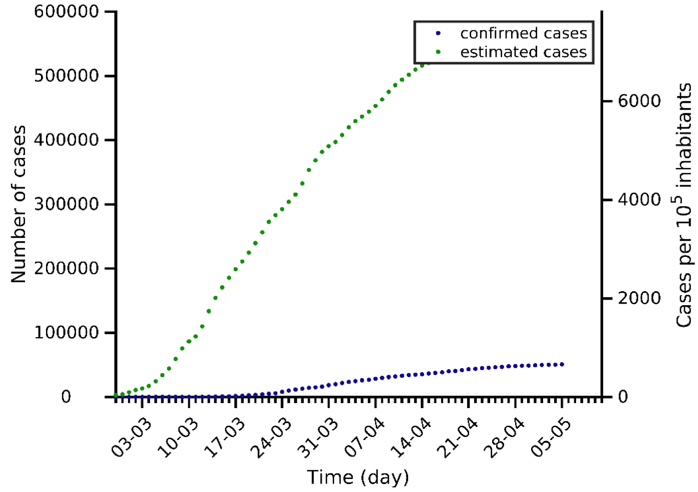


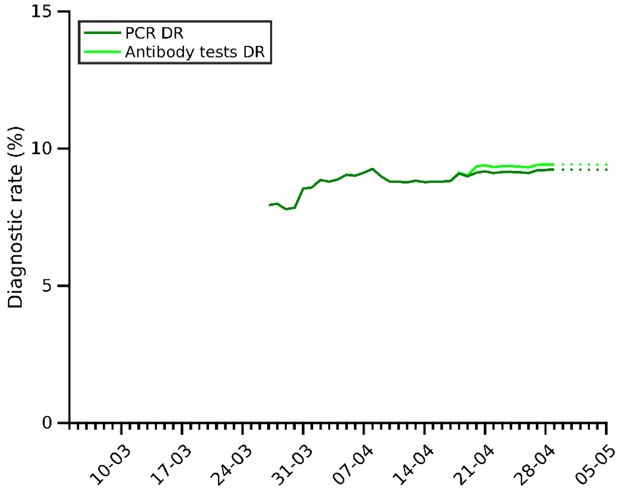


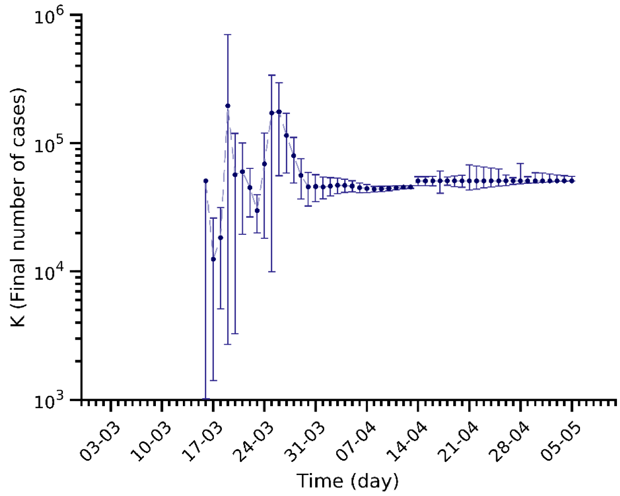


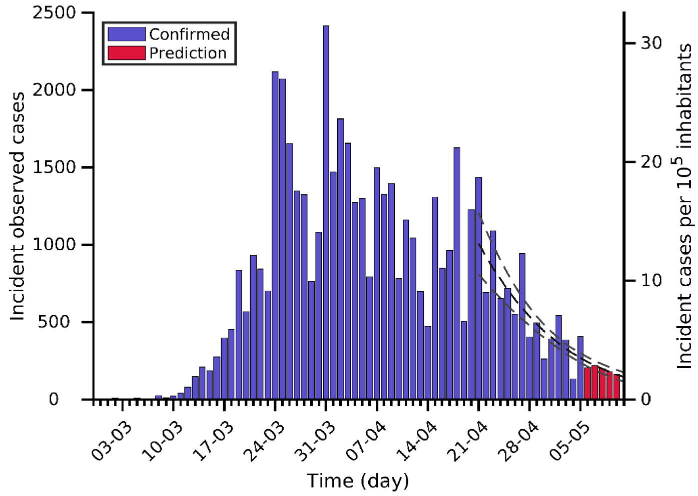
Catalunya 05-05-2020. Population: 7.7M. Current cumulated incidence: 661/10^5

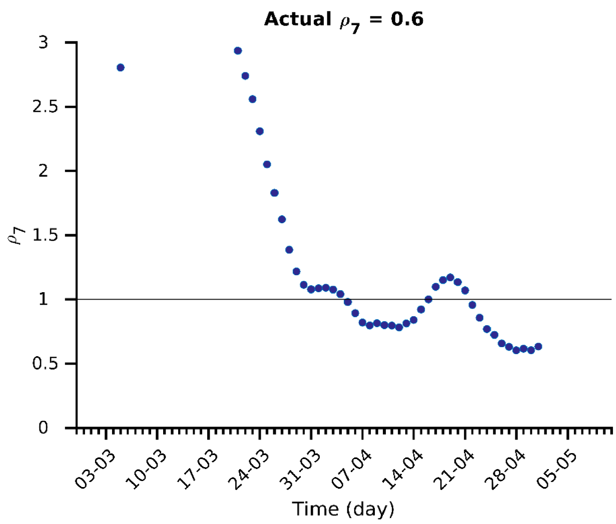


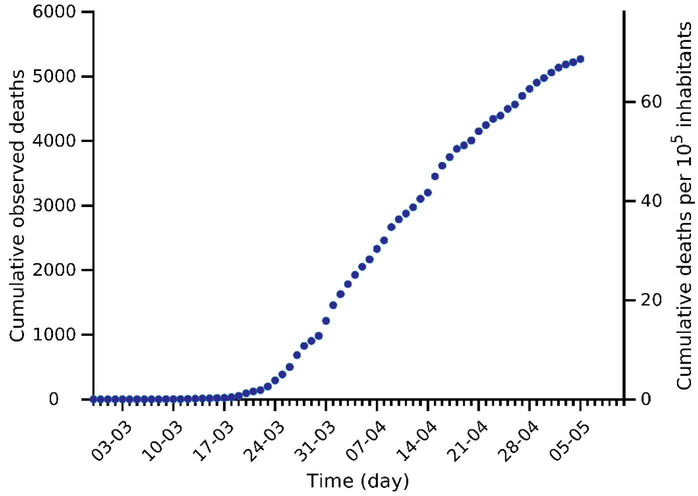


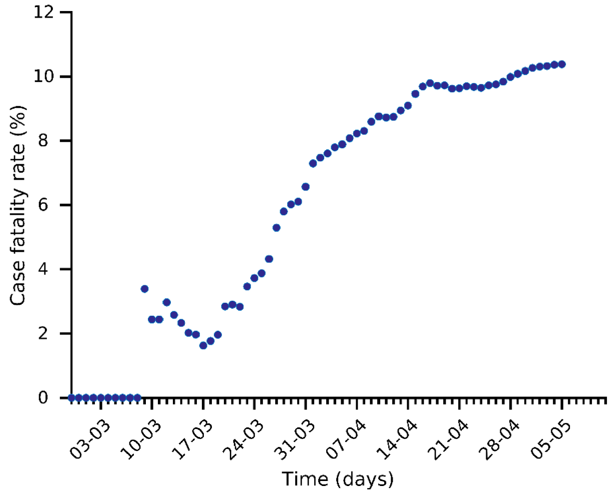




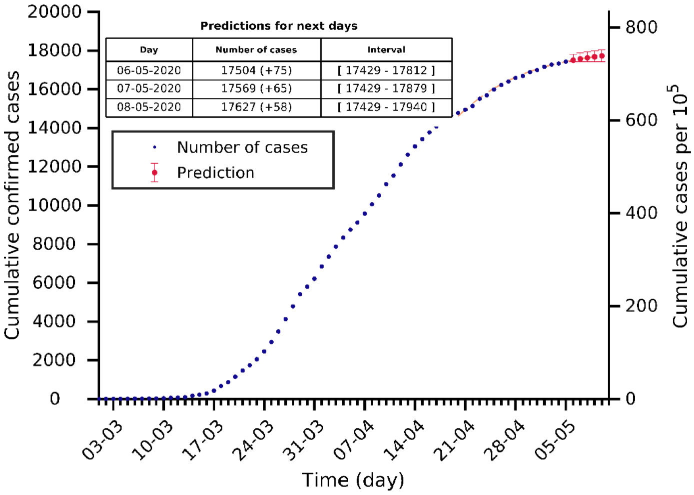


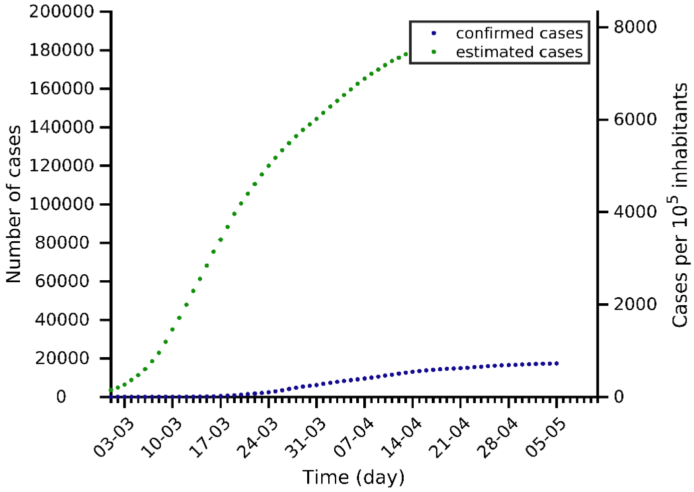


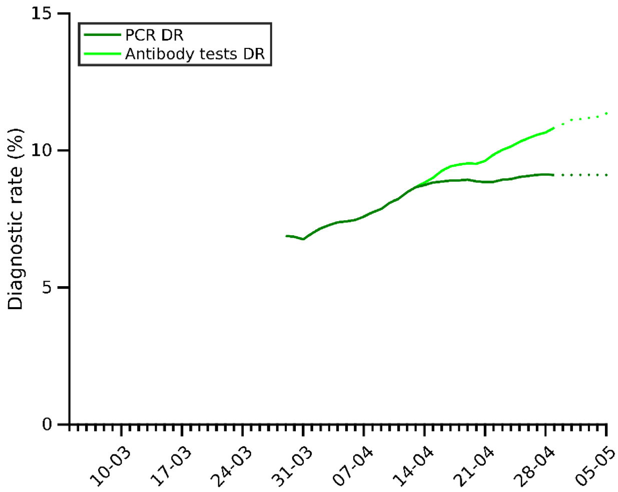


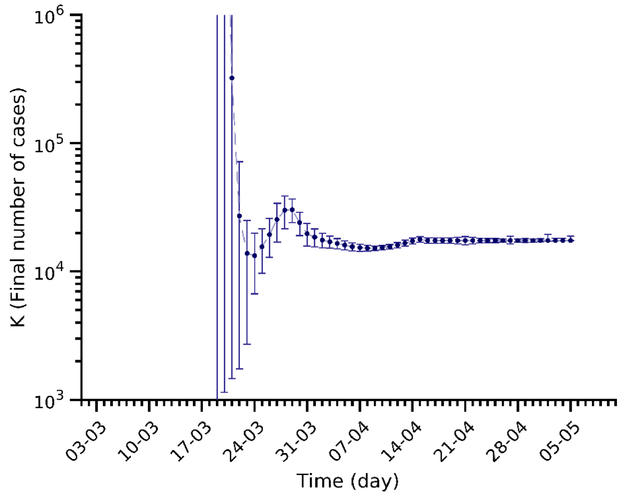


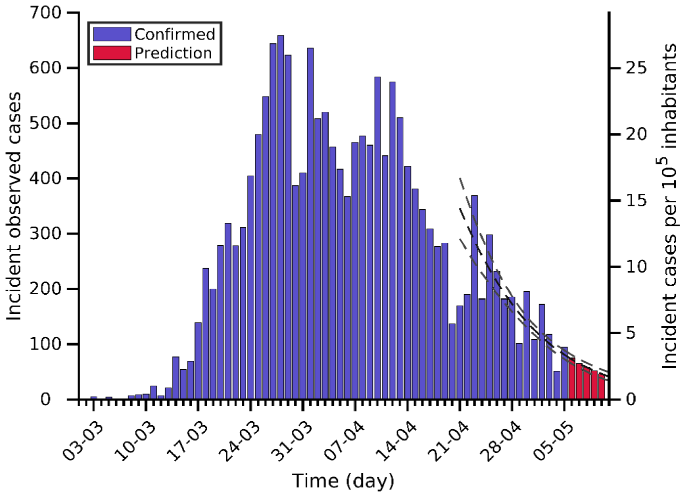
Castilla Leon 05-05-2020. Population: 2.4M. Current cumulated incidence: 726/10⁵

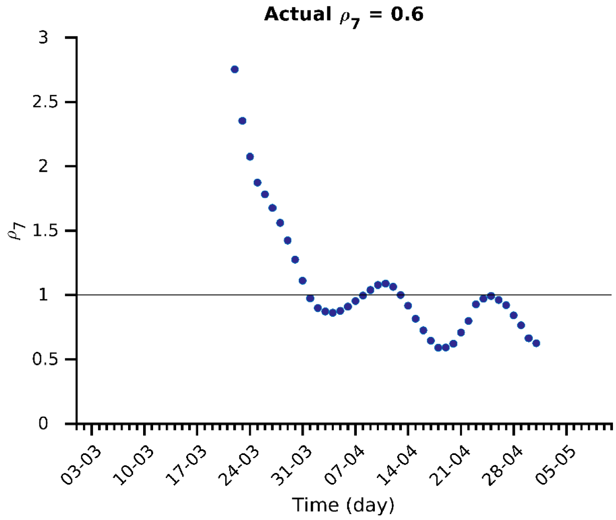


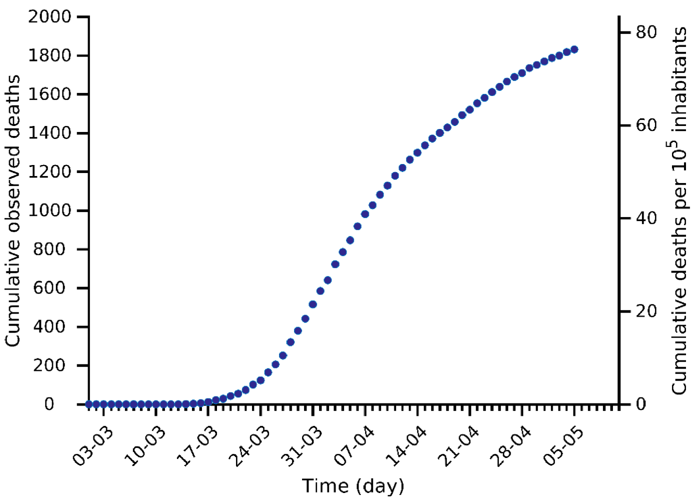


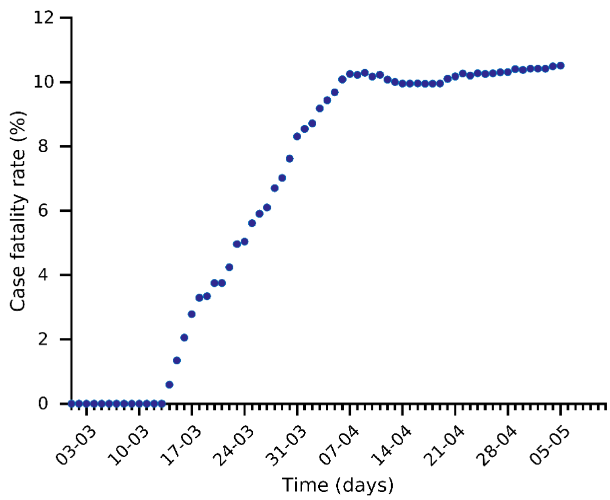




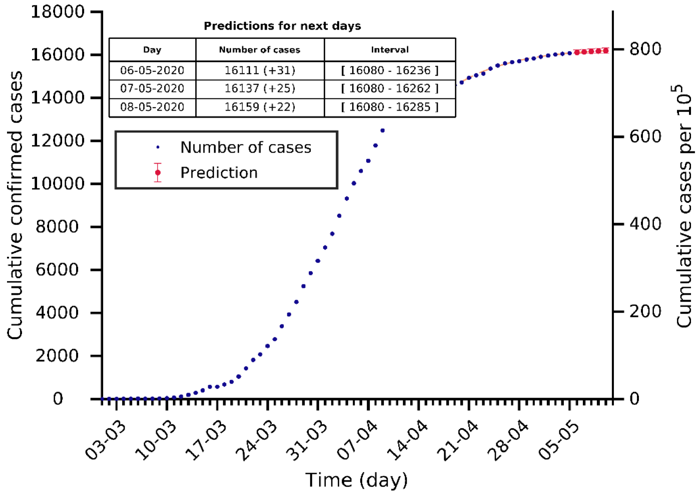


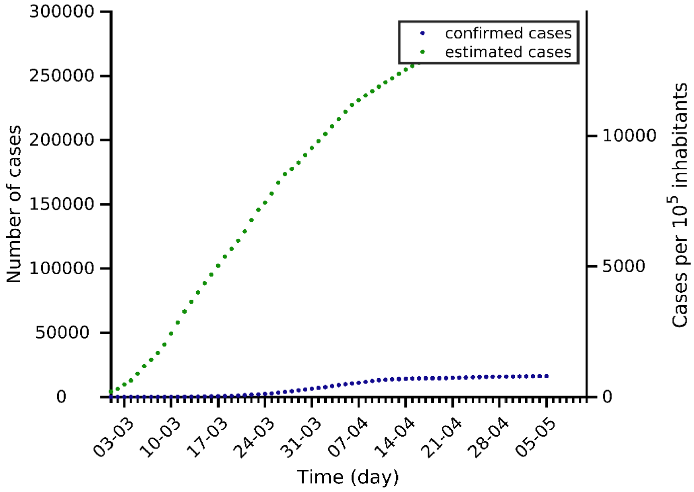


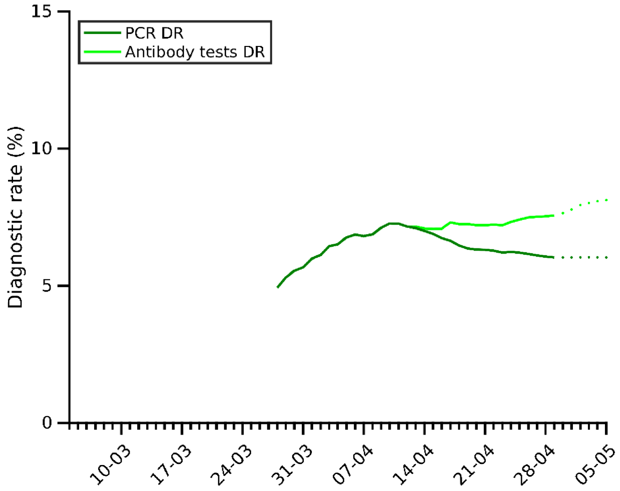


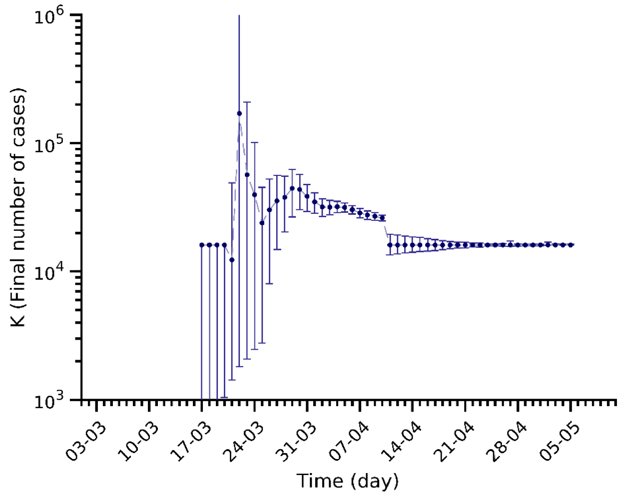


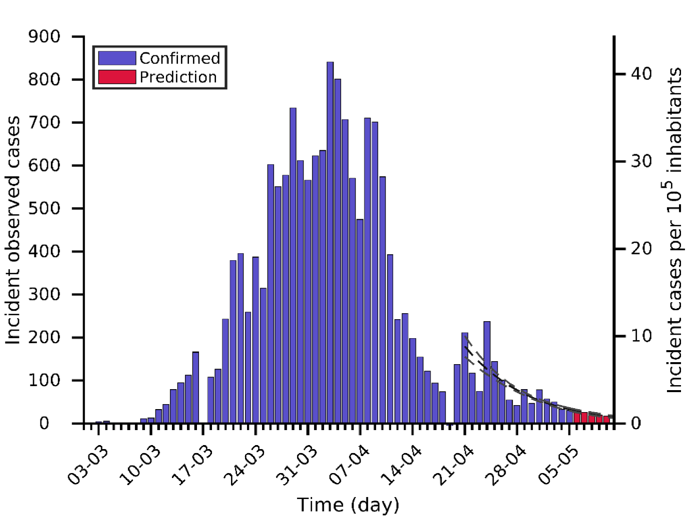
Castilla-La Mancha 05-05-2020. Population: 2.0M. Current cumulated incidence: 79

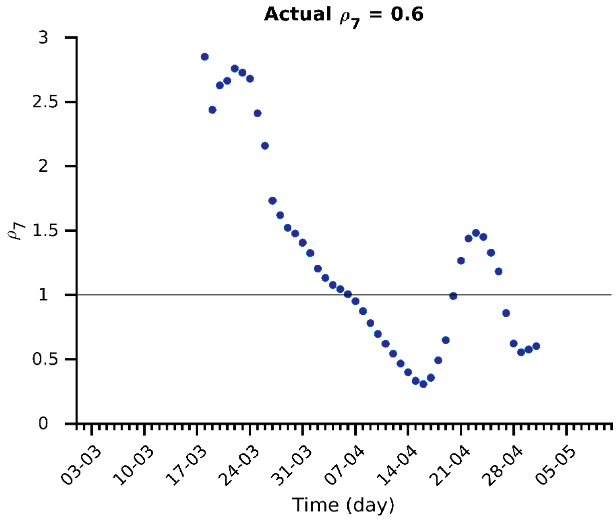


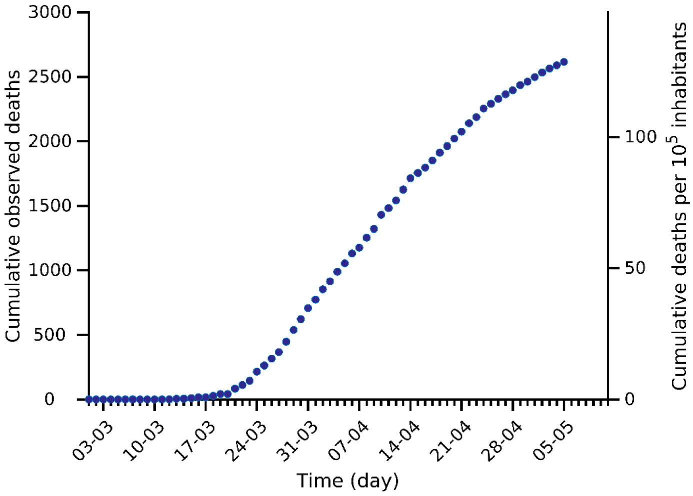


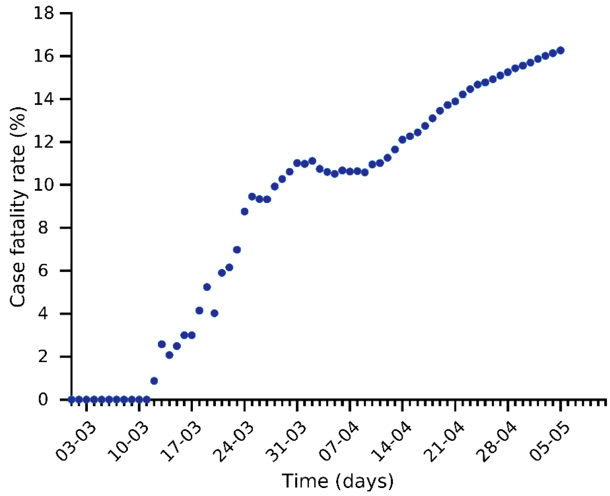




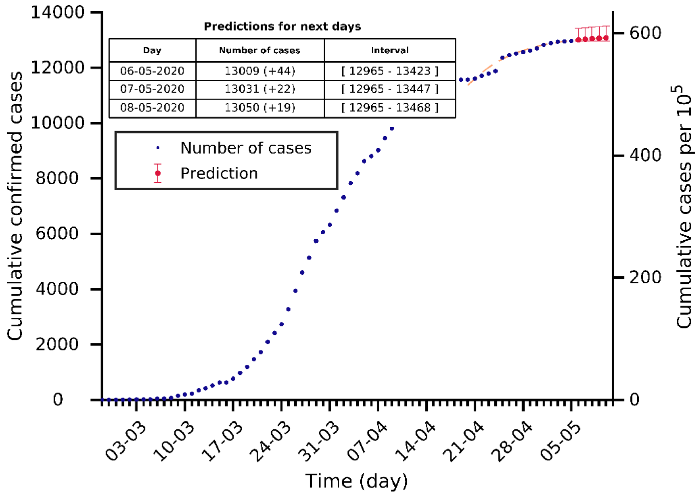


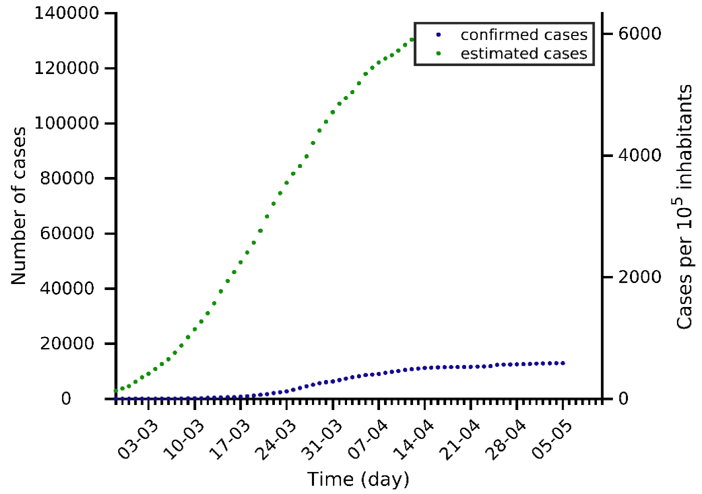


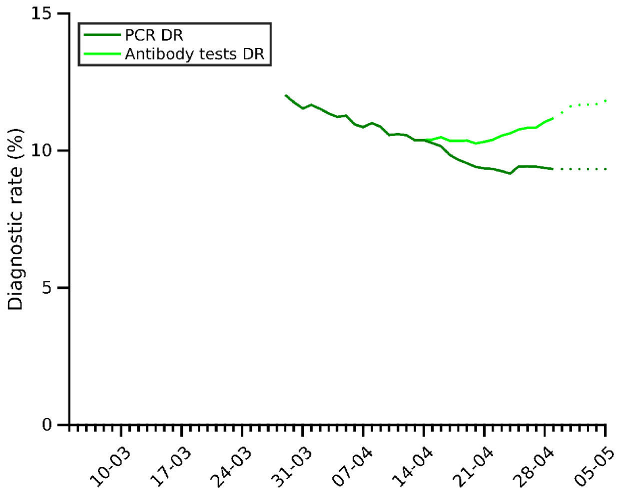


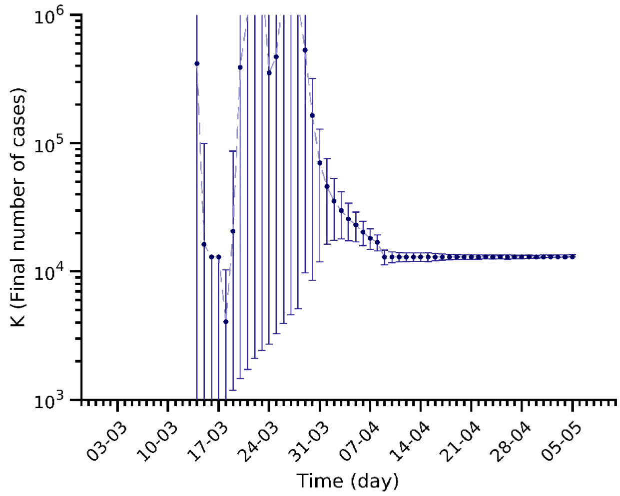


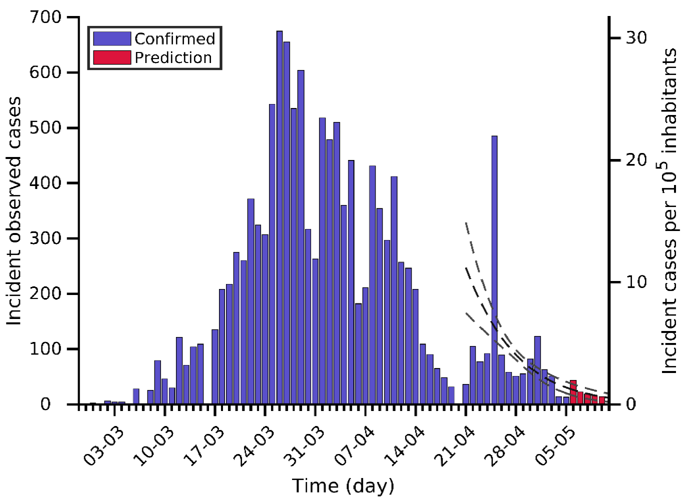
Euskadi 05-05-2020. Population: 2.2M. Current cumulated incidence: 587/10⁵

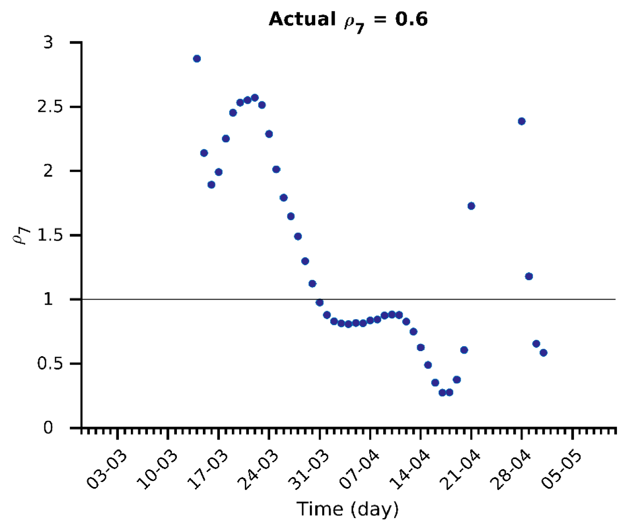


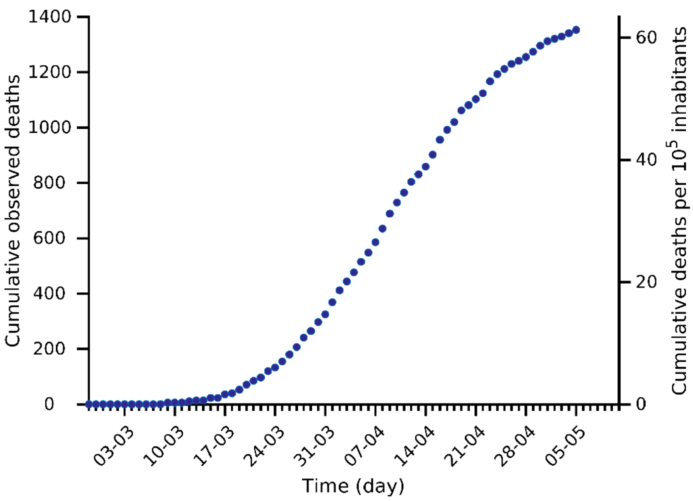


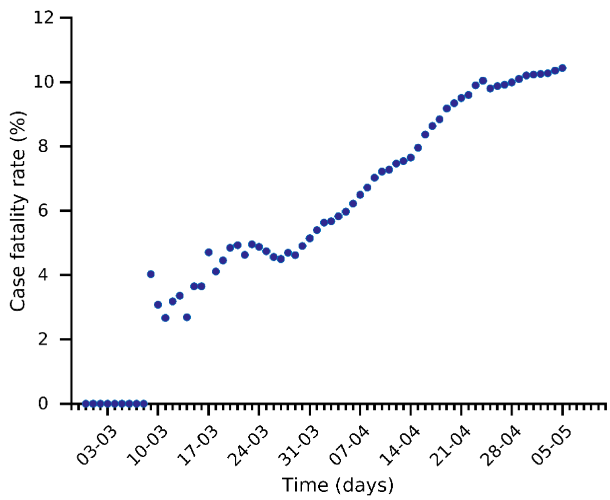




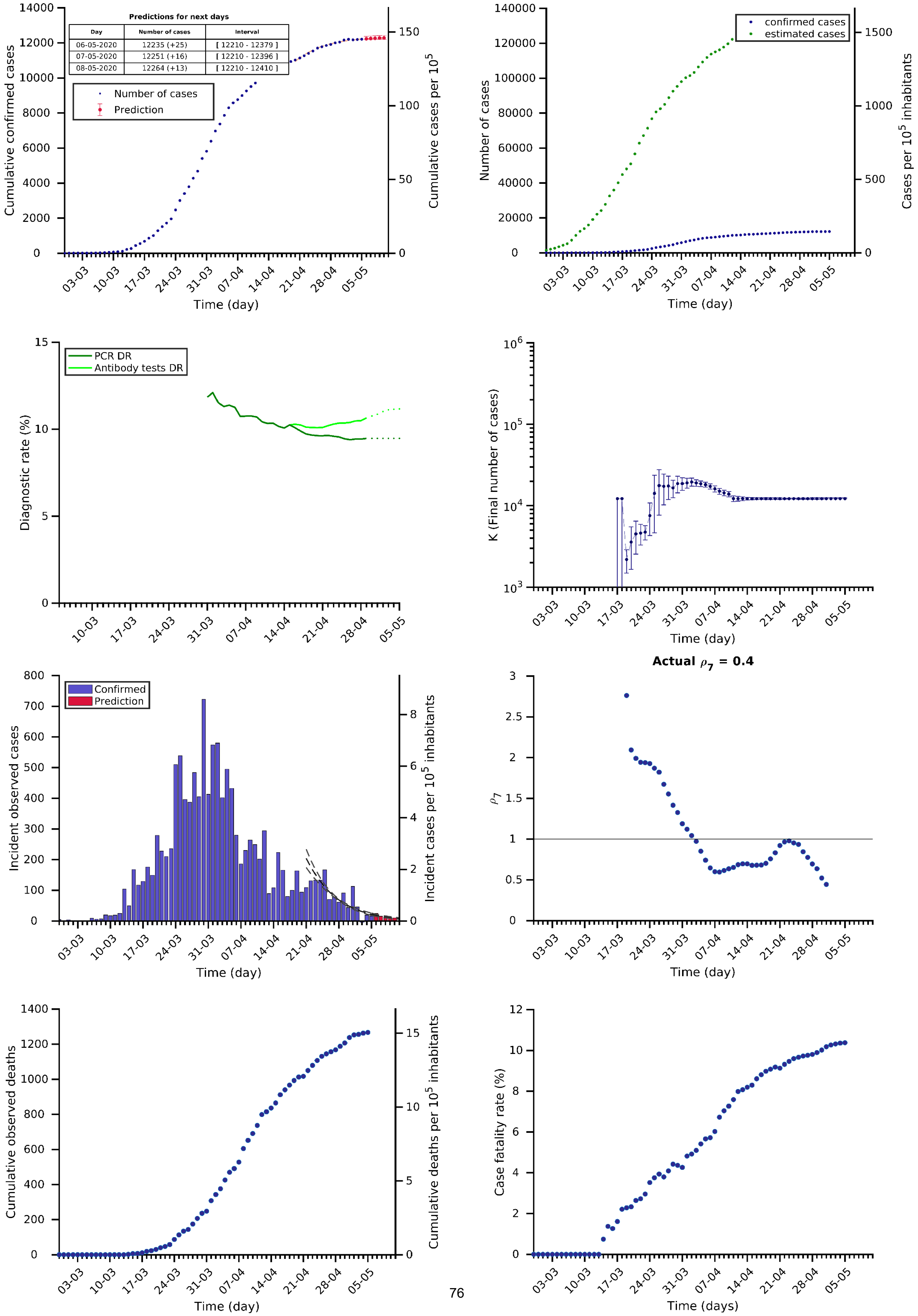




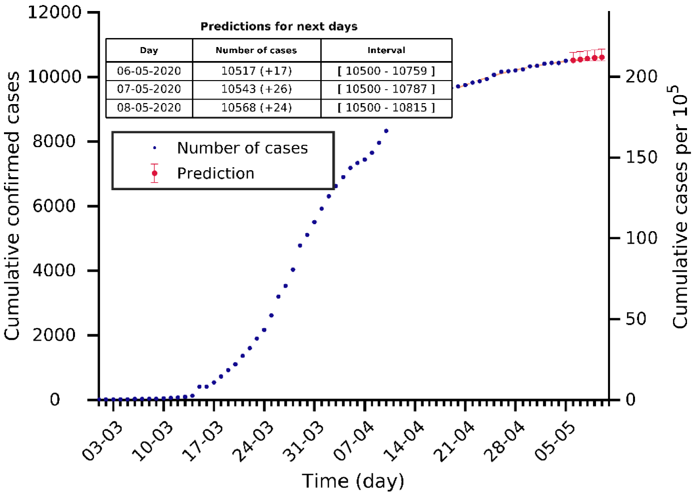


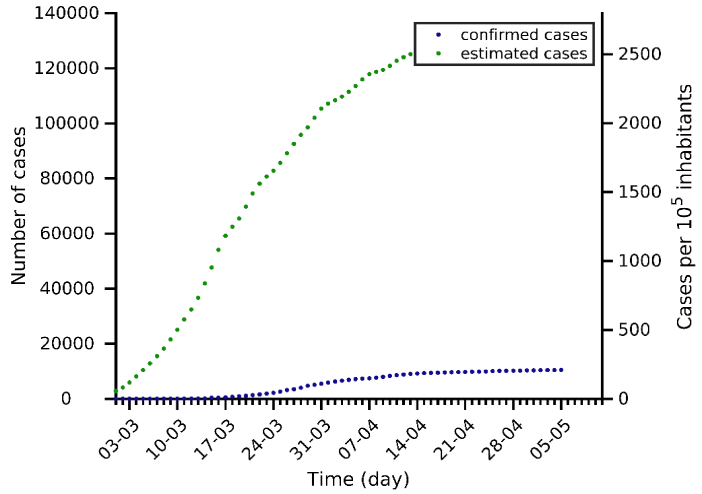


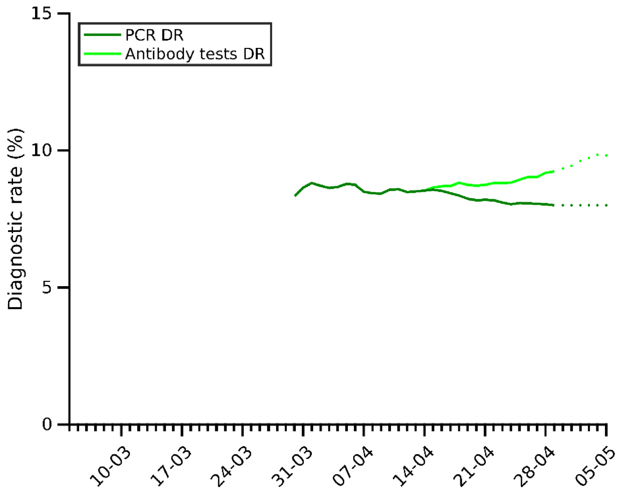
Andalucia 05-05-2020. Population: 8.4M. Current cumulated incidence: 145/10^5

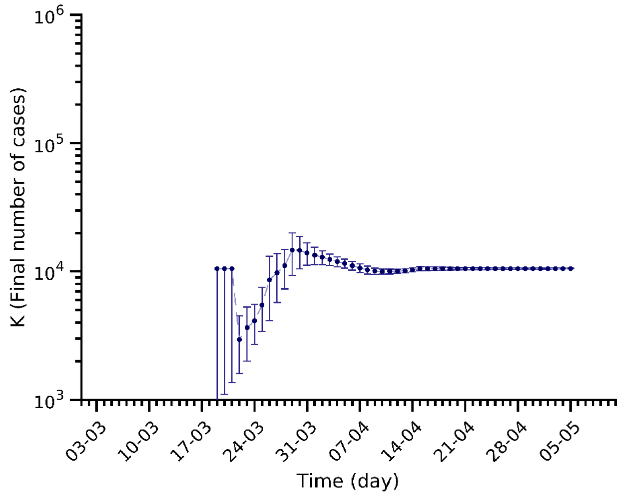


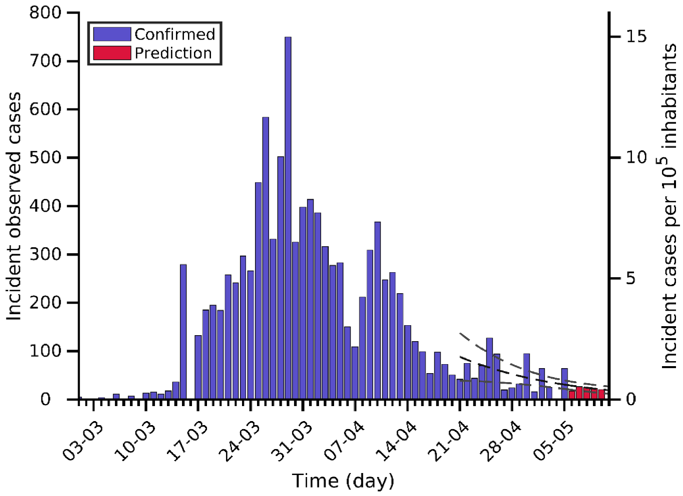
C Valenciana 05-05-2020. Population: 5.0M. Current cumulated incidence: 210/10⁵

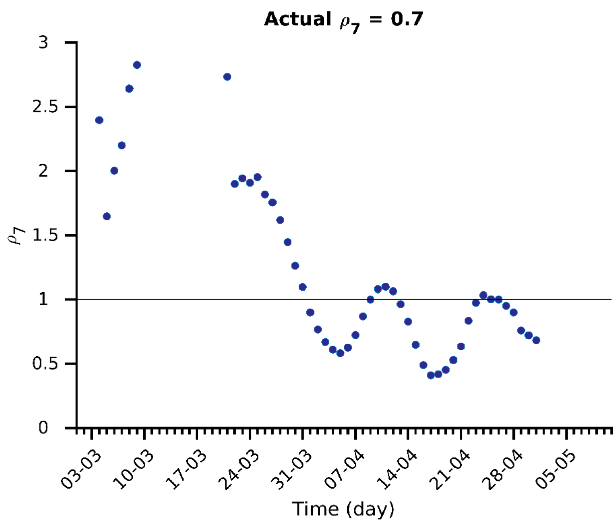


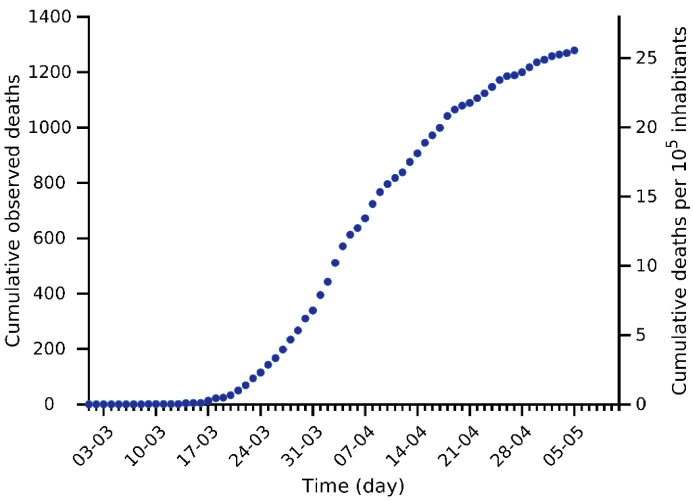


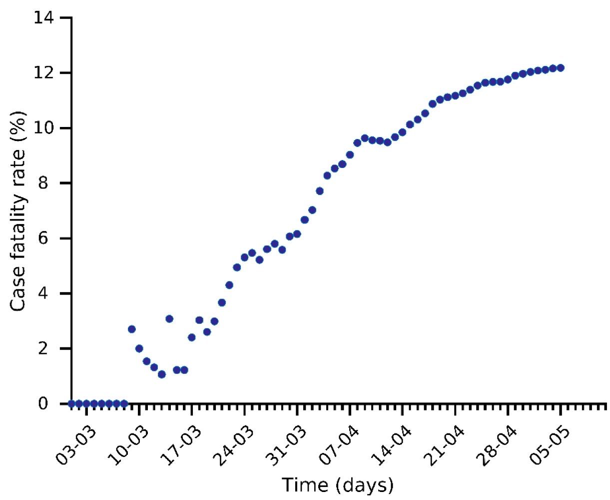




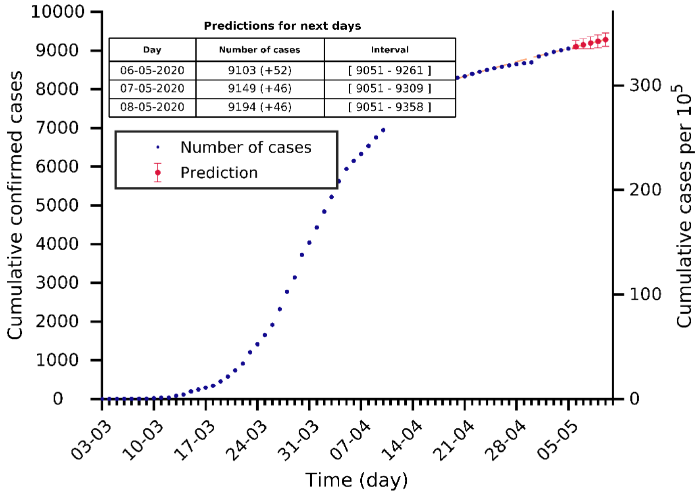


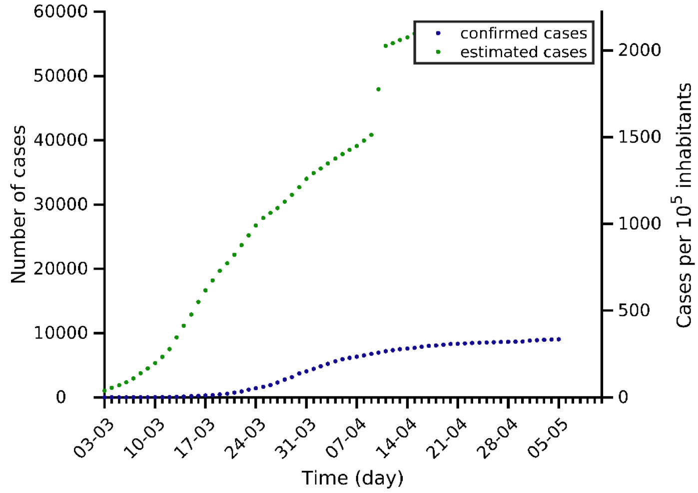


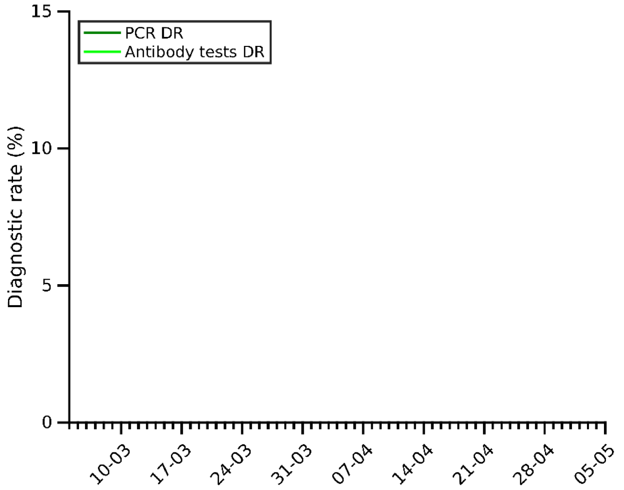


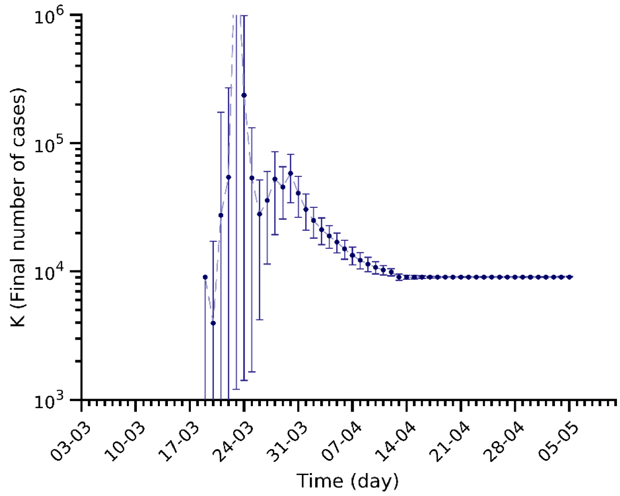


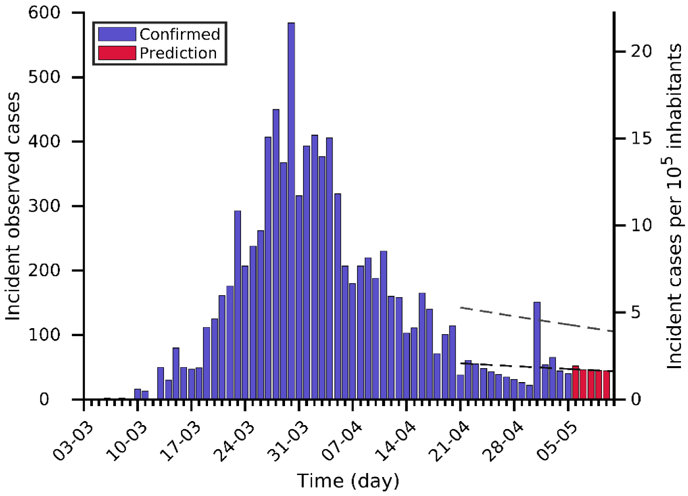
Galicia 05-05-2020. Population: 2.7M. Current cumulated incidence: 335/10⁵

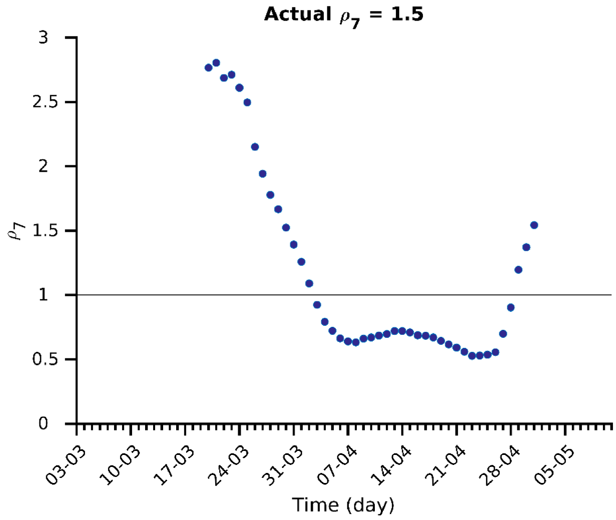


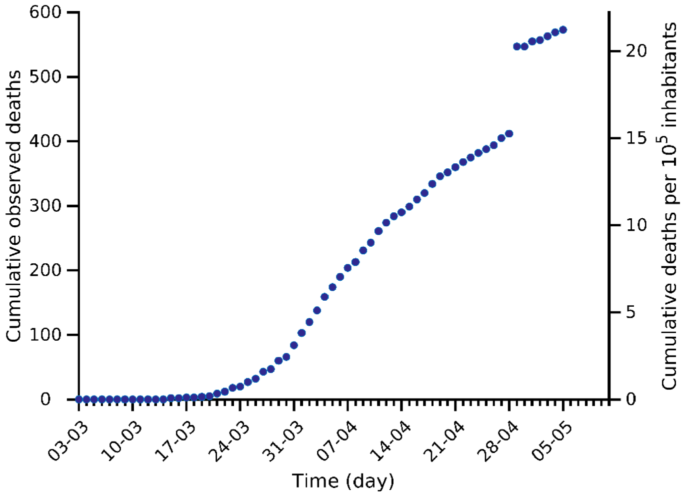


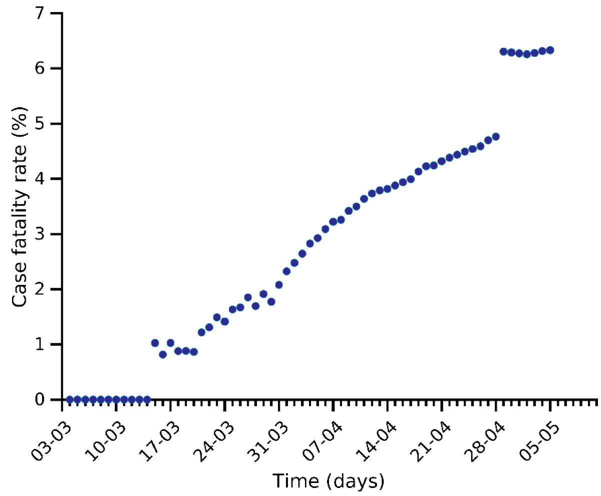




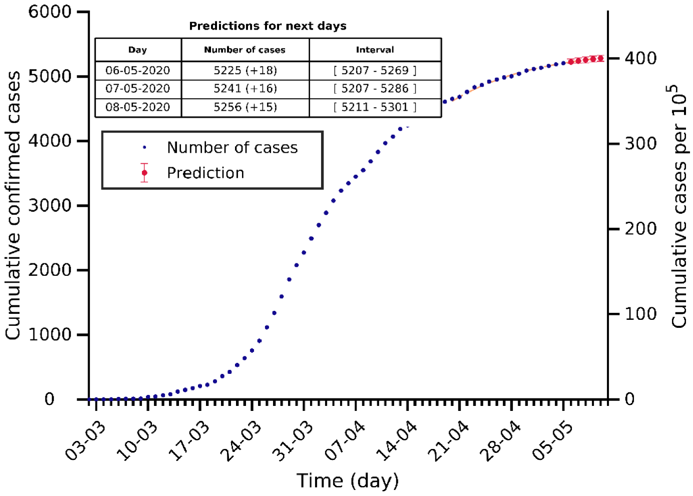


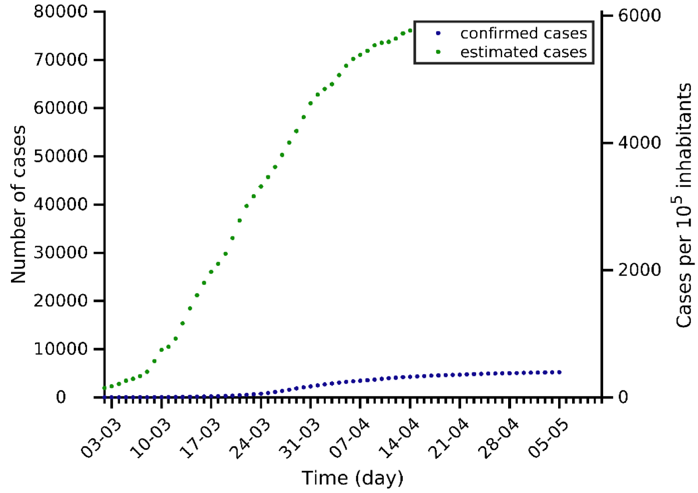


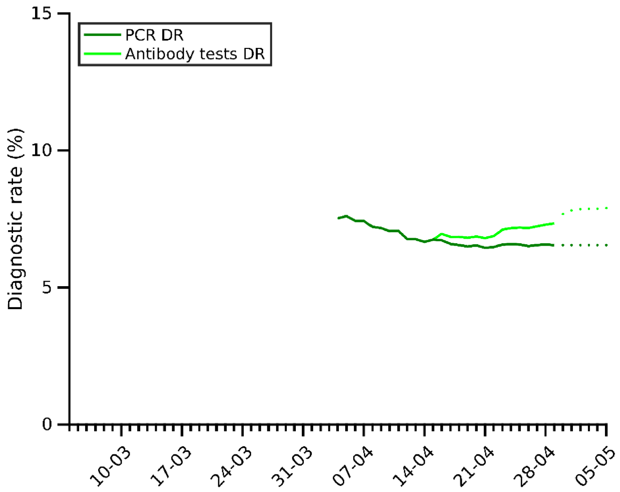


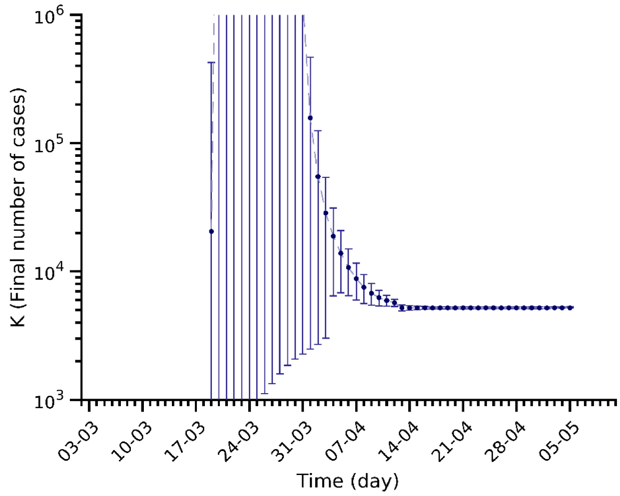


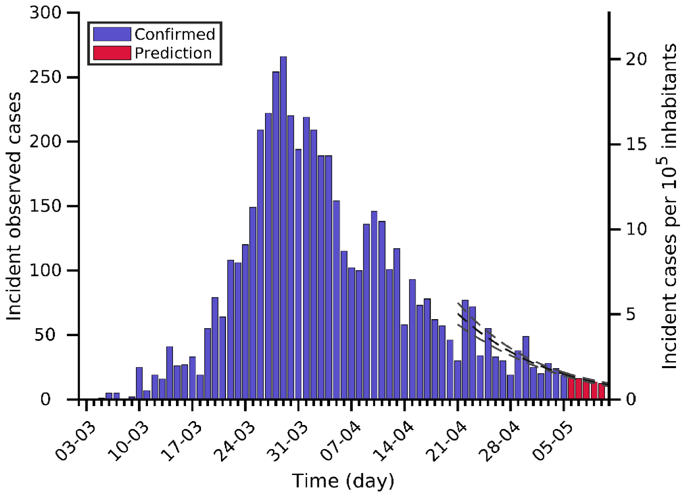
Aragon 05-05-2020. Population: 1.3M. Current cumulated incidence: 395/10⁵

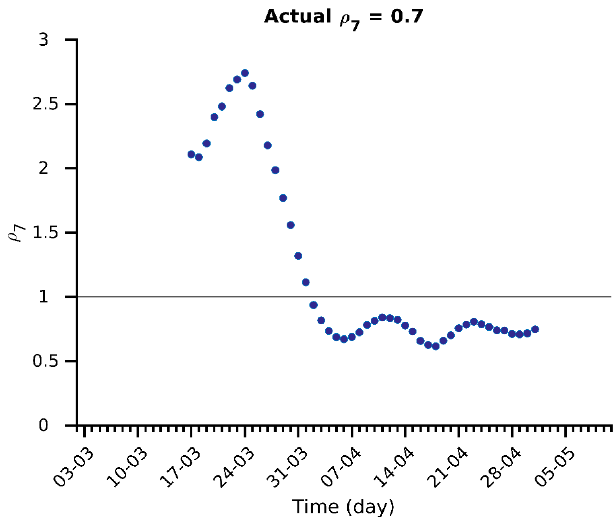


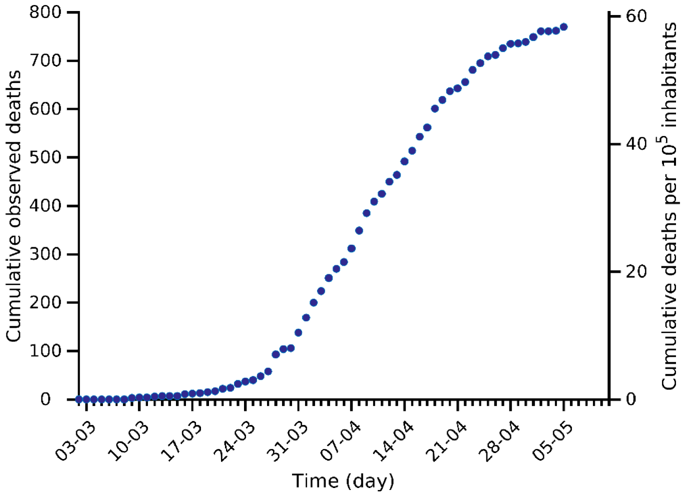


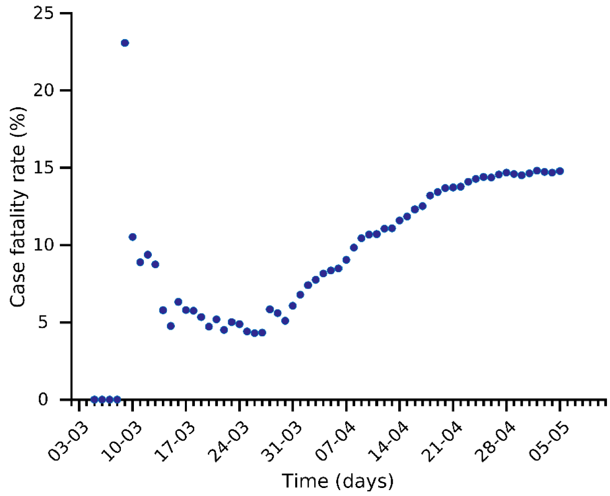




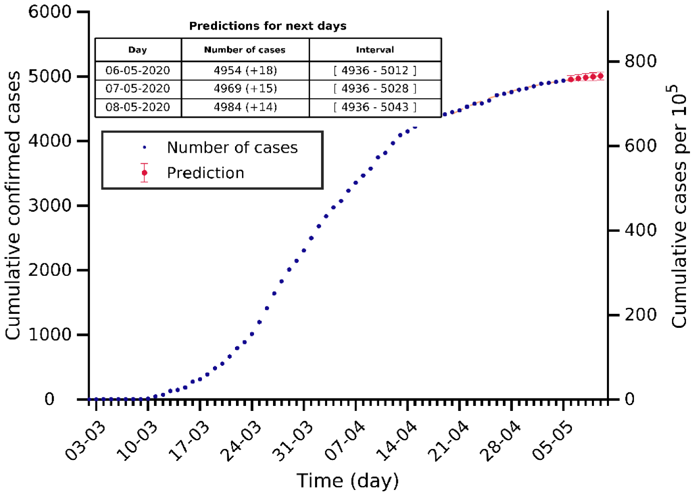


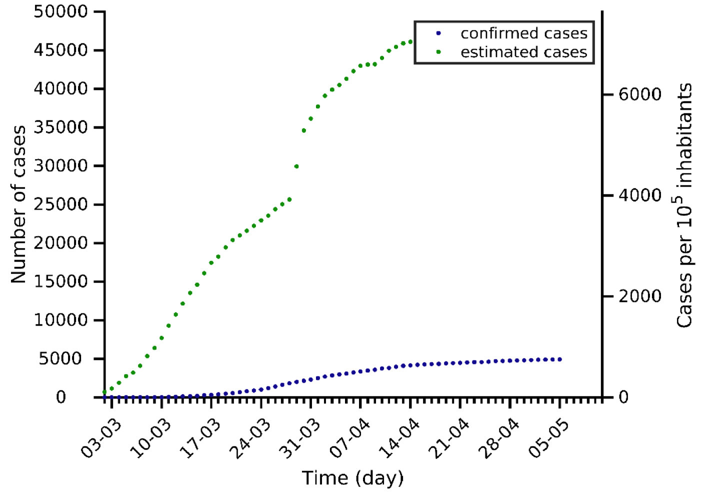


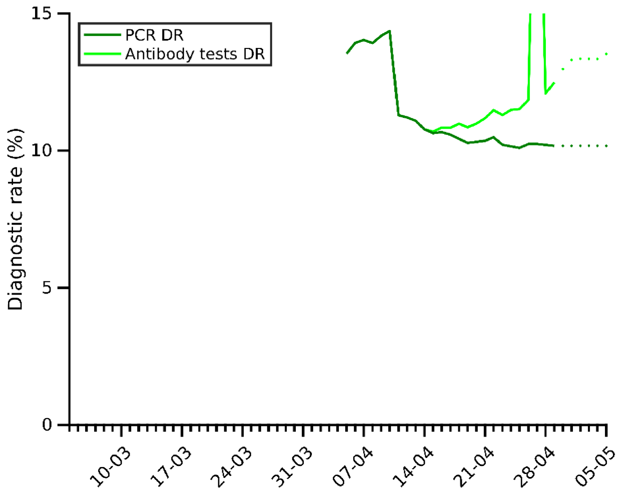


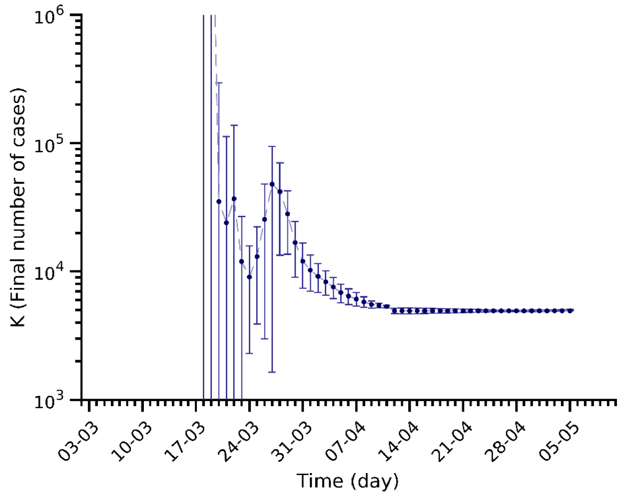


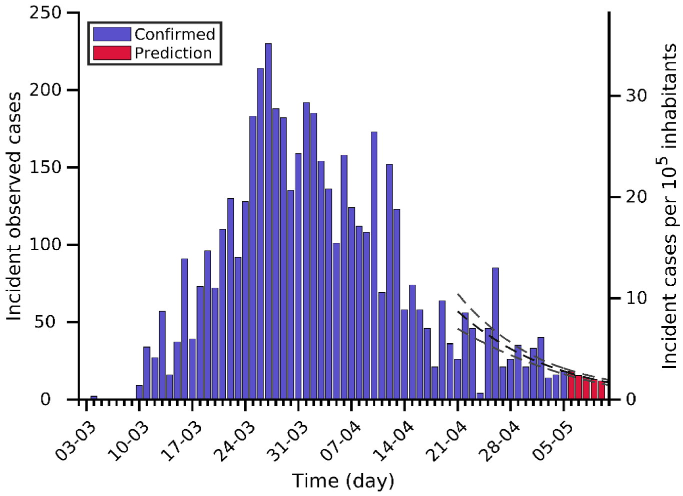
Navarra 05-05-2020. Population: 0.7M. Current cumulated incidence: 754/10⁵

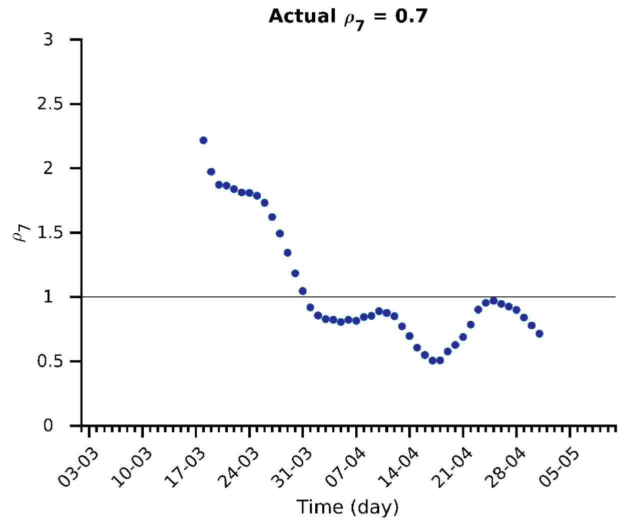


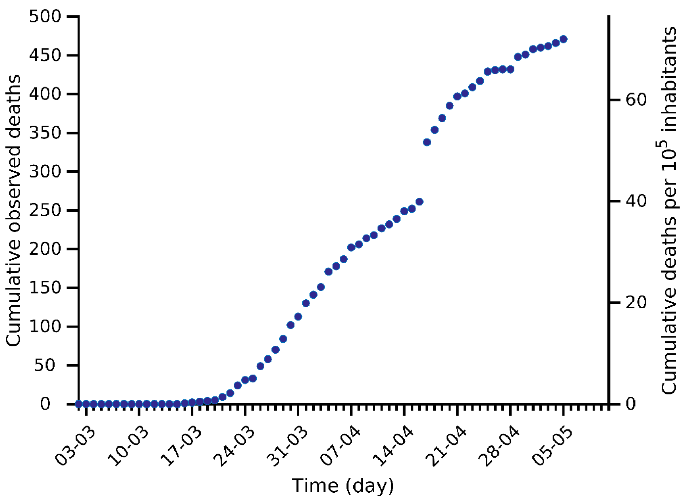


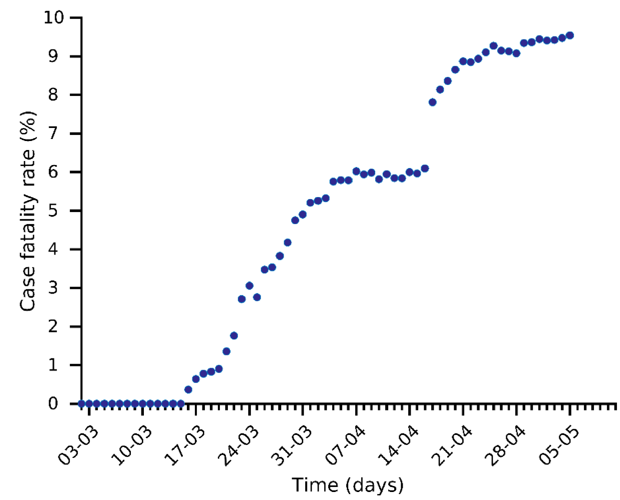




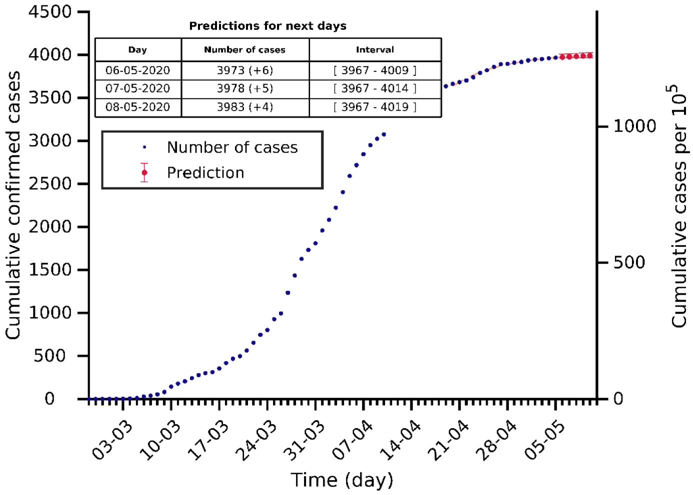


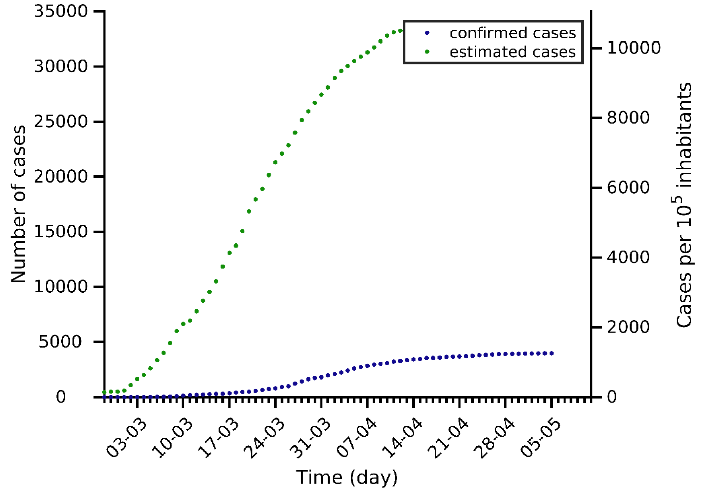


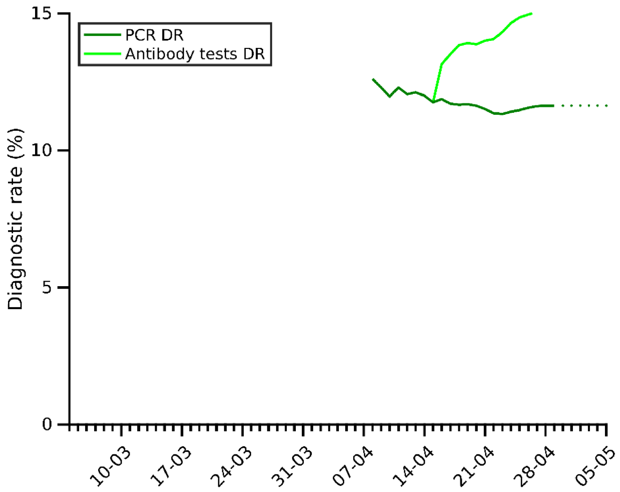


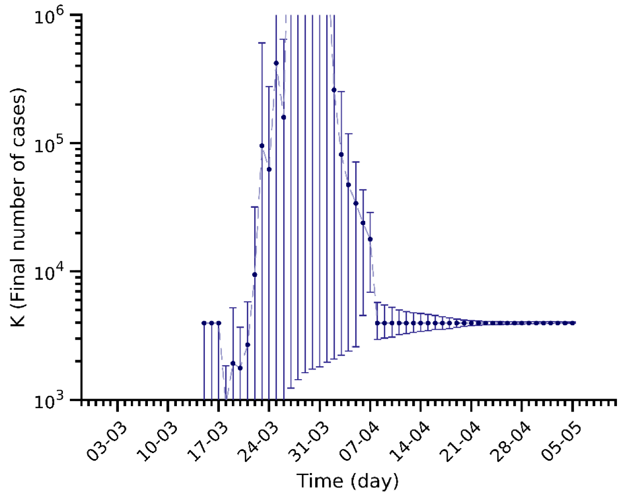


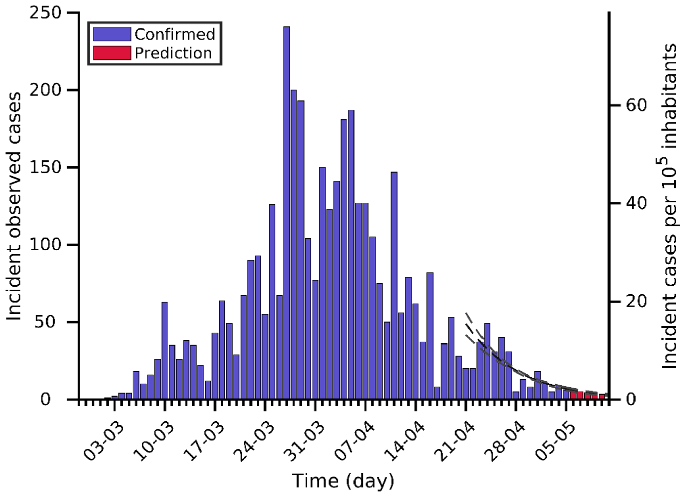
La Rioja 05-05-2020. Population: 0.3M. Current cumulated incidence: 1252/10⁵

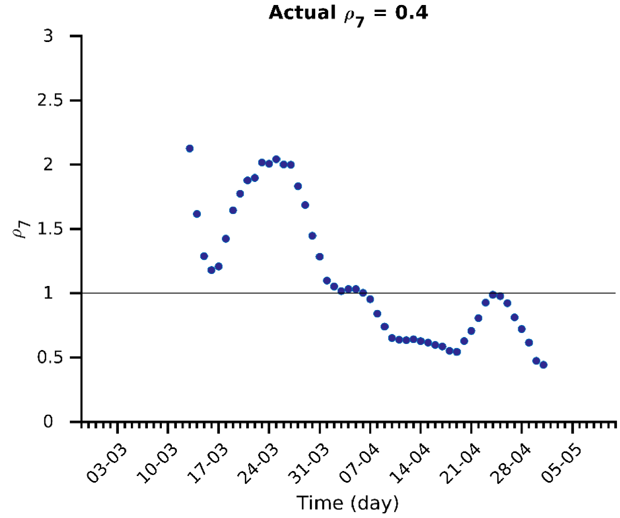


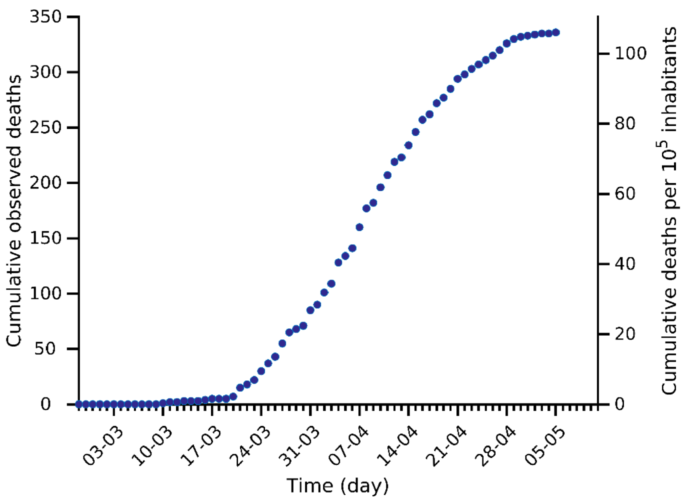


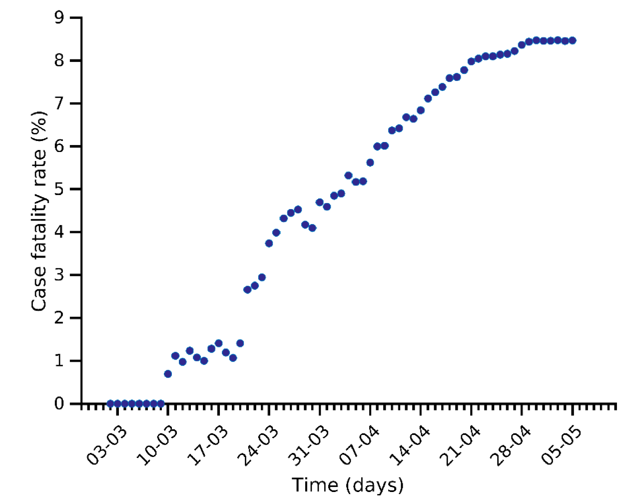




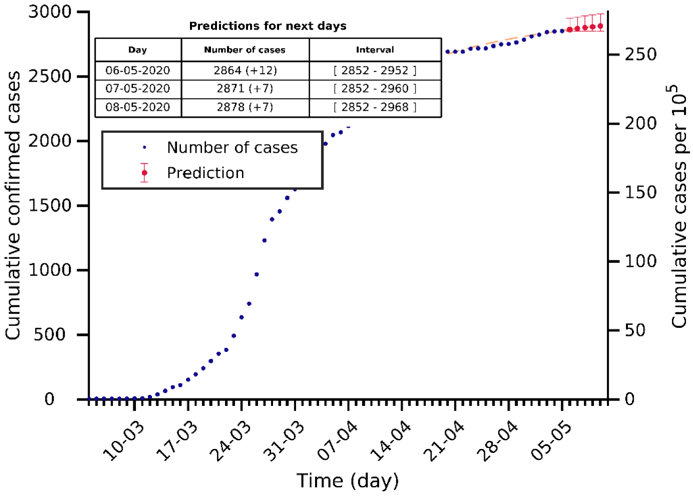


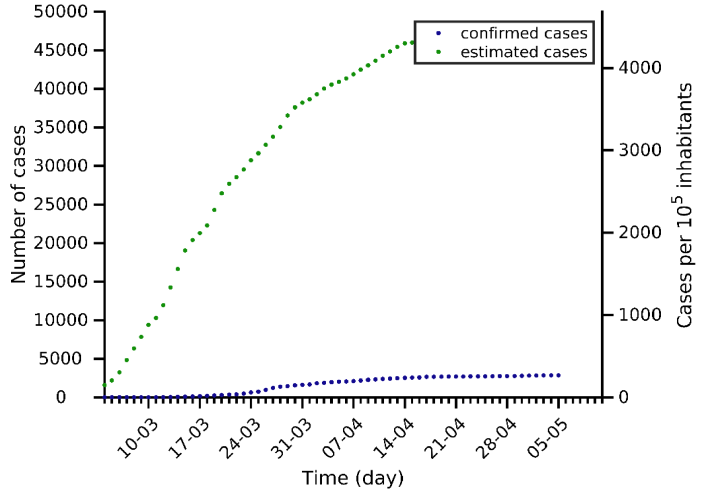


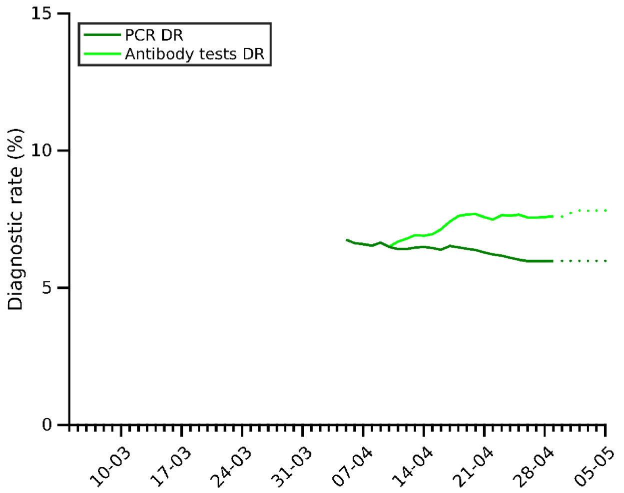


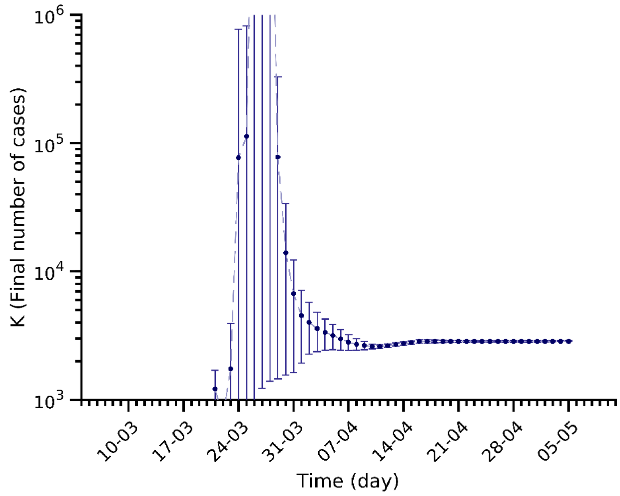


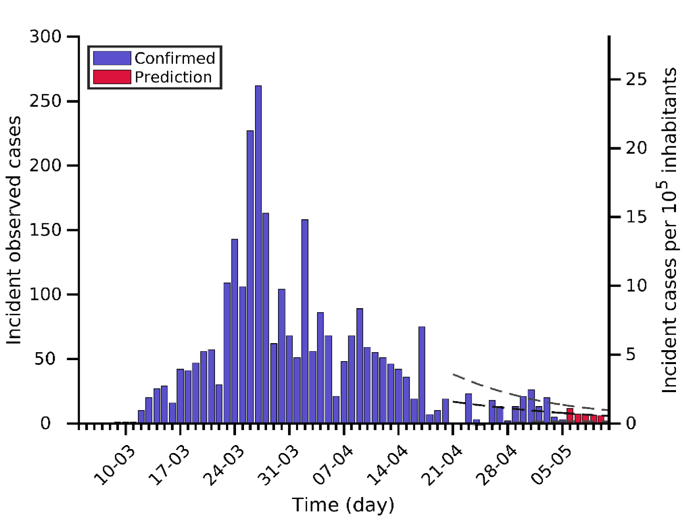
Extremadura 05-05-2020. Population: 1.1M. Current cumulated incidence: 267/10⁵

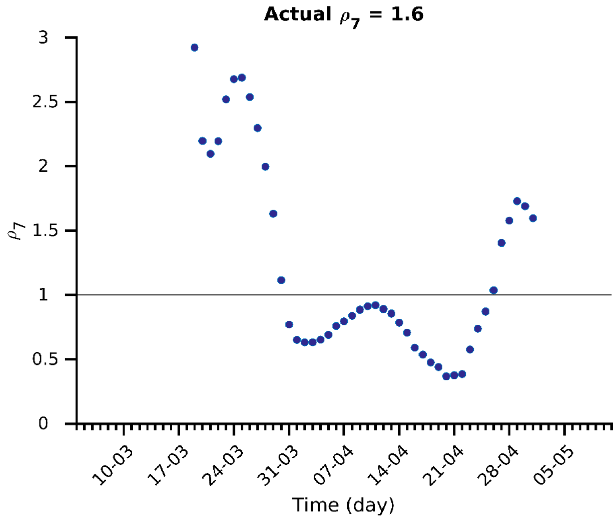


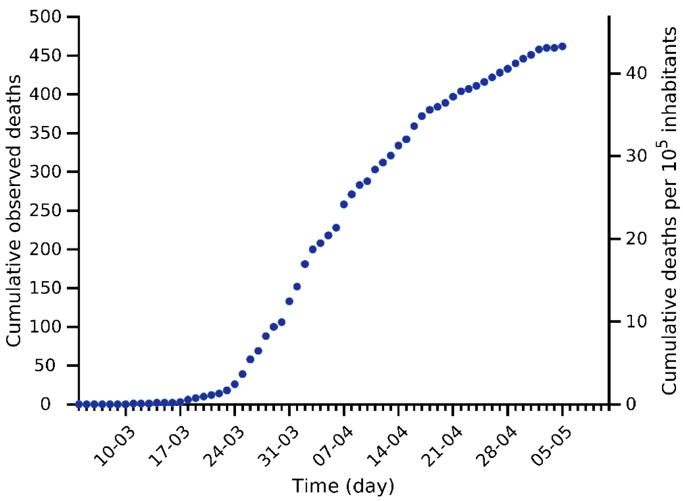


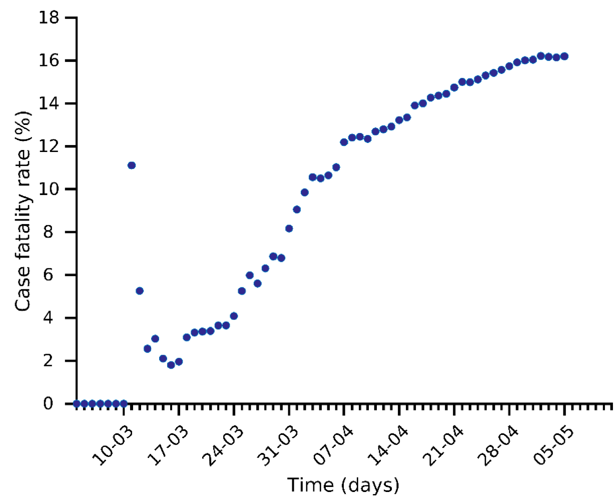




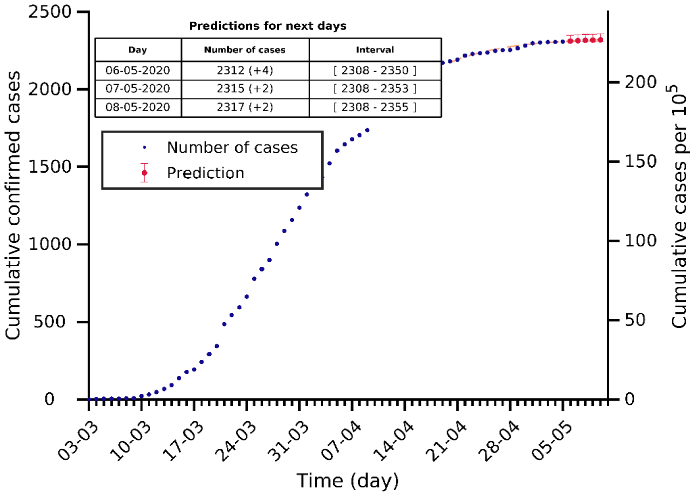


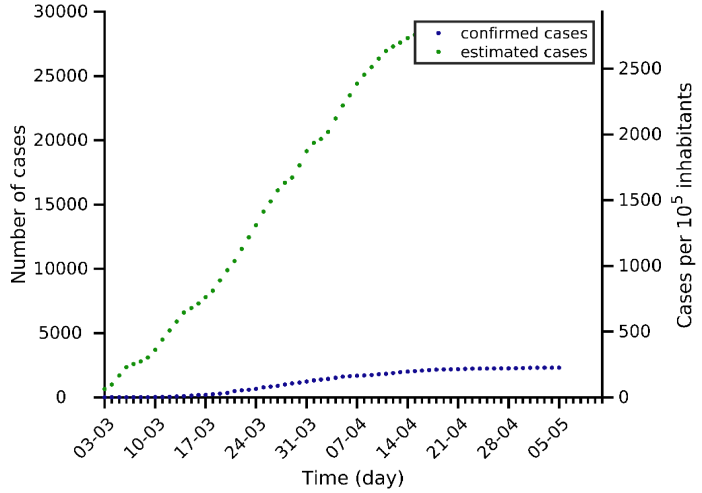


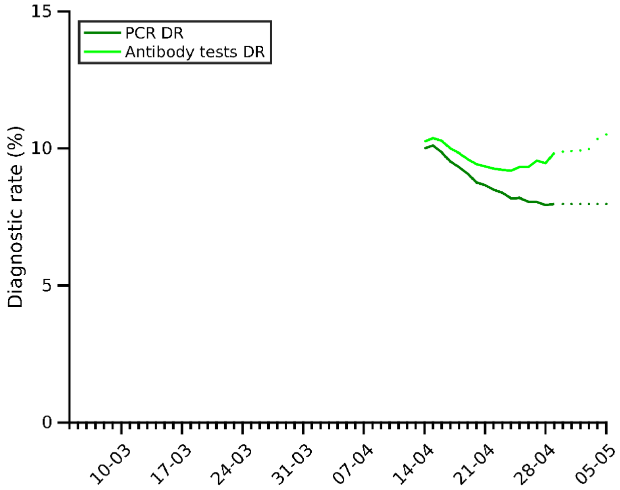


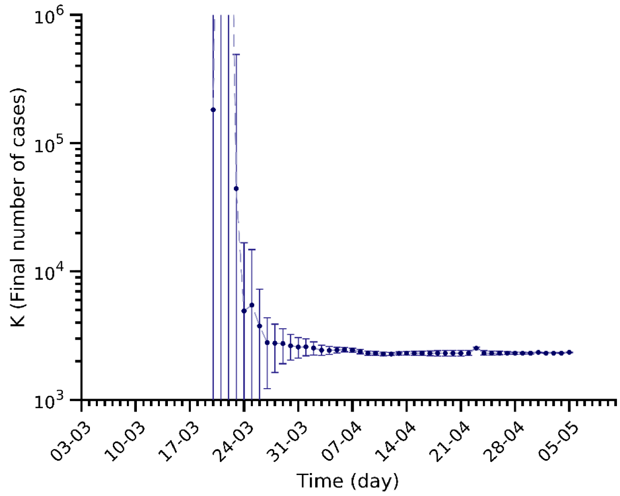


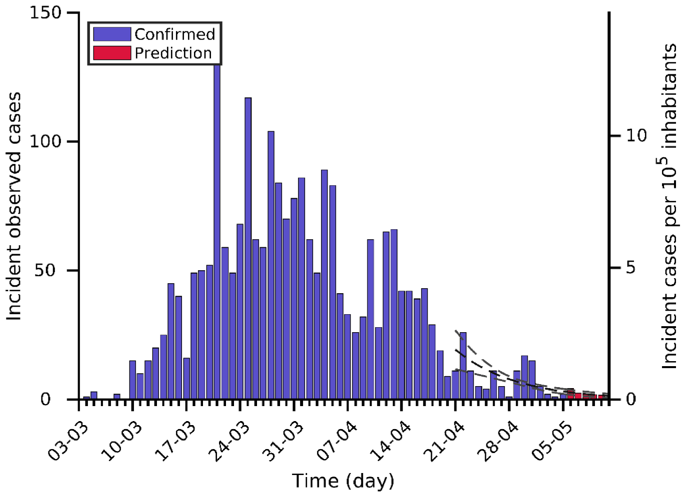
Asturias 05-05-2020. Population: 1.0M. Current cumulated incidence: 226/10⁵

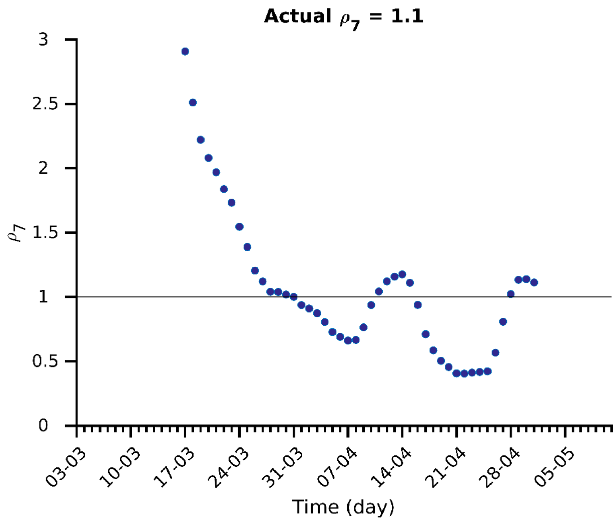


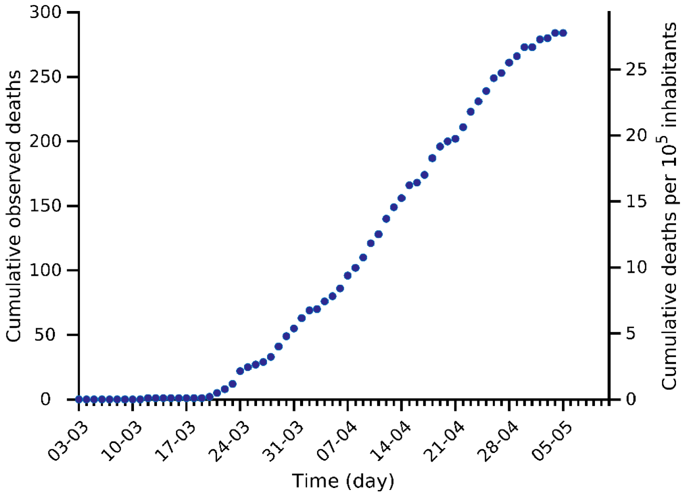


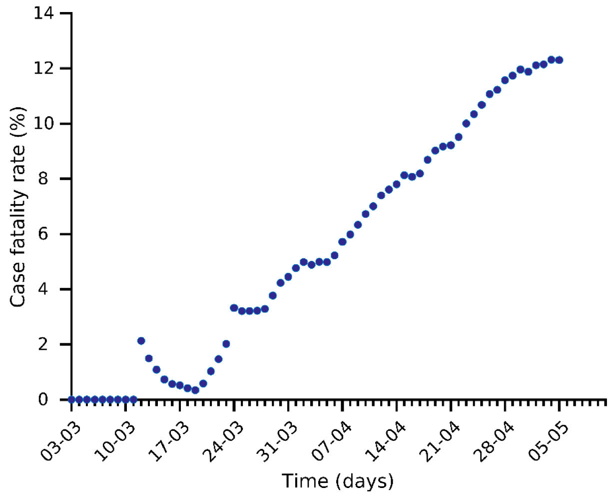




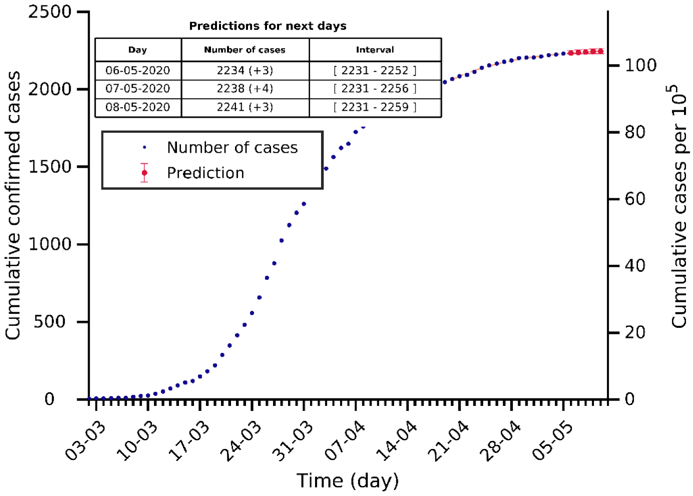


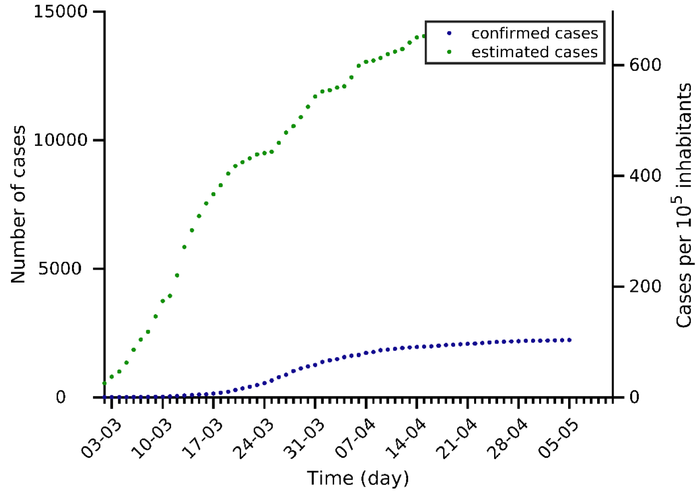


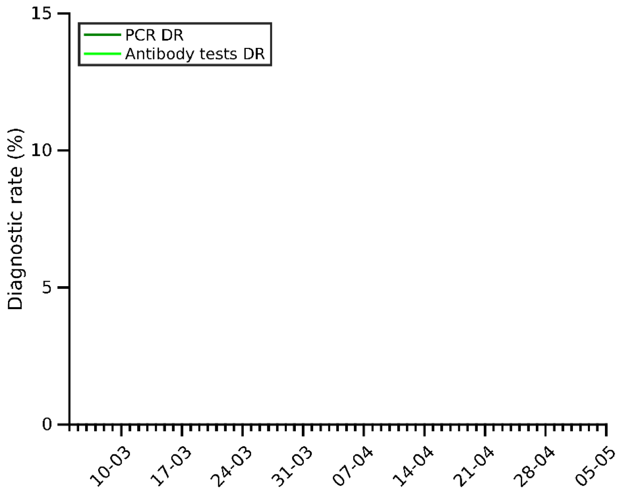


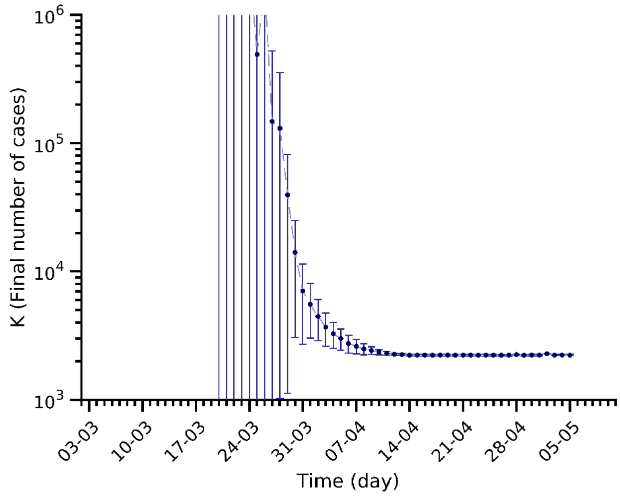


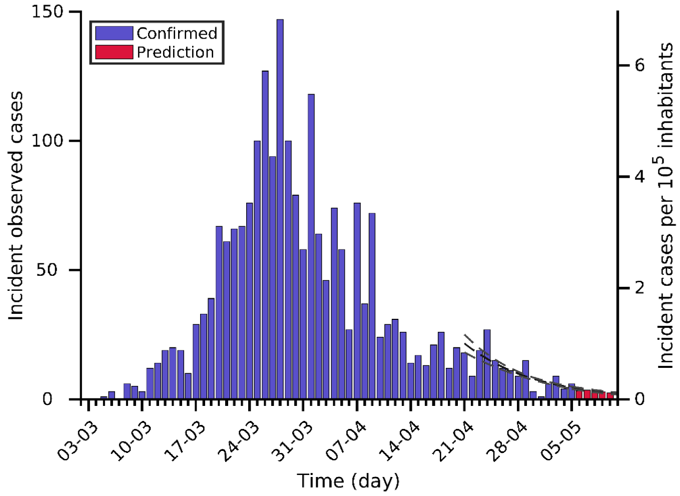
Canarias 05-05-2020. Population: 2.2M. Current cumulated incidence: 104/10⁵

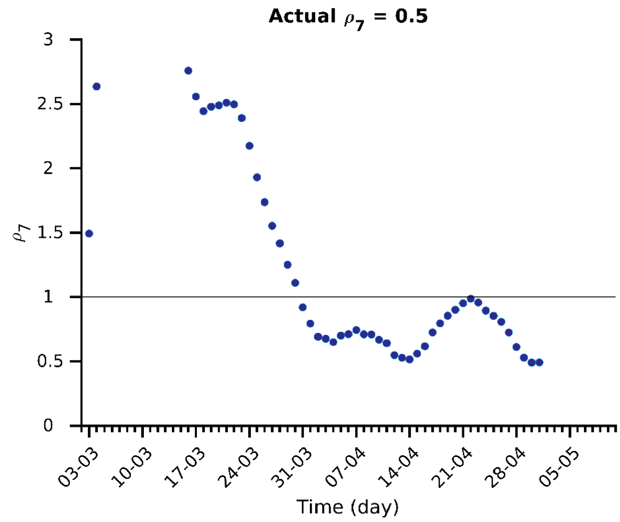


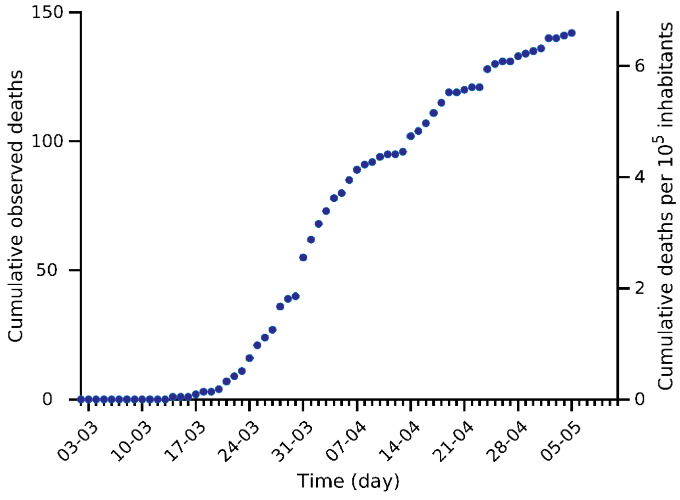


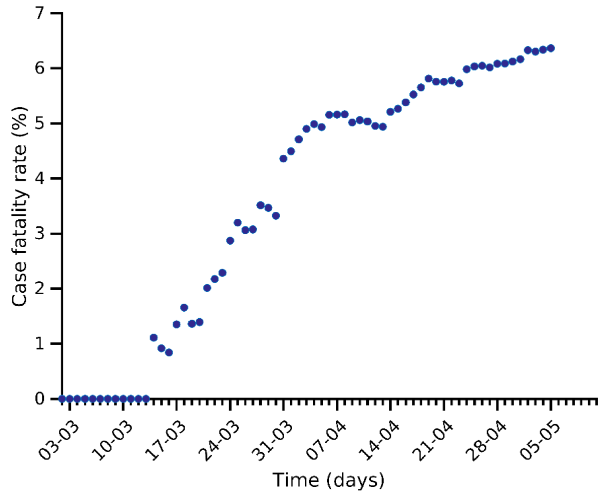




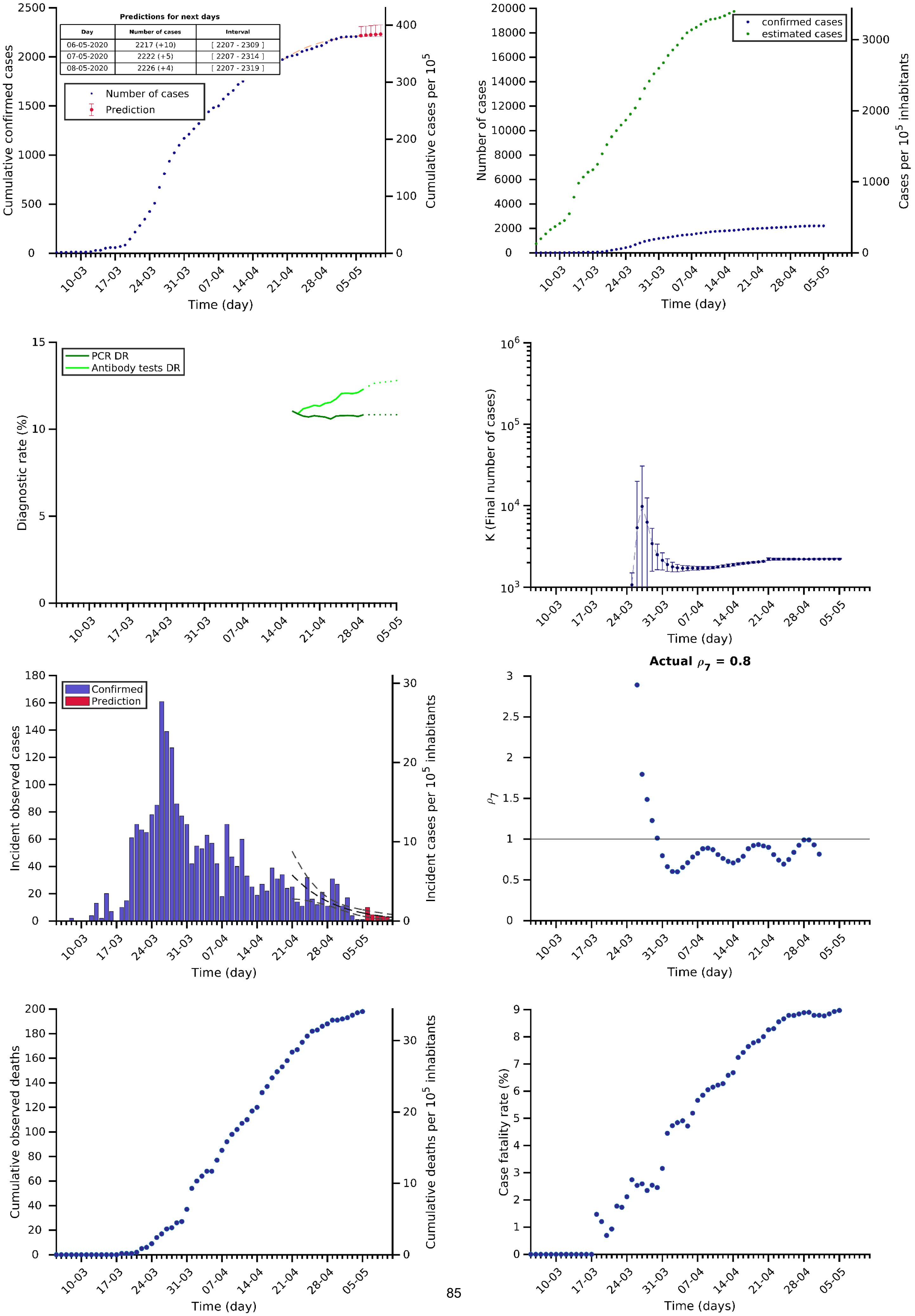




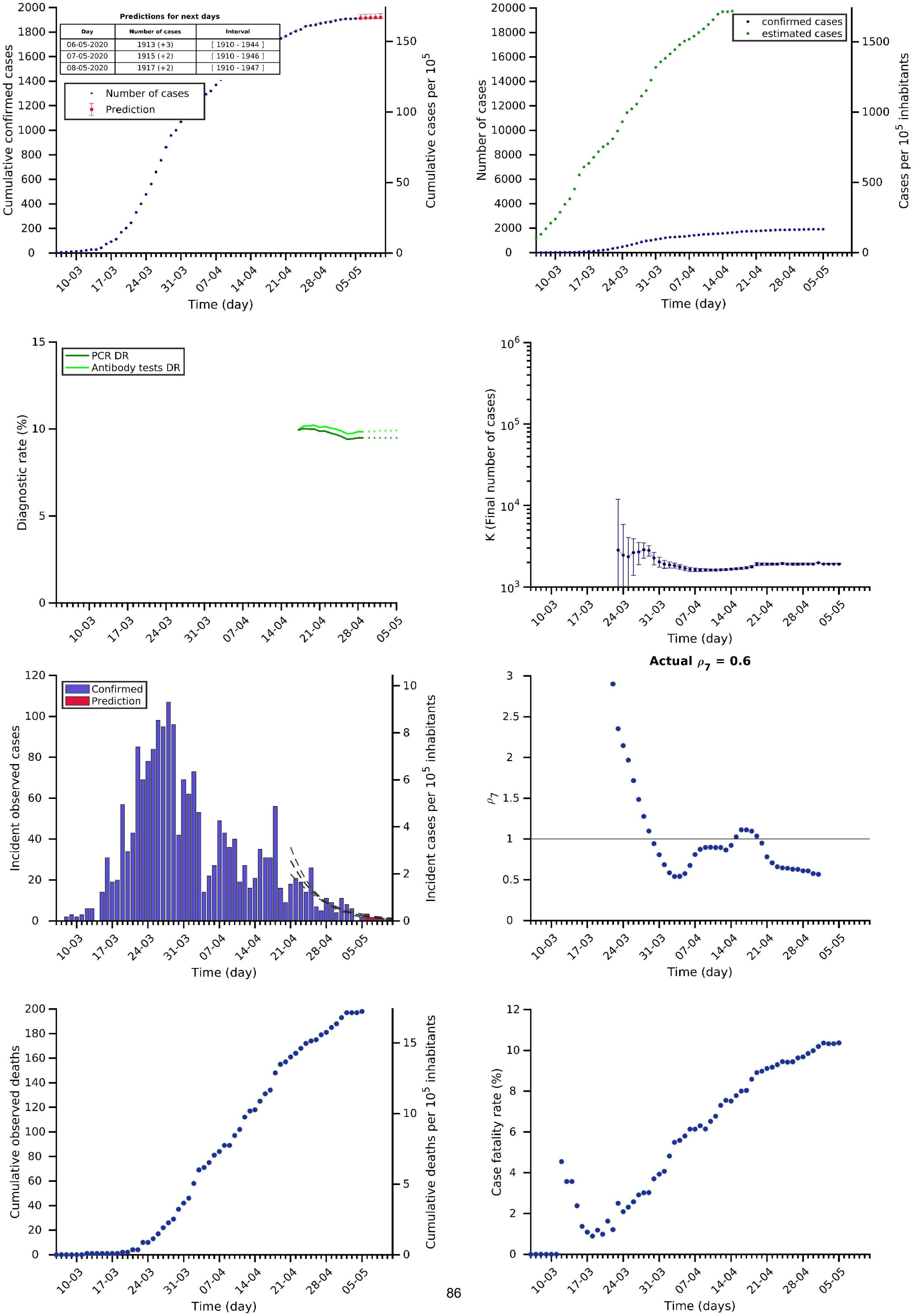




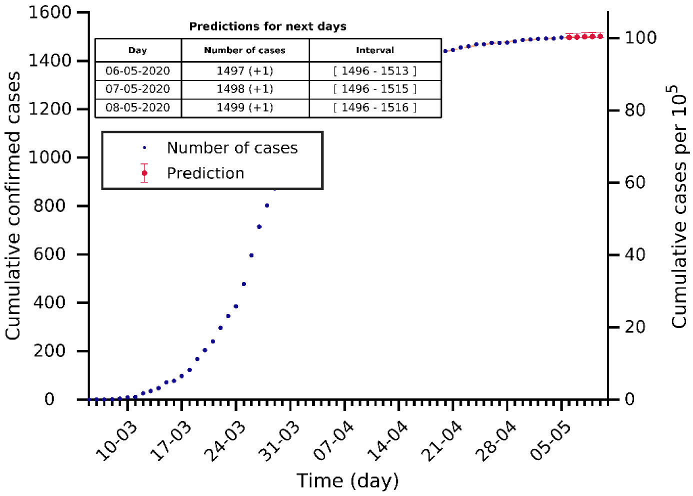
Cantabria 05-05-2020. Population: 0.6M. Current cumulated incidence: 380/10⁵

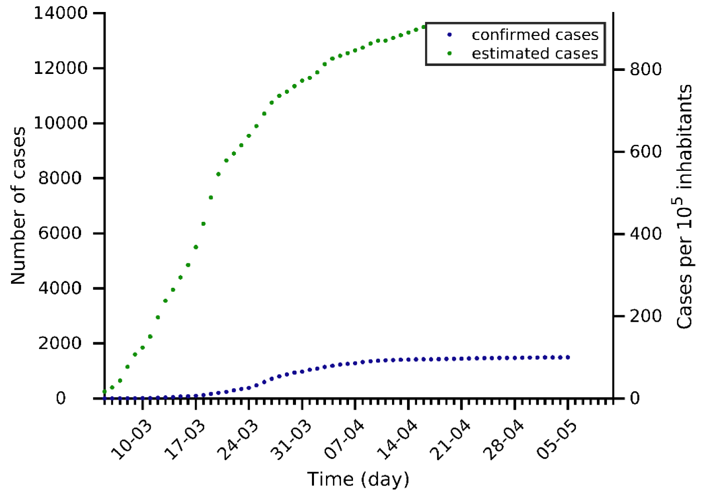


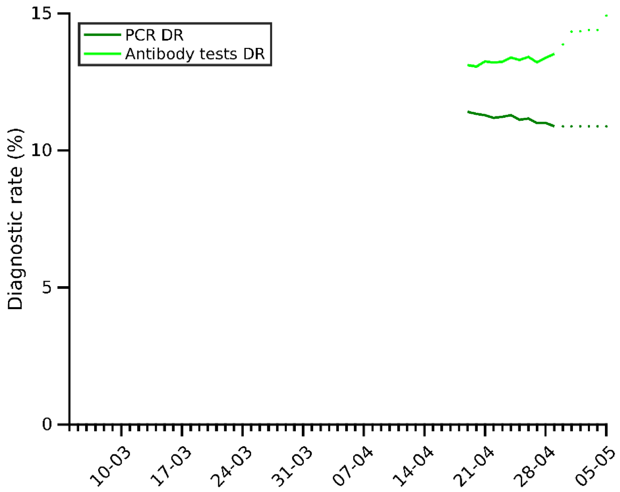
Baleares 05-05-2020. Population: 1.1M. Current cumulated incidence: 166/10^5

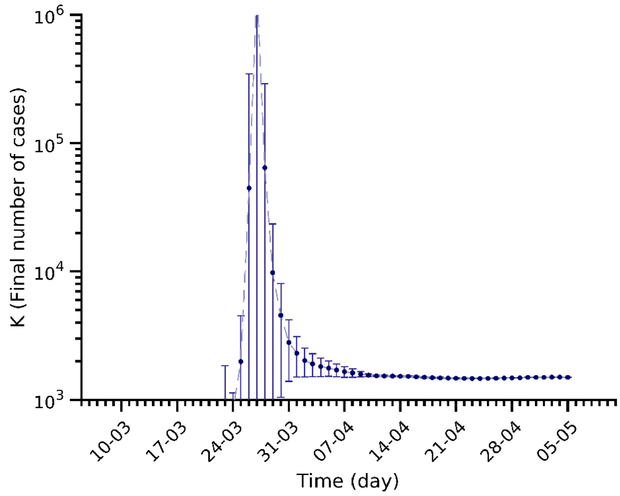


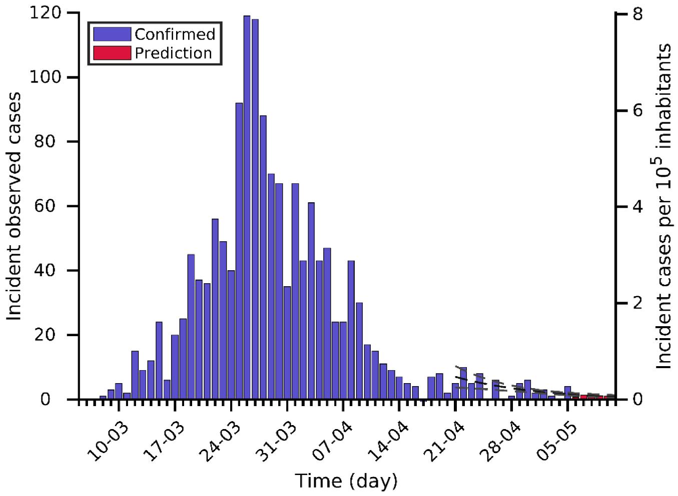
Murcia 05-05-2020. Population: 1.5M. Current cumulated incidence: 100/10⁵

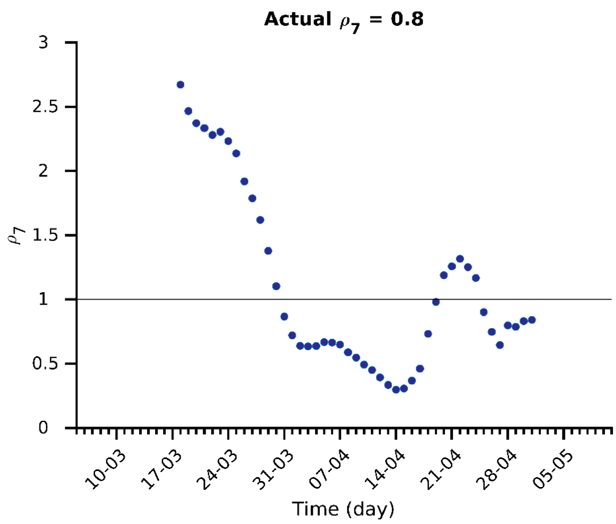


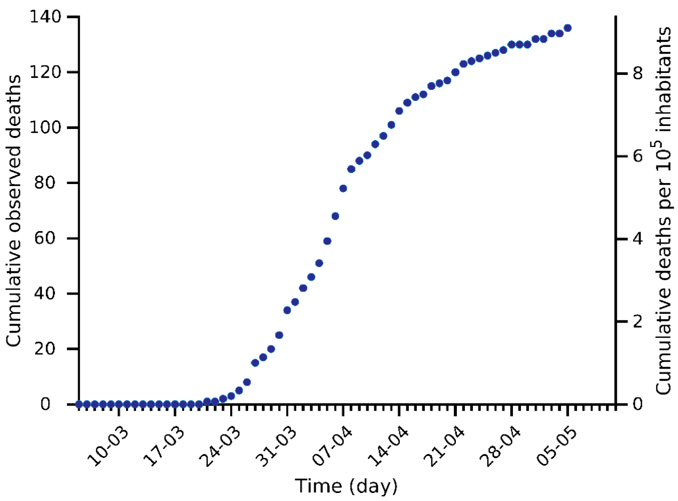


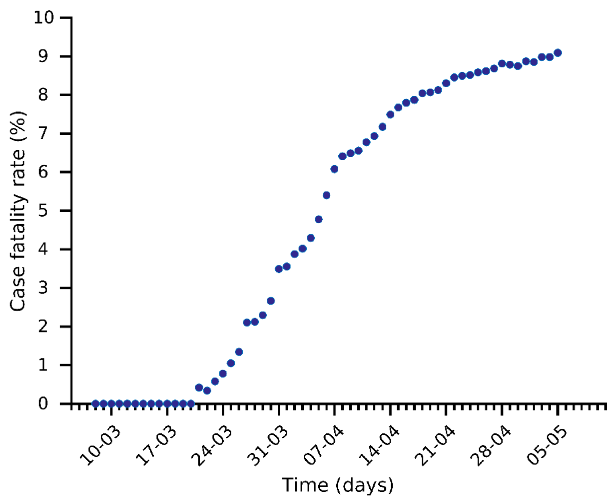








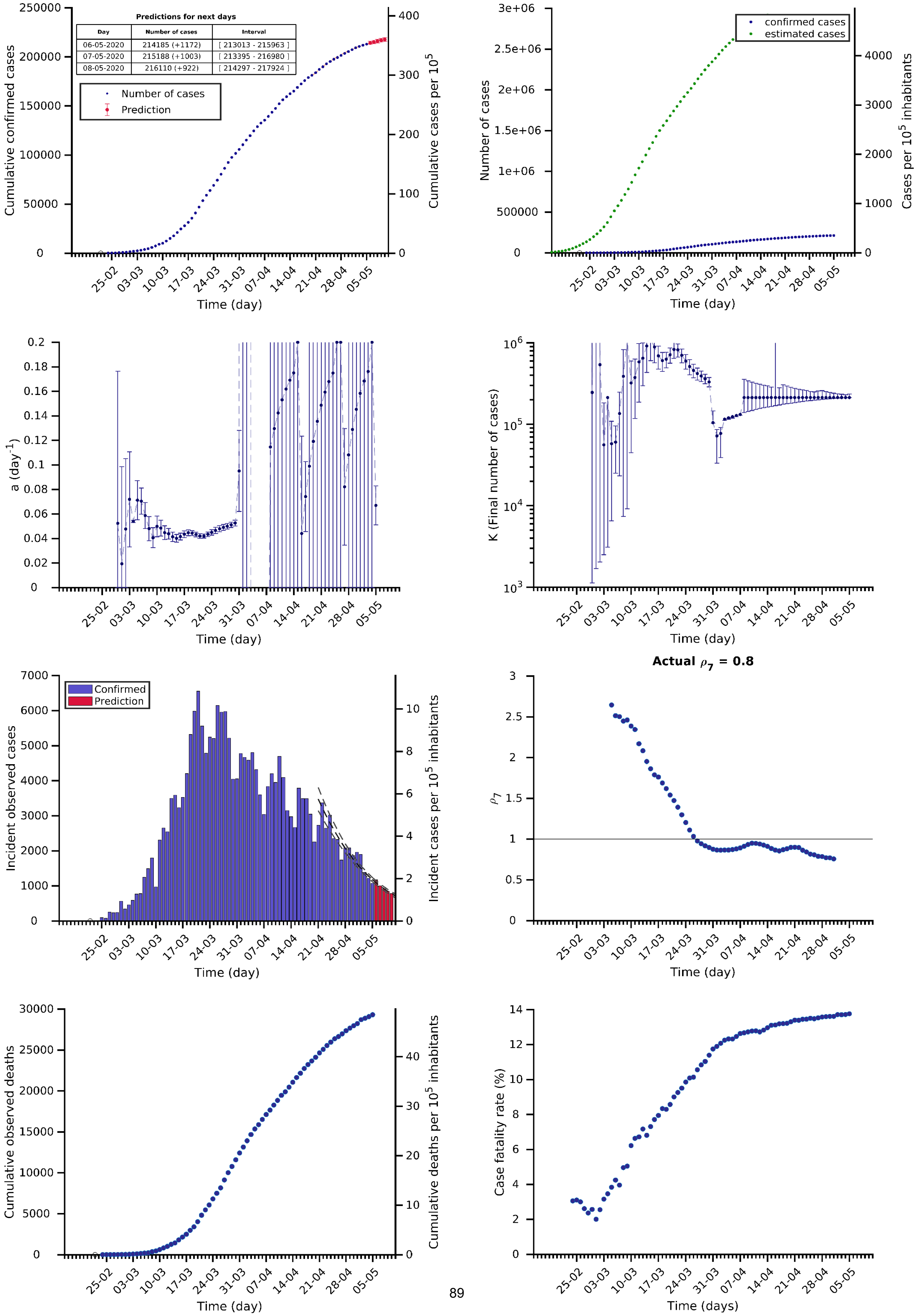




(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale

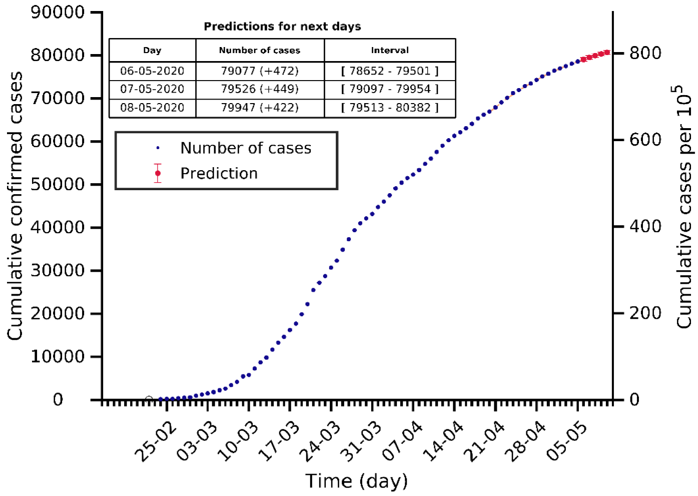
Italy 05-05-2020. Population: 60.5M. Current cumulated incidence: 352/10^5

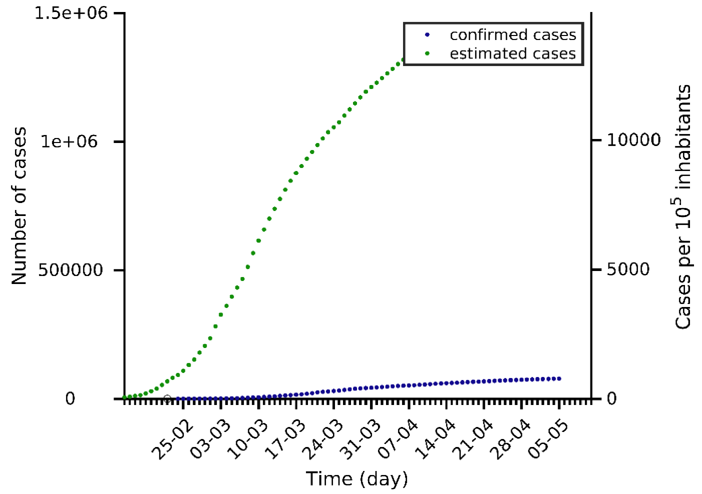


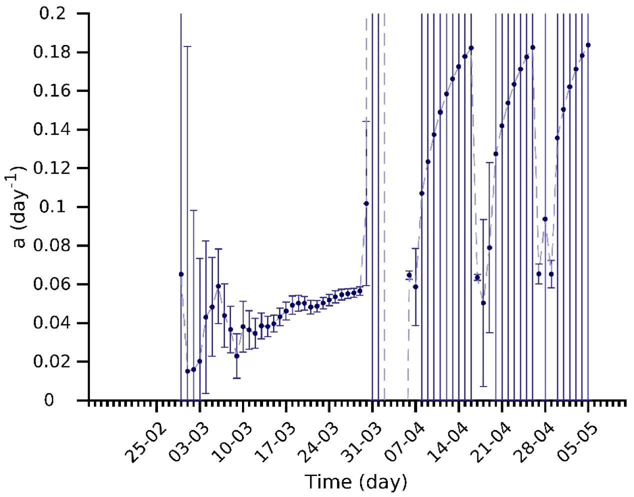
Predictions for next days

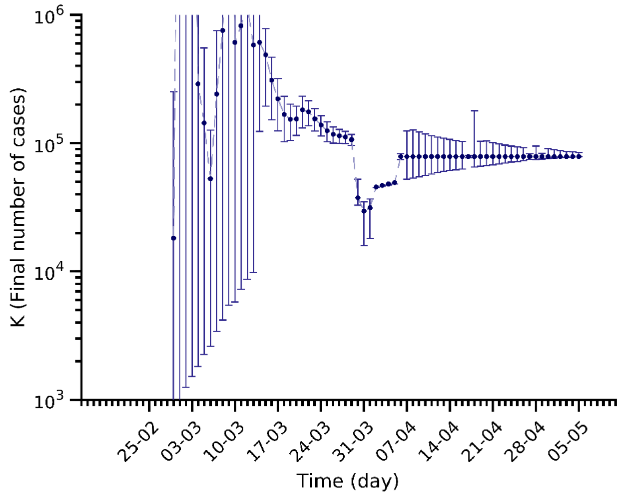
Day	Number of cases	Interval
06-05-2020	214185 (+1172)	[213013 - 215963]
07-05-2020	215188 (+1003)	[213395 - 216980]
08-05-2020	216110 (+922)	[214297 - 217924]

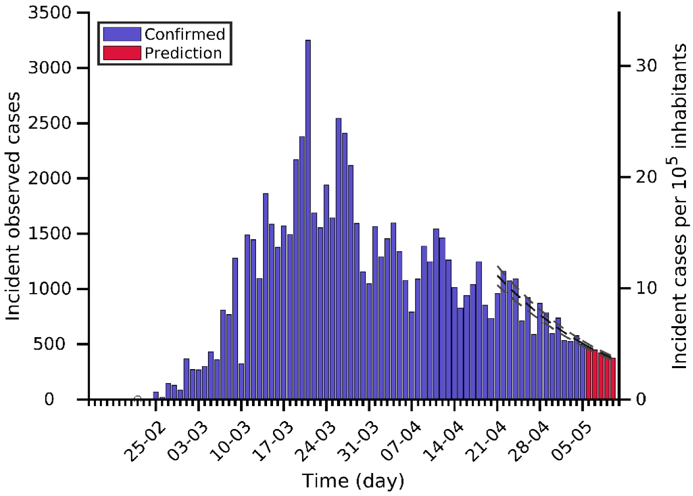
Lombardia 05-05-2020. Population: 10.1M. Current cumulated incidence: 781/10^5

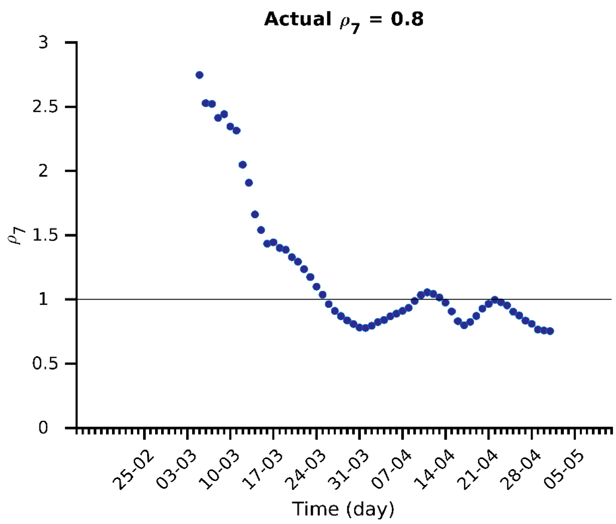


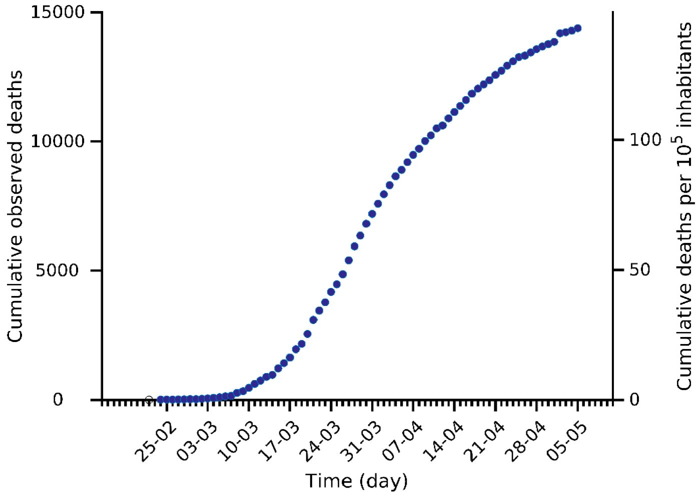


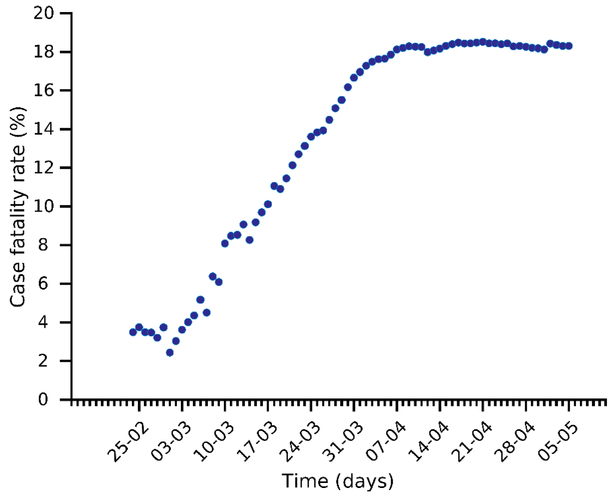




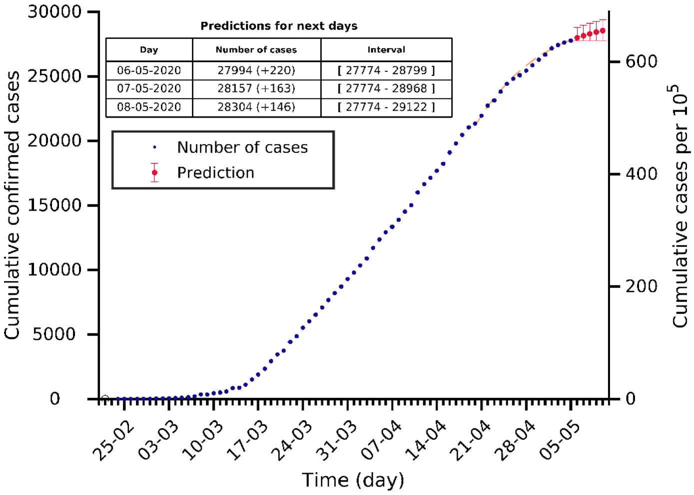


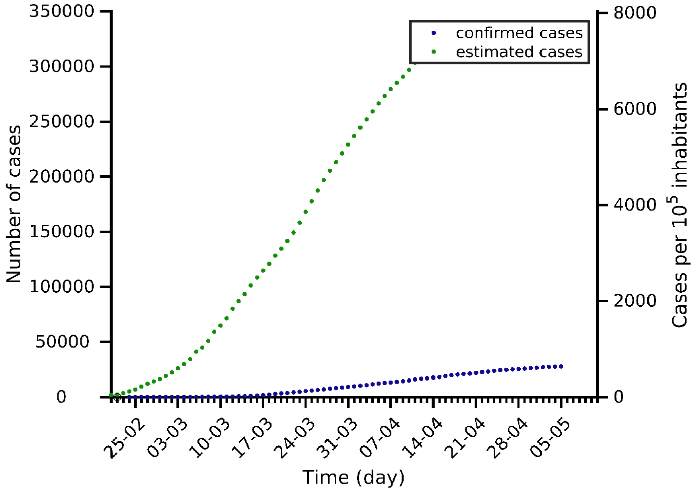


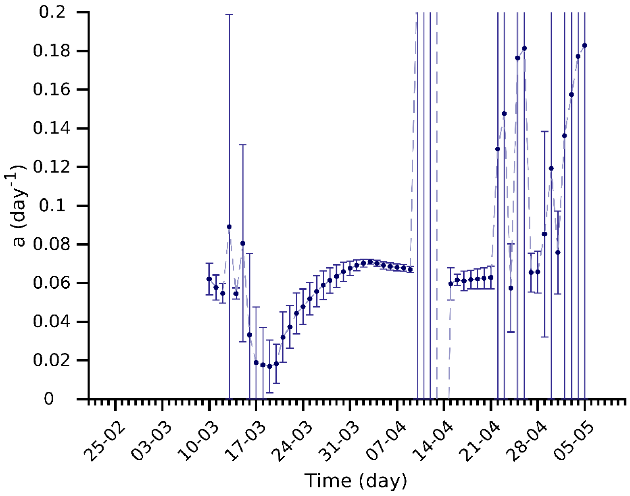


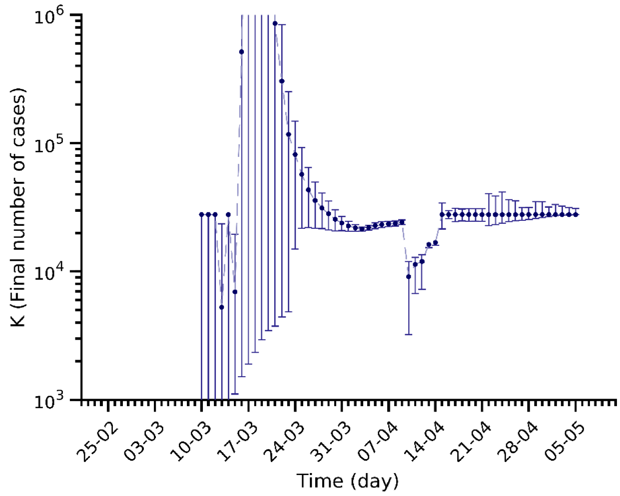


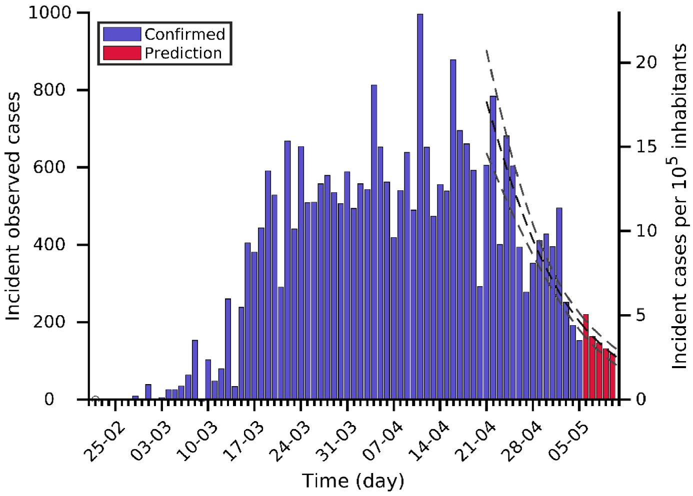
Piemonte 05-05-2020. Population: 4.4M. Current cumulated incidence: 638/10⁵

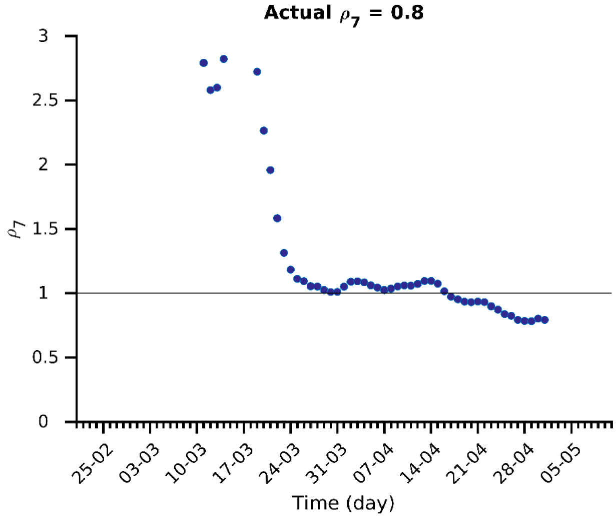


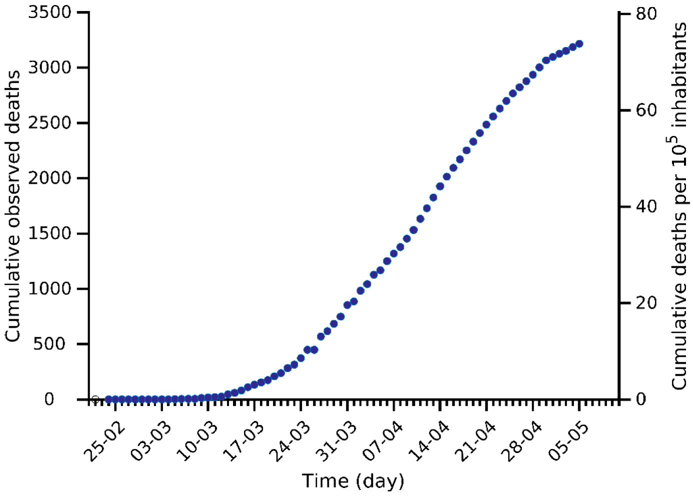


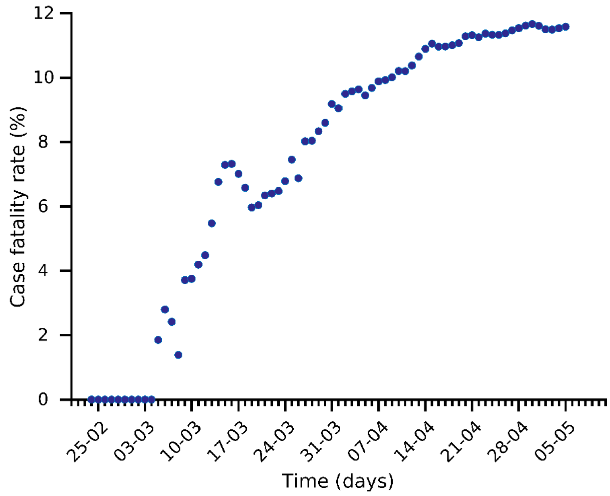




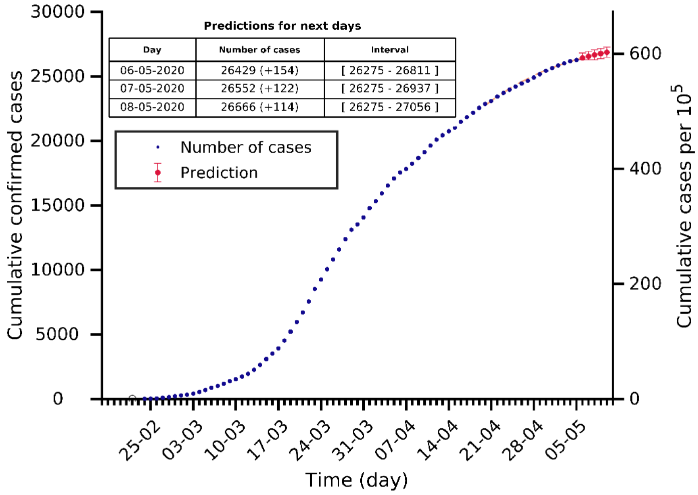


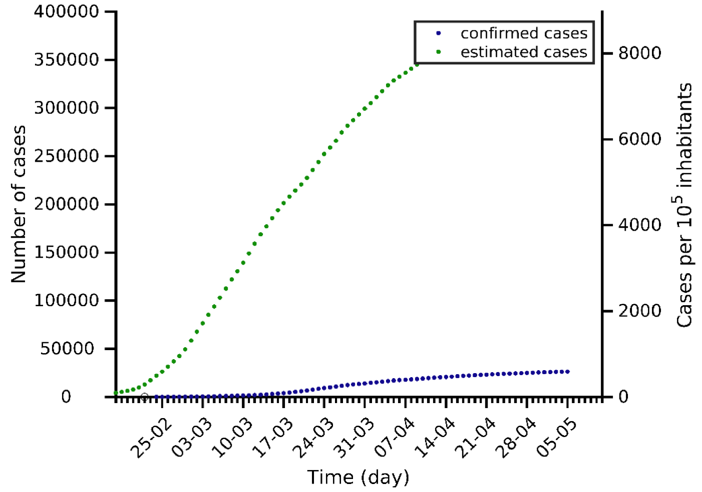


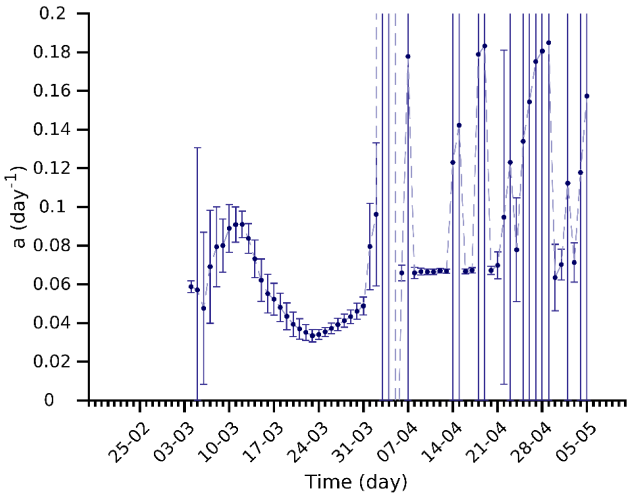


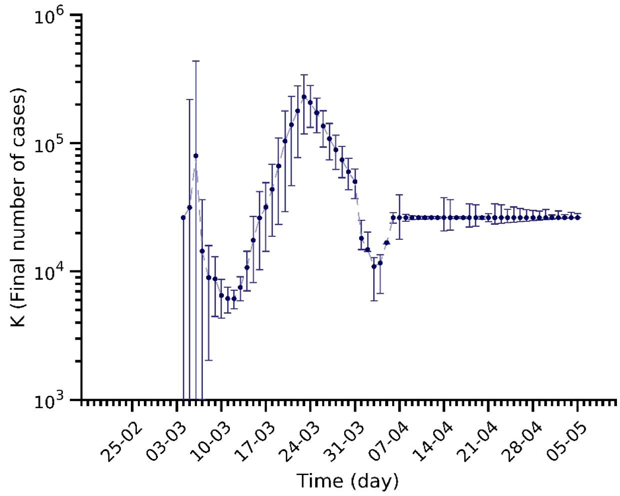


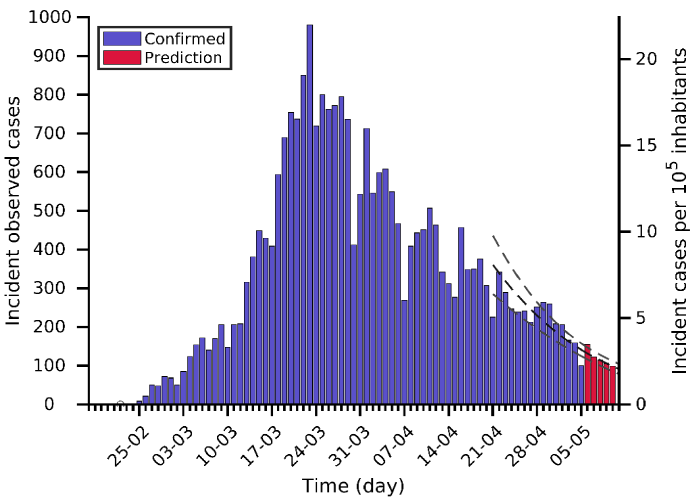
Emilia Romagna 05-05-2020. Population: 4.5M. Current cumulated incidence: 589/1

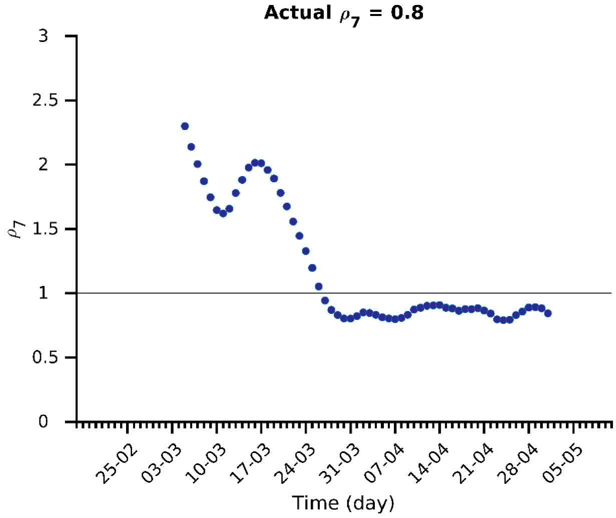


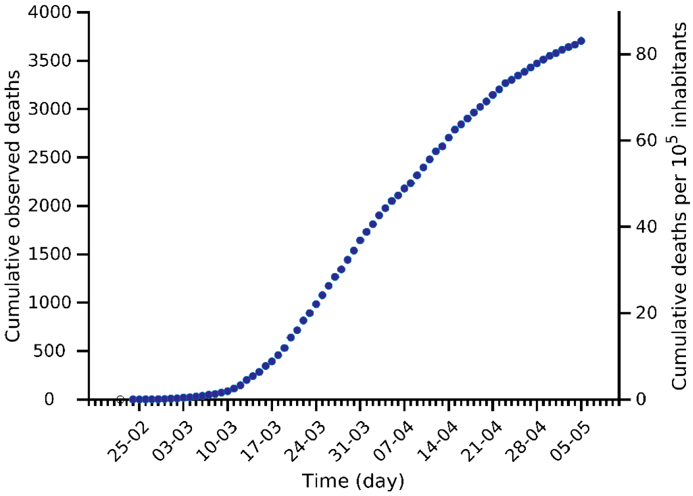


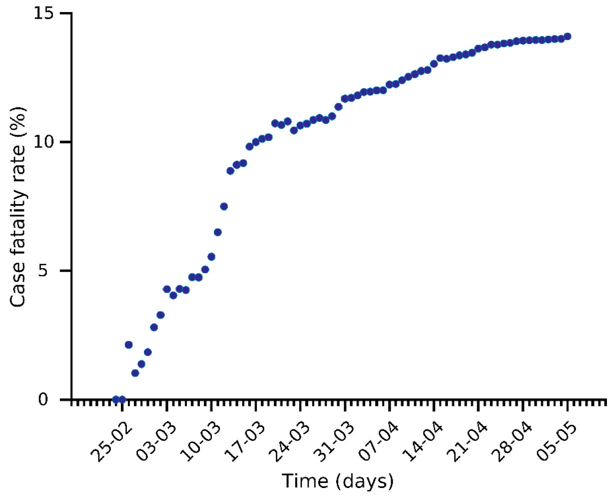




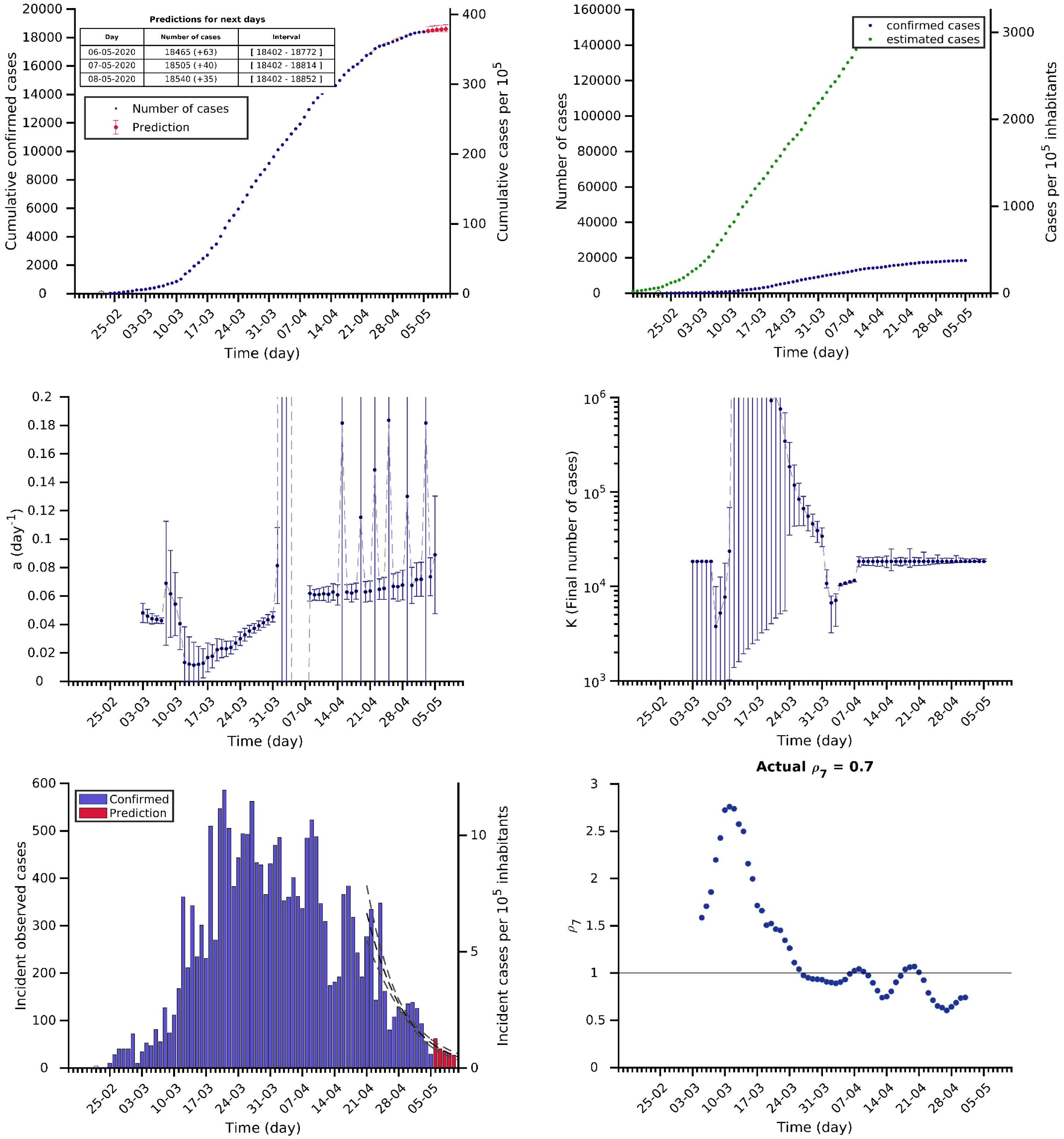


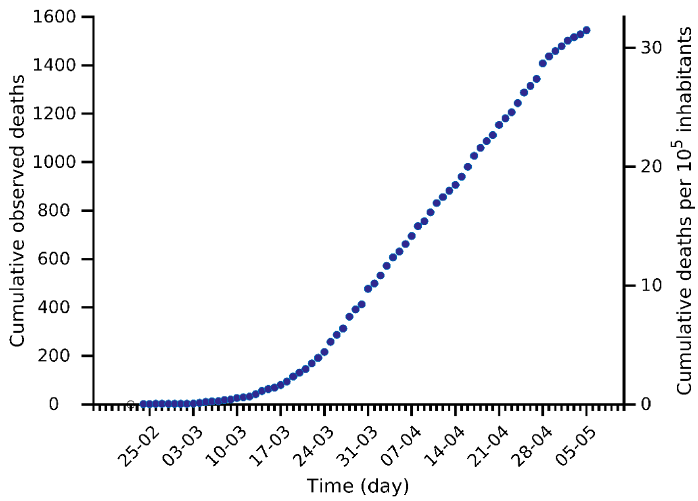


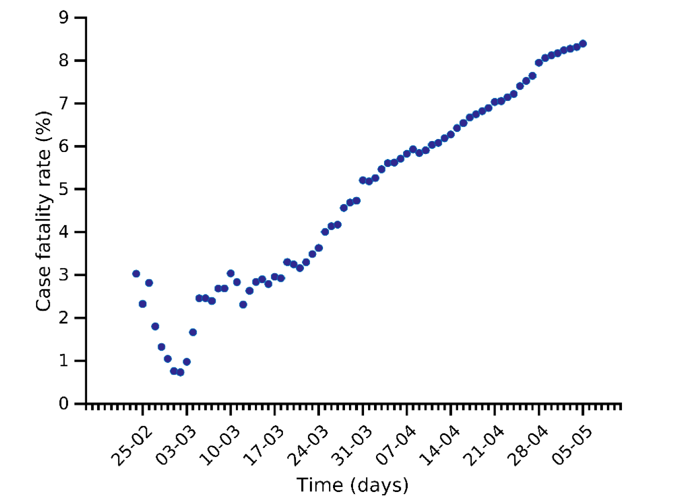




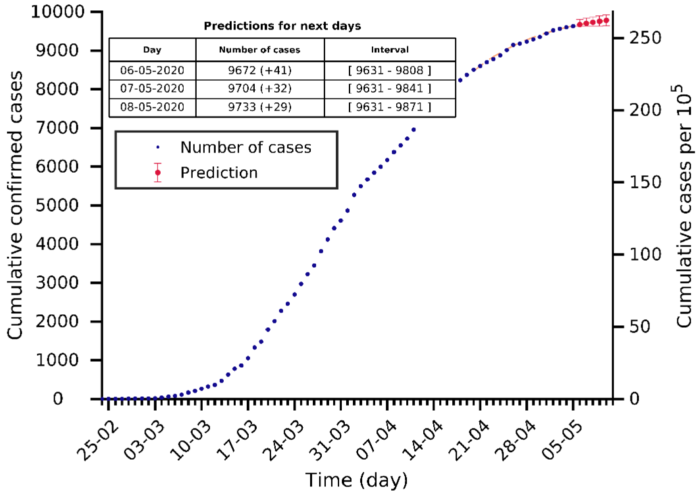
Veneto 05-05-2020. Population: 4.9M. Current cumulated incidence: 375/10^5



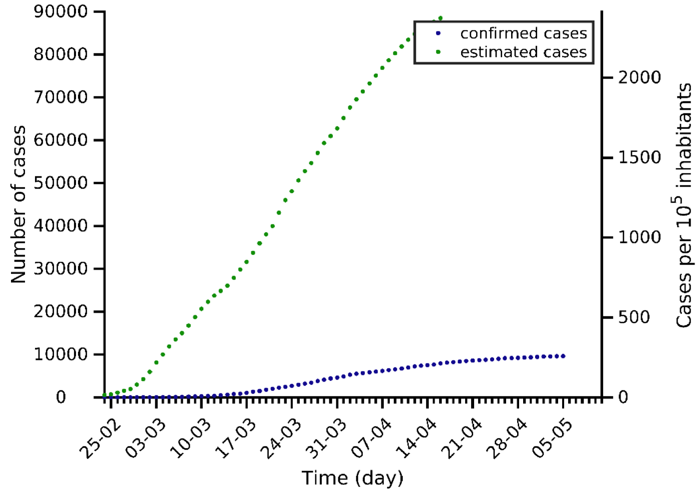


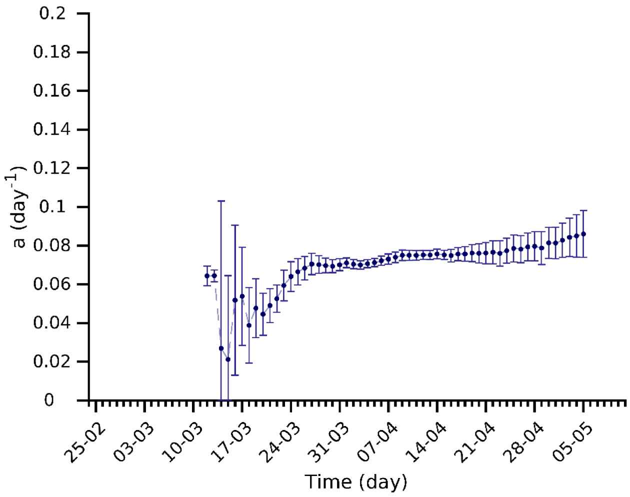


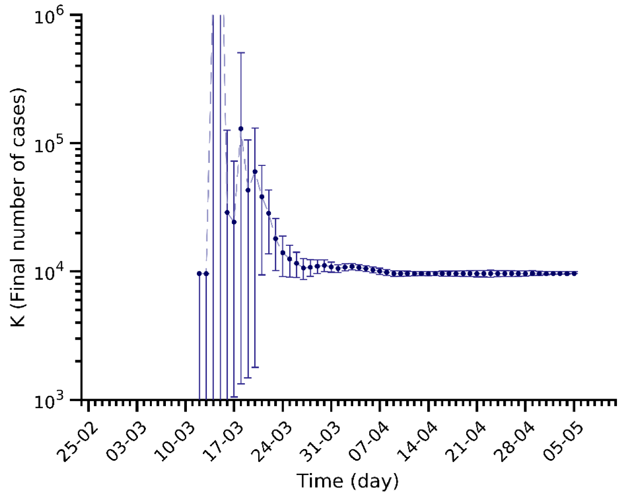
Toscana 05-05-2020. Population: 3.7M. Current cumulated incidence: 258/10^5

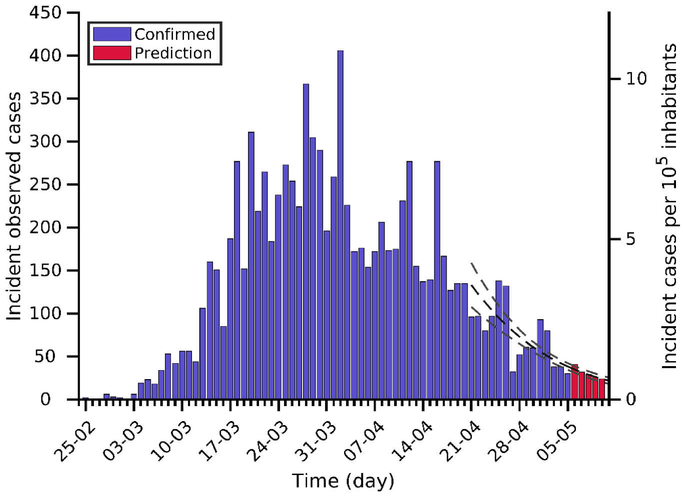


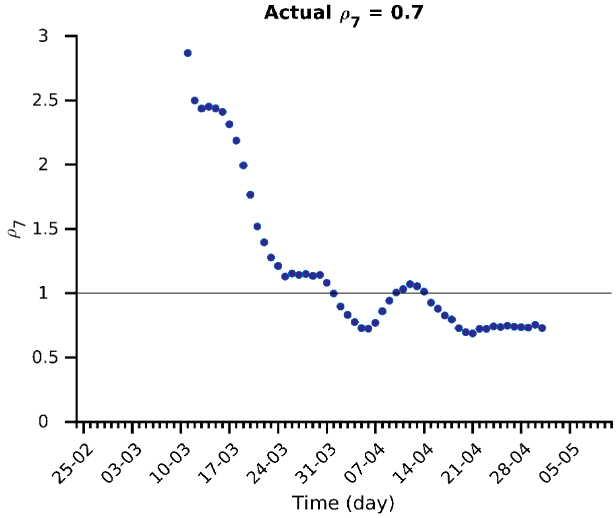
Day	Number of cases	Interval
06-05-2020	9672 (+41)	[9631 - 9808]
07-05-2020	9704 (+32)	[9631 - 9841]
08-05-2020	9733 (+29)	[9631 - 9871]

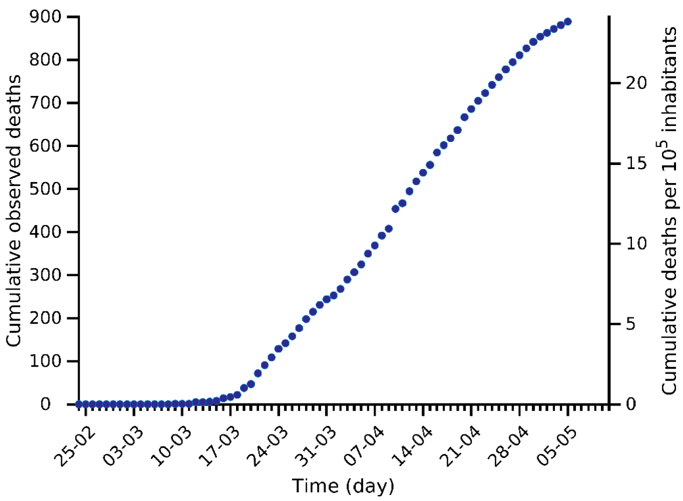


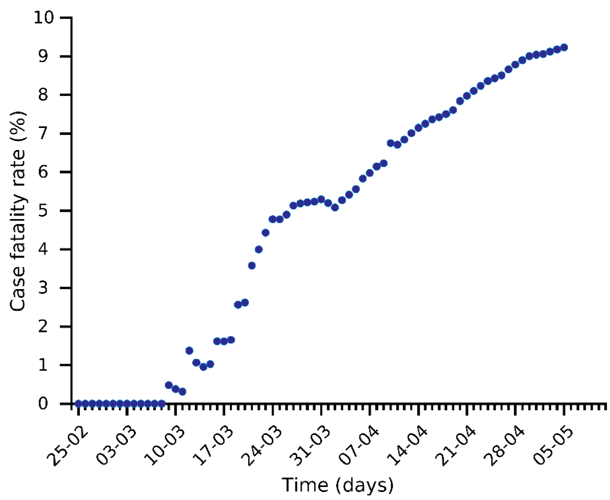




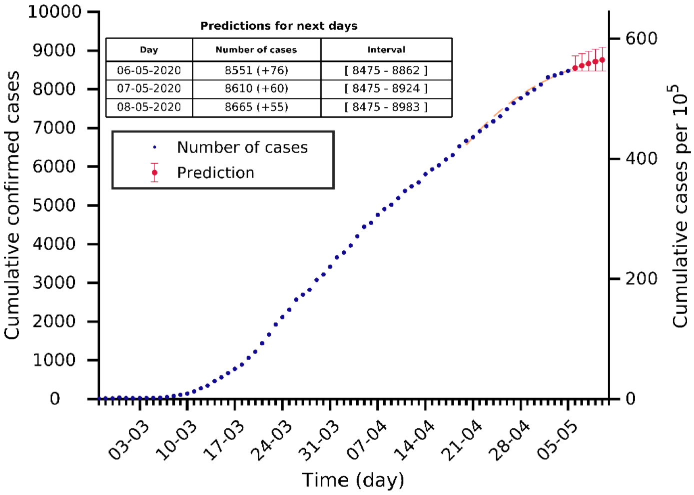


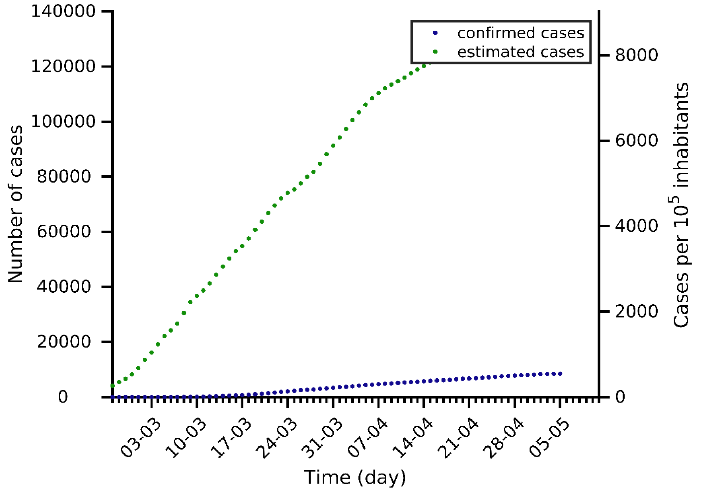


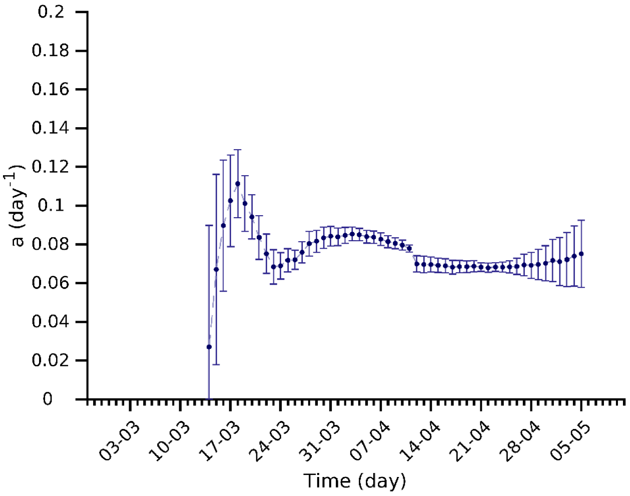


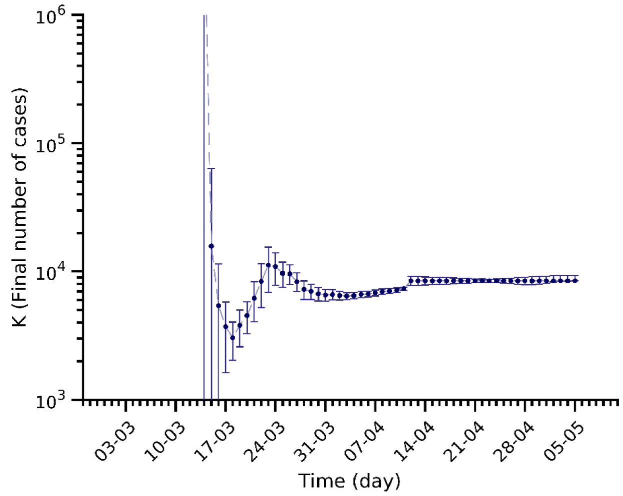


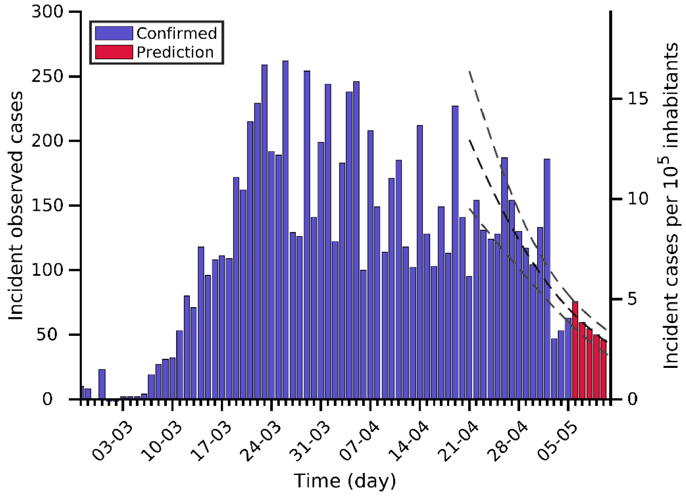
Liguria 05-05-2020. Population: 1.6M. Current cumulated incidence: 546/10⁵

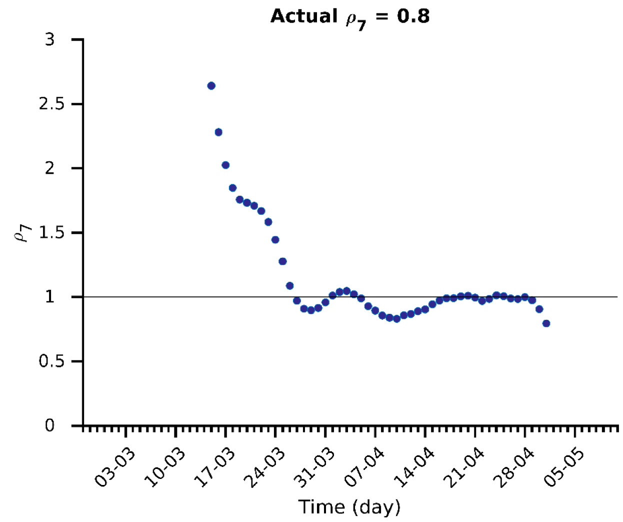


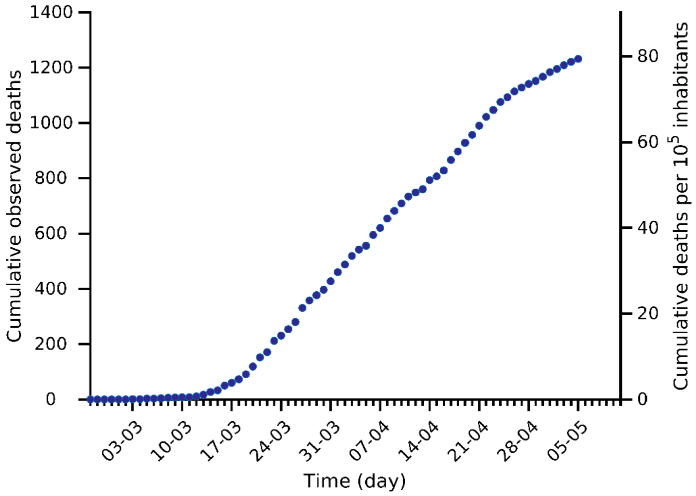


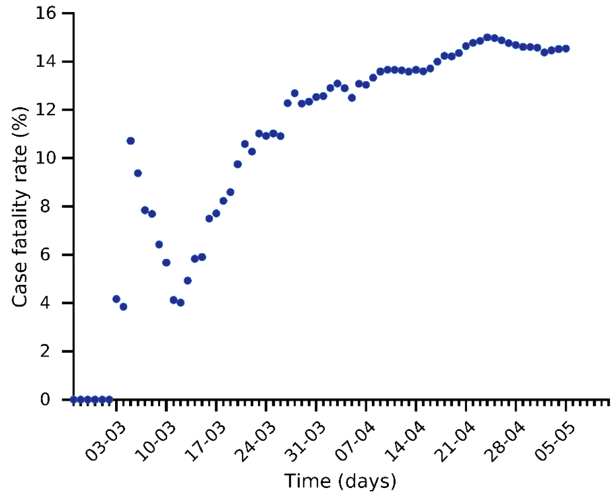




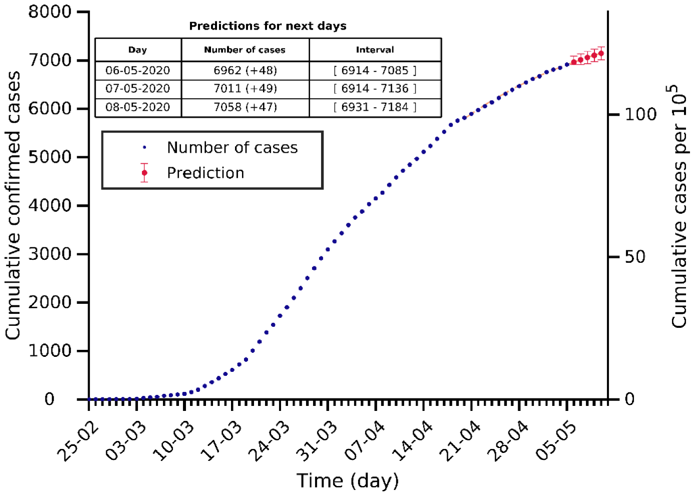


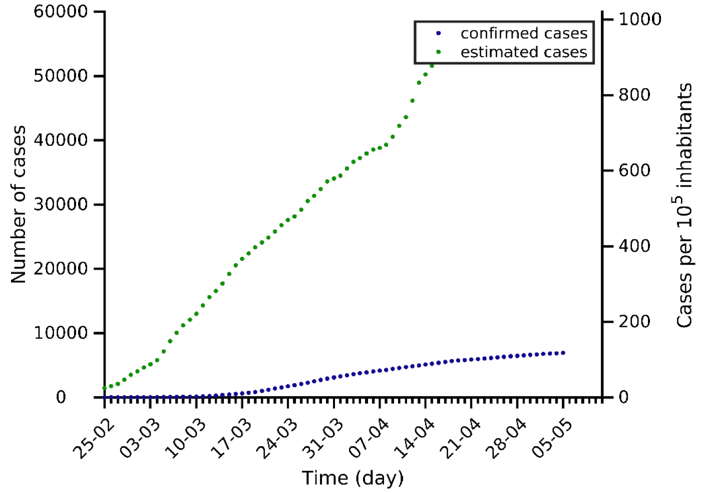


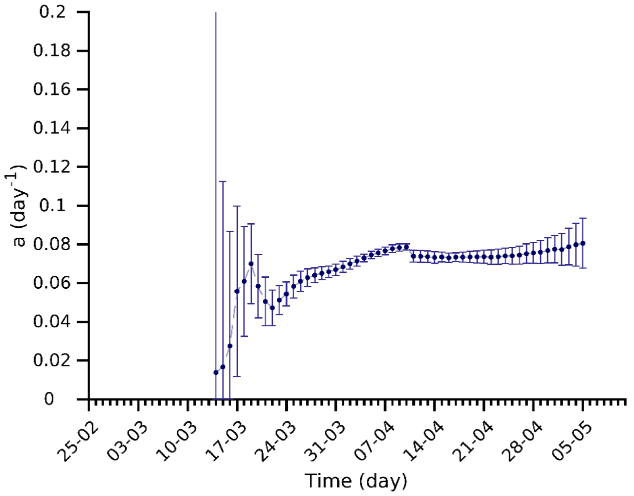


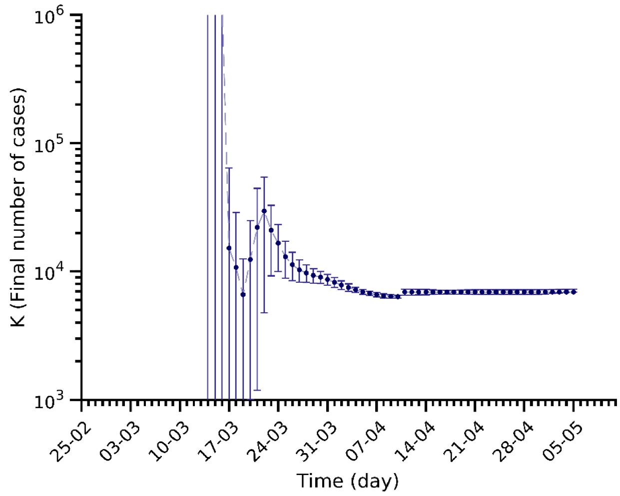


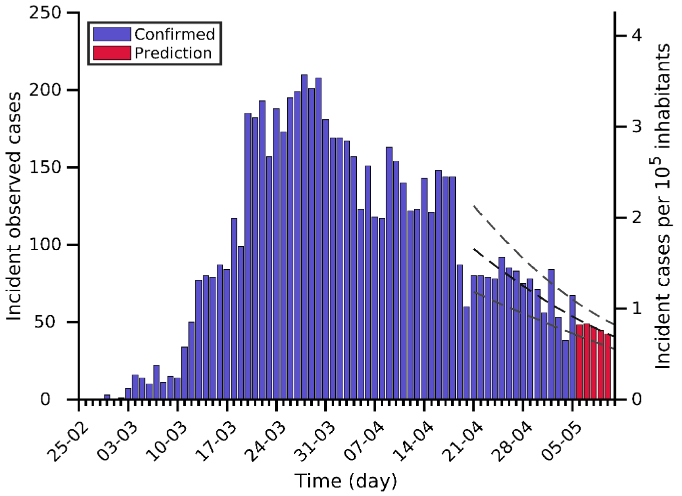
Lazio 05-05-2020. Population: 5.9M. Current cumulated incidence: 118/10⁵

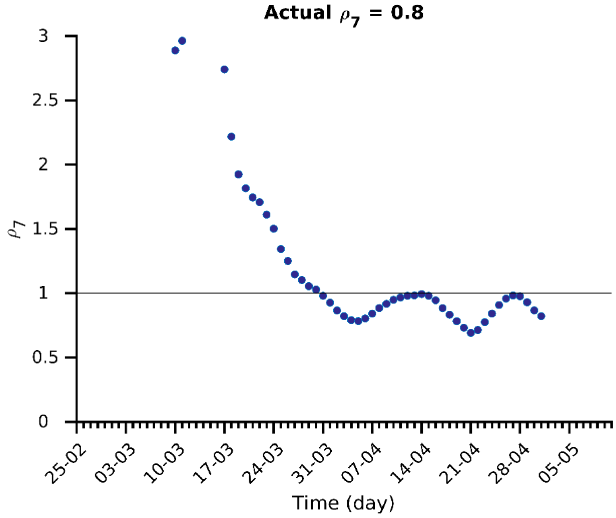


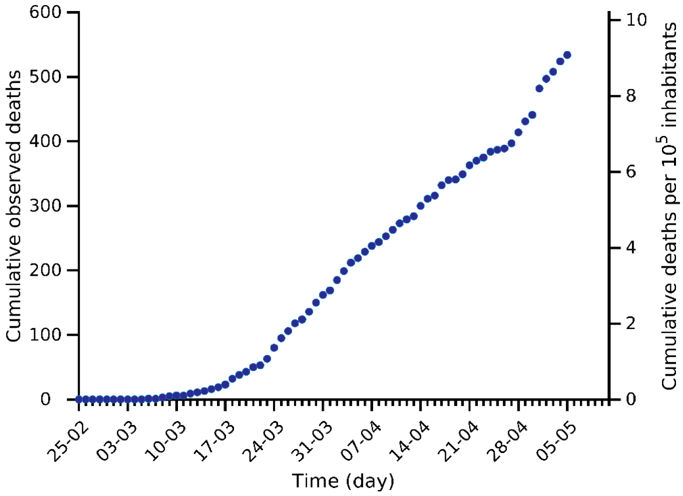


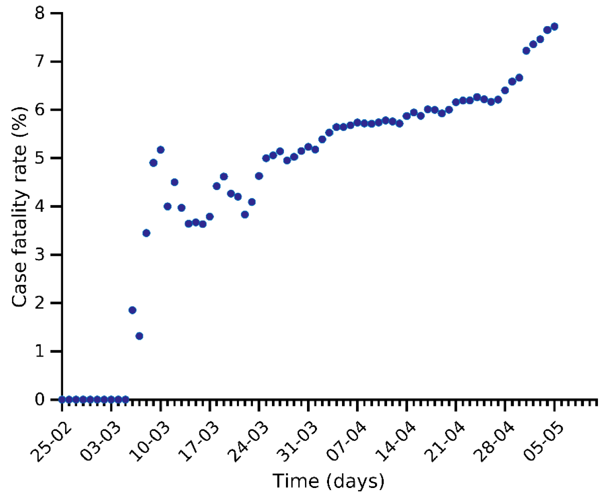




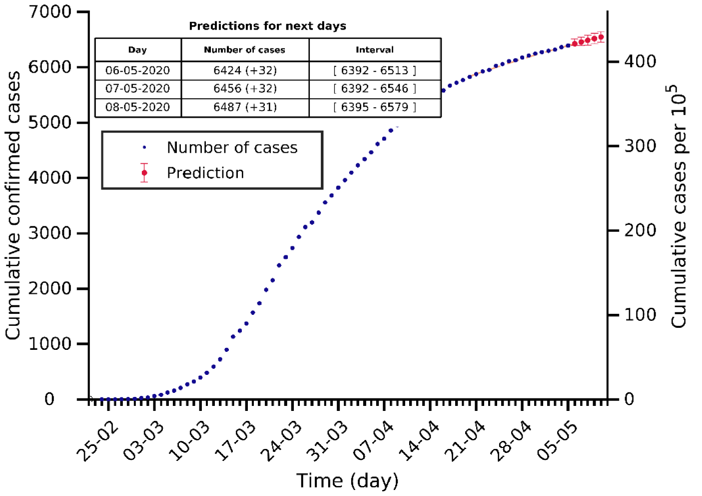


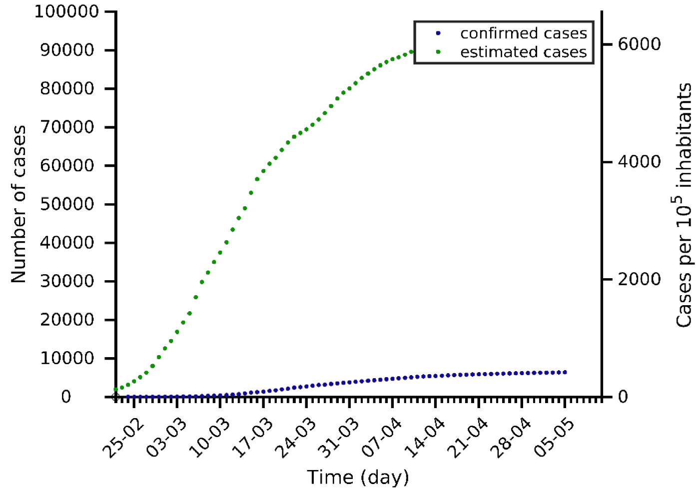


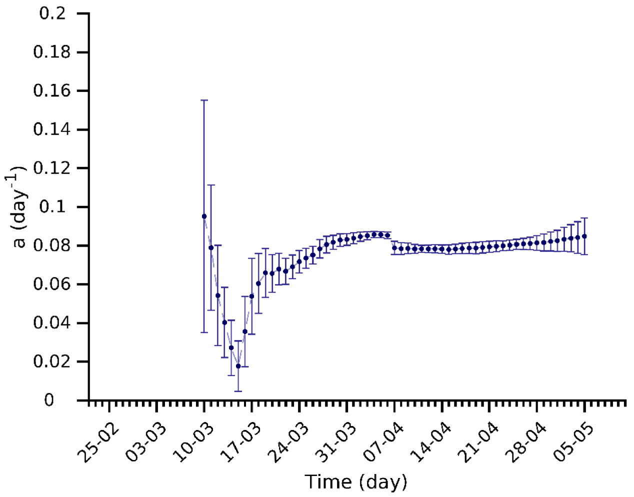


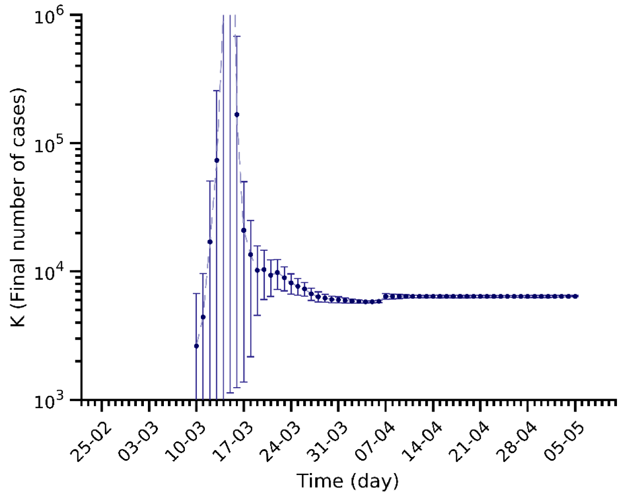


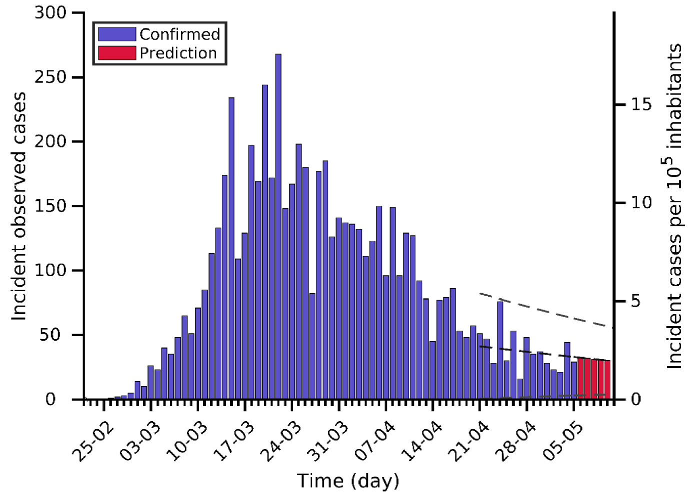
Marche 05-05-2020. Population: 1.5M. Current cumulated incidence: 419/10⁵

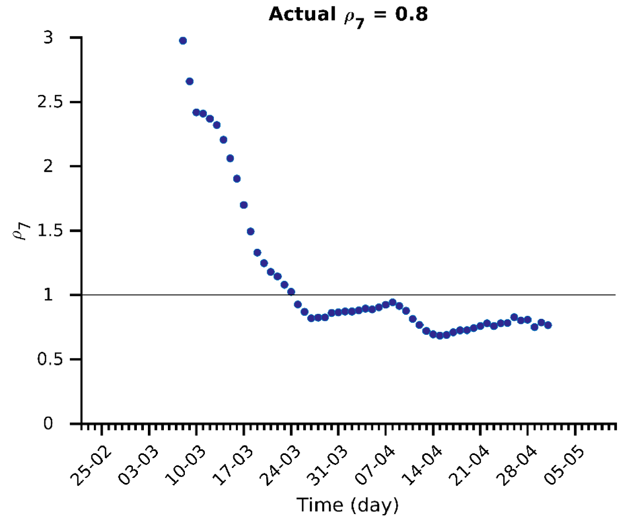


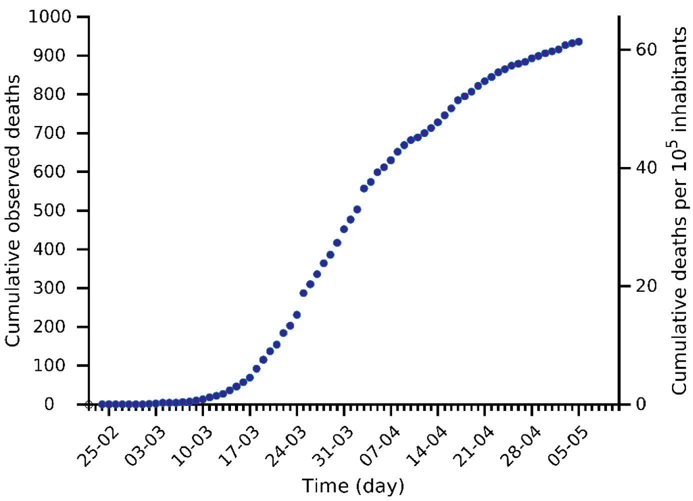


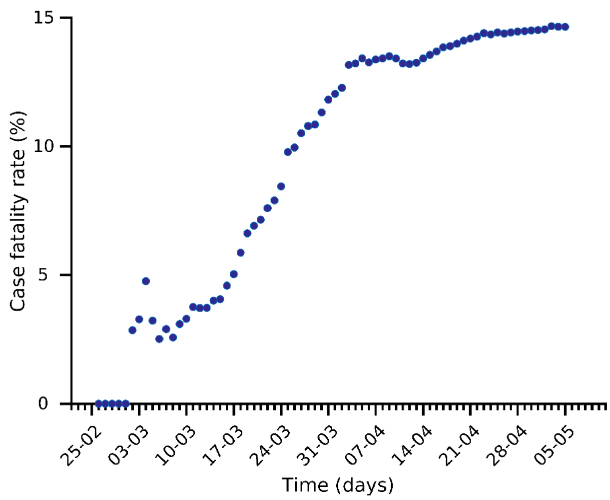




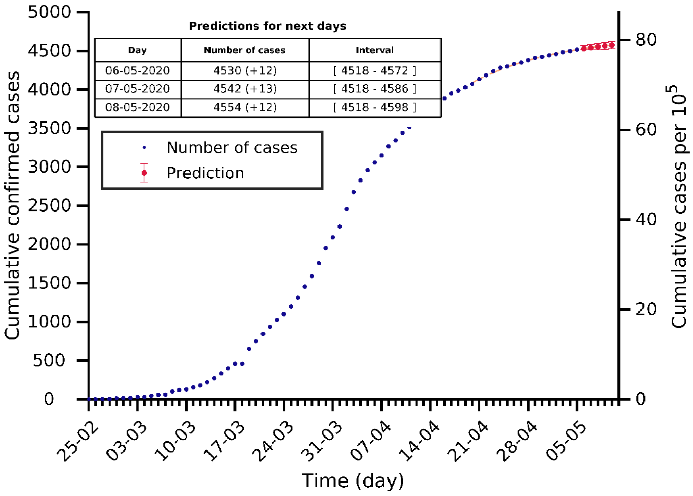


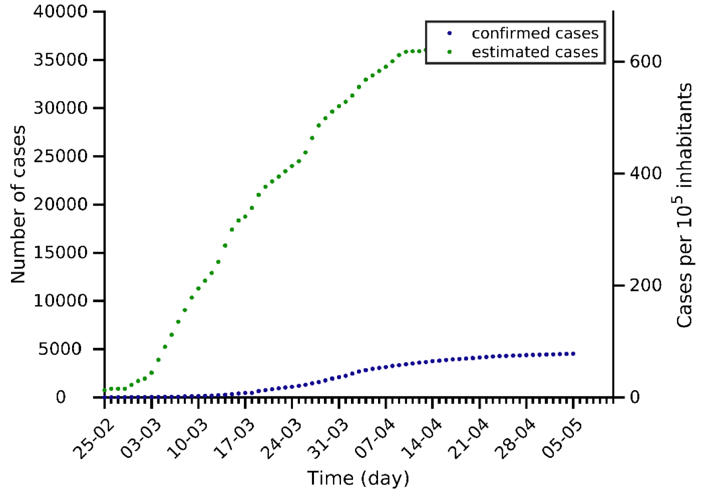


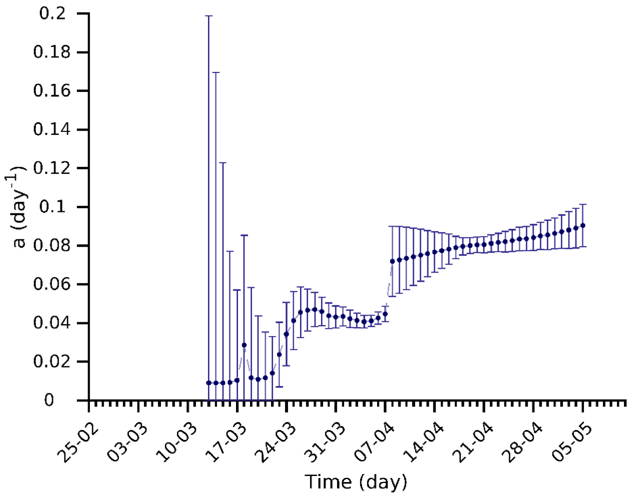


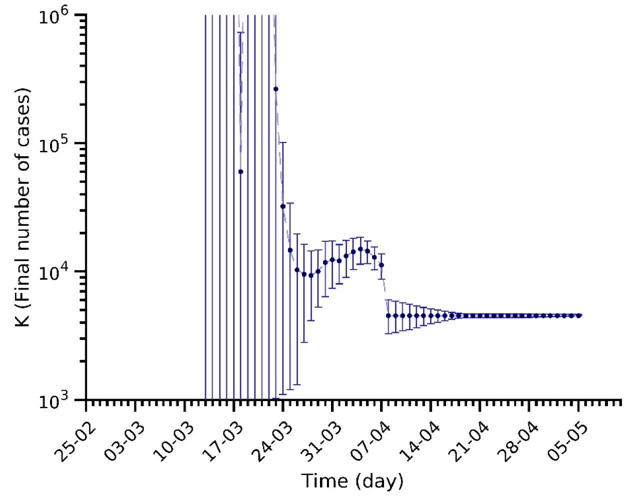


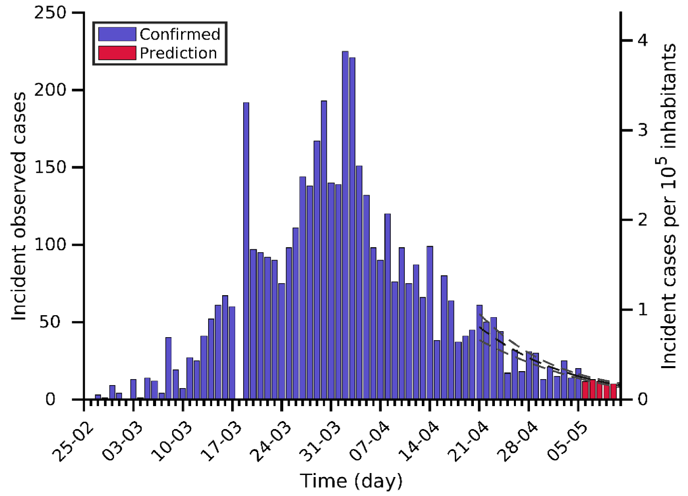
Campania 05-05-2020. Population: 5.8M. Current cumulated incidence: 78/10⁵

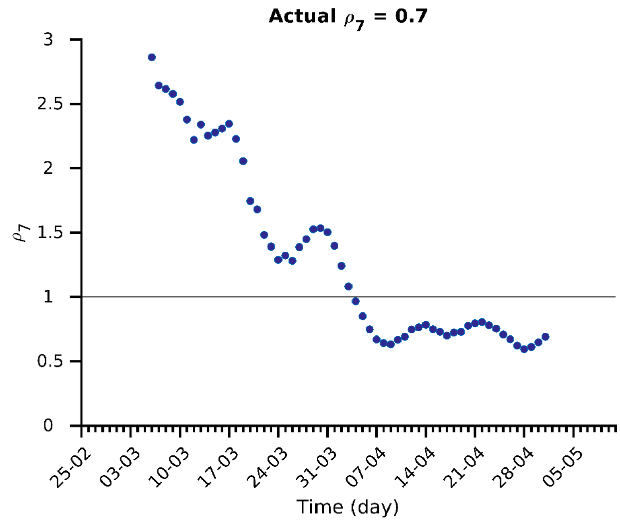


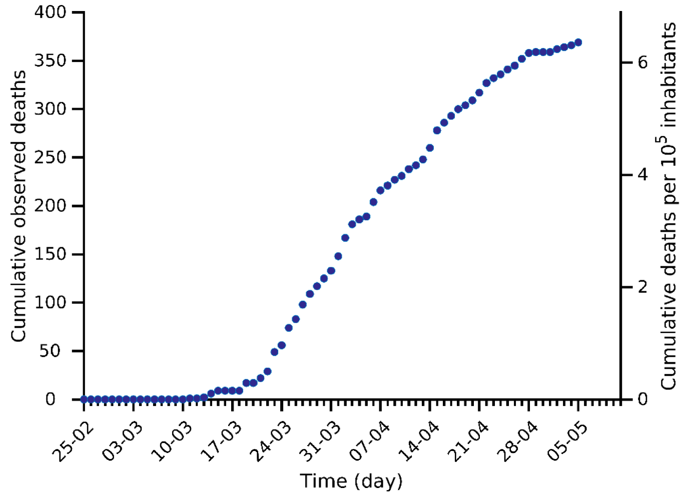


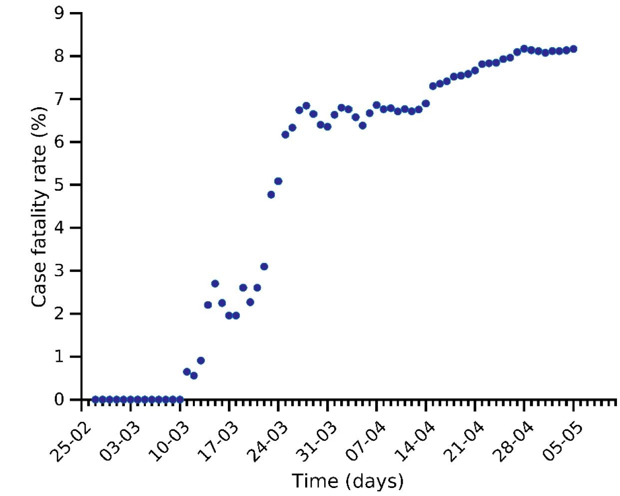




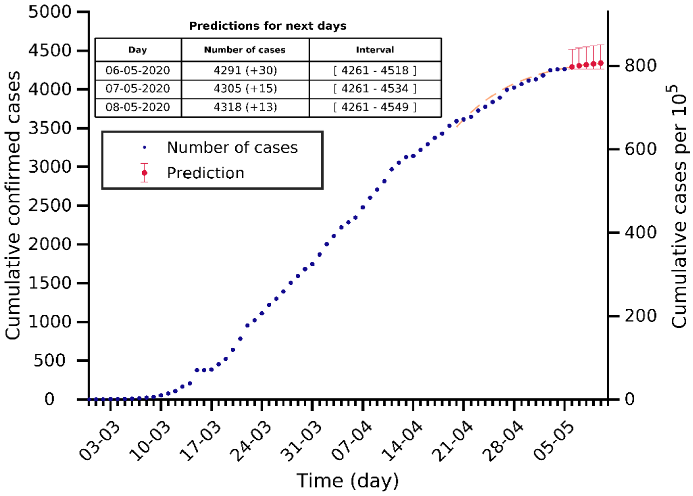


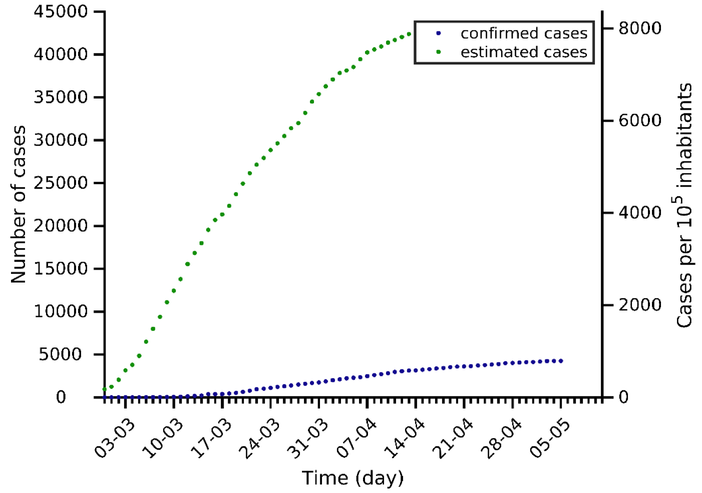


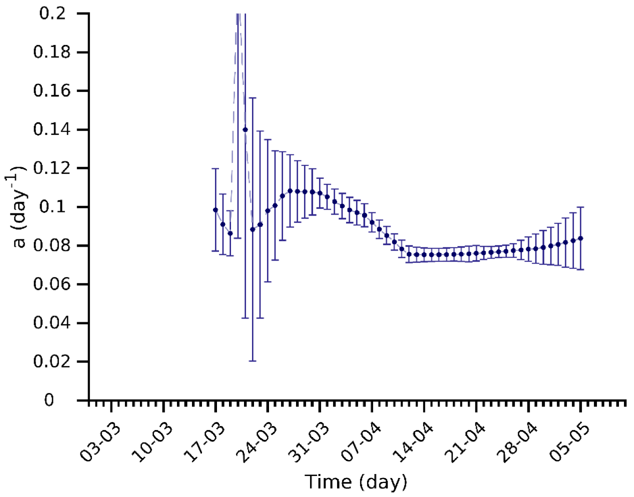


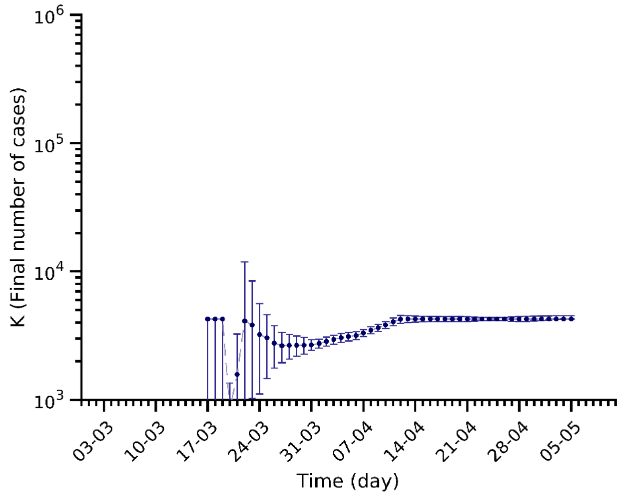


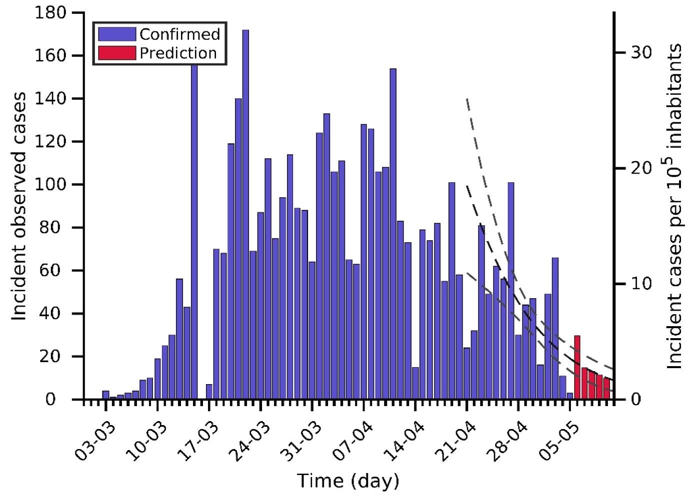
Trento 05-05-2020. Population: 0.5M. Current cumulated incidence: 792/10^5

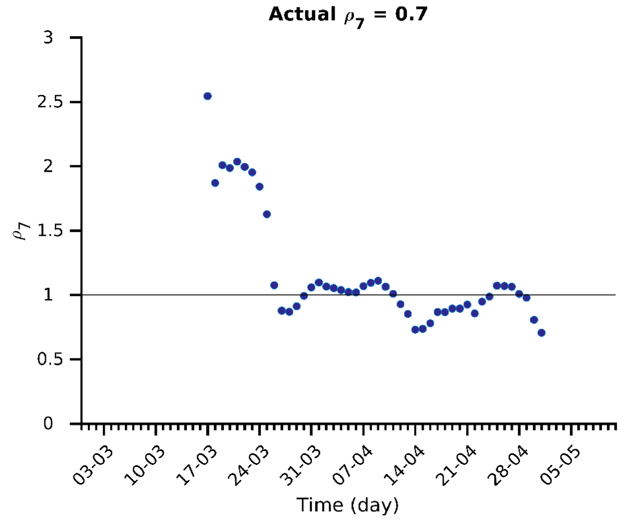


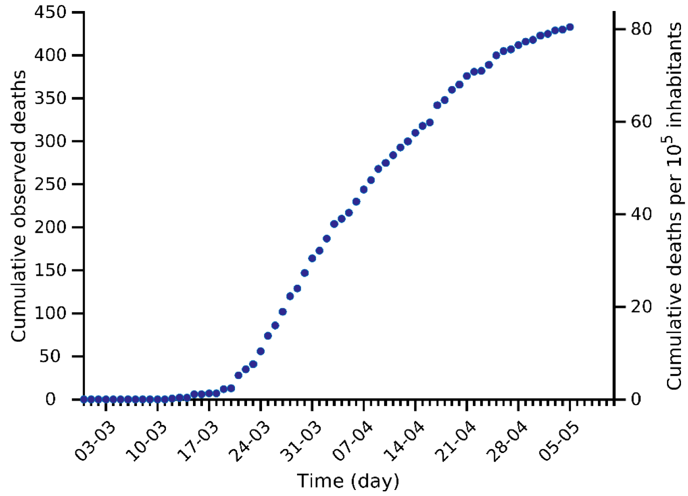


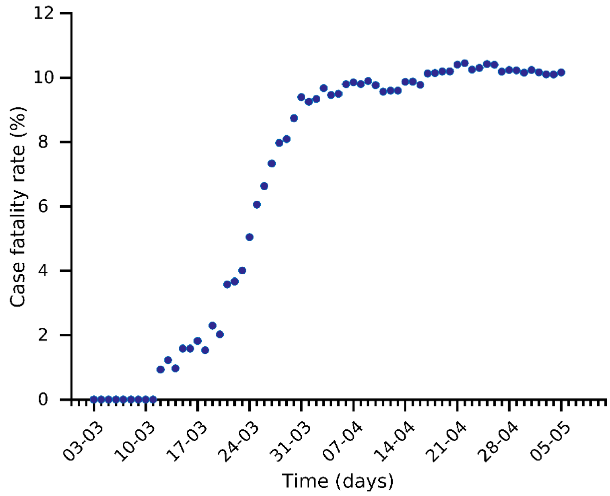




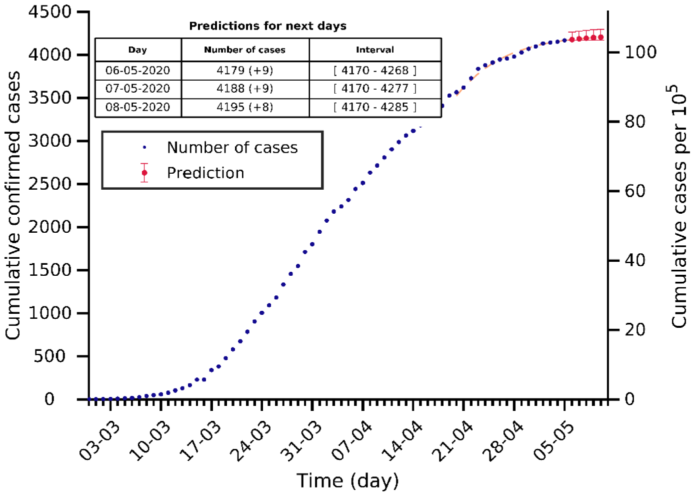


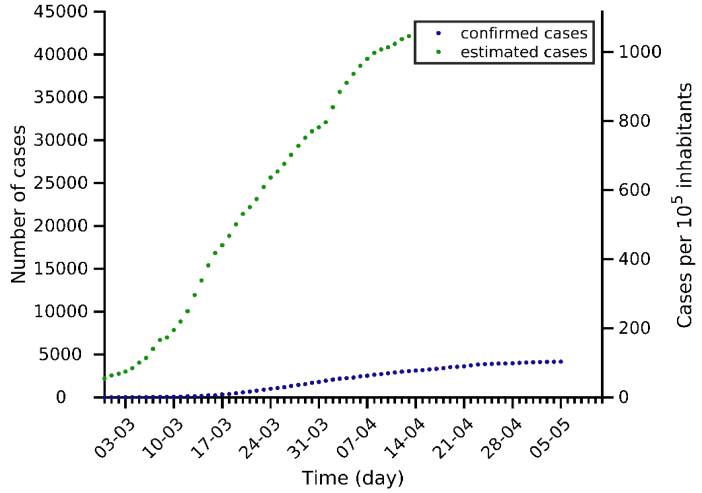


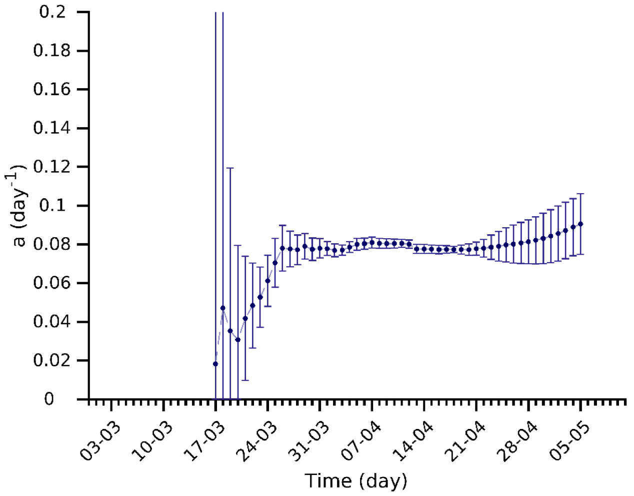


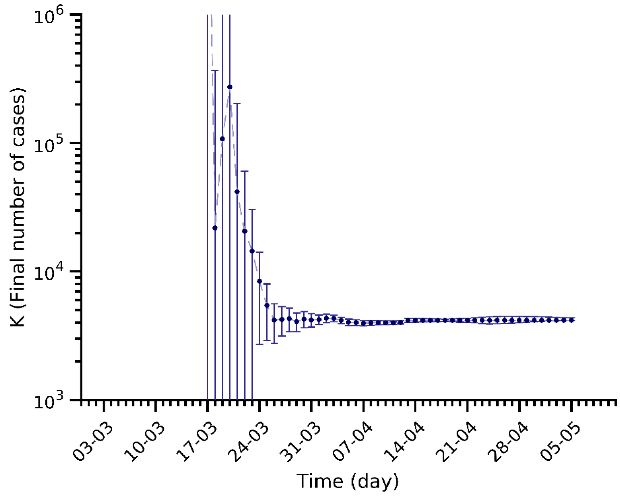


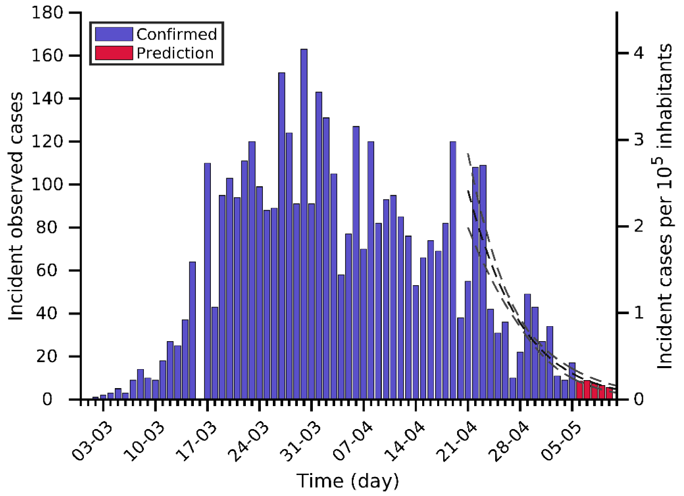
Puglia 05-05-2020. Population: 4.0M. Current cumulated incidence: 103/10⁵

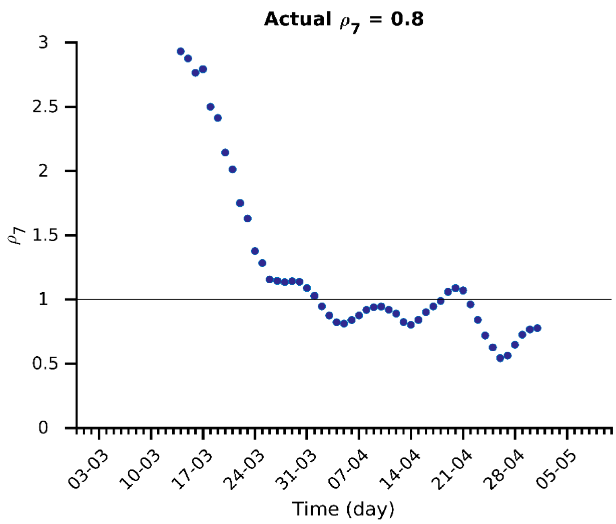


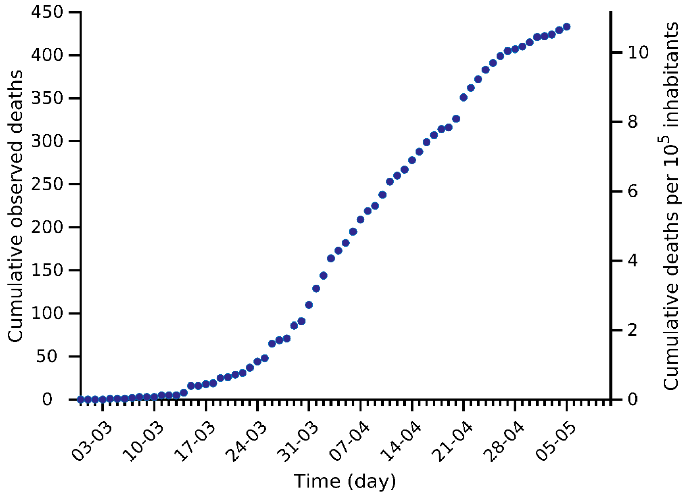


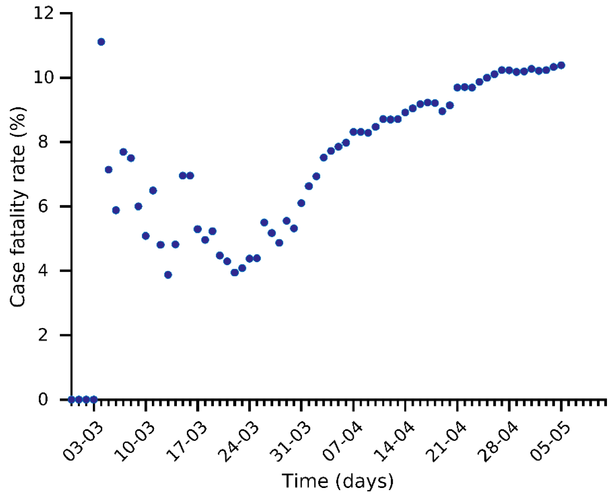




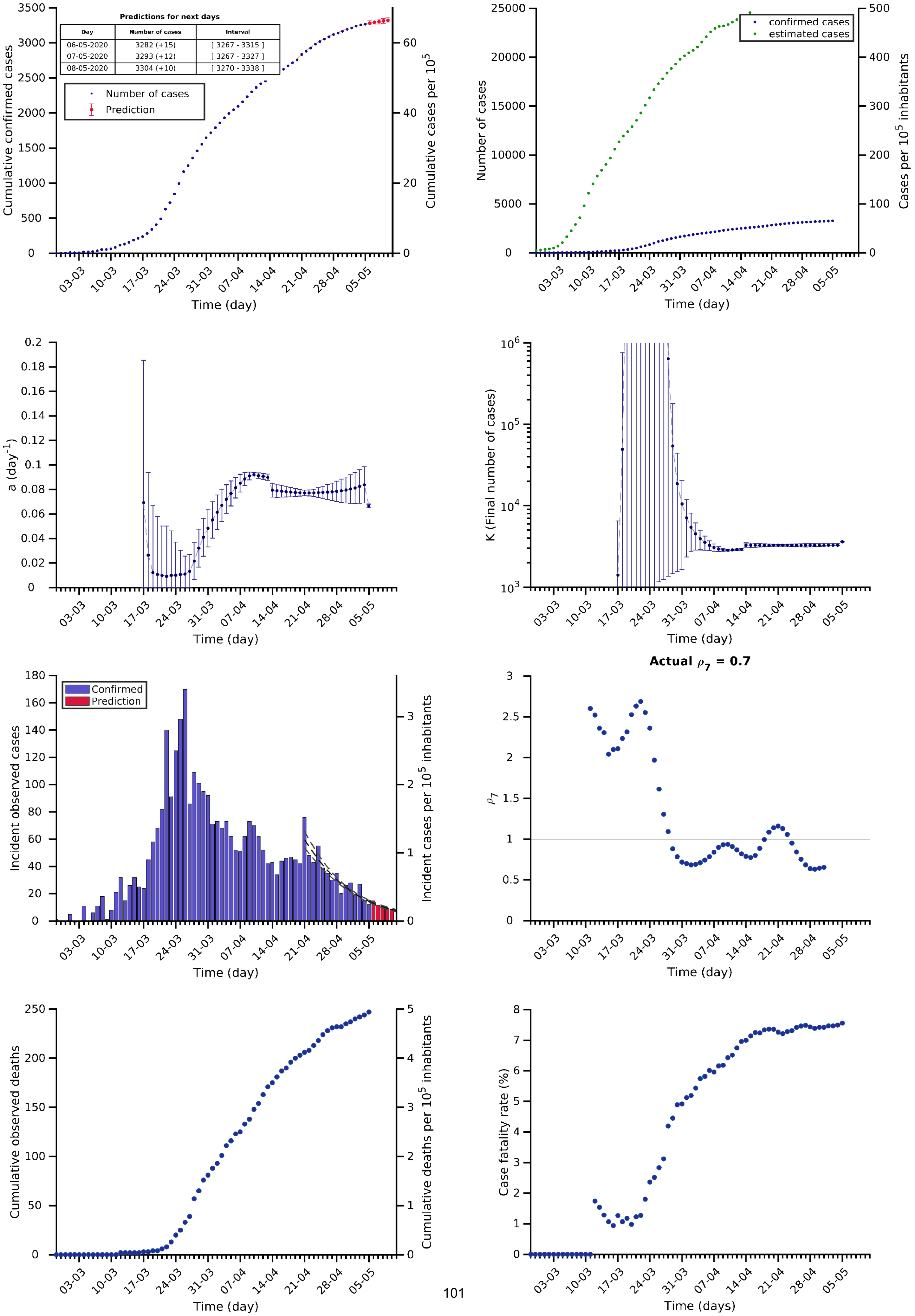








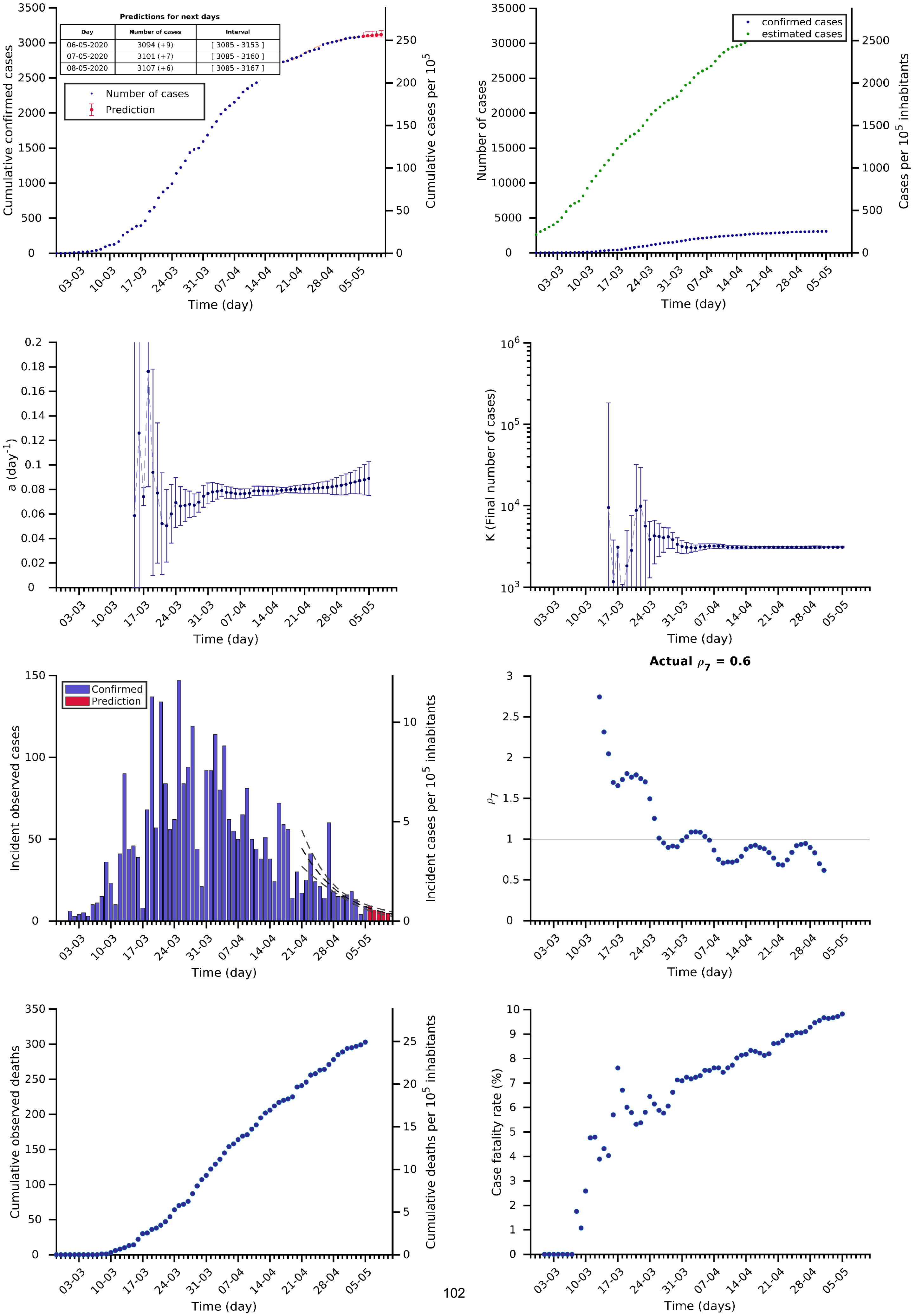
Sicilia 05-05-2020. Population: 5.0M. Current cumulated incidence: 65/10⁵



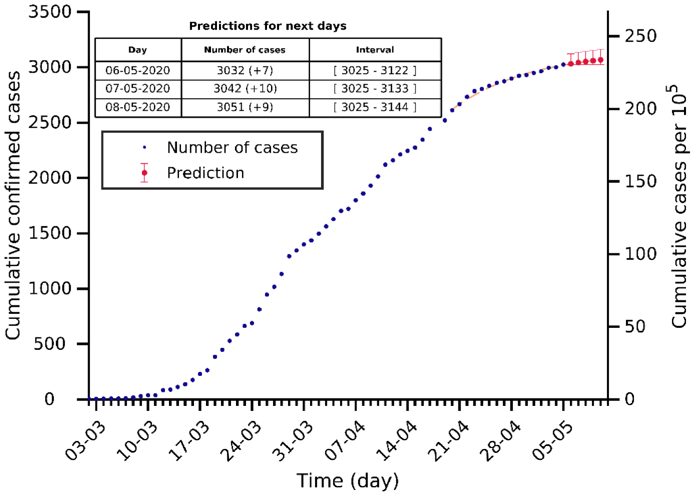
Predictions for next days

Day	Number of cases	Interval
06-05-2020	3282 (+15)	[3267 - 3315]
07-05-2020	3293 (+12)	[3267 - 3327]
08-05-2020	3304 (+10)	[3270 - 3338]

Friuli Venezia Giulia 05-05-2020. Population: 1.2M. Current cumulated incidence: 2

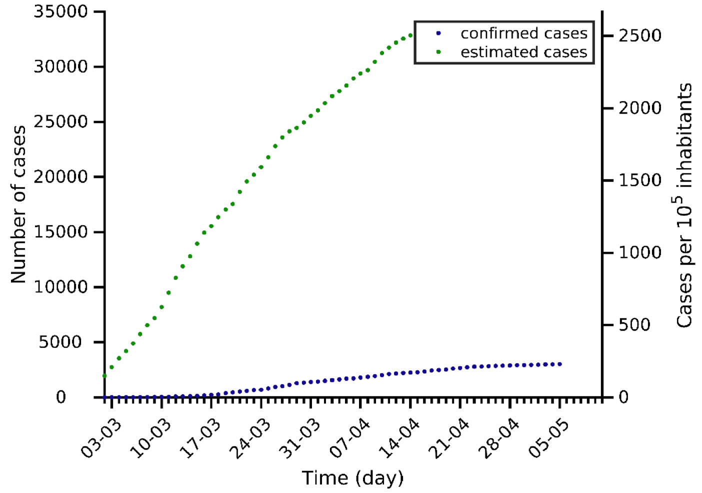


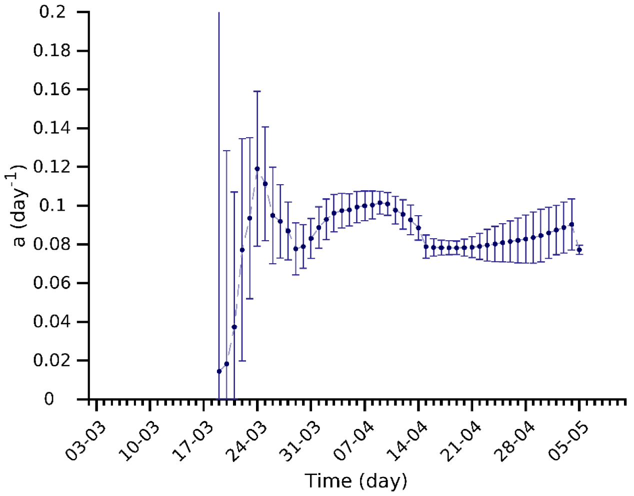
Abruzzo 05-05-2020. Population: 1.3M. Current cumulated incidence: 231/10⁵

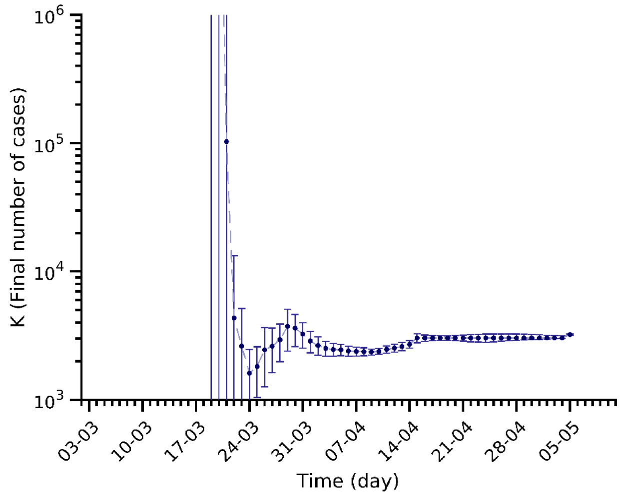


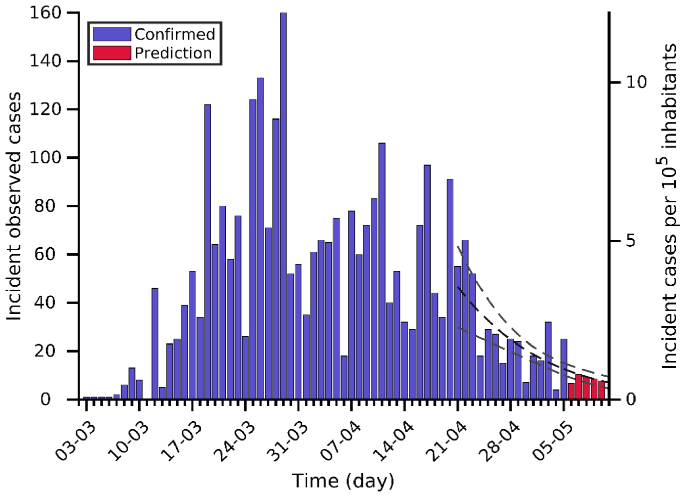
Predictions for next days

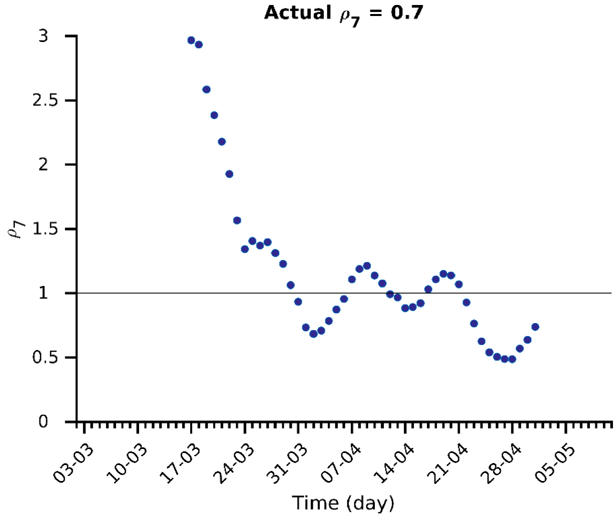
Day	Number of cases	Interval
06-05-2020	3032 (+7)	[3025 - 3122]
07-05-2020	3042 (+10)	[3025 - 3133]
08-05-2020	3051 (+9)	[3025 - 3144]

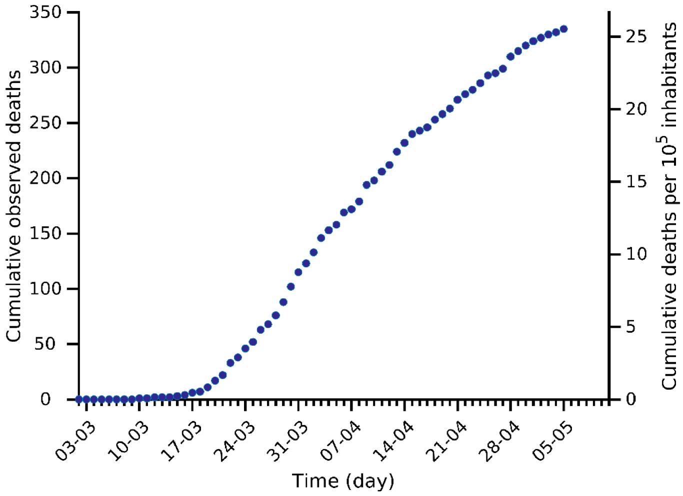


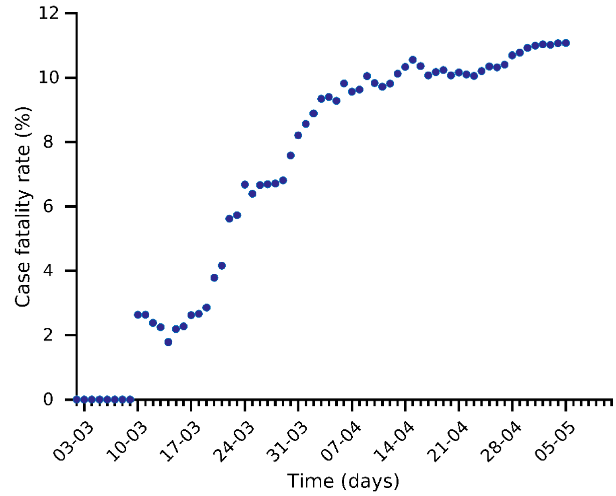




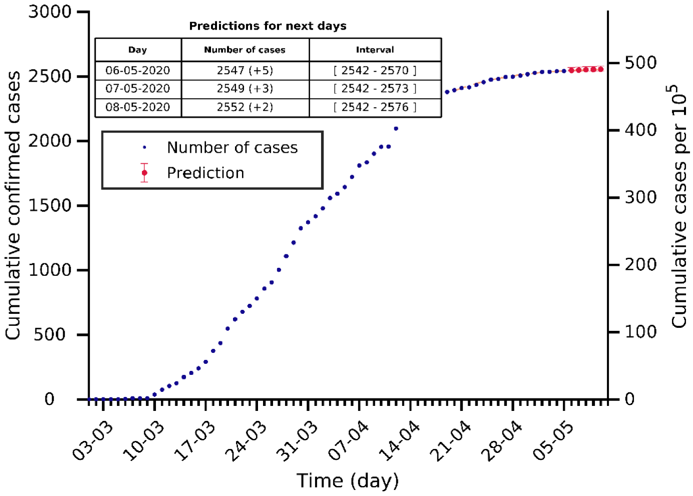


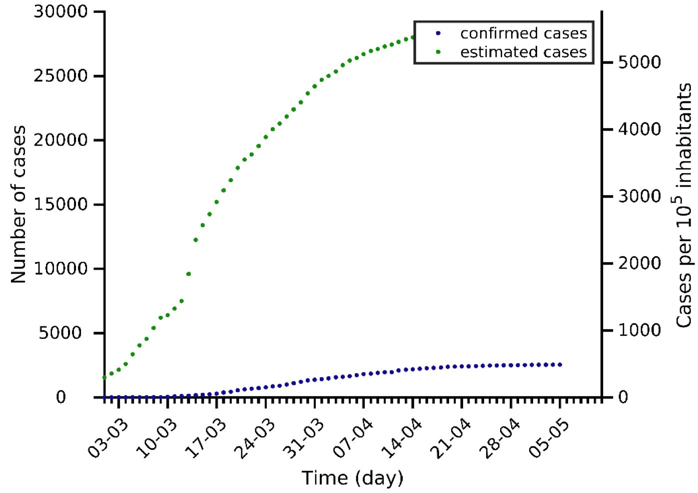


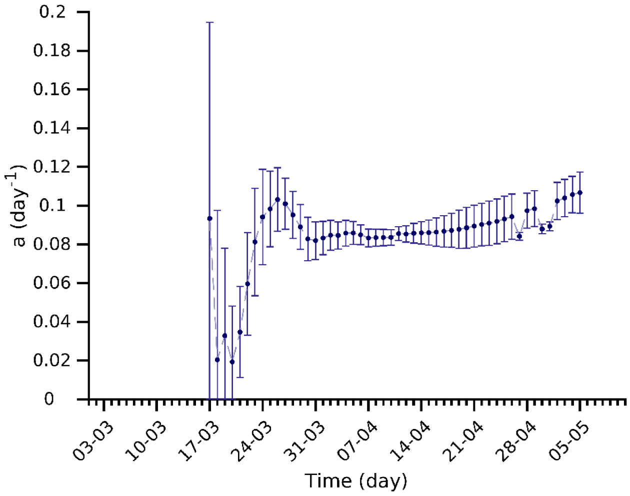


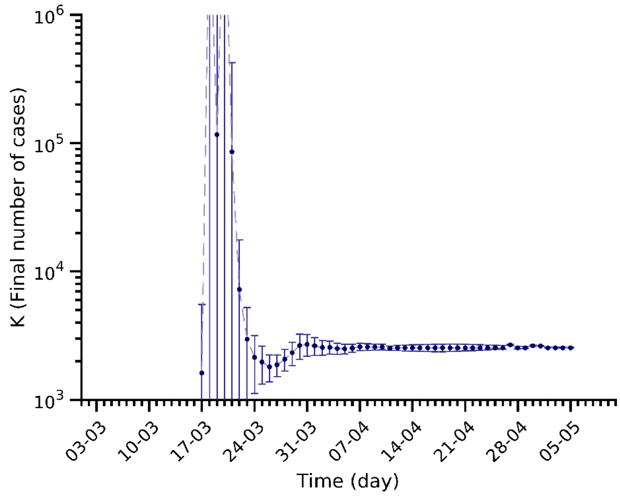


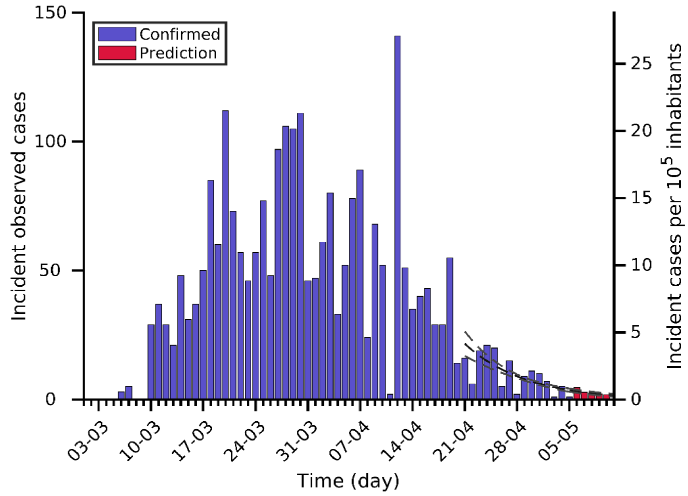
Bolzano 05-05-2020. Population: 0.5M. Current cumulated incidence: 488/10⁵

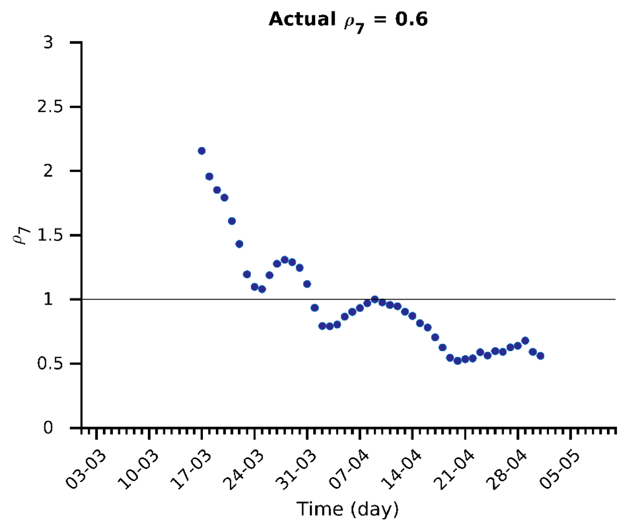


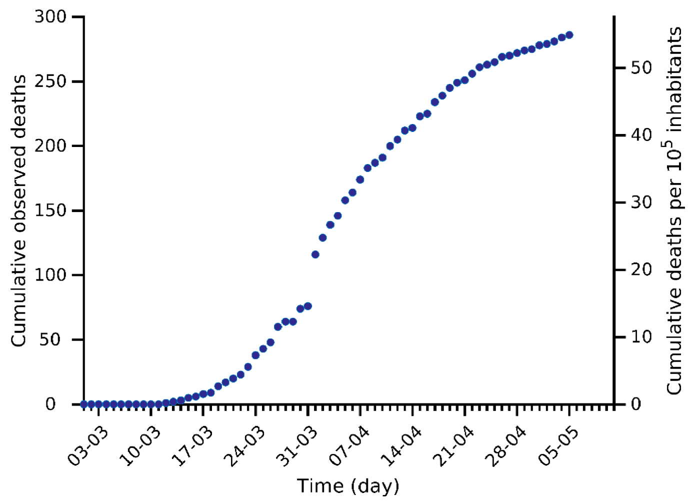


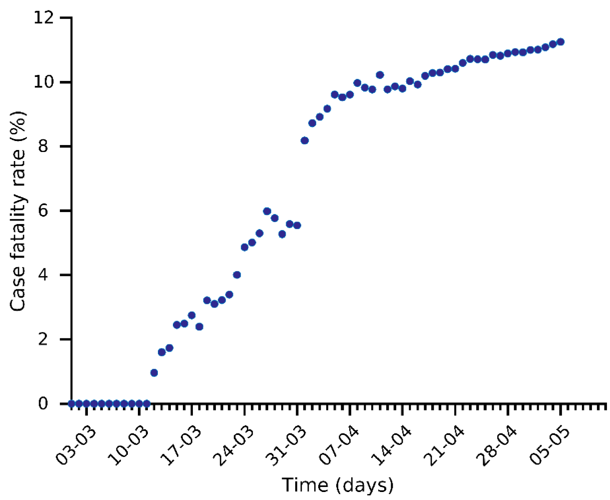




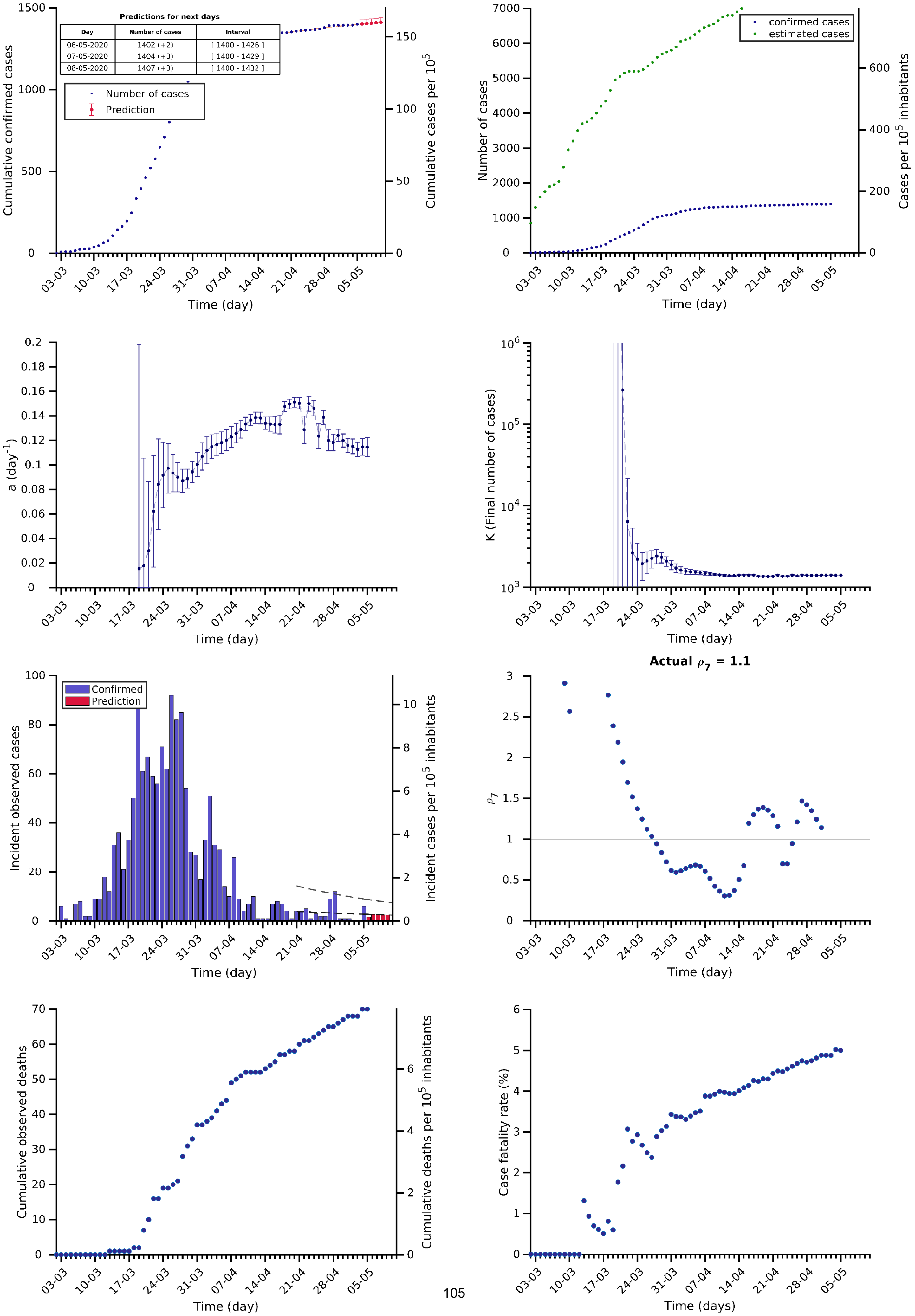




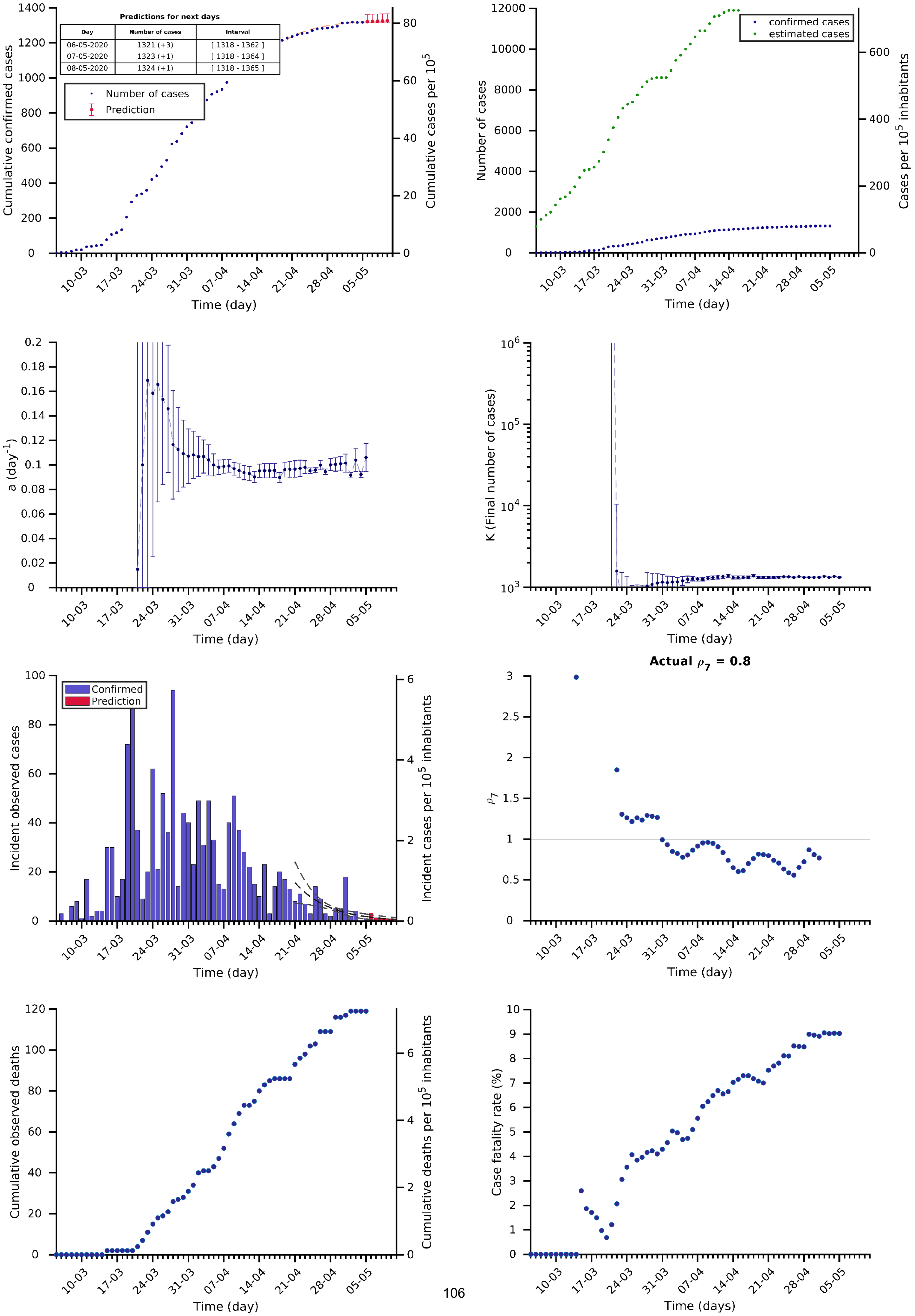




Umbria 05-05-2020. Population: 0.9M. Current cumulated incidence: 159/10^5

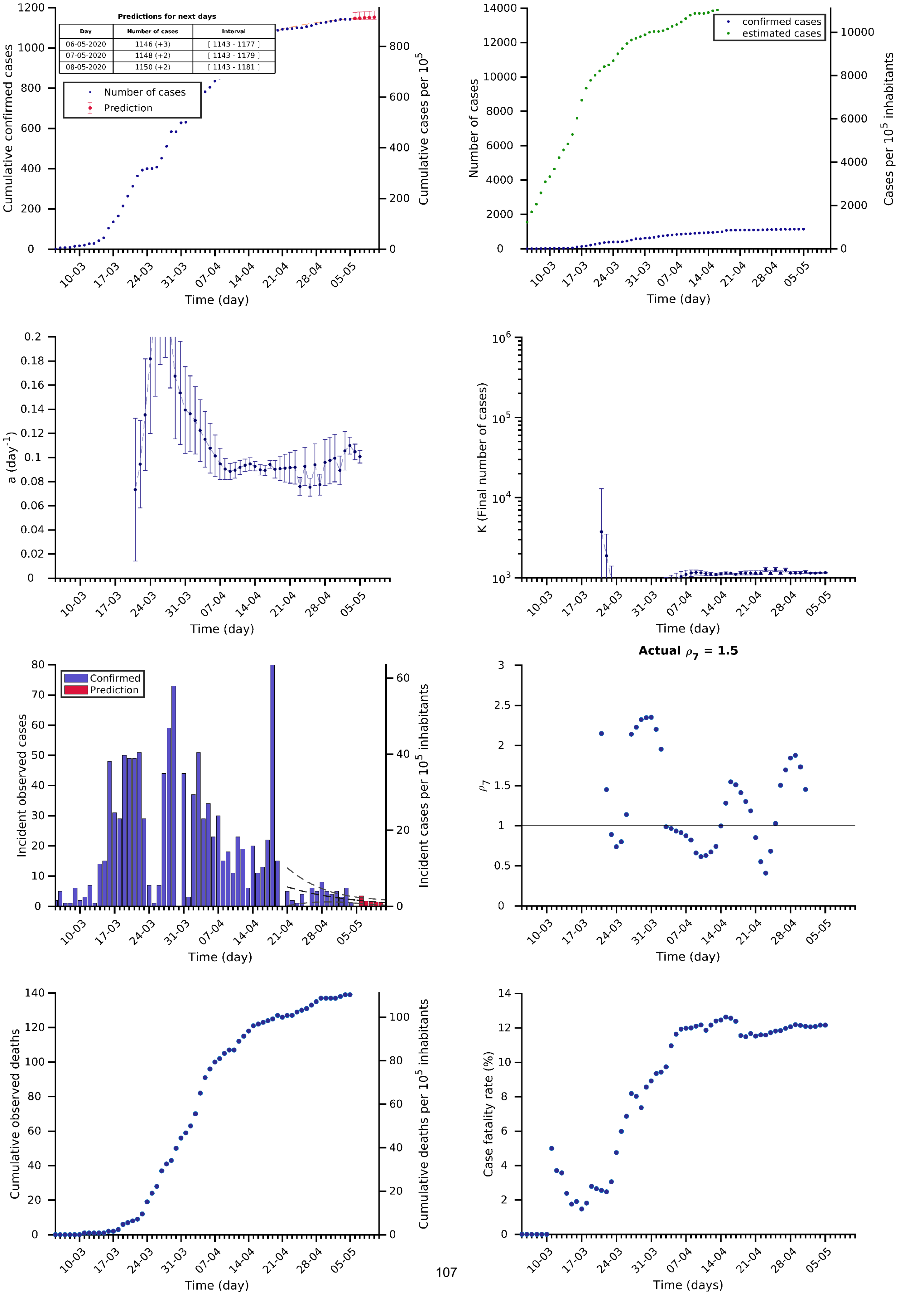


Sardegna 05-05-2020. Population: 1.6M. Current cumulated incidence: 80/10⁵



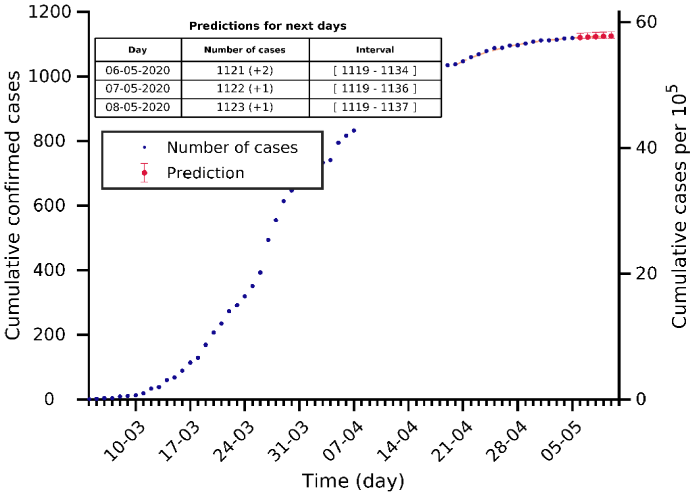
Day	Number of cases	Interval
06-05-2020	1321 (+3)	[1318 - 1362]
07-05-2020	1323 (+1)	[1318 - 1364]
08-05-2020	1324 (+1)	[1318 - 1365]

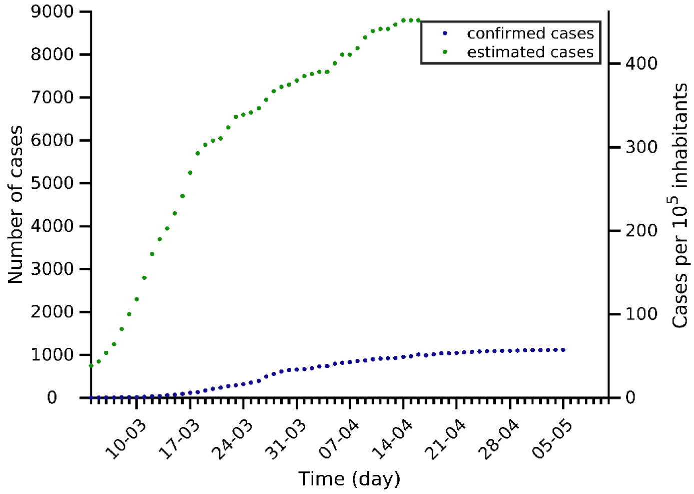
Valle dAosta 05-05-2020. Population: 0.1M. Current cumulated incidence: 907/10⁵

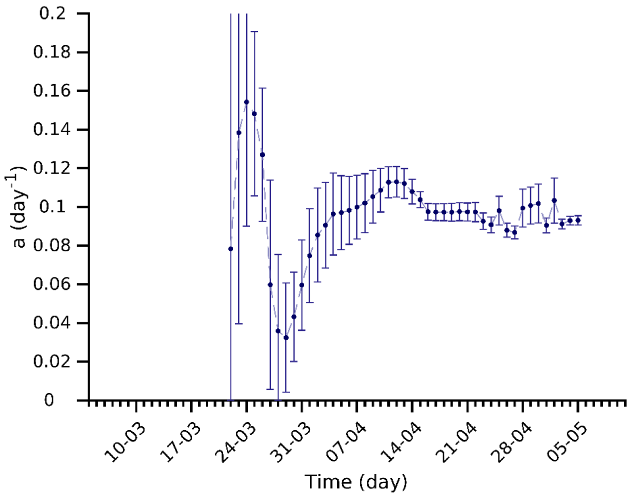


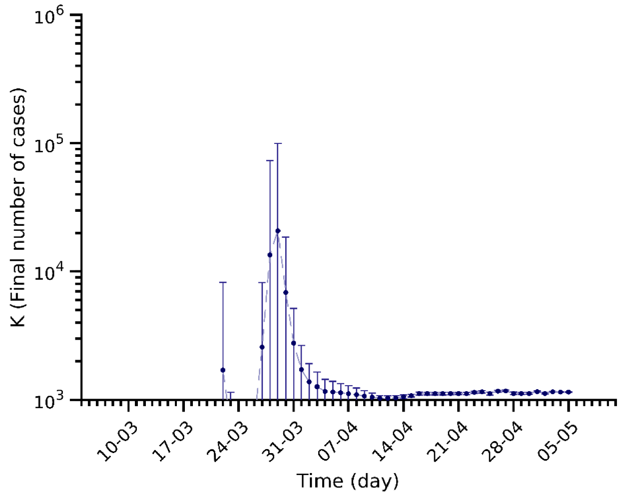
Day	Number of cases	Interval
06-05-2020	1146 (+3)	[1143 - 1177]
07-05-2020	1148 (+2)	[1143 - 1179]
08-05-2020	1150 (+2)	[1143 - 1181]

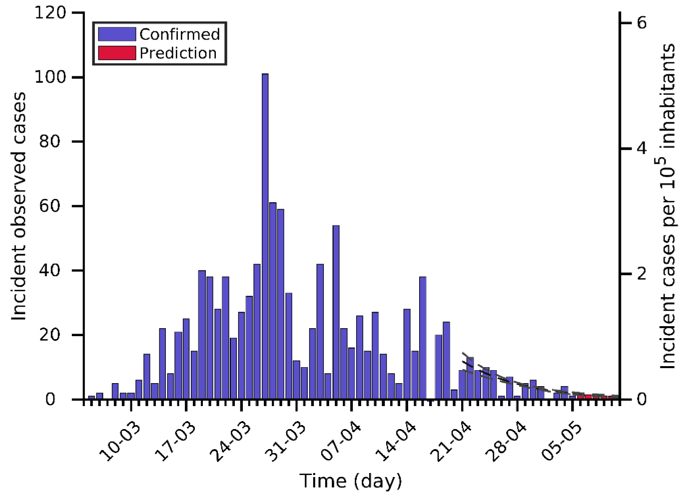
Calabria 05-05-2020. Population: 1.9M. Current cumulated incidence: 57/10⁵

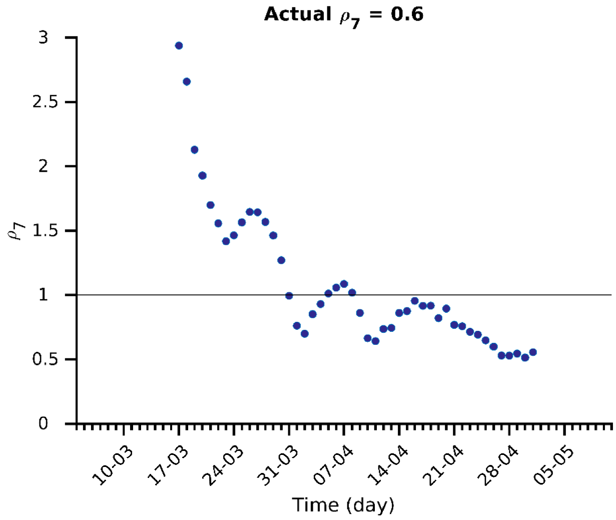


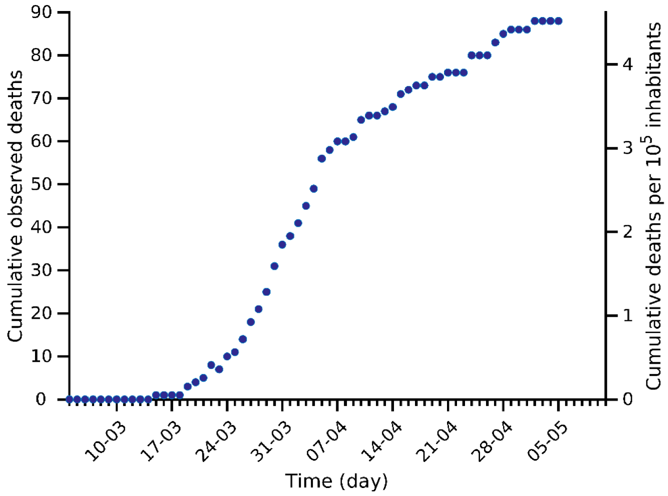


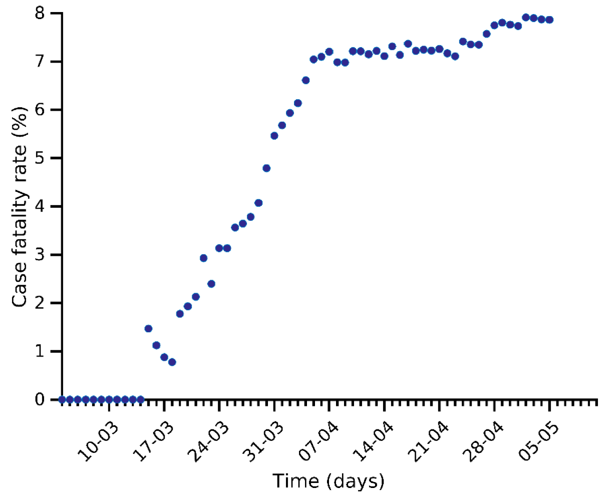




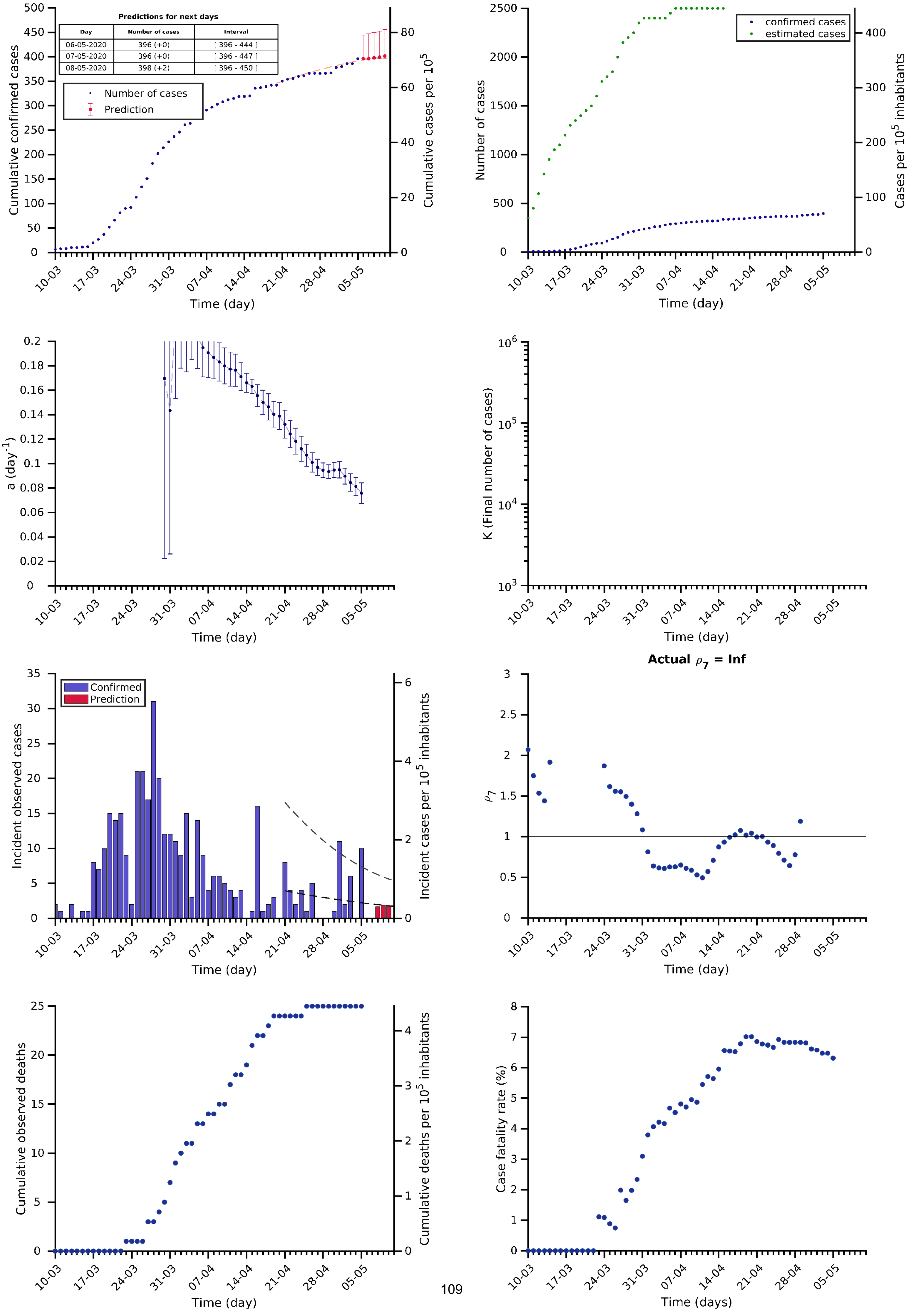




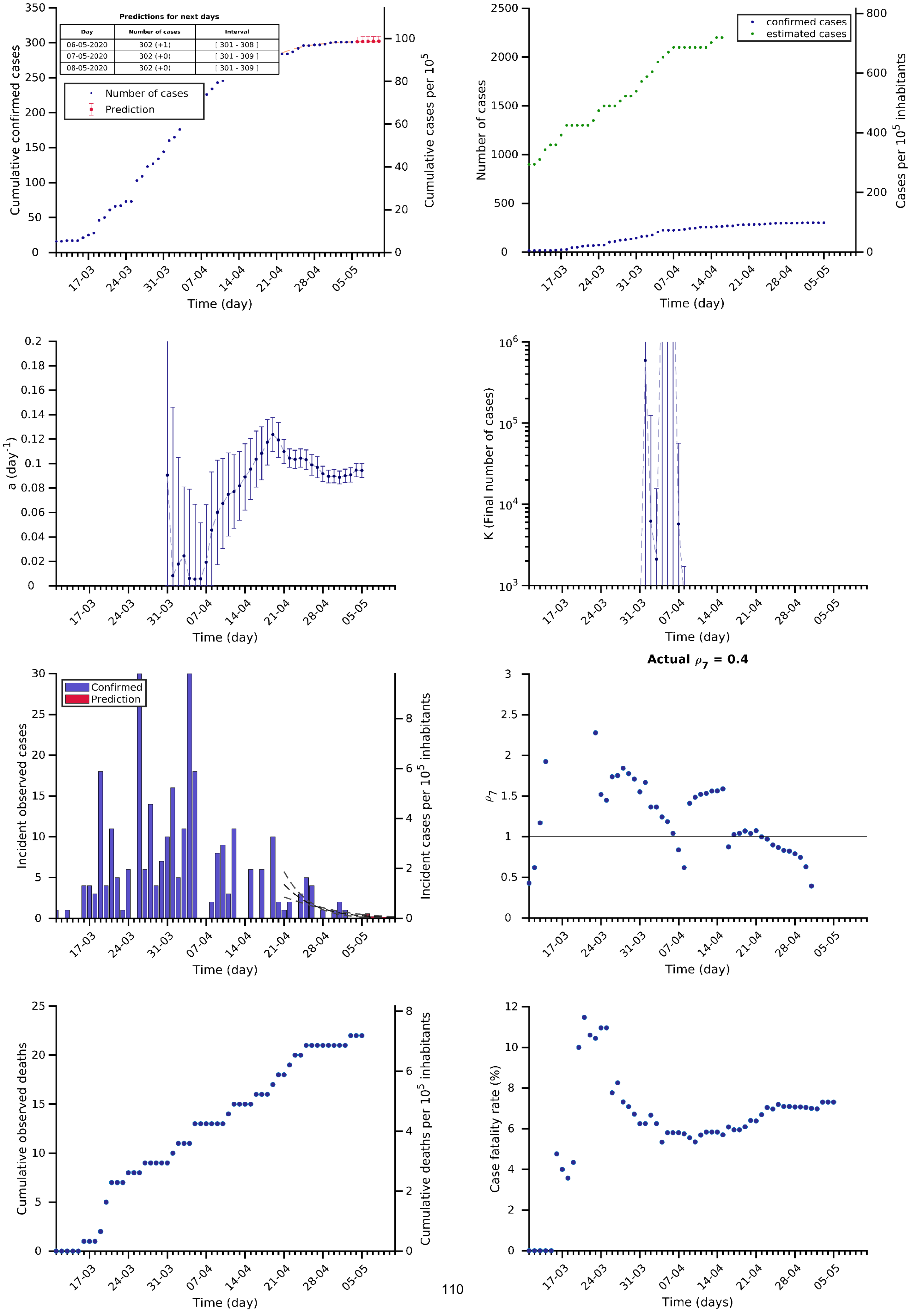




Basilicata 05-05-2020. Population: 0.6M. Current cumulated incidence: 70/10⁵



Molise 05-05-2020. Population: 0.3M. Current cumulated incidence: 98/10⁵



Day	Number of cases	Interval
06-05-2020	302 (+1)	[301 - 308]
07-05-2020	302 (+0)	[301 - 309]
08-05-2020	302 (+0)	[301 - 309]

Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports[1], from European Centre for Disease Prevention and Control (ECDC)[2] and from Ministerio de Sanidad[3]. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ: this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report (*t-1*):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day *t*.

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

(I) an initial period where most of the cases are imported;
(II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

[1] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
[2] https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases
[3] https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm
https://github.com/datadista/datasets/tree/master/COVID%2019 , https://covid19.isciii.es/

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model[4] correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K\, e^{-ln\left(\frac{K}{N_0}\right)\cdot\, e^{-\,a\cdot(t-t_0)}}$$

where *N(t)* is the cumulated number of confirmed cases at *t* (in days), and N_0 is the number of cumulated cases the day at day t_0. The model has two parameters:

- ✓ *a* is the velocity at which specific spreading rate is slowing down;
- ✓ *K* is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which *N(t)* overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (*a* and *K*) and the R^2 of the fitting. At the initial stages the dynamics is exponential and *K* cannot be correctly evaluated. In fact, at this stage the most relevant parameter is *a*. Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted *a* with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted *K* with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $a>0.2\ day^{-1}$, if $K>10^6$ or if the error in K overpasses 10^6.

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

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[4] Madden LV. Quantification of disease progression. Protection Ecology 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days[5];
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors[6] in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

[5] At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

[6] Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3