UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Computational Biology and Complex Systems Research Group

CMCiB Comparative Medicine & Bioimage Centre of Catalonia

IGTP Germans Trias i Pujol Research Institute

Daily report 01-05-2020

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

Situation report 48

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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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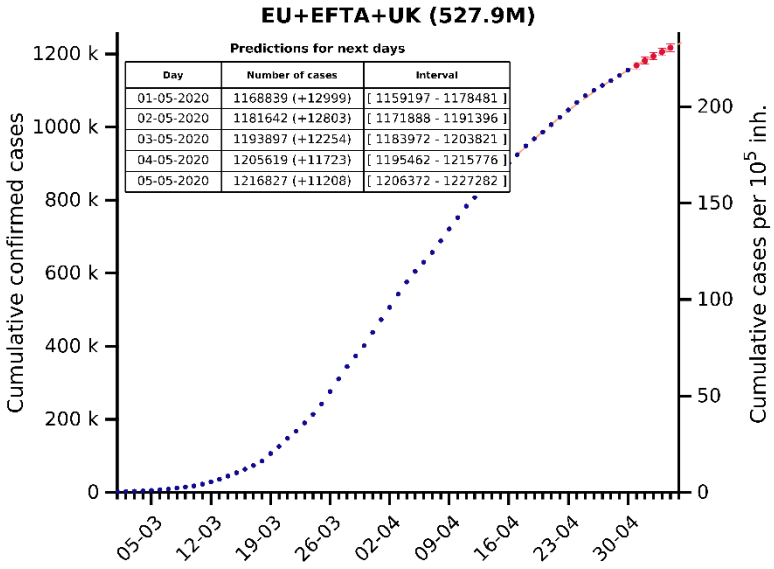
(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs

On the decreasing process, EU+EFTA+UK has overcome several peaks. Luckily, maximums of these peaks have been found at different levels: 35,000 at the beginning of April and at 30,000, 25,000, 20,000, and 15,000 on subsequent weeks. Therefore, on average, new cases are decreasing at the slope of 5,000 cases per week. The $\rho_7 < 1$ is the *responsible* for (or the reflection of) such decrease. It has been maintained between 0.9-0.8 for these 5 weeks**. If this trend is maintained, we should gradually decrease until the level of 10,000 cases during next week**.

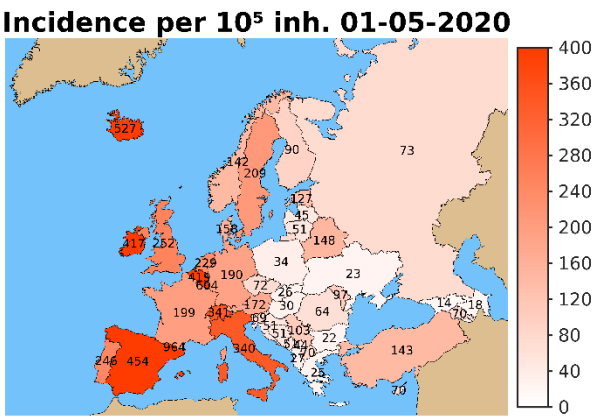


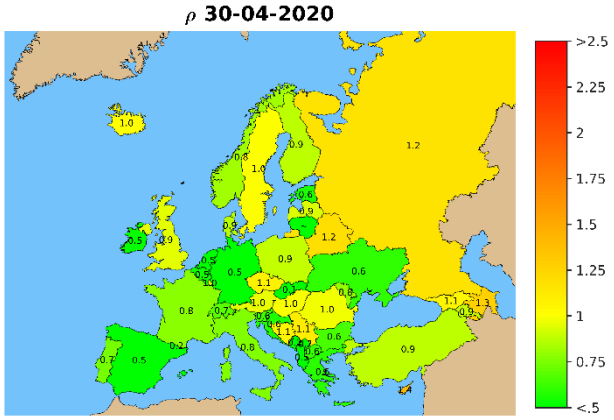
Cumulative cases are around 1,160,000. Expected final number has slightly decreased and it is close to 1,5M. Thus, **we would be at 77 % of this final value**. Nevertheless, and as we have mentioned in past days, the deconfinement process that is planned for most countries during May could affect these predictions.

Countries with highest number of cases are strongly contributing to this global control tendency. Among top five (Spain, Italy, UK, Germany and France) only UK remains at compromised situation. Despite ρ_7 is at the level of 0.9, the number of new cases is still high. Thus, although there is no significant growth, there is neither a decrease in new cases. UK's peak is showing a wide plateau.

Trends for specific countries

UK and **Sweden** are at a similar risk level. In absolute numbers, **UK** presents the highest number of active cases (68,160 new cases last 14 days), while **Sweden** reports 8,552. Nevertheless, relative numbers provide a more similar picture: a 14-day attack rate of 103 per 10^5 inh. for **UK**, and 87 per 10^5 inh. for **Sweden**. Both countries have a ρ_7 close to 1 and an EPG_{REP} close to 90. Looking at estimated EPG, both countries are leading the ranking with an EPG_{EST} around 1,600. **Belgium** and **Ireland** seem to be improving its situation, slowly but surely.





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	213,435	460.5	24,543	53.0	33,872	73.1	0.74	54	634
Italy	205,463	345.7	27,967	47.1	36,522	61.5	0.81	50	691
United Kingdom	171,253	257.8	26,771	40.3	68,160	102.6	0.94	96	1,640
Germany	159,119	194.2	6,288	7.7	25,289	30.9	0.69	21	94
France	129,581	200.2	24,376	37.7	20,734	32.0	0.78	25	520
Belgium	48,519	427.2	7,594	66.9	13,710	120.7	0.74	89	1,589
Netherlands	39,316	231.4	4,795	28.2	10,102	59.5	0.64	38	476
Switzerland	29,503	344.3	1,422	16.6	2,852	33.3	0.72	24	121
Portugal	25,056	241.6	989	9.5	6,215	59.9	0.74	44	201
Sweden	21,092	214.4	2,586	26.3	8,552	86.9	1.02	89	1,622
Ireland	20,612	436.1	1,232	26.1	7,341	155.3	0.88	137	1,005
Austria	15,457	177.4	584	6.7	1,009	11.6	0.96	11	42
Poland	12,877	33.7	644	1.7	4,959	13.0	0.96	12	79
Romania	12,240	61.9	717	3.6	4,533	22.9	0.99	23	157
Denmark	9,158	160.3	452	7.9	2,279	39.9	0.96	38	202
Norway	7,710	143.6	204	3.8	919	17.1	0.74	13	37
Czech Republic	7,682	72.4	236	2.2	1,249	11.8	0.67	8	27
Finland	4,995	90.8	211	3.8	1,626	29.5	0.85	25	131
Luxembourg	3,784	656.9	90	15.6	340	59.0	0.62	37	ND
Hungary	2,863	29.4	323	3.3	1,100	11.3	0.86	10	140
Greece	2,591	23.2	140	1.3	384	3.4	1.10	4	23
Croatia	2,076	49.3	69	1.6	285	6.8	0.64	4	ND
Iceland	1,797	493.3	10	2.7	58	15.9	0.39	6	ND
Estonia	1,689	128.7	52	4.0	255	19.4	0.80	16	ND
Bulgaria	1,506	21.1	66	0.9	706	9.9	1.50	15	ND
Slovenia	1,429	68.8	91	4.4	161	7.7	0.93	7	ND
Slovakia	1,396	25.6	23	0.4	419	7.7	0.42	3	ND
Lithuania	1,385	47.6	45	1.5	236	8.1	NA	NA	NA
Latvia	858	43.5	15	0.8	183	9.3	0.88	8	ND
Cyprus	850	72.6	20	1.7	115	9.8	0.97	10	ND
Malta	465	108.4	4	0.9	53	12.4	ND	ND	ND
Liechtenstein	83	215.3	1	2.6	2	5.2	ND	ND	ND
	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

- ✓ As mentioned in the first section, situation in UK is still worrying. If we average new cases of last 4 days, UK has reported 4,600, Italy 1,900, Spain 1,400, and France and Germany 1,250. Predictions for new days point to a progressive decrease in the four countries (slower in France) but a standstill for UK.
- ✓ Spreading rate ρ_7 is 0.9 for UK, 0.8 for Italy and France, and 0.7 for Spain and Germany.

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 / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	69	11	16
France	63	10	20
Germany	63	12	17
Spain	61	7	12
United Kingdom	59	11	19
Norway	58	9	24
Switzerland	58	9	12
Netherlands	57	11	20
Sweden	57	10	28
Austria	56	10	14
Belgium	56	11	14
Greece	55	18	ND
Iceland	55	5	15
Denmark	53	4	30
Czech Republic	52	11	ND
Finland	51	12	ND
Portugal	51	9	15
Slovenia	51	6	ND
Ireland	50	8	18
Romania	50	15	ND
Estonia	49	5	30
Poland	49	17	ND
Bulgaria	47	21	ND
Luxembourg	47	6	7
Slovakia	47	23	ND
Croatia	46	12	ND
Latvia	45	12	ND
Cyprus	44	12	ND
Hungary	44	18	ND
Malta	43	8	34
Lithuania	42	9	ND
Liechtenstein	37	9	11

Analysis: Mobility: the key parameter during COVID-19 expansion.

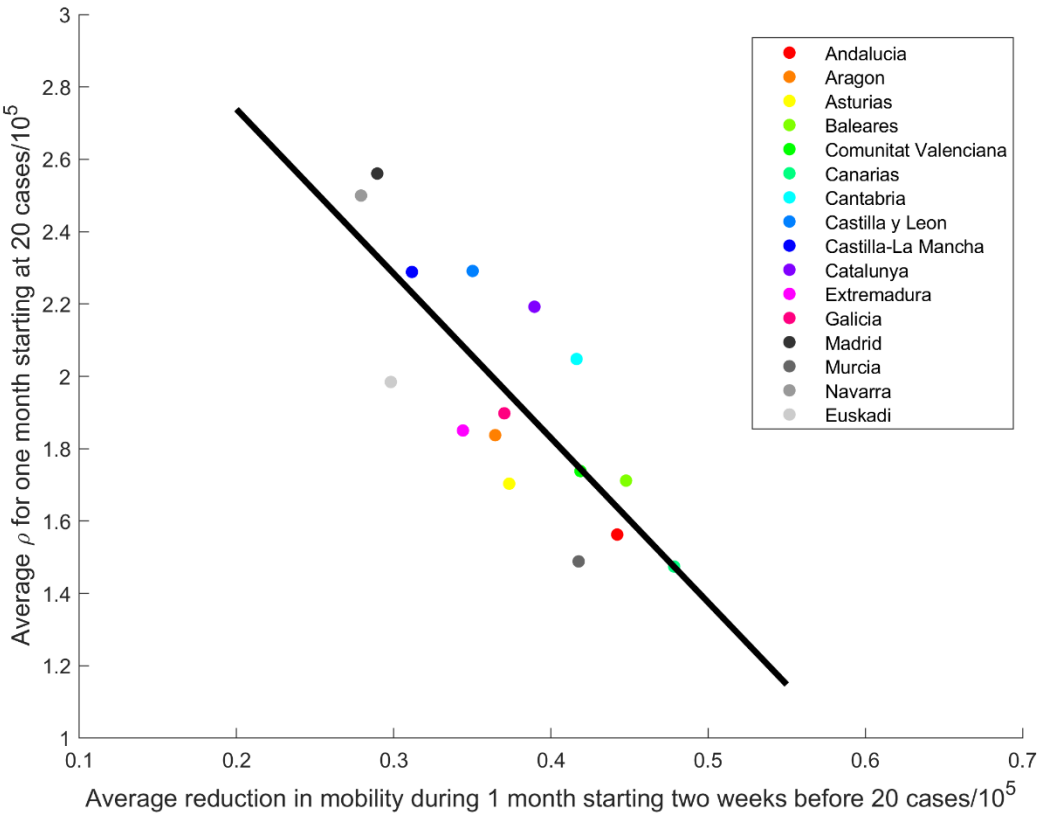
The spreading of COVID-19 all over the world has forced the countries to develop strong mobility protocols to increase social distancing. These strong measures, in combination with the massive testing programs, are the leading keys for blocking the COVID-19 propagation. The variability of these protocols through the different countries is still a matter of discussion.

Territorial variability matters

It has been shown in previous reports that **there is a certain delay between a lockdown measure and its effects on spreading rate**. This delay depends on the country because it is related with the diagnosis delay. Moreover, we have discussed previously about the relevance of the regional scale.

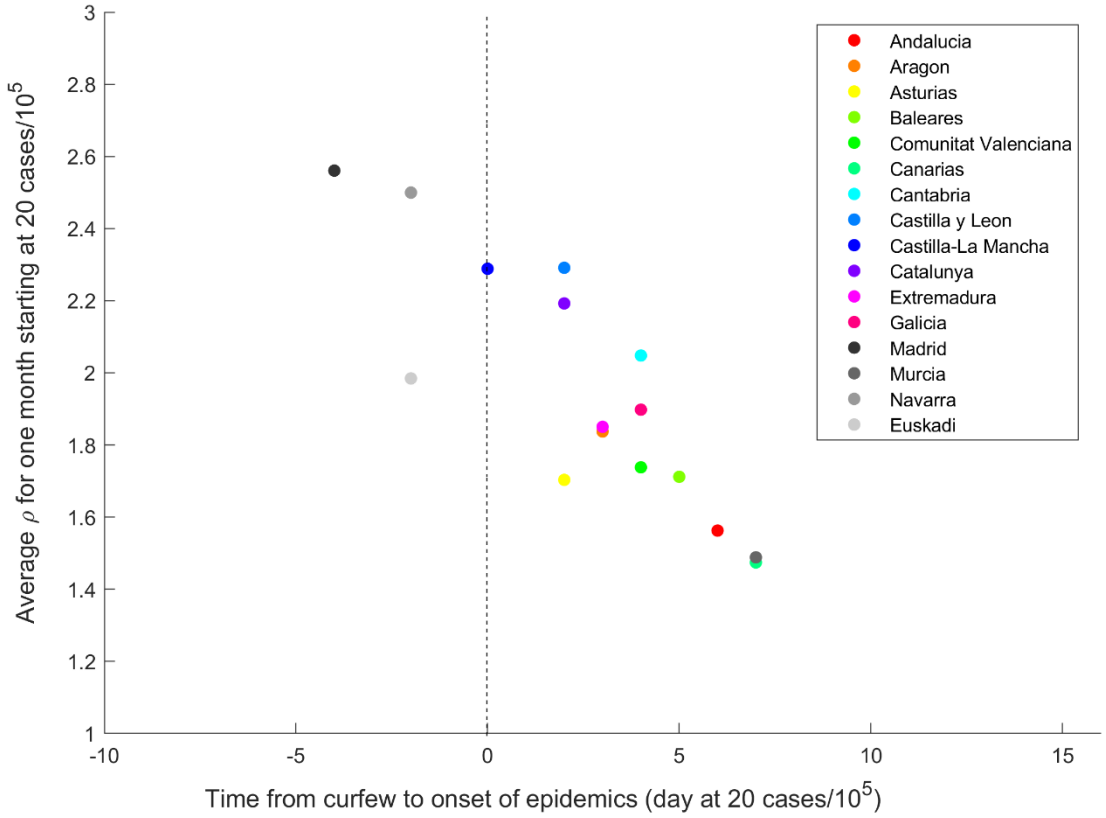
Let us situate the epidemic onset at the moment at which the cumulative incidence reaches 20 cases per 100,000 inhabitants. Let us also assume a delay of 14 days between a lockdown measure and its effects on spreading rate. Given these assumptions, we are going to analyze the effect of the decrease in mobility on the epidemic growth rate in Spanish regions.

We have calculated the **average mobility reduction during two weeks before and after onset**, using *Facebook's Data for Good*. This 1-month average is a measure of the mean mobility of a certain region before and during the initial local outbreak of the pandemic. This onset and, therefore, the start of the 1-month period correspond to a different day for each region. Then, we average the value of ρ during the same period of time (1 month), but with a 14-day delay. In the following figure we show this relation for the autonomous communities of Spain.



Although the state of the pandemic was heterogenous through the communities**, the Spanish lockdown was ordered at the same time for all regions** (15th March). Thus, the threshold incidence (20 cases per 10^5 inh.) occurs before or after the curfew depending on the region. For instance, Madrid reaches this value 4 days

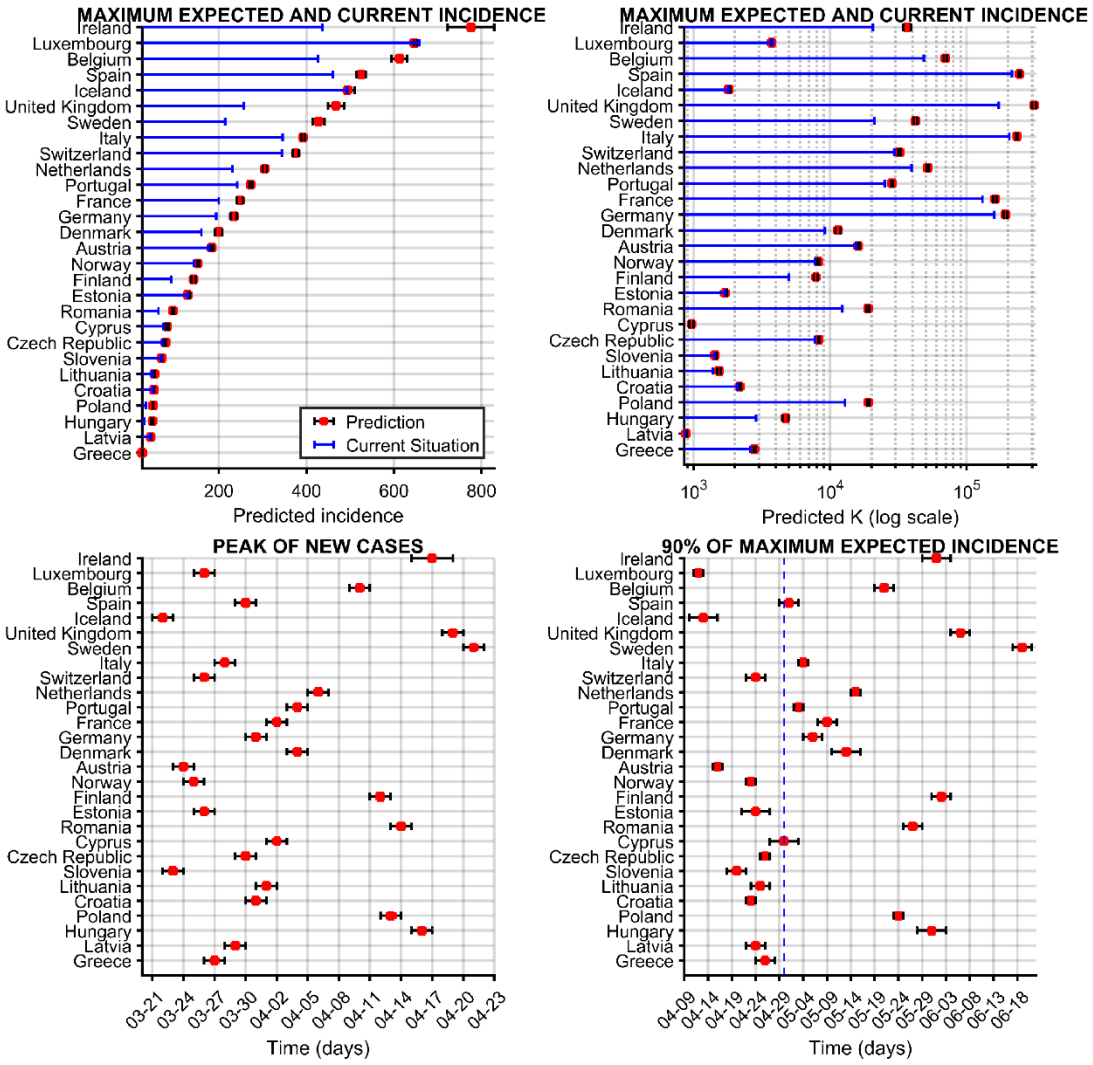
before the curfew while Cantabria does it 4 days after. The next figure shows the 1-month average of ρ starting at the onset day (i.e., the day at which 20 cases per 10^5 inhabitants were overcome) in each Spanish region depending on the time from curfew to onset. Negative values correspond to those countries that had reached 20 cases per 10^5 inhabitants before the lockdown, while positive values correspond to those regions that had lower incidences when curfew was implemented. The figure clearly shows that **the initial epidemic growth (i.e., during first month) is highly related with the time period between the onset and the curfew.**



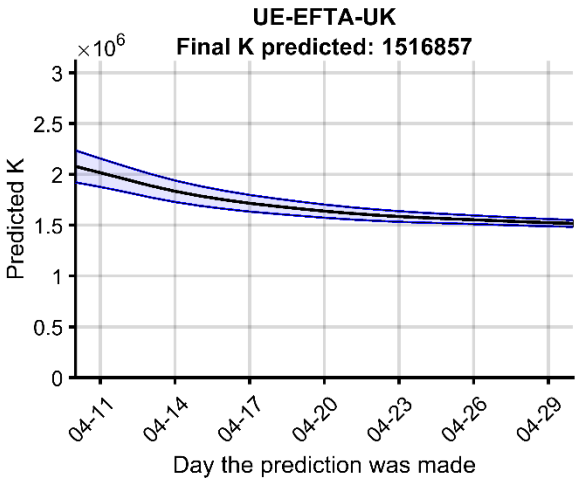
The overall evolution of COVID-19 in each community has been utterly determined by the state of the region at that moment. The communities that reach lower values of ρ where the ones that reduce the mobility early in the dawning days of the pandemic. Thus, social distancing measures must be punctually imposed to slow down COVID-19 spreading.

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.



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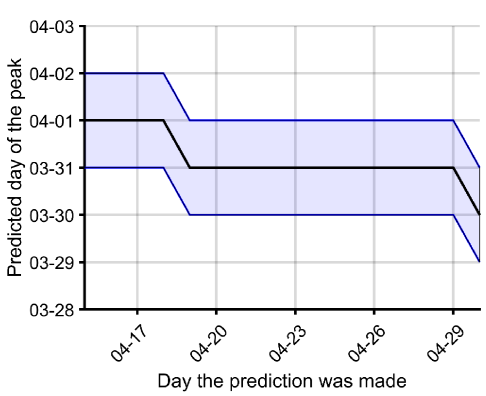
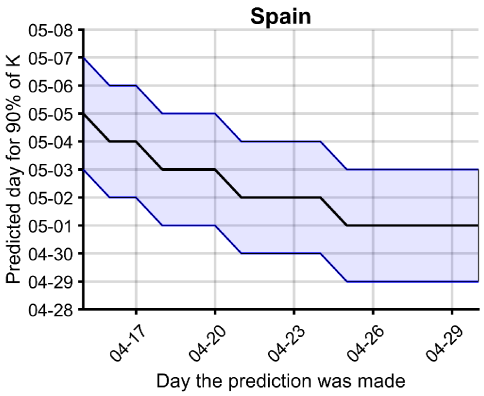
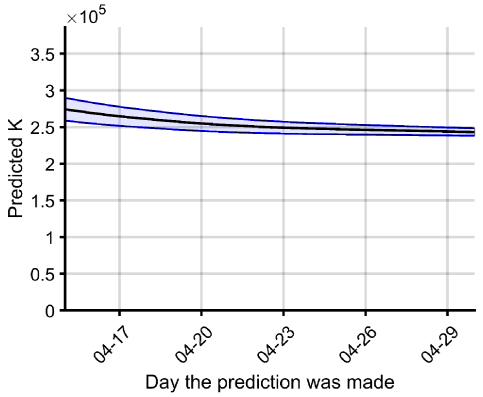
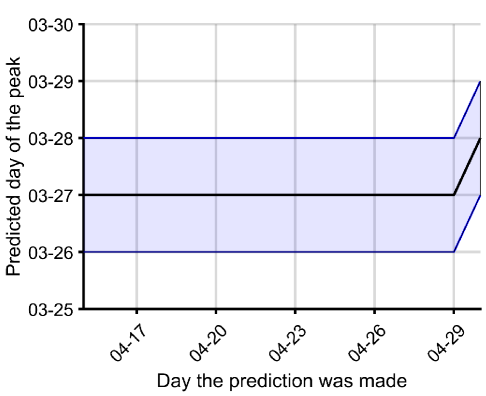
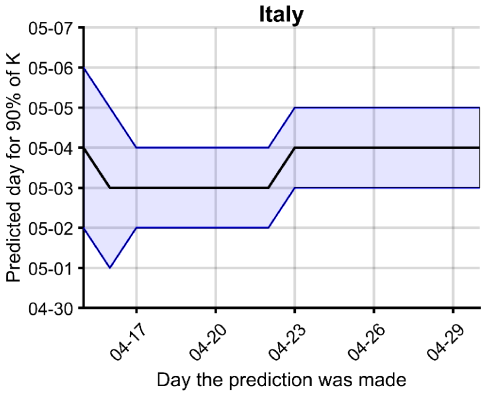
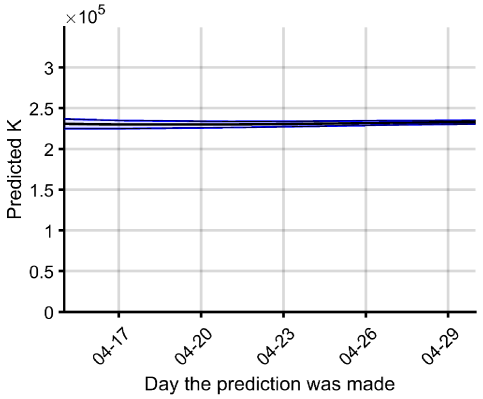

Predicted day of the peak
04-03
04-02
04-01
03-31
03-30
03-29
03-28
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

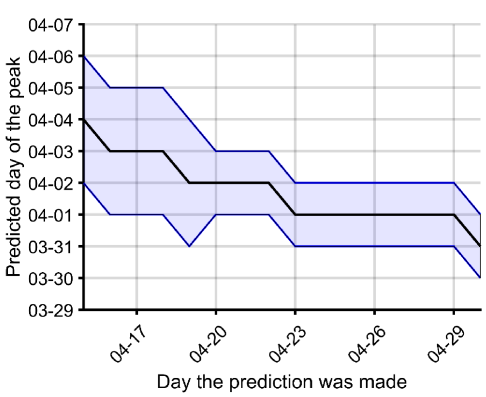

Spain
Predicted day for 90% of K
05-08
05-07
05-06
05-05
05-04
05-03
05-02
05-01
04-30
04-29
04-28
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

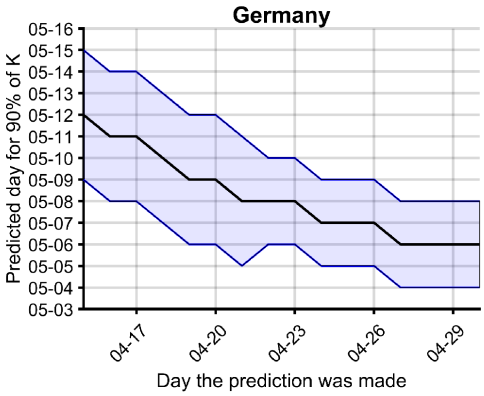

×10^5
Predicted K
3.5
3
2.5
2
1.5
1
0.5
0
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

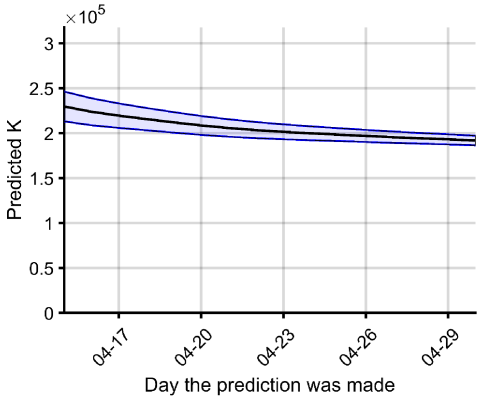

Predicted day of the peak
03-30
03-29
03-28
03-27
03-26
03-25
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

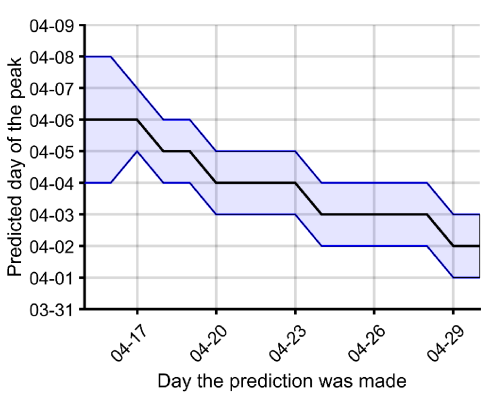

Italy
Predicted day for 90% of K
05-07
05-06
05-05
05-04
05-03
05-02
05-01
04-30
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

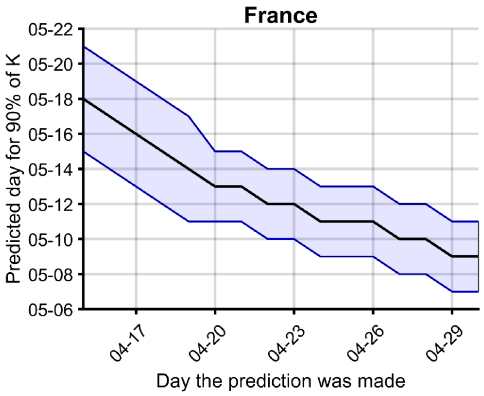

×10^5
Predicted K
3
2.5
2
1.5
1
0.5
0
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

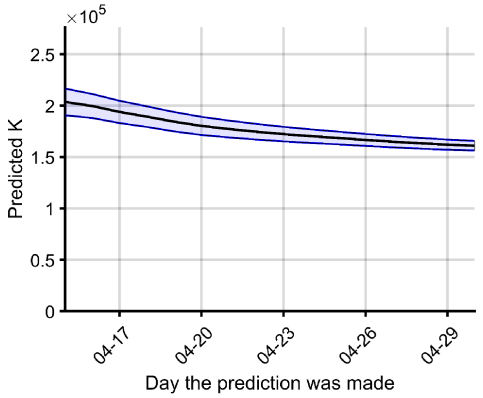

Predicted day of the peak
04-07
04-06
04-05
04-04
04-03
04-02
04-01
03-31
03-30
03-29
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

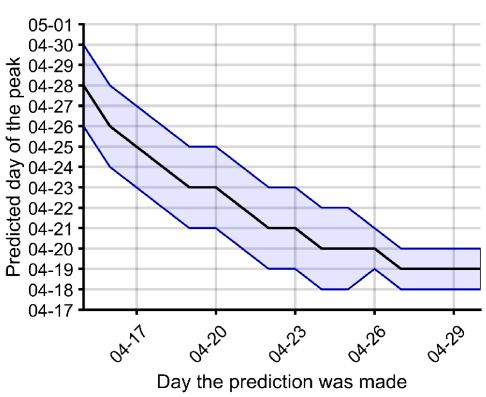

Germany
Predicted day for 90% of K
05-16
05-15
05-14
05-13
05-12
05-11
05-10
05-09
05-08
05-07
05-06
05-05
05-04
05-03
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

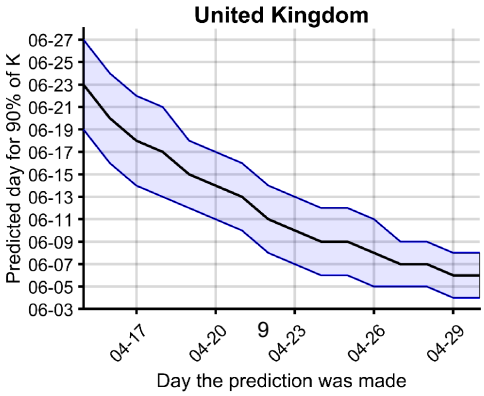

×10^5
Predicted K
3
2.5
2
1.5
1
0.5
0
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

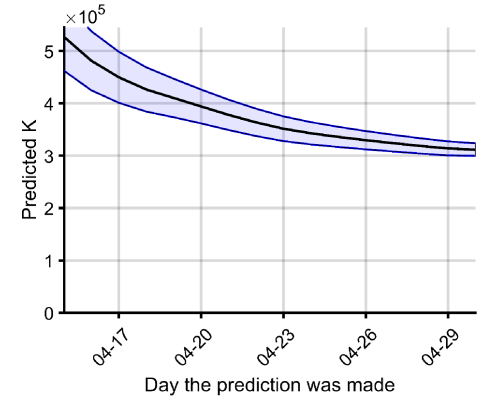

Predicted day of the peak
04-09
04-08
04-07
04-06
04-05
04-04
04-03
04-02
04-01
03-31
04-17
04-20
04-23
04-26
04-29
Day the prediction was made


France
Predicted day for 90% of K
05-22
05-20
05-18
05-16
05-14
05-12
05-10
05-08
05-06
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

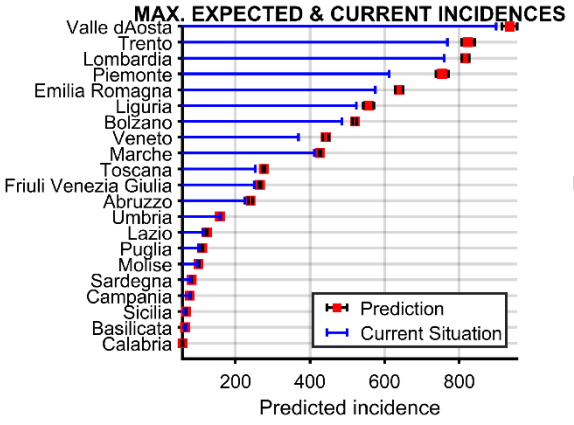

×10^5
Predicted K
2.5
2
1.5
1
0.5
0
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

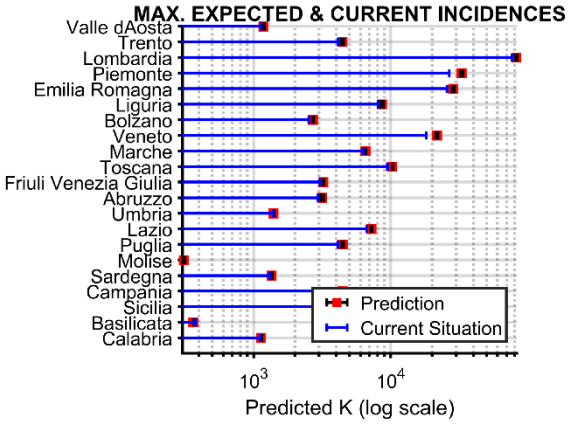

Predicted day of the peak
05-01
04-30
04-29
04-28
04-27
04-26
04-25
04-24
04-23
04-22
04-21
04-20
04-19
04-18
04-17
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

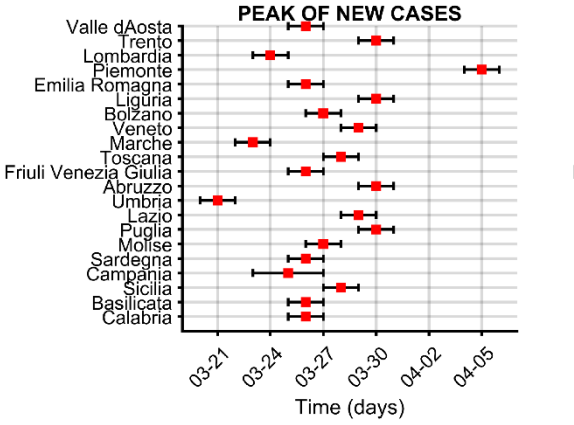

United Kingdom
Predicted day for 90% of K
06-27
06-25
06-23
06-21
06-19
06-17
06-15
06-13
06-11
06-09
06-07
06-05
06-03
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

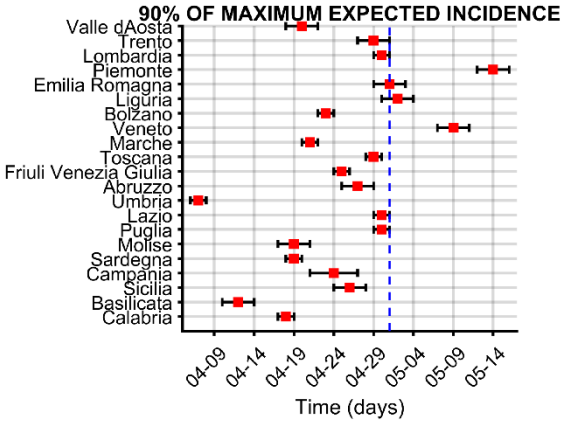

×10^5
Predicted K
5
4
3
2
1
0
04-17
04-20
04-23
04-26
04-29
Day the prediction was made

Italian regions

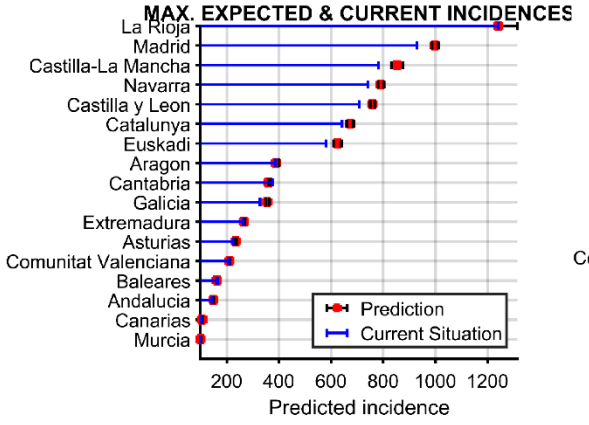


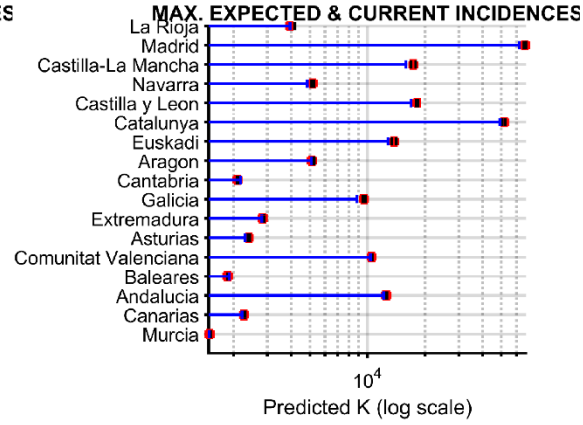


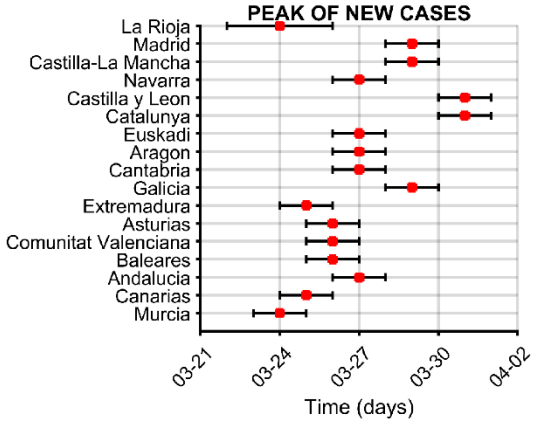


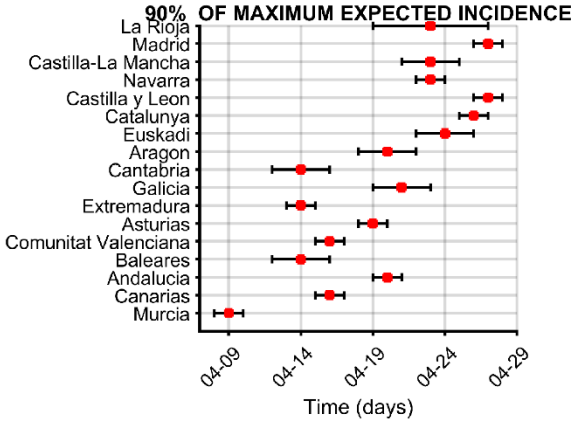


Spanish regions









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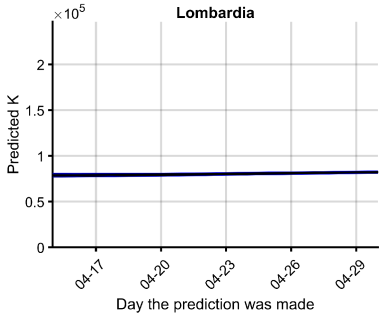
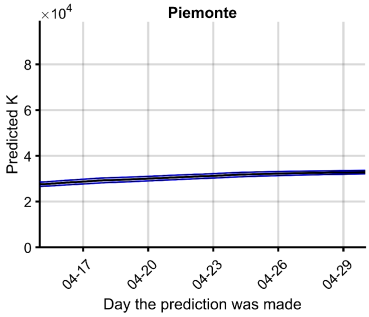

Lombardia
×10^5
Predicted K
Day the prediction was made
04-17
04-20
04-23
04-26
04-29


Piemonte
×10^4
Predicted K
Day the prediction was made
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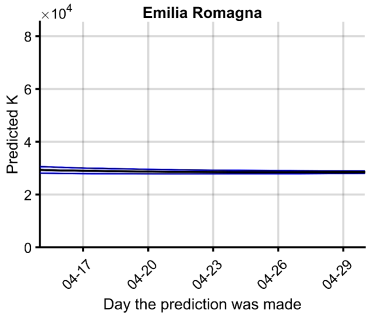
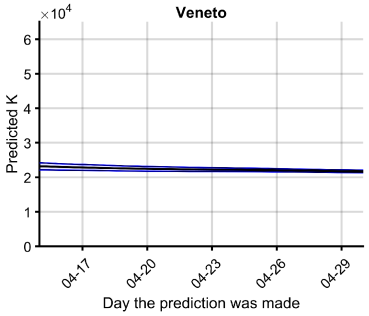
04-20
04-23
04-26
04-29


Emilia Romagna
×10^4
Predicted K
Day the prediction was made
04-17
04-20
04-23
04-26
04-29


Veneto
×10^4
Predicted K
Day the prediction was made
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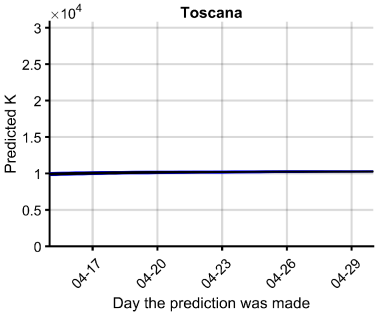
04-29


Toscana
×10^4
Predicted K
Day the prediction was made
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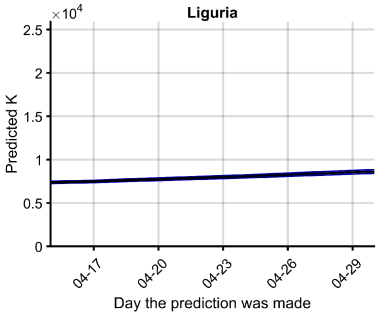
04-20
04-23
04-26
04-29


Liguria
×10^4
Predicted K
Day the prediction was made
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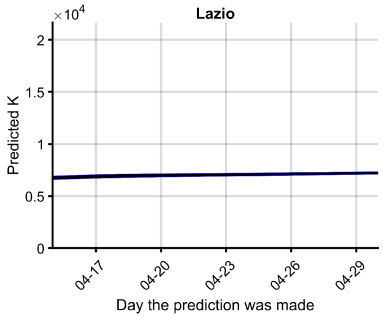
04-26
04-29


Lazio
×10^4
Predicted K
Day the prediction was made
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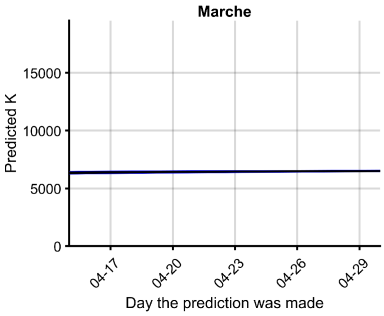
04-26
04-29


Marche
Predicted K
Day the prediction was made
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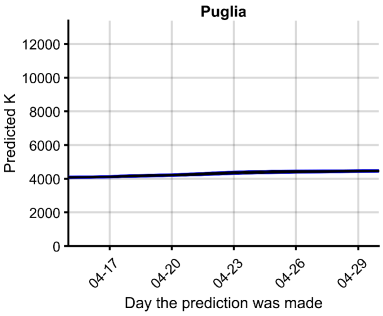
04-29


Puglia
Predicted K
Day the prediction was made
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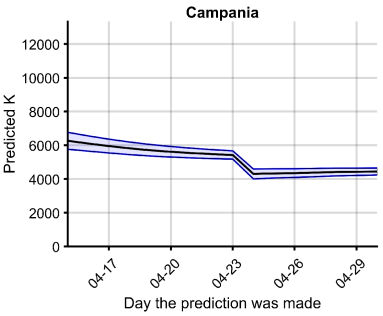
04-29


Campania
Predicted K
Day the prediction was made
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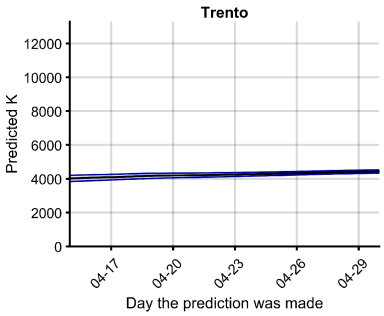
04-29


Trento
Predicted K
Day the prediction was made
04-17
04-20
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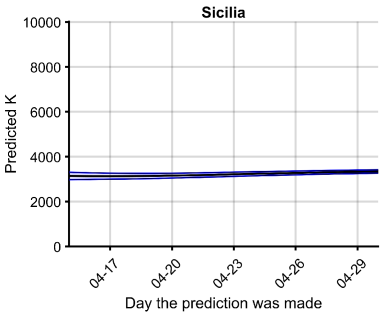
04-29


Sicilia
Predicted K
Day the prediction was made
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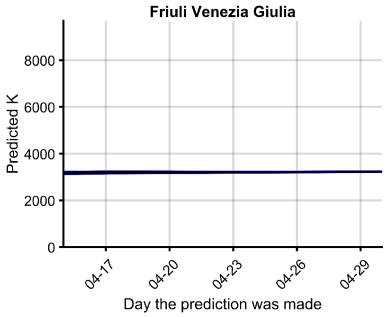
Friuli Venezia Giulia
Predicted K
Day the prediction was made
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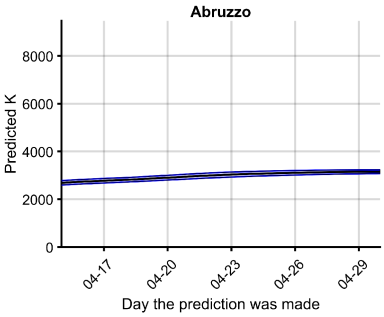
Abruzzo
Predicted K
Day the prediction was made
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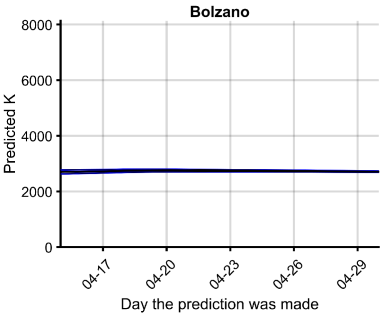
Bolzano
Predicted K
Day the prediction was made
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04-20
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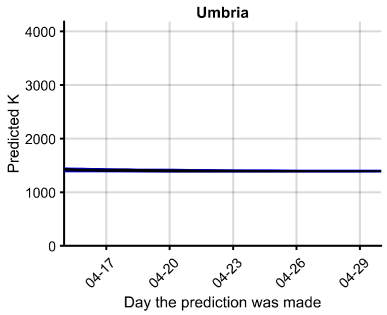
04-29


Umbria
Predicted K
Day the prediction was made
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04-20
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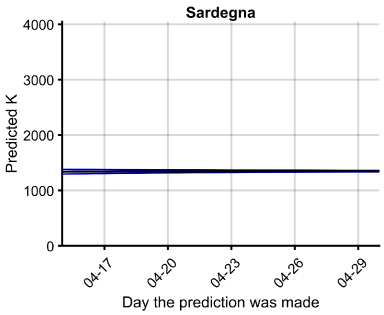
04-29


Sardegna
Predicted K
Day the prediction was made
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04-20
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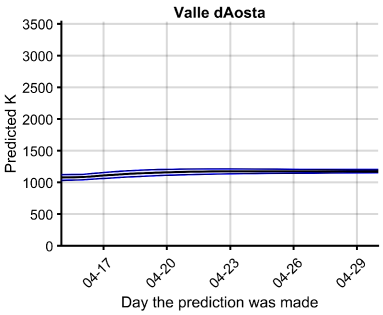
04-29


Valle dAosta
Predicted K
Day the prediction was made
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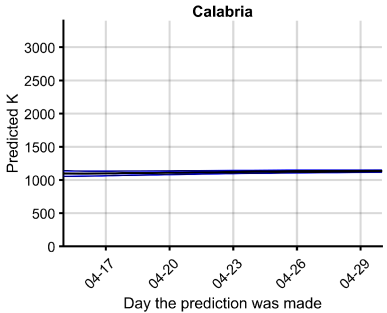
04-29


Calabria
Predicted K
Day the prediction was made
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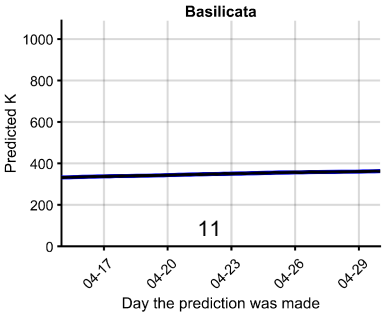
04-26
04-29


Basilicata
Predicted K
Day the prediction was made
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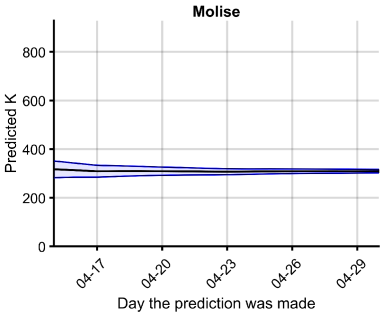
04-29


Molise
Predicted K
Day the prediction was made
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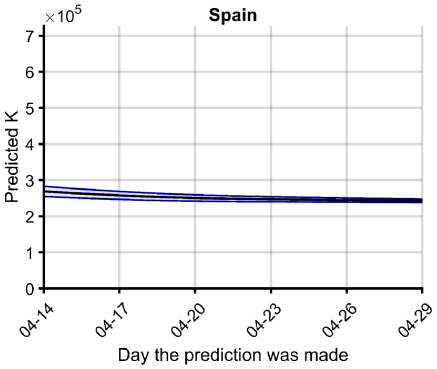
04-29

2020-04-30


Spain
×10^5
Predicted K
Day the prediction was made
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04-17
04-20
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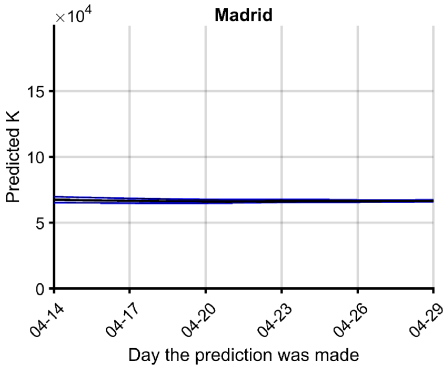
04-26
04-29


Madrid
×10^4
Predicted K
Day the prediction was made
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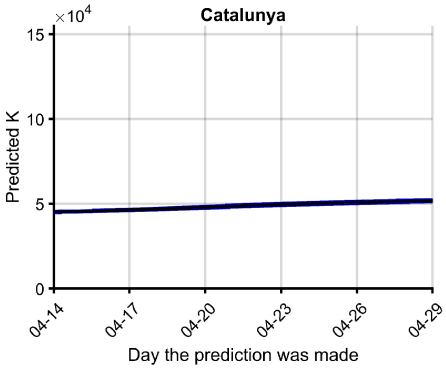
04-29


Catalunya
×10^4
Predicted K
Day the prediction was made
04-14
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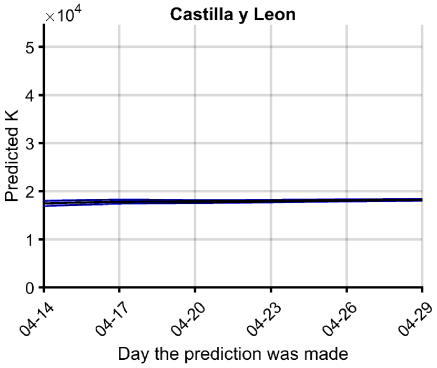
04-29


Castilla y Leon
×10^4
Predicted K
Day the prediction was made
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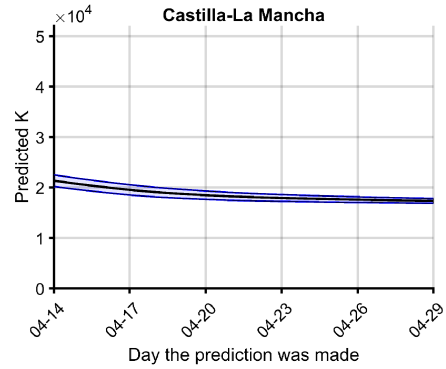
04-26
04-29


Castilla-La Mancha
×10^4
Predicted K
Day the prediction was made
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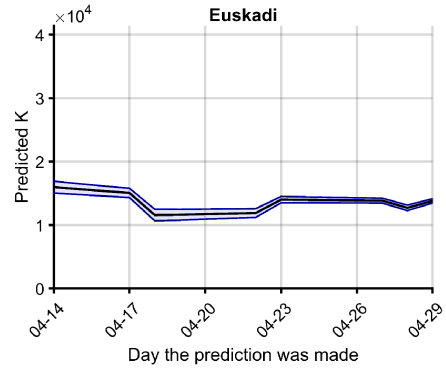
04-29


Euskadi
×10^4
Predicted K
Day the prediction was made
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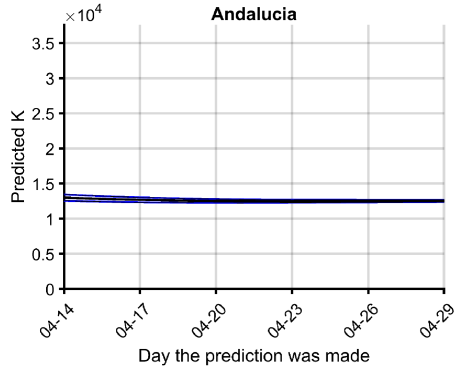
Andalucia
×10^4
Predicted K
Day the prediction was made
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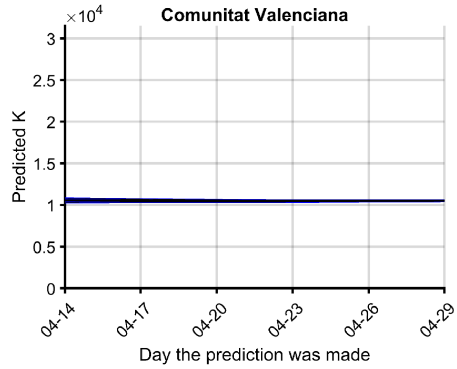
Comunitat Valenciana
×10^4
Predicted K
Day the prediction was made
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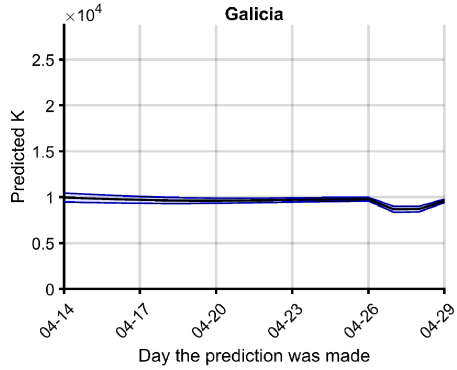
04-29


Galicia
×10^4
Predicted K
Day the prediction was made
04-14
04-17
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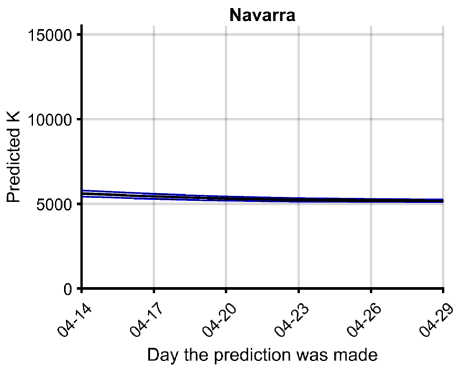
04-29


Navarra
Predicted K
Day the prediction was made
04-14
04-17
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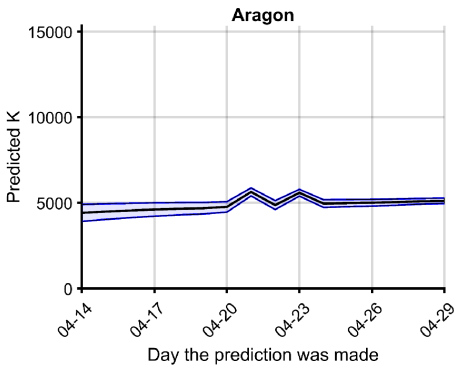
Aragon
Predicted K
Day the prediction was made
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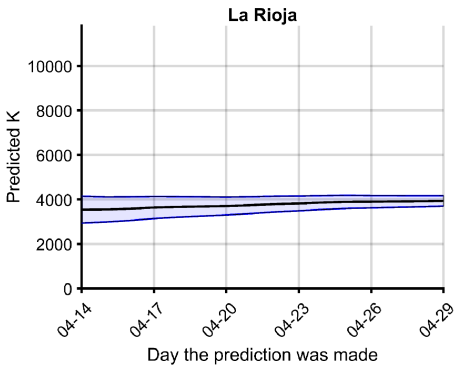
La Rioja
Predicted K
Day the prediction was made
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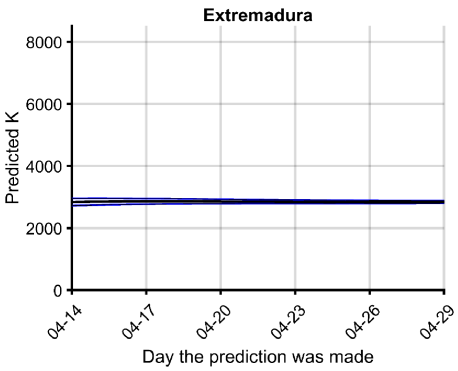
Extremadura
Predicted K
Day the prediction was made
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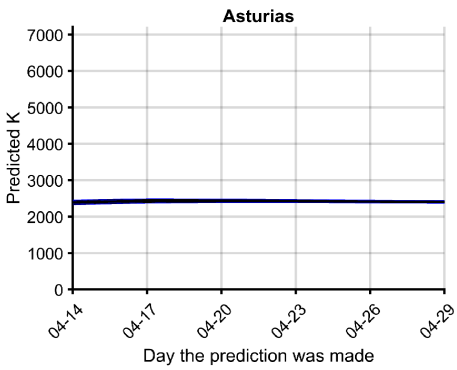
Asturias
Predicted K
Day the prediction was made
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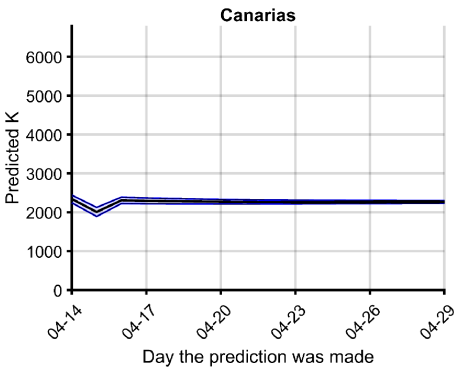
Canarias
Predicted K
Day the prediction was made
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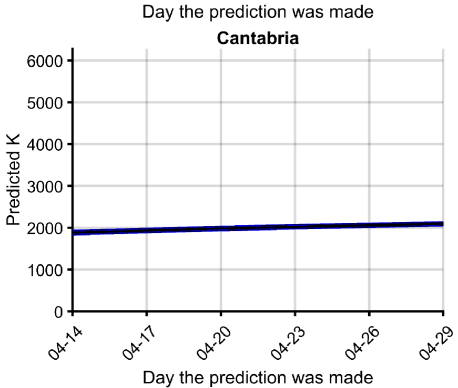
Cantabria
Predicted K
Day the prediction was made
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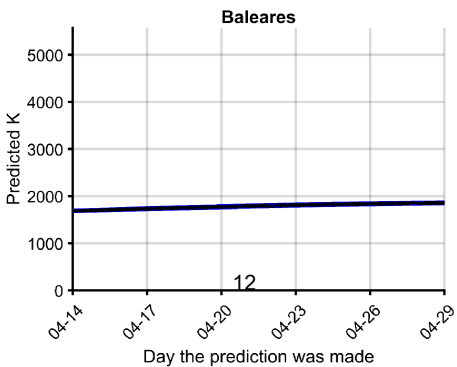
04-29


Baleares
Predicted K
Day the prediction was made
04-14
04-17
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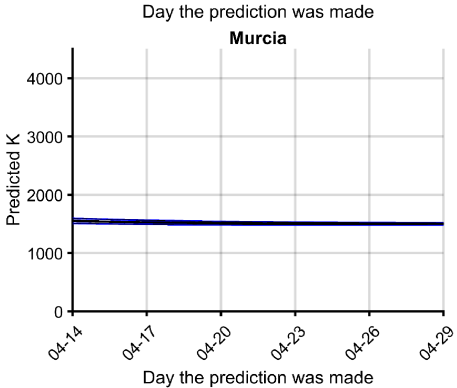
04-26
04-29


Murcia
Predicted K
Day the prediction was made
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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	76,469	761.5	13,860	138.0	12,334	122.8	0.83	103	1,921
Piemonte	26,684	612.5	3,097	71.1	6,881	158.0	0.79	125	1,573
Emilia Romagna	25,644	575.0	3,579	80.3	3,810	85.4	0.86	73	1,064
Veneto	18,098	368.9	1,479	30.1	2,724	55.5	0.60	34	300
Toscana	9,445	253.2	854	22.9	1,335	35.8	0.74	26	264
Liguria	8,126	524.0	1,184	76.4	1,938	125.0	0.98	123	1,907
Lazio	6,672	113.5	482	8.2	1,148	19.5	0.98	19	145
Marche	6,275	411.4	911	59.7	607	39.8	0.80	32	489
Campania	4,444	76.6	359	6.2	493	8.5	0.62	5	45
Trento	4,132	385.3	423	39.4	756	70.5	1.06	75	1,601
Puglia	4,099	101.7	421	10.4	772	19.2	0.56	11	116
Sicilia	3,194	63.9	237	4.7	569	11.4	0.68	8	61
Friuli Venezia Giulia	3,041	250.2	294	24.2	366	30.1	0.95	29	291
Abruzzo	2,948	224.8	324	24.7	505	38.5	0.49	19	219
Bolzano	2,528	2,353.0	278	258.8	232	215.9	0.63	135	312
Umbria	1,393	157.9	68	7.7	56	6.3	1.47	9	ND
Sardegna	1,313	80.1	117	7.1	135	8.2	0.65	5	49
Valle dAosta	1,133	902.0	137	109.1	140	111.5	1.70	189	2,066
Calabria	1,112	57.1	86	4.4	121	6.2	0.53	3	ND
Basilicata	378	67.2	25	4.4	41	7.3	0.64	5	ND
Molise	300	98.2	21	6.9	31	10.1	0.82	8	ND
	Scale								
	Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
	Best	Best	Best	Best	Best	Best	0.0	0	0

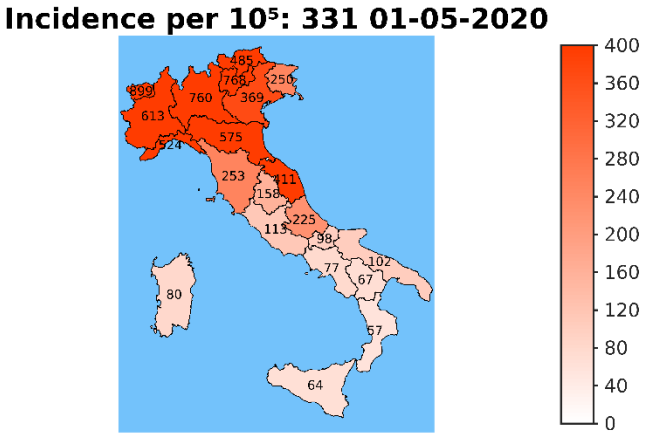
Spain

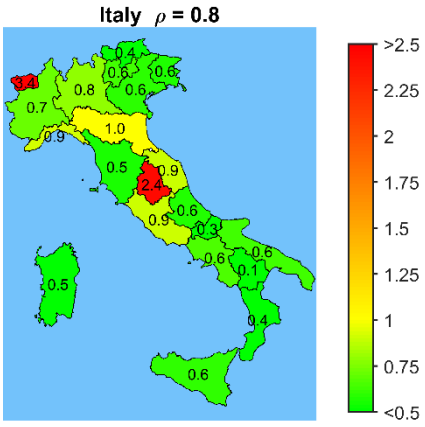
	Reported data						Indexes		
Autonomous regions	Cumulative cases	Attack rate /10^5 inh.	Cumulated deaths	Mortality rate /10^5 inh.	Active cases (last 14 days)	14-day attack rate /10^5 inh.	ρ_7 [1]	EPG_{REP} [2]	EPG_{EST} [3]
Madrid	61,829	931.1	8,222	123.8	9,836	148.1	0.72	107	1,492
Catalunya	49,307	651.8	5,061	66.9	10,991	145.3	0.63	92	962
Castilla y Leon	16,993	705.7	1,770	73.5	2,909	120.8	0.92	111	1,211
Castilla-La Mancha	15,910	781.6	2,498	122.7	1,387	68.1	0.86	59	946
Euskadi	12,824	588.8	1,312	60.2	1,334	61.2	3.48	213	2,350
Andalucia	12,161	144.3	1,238	14.7	1,489	17.7	0.78	14	148
Comunitat Valenciana	10,347	208.0	1,245	25.0	861	17.3	0.95	16	200
Galicia	8,848	327.7	555	20.6	835	30.9	NA	NA	NA
Aragon	5,116	387.3	749	56.7	627	47.5	0.7	35	551
Navarra	4,848	745.9	458	70.5	520	80.0	0.92	74	753
La Rioja	3,936	1,255.2	333	106.2	389	124.1	0.81	101	865
Extremadura	2,811	263.9	451	42.3	155	14.5	1.40	20	380
Asturias	2,298	224.8	273	26.7	174	17.0	0.81	14	179
Canarias	2,206	99.9	136	6.2	197	8.9	0.72	6	41
Cantabria	2,184	375.5	192	33.0	300	51.6	0.92	48	457
Baleares	1,894	159.5	193	16.2	226	19.0	0.6	12	130
Murcia	1,488	100.0	132	8.9	65	4.4	0.64	3	24
Melilla	115	135.8	2	2.4	11	13.0	ND	ND	ND
Ceuta	101	119.0	4	4.7	3	3.5	ND	ND	ND
	Scale								
	Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
	Best	Best	Best	Best	Best	Best	0.0	0	0

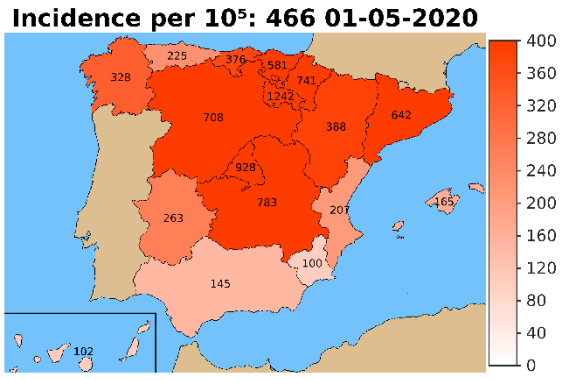
[1] ρ_3 is the average of 7 consecutive ρ, but can still fluctuate. [2] EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10^5 inhabitants (i.e. density of cases) by ρ_3 (a value related with effective reproduction number and that, therefore,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

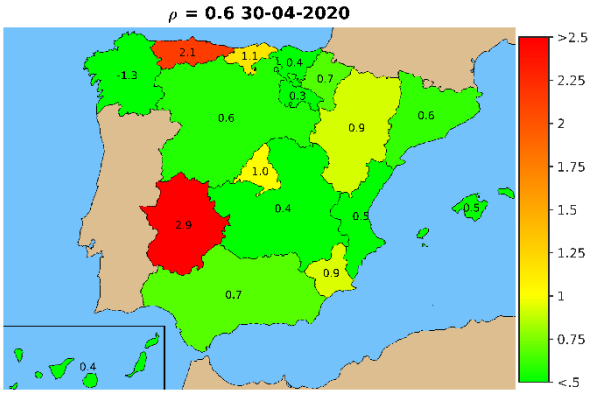
Maps of Italian and Spanish regions

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





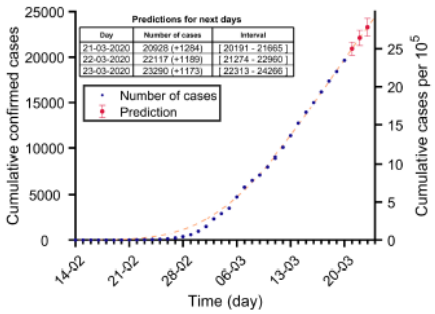


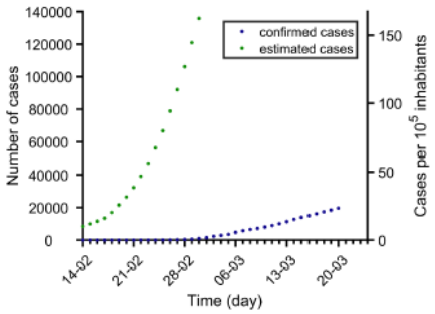


Legend: Countries' reports details

Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: $23/10^5$

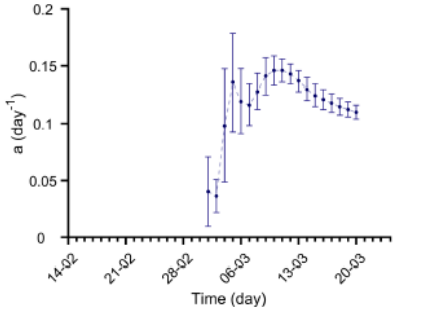
Confirmed cases: data (blue), model fitted (dashed line), predictions (red points and table)

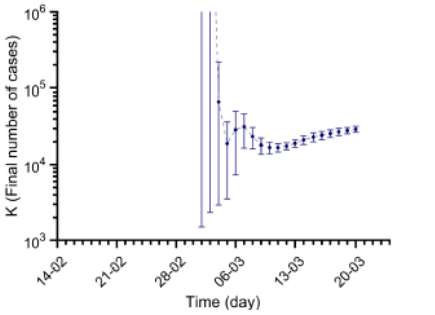




Estimated cases using death rate (see Methods)

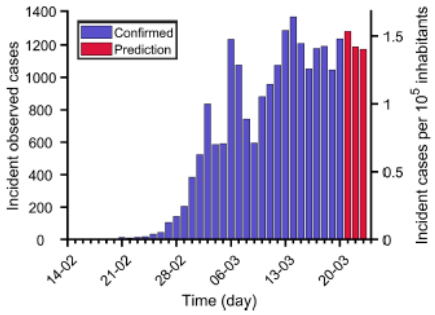
Fitted *a* value using points prior to each date

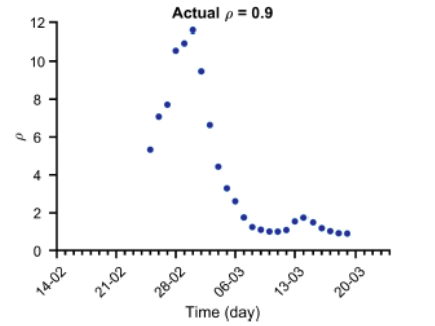




Fitted *K* value using points prior to each date

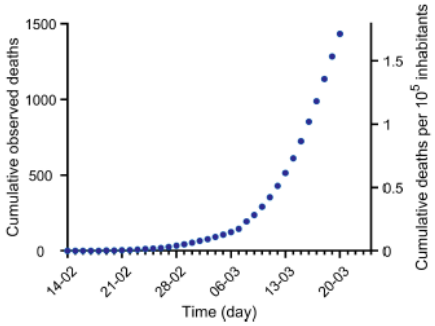
Reported and predicted new cases

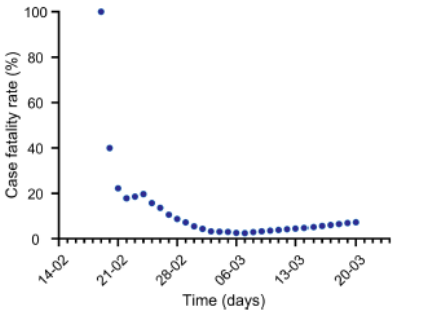




Evolution of ρ, a parameter related with Reproduction number (see Methods)

Reported deaths



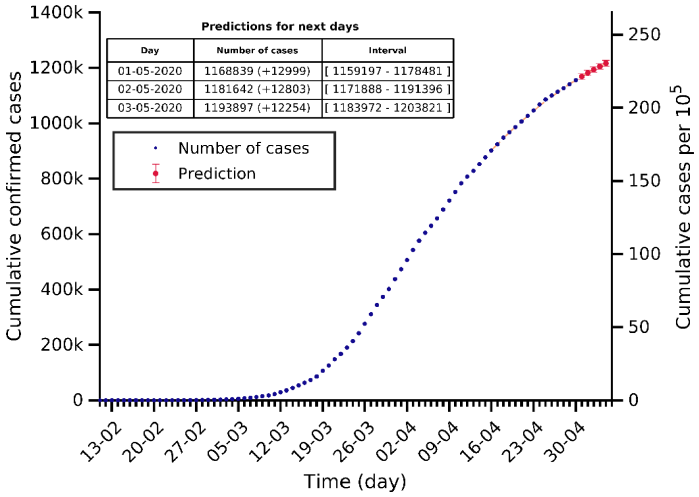


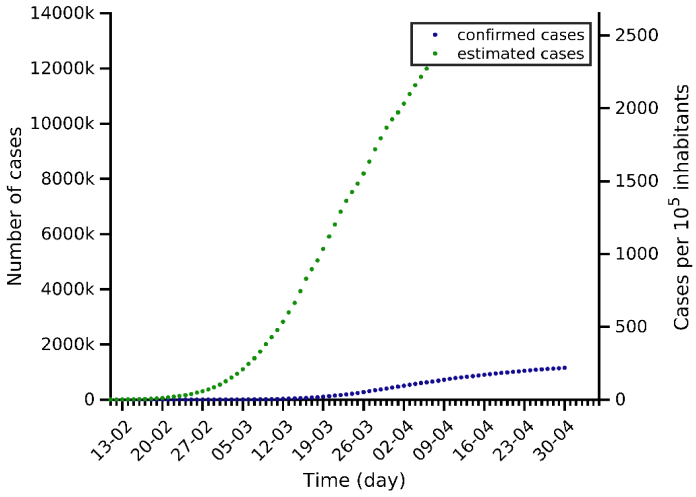
Deaths / cumulated reported cases

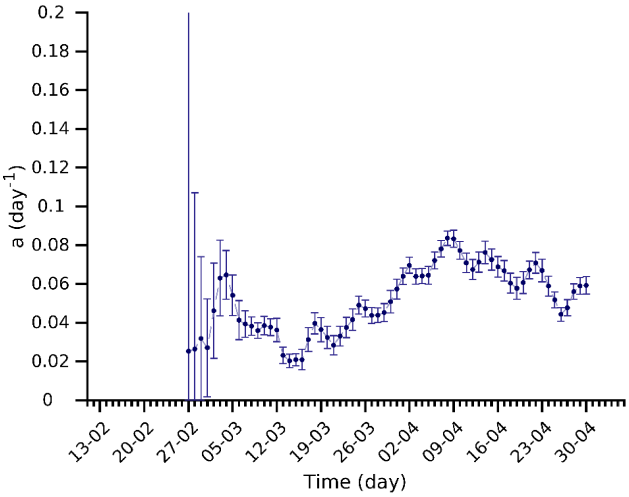
(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

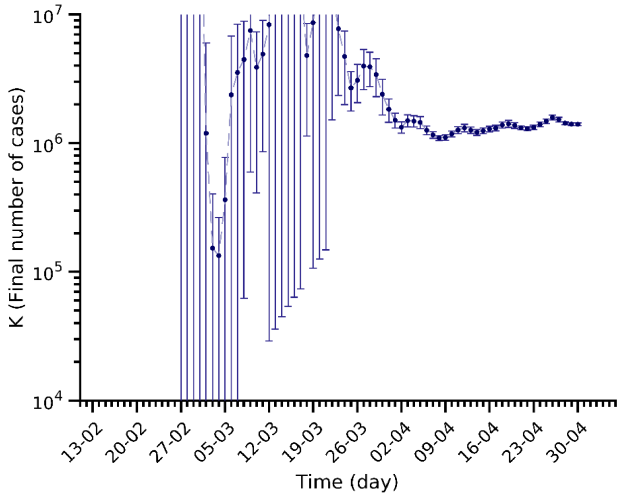
Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

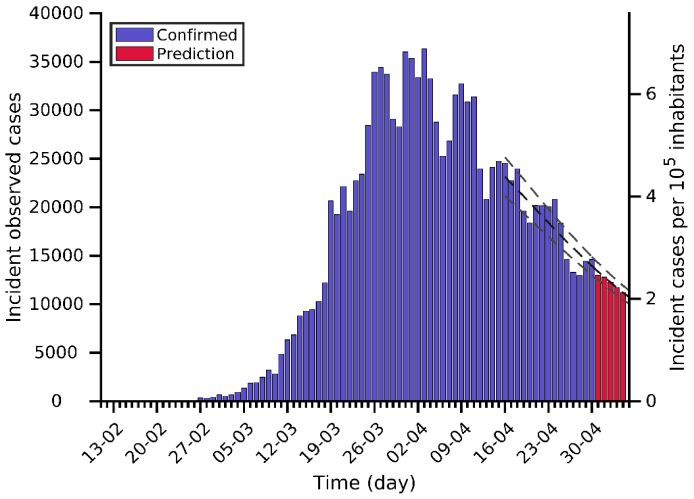
EU+EFTA+UK 30-04-2020. Population: 527.9M. Current cumulated incidence: 219/1

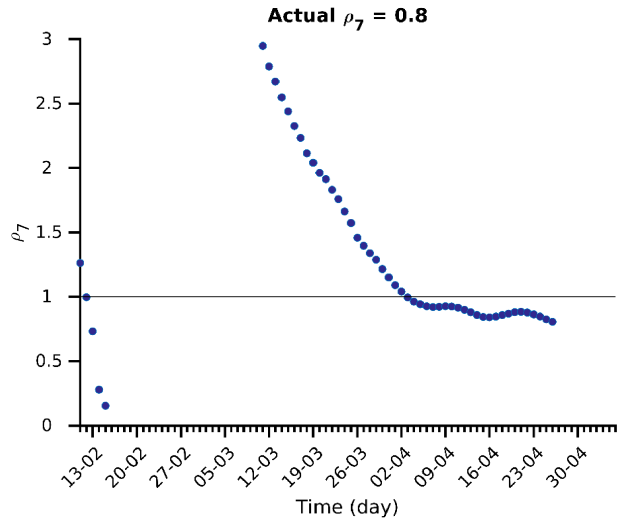


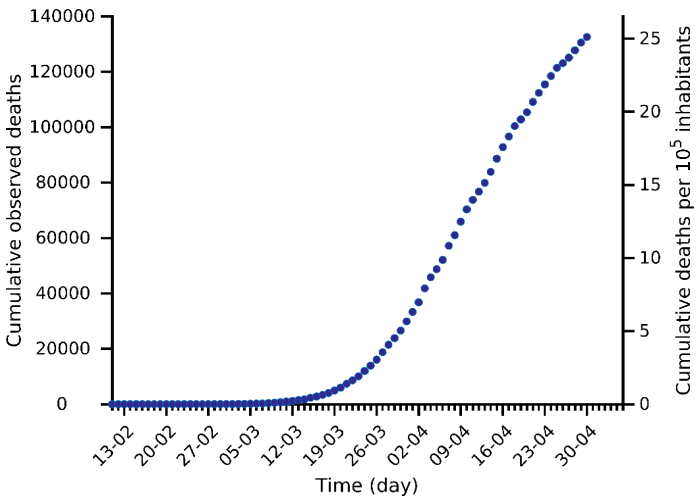


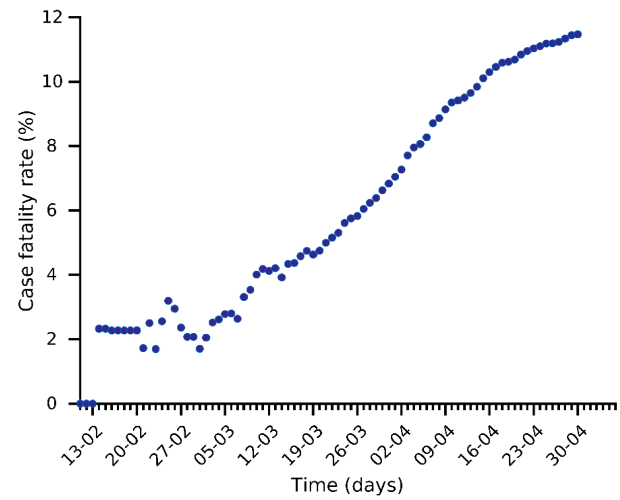




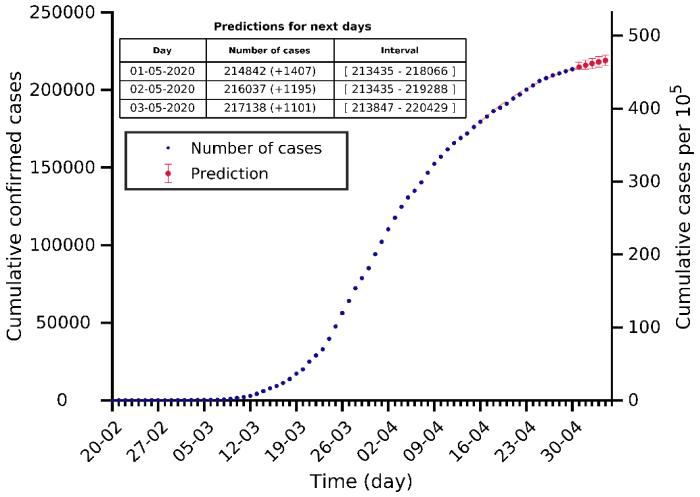


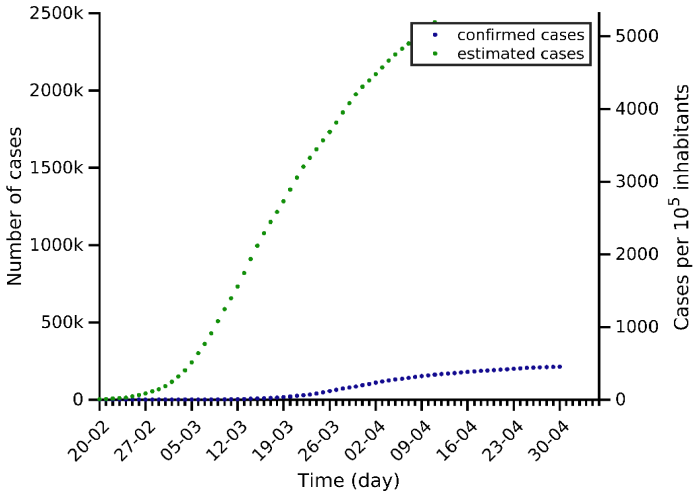


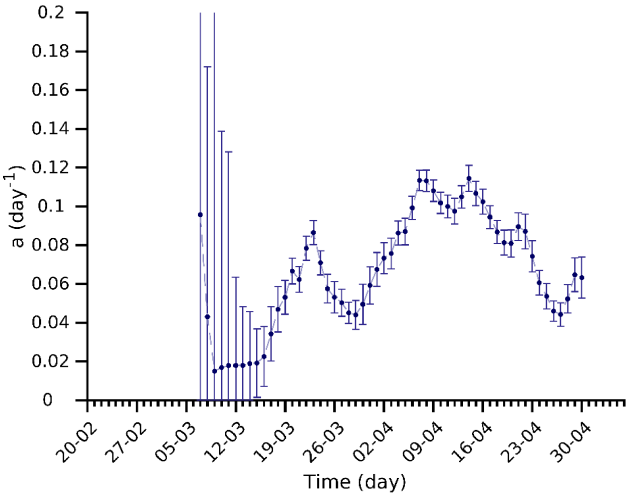


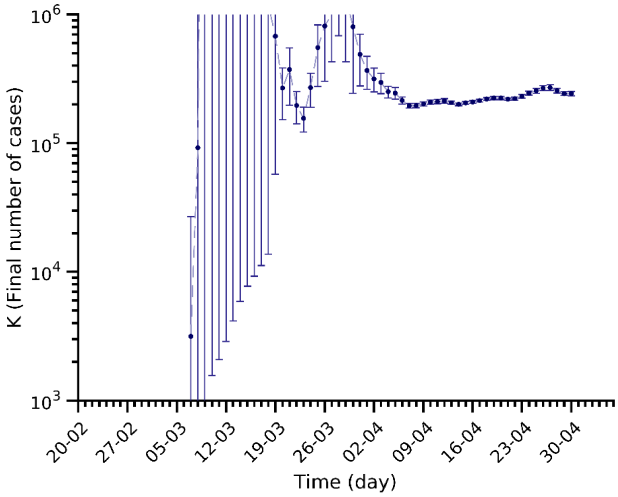


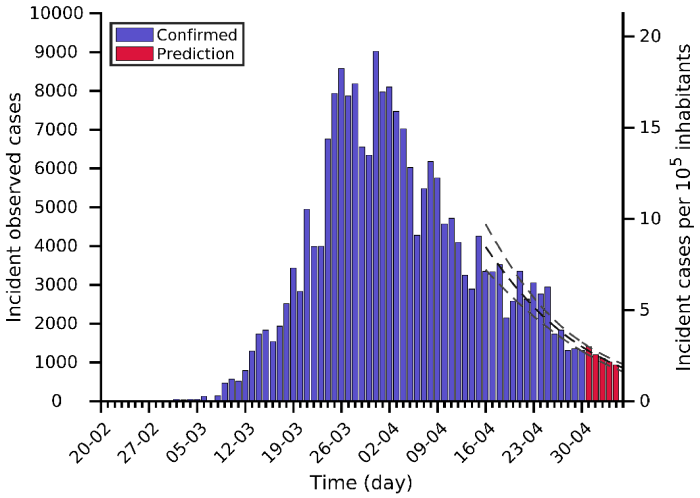
Spain 30-04-2020. Population: 47.0M. Current cumulated incidence: 454/10^5

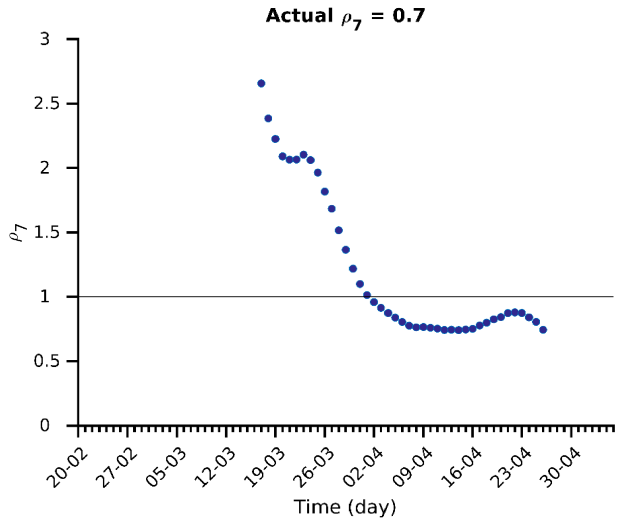


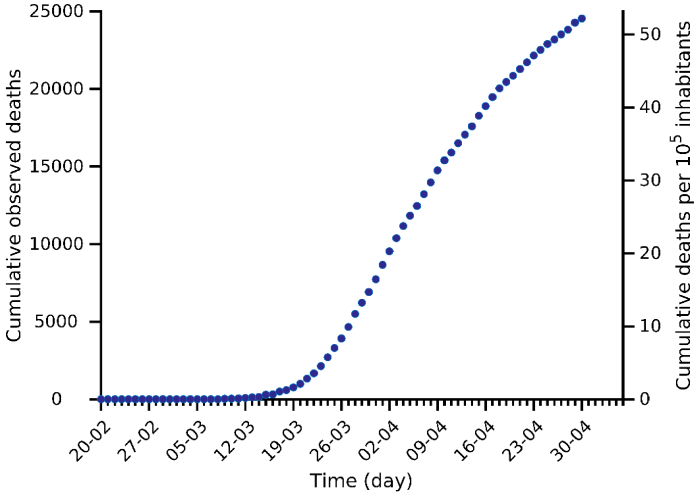


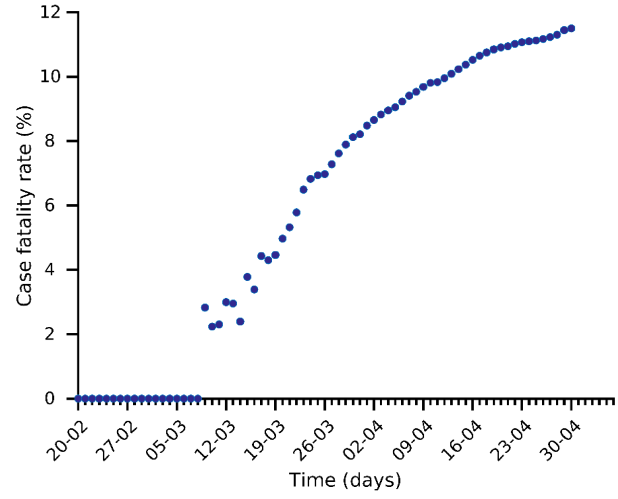




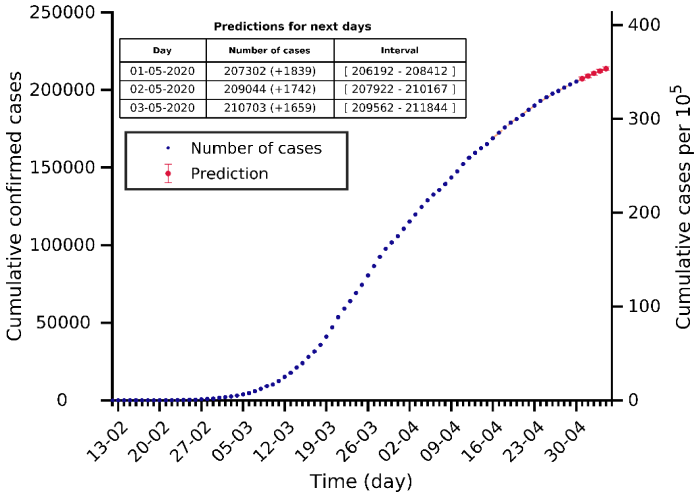


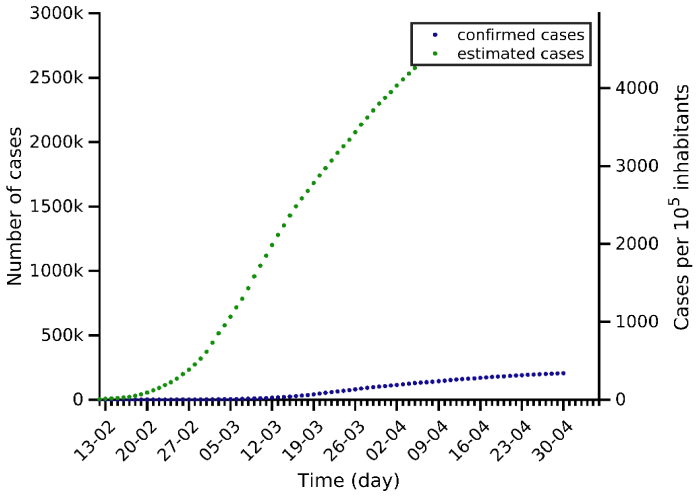


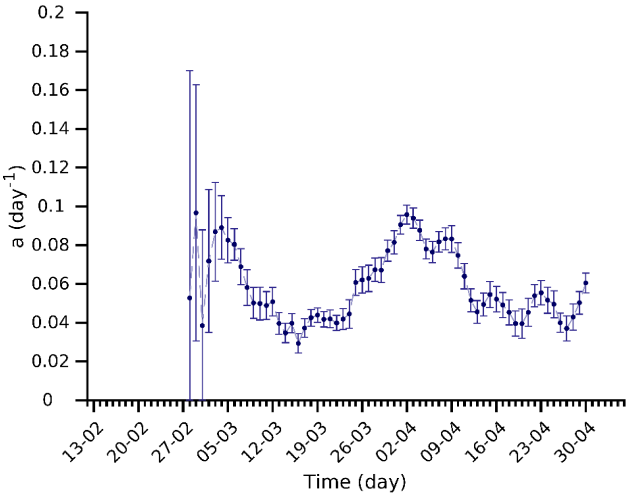


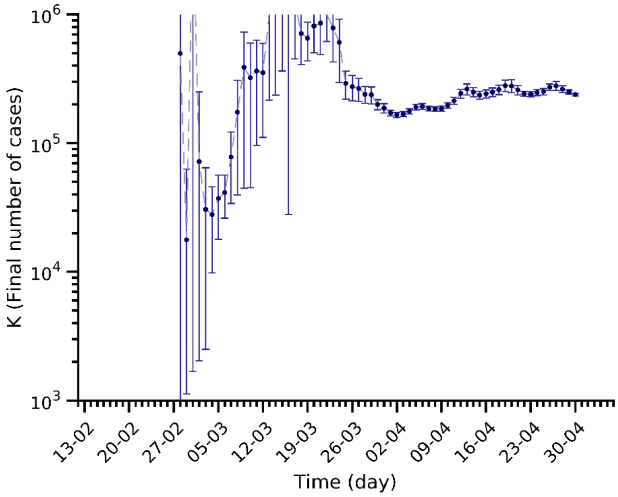


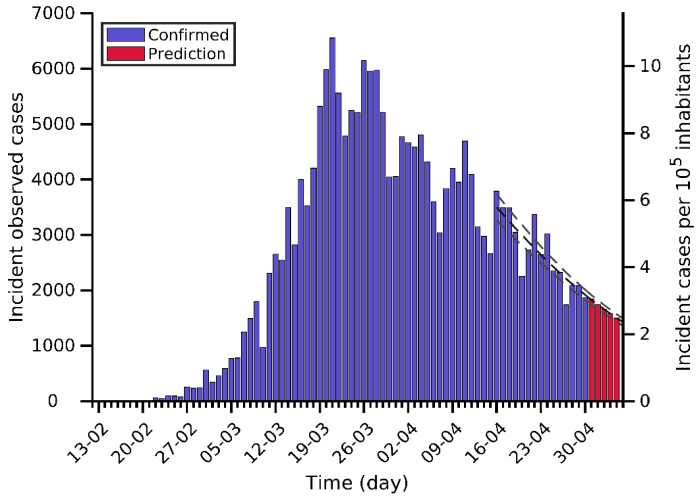
Italy 30-04-2020. Population: 60.5M. Current cumulated incidence: 340/10^5

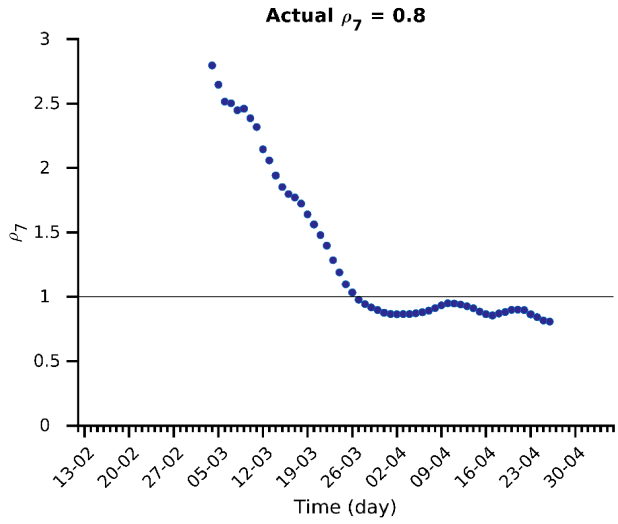


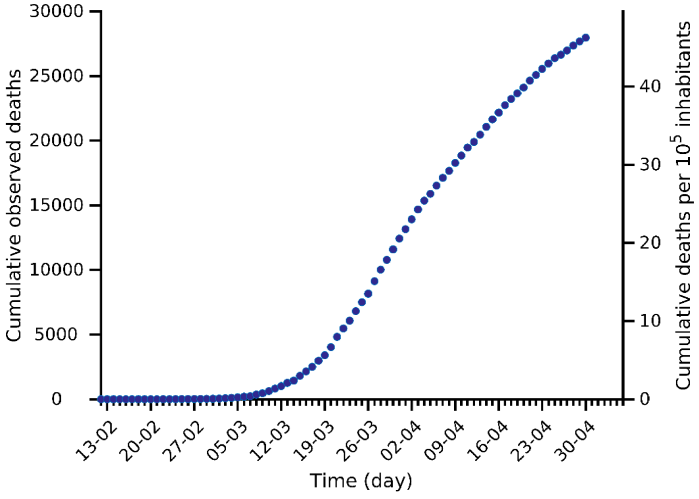


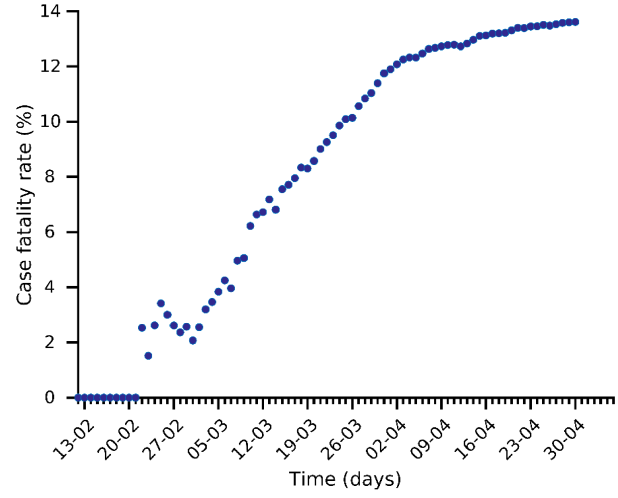




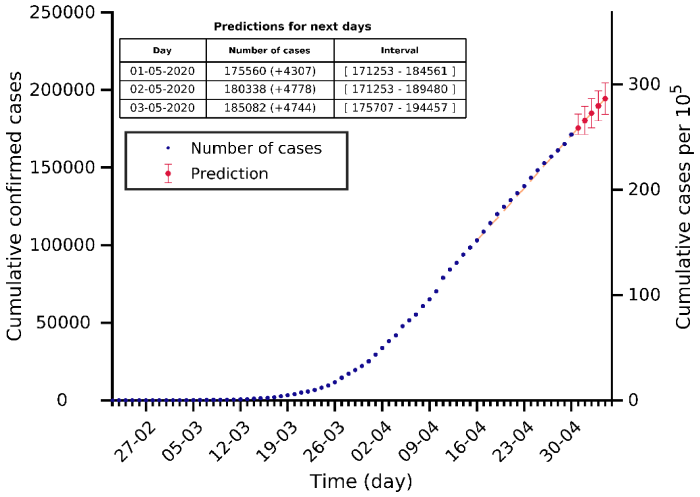


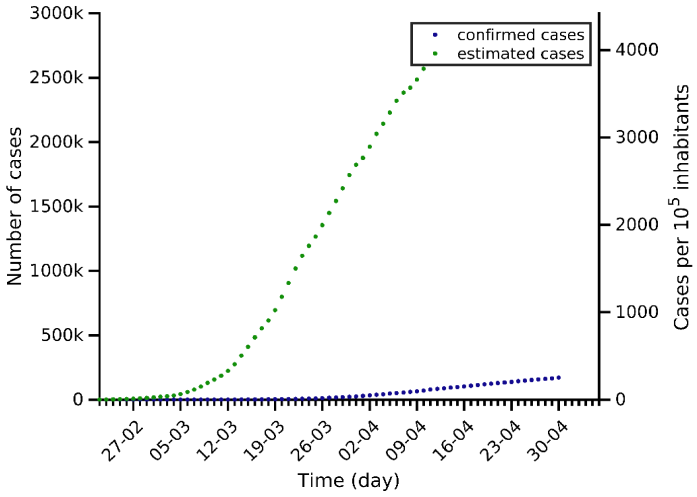


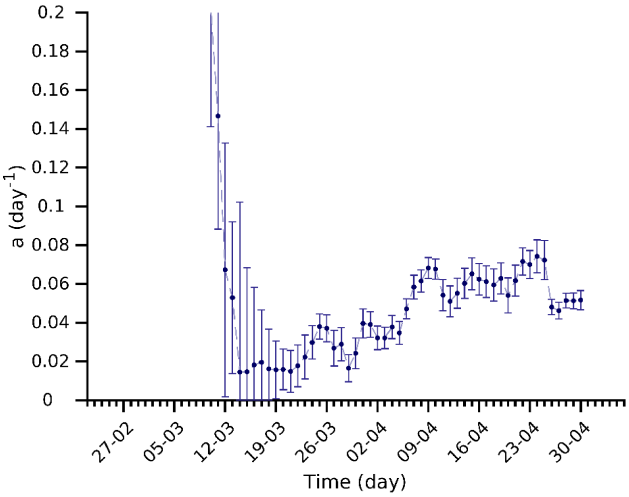


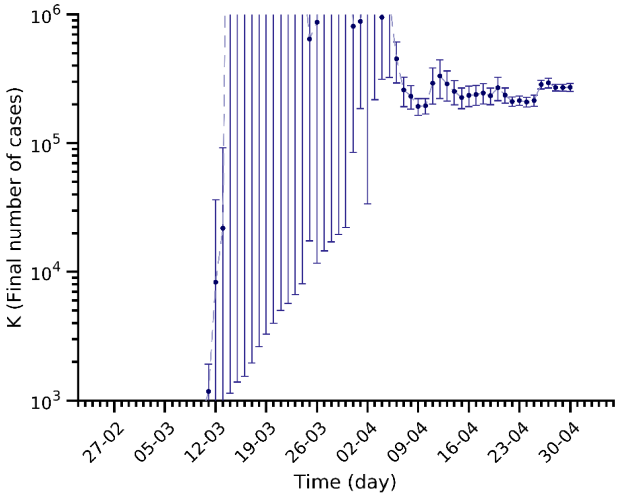


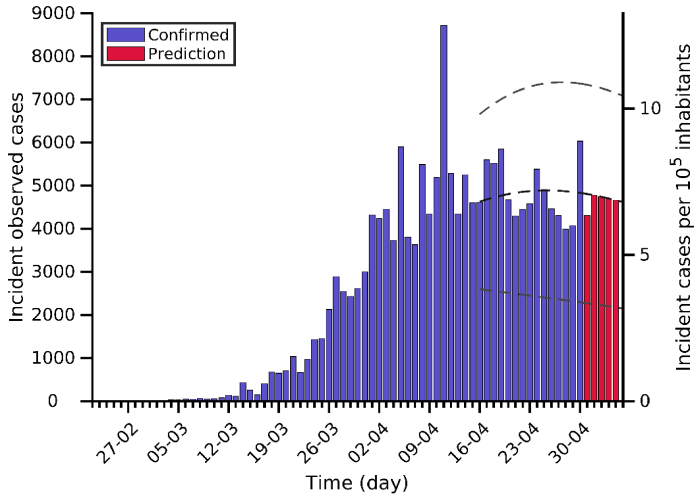
UK 30-04-2020. Population: 67.9M. Current cumulated incidence: 252/10^5

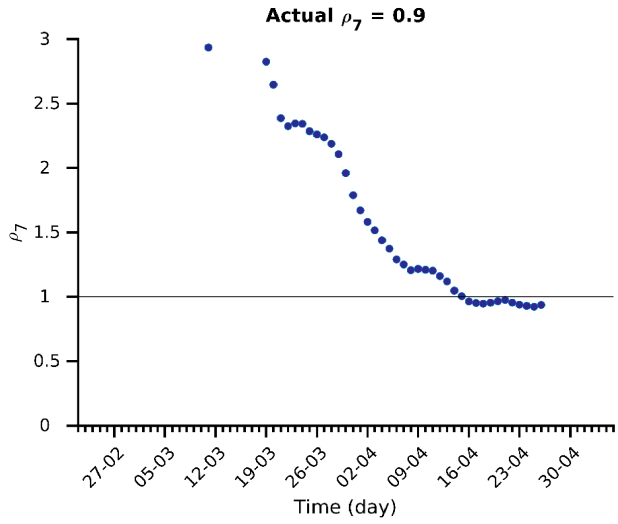


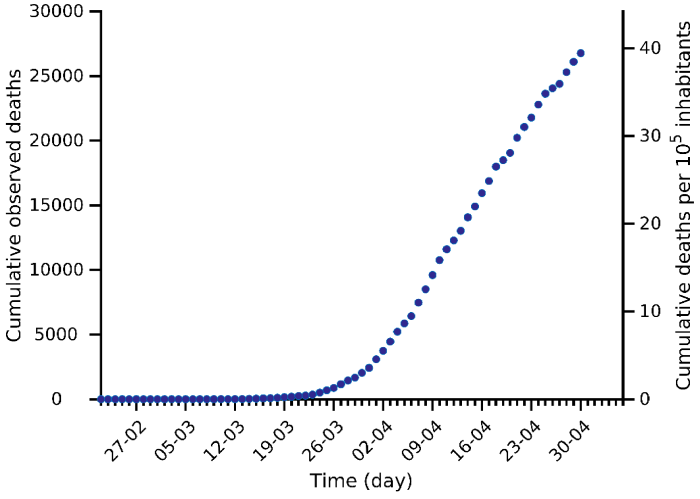


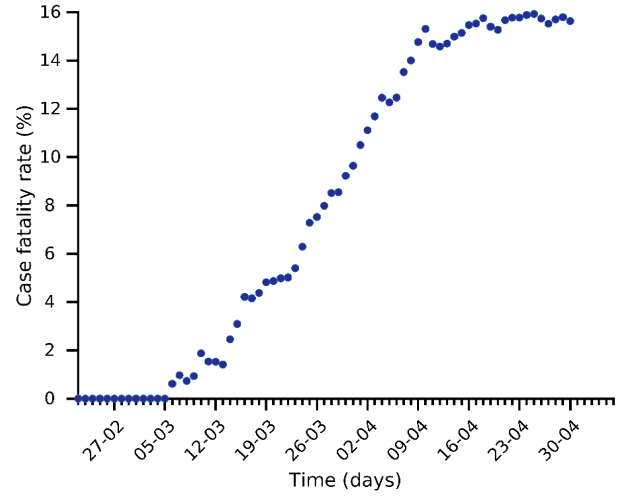




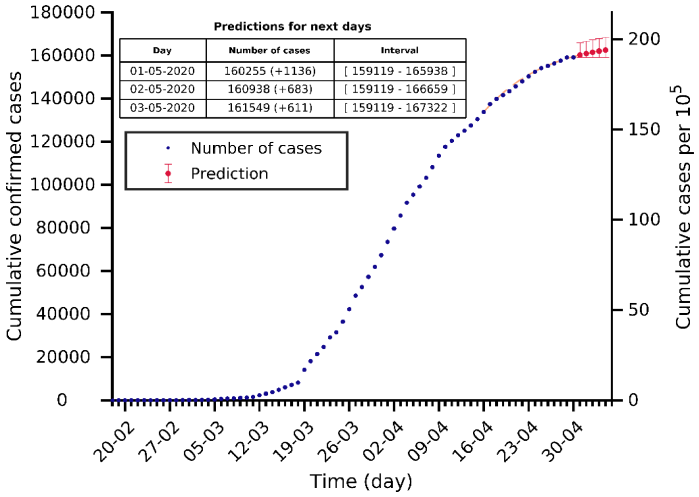


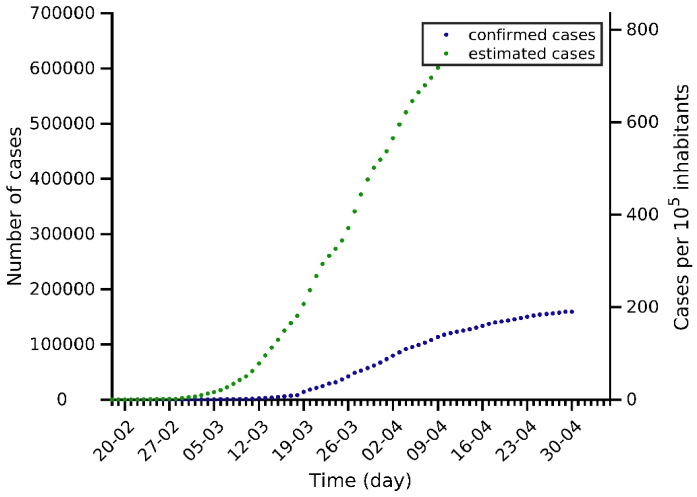


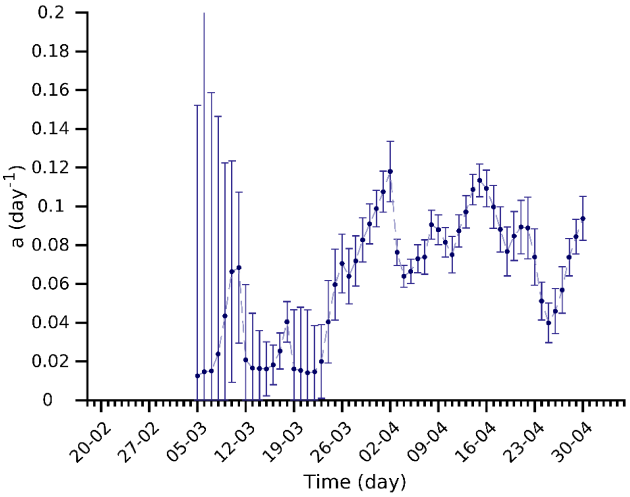


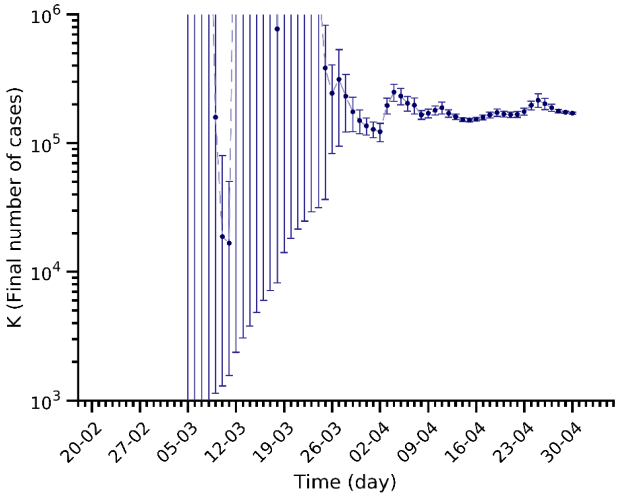


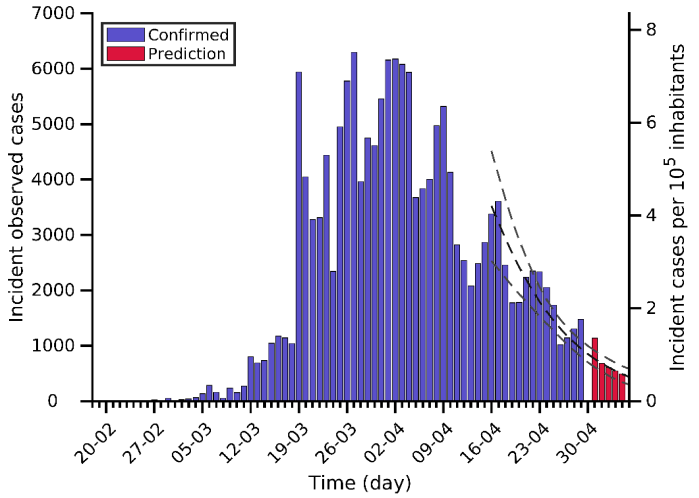
Germany 30-04-2020. Population: 83.8M. Current cumulated incidence: 190/10⁵

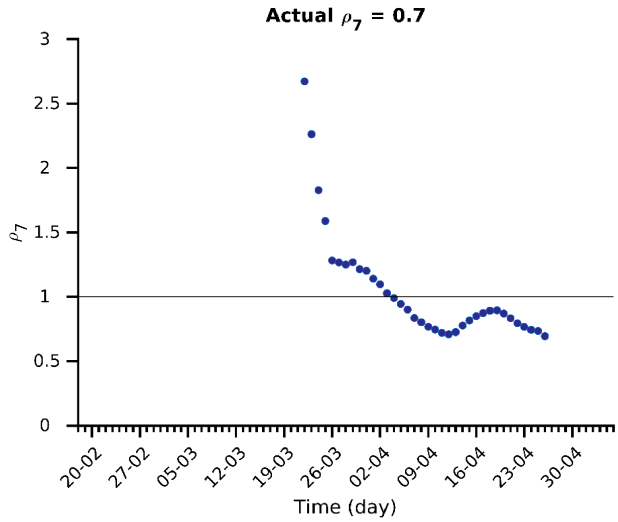


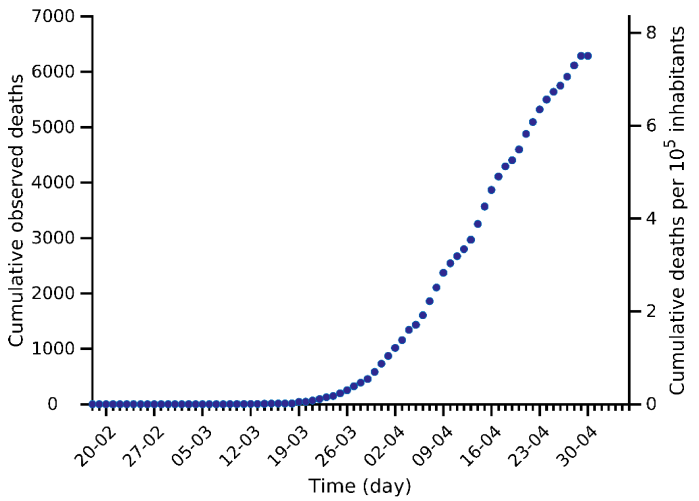


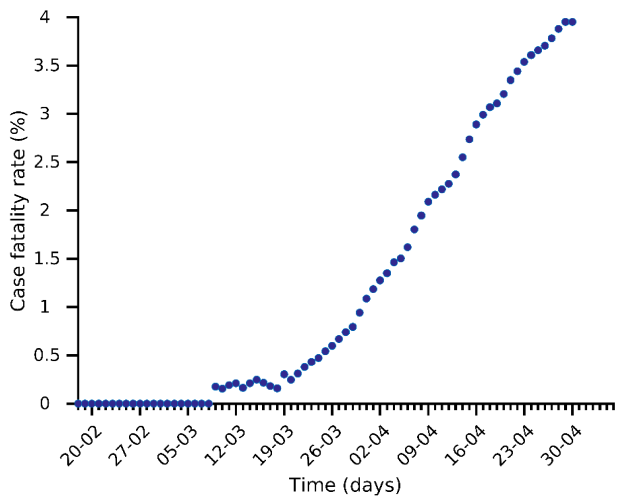




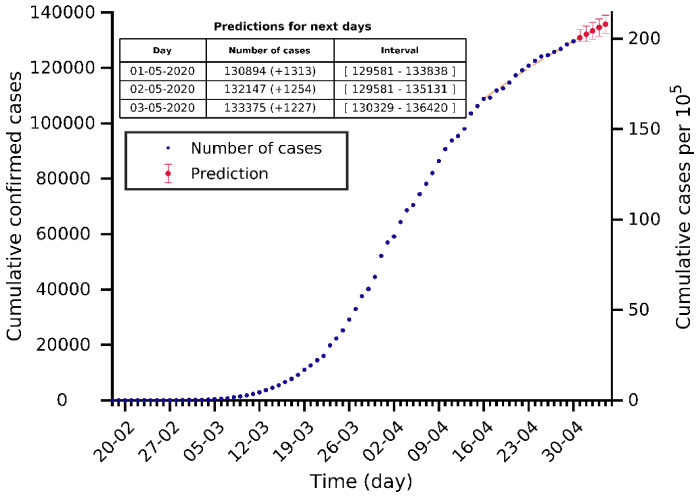


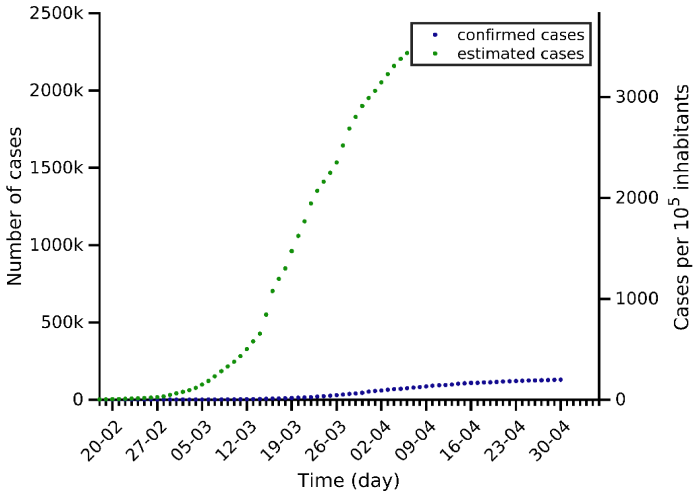


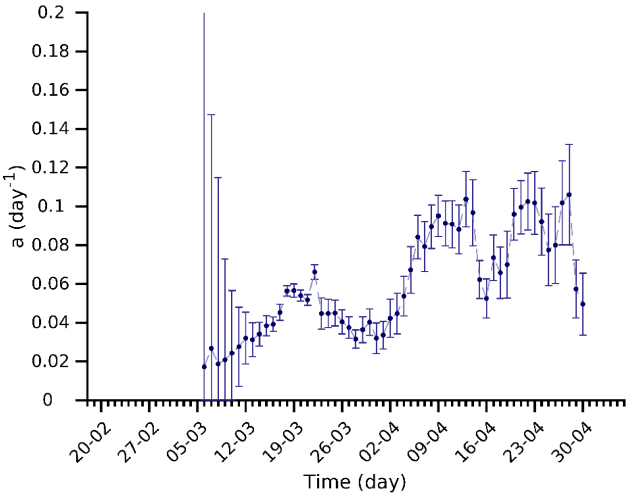


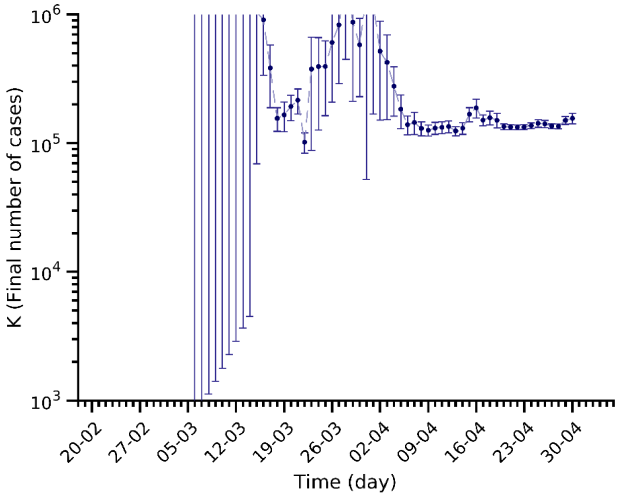


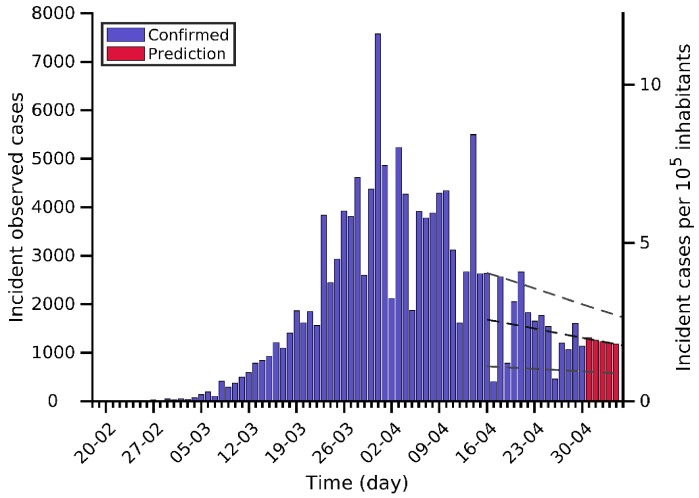
France 30-04-2020. Population: 65.3M. Current cumulated incidence: 199/10^5

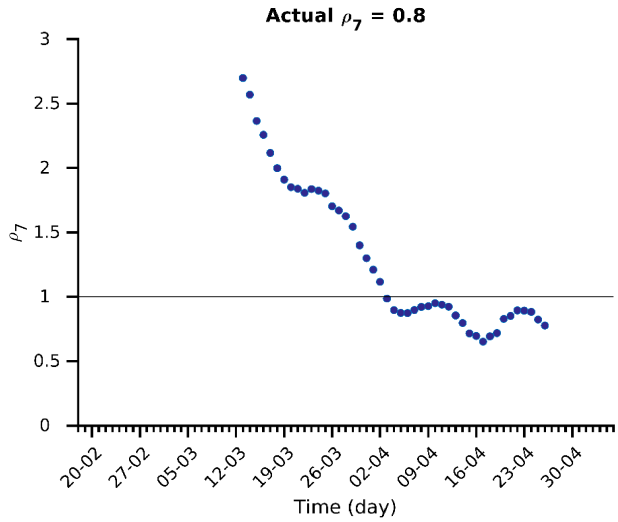


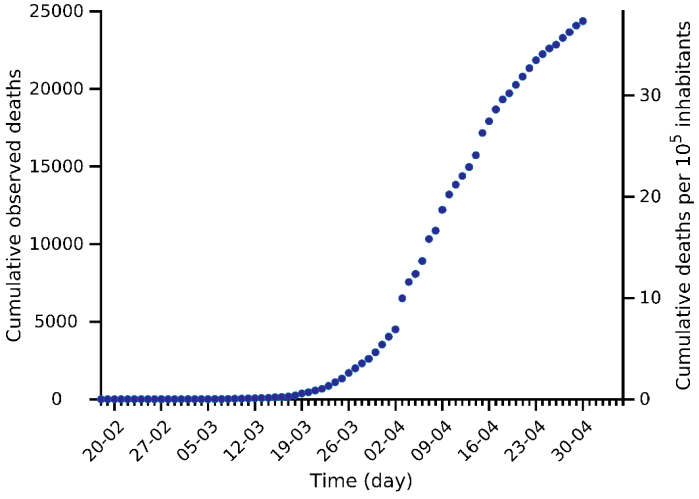


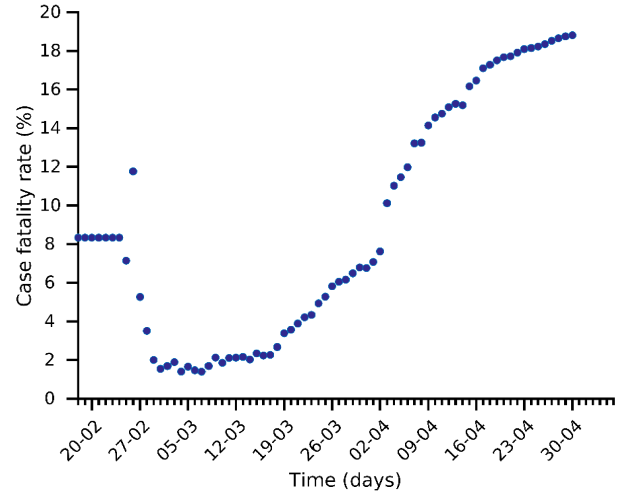




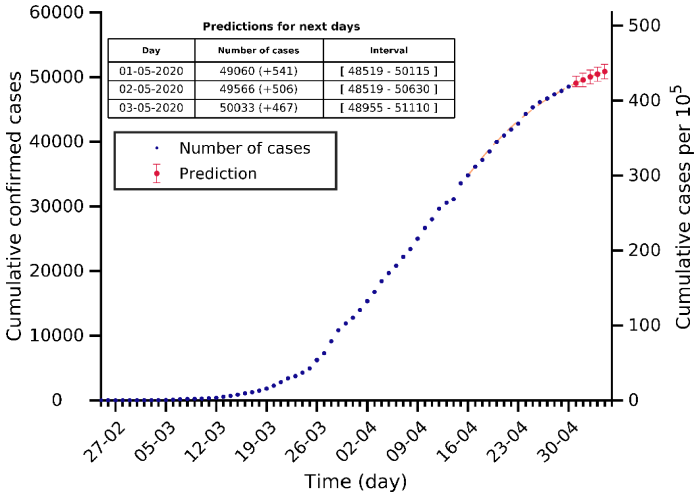


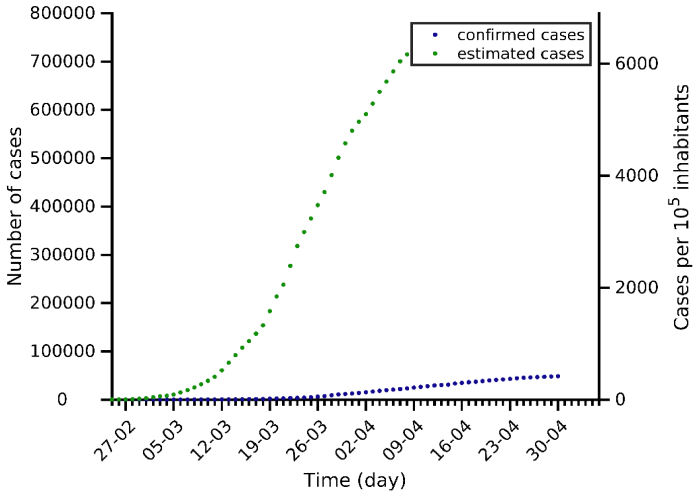


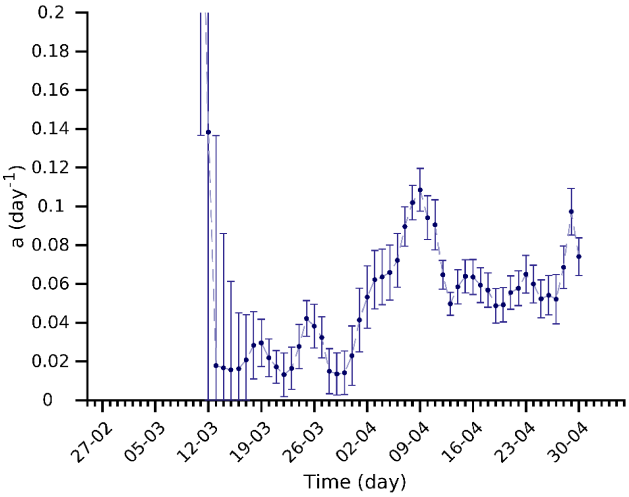


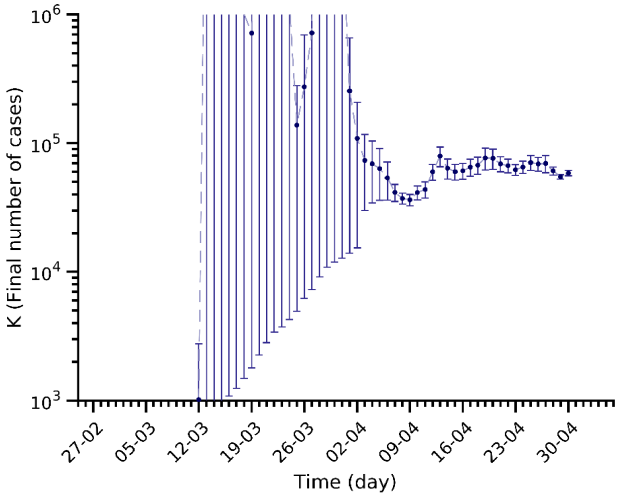


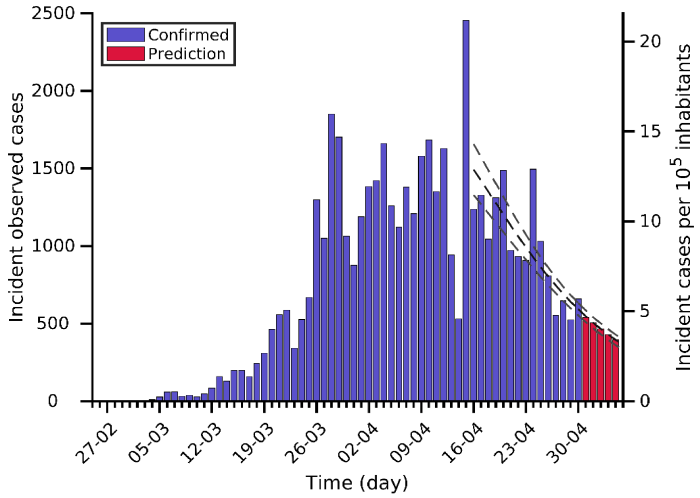
Belgium 30-04-2020. Population: 11.6M. Current cumulated incidence: 419/10^5

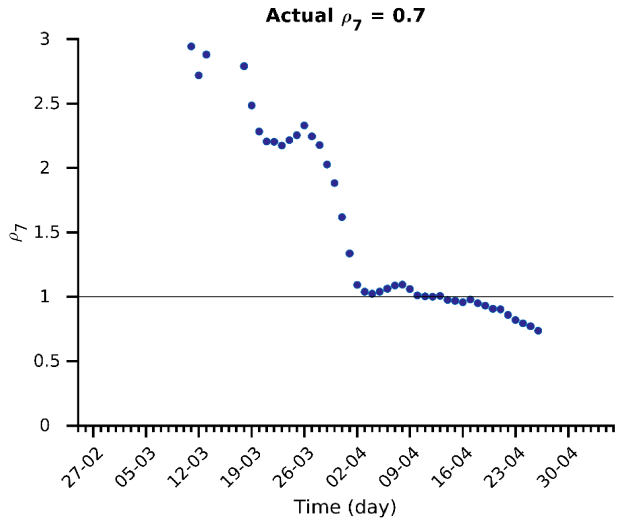


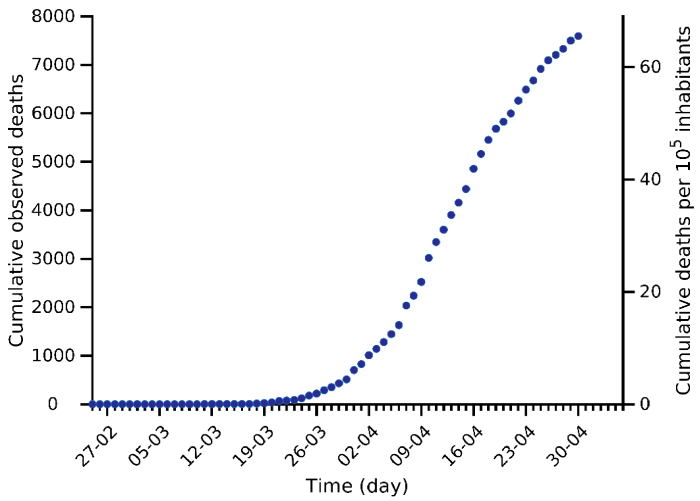


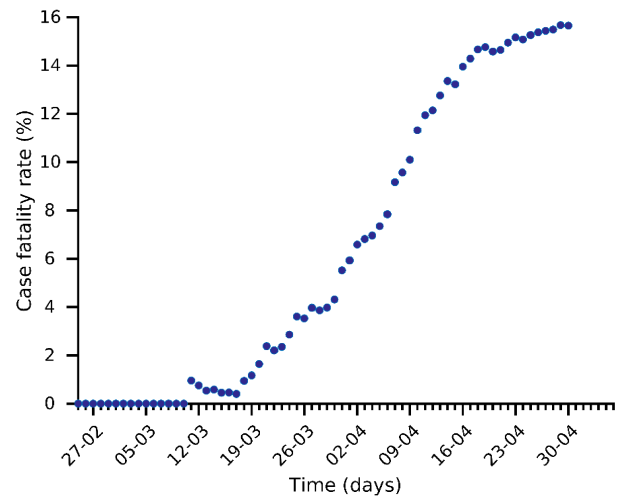




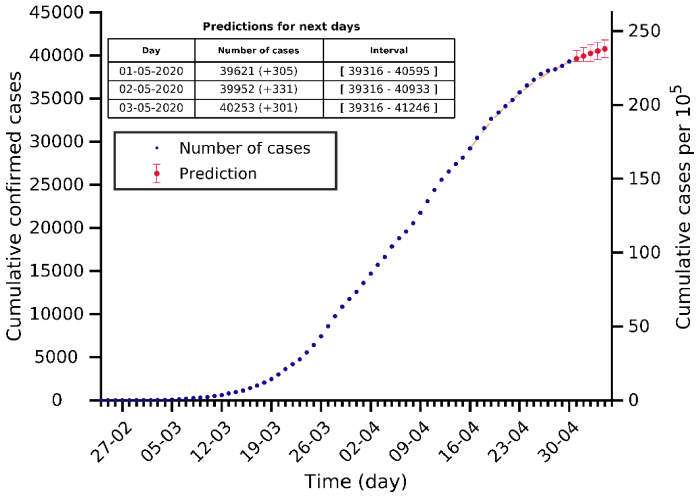


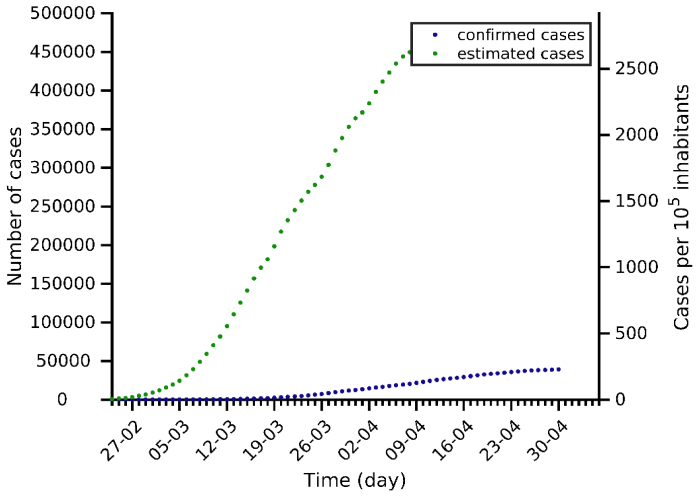


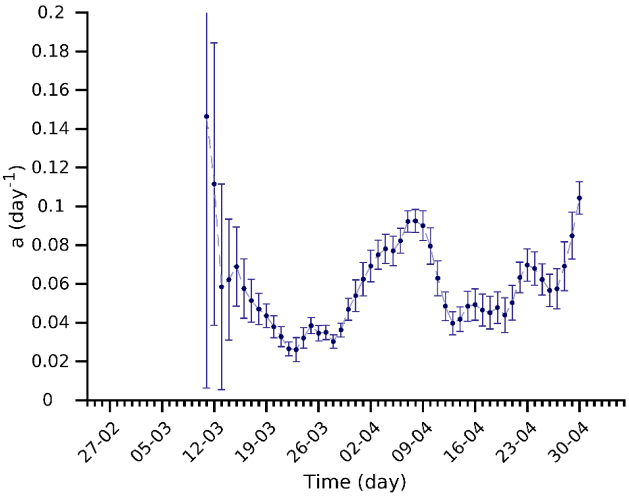


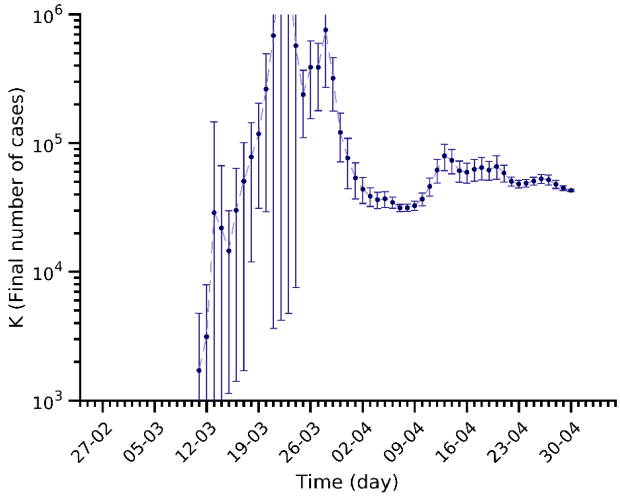


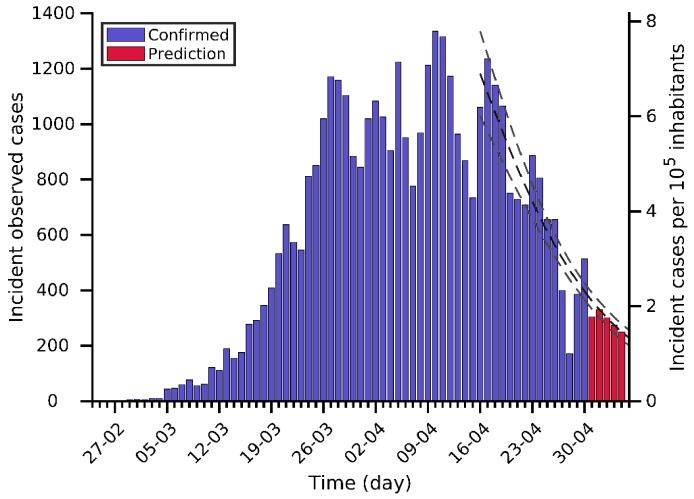
Netherlands 30-04-2020. Population: 17.1M. Current cumulated incidence: 229/10^5

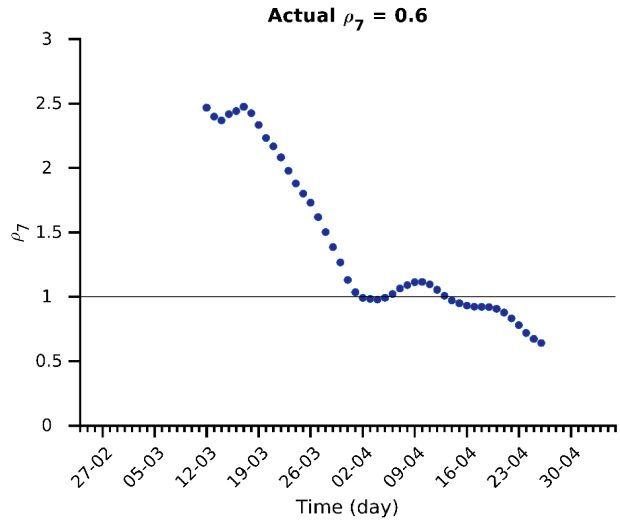


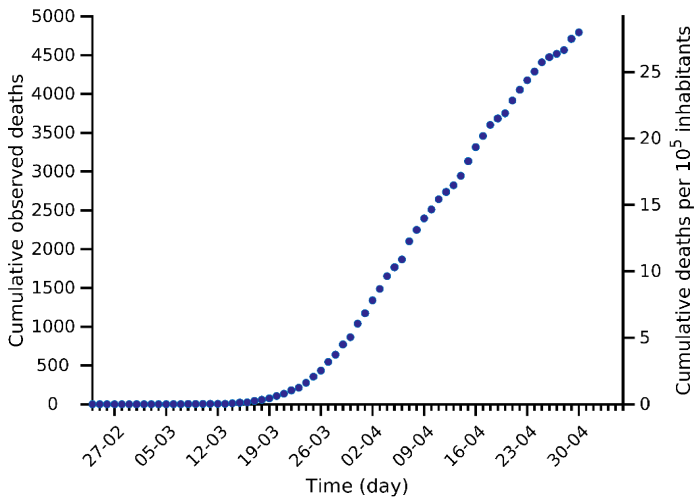


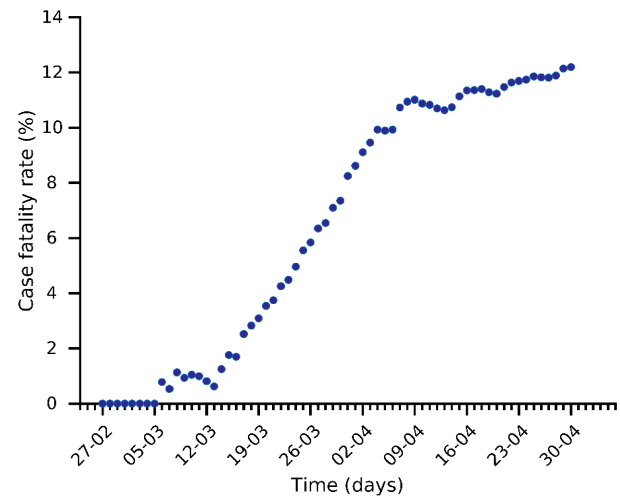




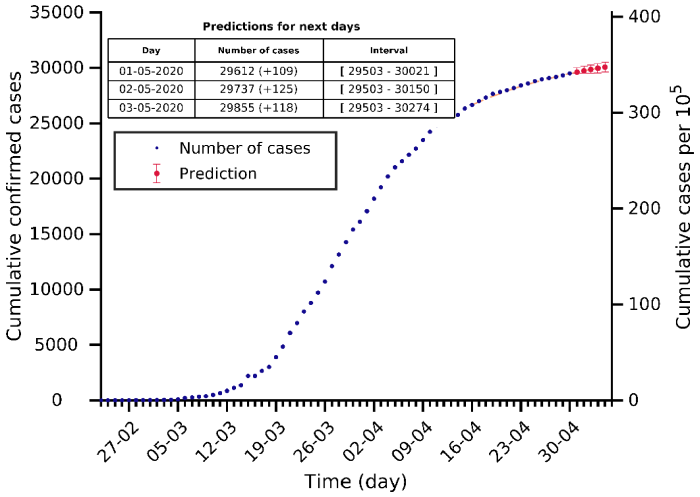


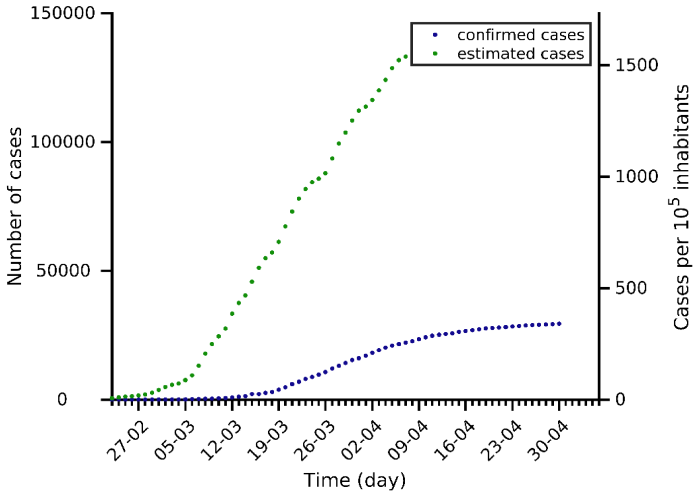


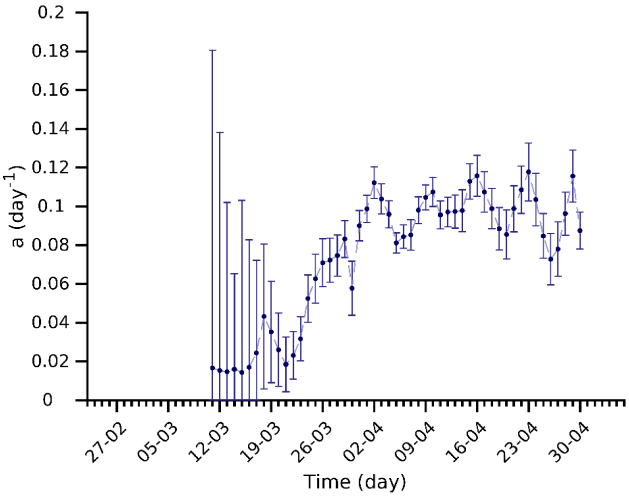


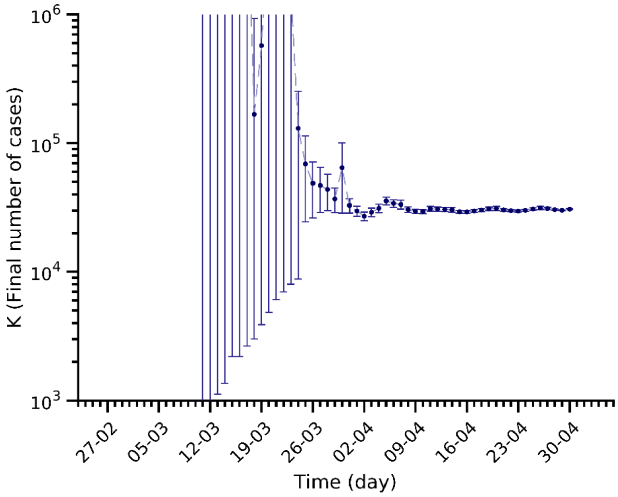


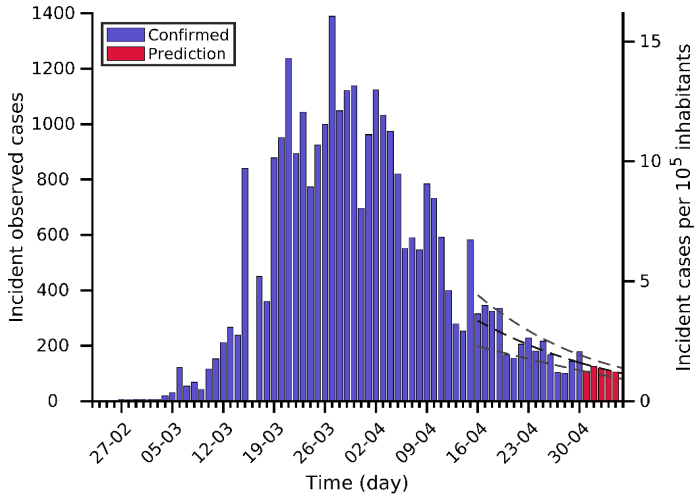
Switzerland 30-04-2020. Population: 8.7M. Current cumulated incidence: 341/10⁵

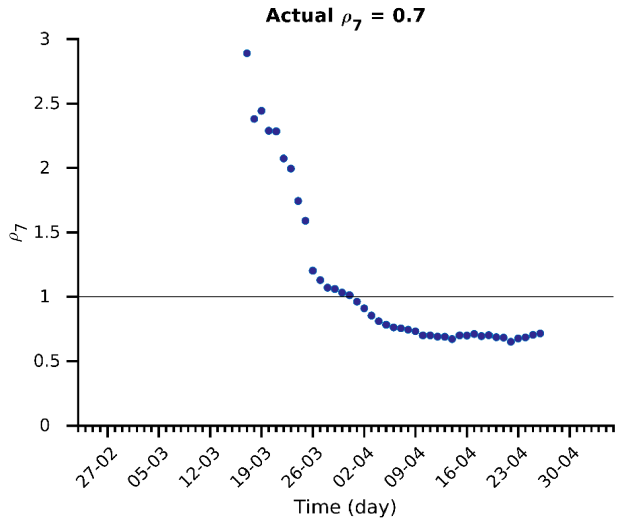


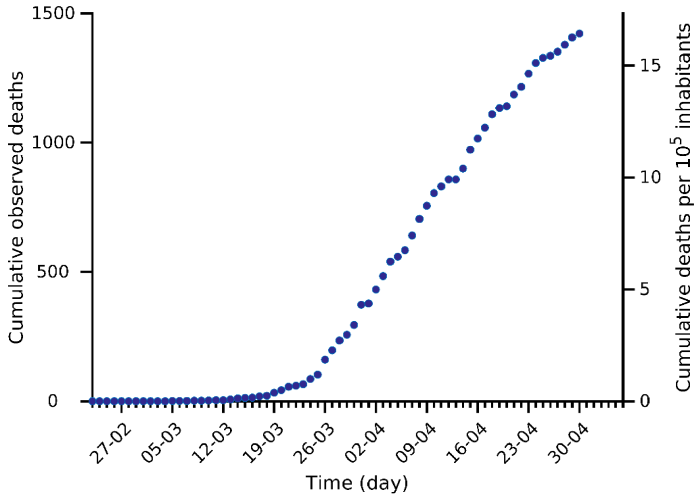


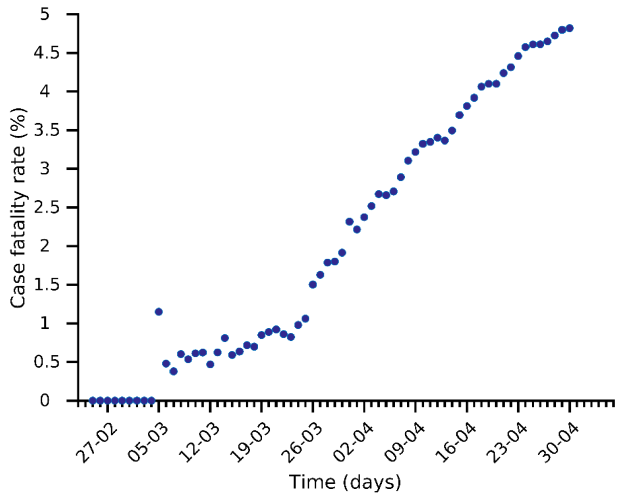




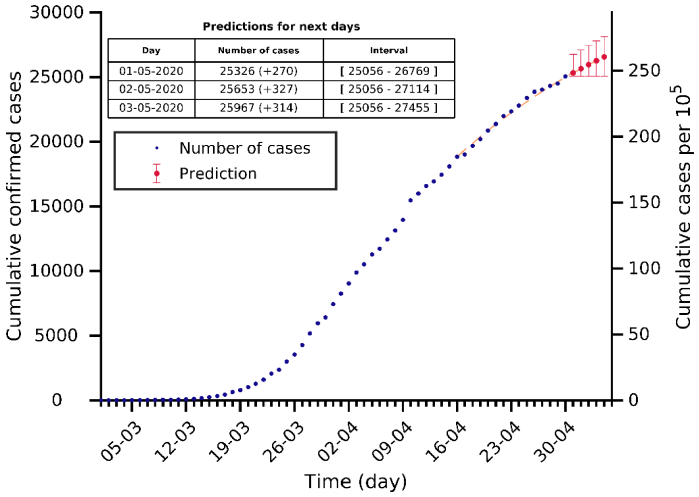


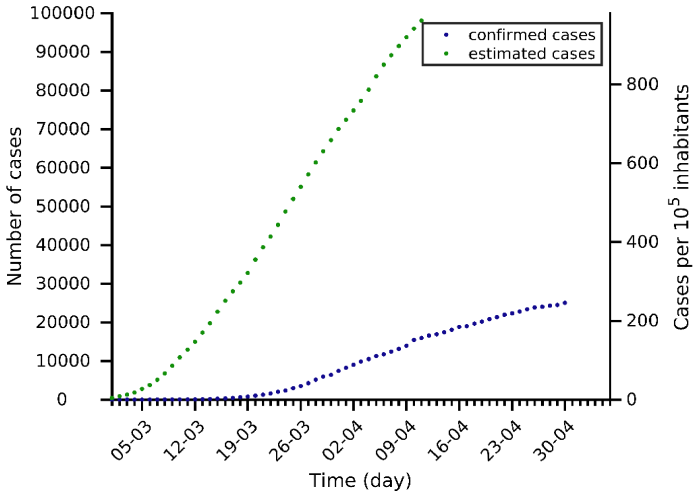


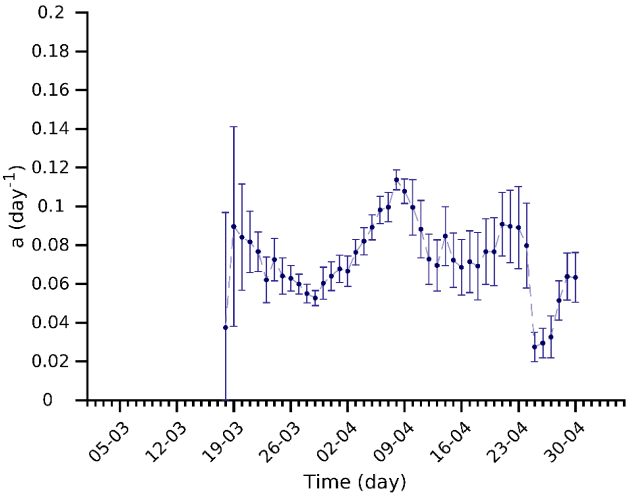


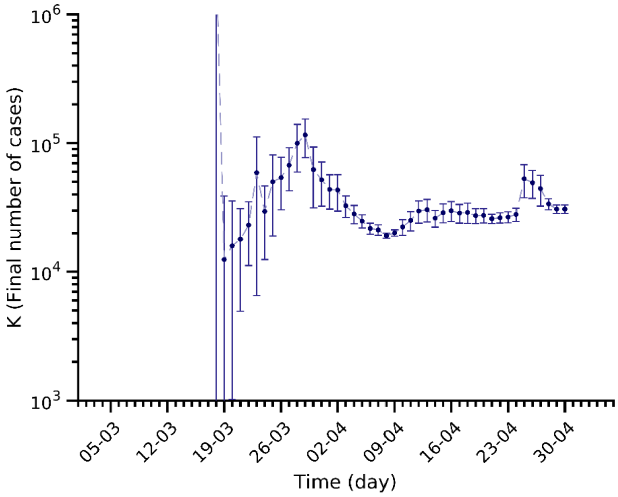


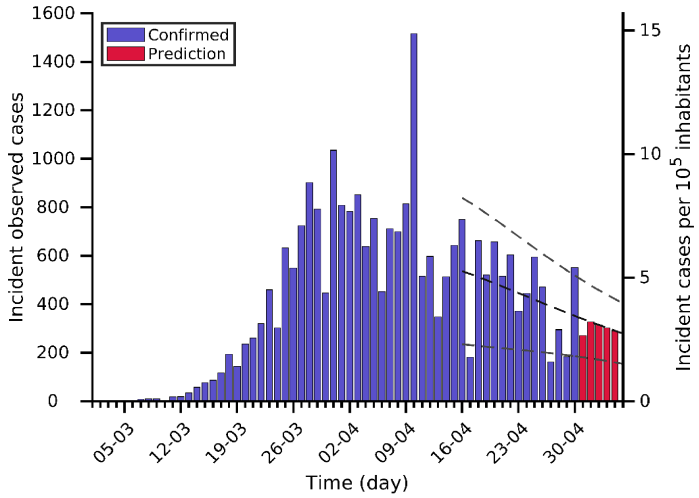
Portugal 30-04-2020. Population: 10.2M. Current cumulated incidence: 246/10⁵

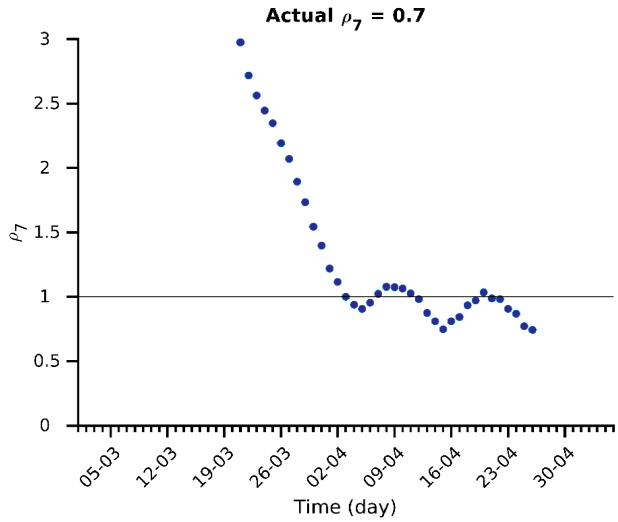


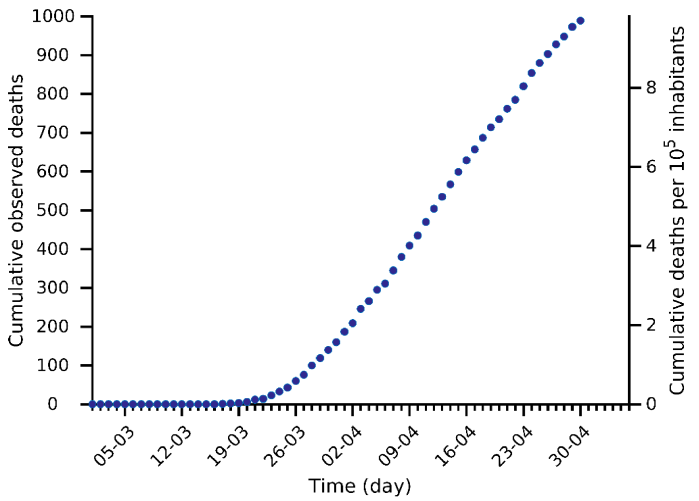


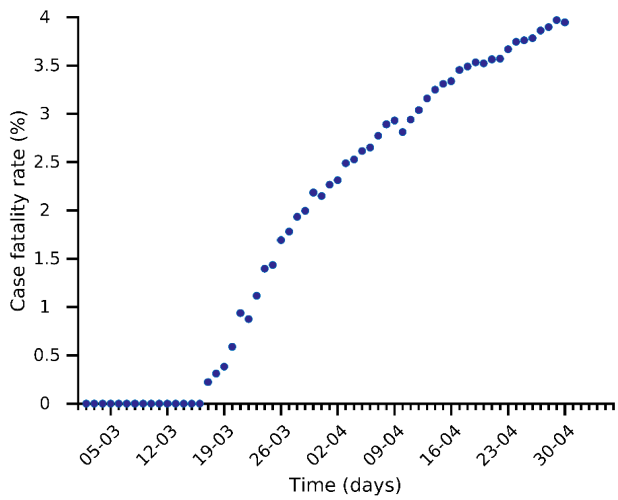




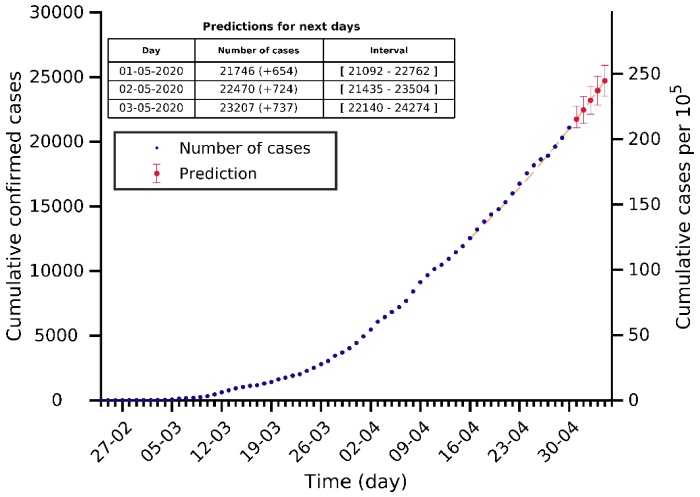


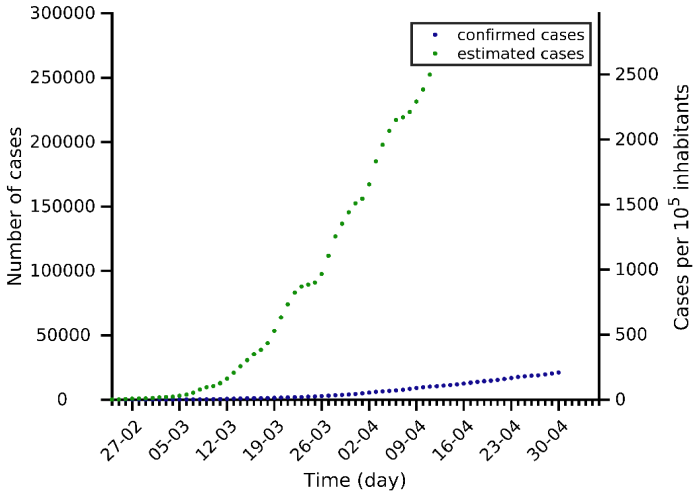


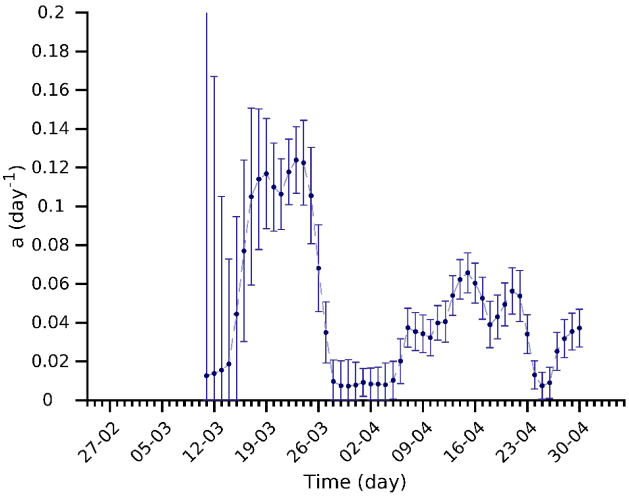


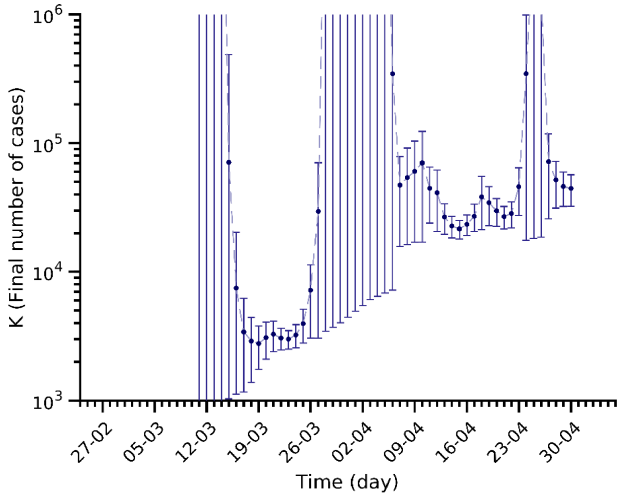


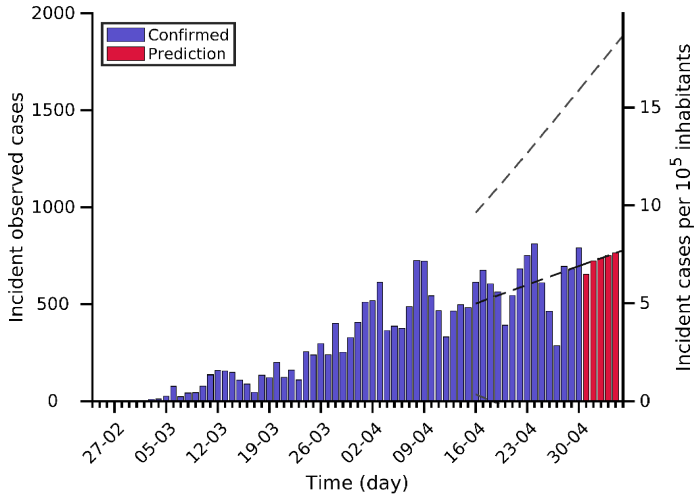
Sweden 30-04-2020. Population: 10.1M. Current cumulated incidence: 209/10⁵

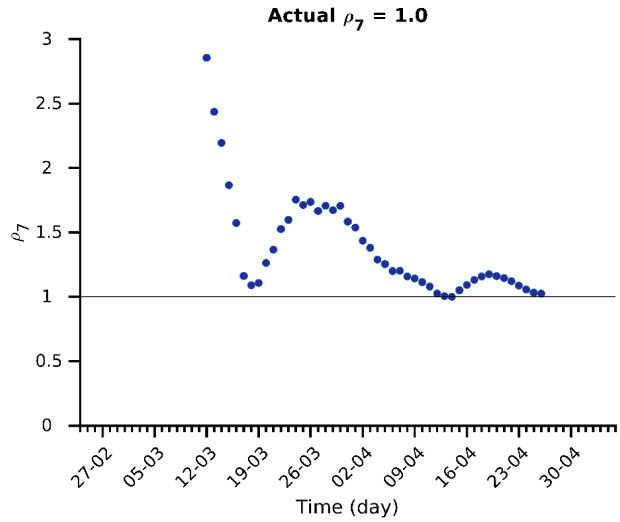


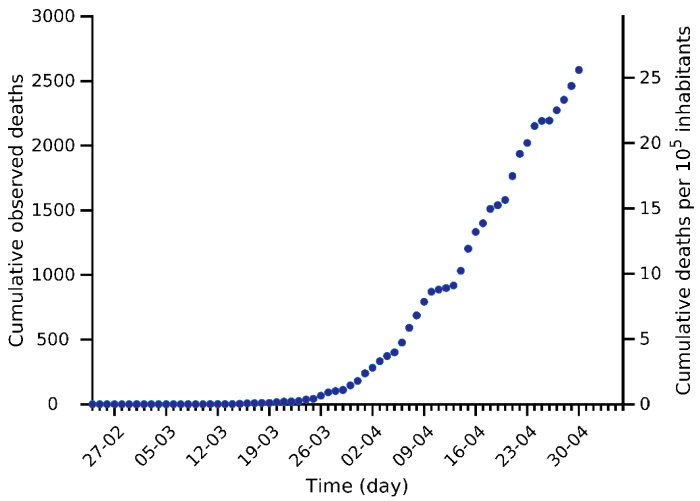


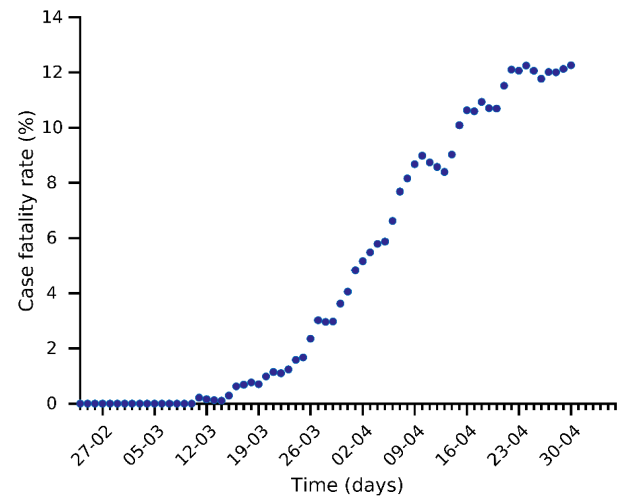




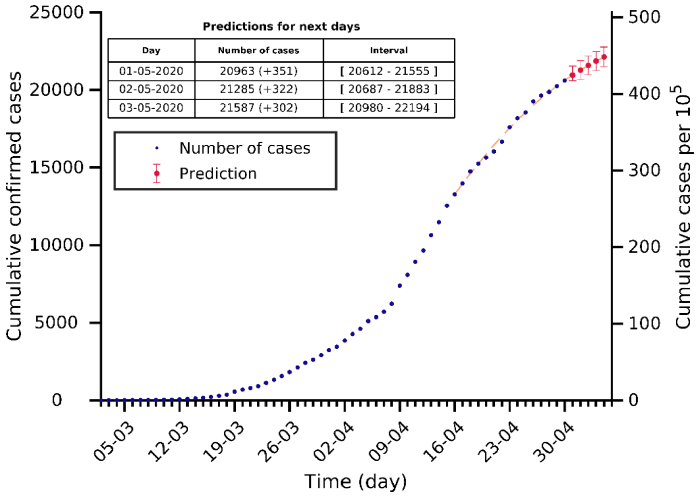


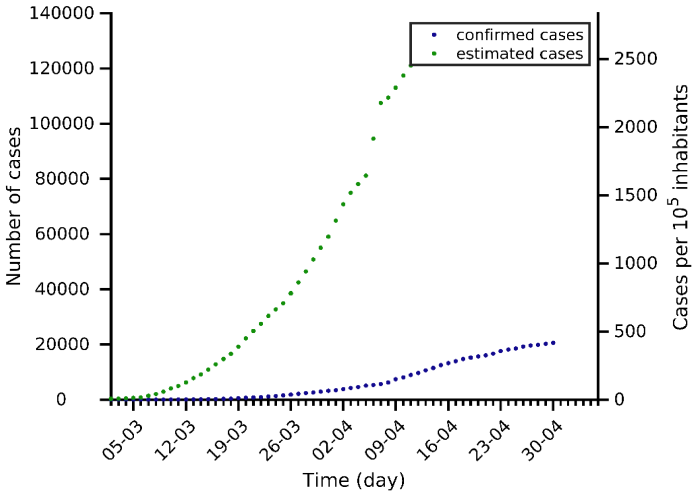


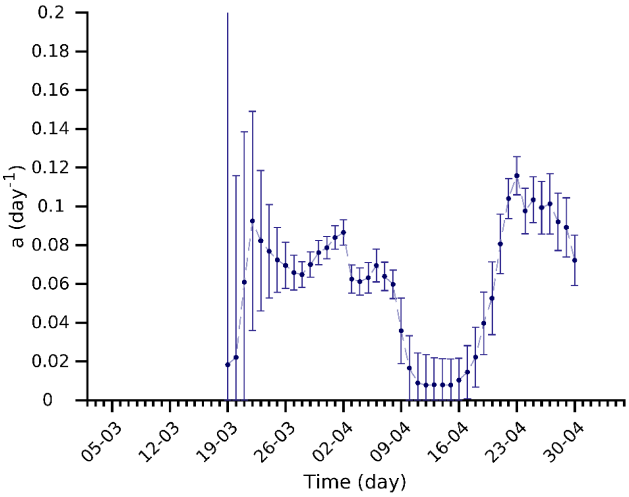


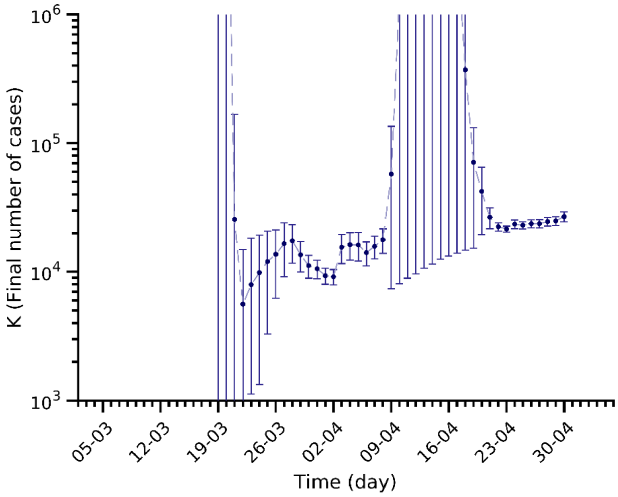


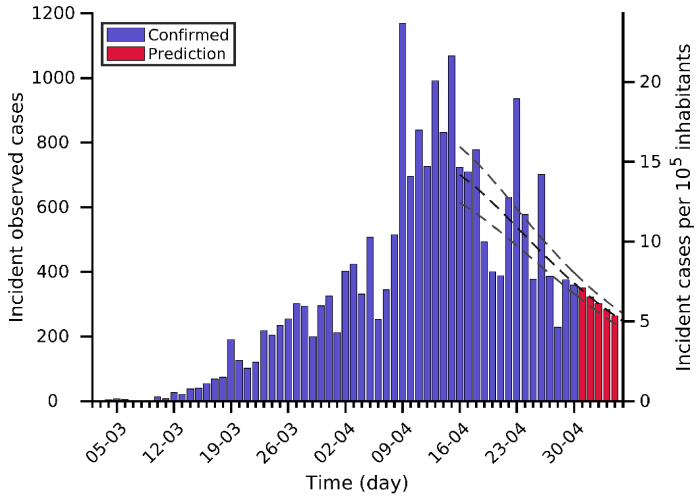
Ireland 30-04-2020. Population: 4.9M. Current cumulated incidence: 417/10^5

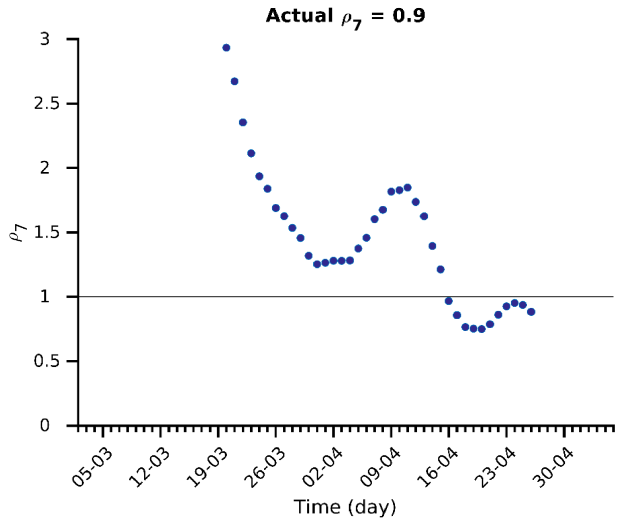


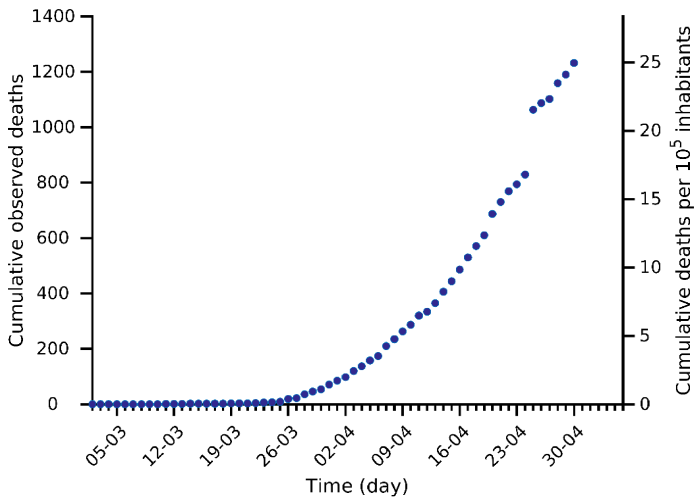


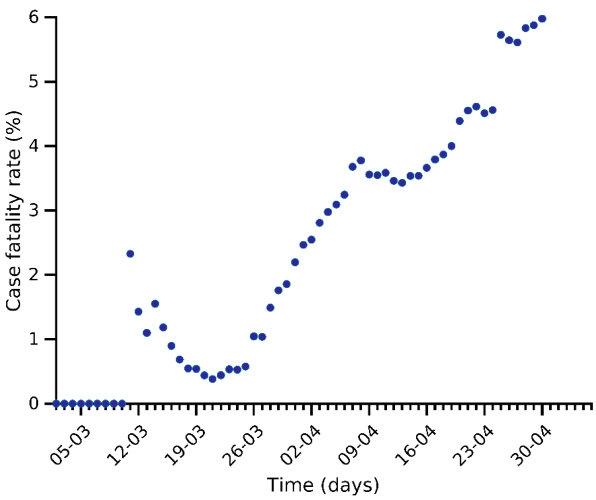




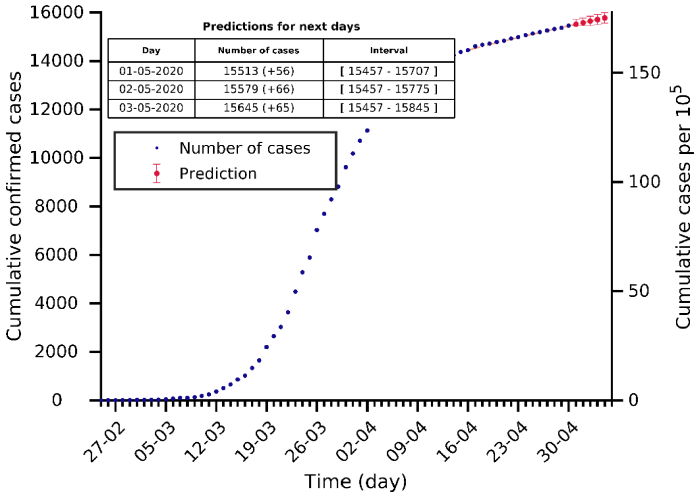


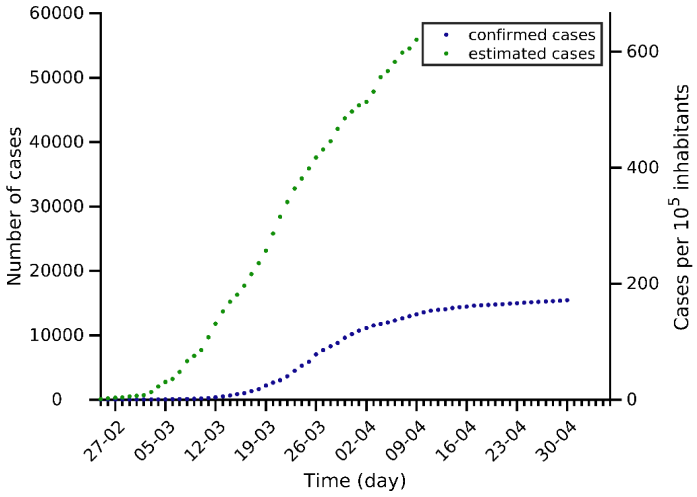


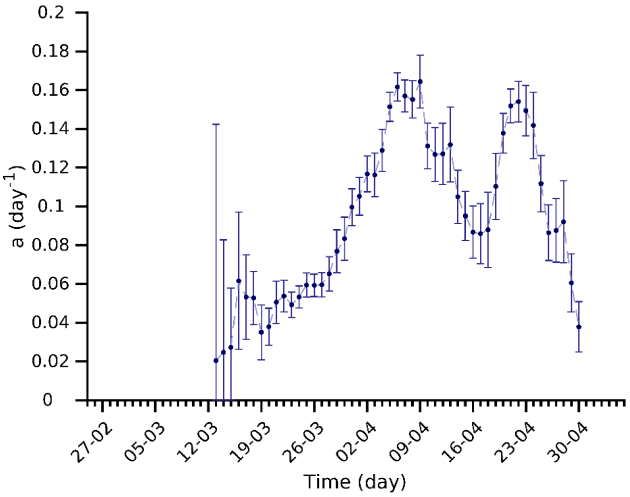


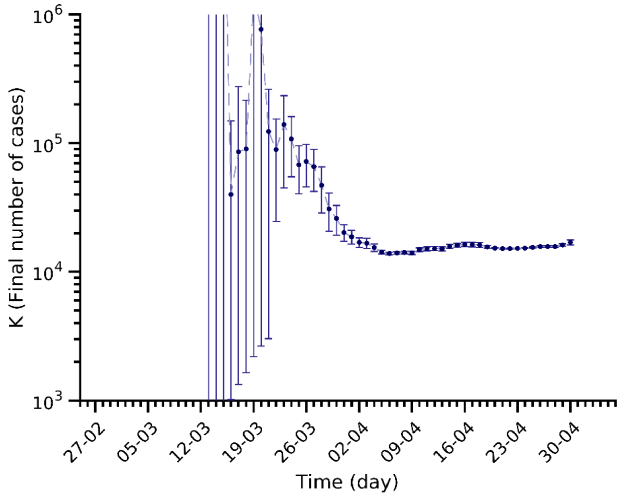


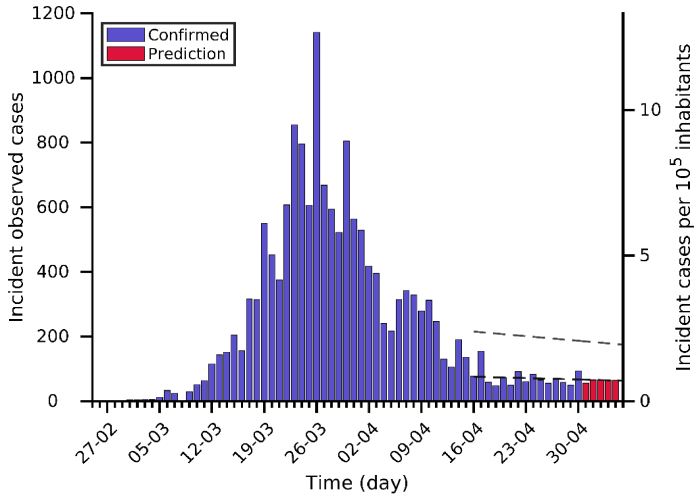
Austria 30-04-2020. Population: 9.0M. Current cumulated incidence: 172/10⁵

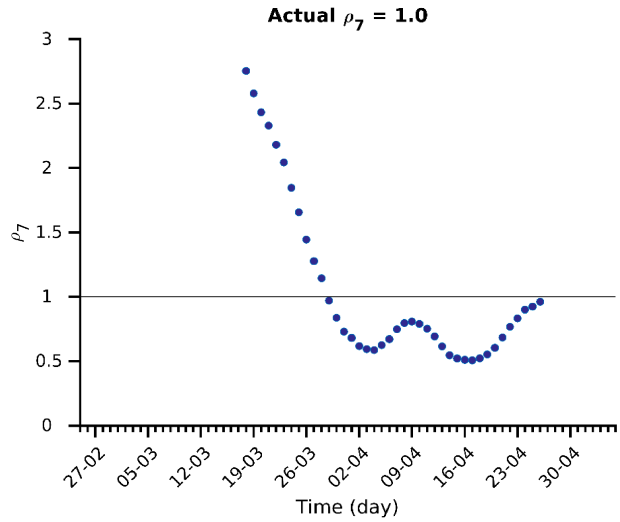


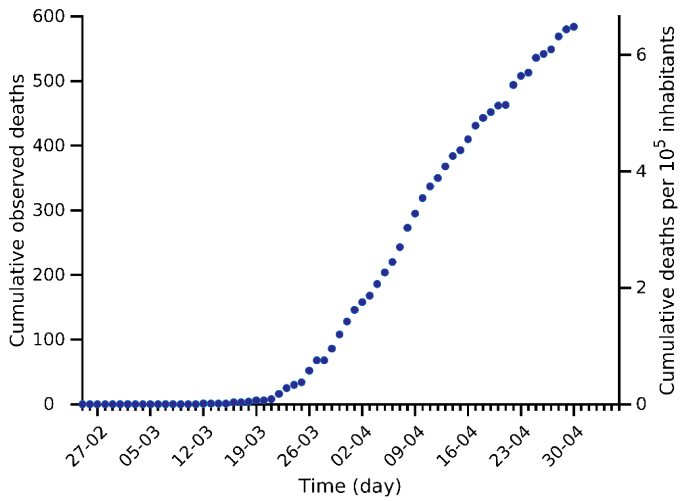


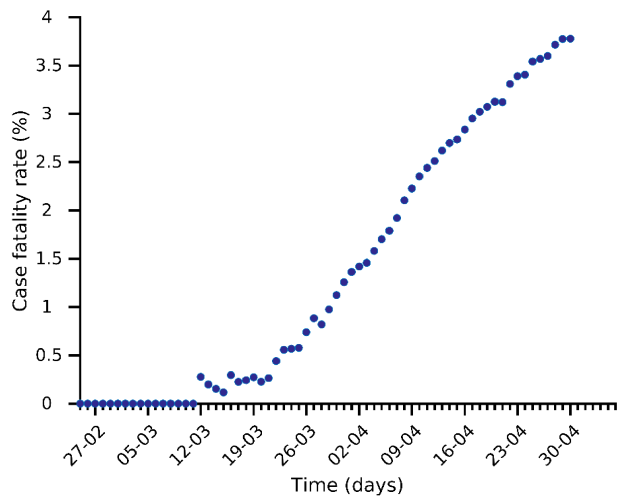




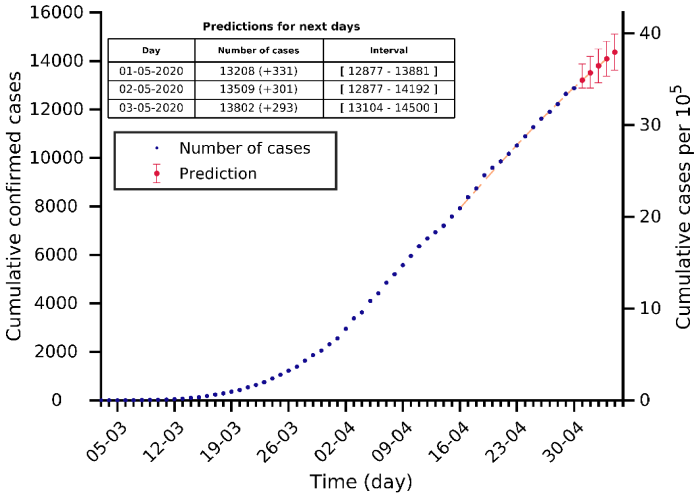


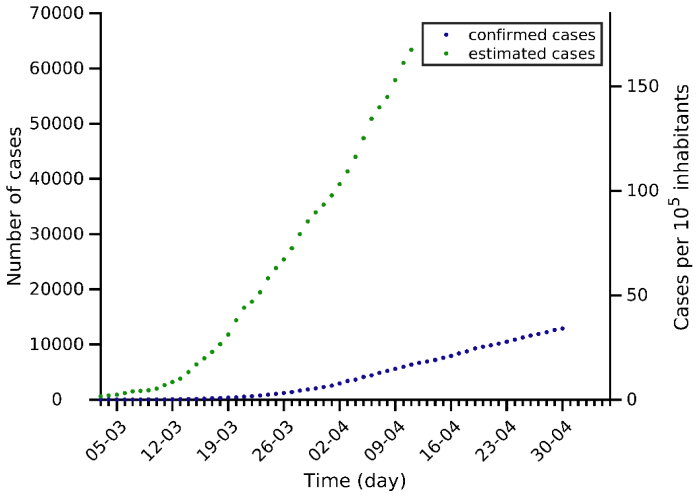


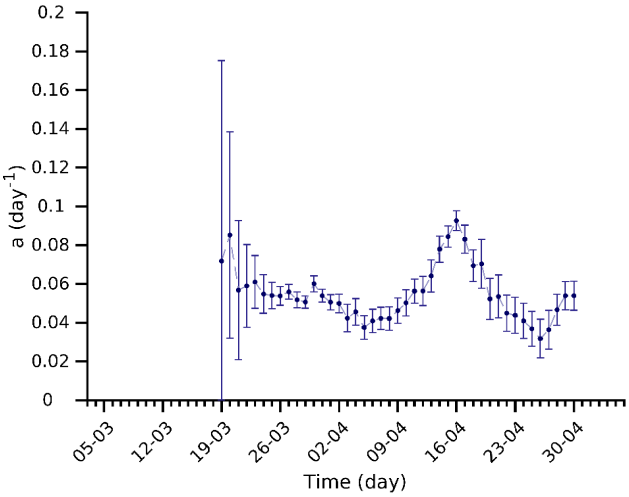


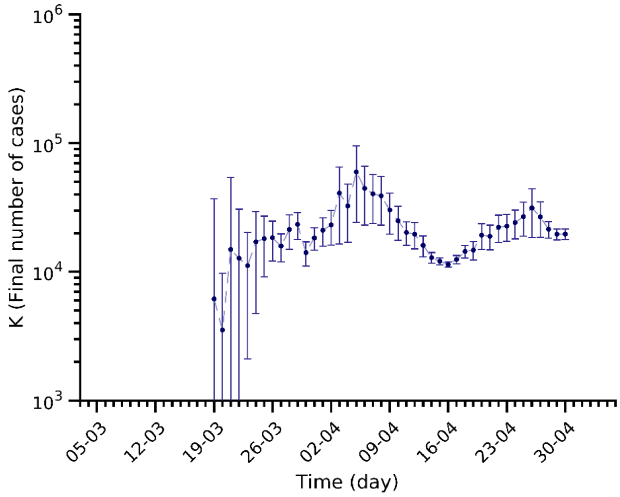


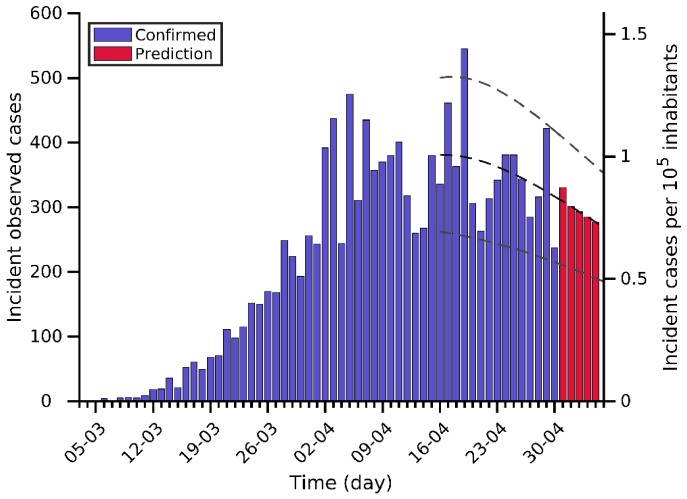
Poland 30-04-2020. Population: 37.8M. Current cumulated incidence: 34/10^5

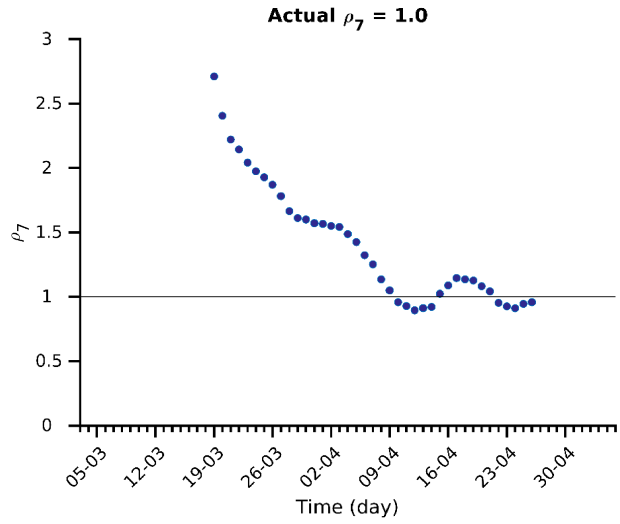


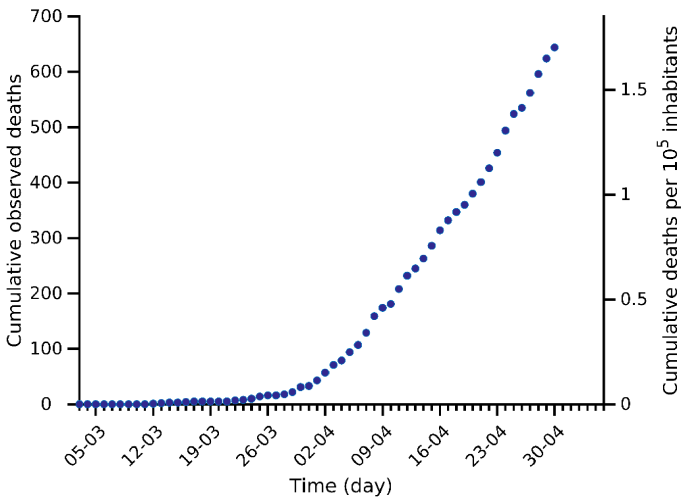


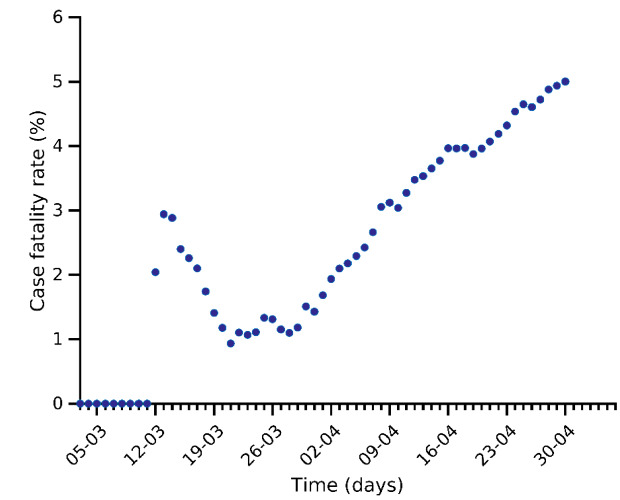




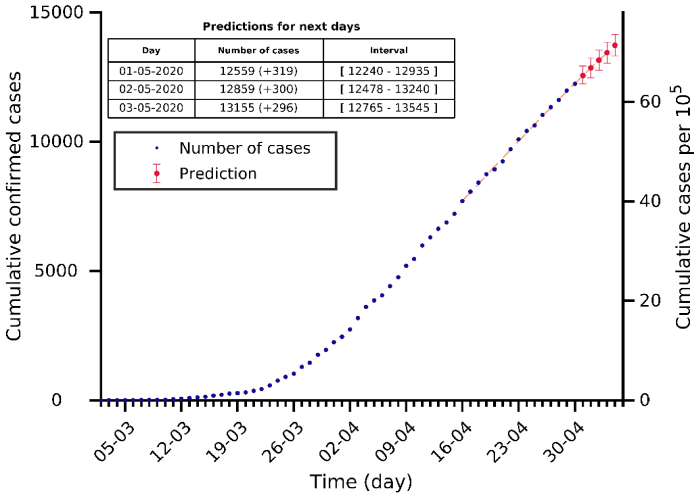


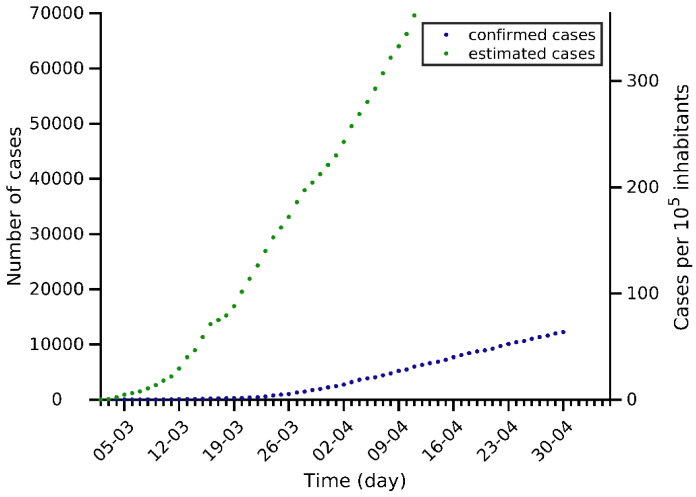


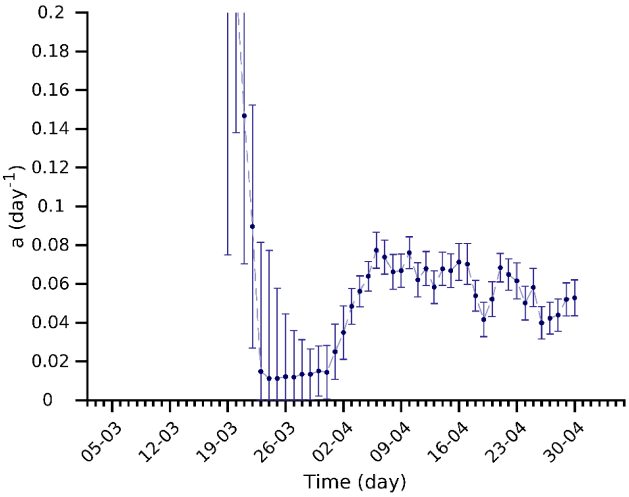


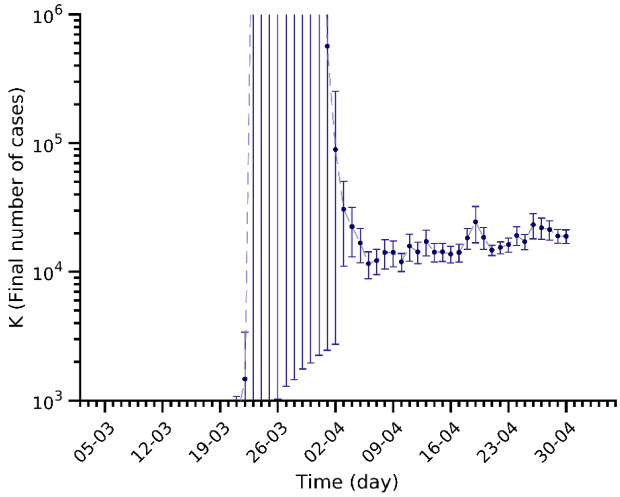


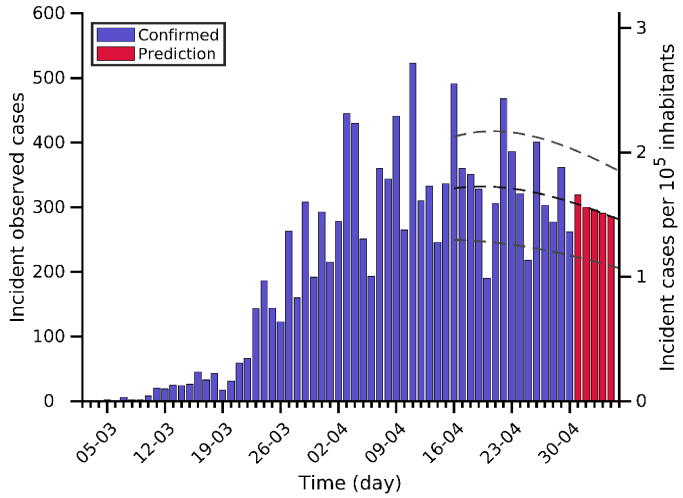
Romania 30-04-2020. Population: 19.2M. Current cumulated incidence: 64/10^5

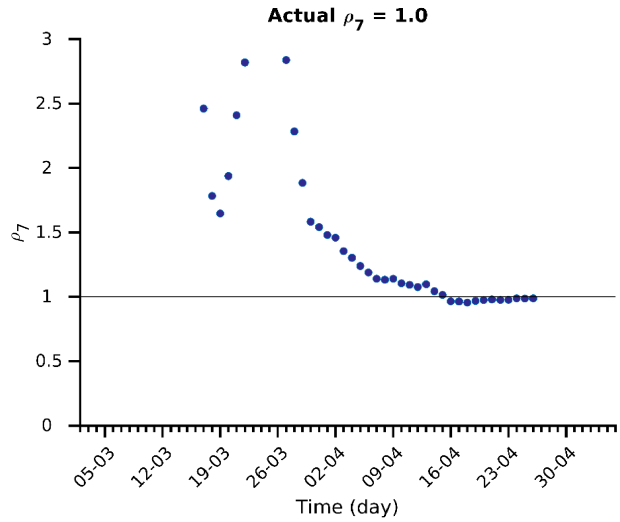


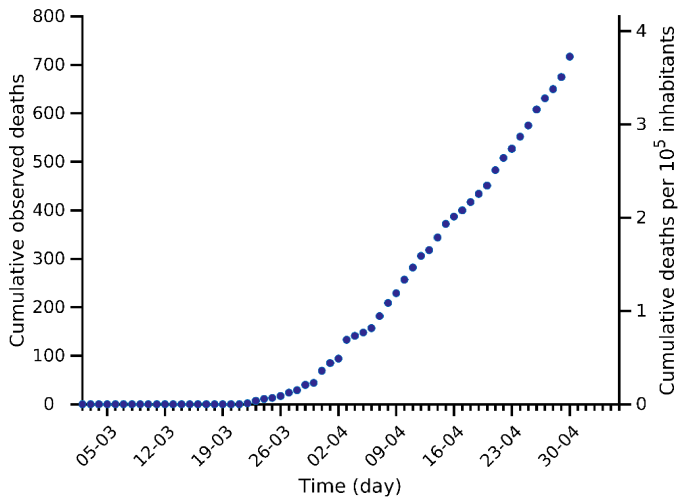


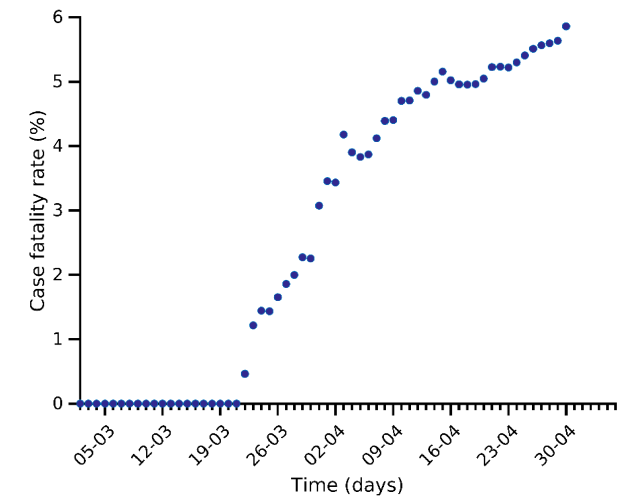




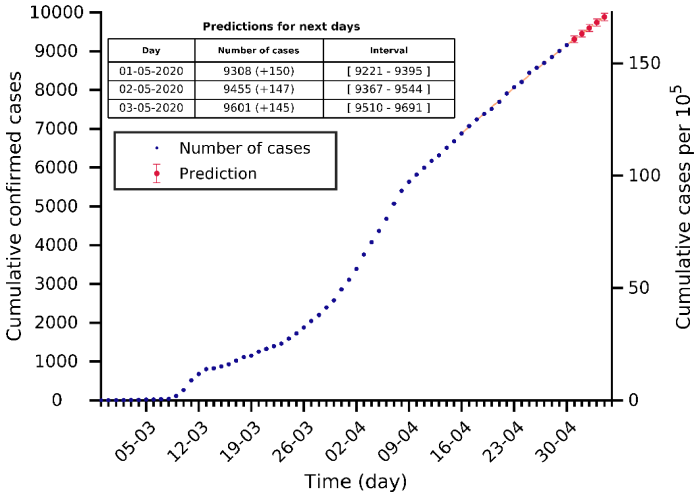


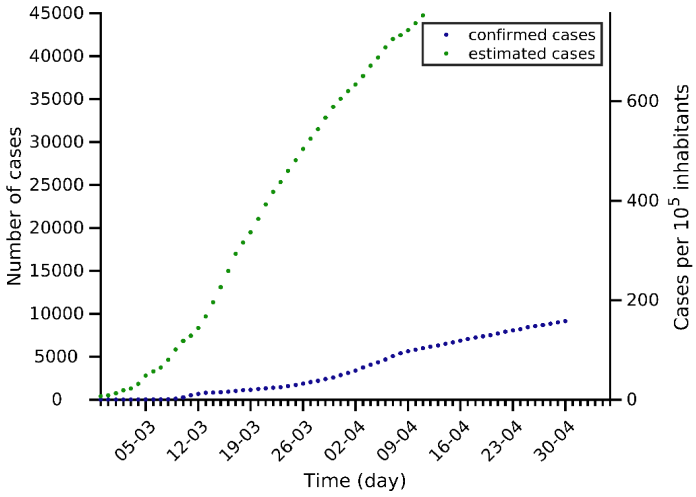


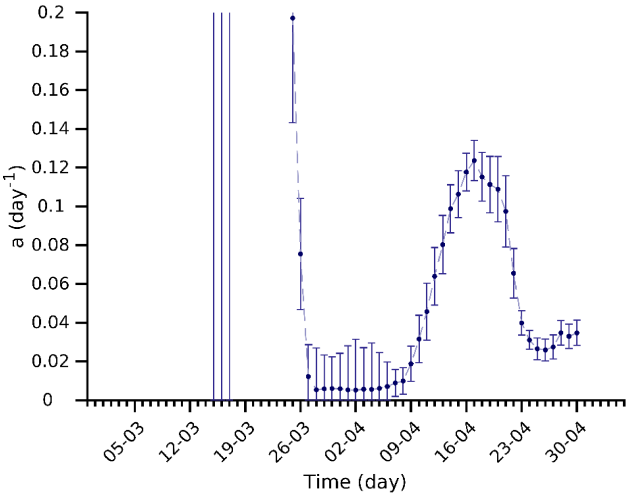


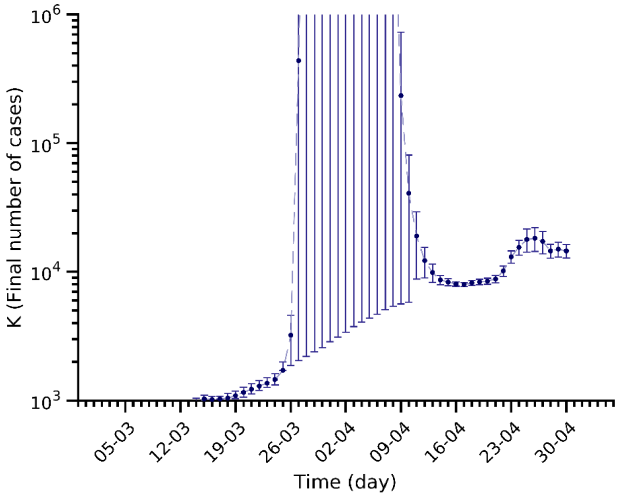


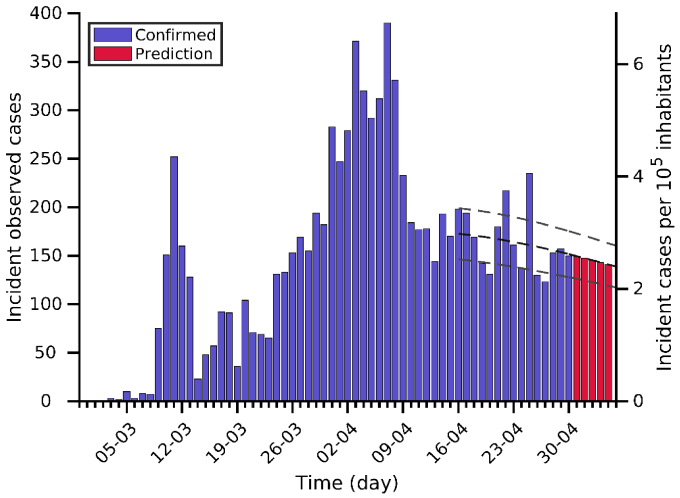
Denmark 30-04-2020. Population: 5.8M. Current cumulated incidence: $158/10^5$

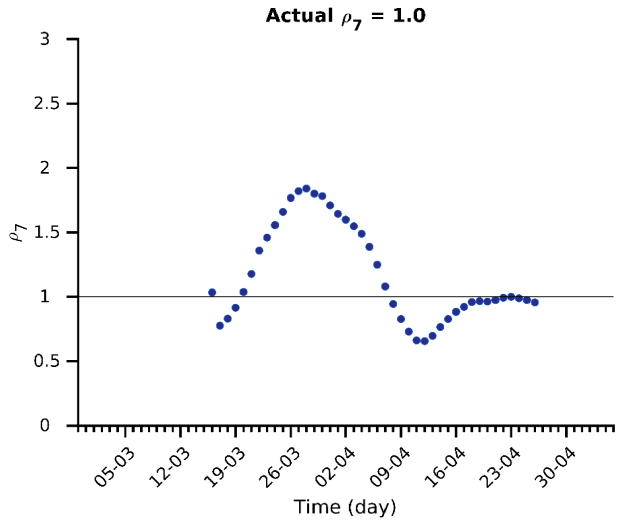


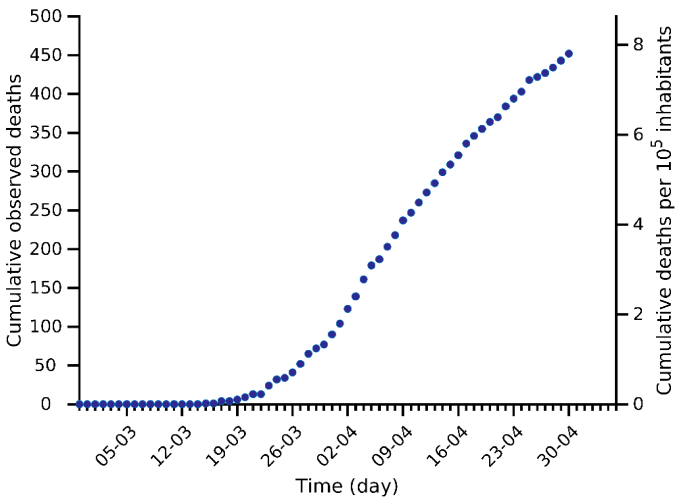


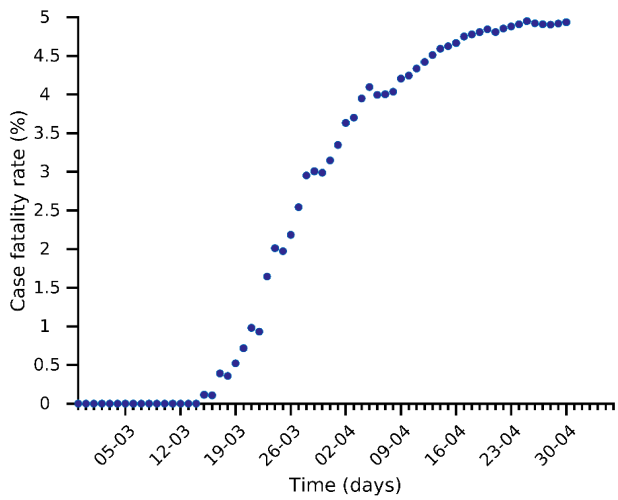




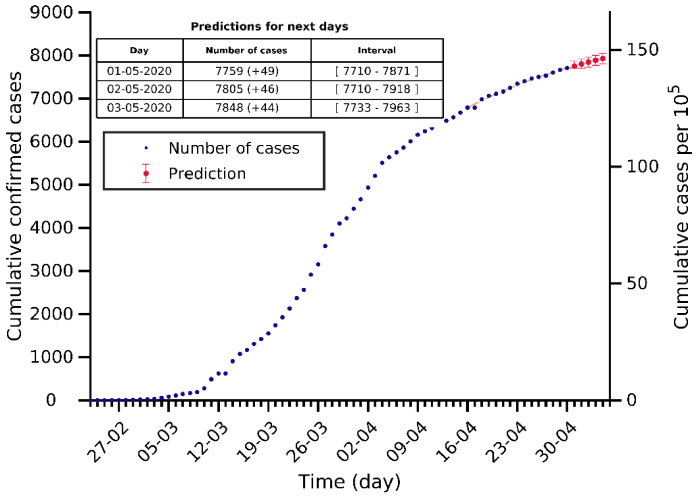


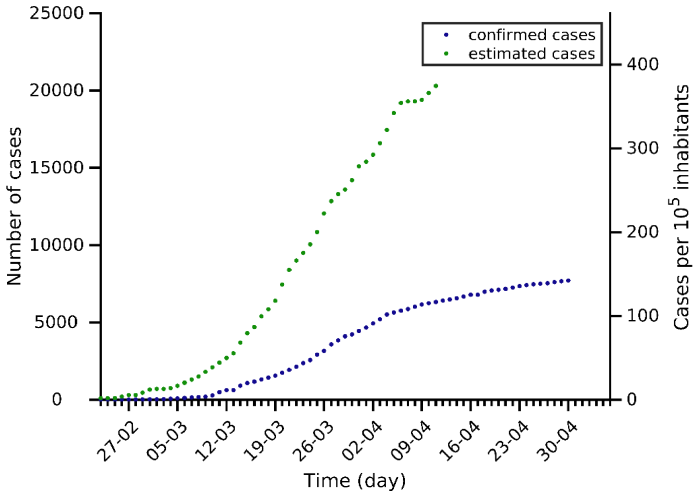


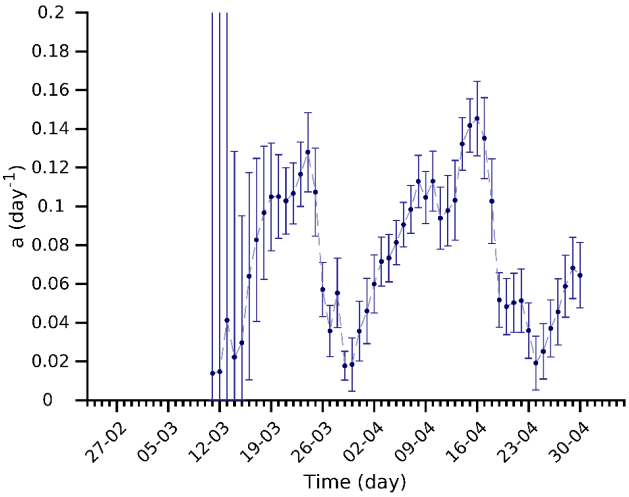


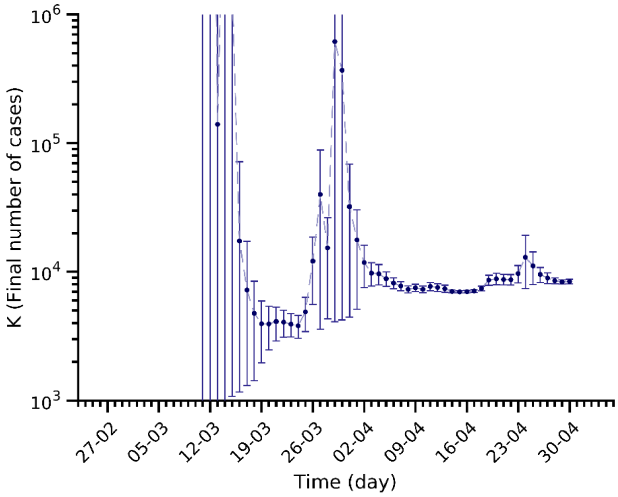


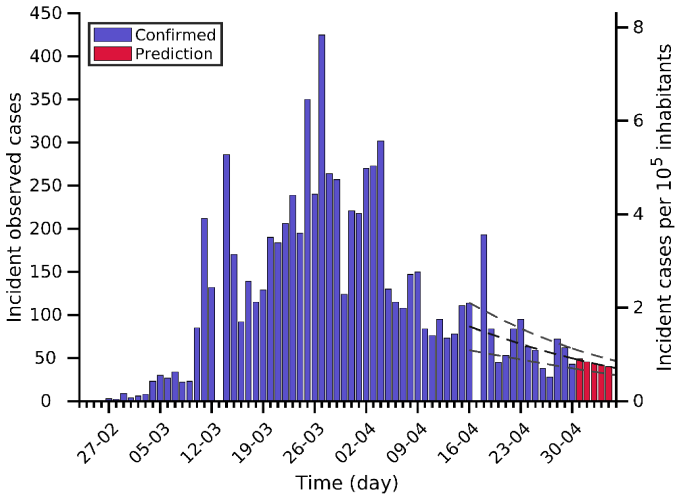
Norway 30-04-2020. Population: 5.4M. Current cumulated incidence: 142/10⁵

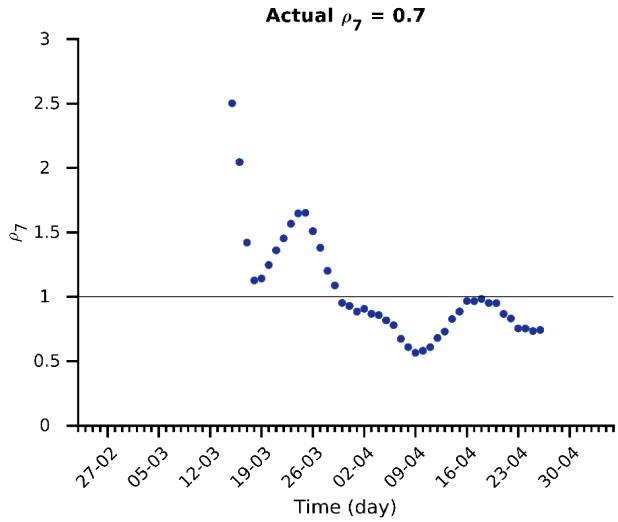


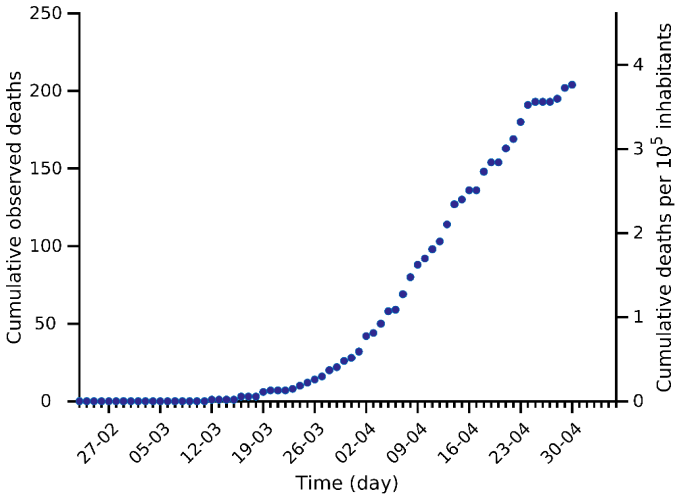


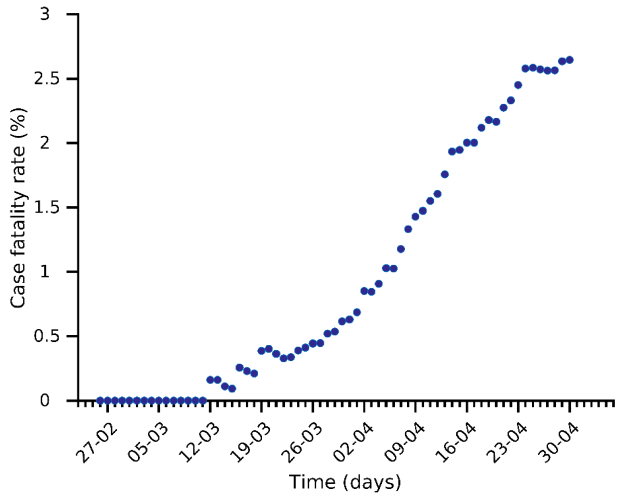




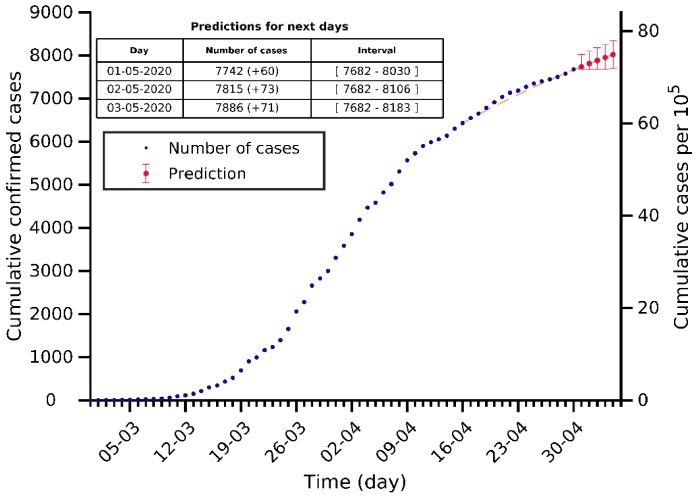


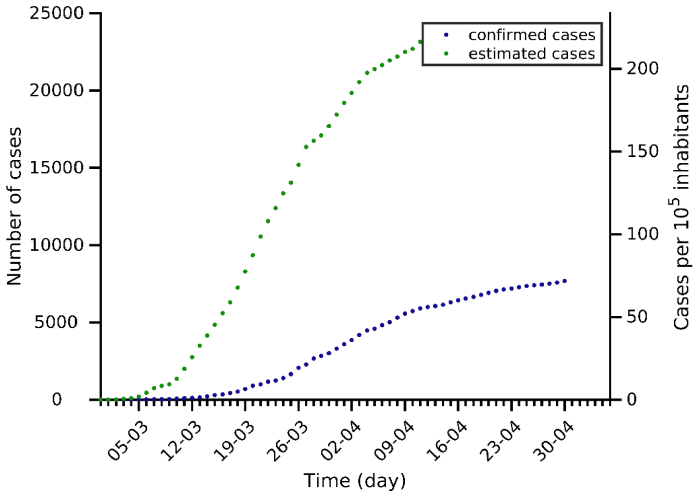


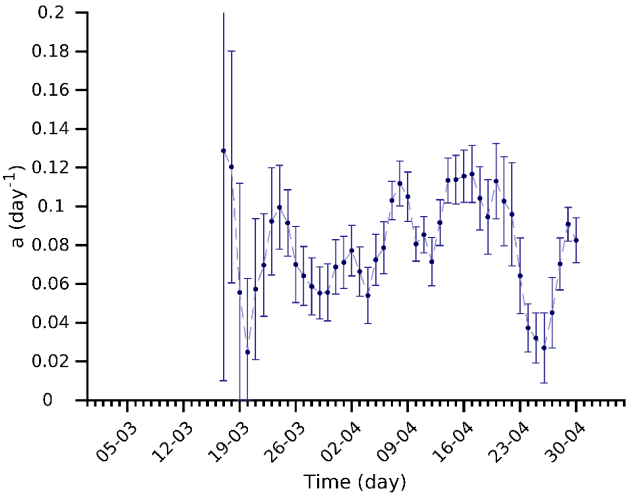


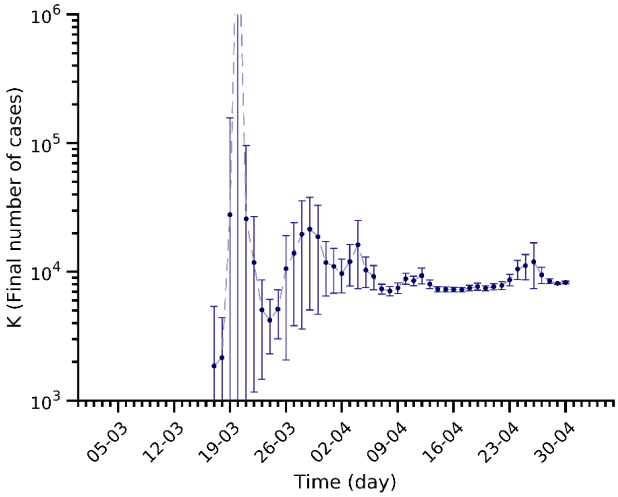


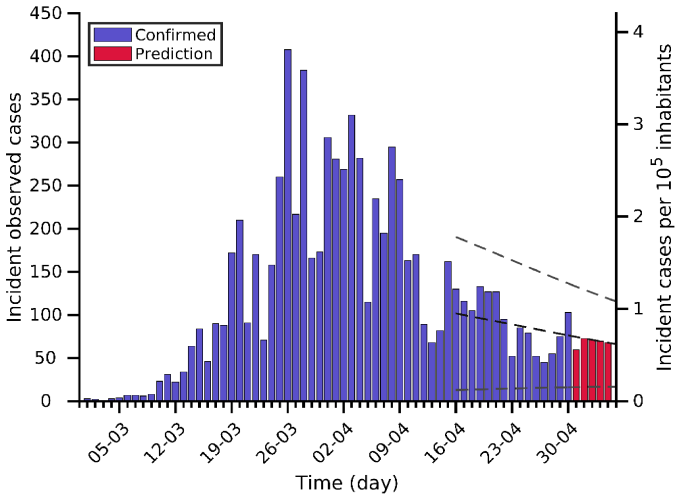
Czech Rep 30-04-2020. Population: 10.7M. Current cumulated incidence: 72/10^5

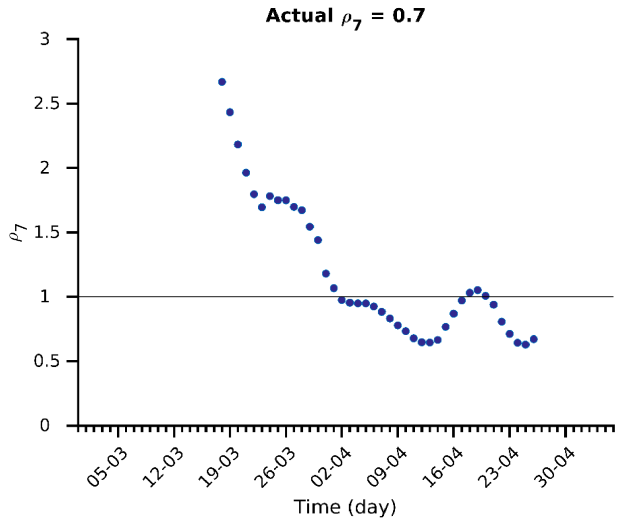


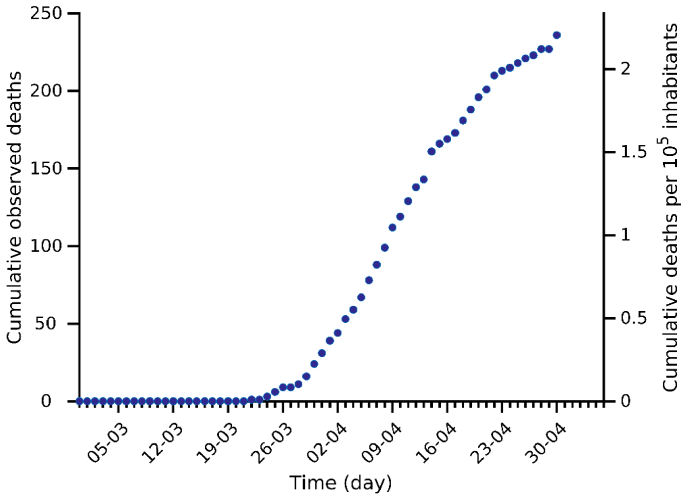


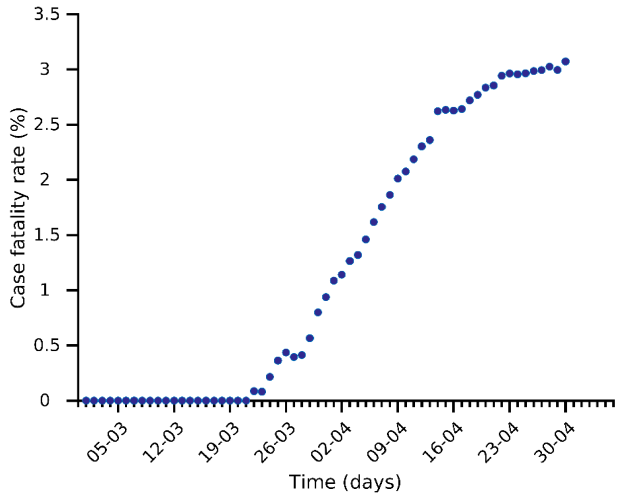




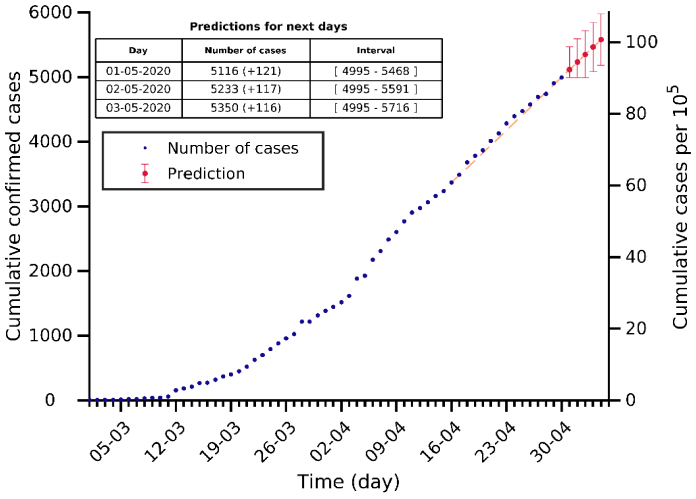


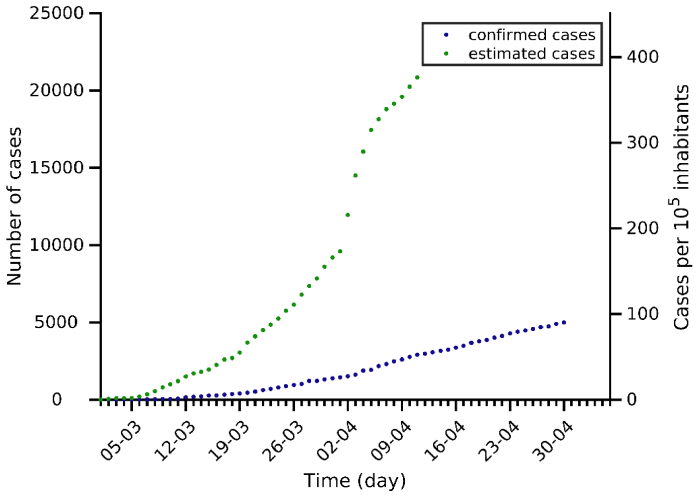


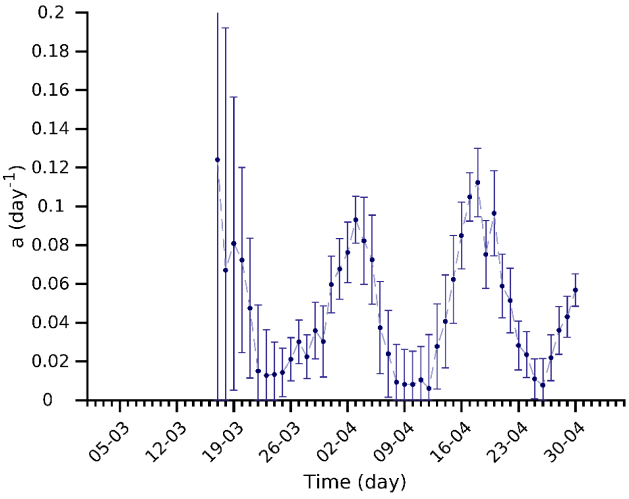


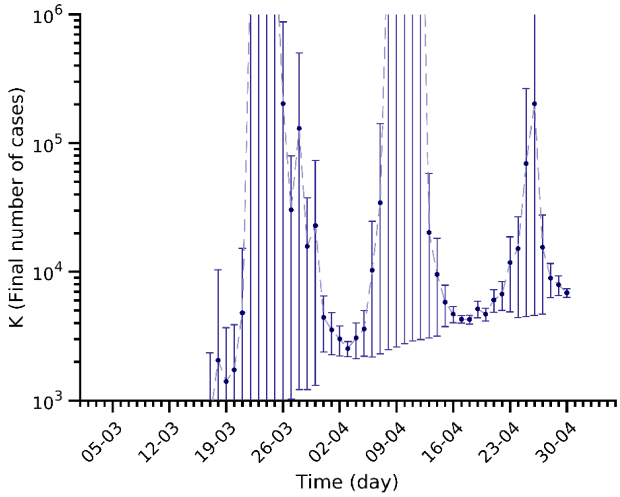


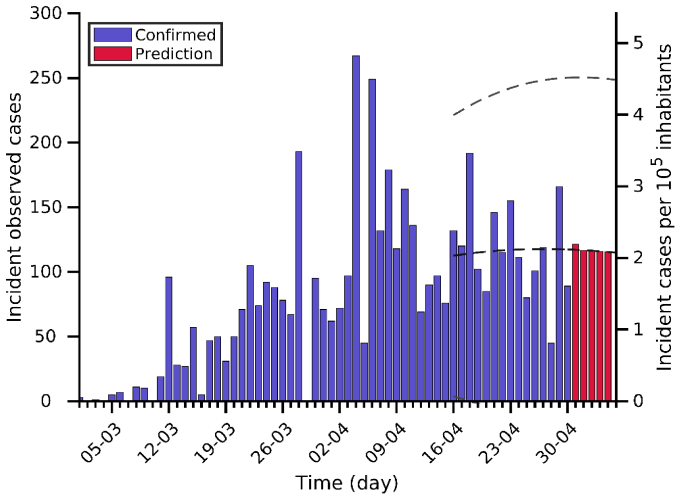
Finland 30-04-2020. Population: 5.5M. Current cumulated incidence: $90/10^5$

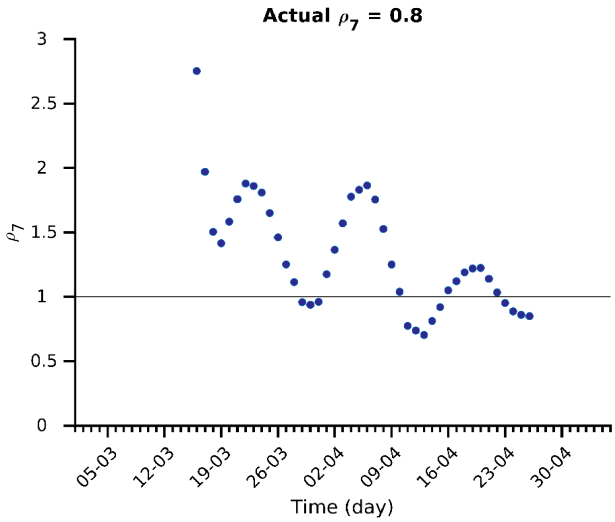


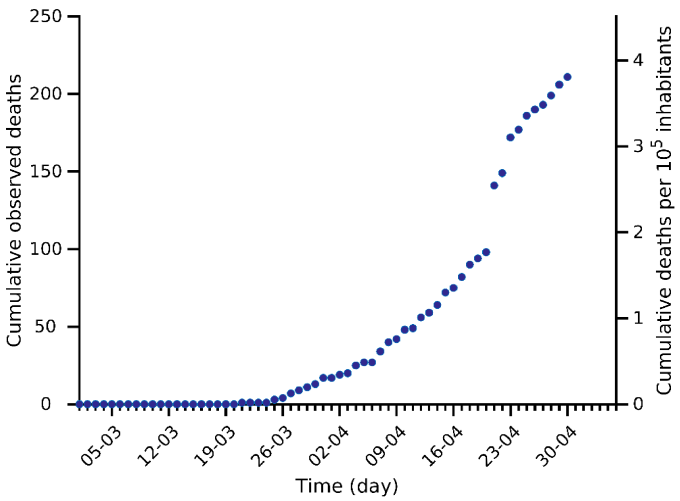


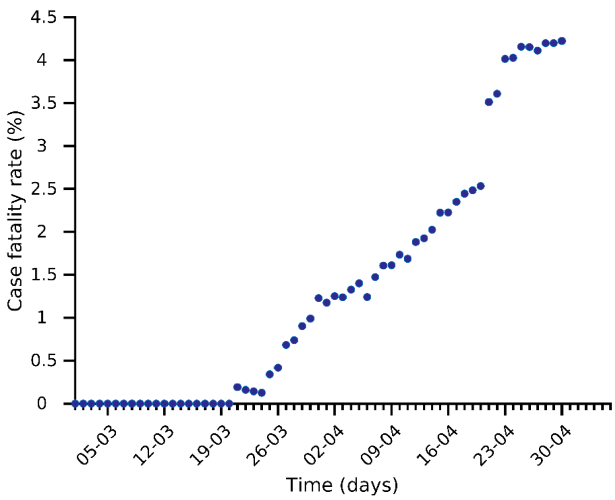




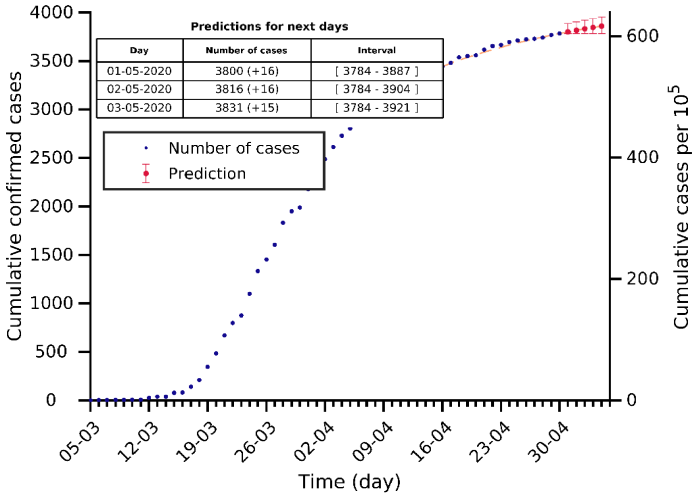


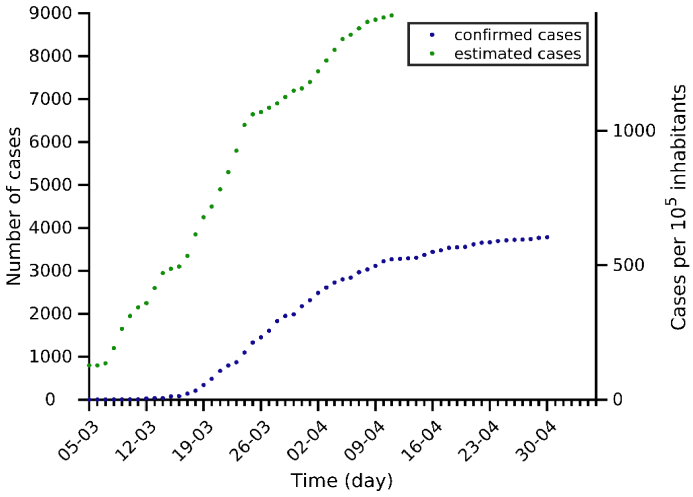


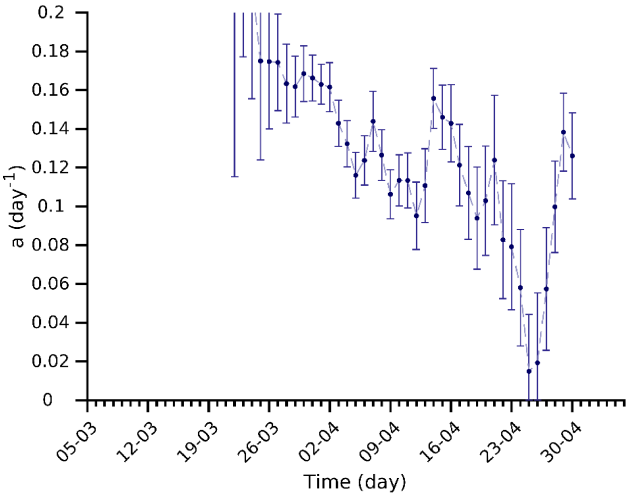


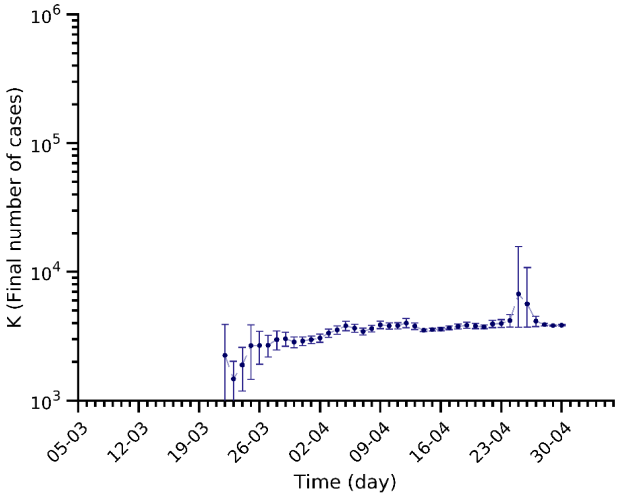


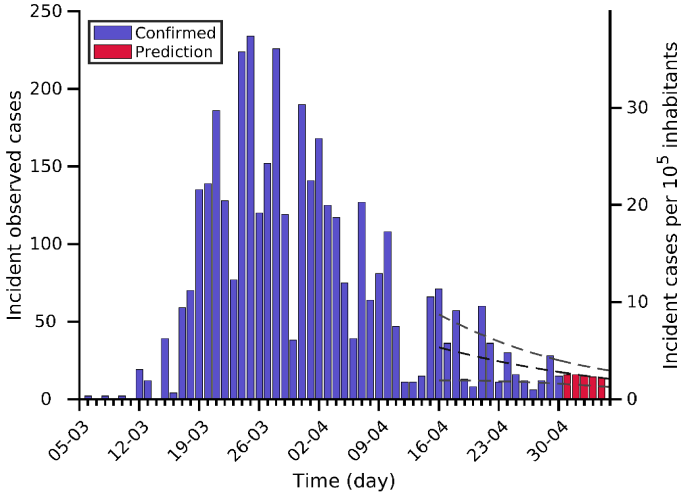
Luxembourg 30-04-2020. Population: 0.6M. Current cumulated incidence: 604/10^5

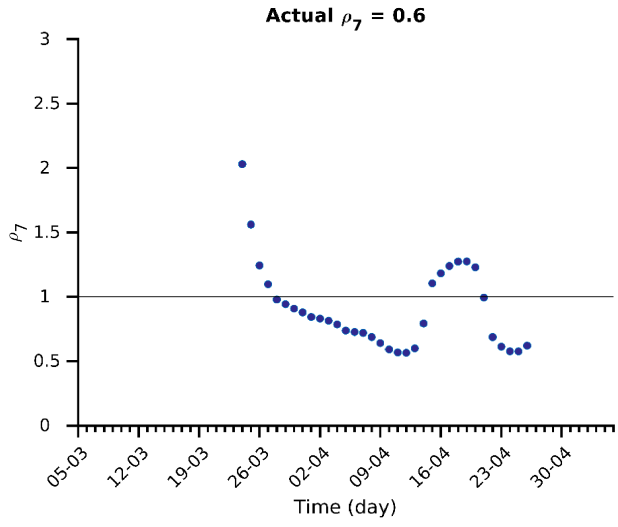


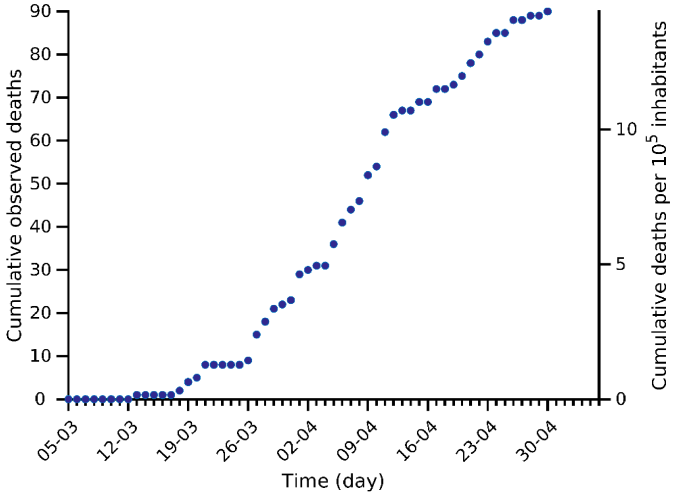


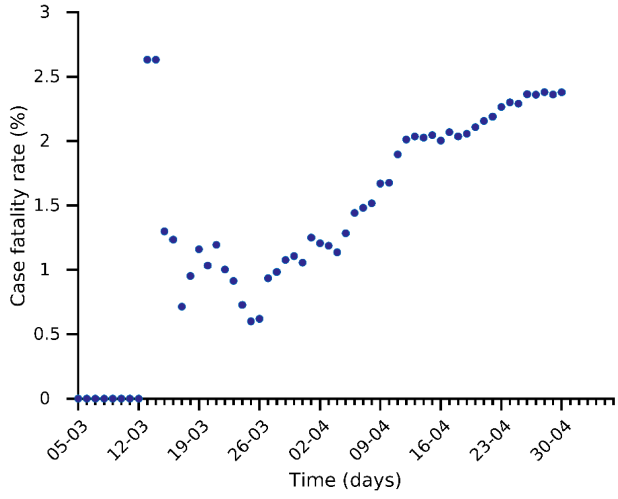




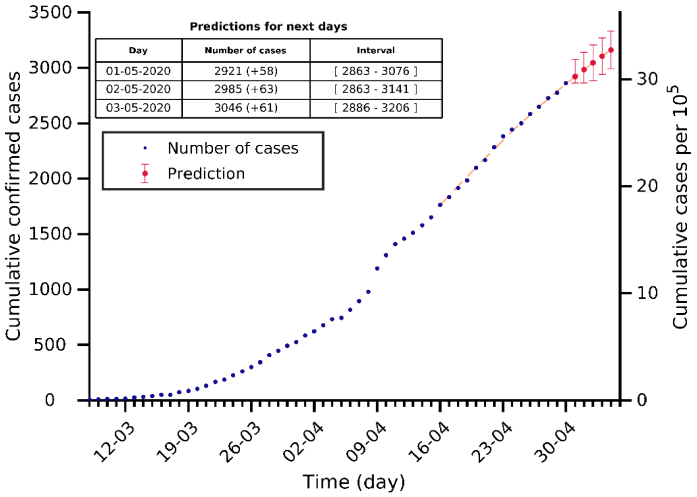


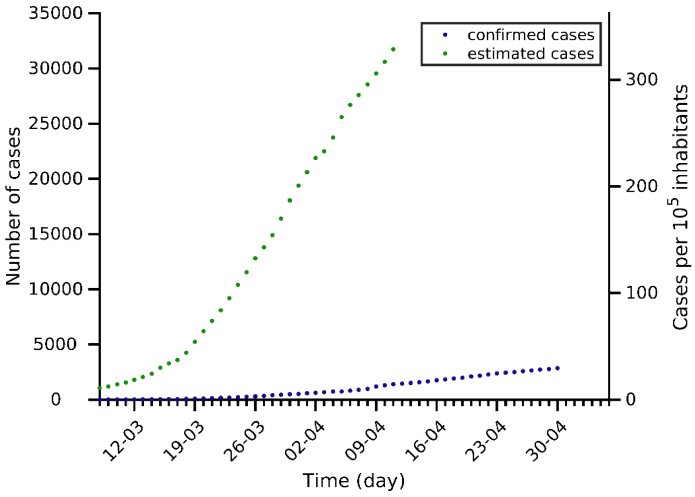


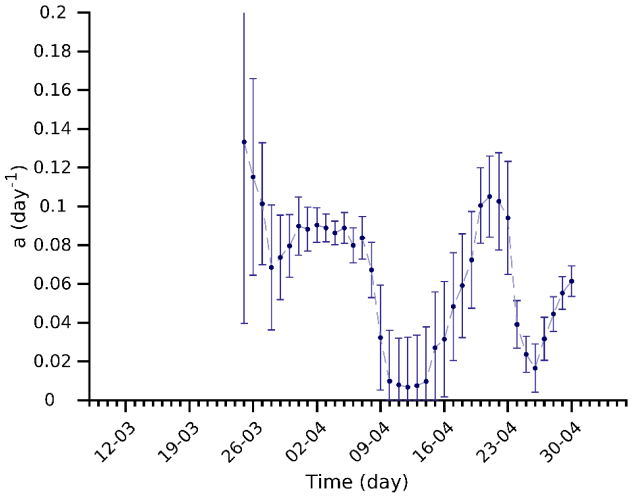


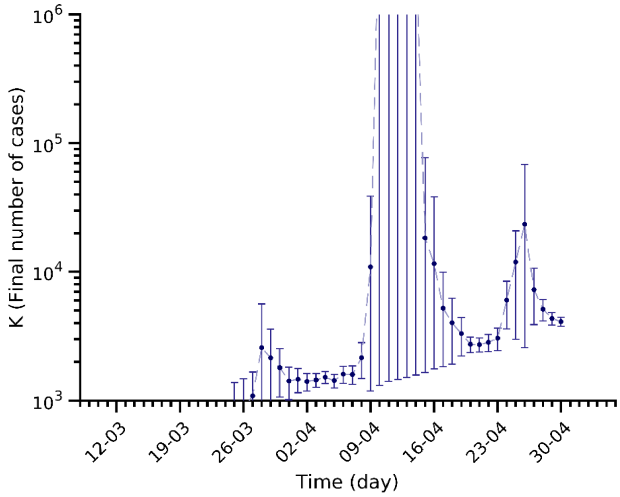


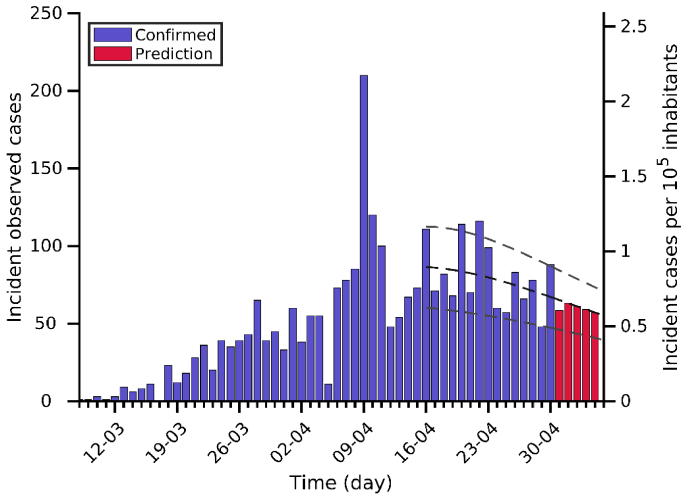
Hungary 30-04-2020. Population: 9.7M. Current cumulated incidence: $30/10^5$

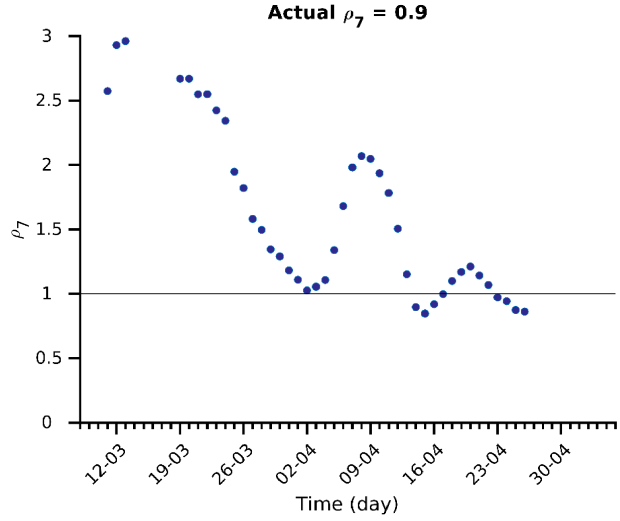


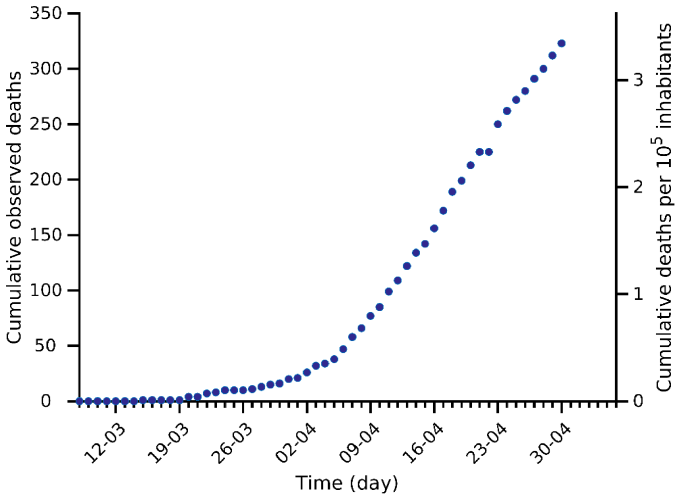


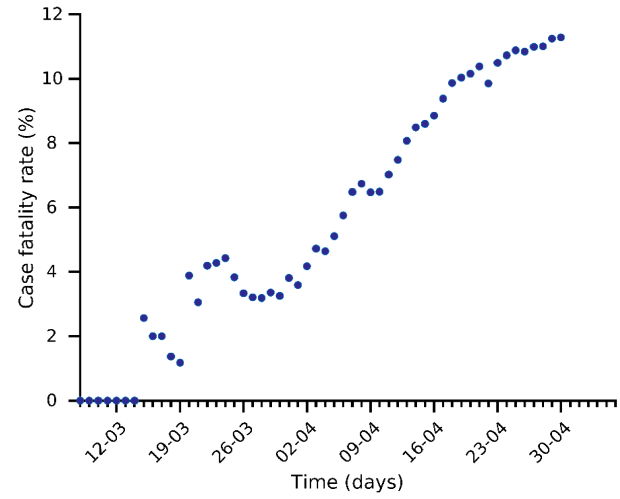




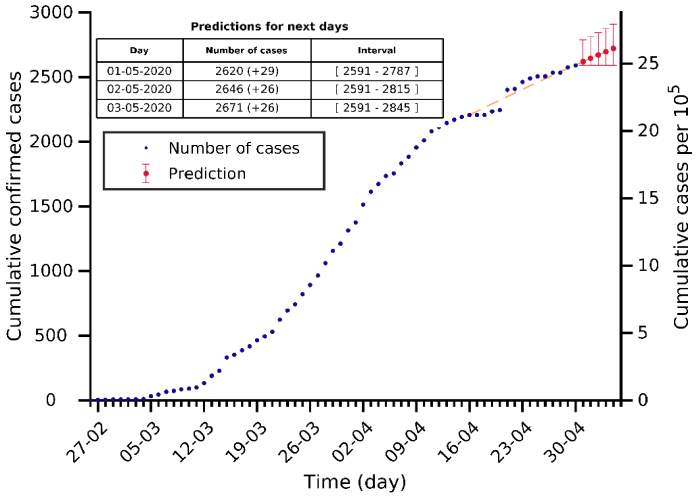


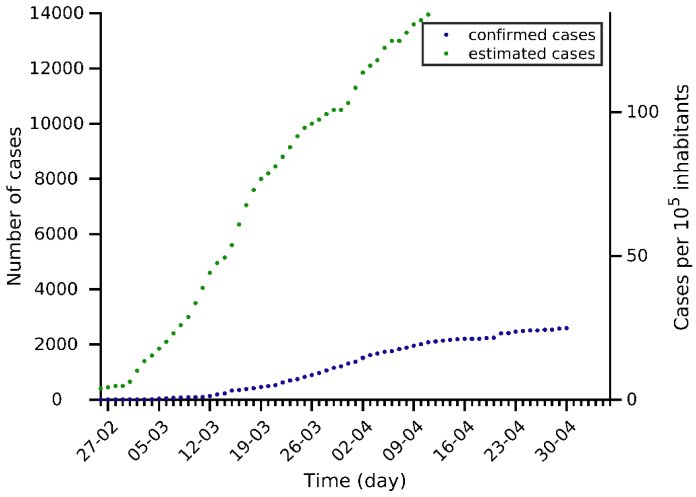


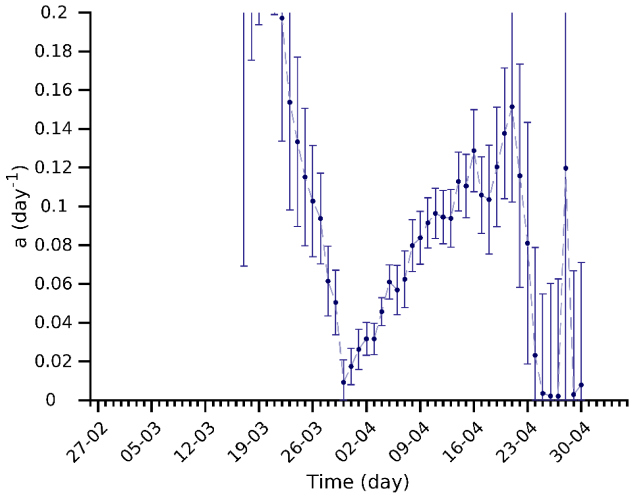


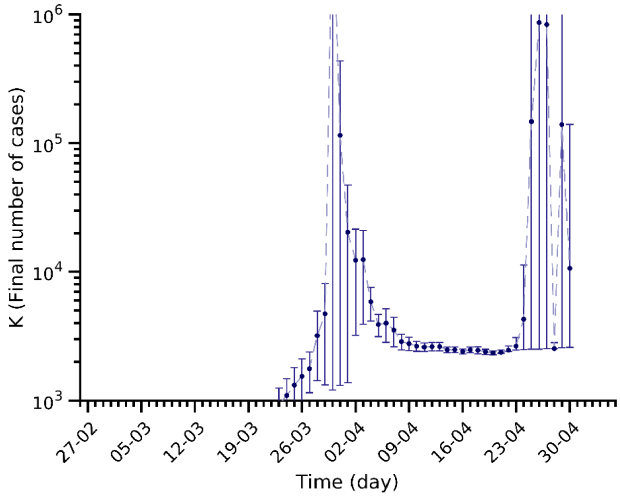


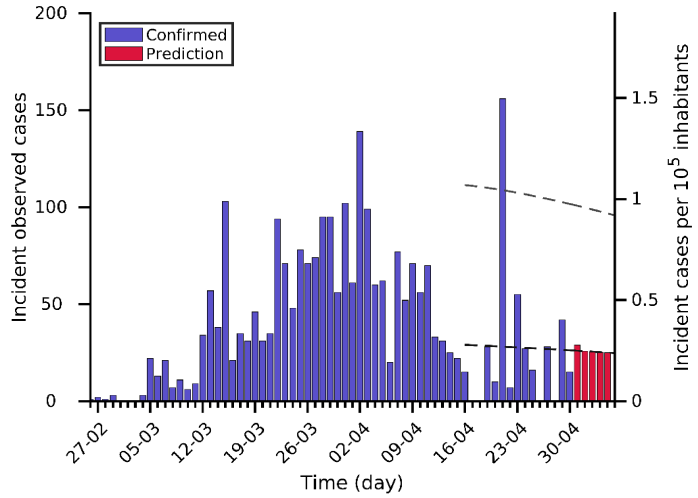
Greece 30-04-2020. Population: 10.4M. Current cumulated incidence: 25/10^5

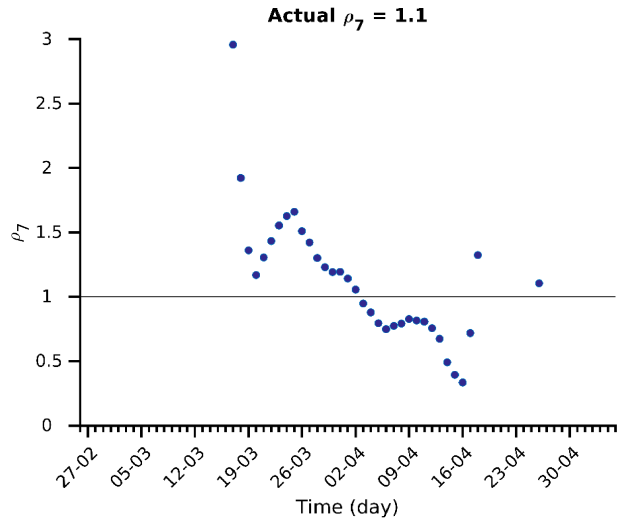


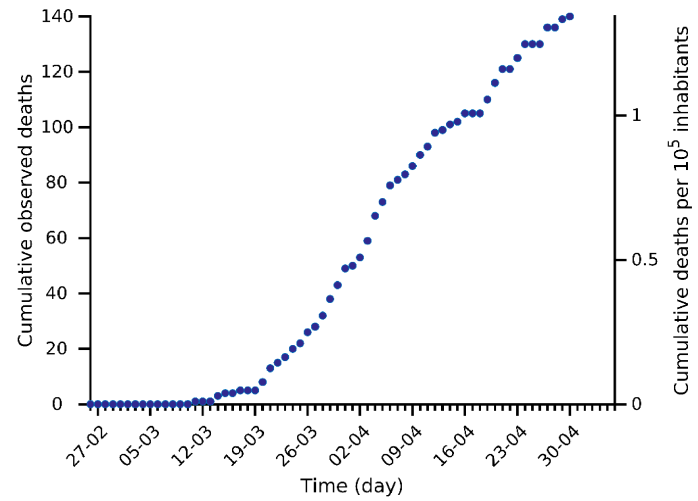


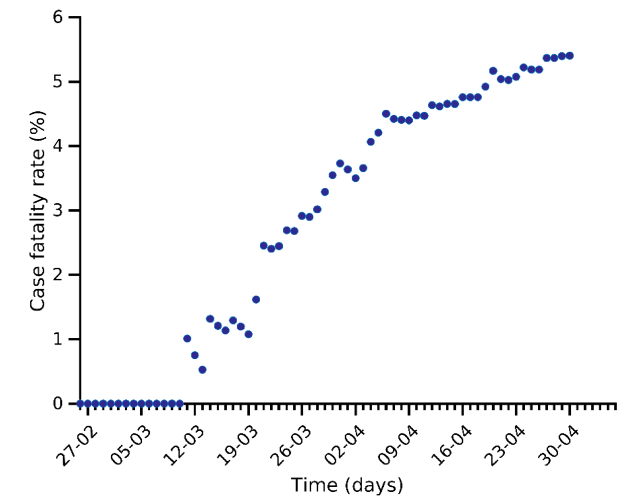




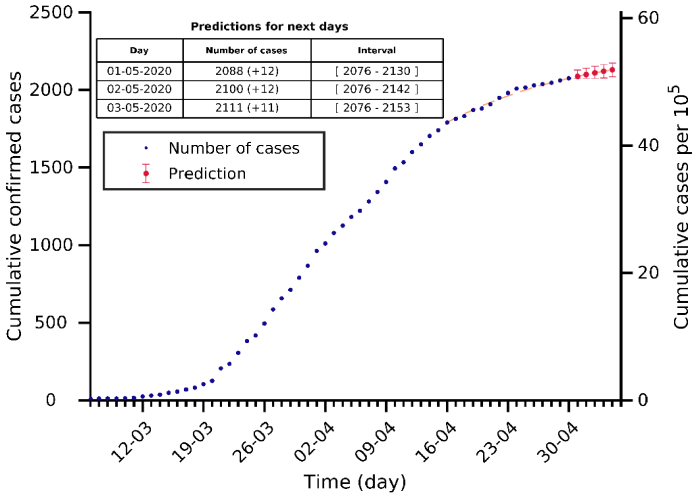


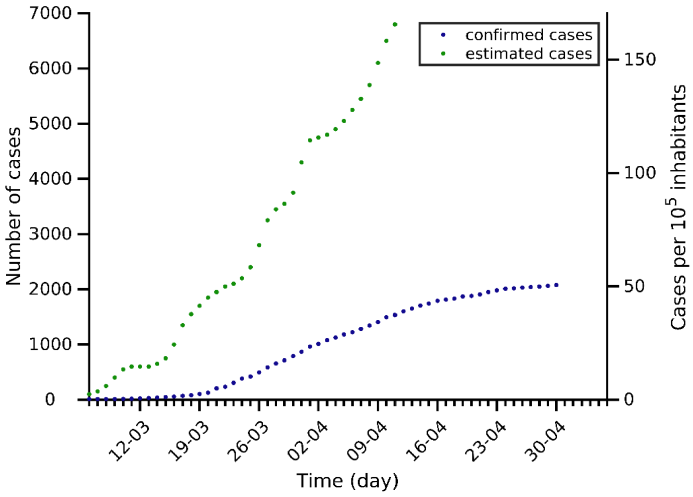


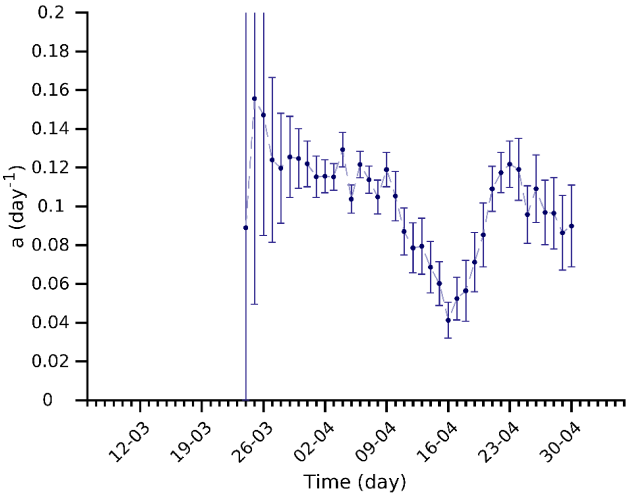


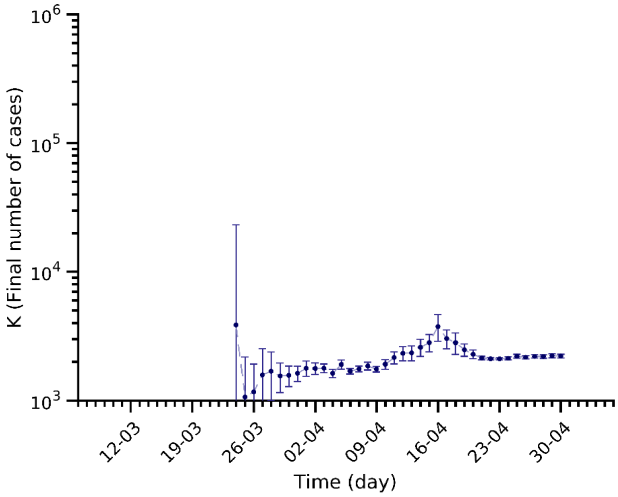


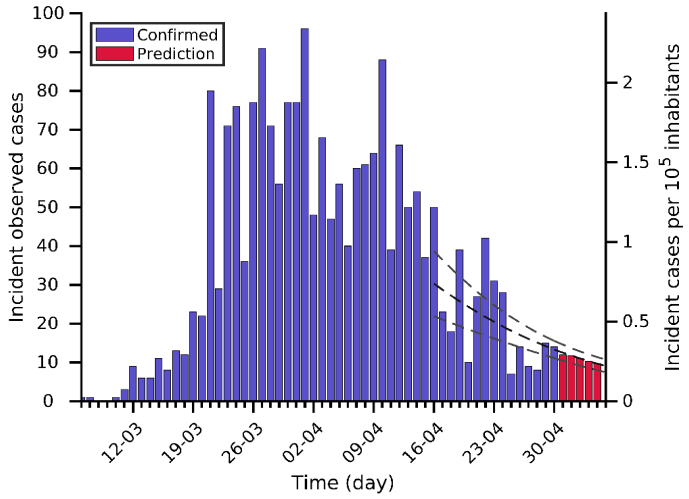
Croatia 30-04-2020. Population: 4.1M. Current cumulated incidence: $51/10^5$

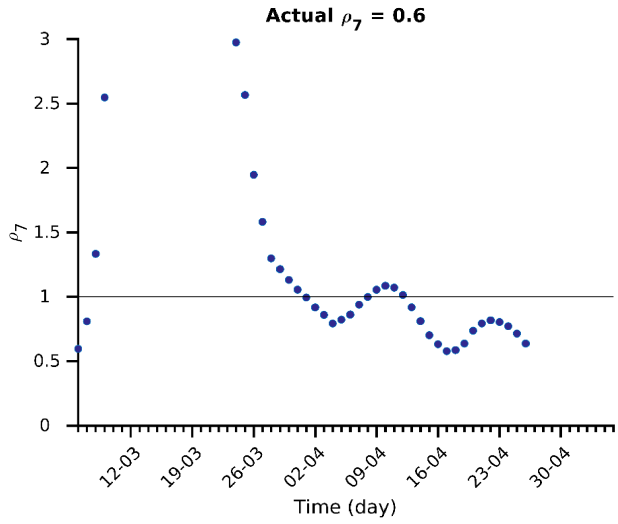


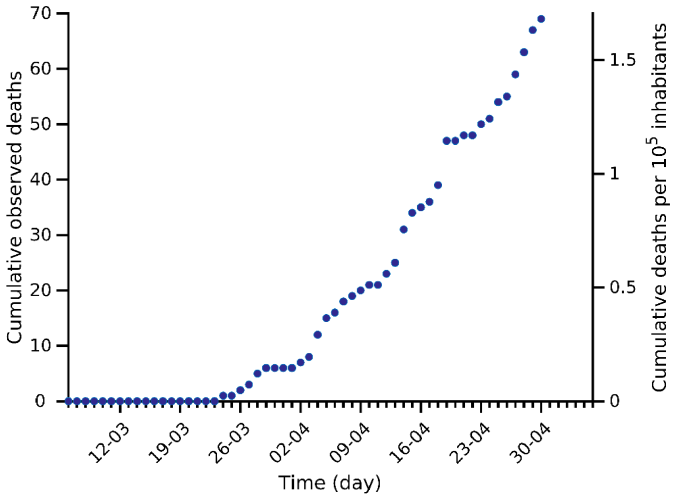


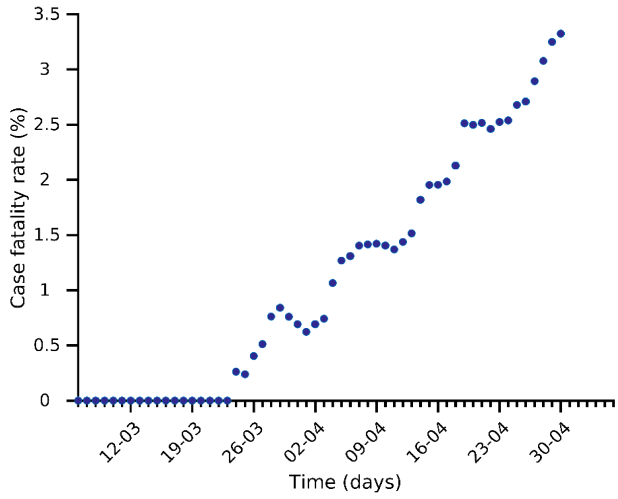




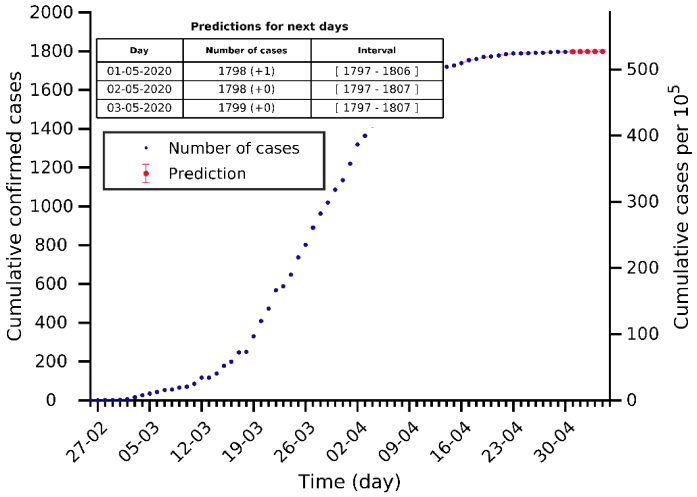


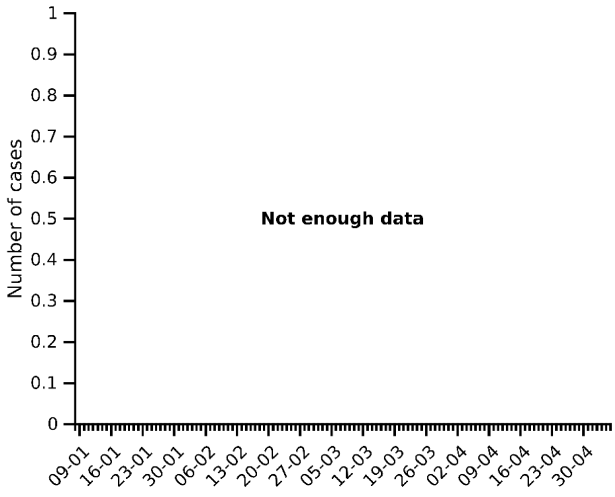


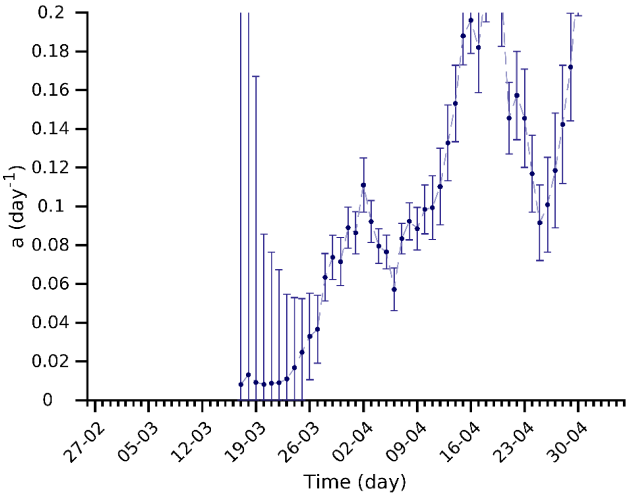


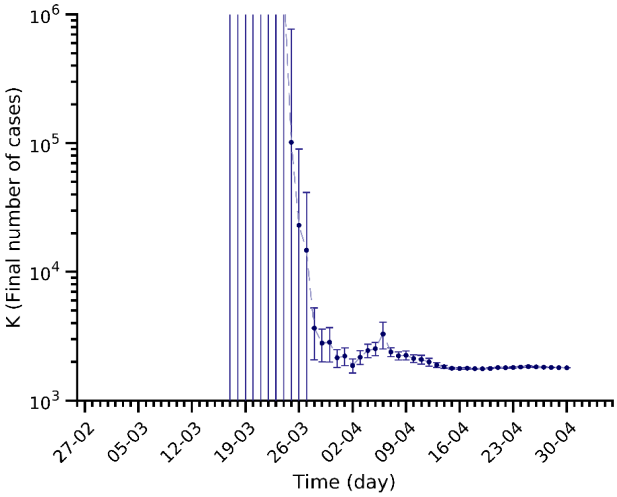


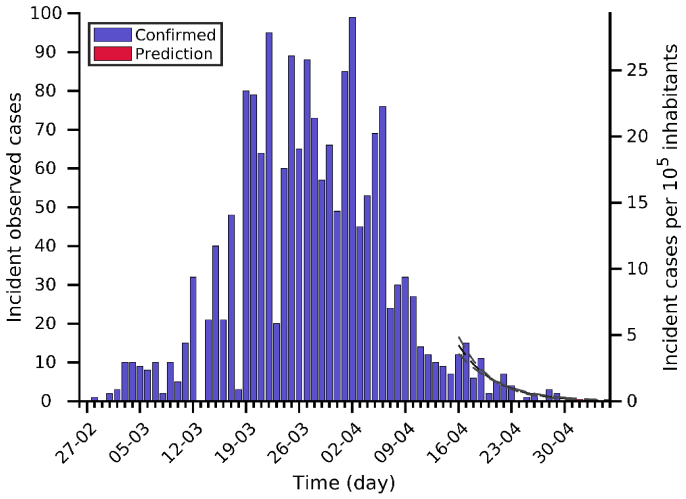
Iceland 30-04-2020. Population: 0.3M. Current cumulated incidence: 527/10^5

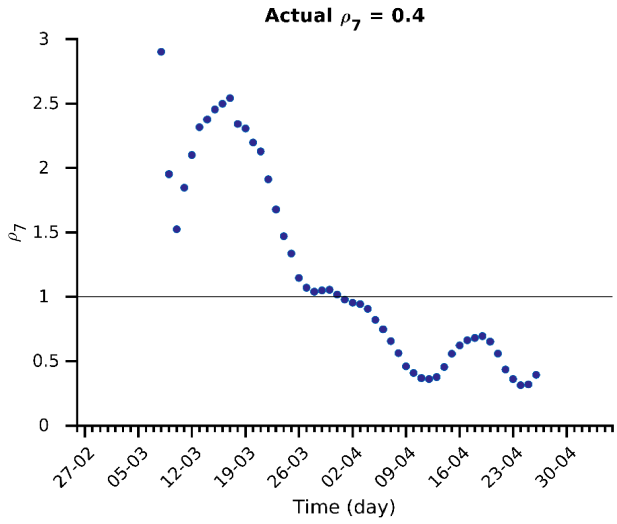


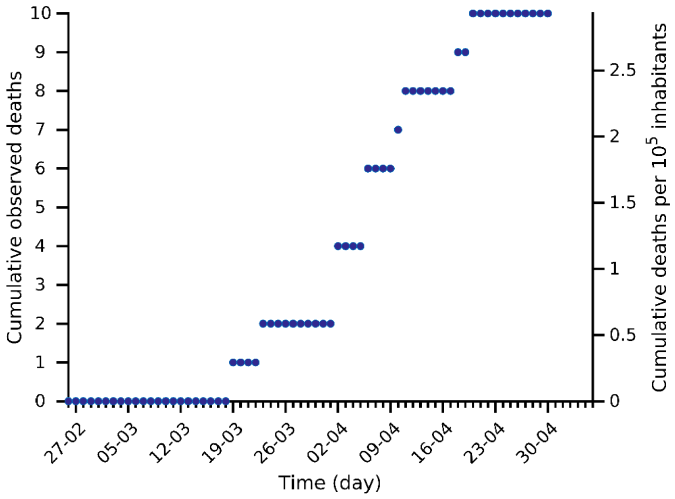


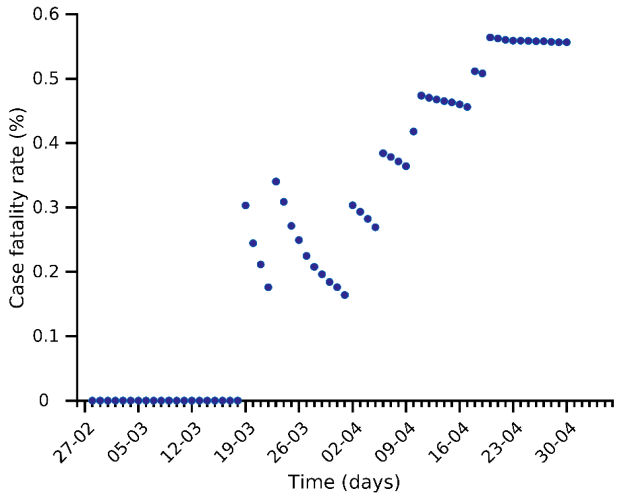




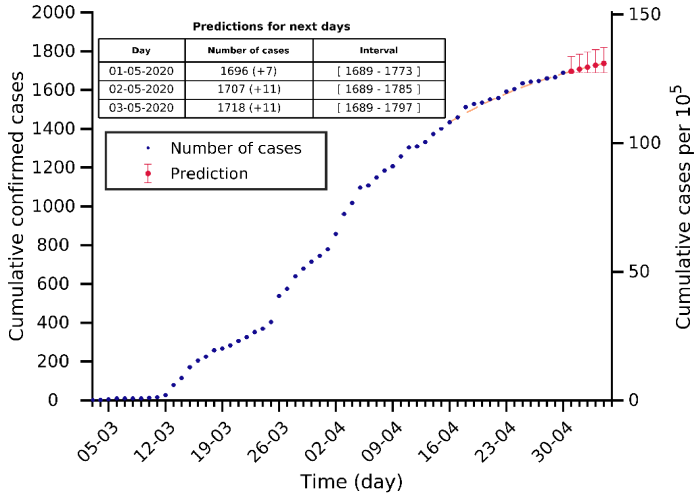


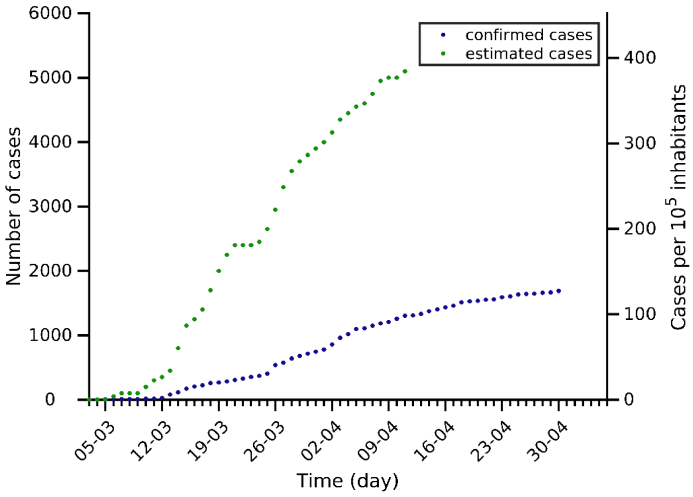


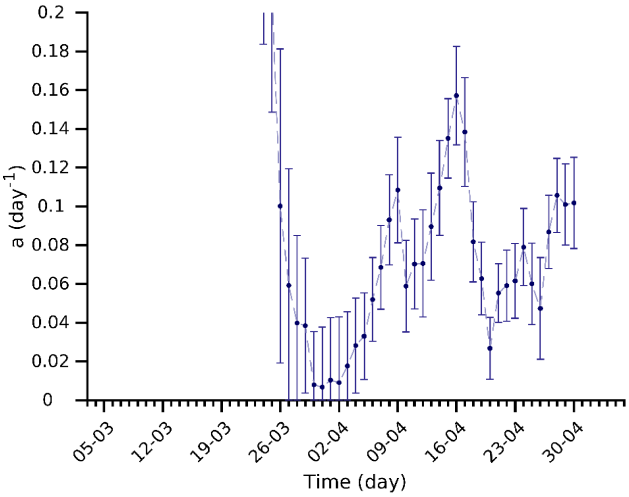


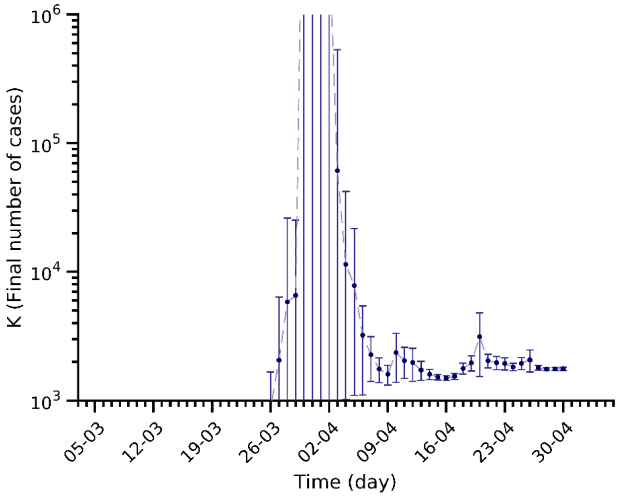


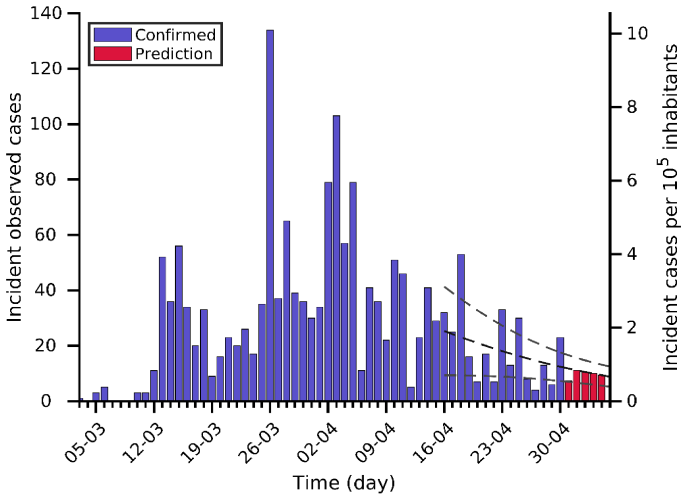
Estonia 30-04-2020. Population: 1.3M. Current cumulated incidence: 127/10⁵

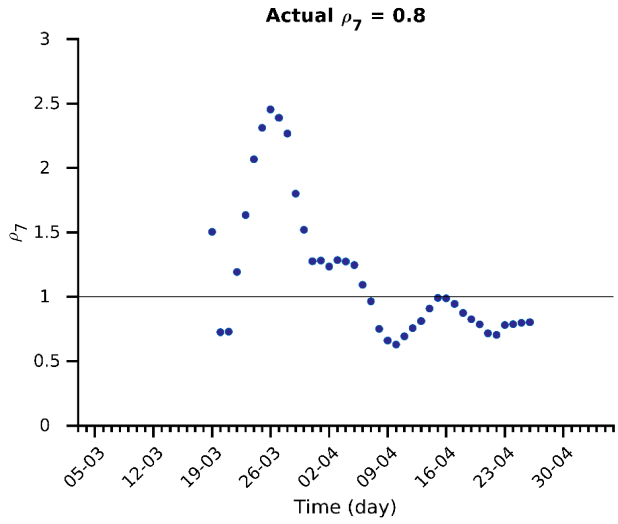


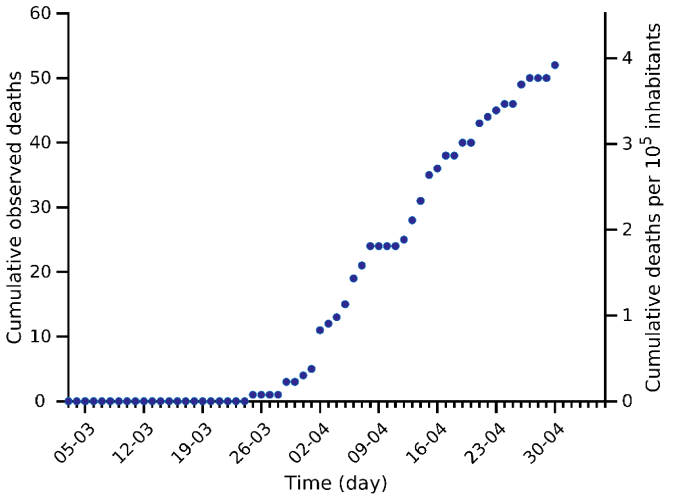


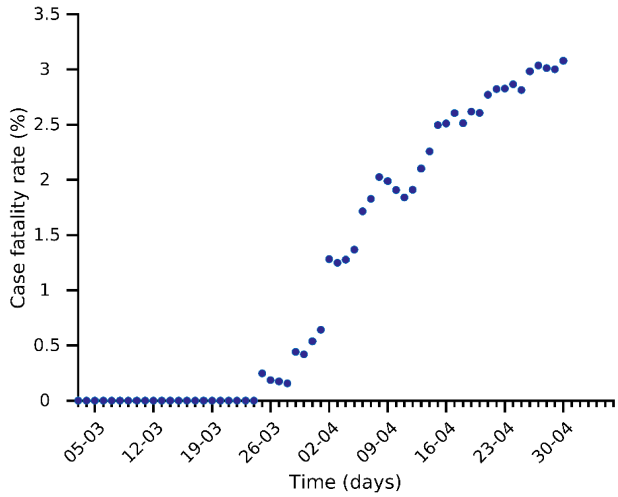




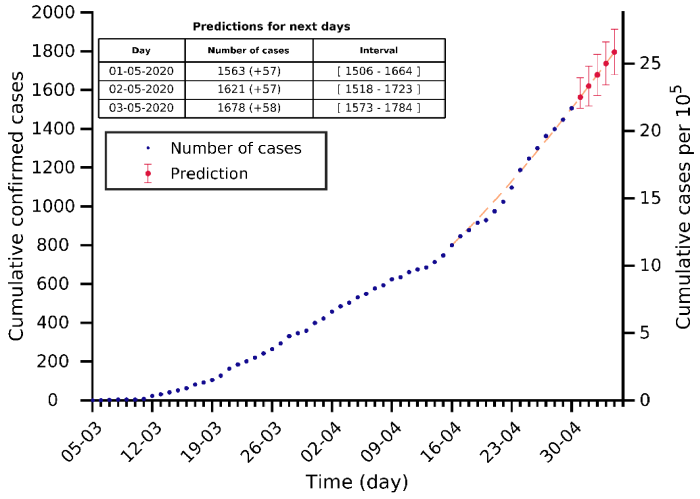


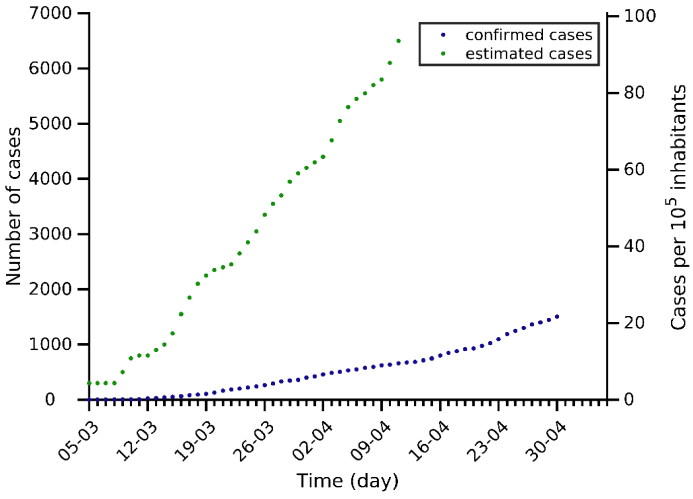


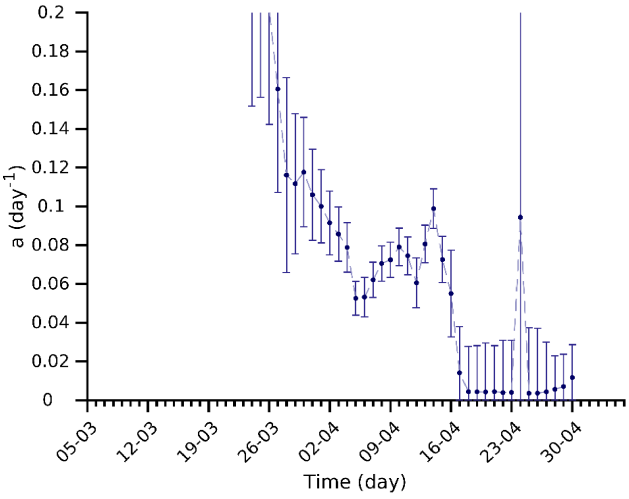


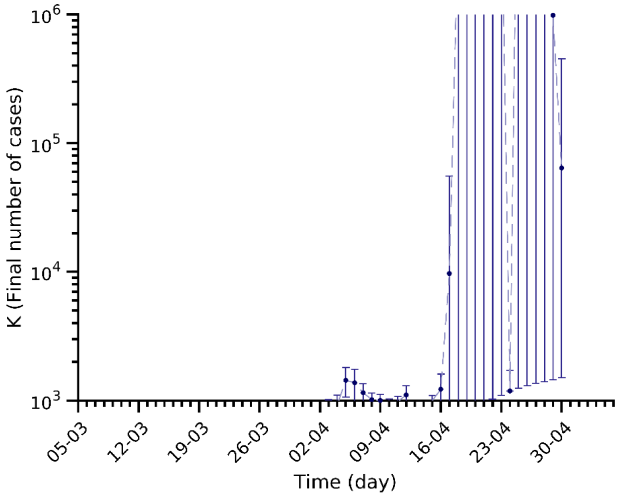


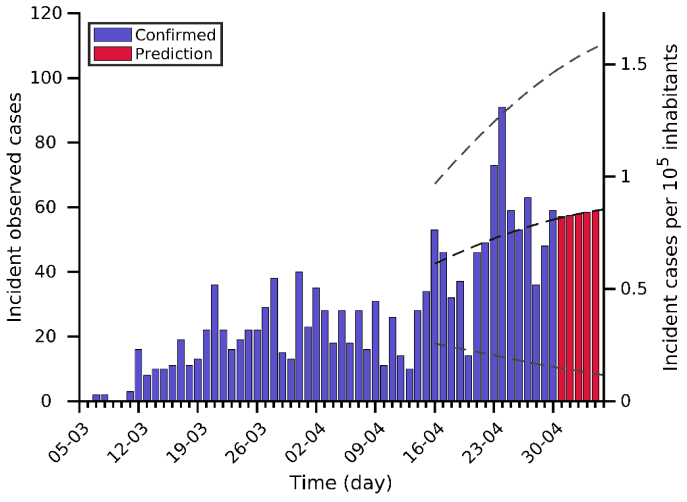
Bulgaria 30-04-2020. Population: 6.9M. Current cumulated incidence: 22/10^5

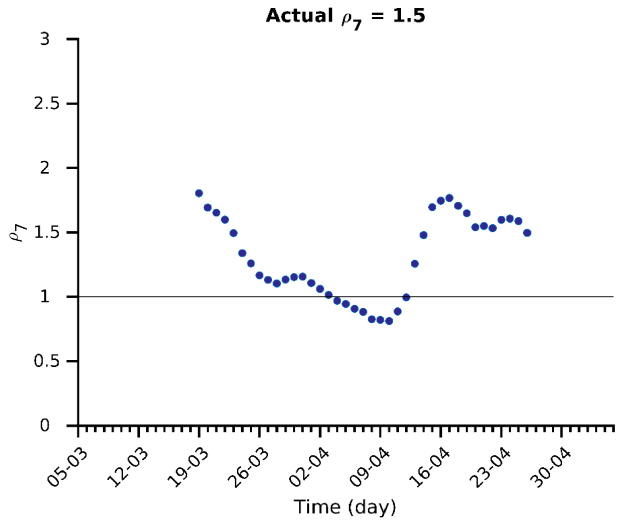


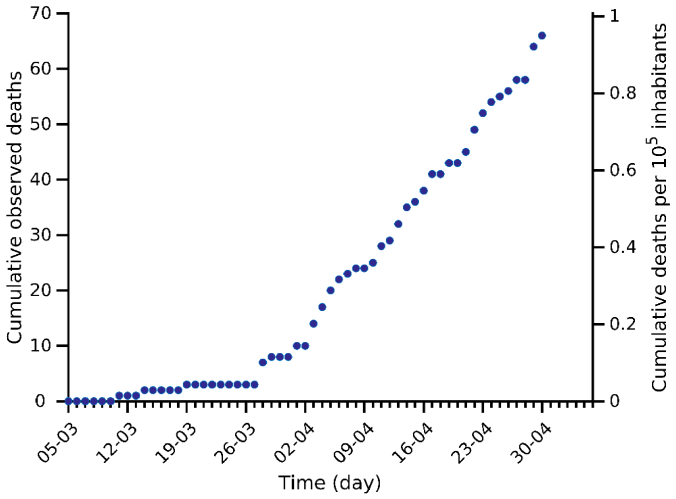


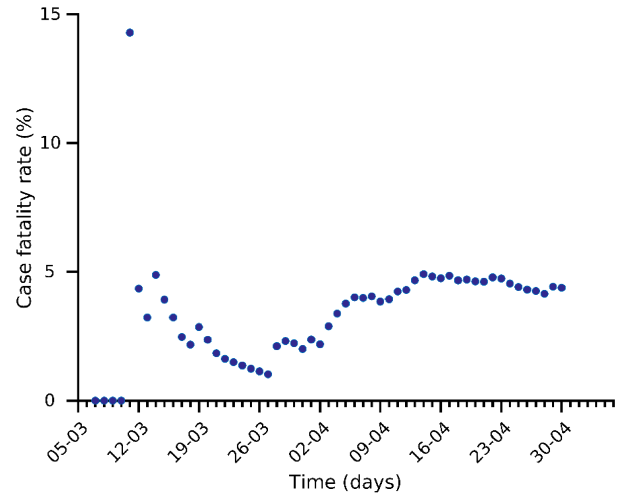




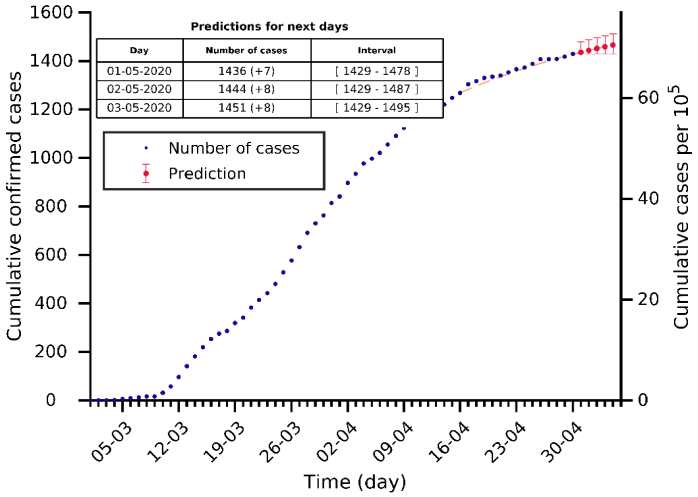


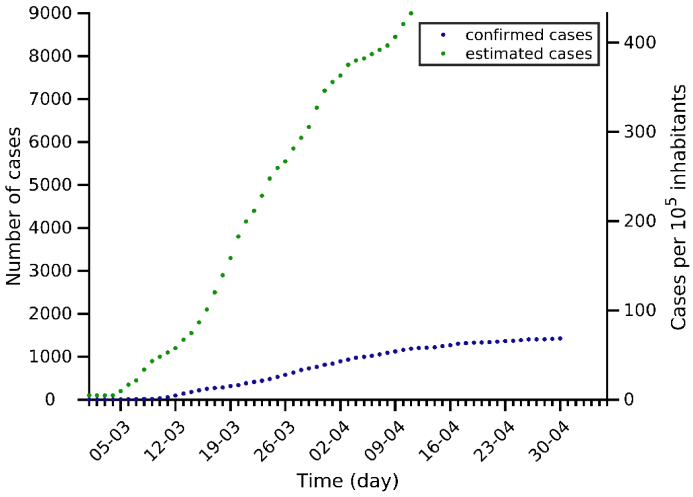


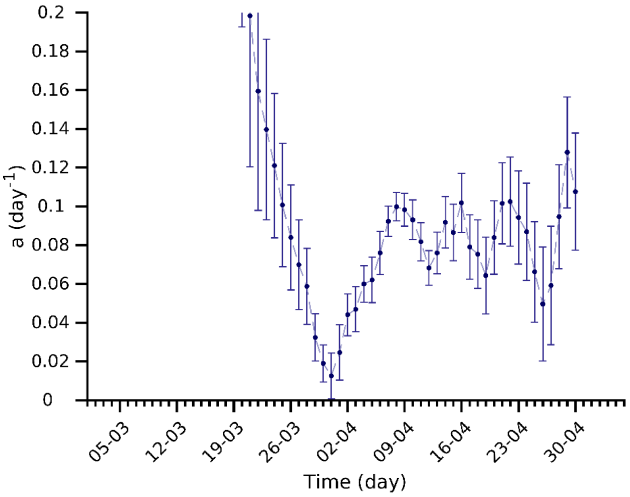


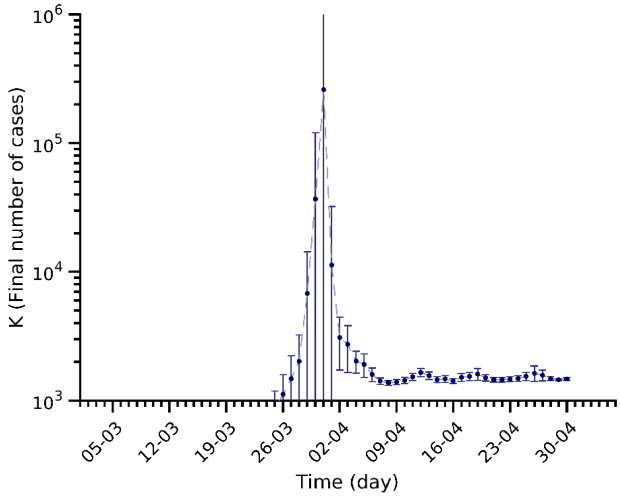


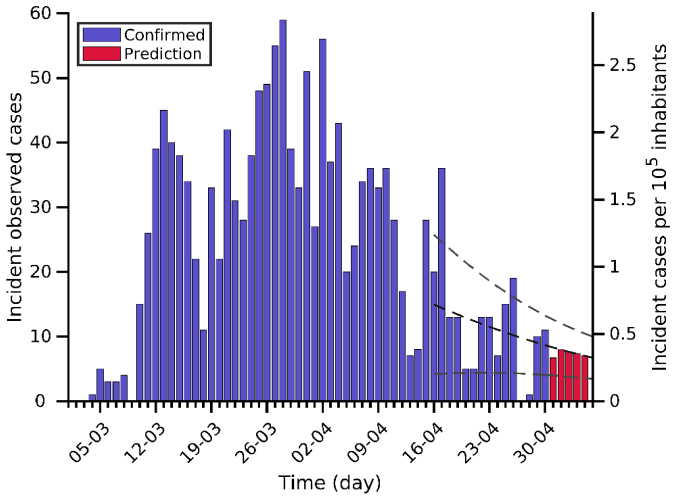
Slovenia 30-04-2020. Population: 2.1M. Current cumulated incidence: 69/10^5

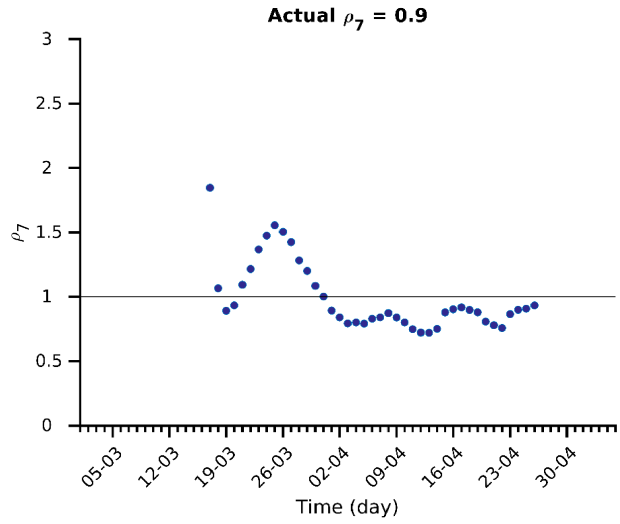


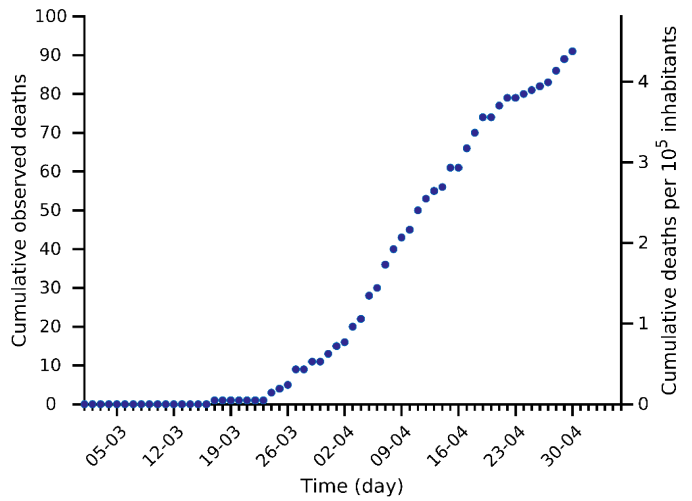


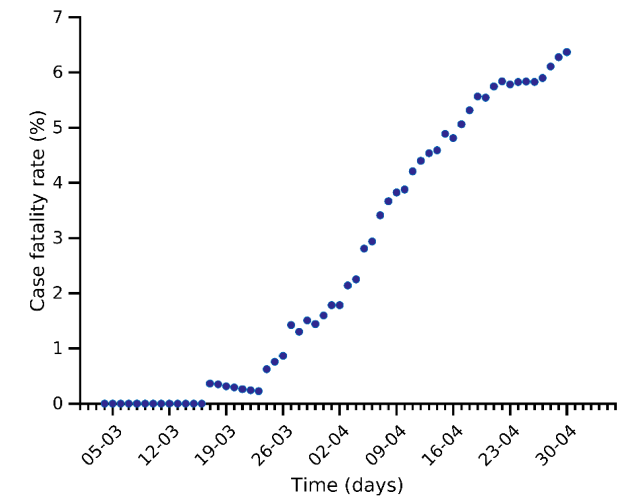




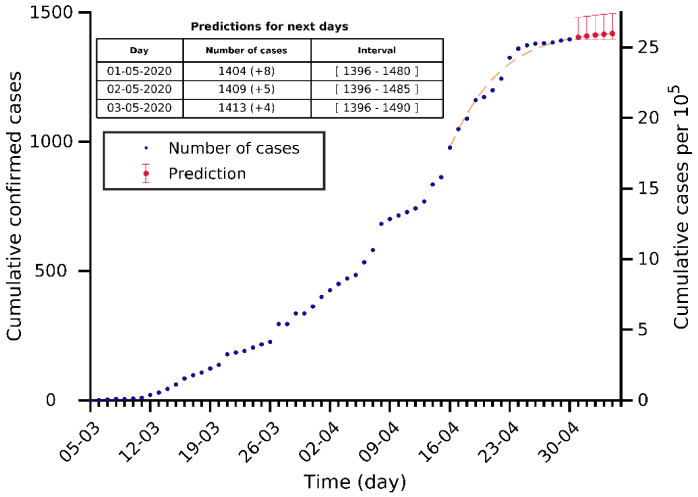


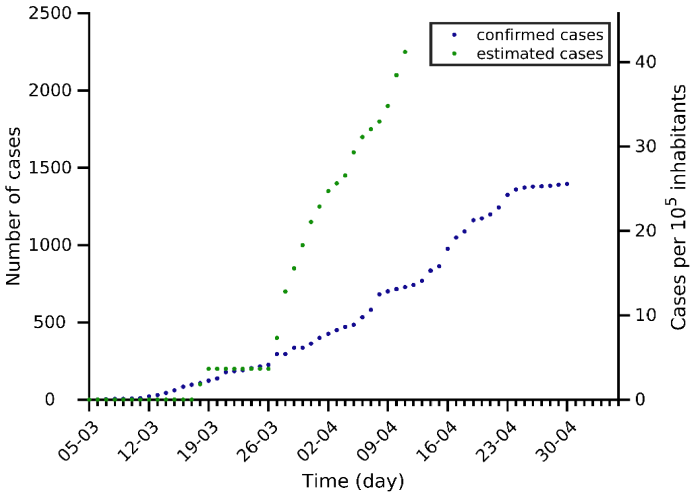


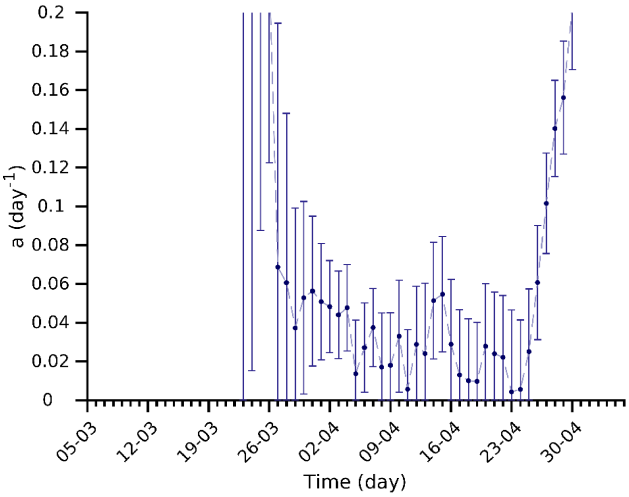


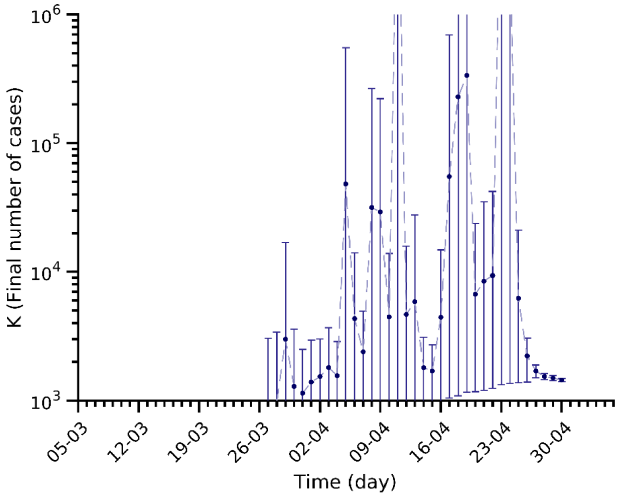


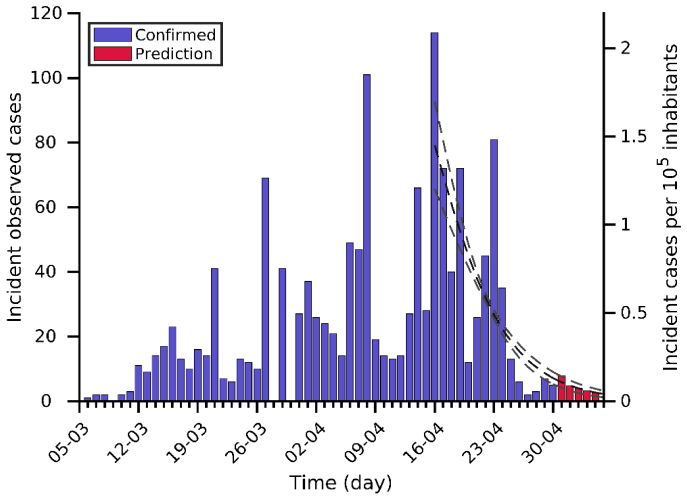
Slovakia 30-04-2020. Population: 5.5M. Current cumulated incidence: 26/10^5

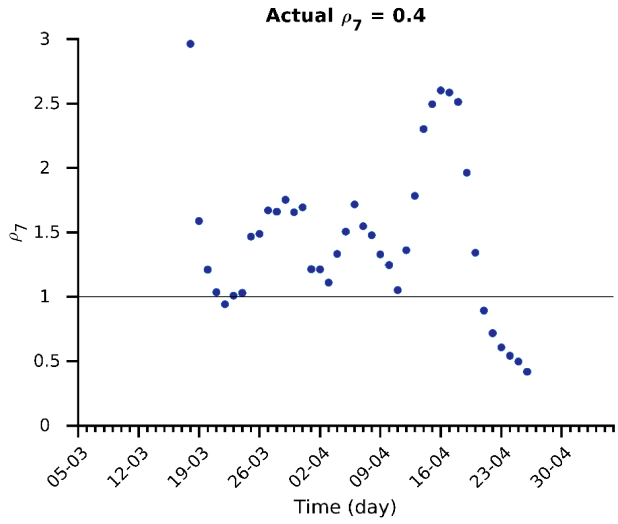


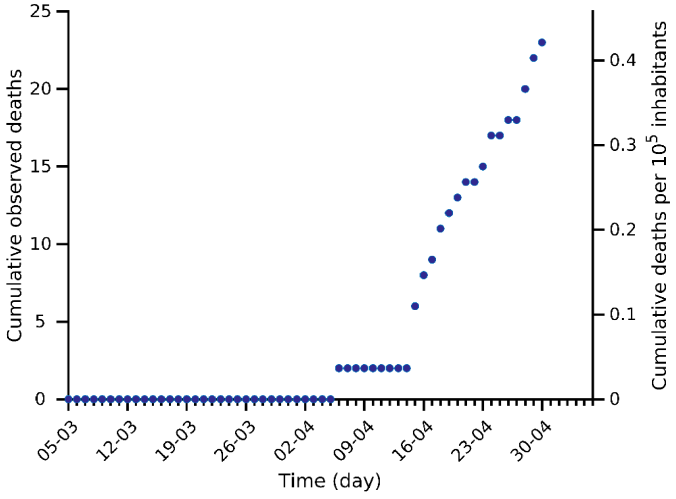


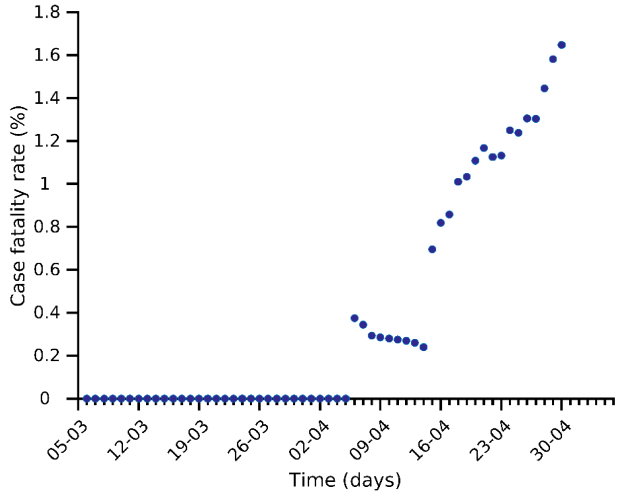




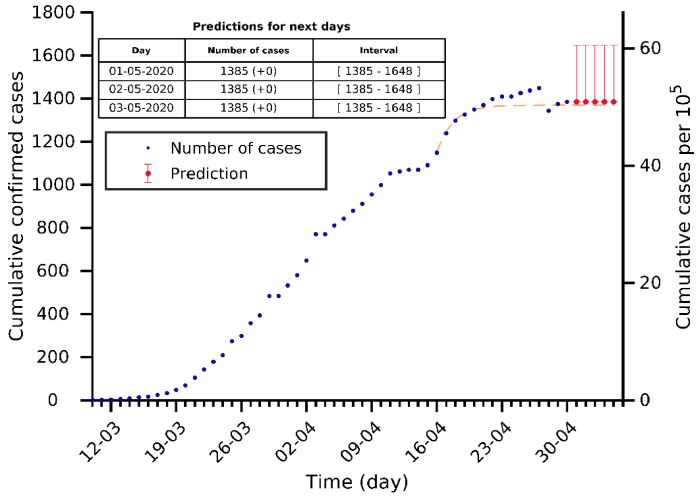


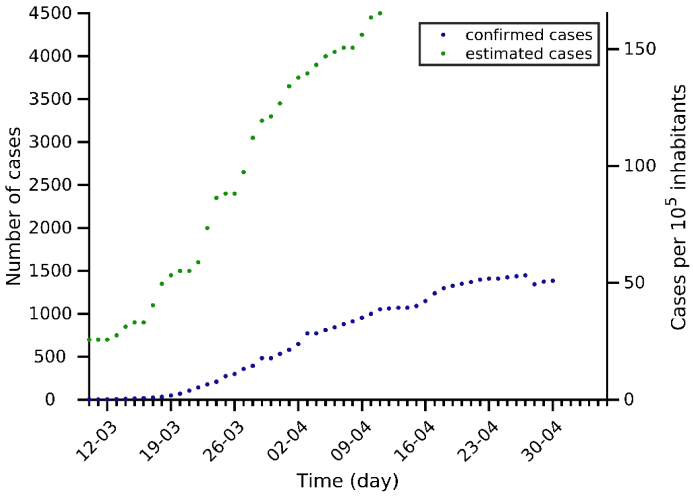


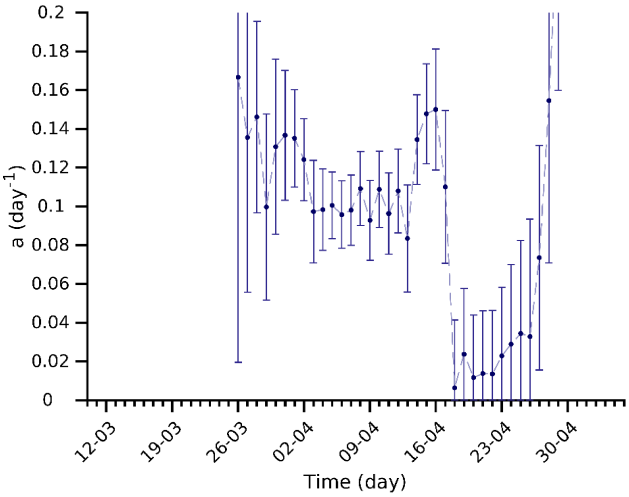


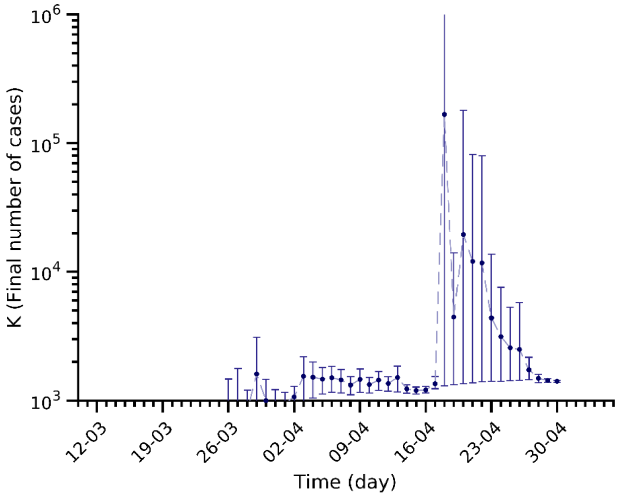


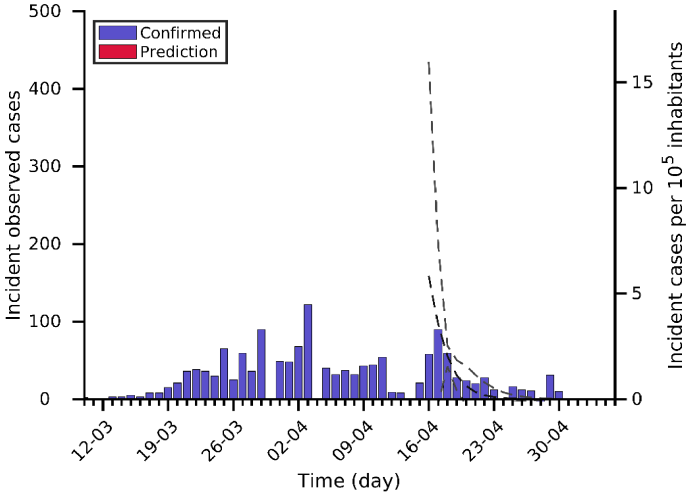
Lithuania 30-04-2020. Population: 2.7M. Current cumulated incidence: 51/10^5

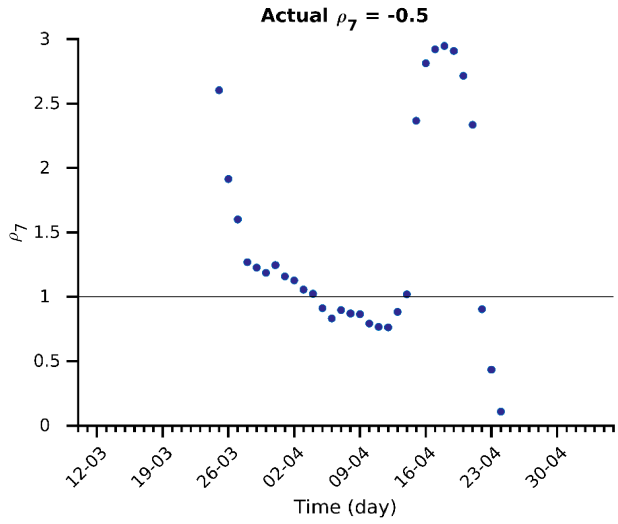


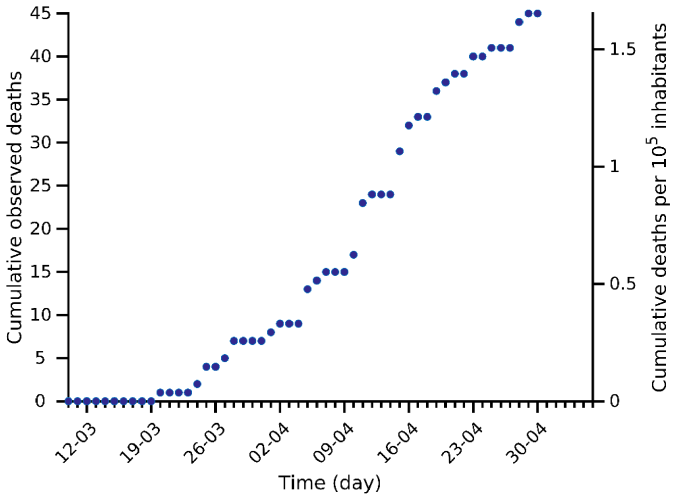


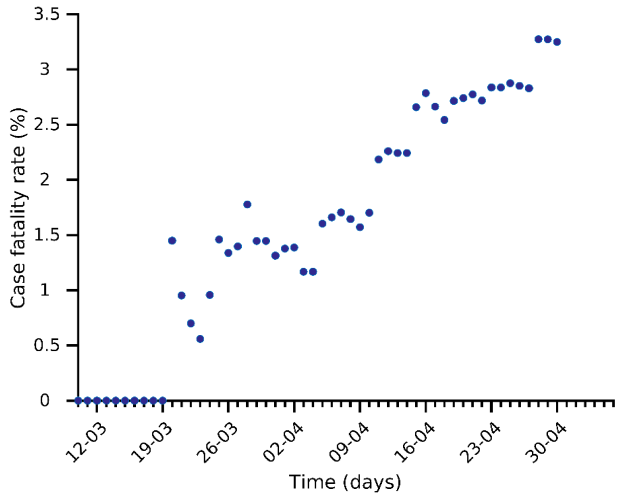




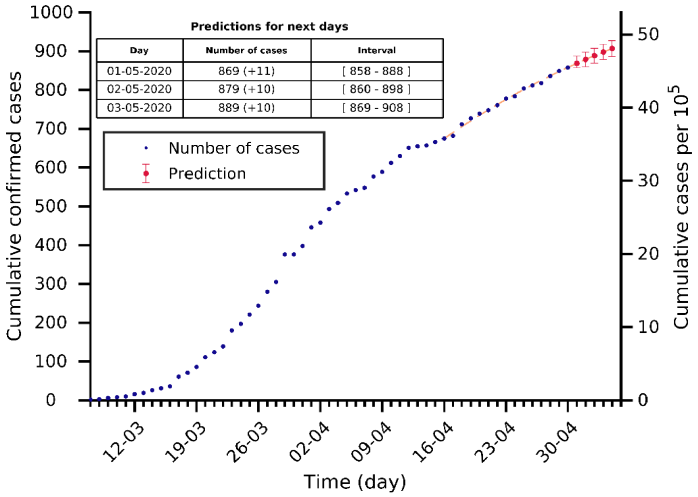


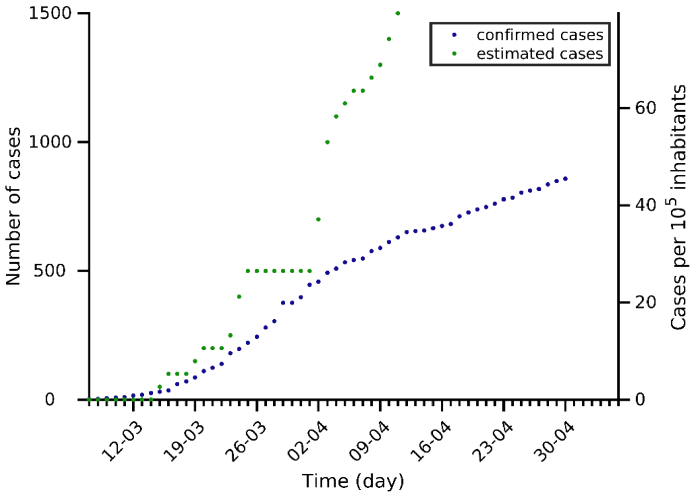


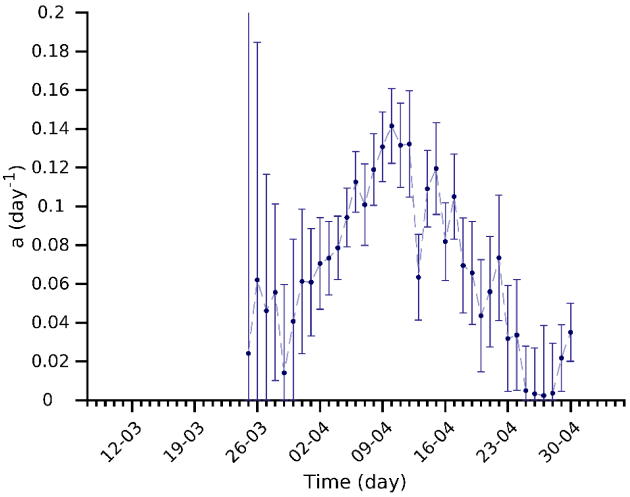


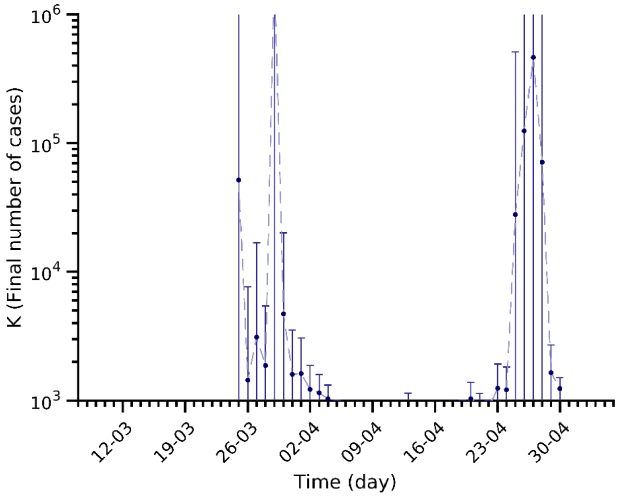


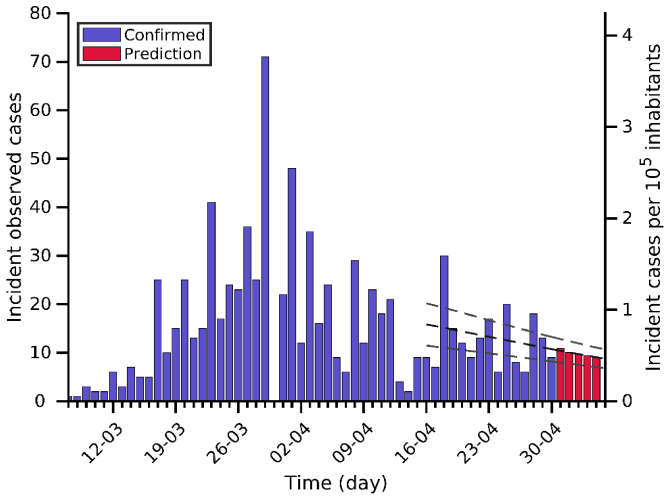
Latvia 30-04-2020. Population: 1.9M. Current cumulated incidence: $45/10^5$

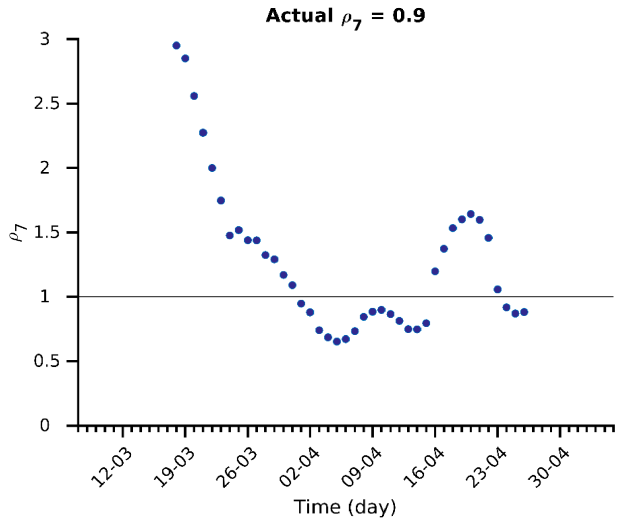


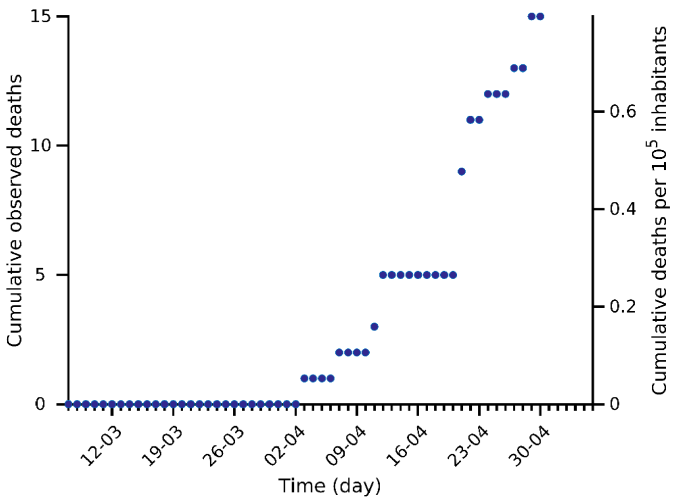


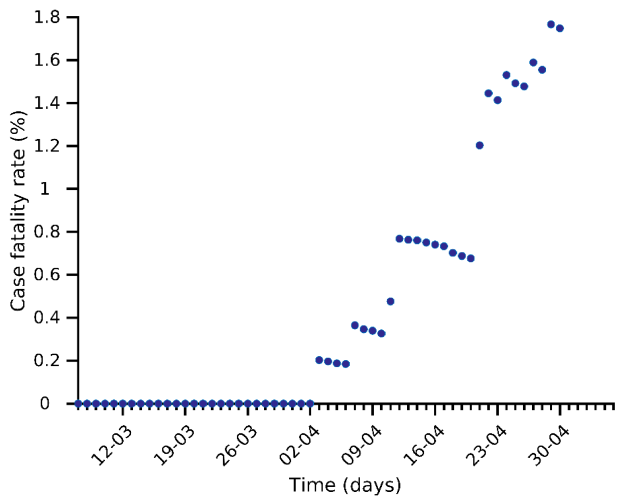




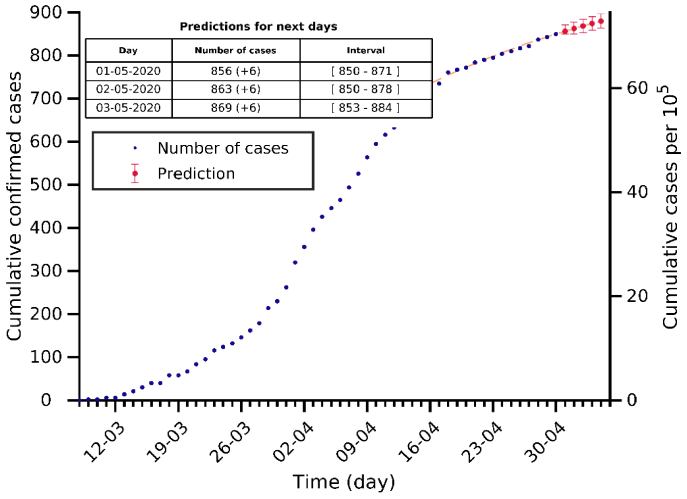


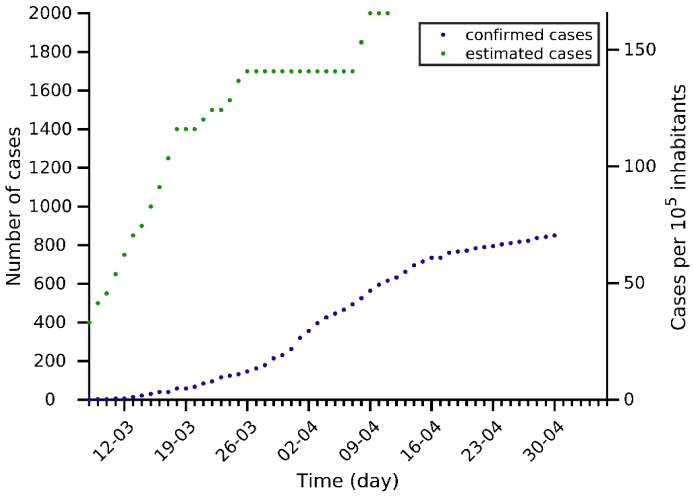


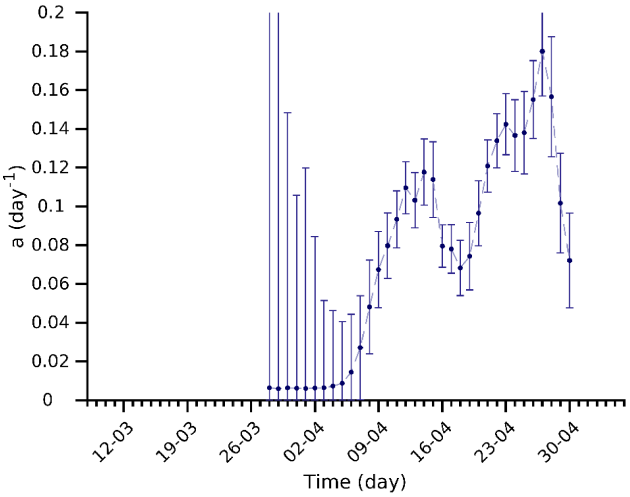


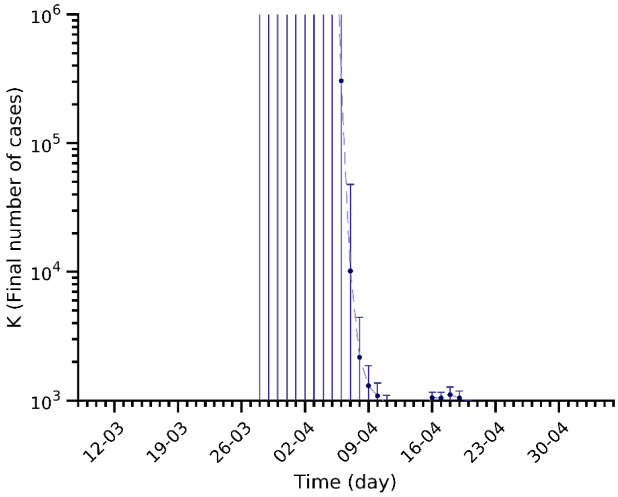


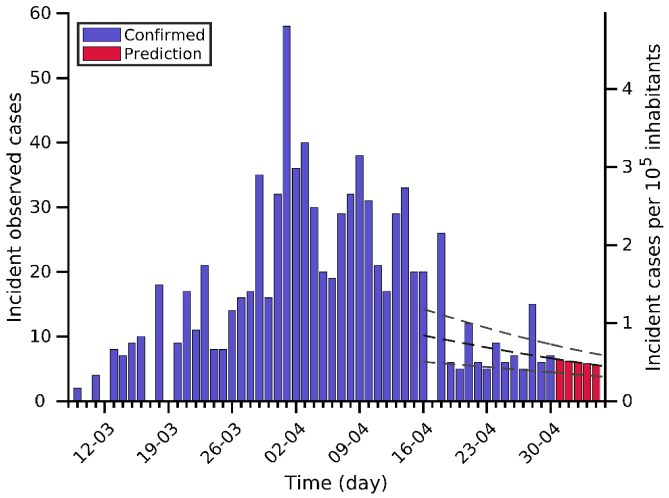
Cyprus 30-04-2020. Population: 1.2M. Current cumulated incidence: 70/10^5

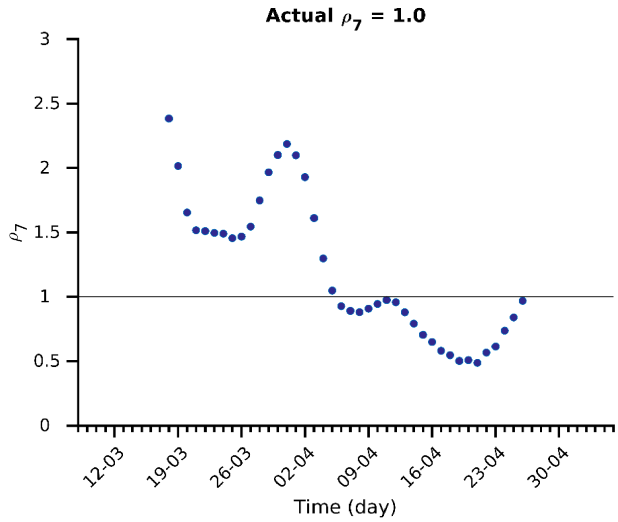


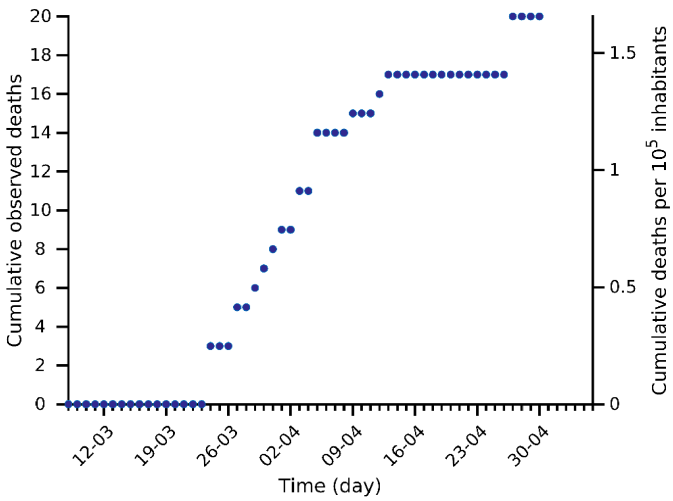


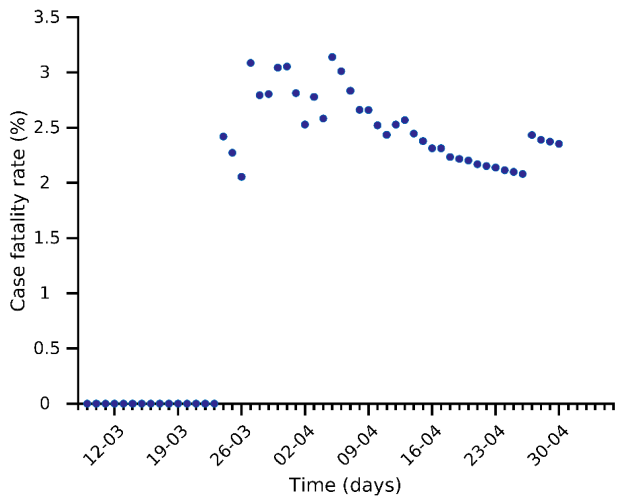




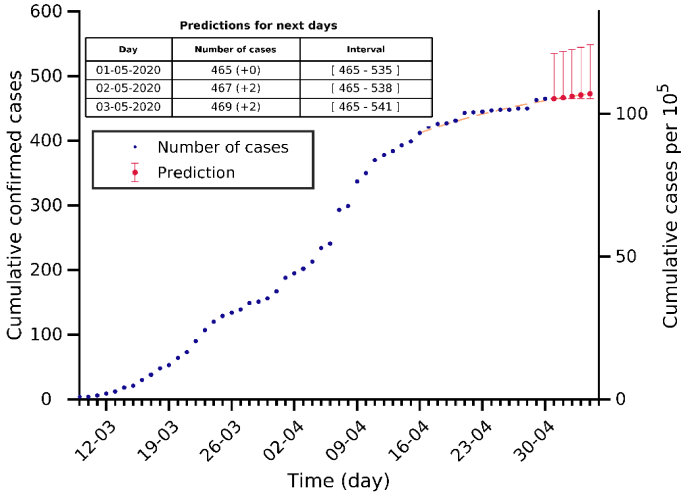


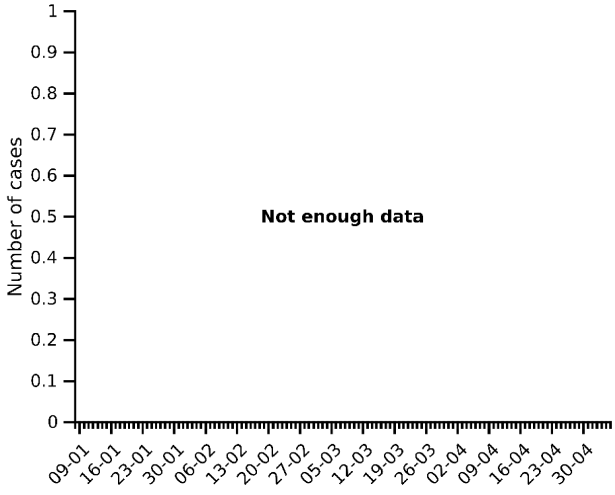


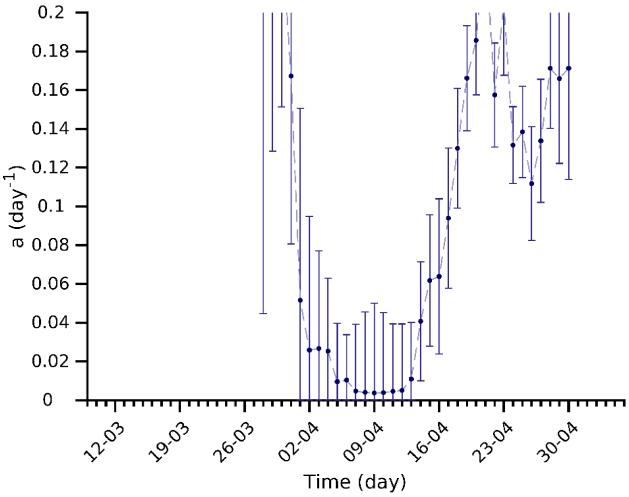


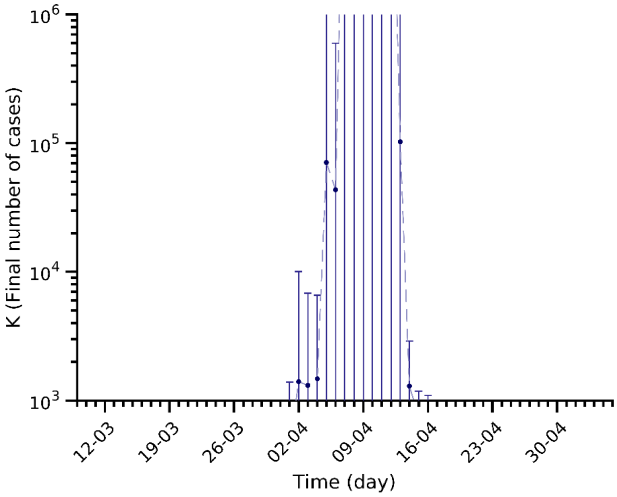


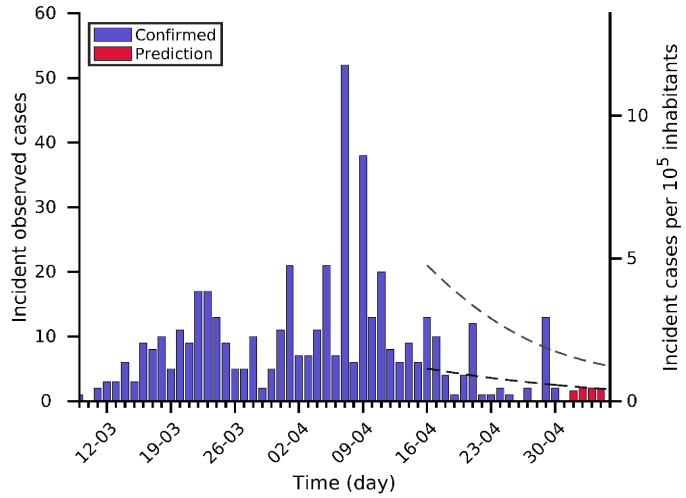
Malta 30-04-2020. Population: 0.4M. Current cumulated incidence: $105/10^5$

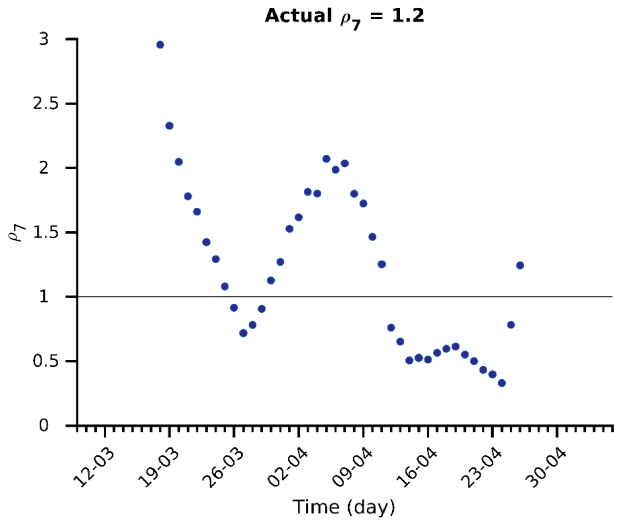


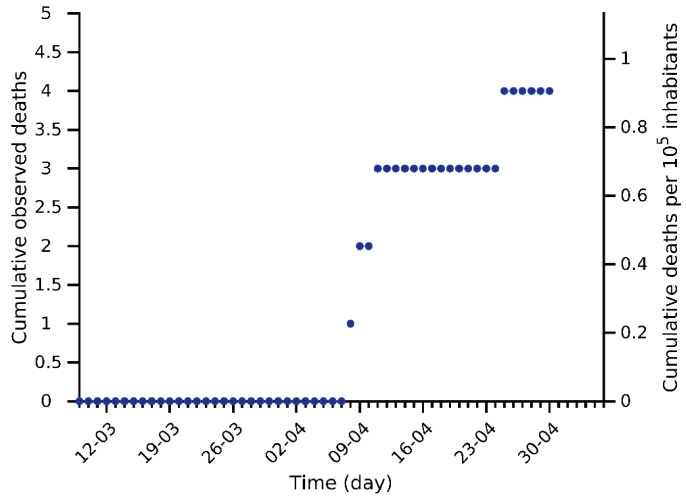


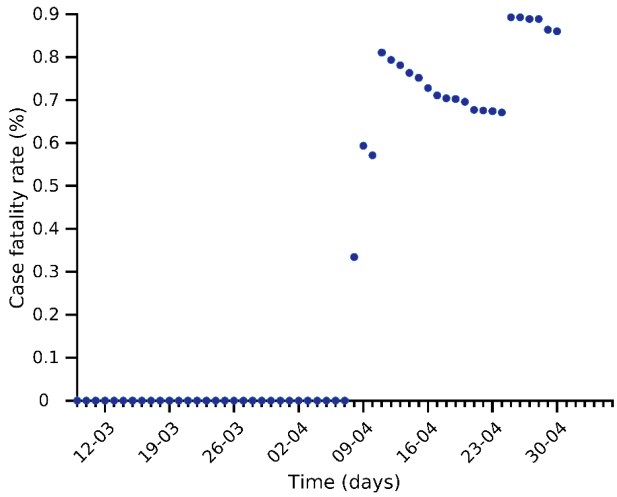








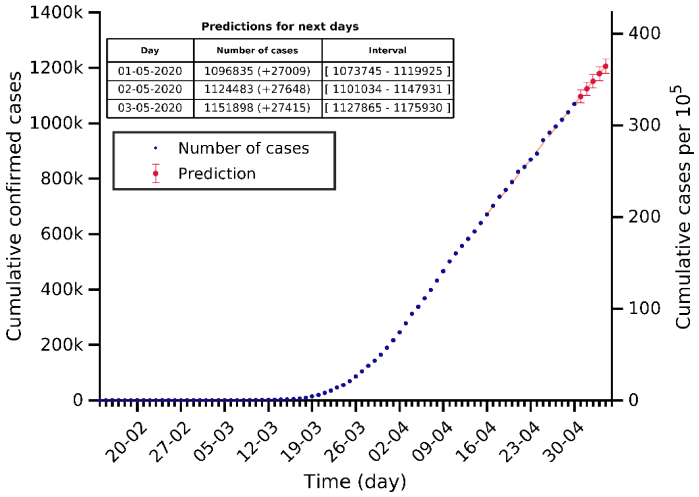


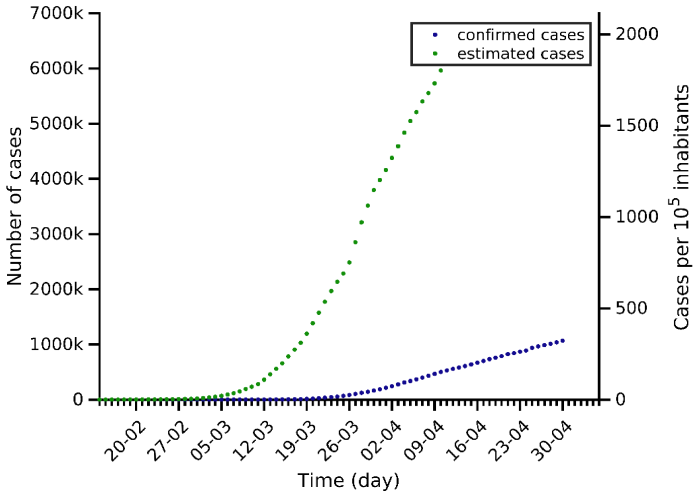


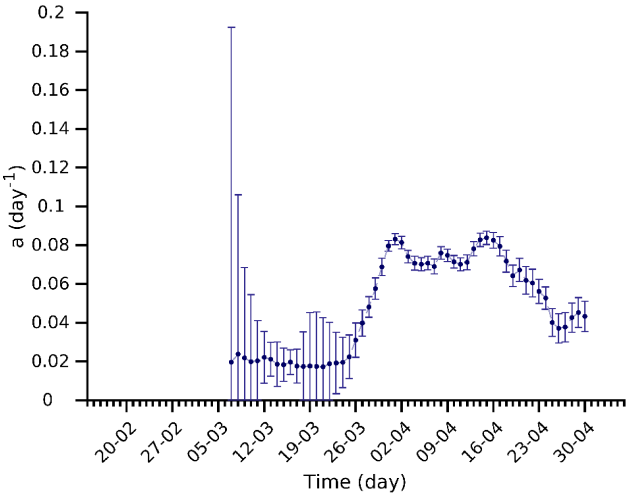
(2) Analysis and prediction of COVID-19 for other countries

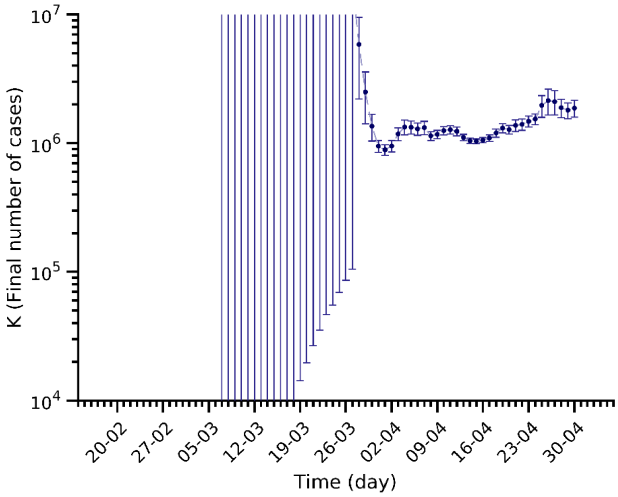
Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

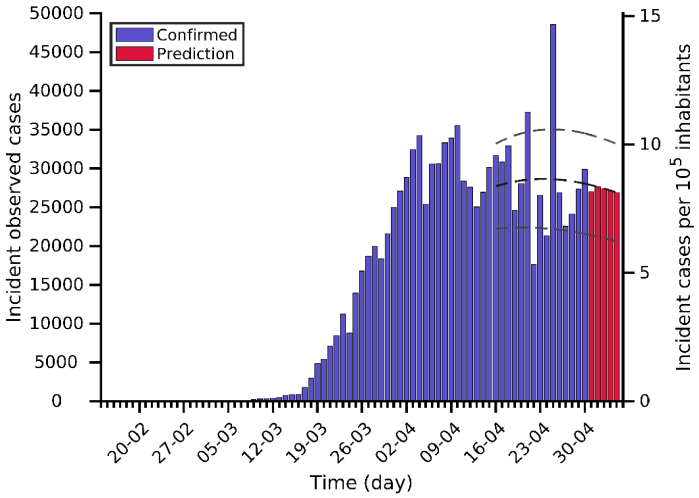
USA 30-04-2020. Population: 331.0M. Current cumulated incidence: $323/10^5$

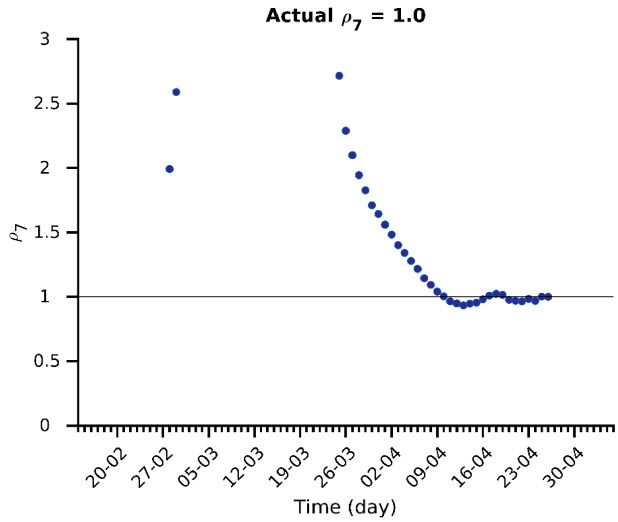


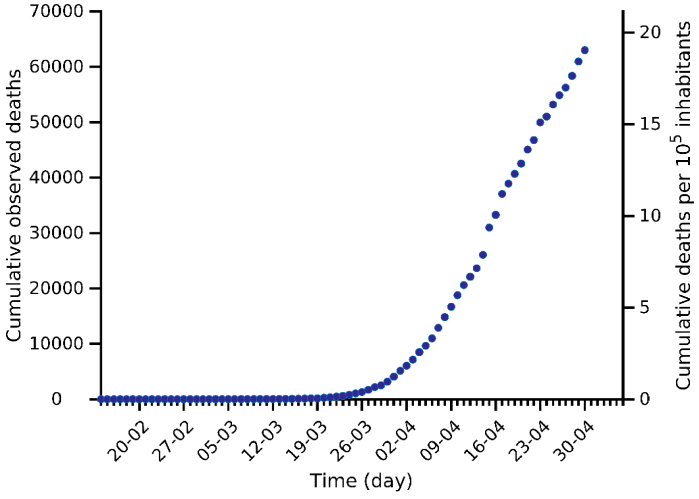


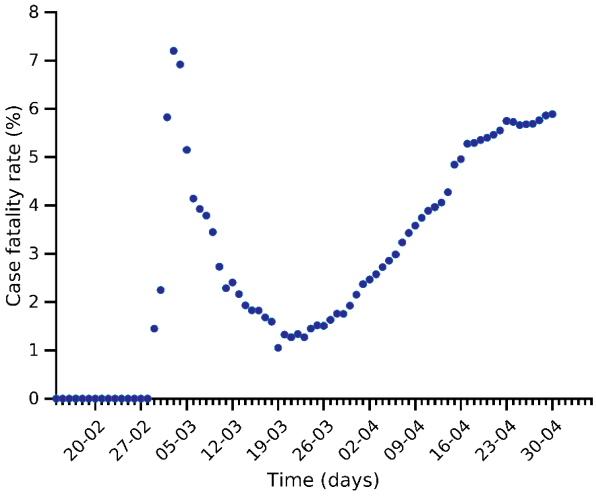




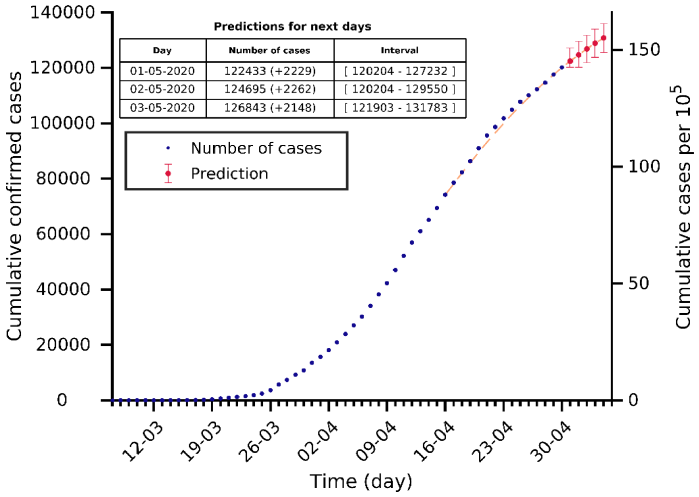


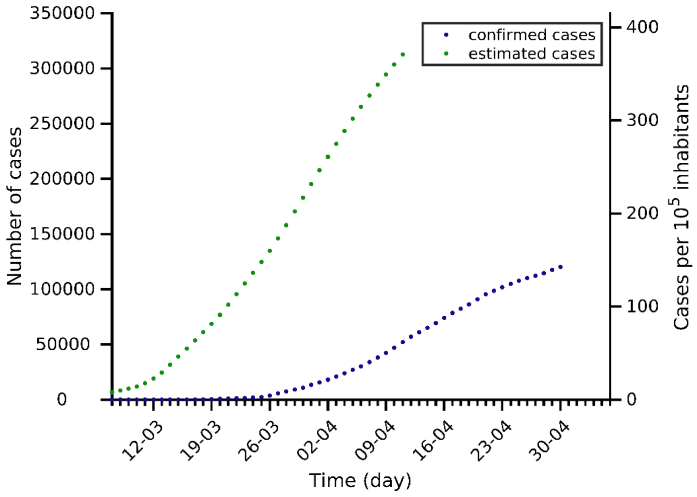


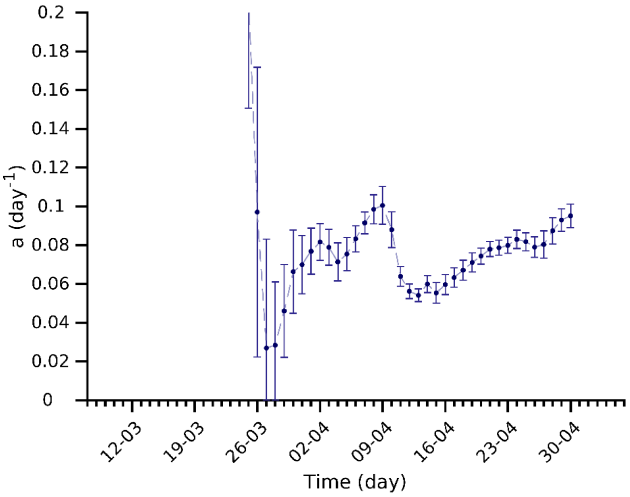


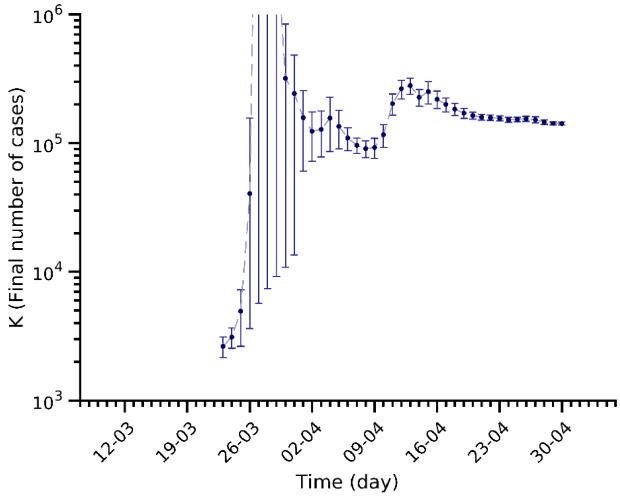


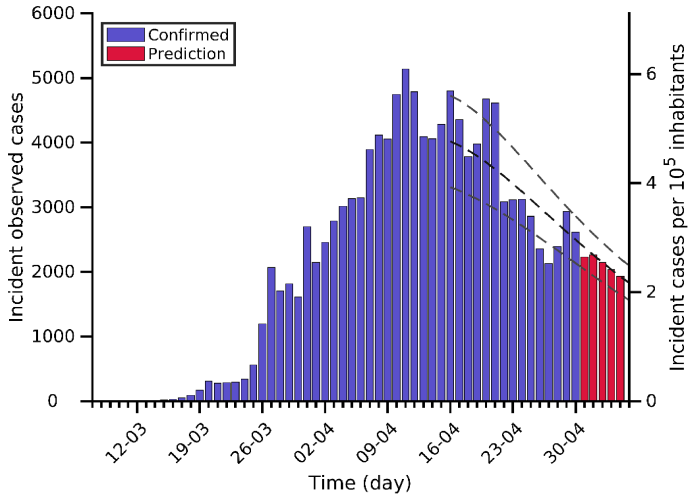
Turkey 30-04-2020. Population: 84.3M. Current cumulated incidence: 143/10^5

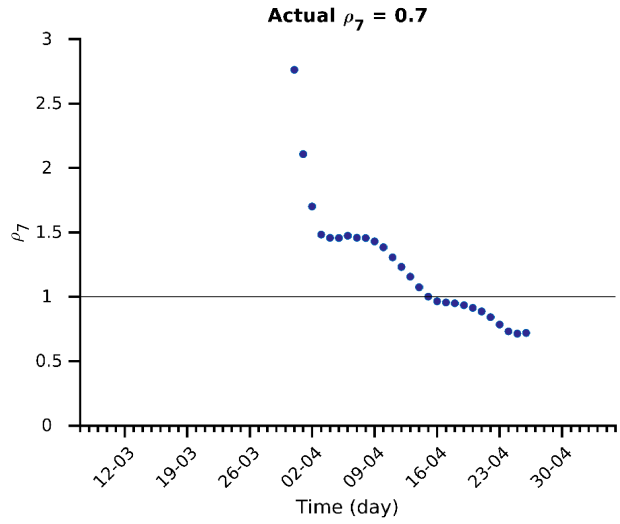


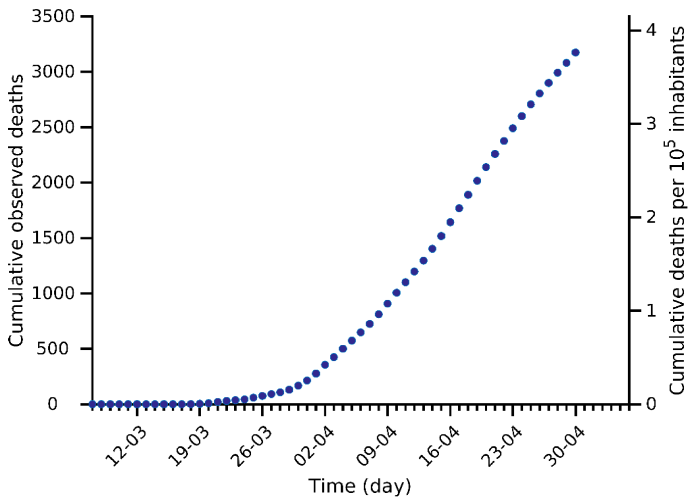


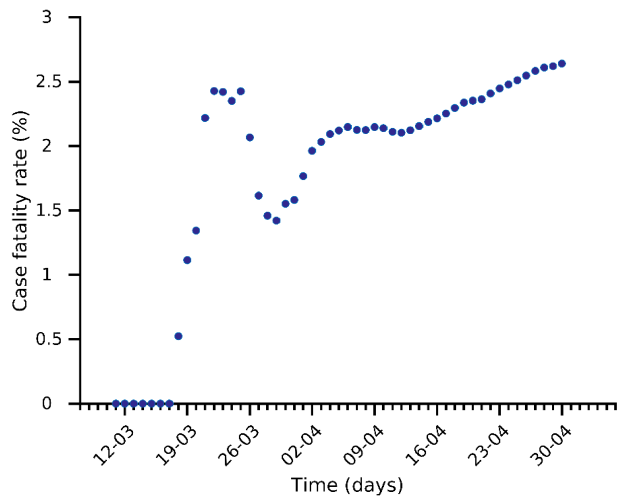




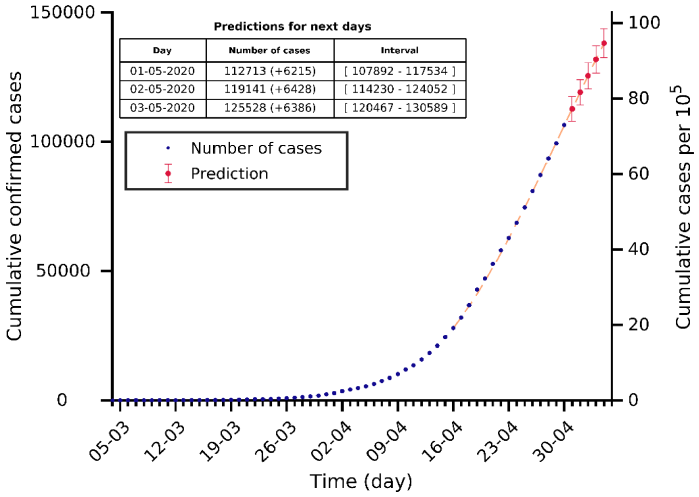


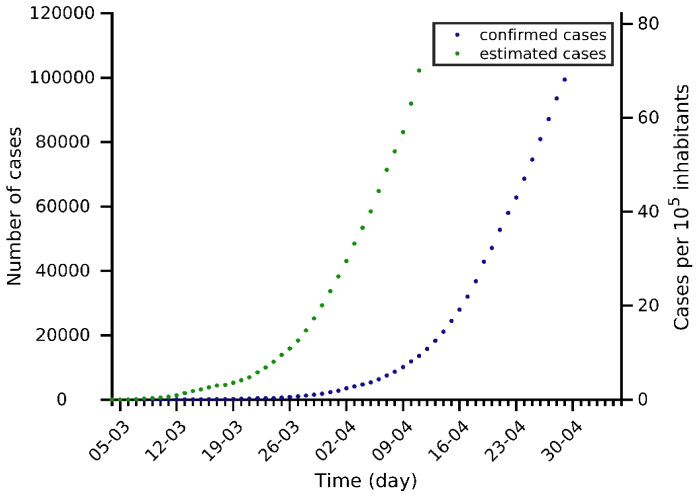


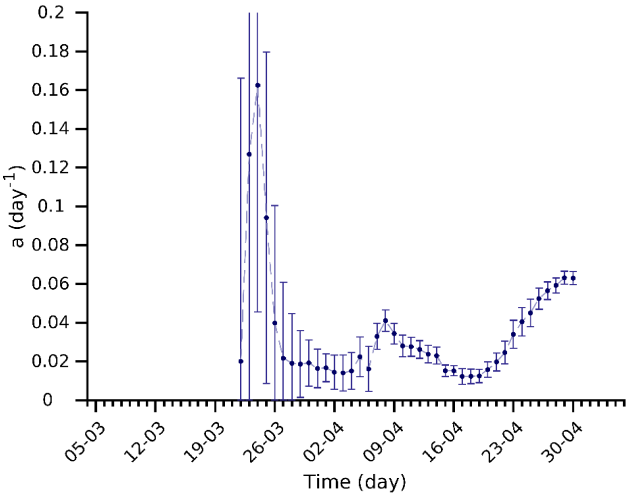


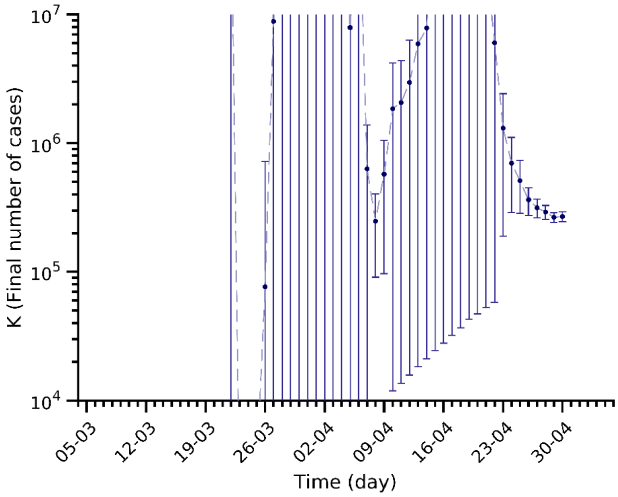


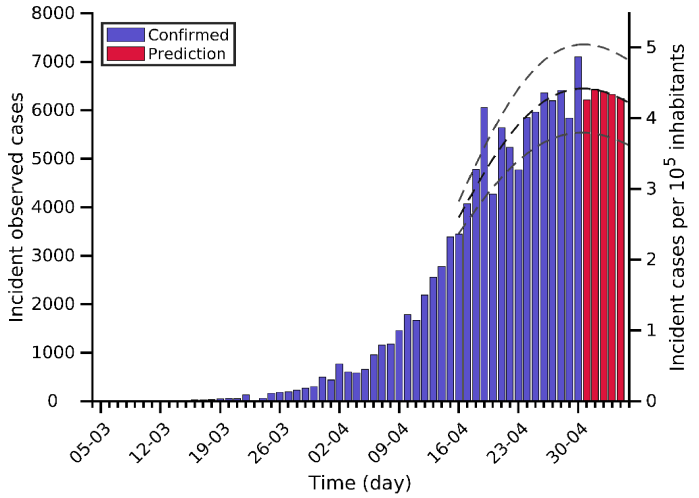
Russia 30-04-2020. Population: 145.9M. Current cumulated incidence: 73/10⁵

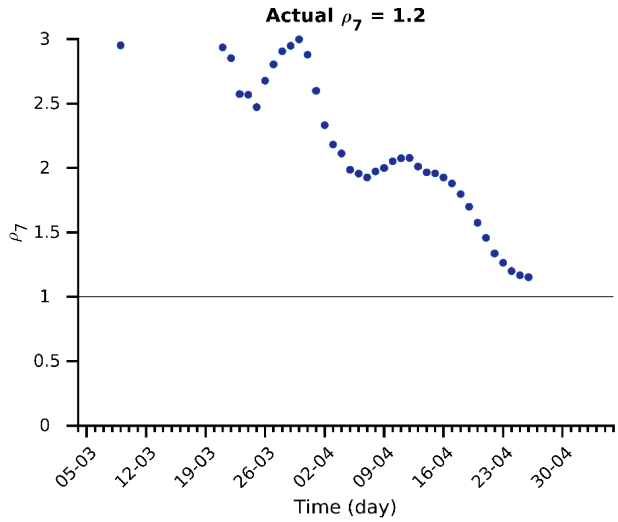


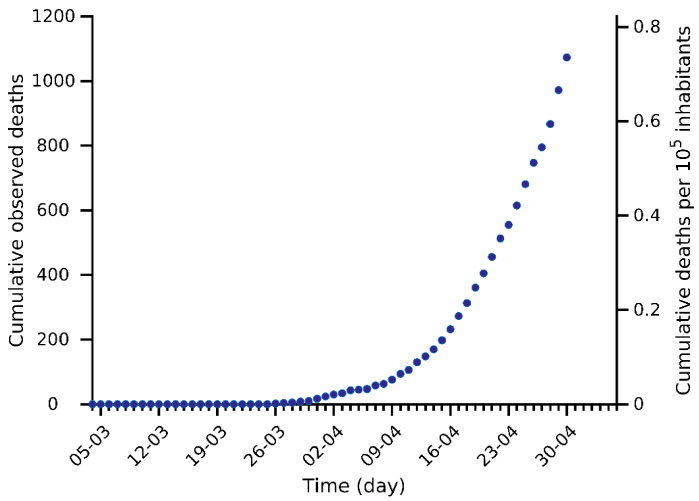


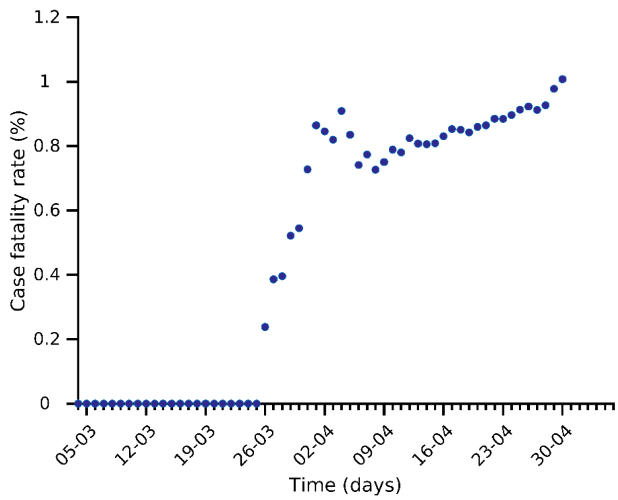




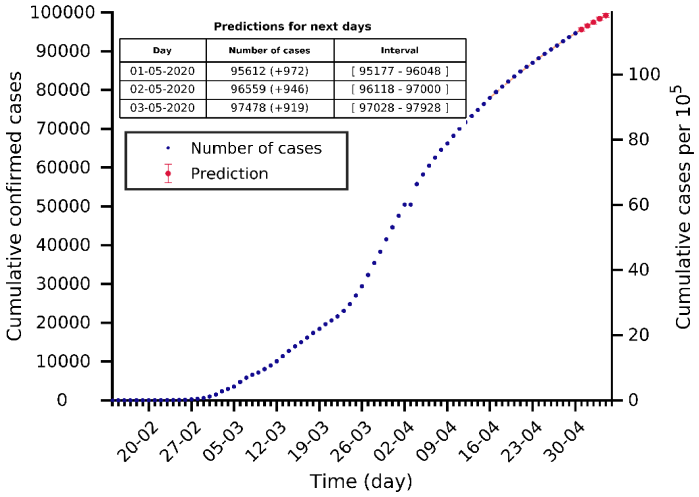


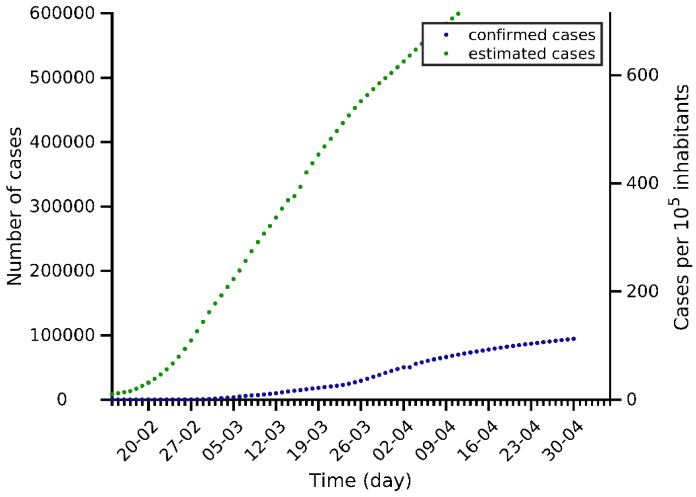


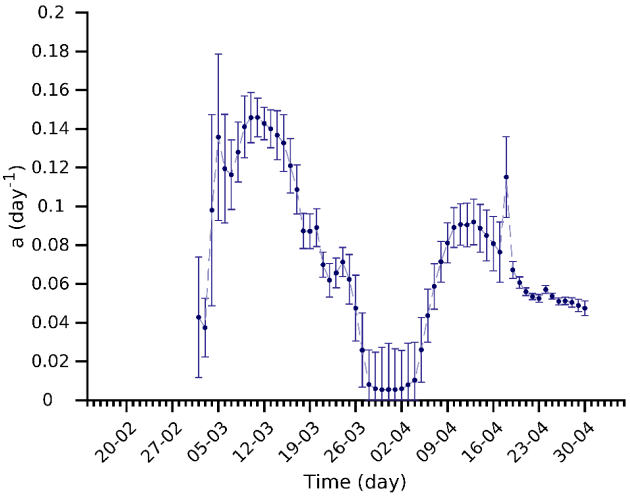


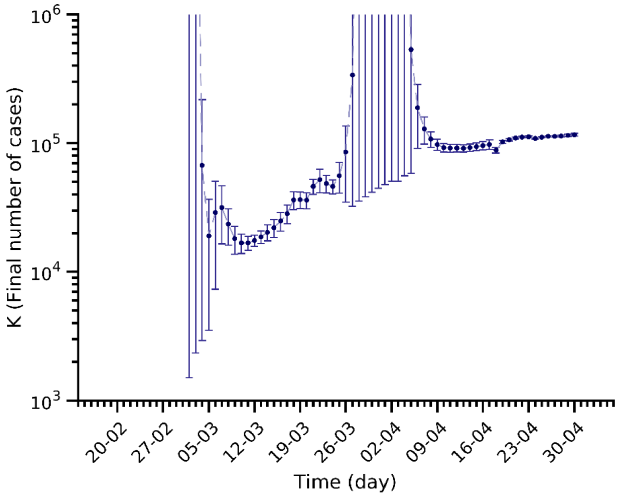


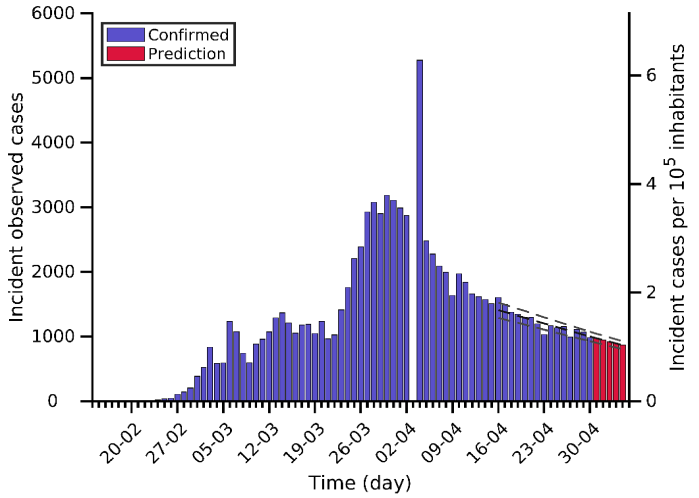
Iran 30-04-2020. Population: 84.0M. Current cumulated incidence: 113/10^5

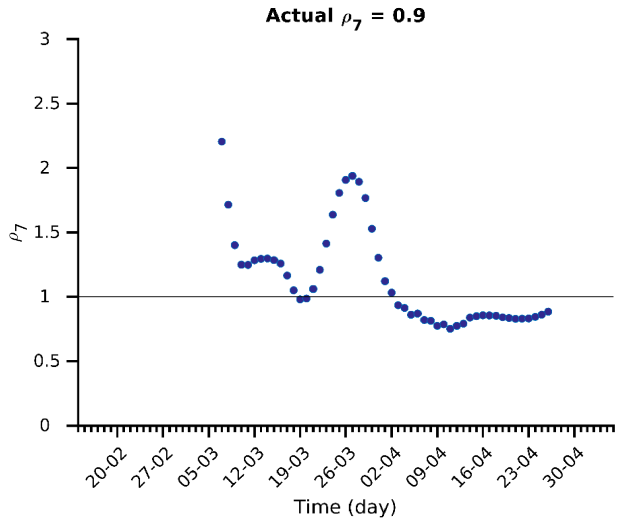


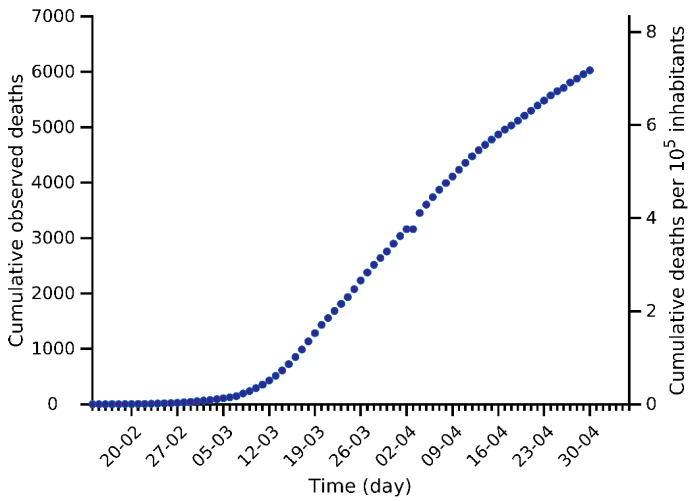


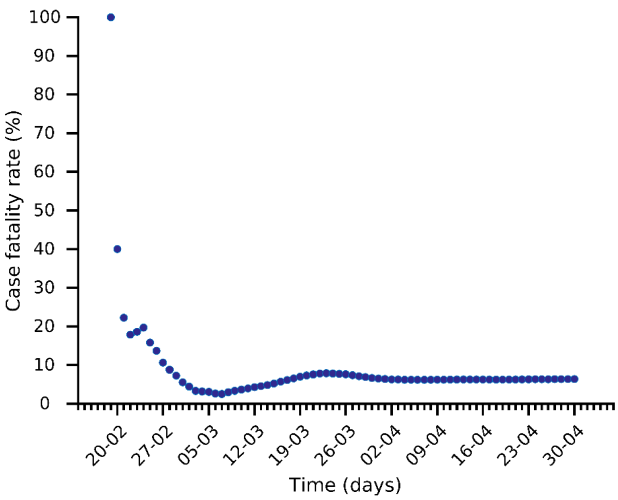








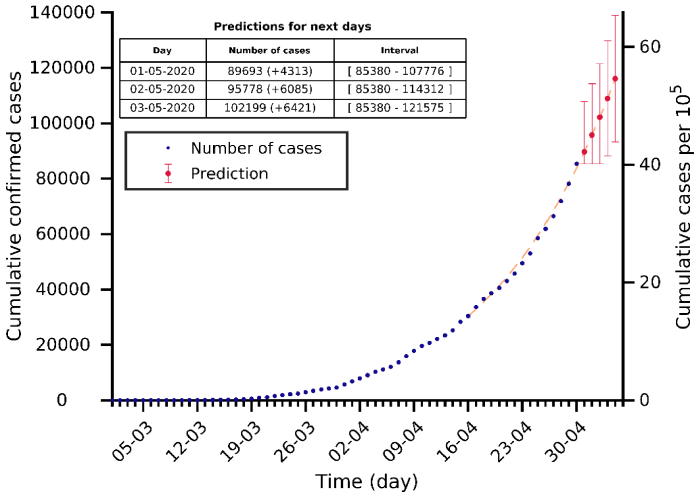


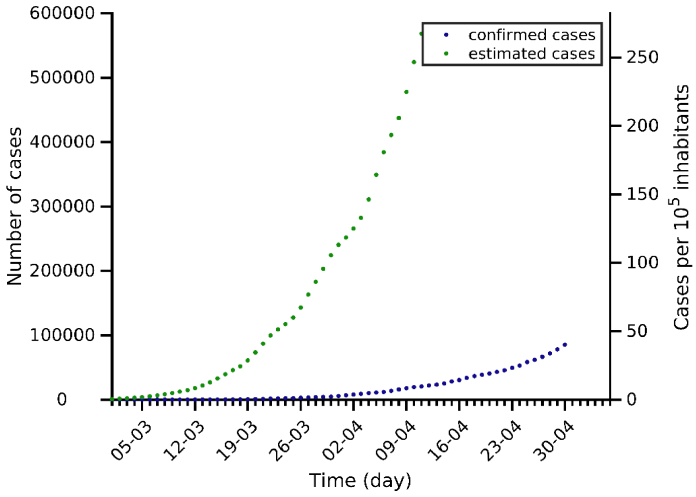


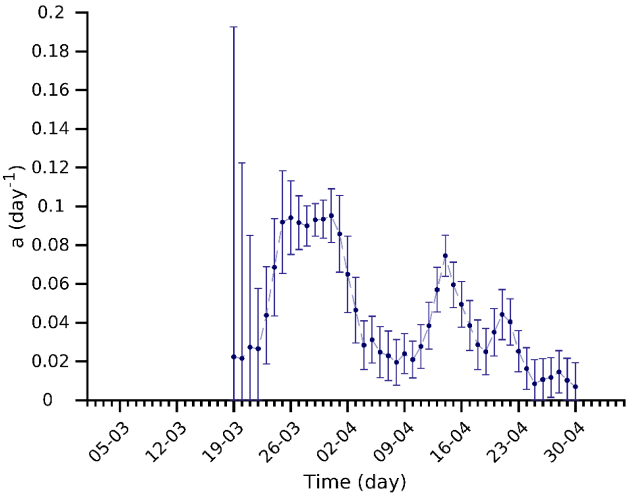
Brazil 30-04-2020. Population: 212.6M. Current cumulated incidence: $40/10^5$

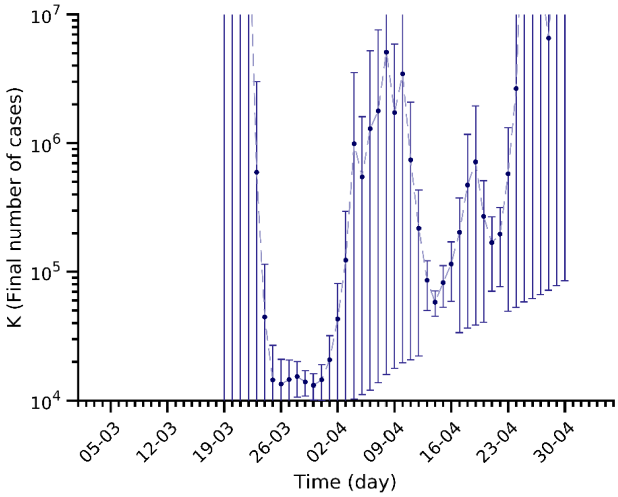
Predictions for next days

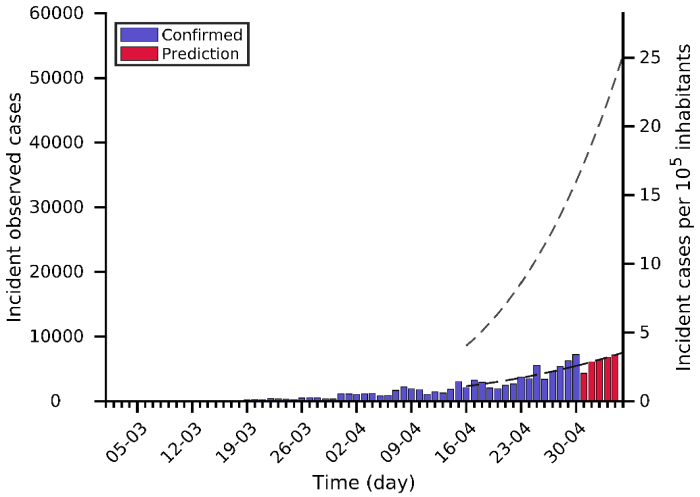
Day	Number of cases	Interval
01-05-2020	89693 (+4313)	[85380 - 107776]
02-05-2020	95778 (+6085)	[85380 - 114312]
03-05-2020	102199 (+6421)	[85380 - 121575]

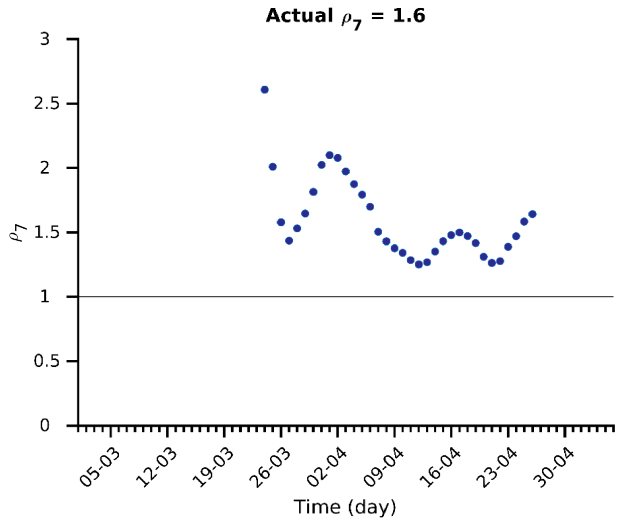


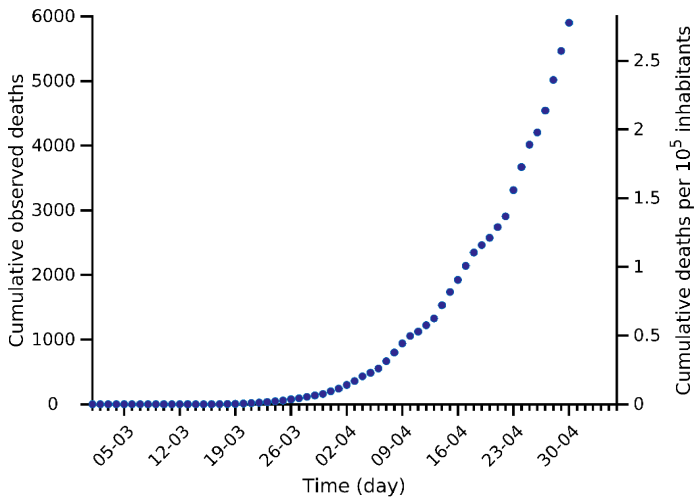


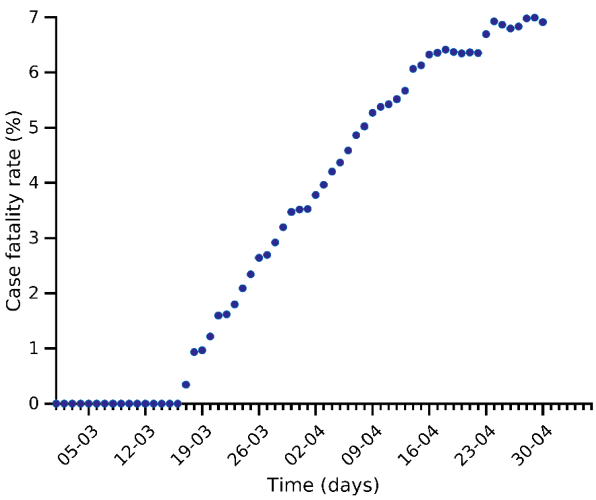




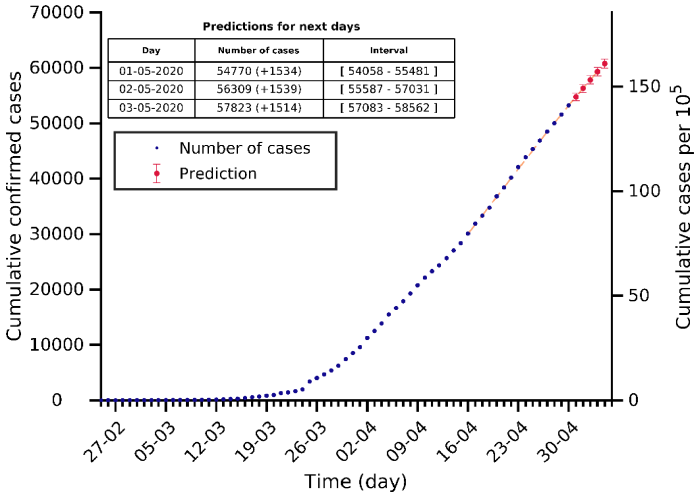


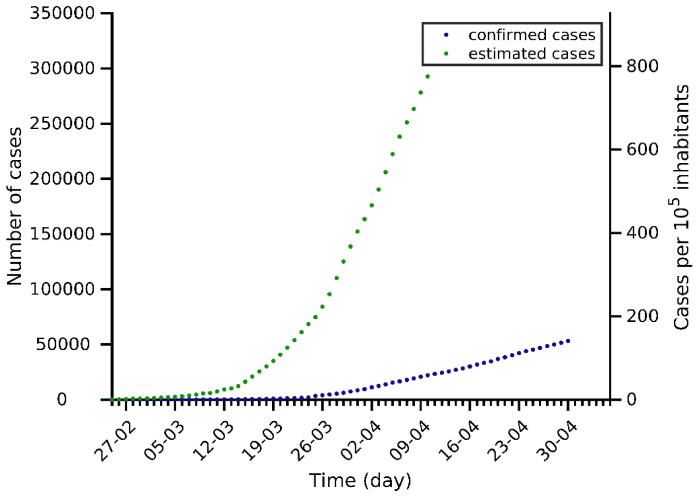


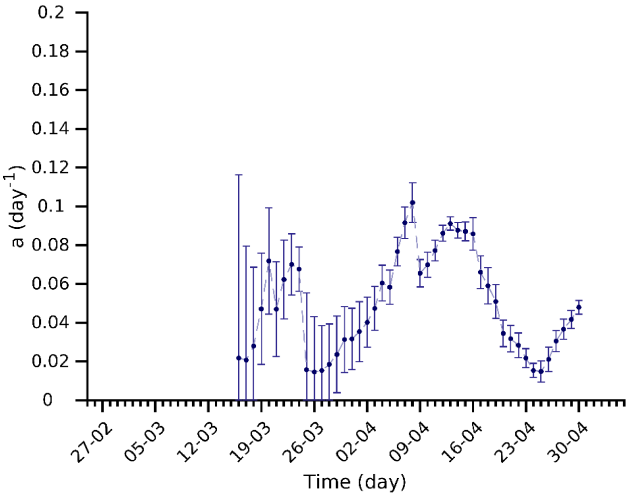


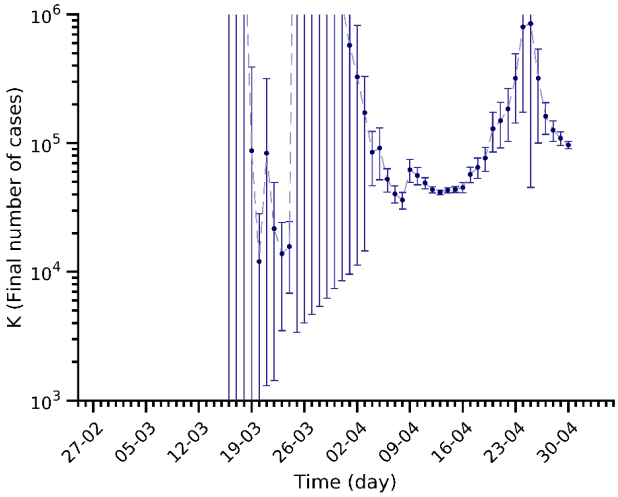


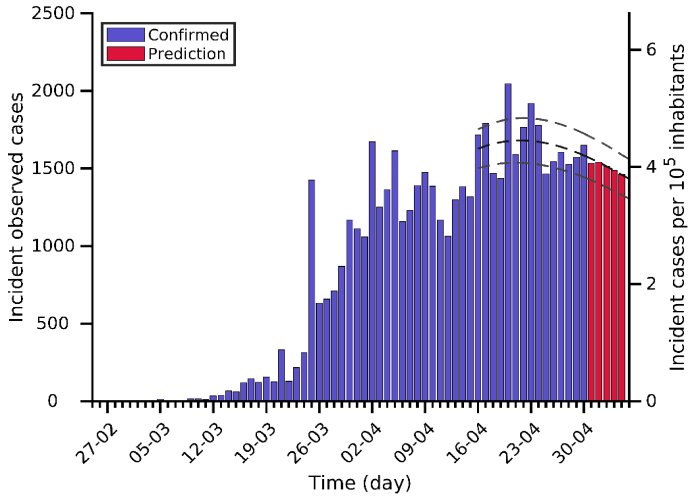
Canada 30-04-2020. Population: 37.7M. Current cumulated incidence: 141/10⁵

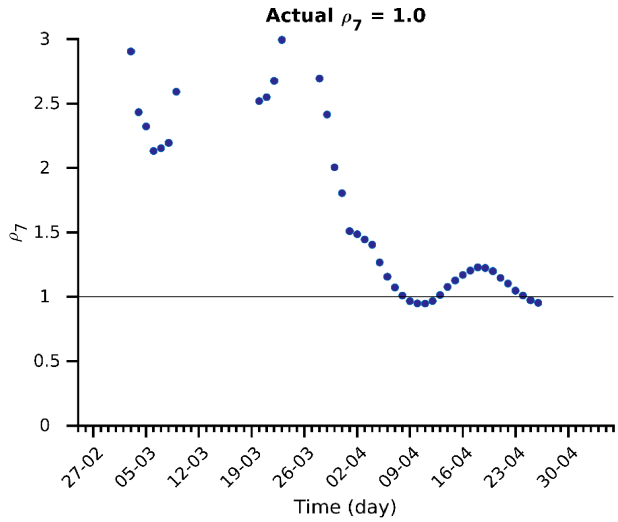


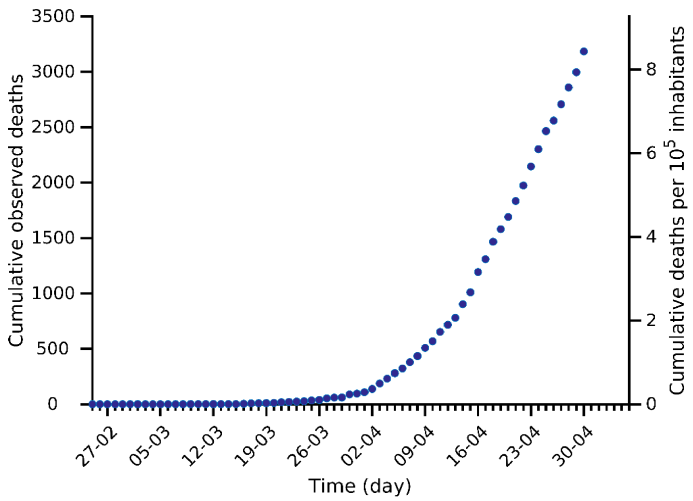


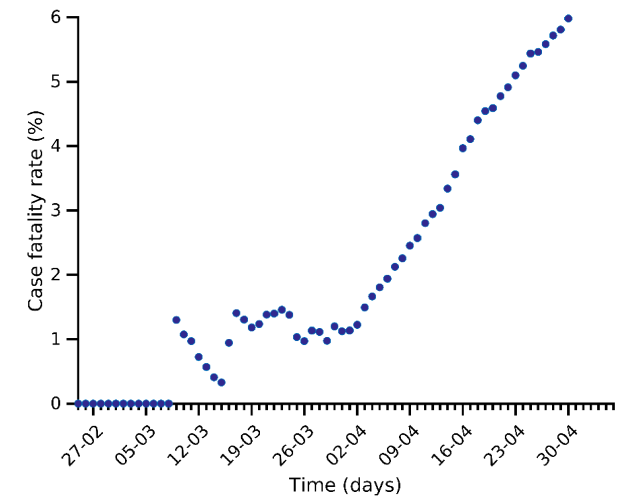




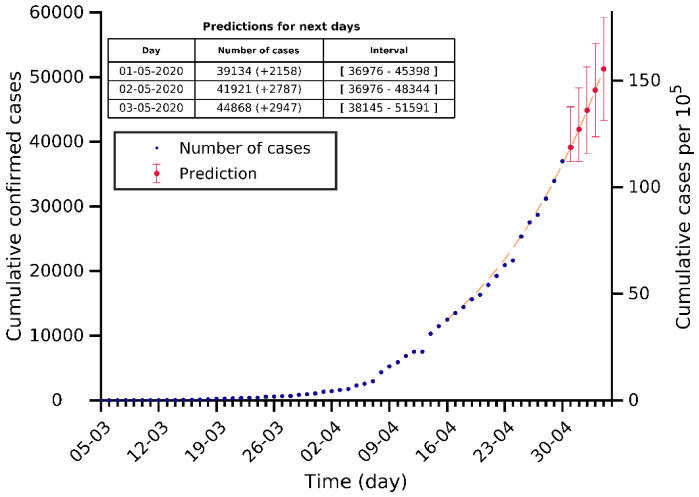


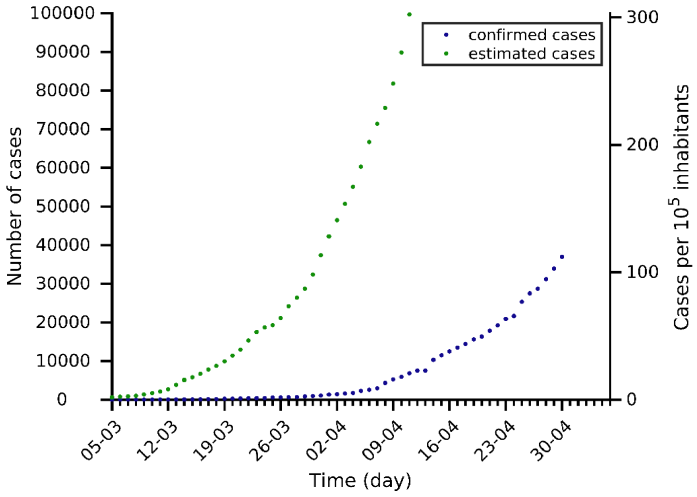


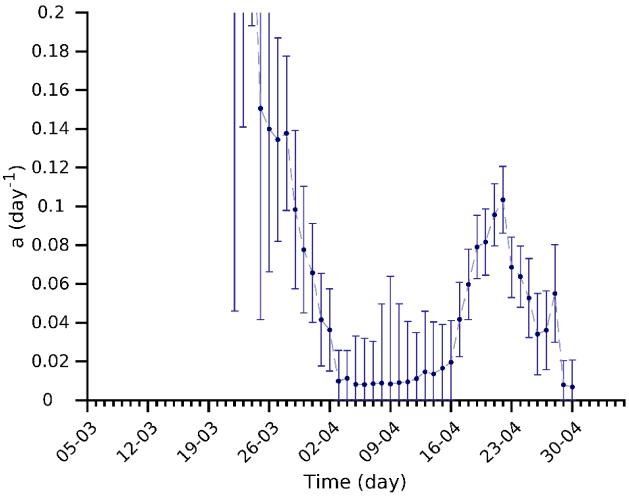


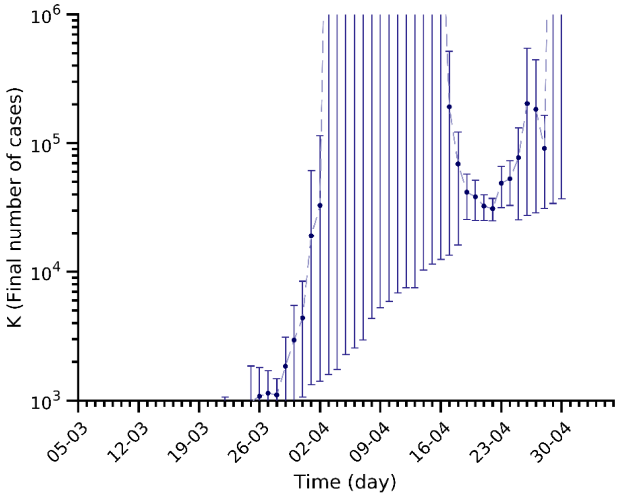


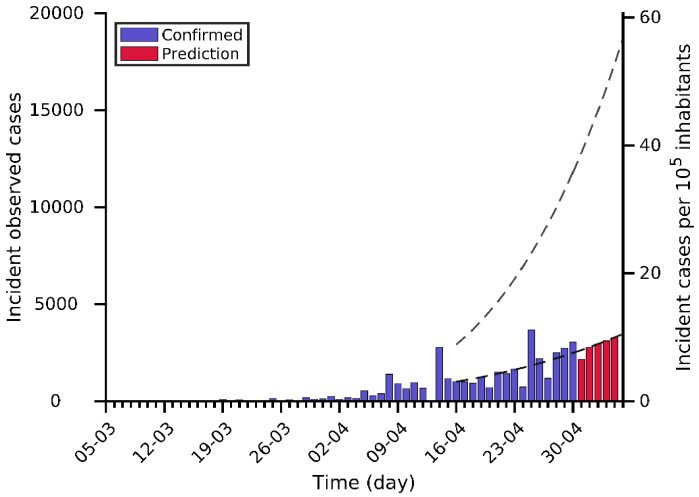
Peru 30-04-2020. Population: 33.0M. Current cumulated incidence: 112/10^5

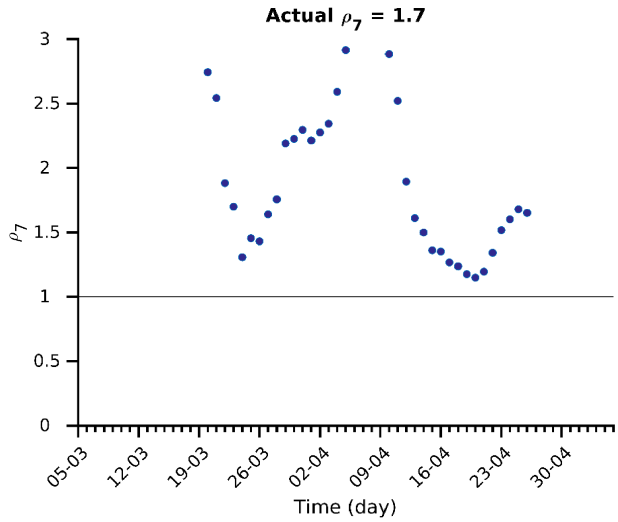


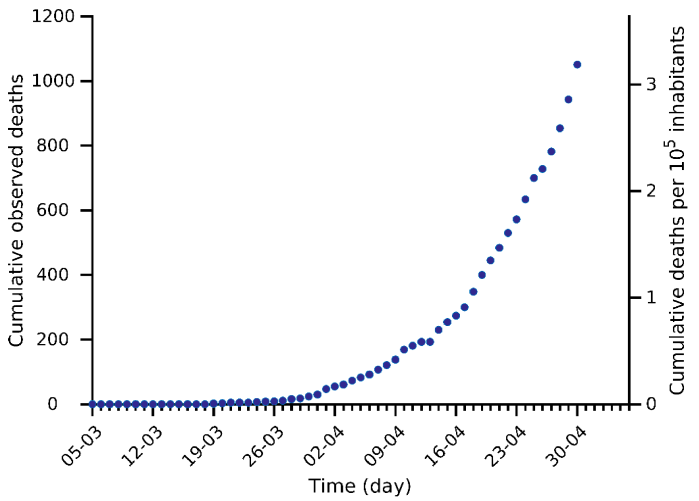


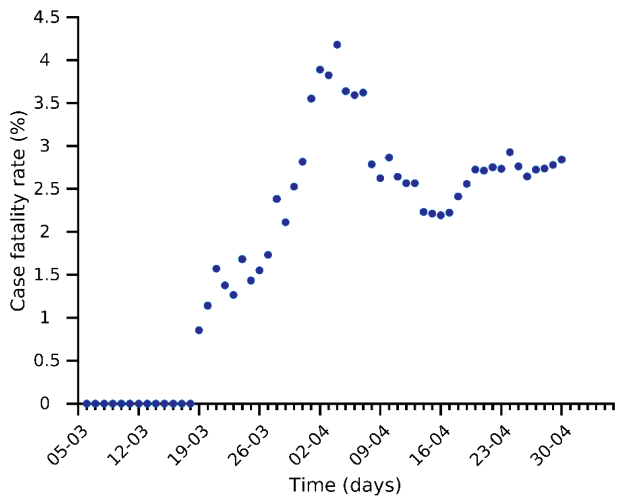




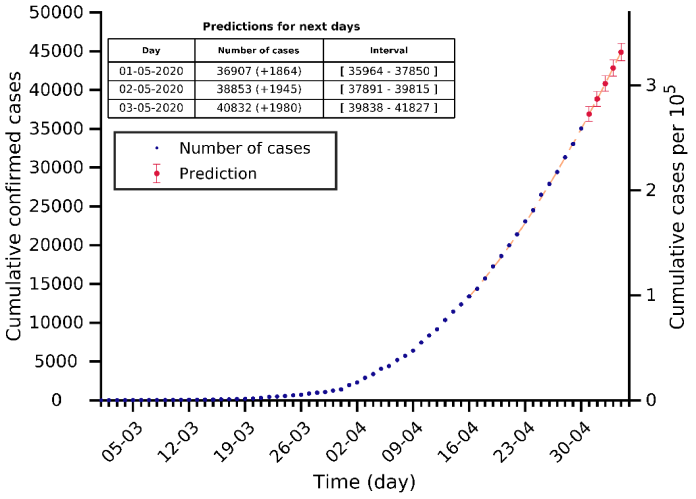


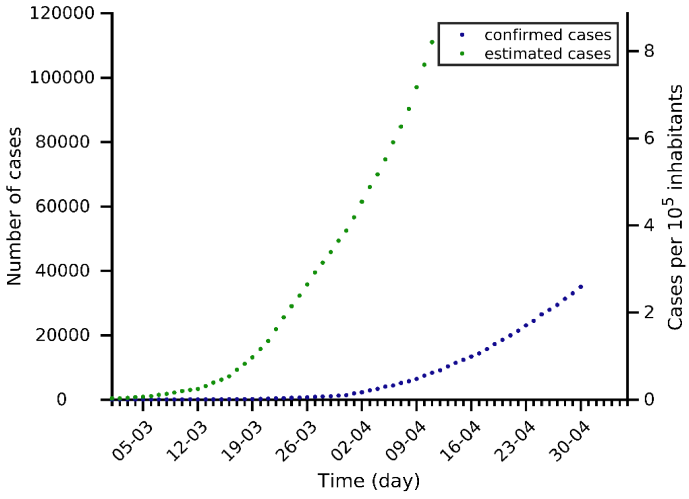


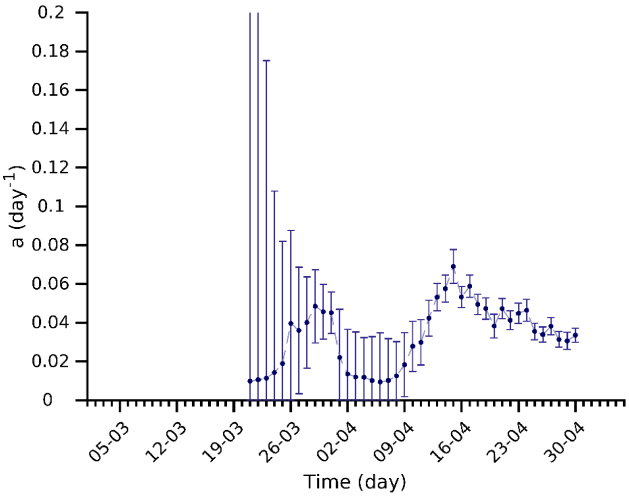


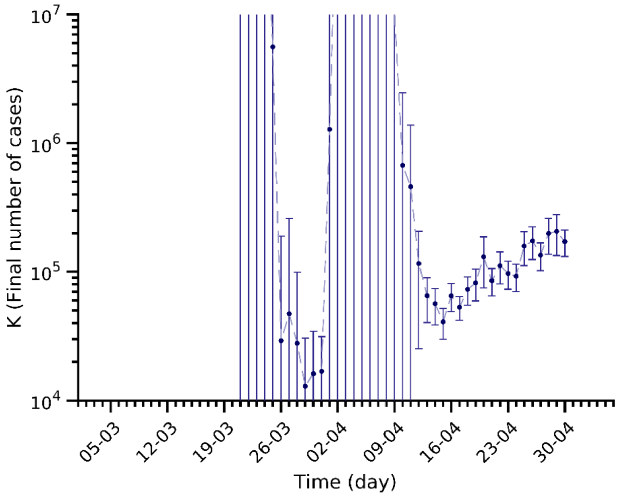


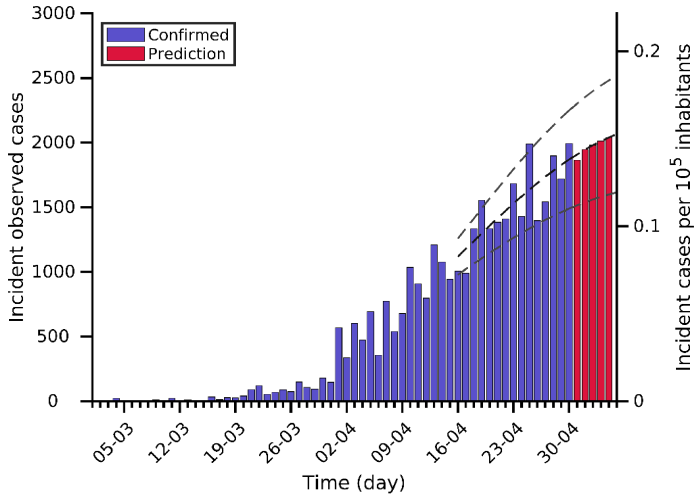
India 30-04-2020. Population: 1353.0M. Current cumulated incidence: $3/10^5$

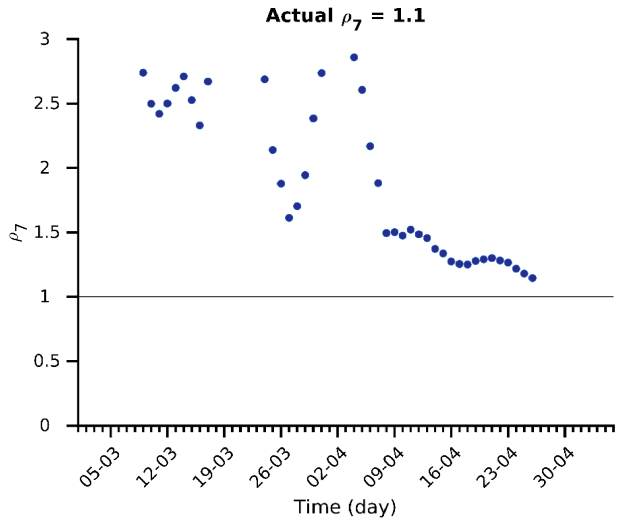


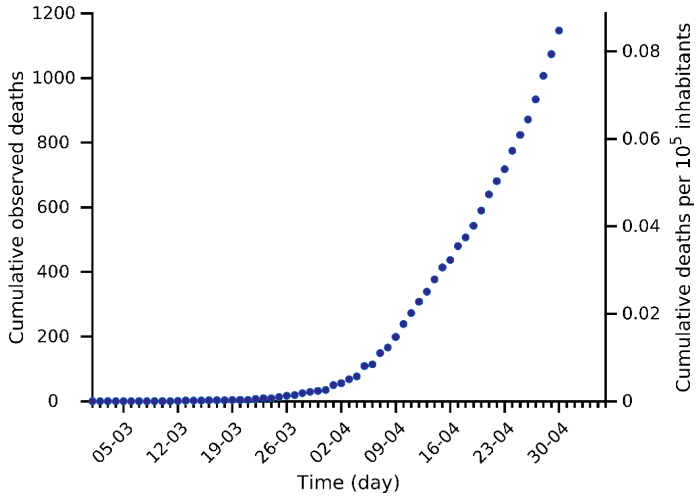


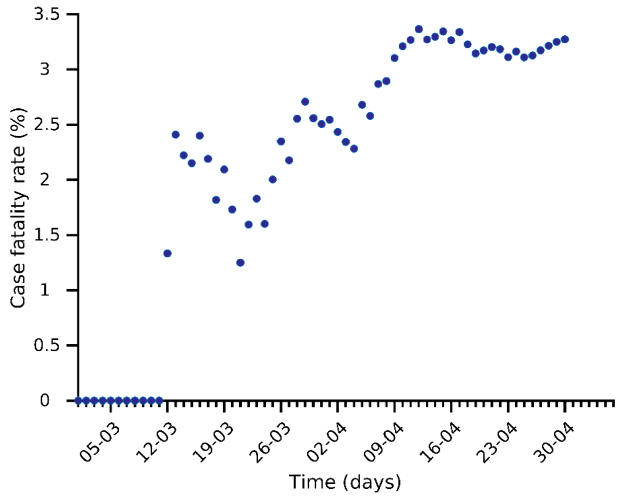




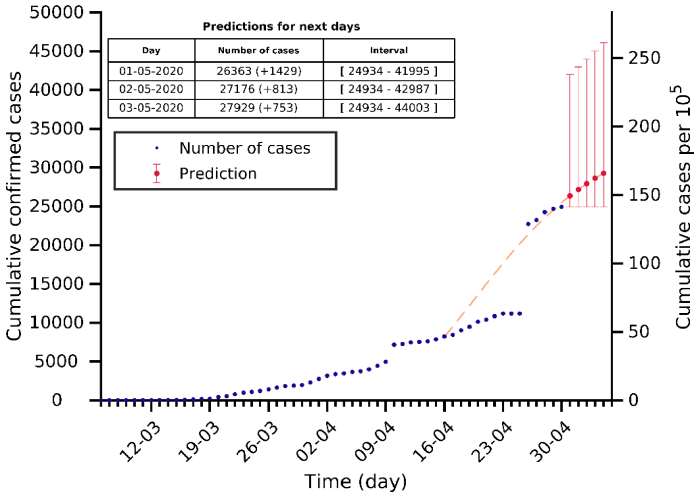


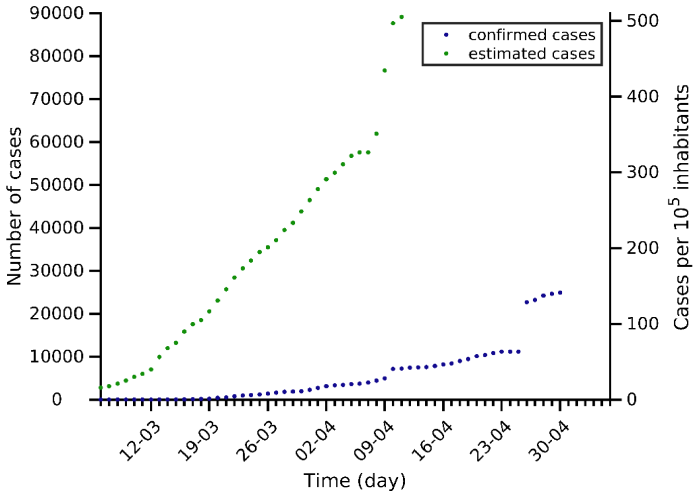


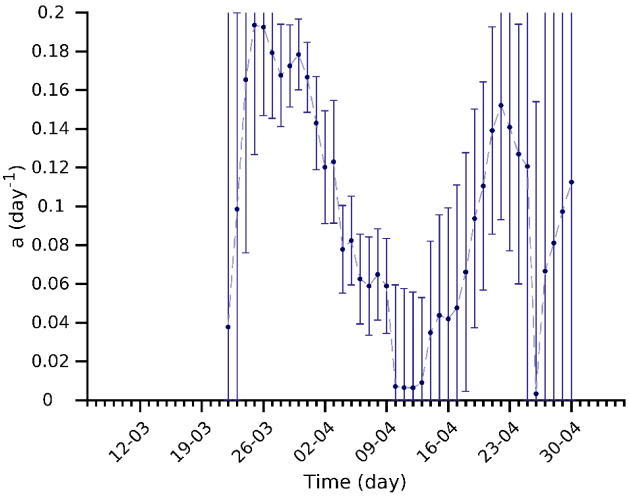


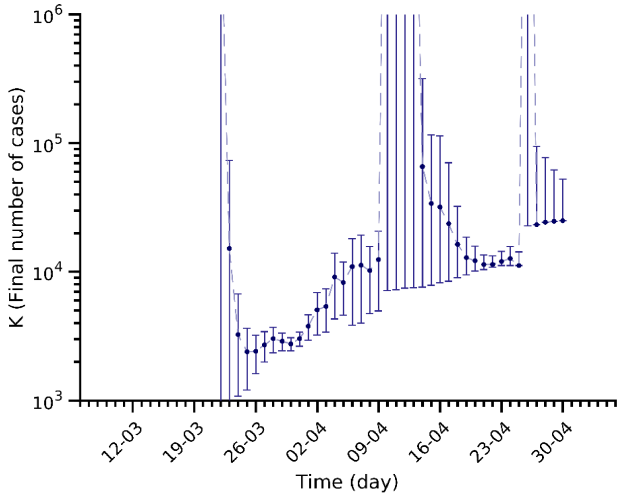


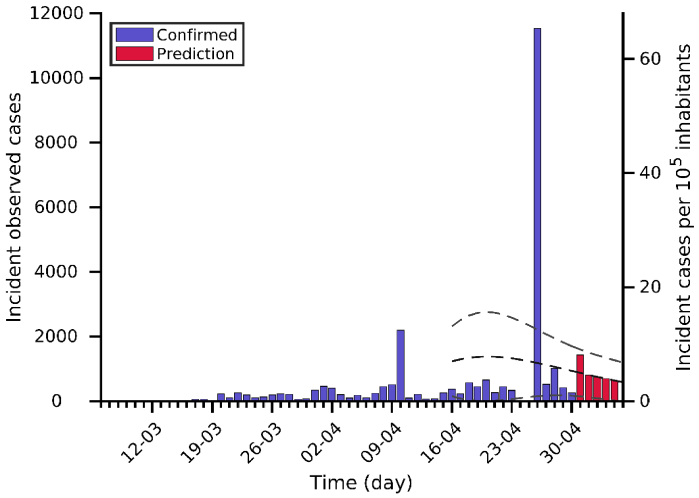
Ecuador 30-04-2020. Population: 17.6M. Current cumulated incidence: 141/10^5

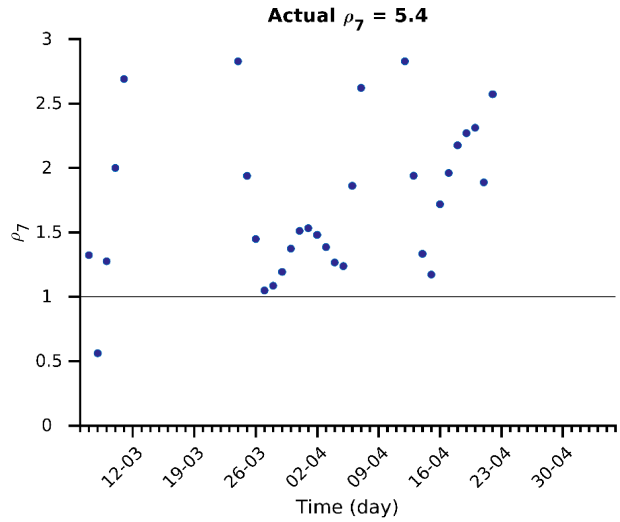


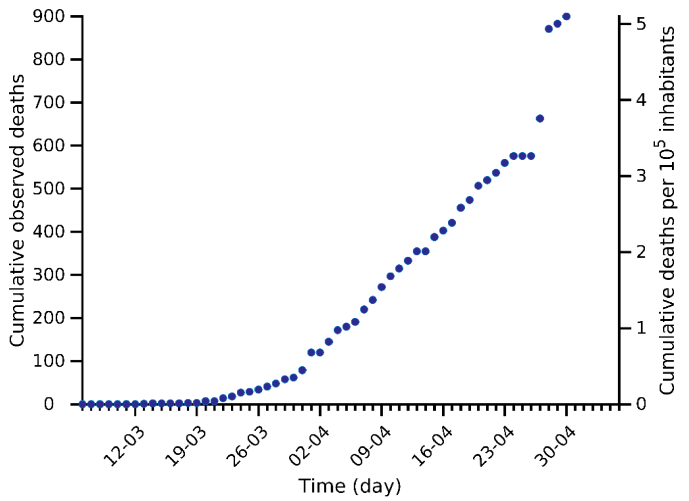


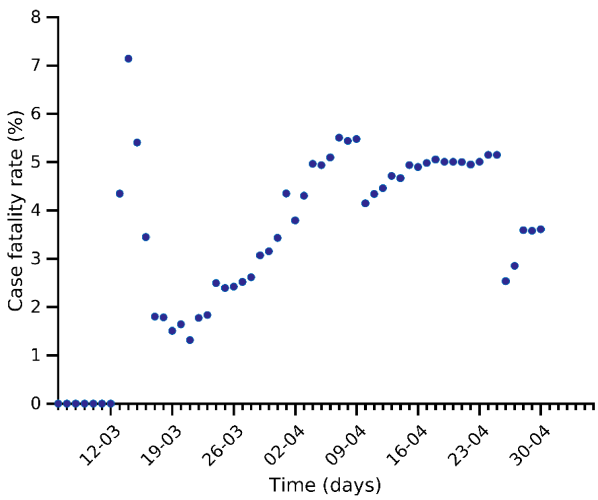




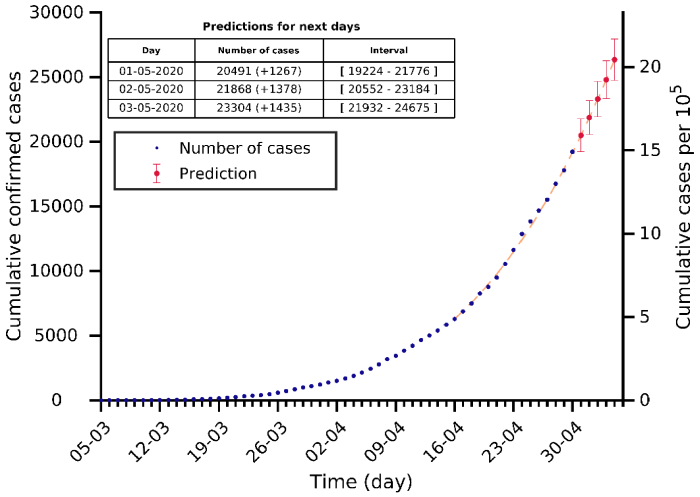


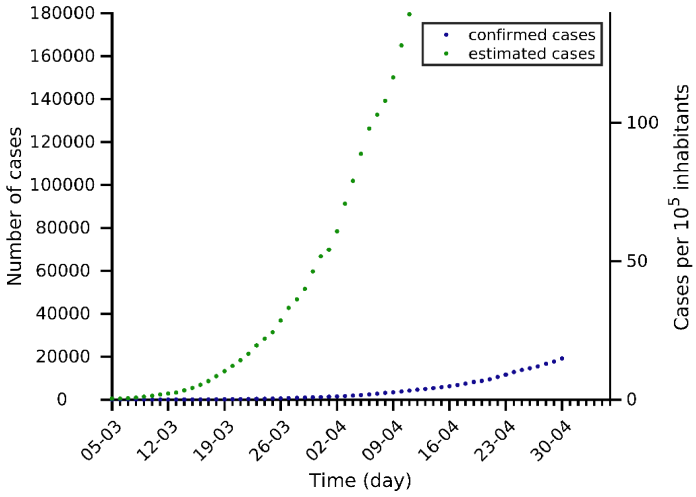


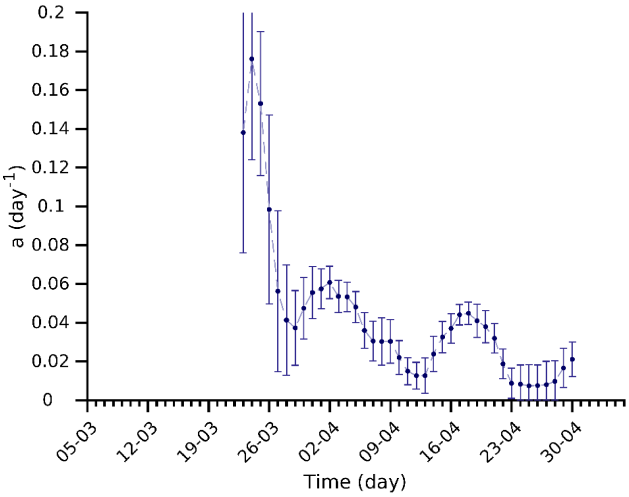


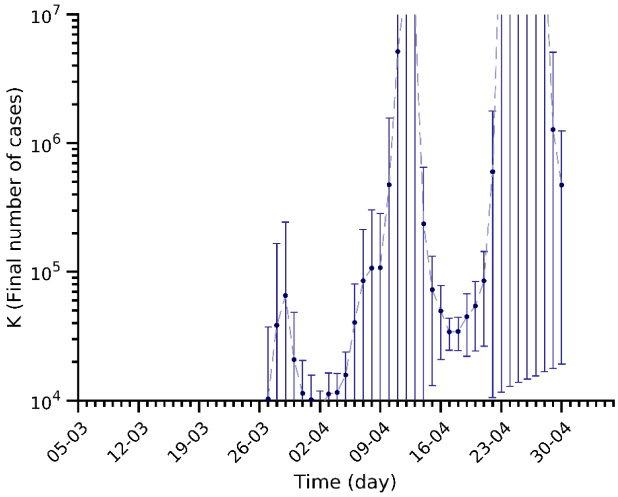


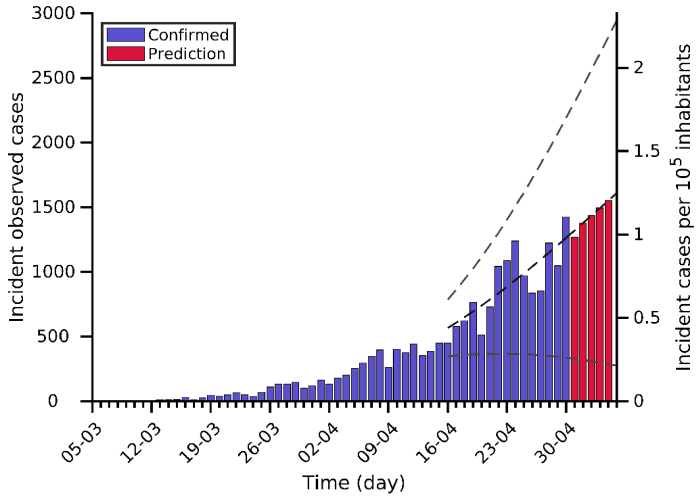
Mexico 30-04-2020. Population: 128.9M. Current cumulated incidence: $15/10^5$

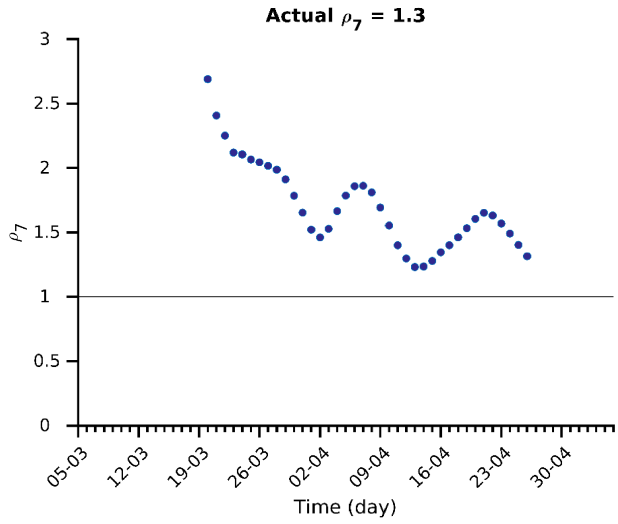


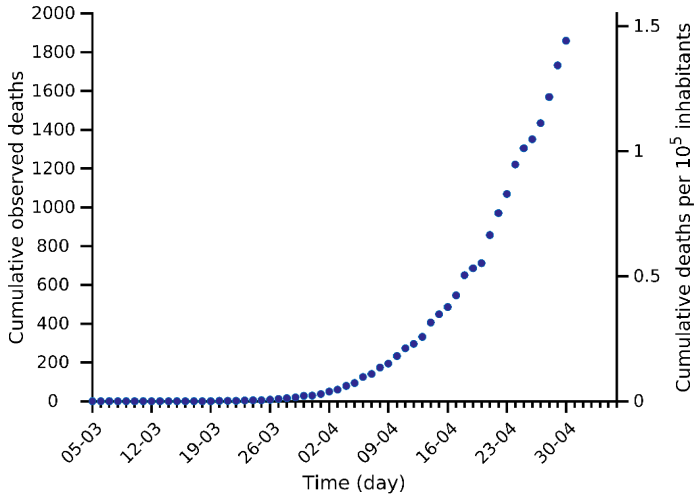


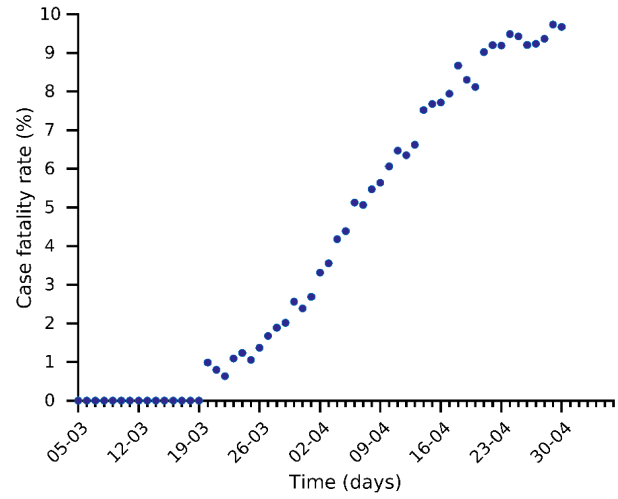




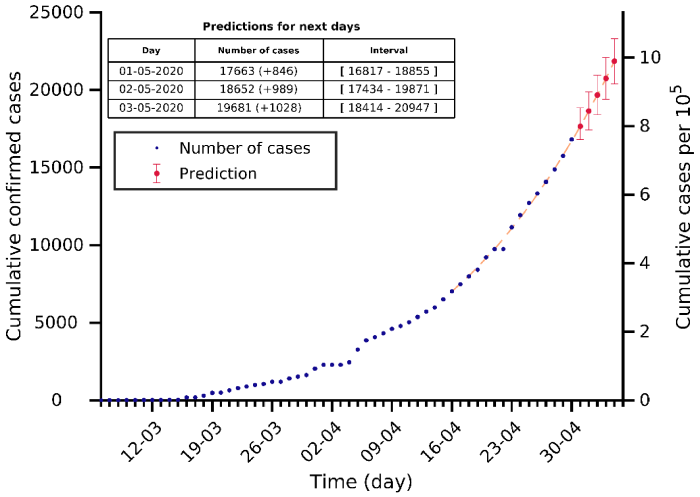


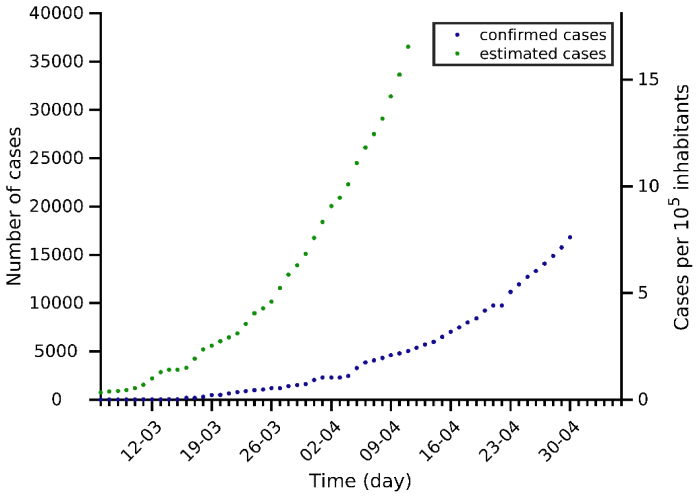


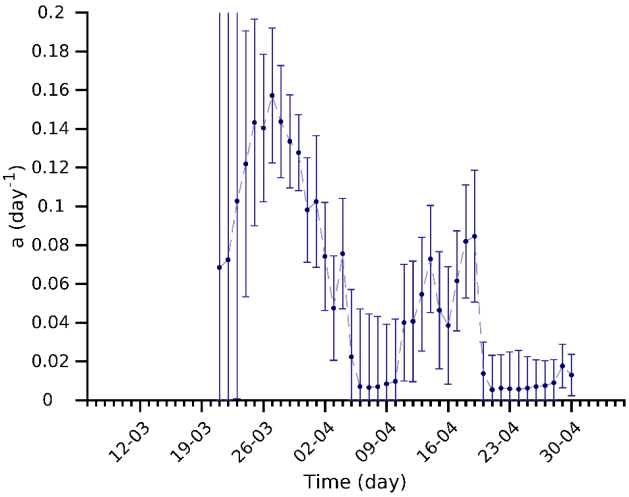


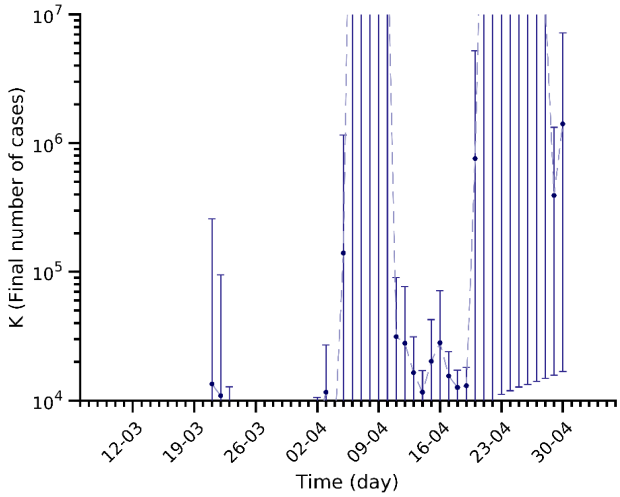


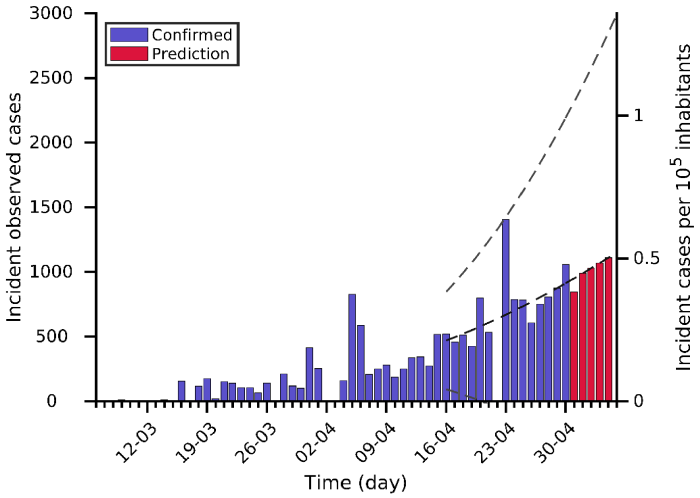
Pakistan 30-04-2020. Population: 220.9M. Current cumulated incidence: $8/10^5$

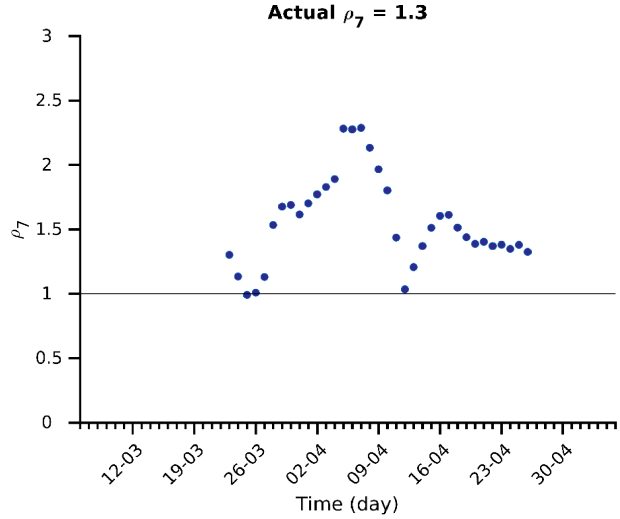


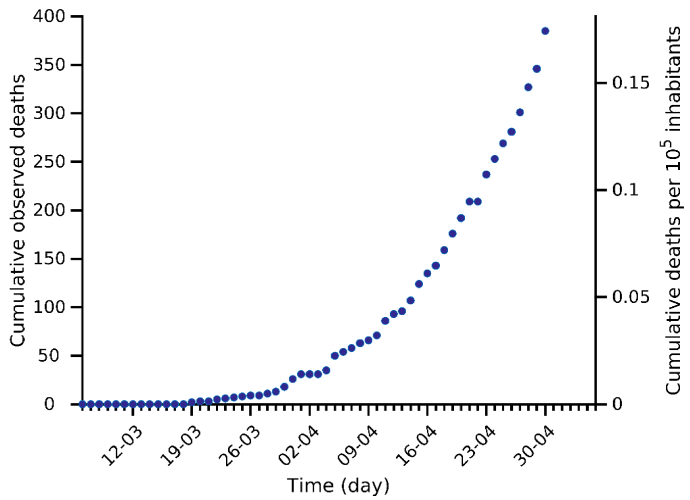


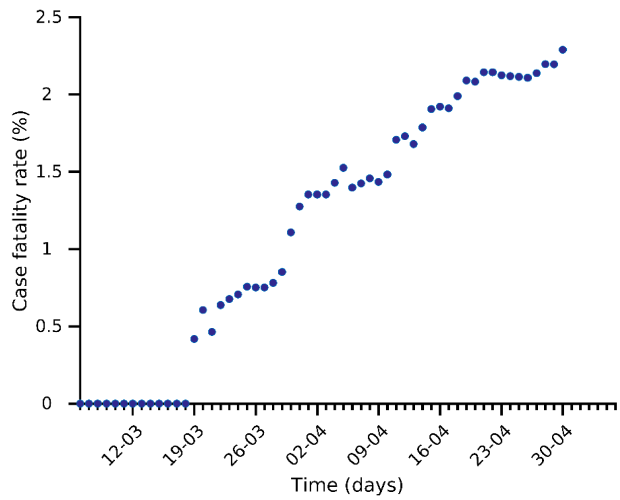




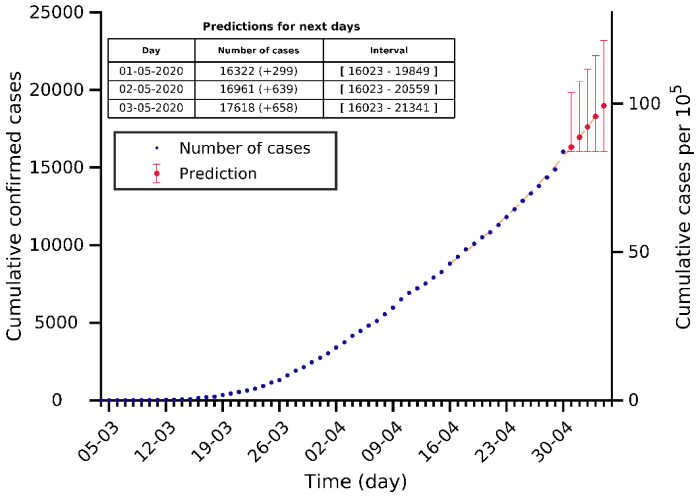


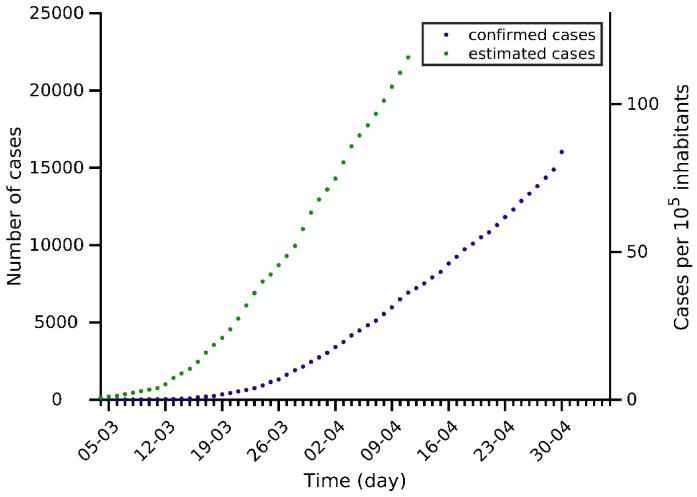


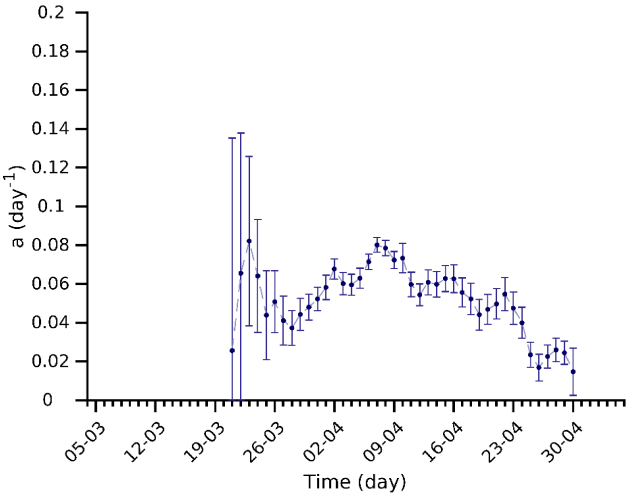


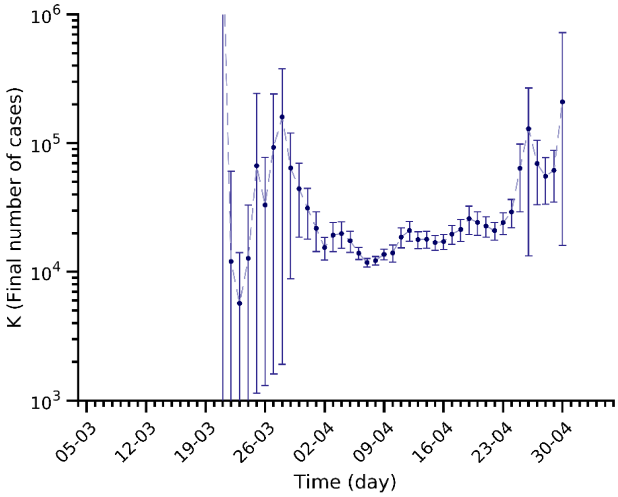


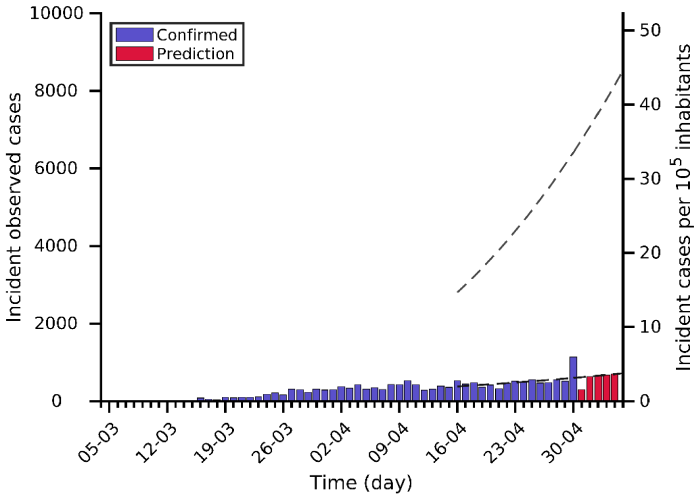
Chile 30-04-2020. Population: 19.1M. Current cumulated incidence: 84/10^5

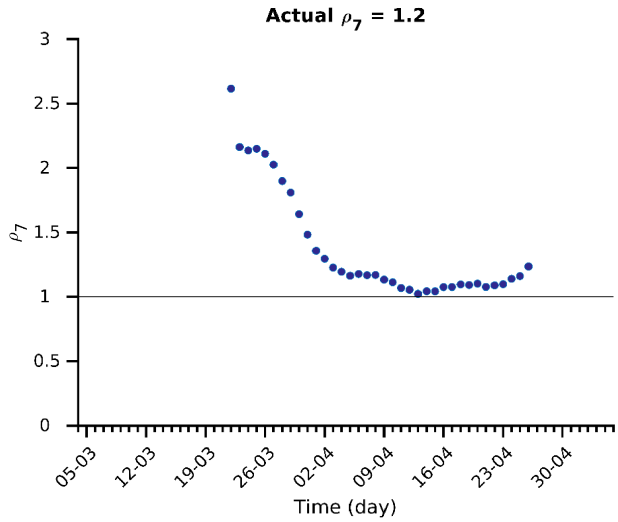


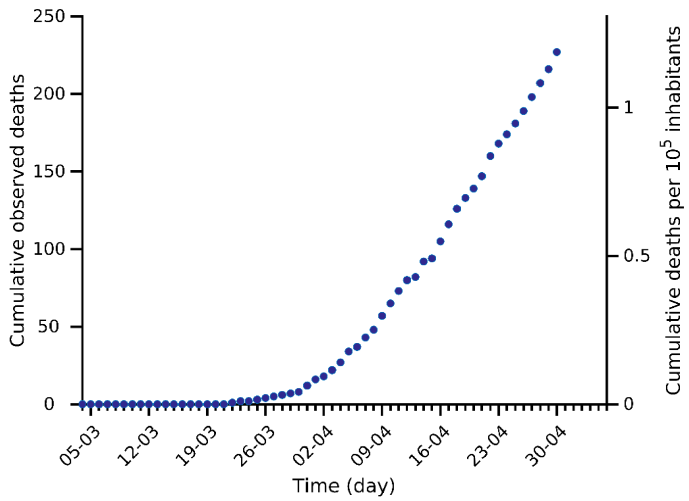


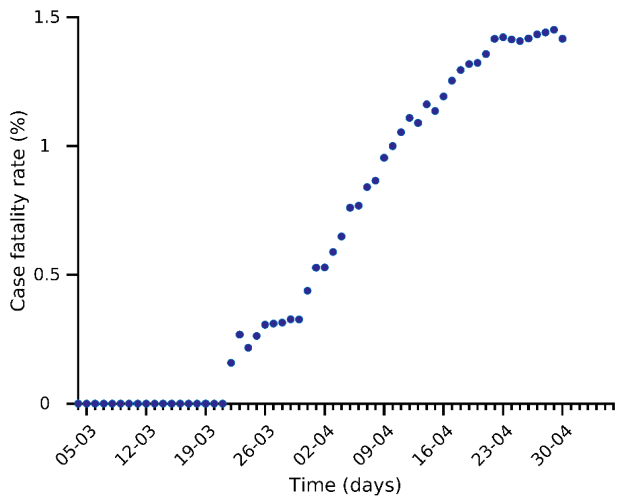




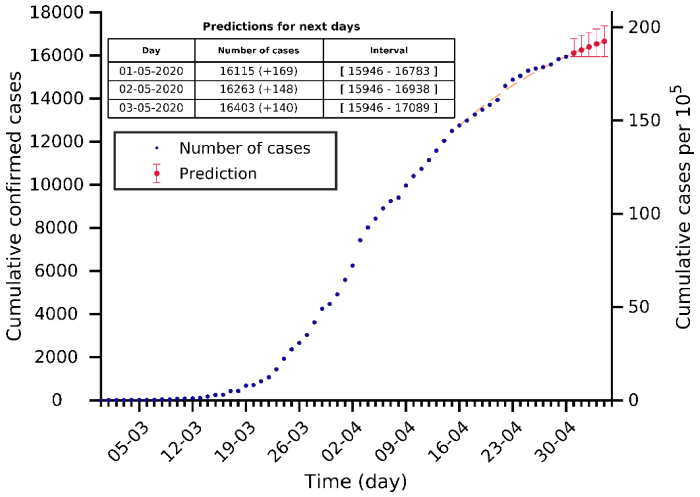


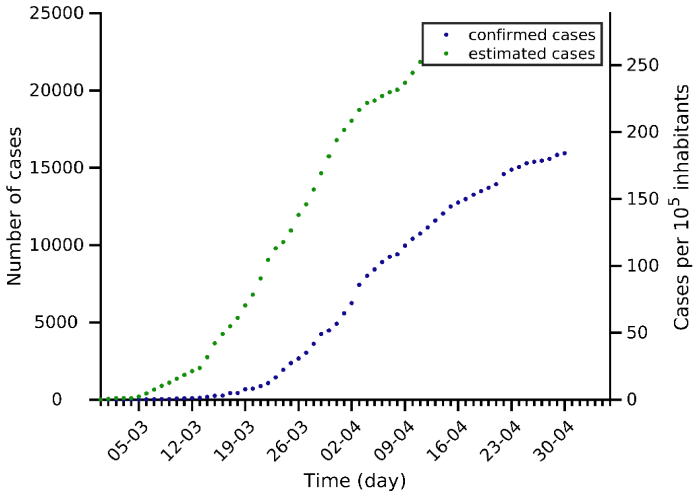


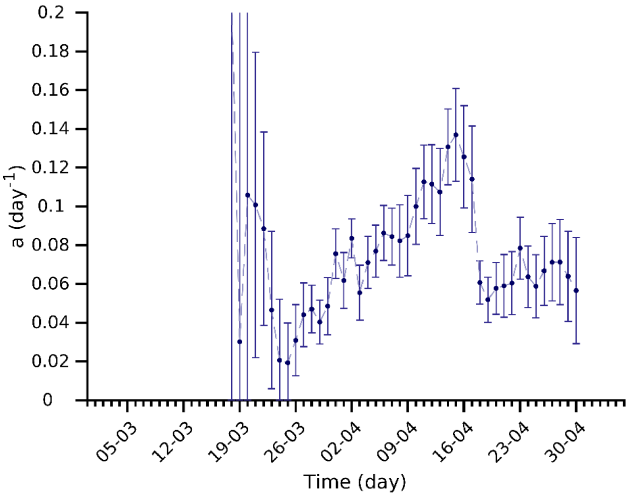


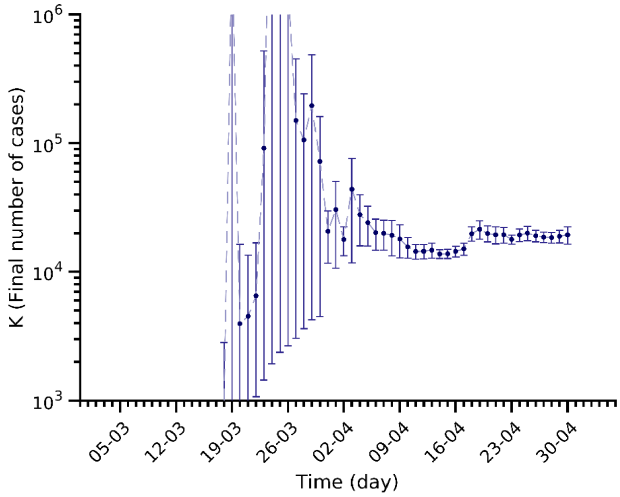


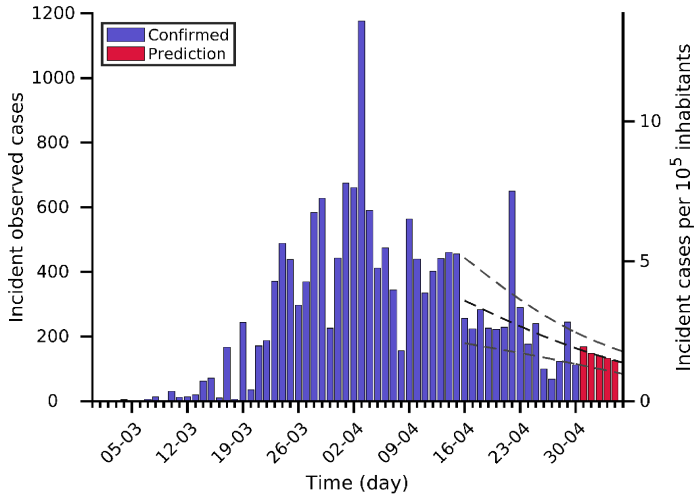
Israel 30-04-2020. Population: 8.7M. Current cumulated incidence: $184/10^5$

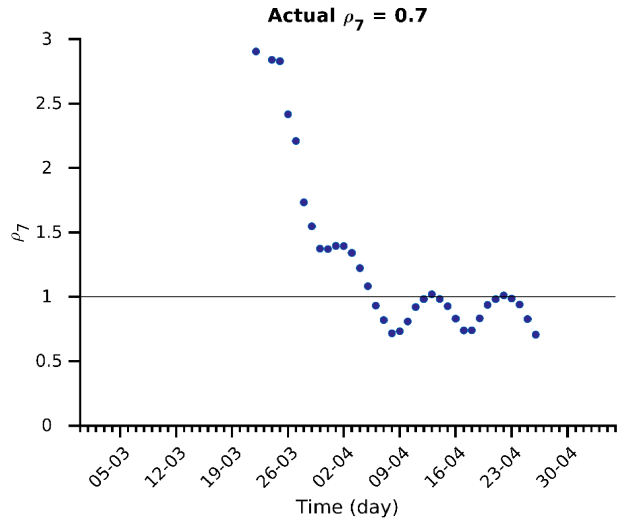


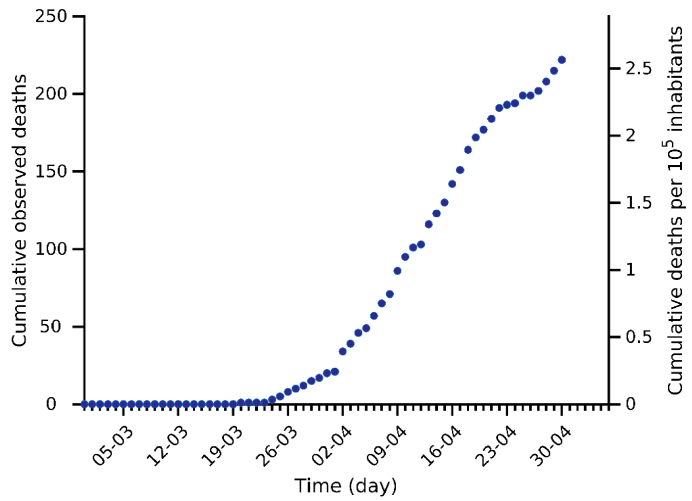


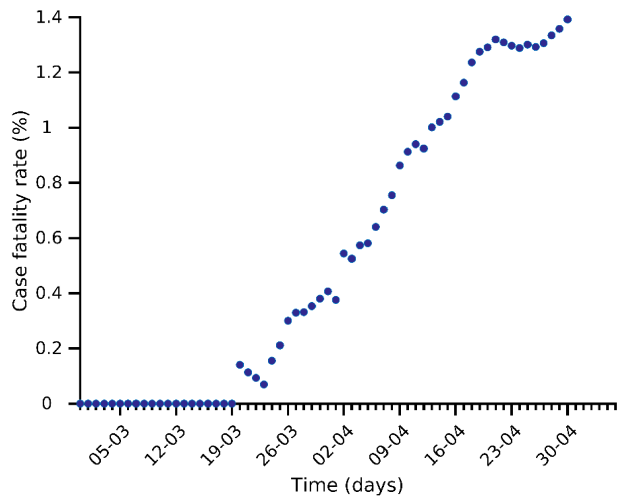




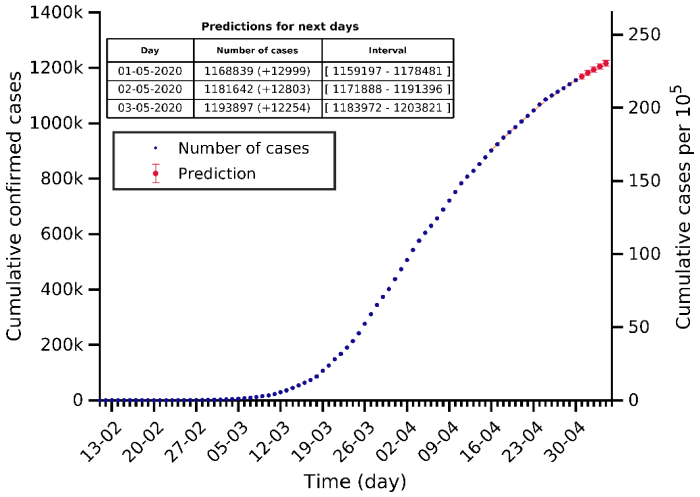


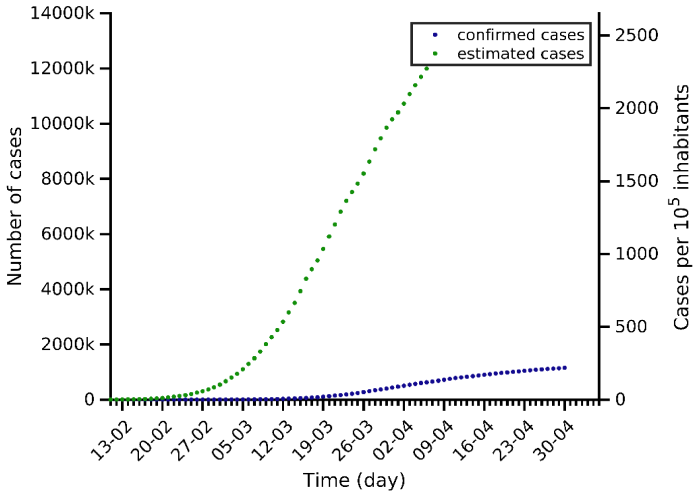


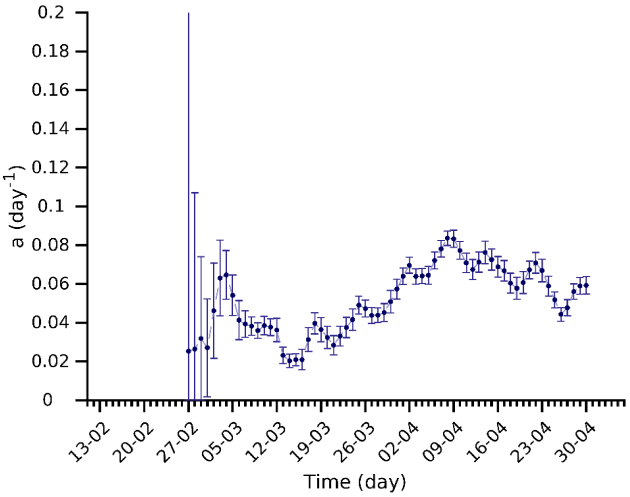


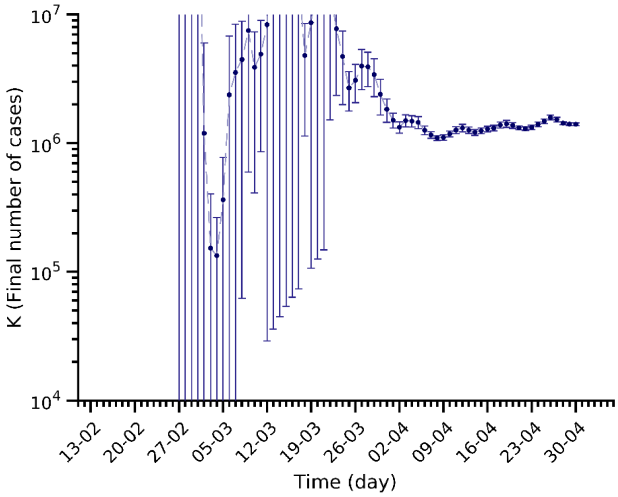


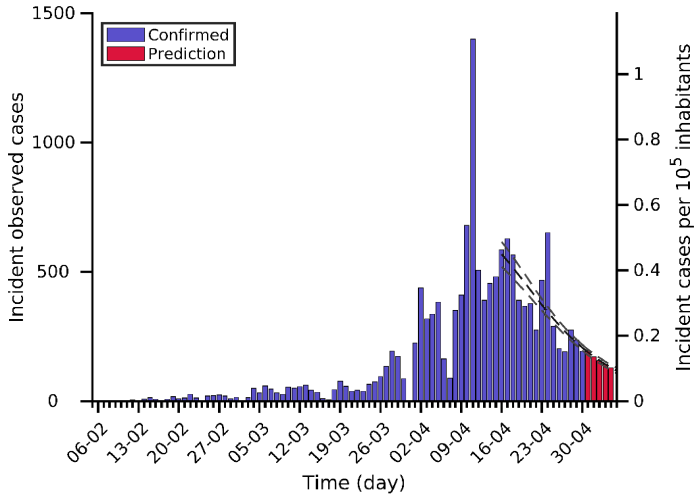
Japan 30-04-2020. Population: 126.5M. Current cumulated incidence: 11/10^5

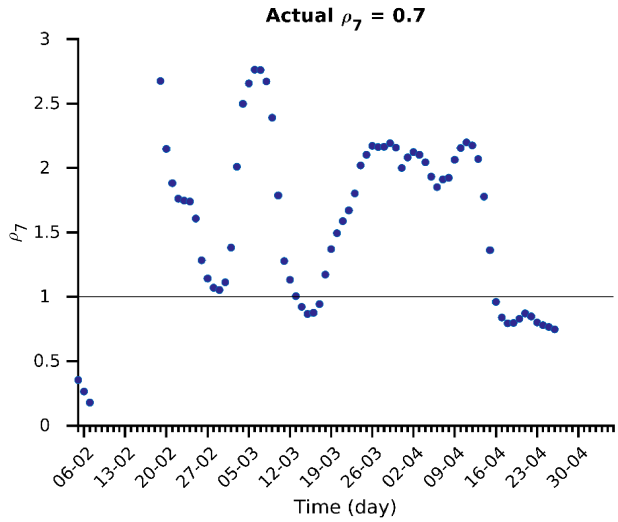


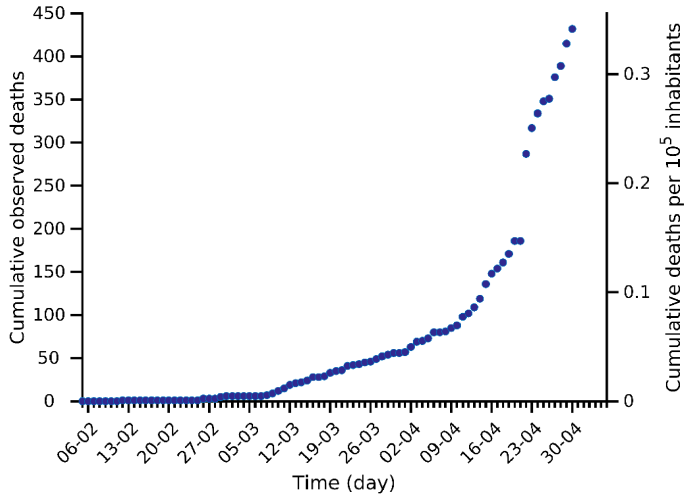


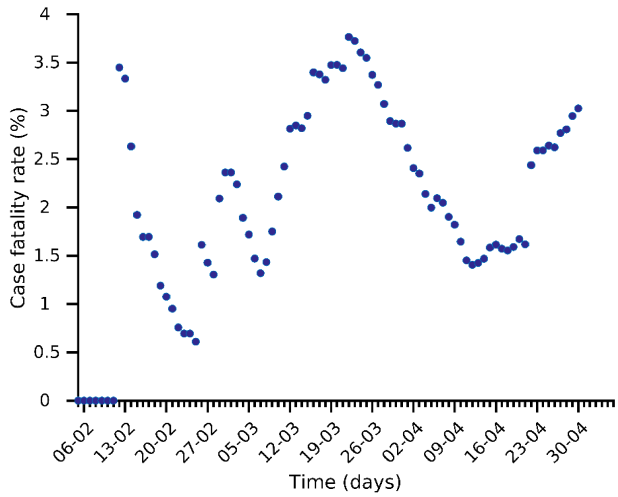




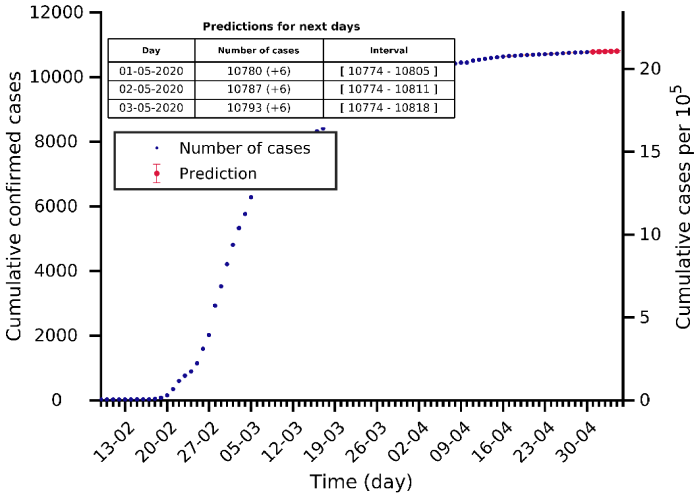


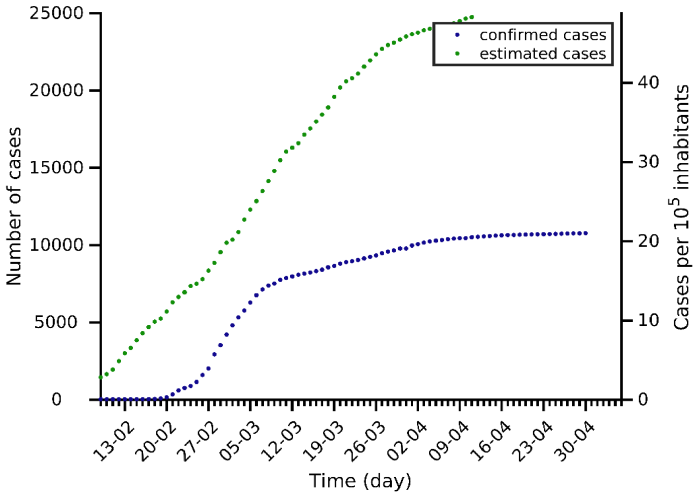


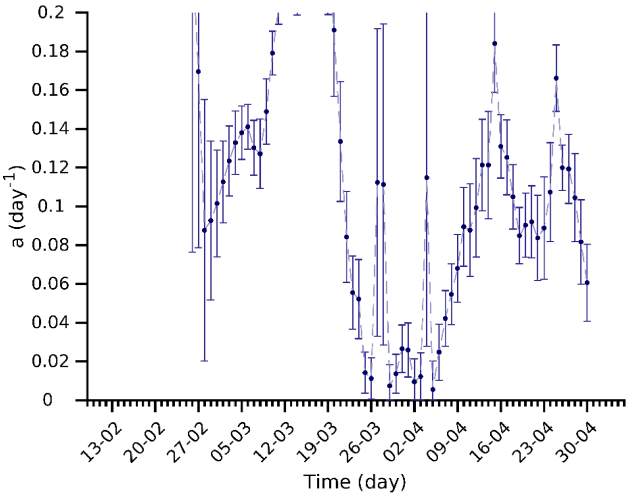


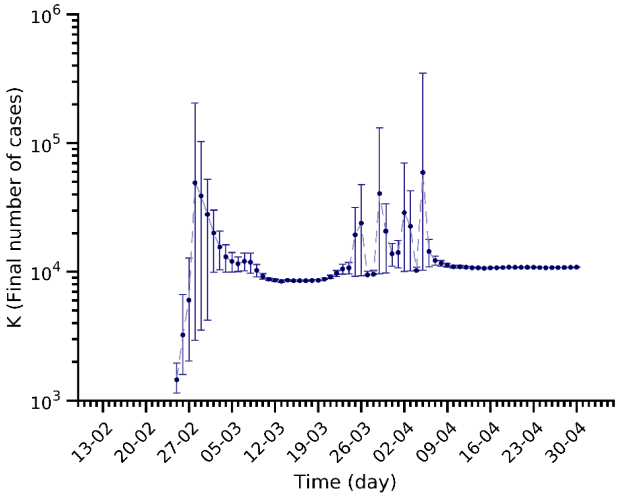


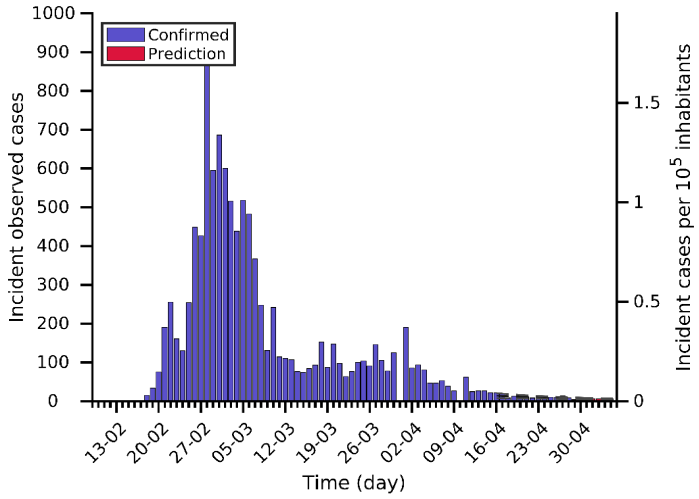
South Korea 30-04-2020. Population: 51.3M. Current cumulated incidence: 21/10^5

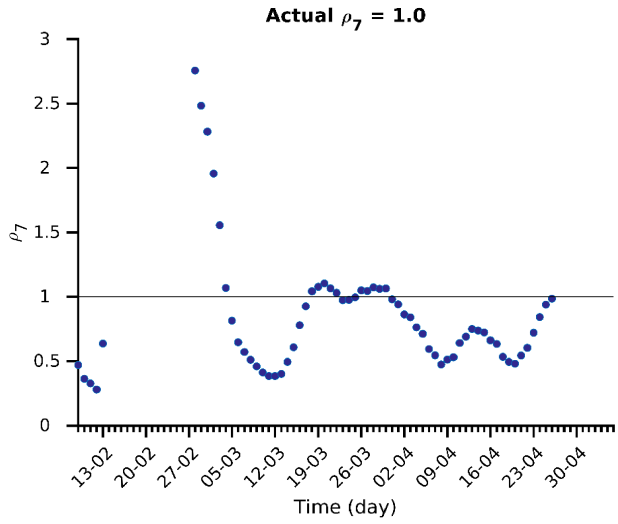


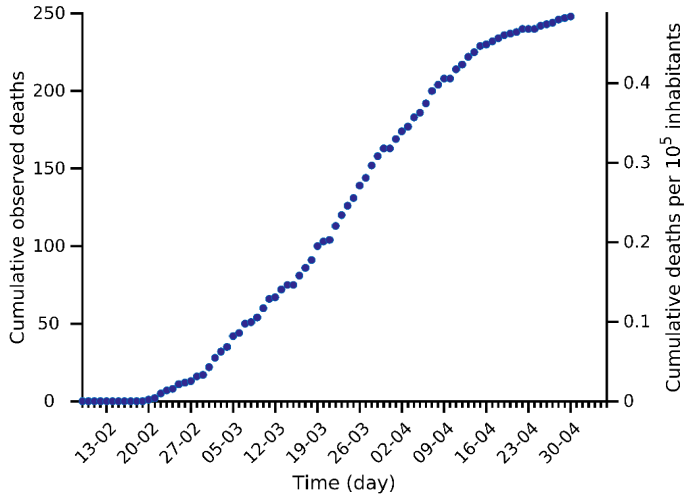


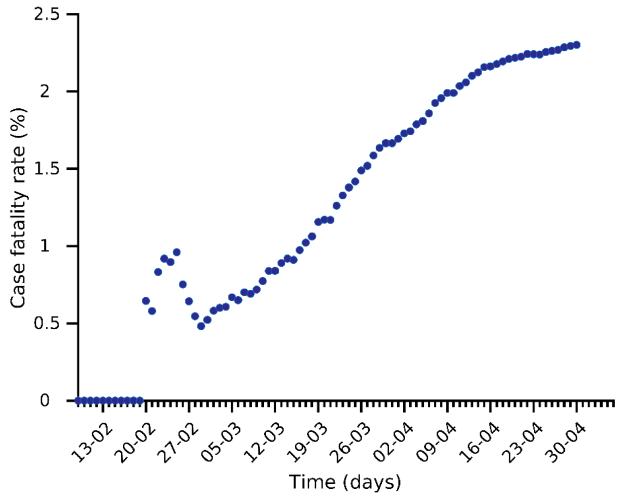




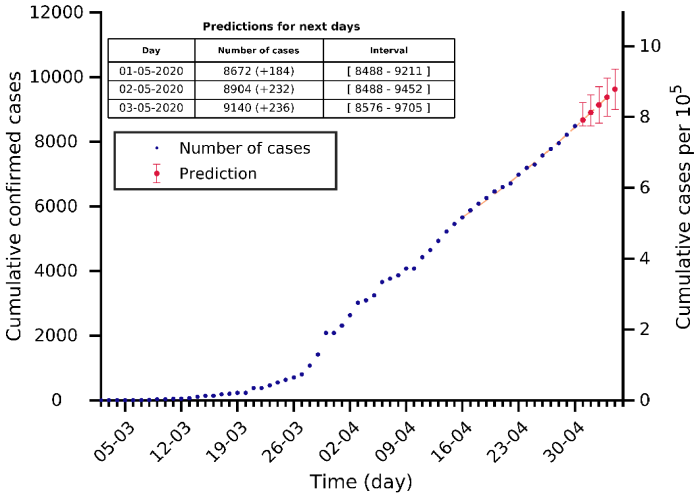


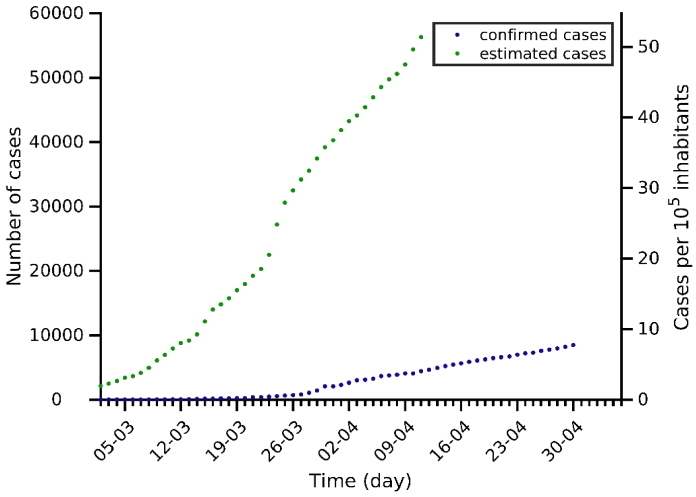


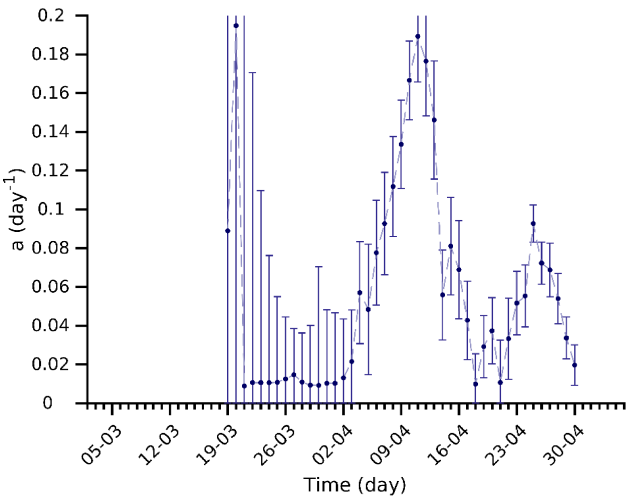


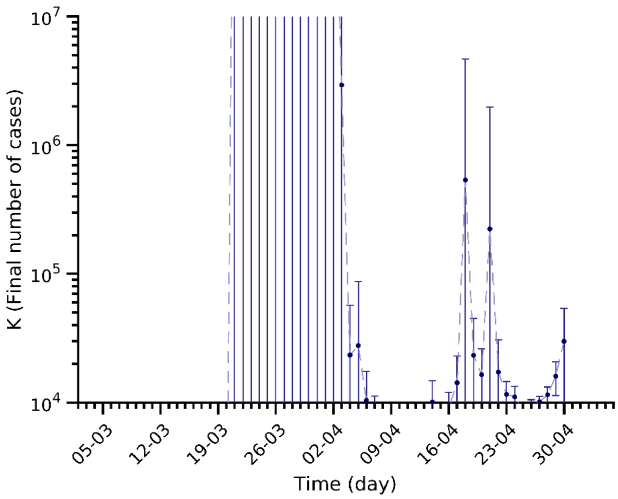


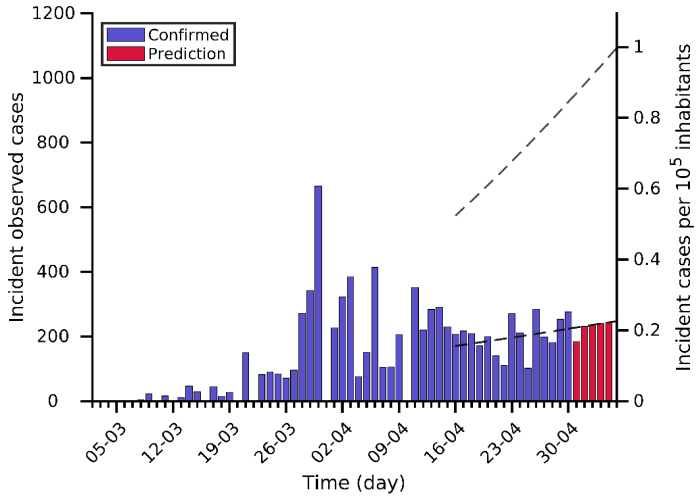
Philippines 30-04-2020. Population: 109.6M. Current cumulated incidence: $8/10^5$

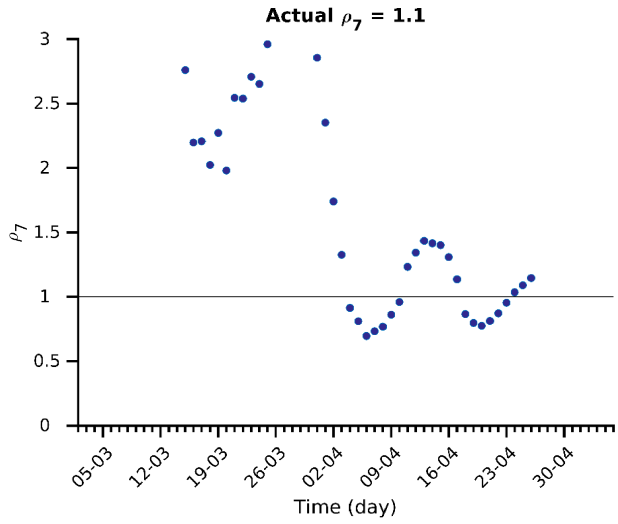


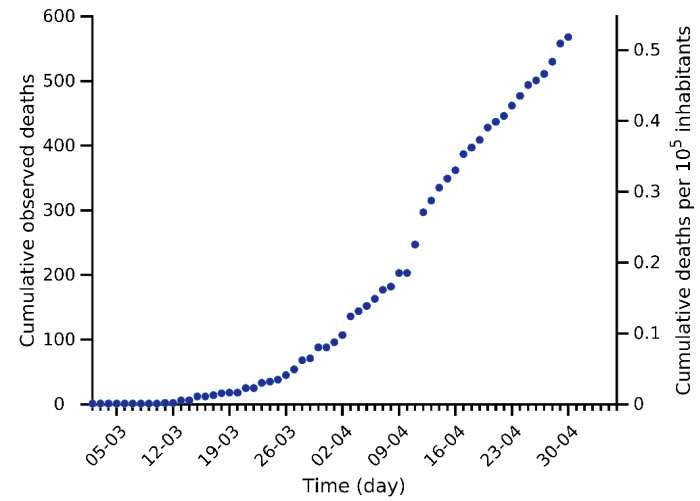


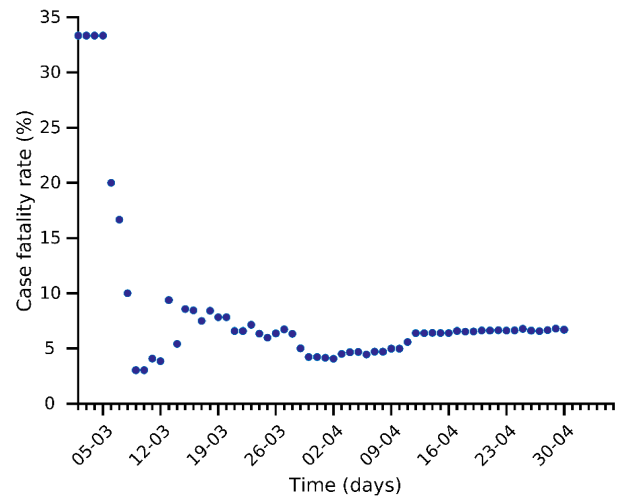




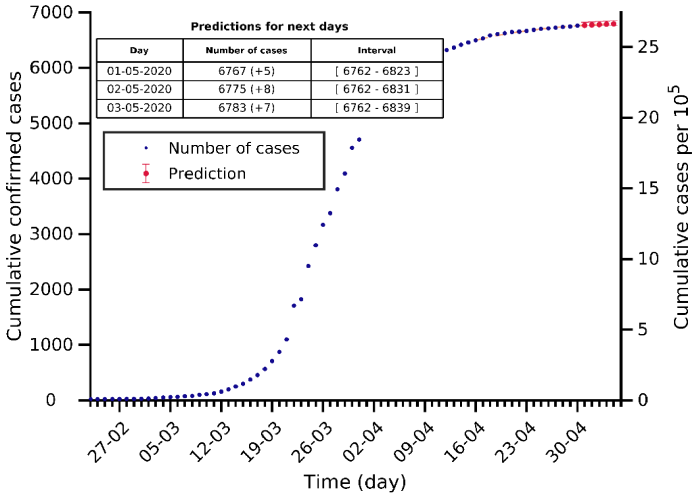


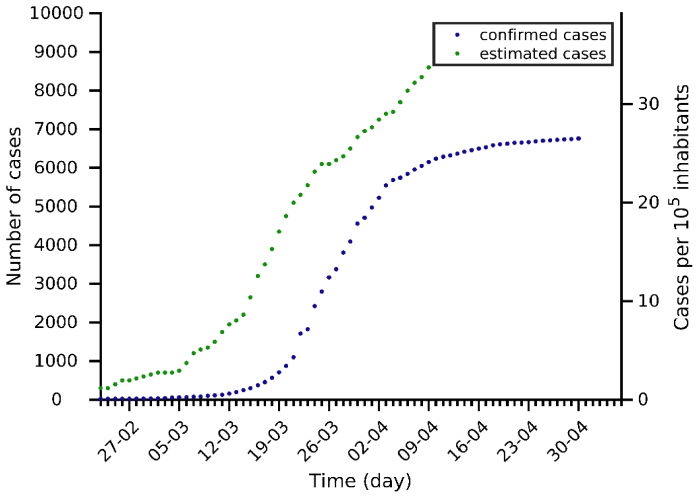


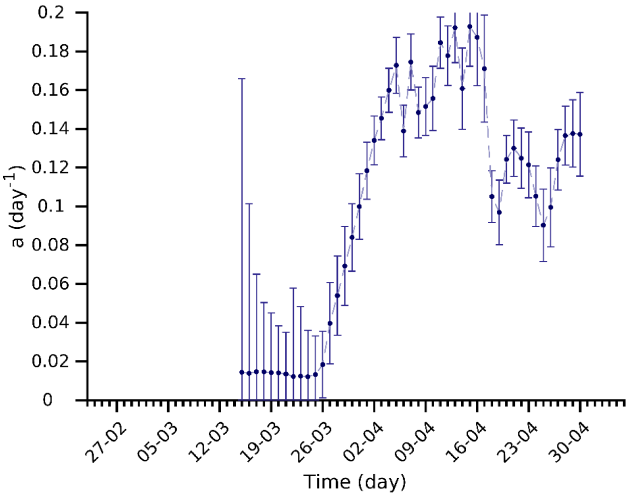


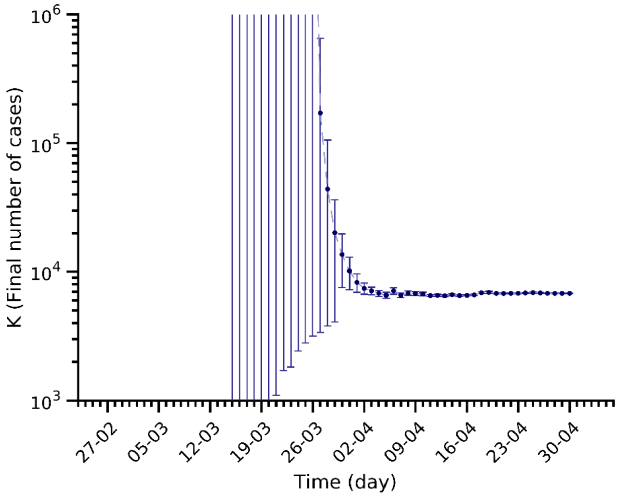


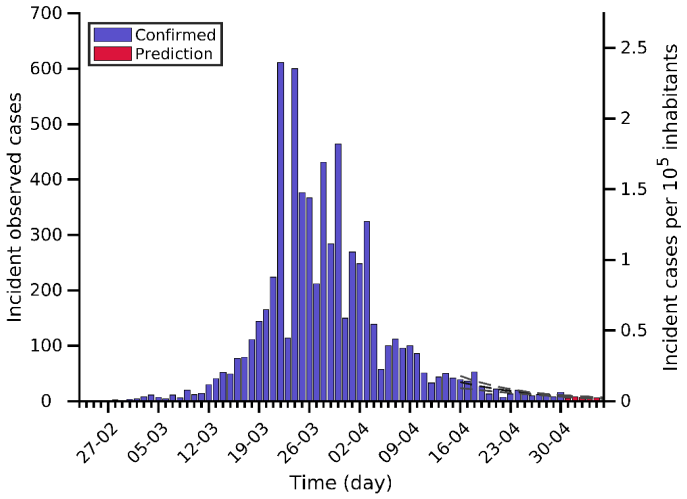
Australia 30-04-2020. Population: 25.5M. Current cumulated incidence: $27/10^5$

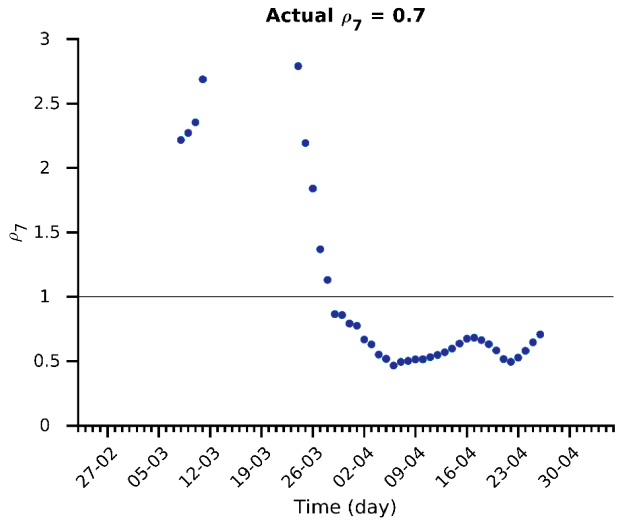


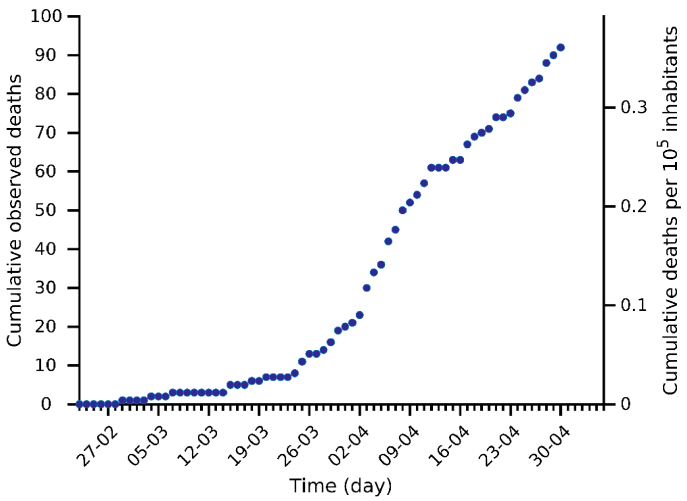


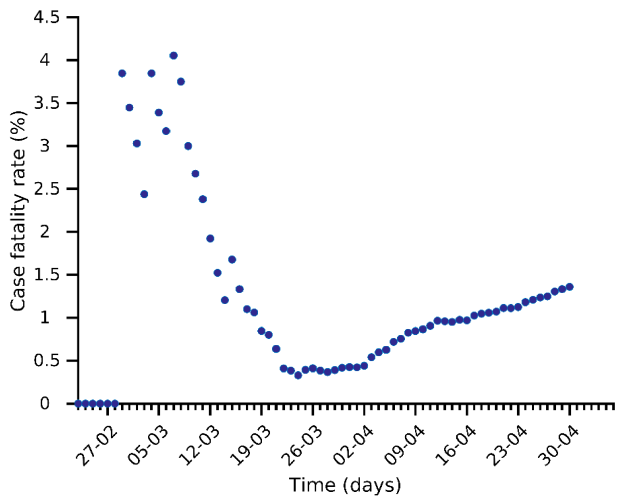




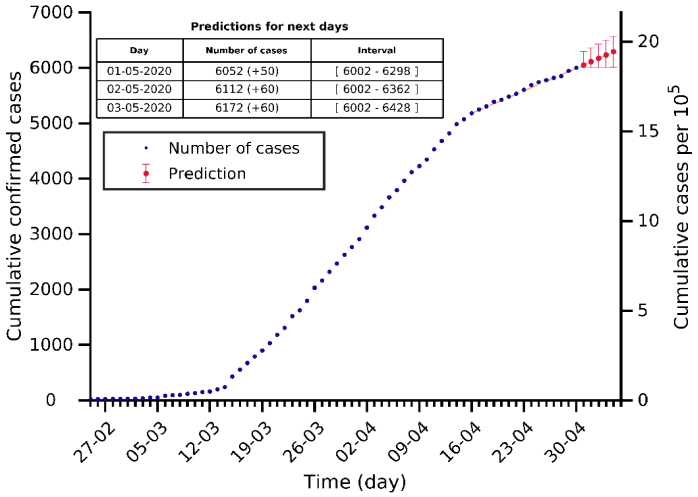


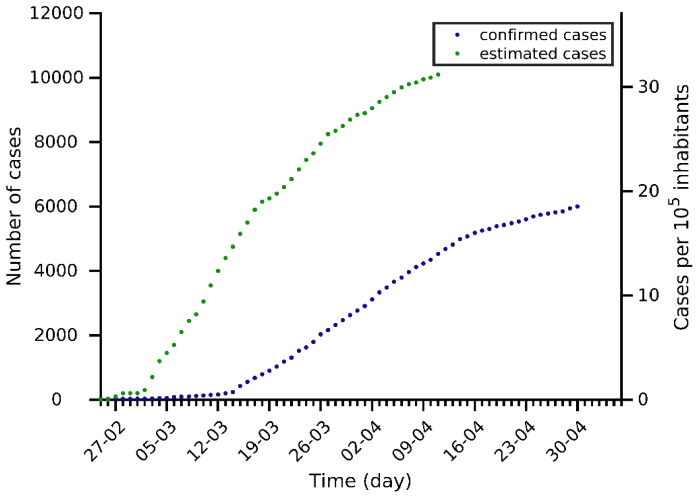


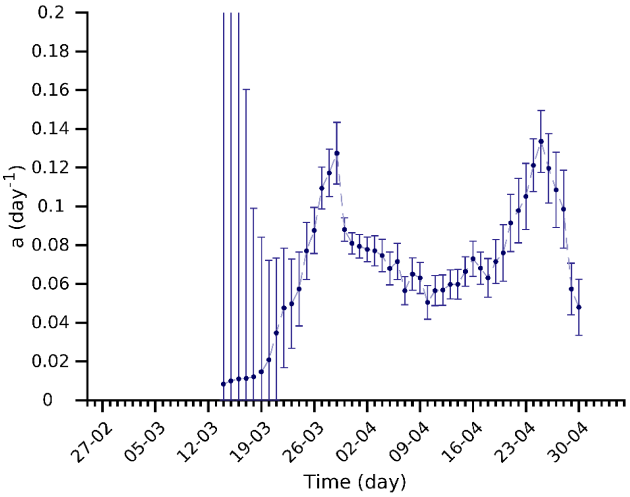


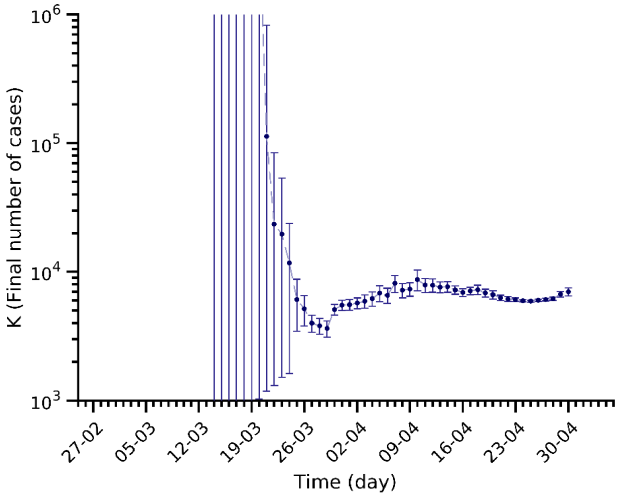


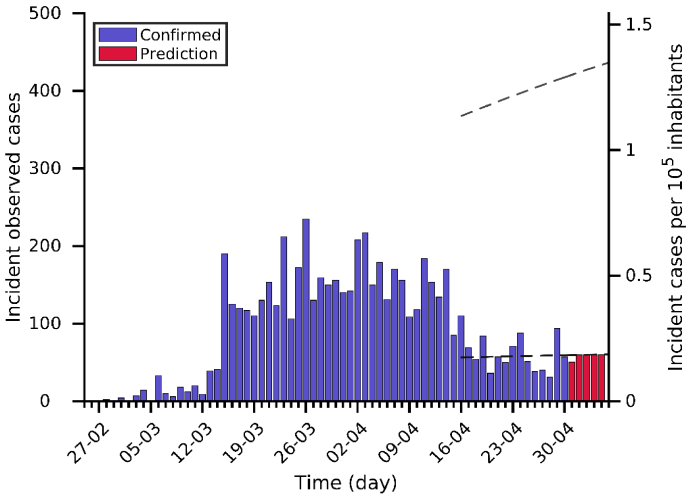
Malaysia 30-04-2020. Population: 32.4M. Current cumulated incidence: $19/10^5$

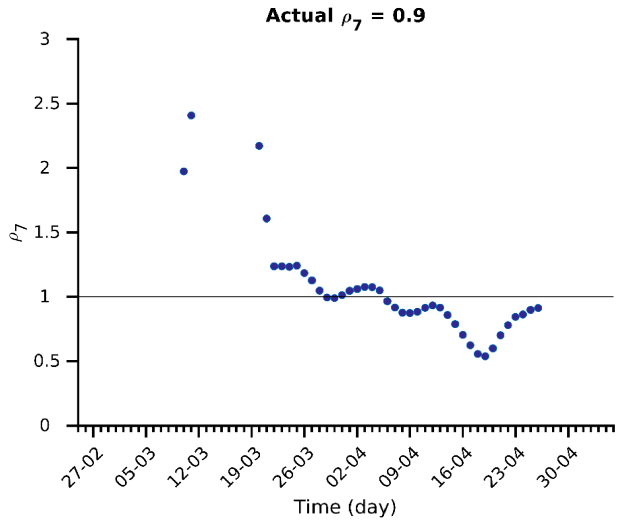


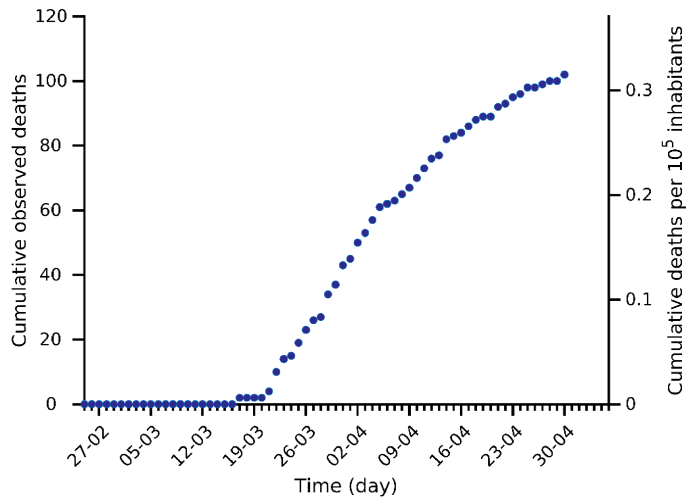


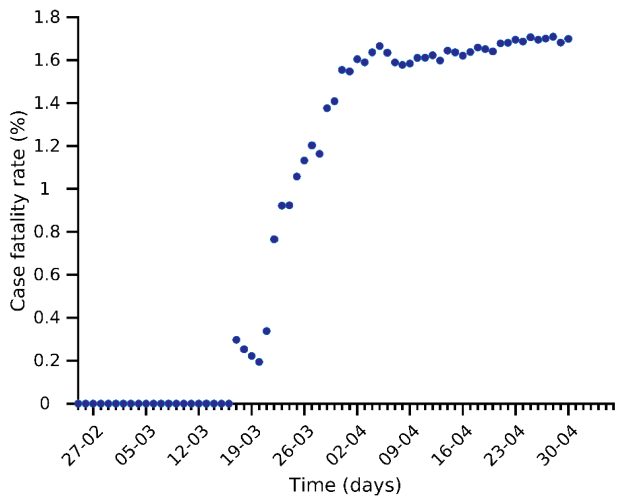




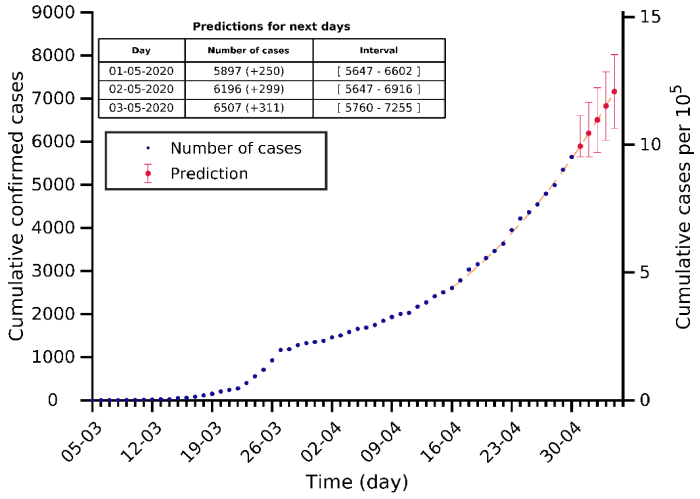


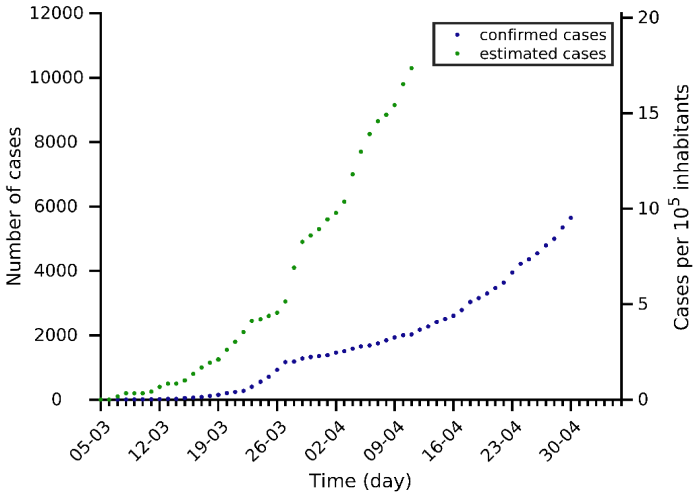


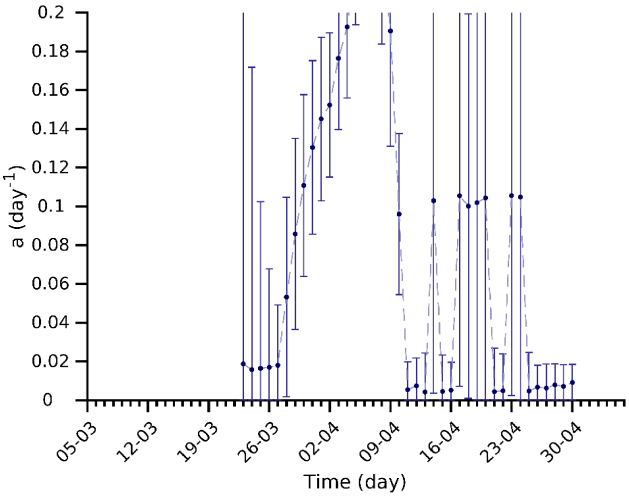


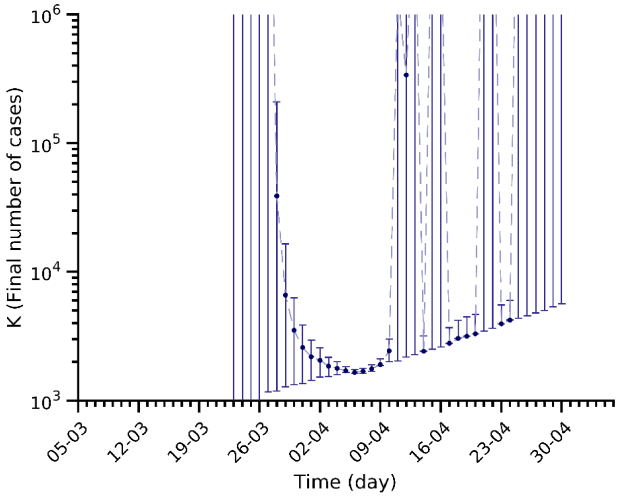


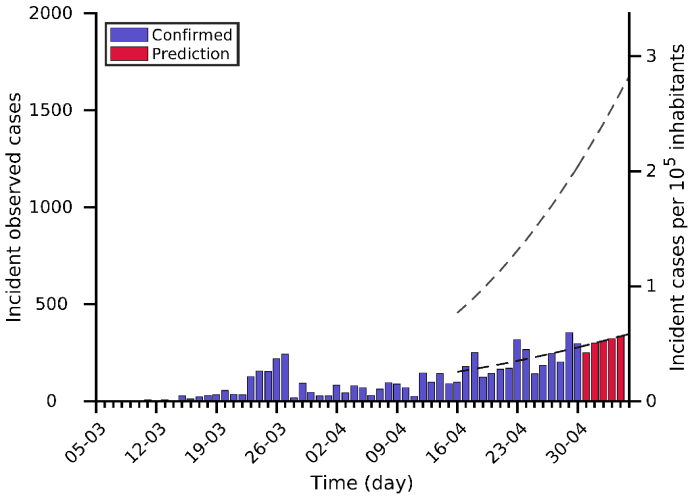
South Africa 30-04-2020. Population: 59.3M. Current cumulated incidence: 10/10^5

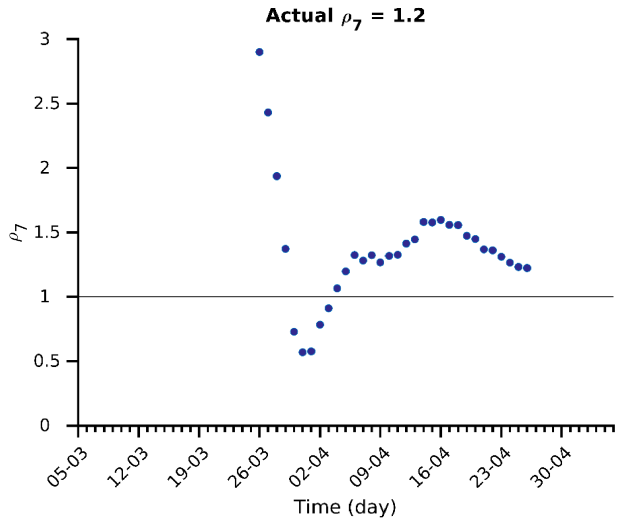


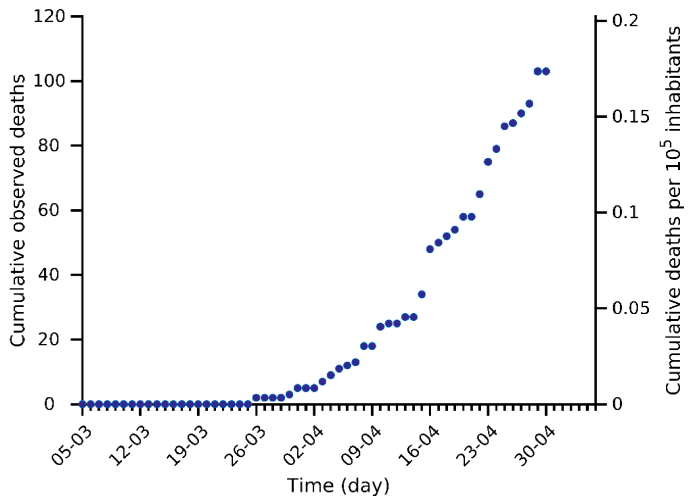


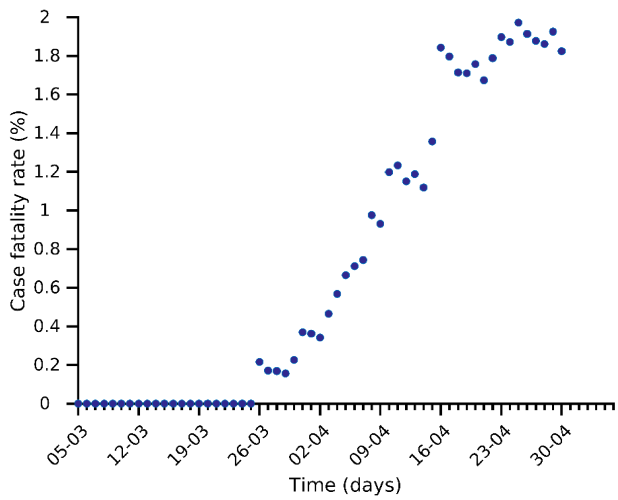








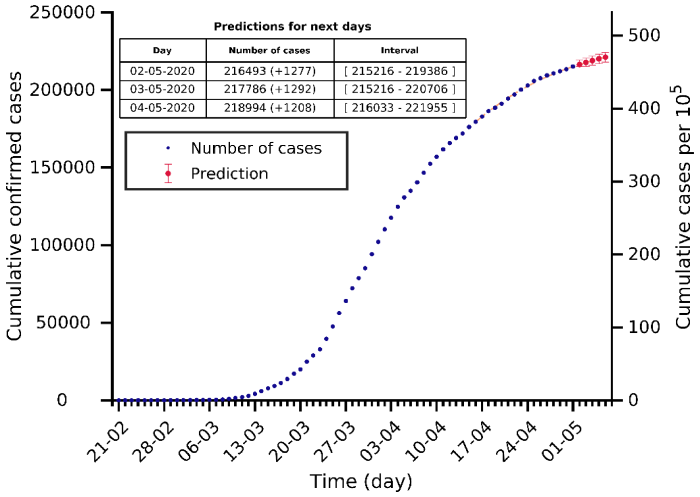


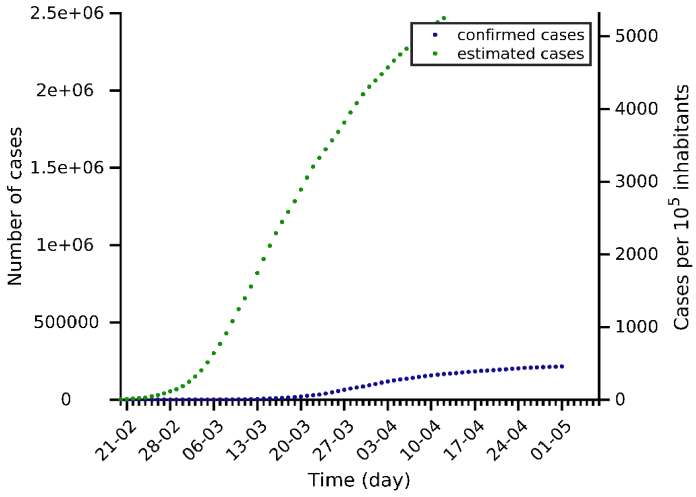


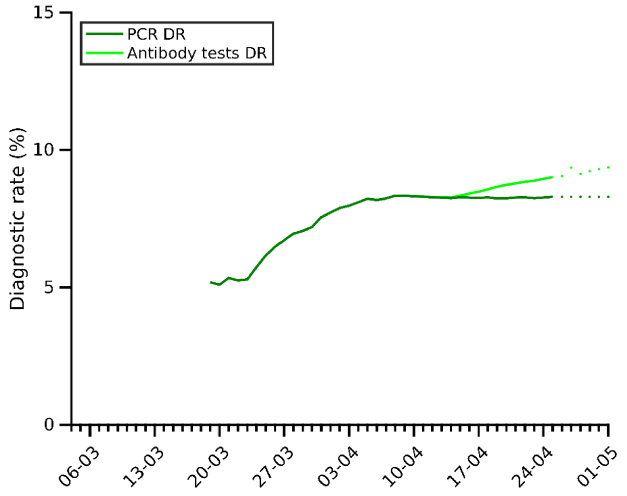
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

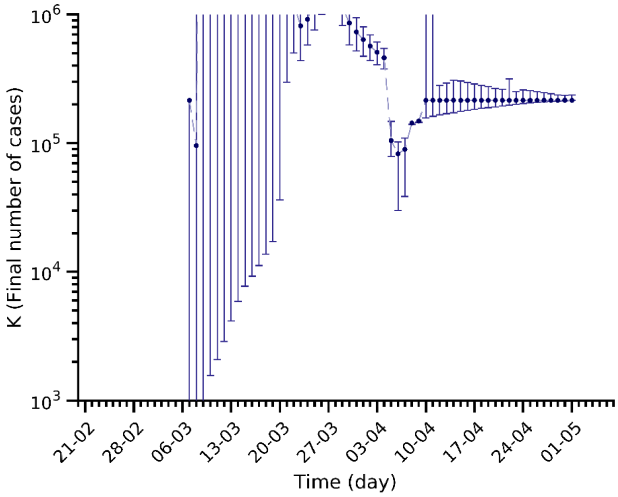
Data obtained from https://github.com/datadista/datasets/tree/master/COVID%2019 and https://covid19.isciii.es/

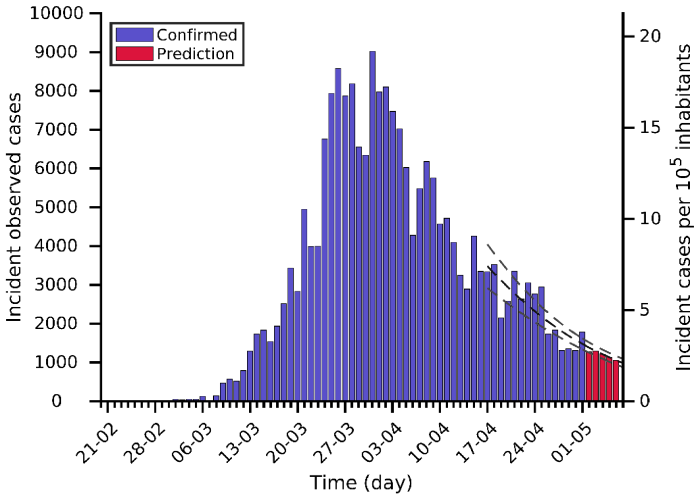
Spain 01-05-2020. Population: 47.0M. Current cumulated incidence: 458/10^5

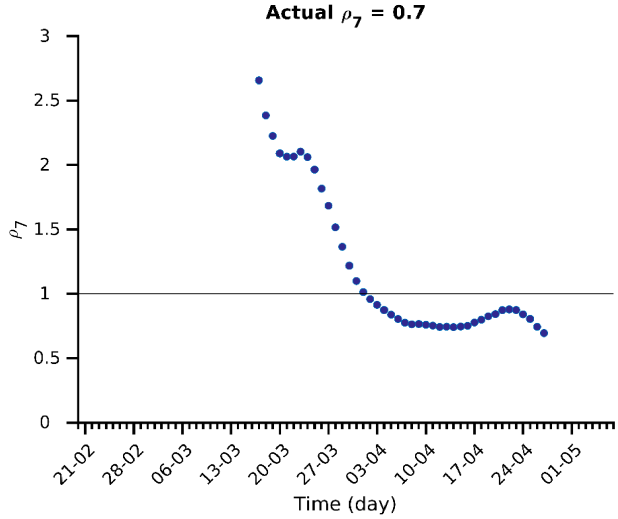


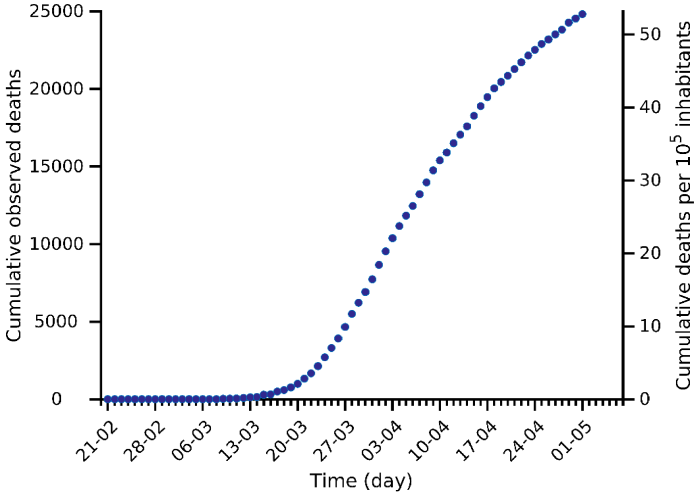


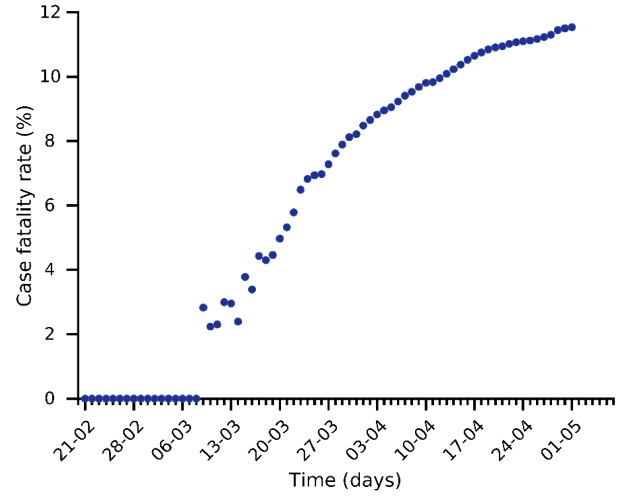




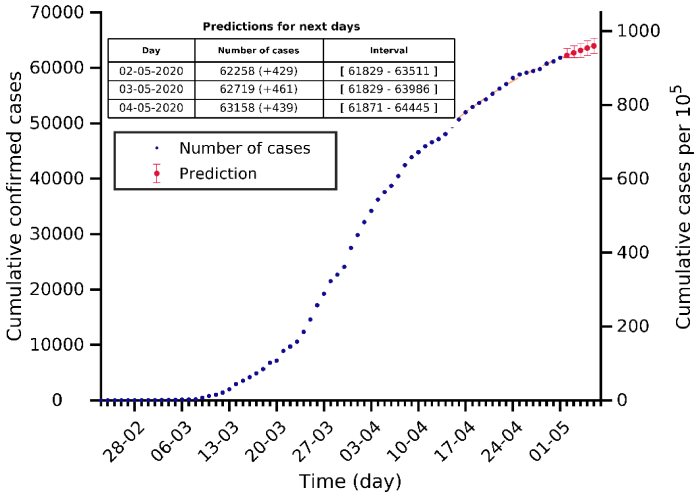


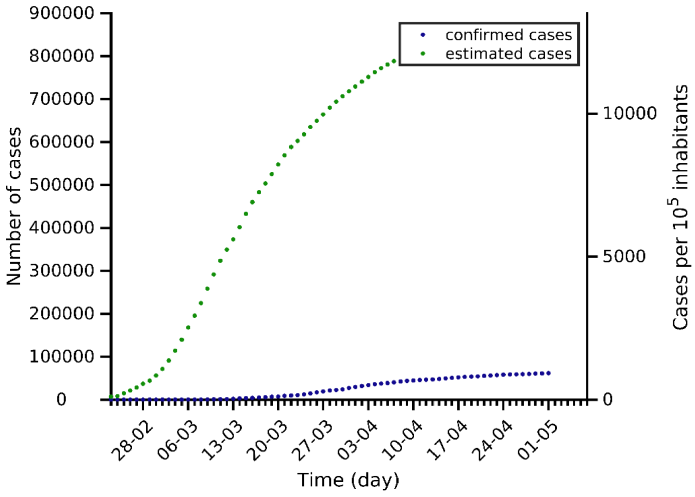


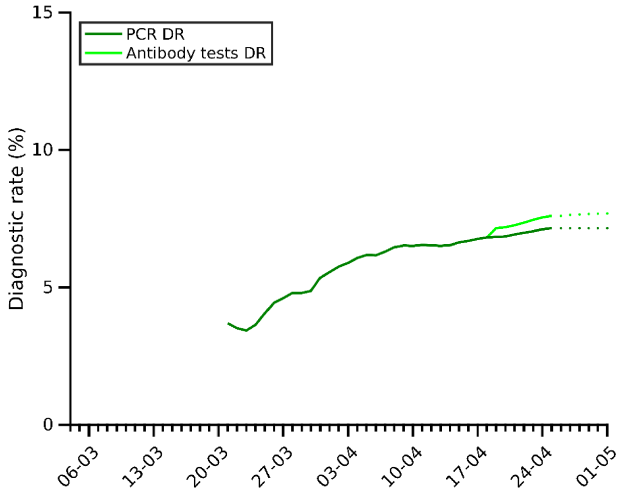


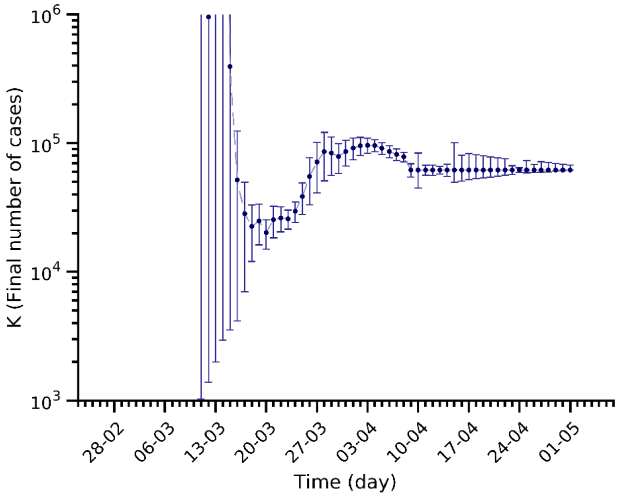


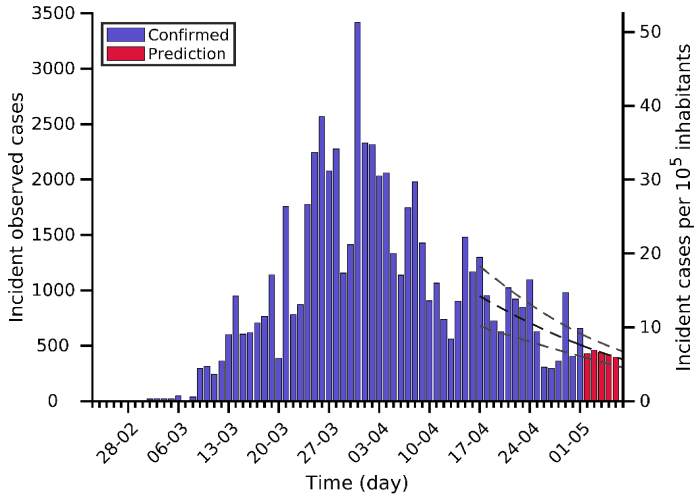
Madrid 01-05-2020. Population: 6.7M. Current cumulated incidence: 928/10^5

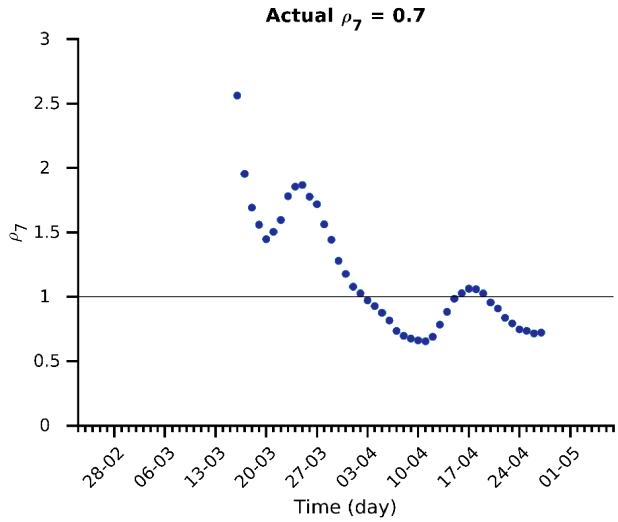


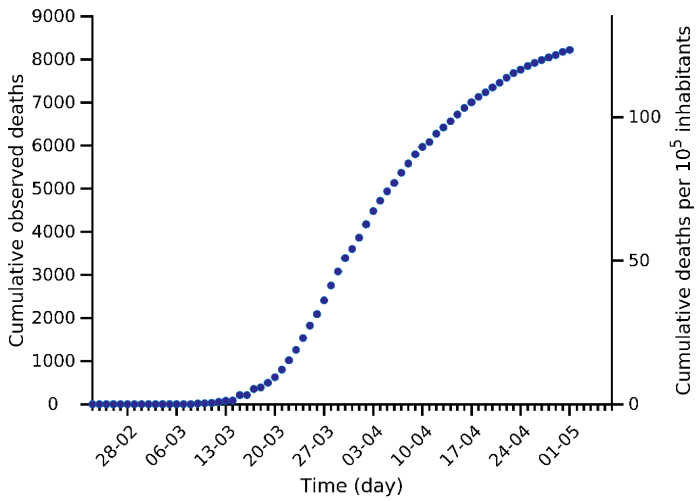


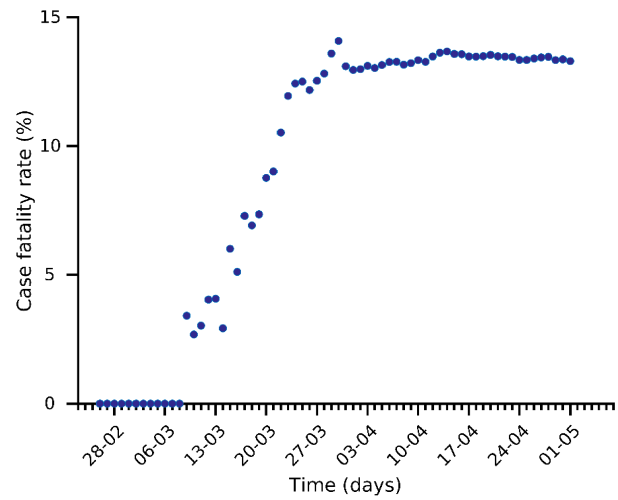




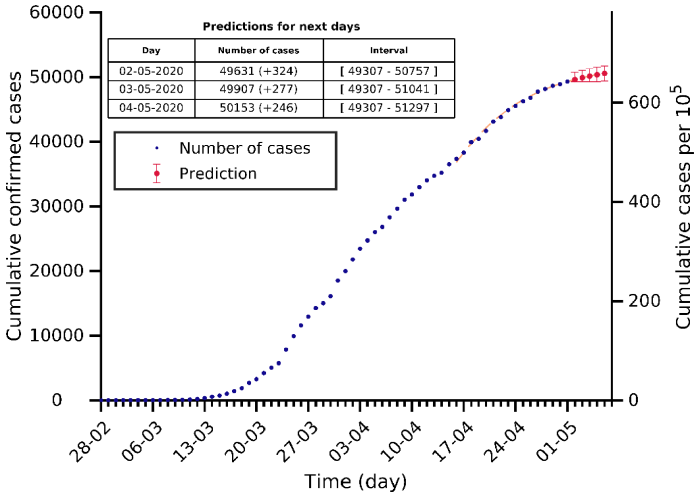


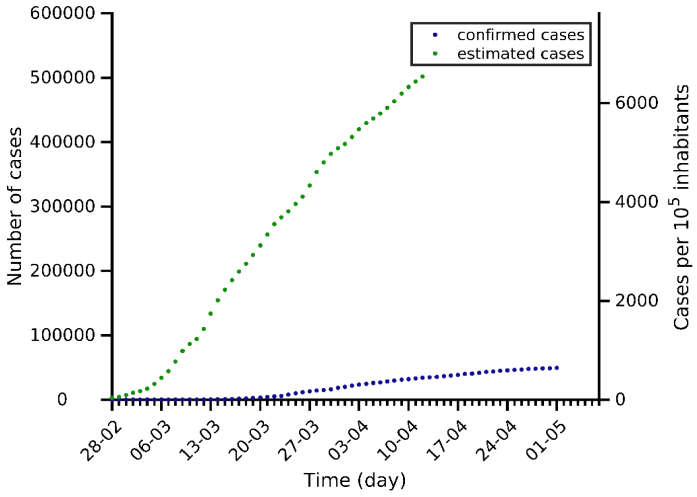


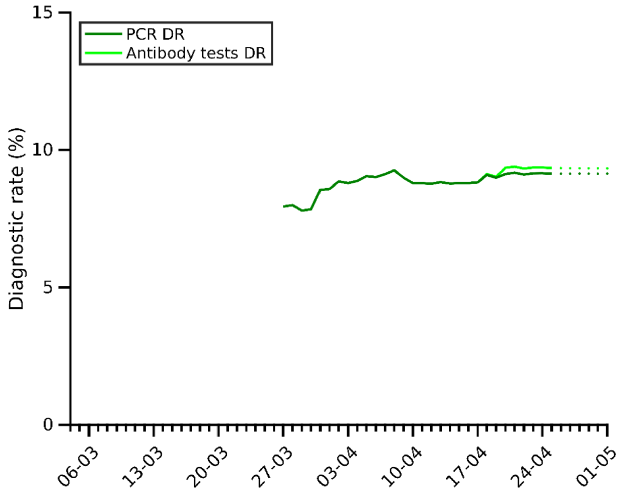


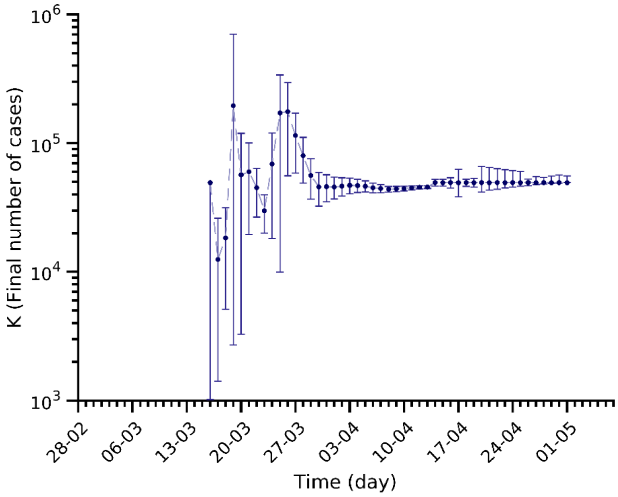


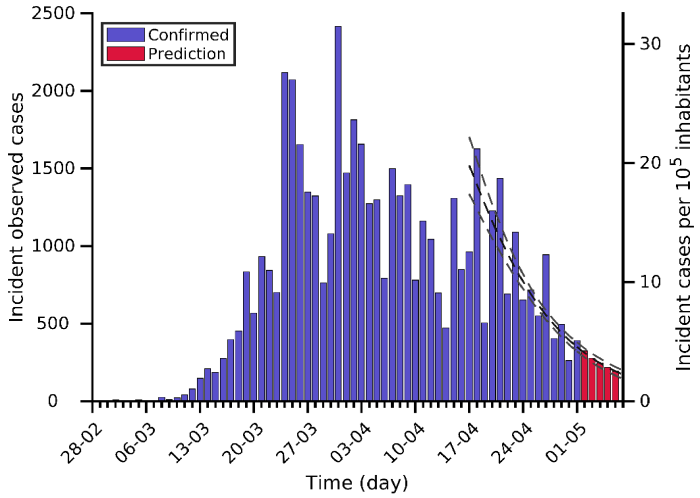
Catalunya 01-05-2020. Population: 7.7M. Current cumulated incidence: $642/10^5$

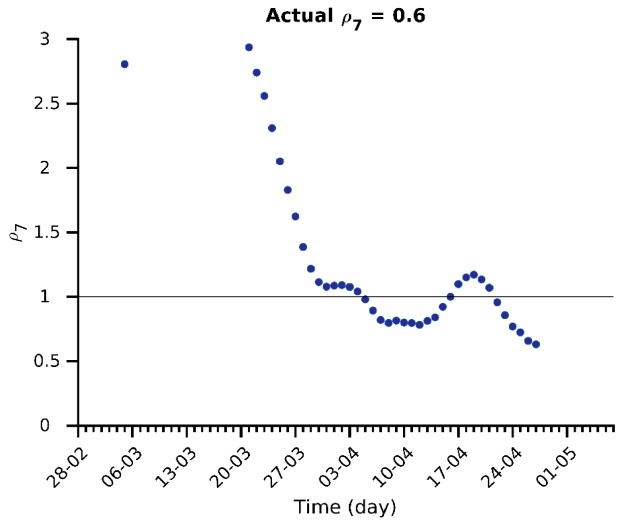


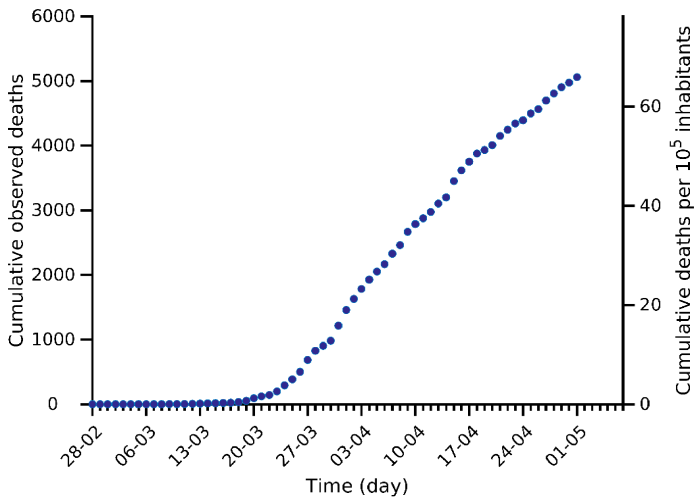


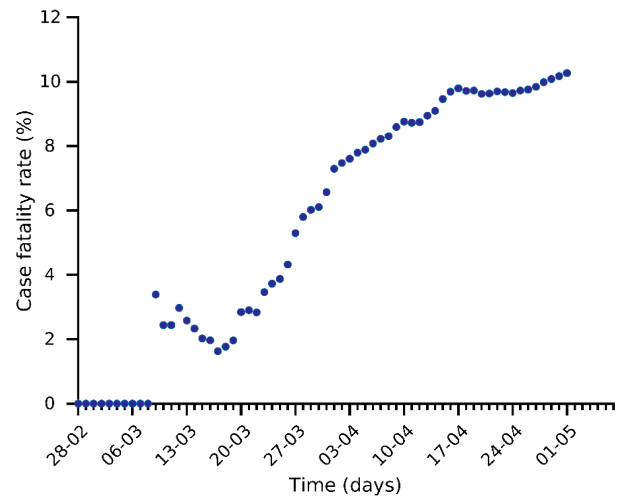




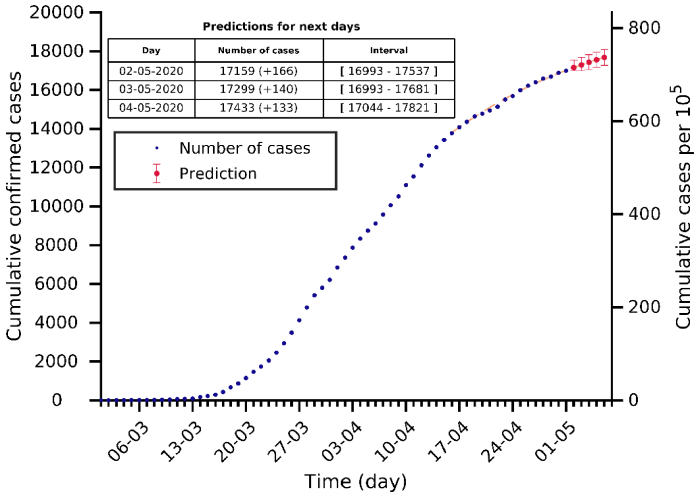


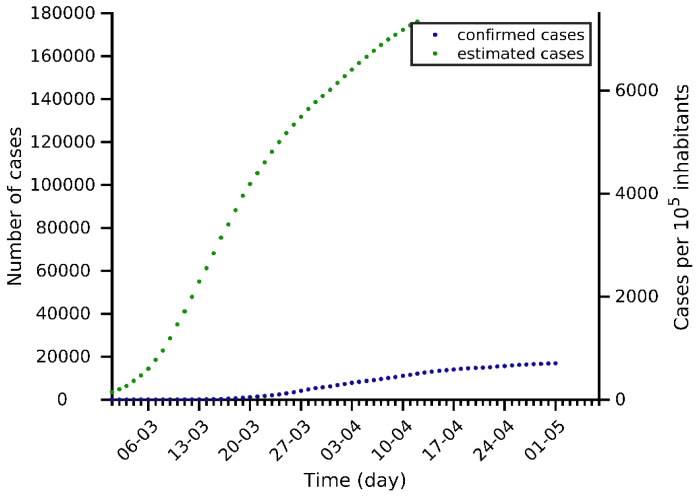


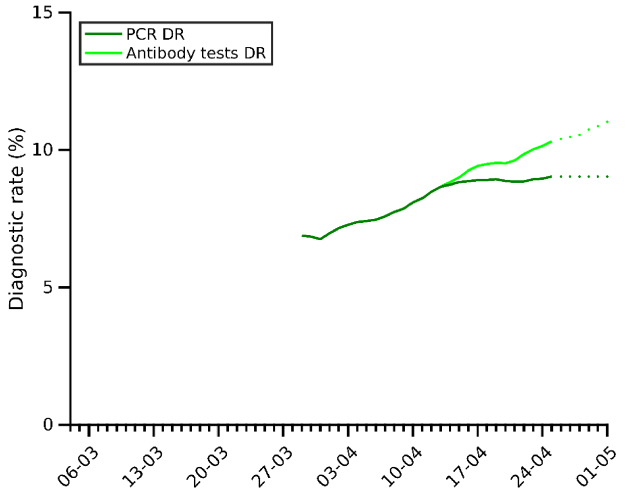


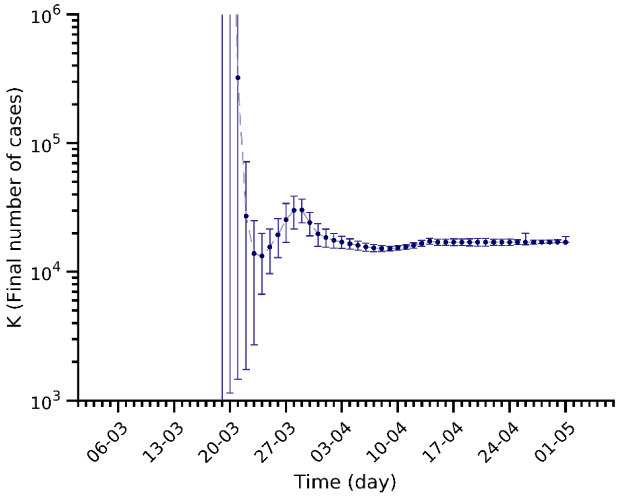


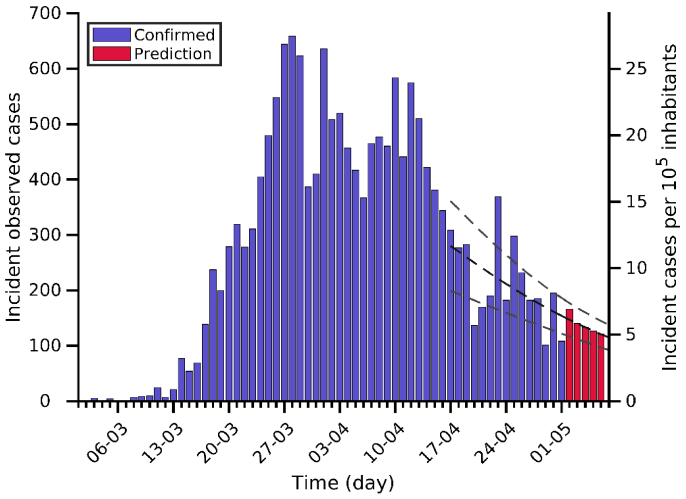
Castilla Leon 01-05-2020. Population: 2.4M. Current cumulated incidence: 708/10^5

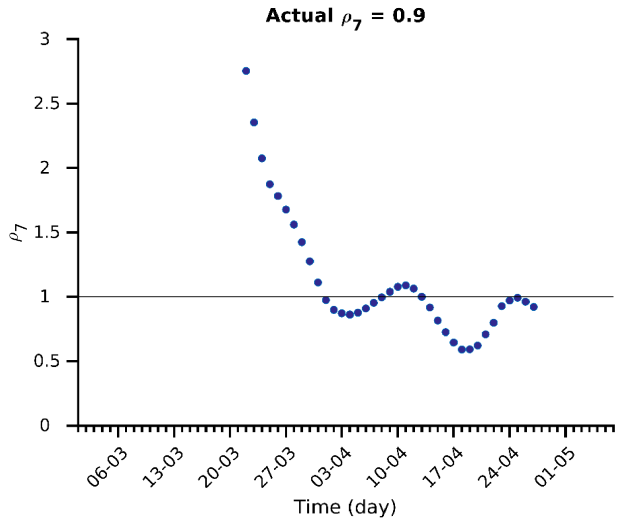


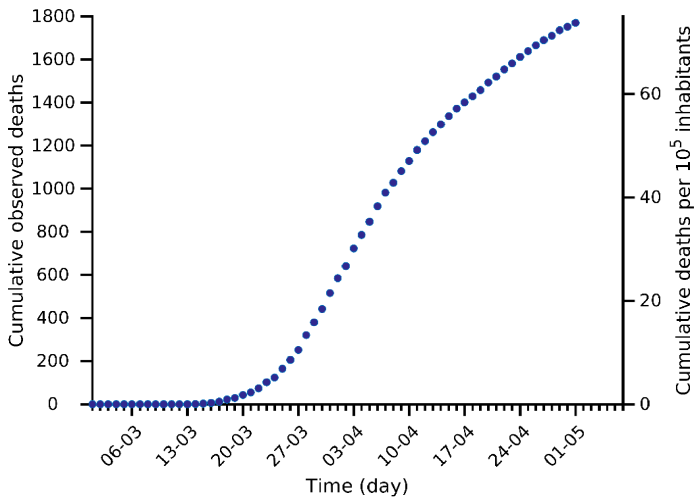


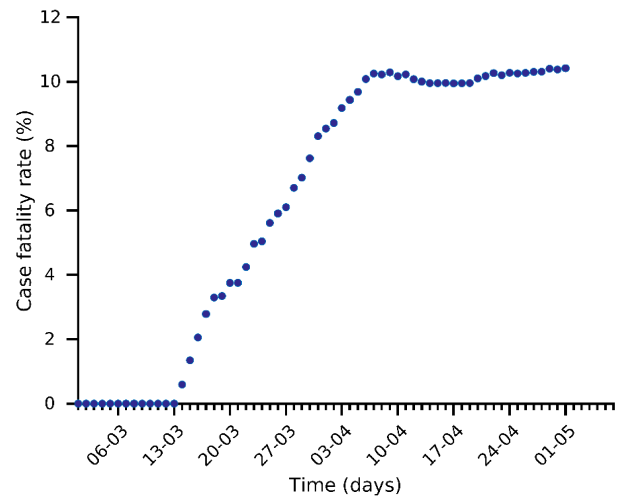




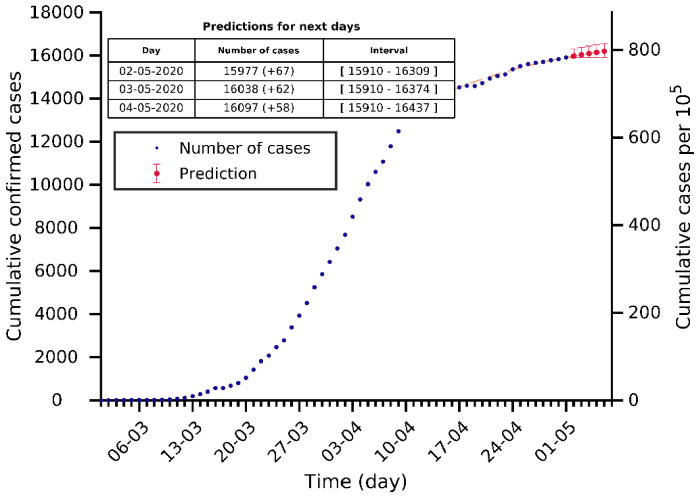


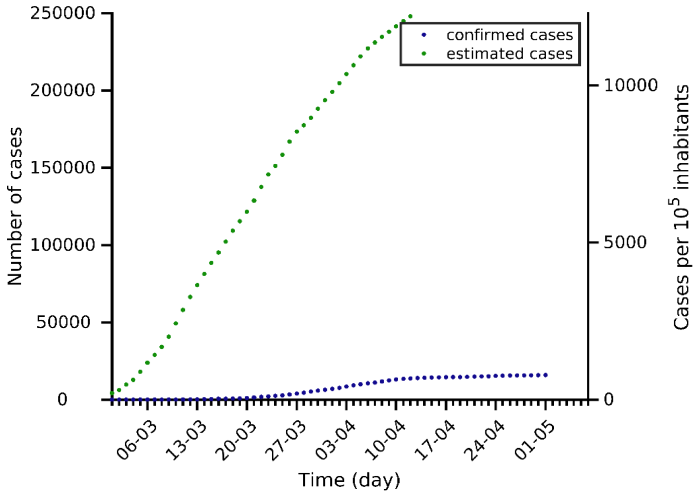


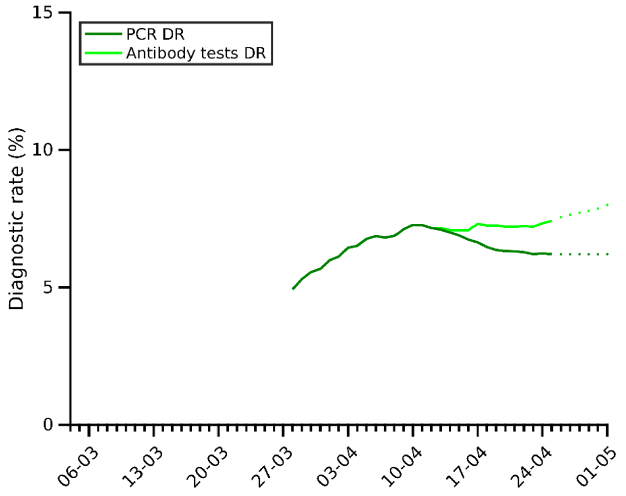


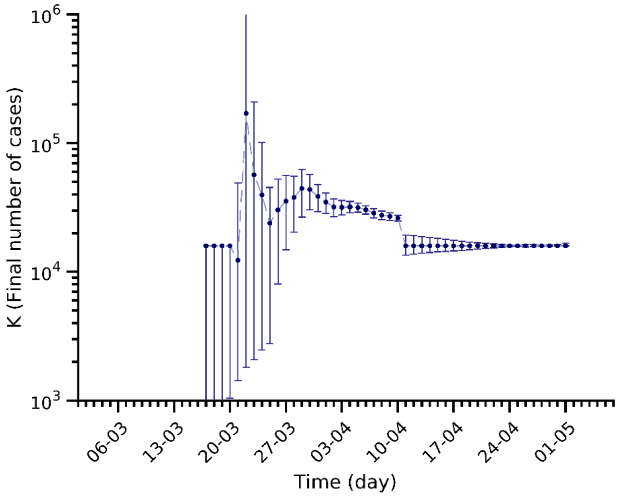


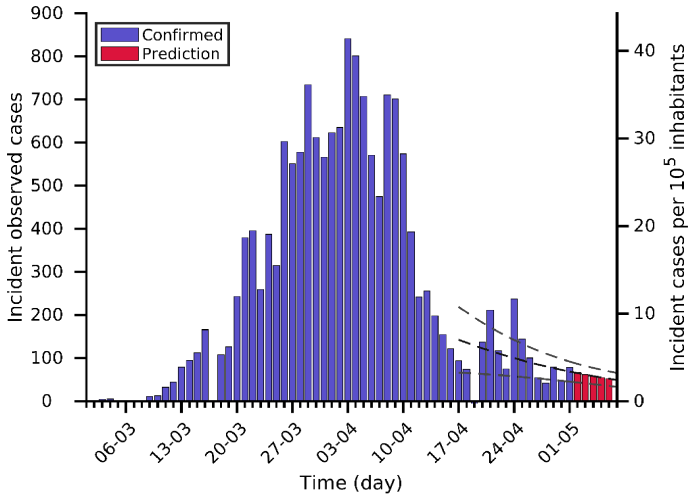
Castilla-La Mancha 01-05-2020. Population: 2.0M. Current cumulated incidence: 78

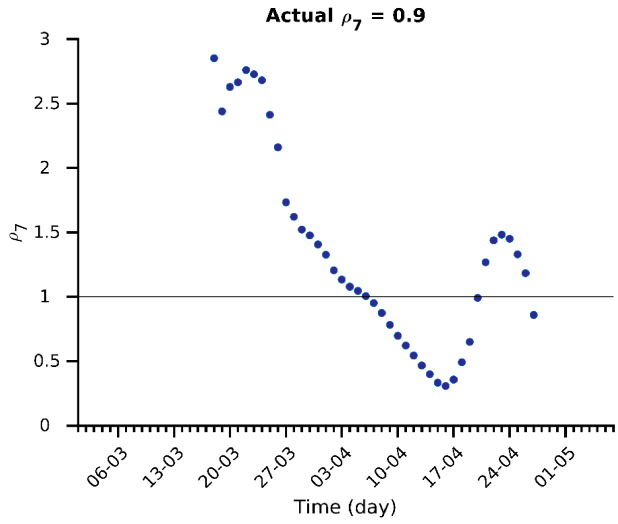


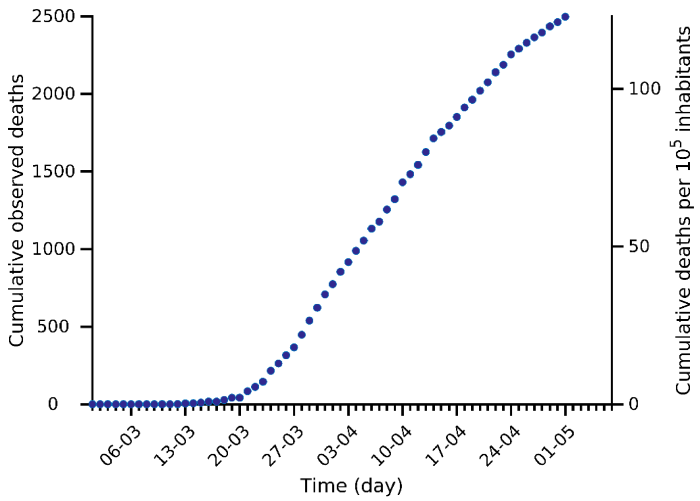


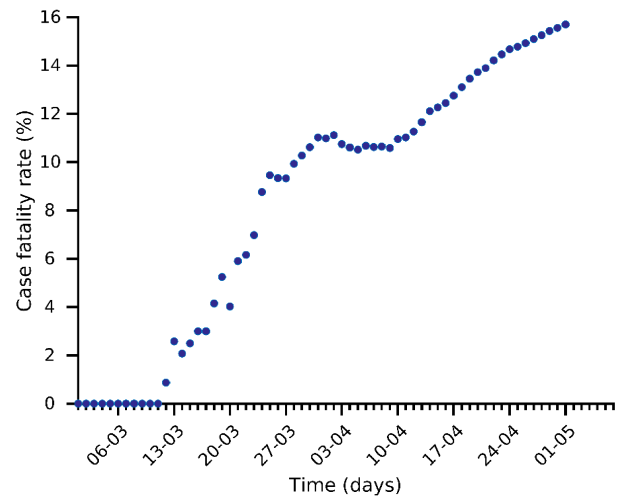




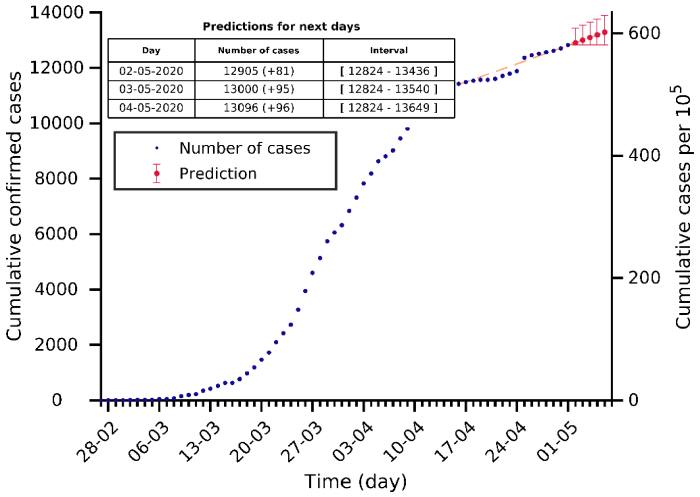


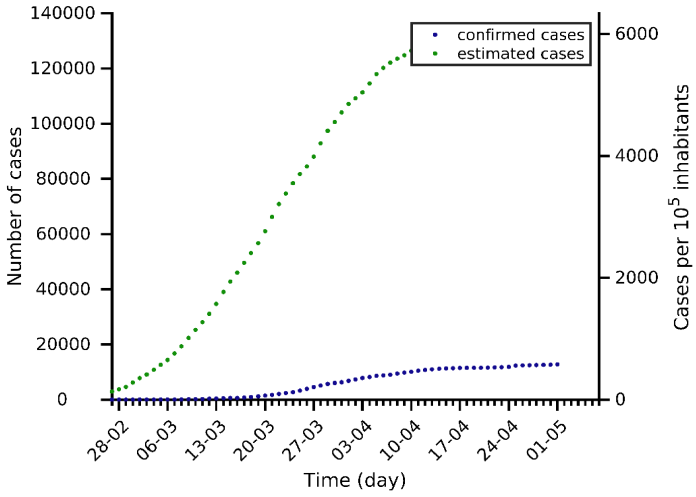


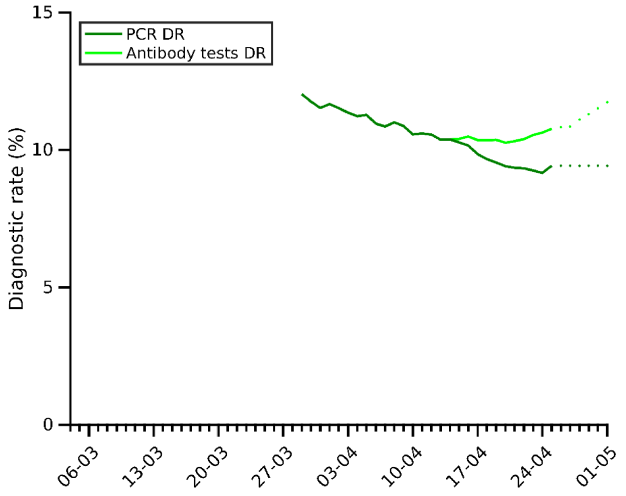


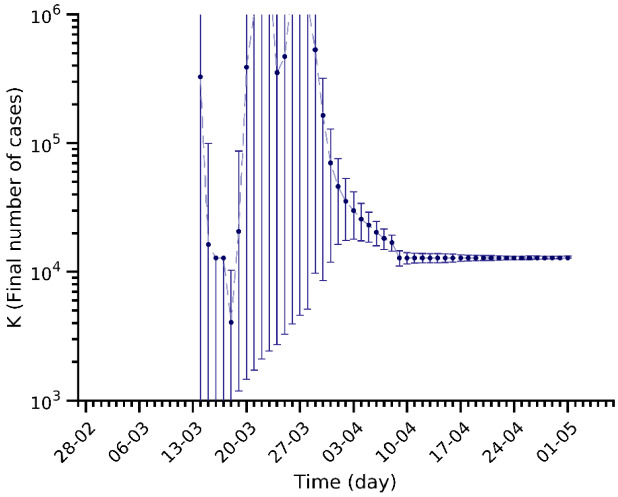


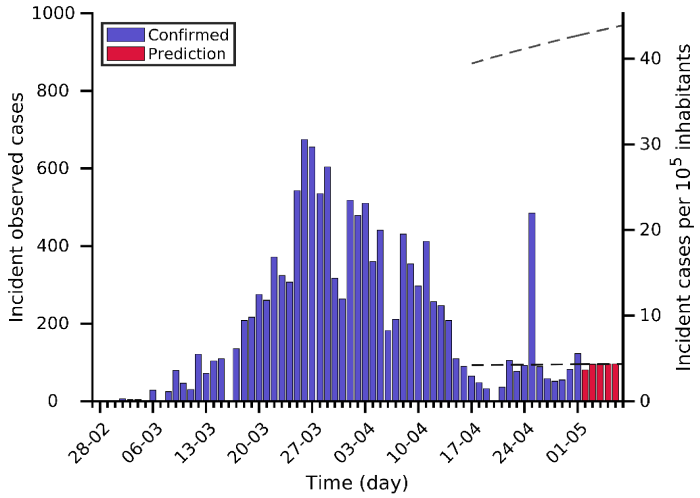
Euskadi 01-05-2020. Population: 2.2M. Current cumulated incidence: 581/10^5

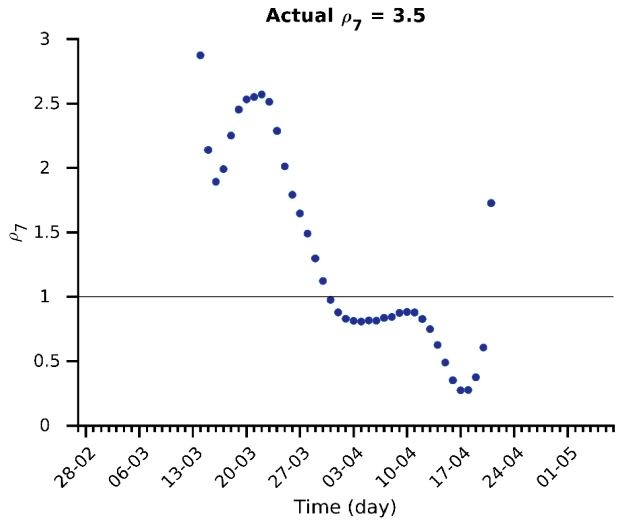


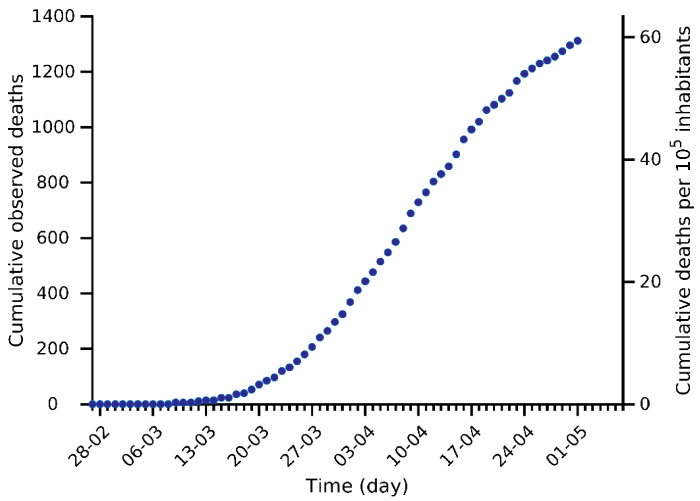


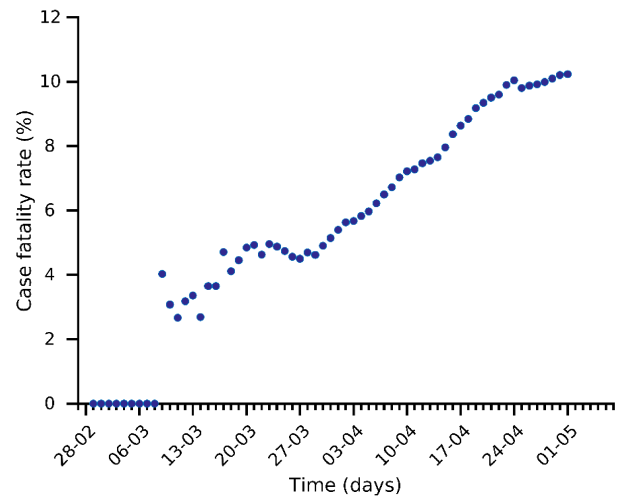




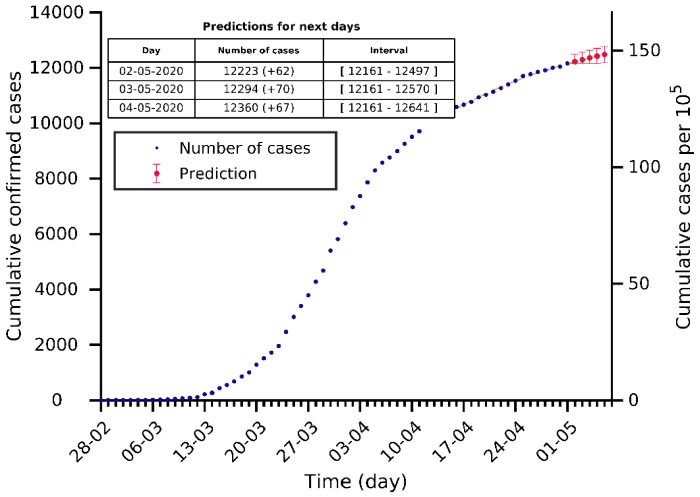


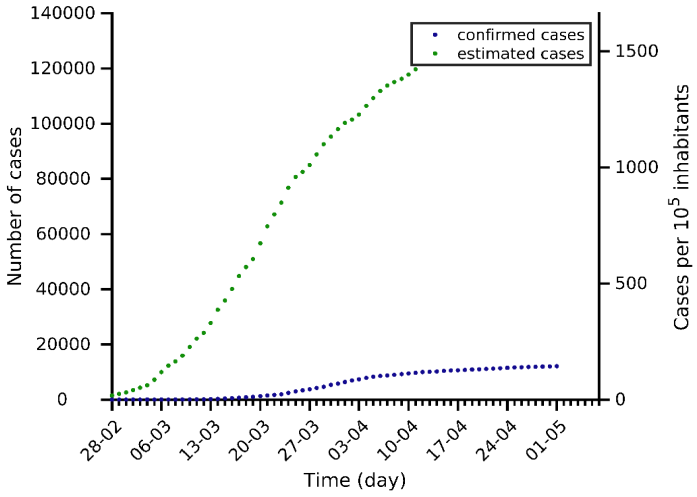


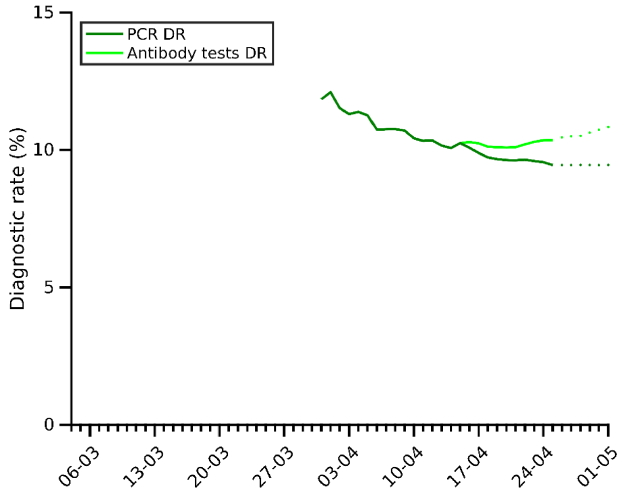


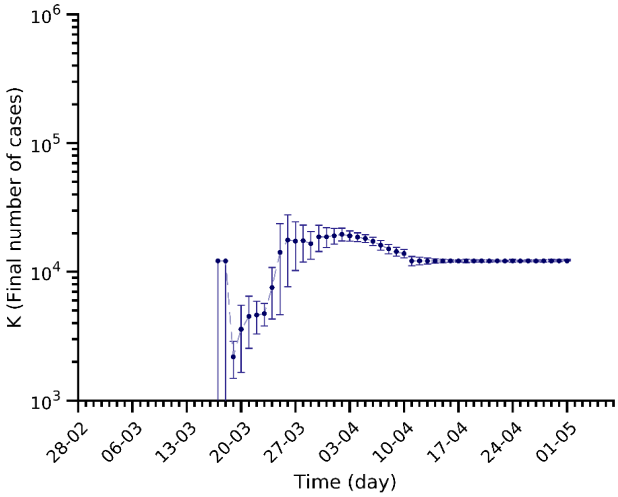


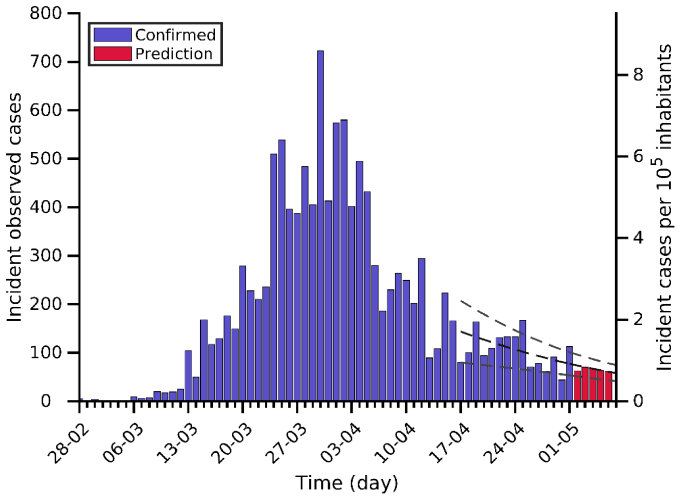
Andalucia 01-05-2020. Population: 8.4M. Current cumulated incidence: 145/10^5

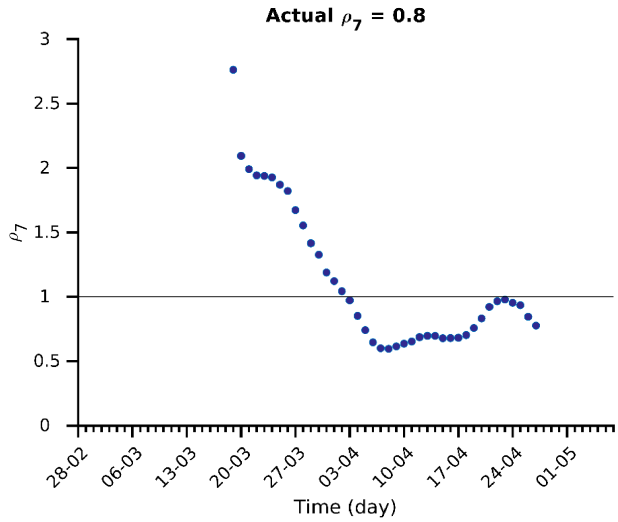


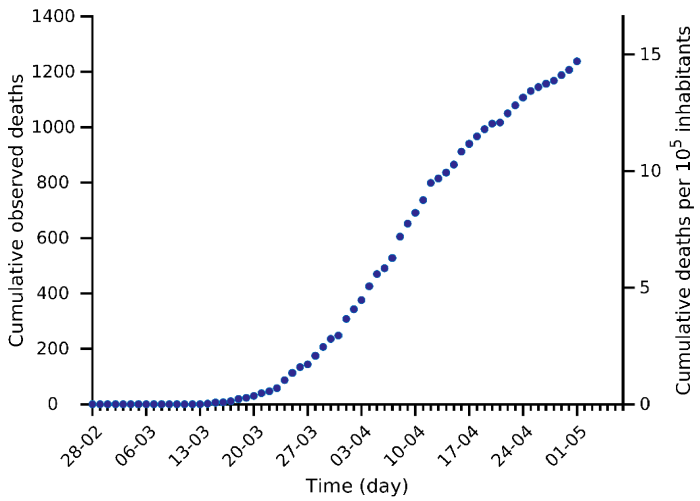


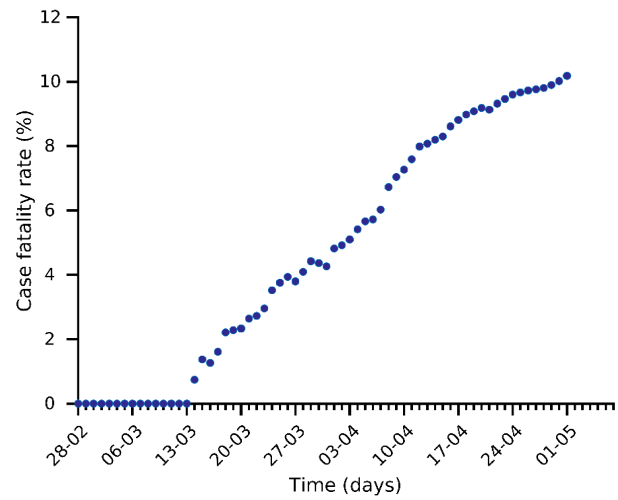




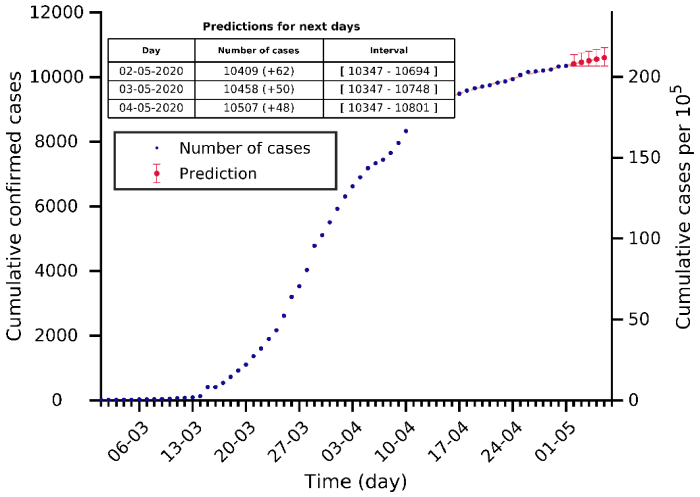


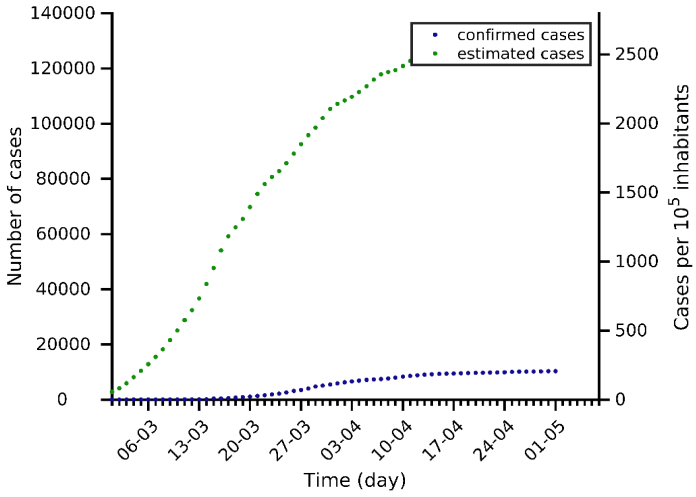


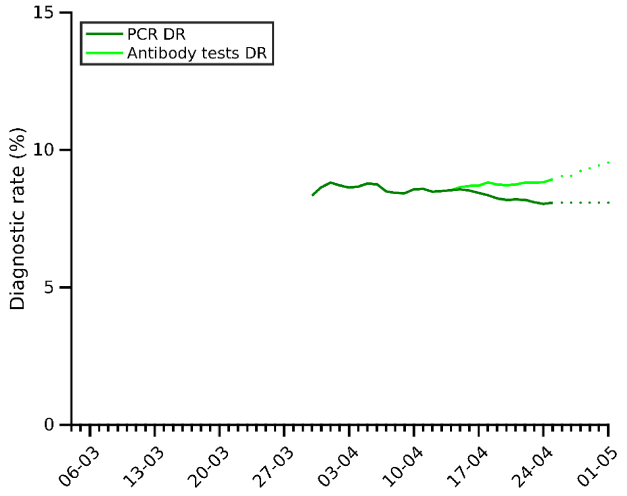


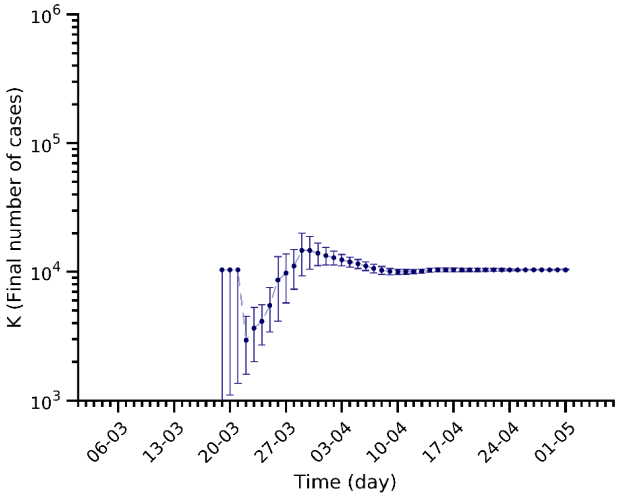


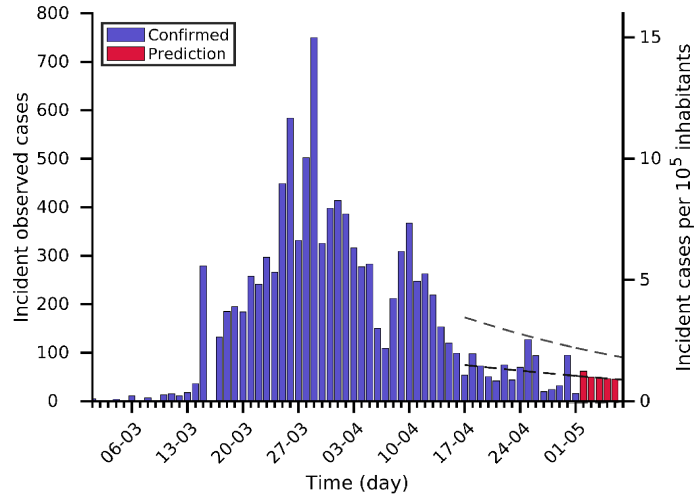
C Valenciana 01-05-2020. Population: 5.0M. Current cumulated incidence: 207/10^5

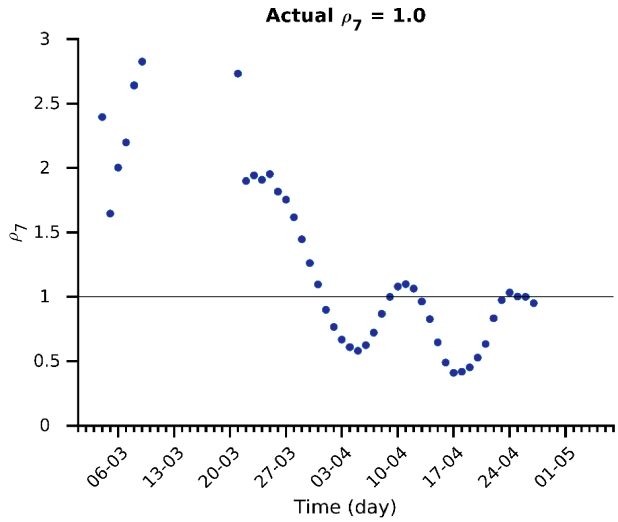


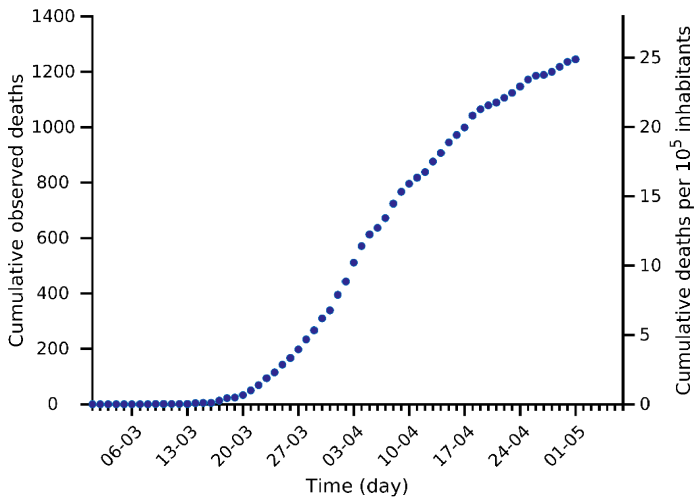


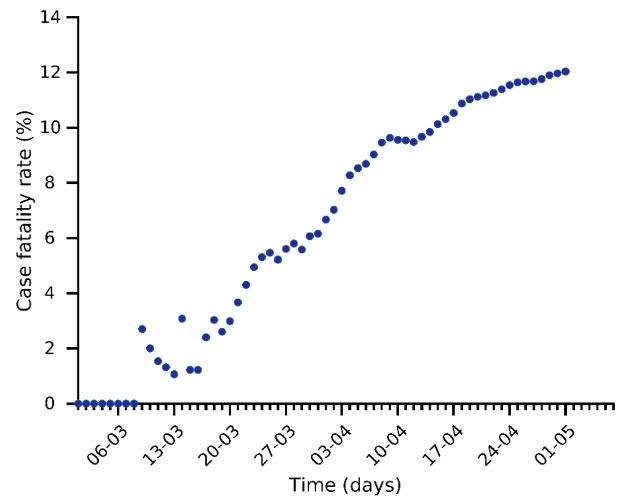




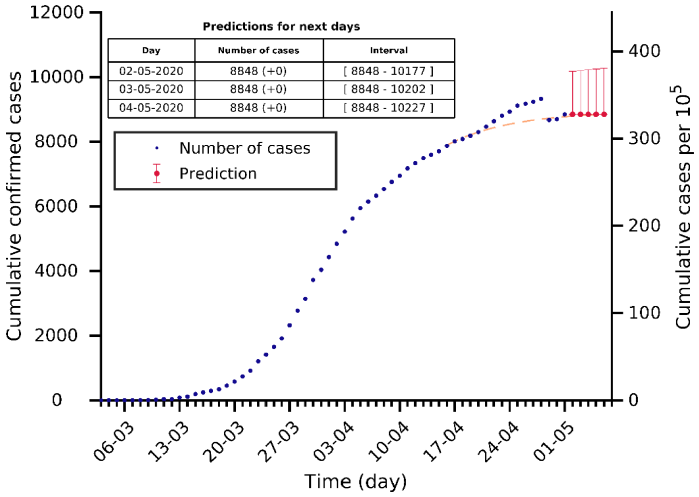


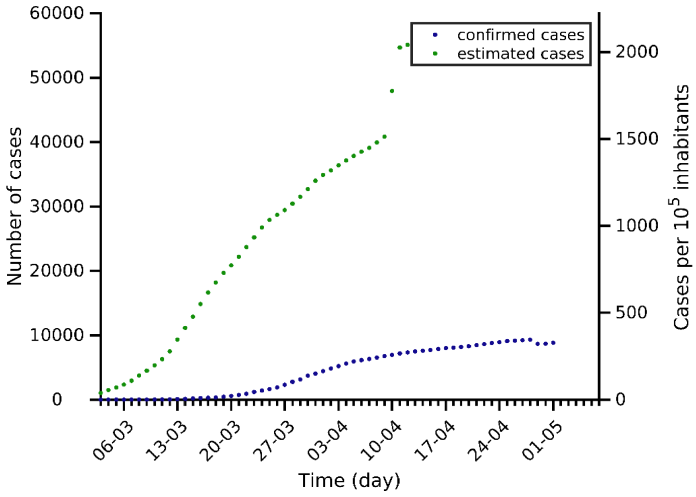


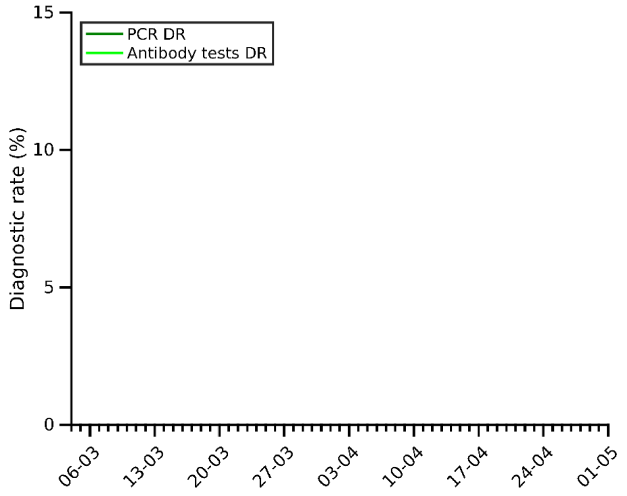


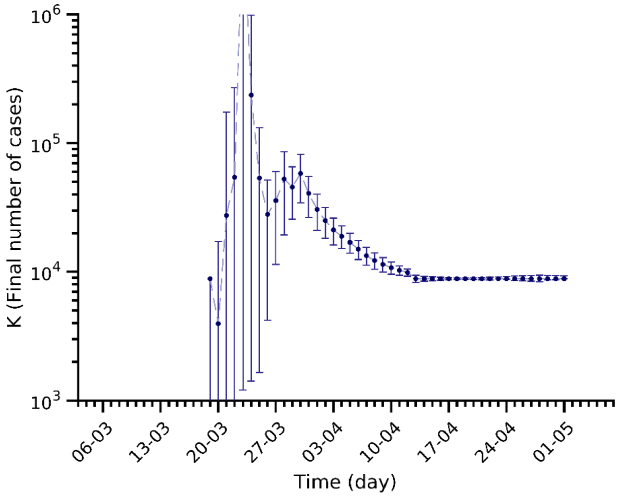


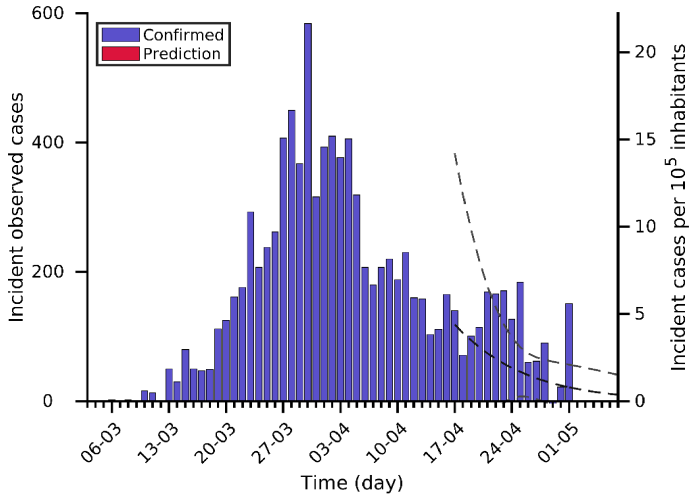
Galicia 01-05-2020. Population: 2.7M. Current cumulated incidence: 328/10^5

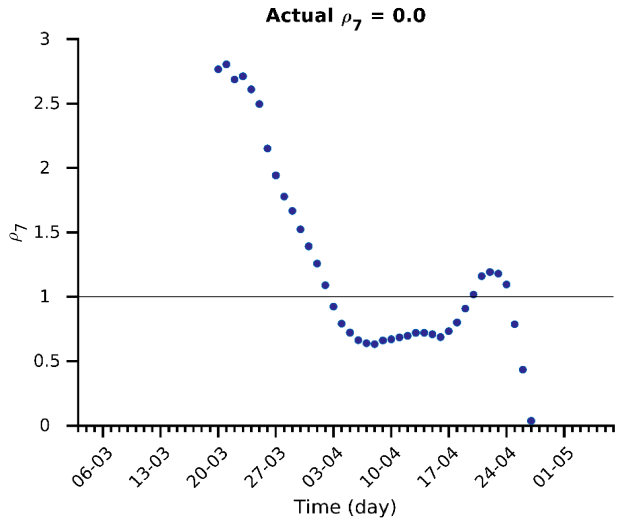


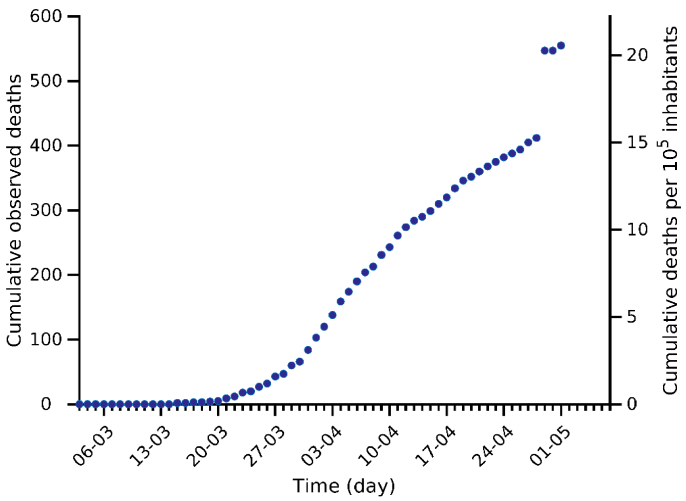


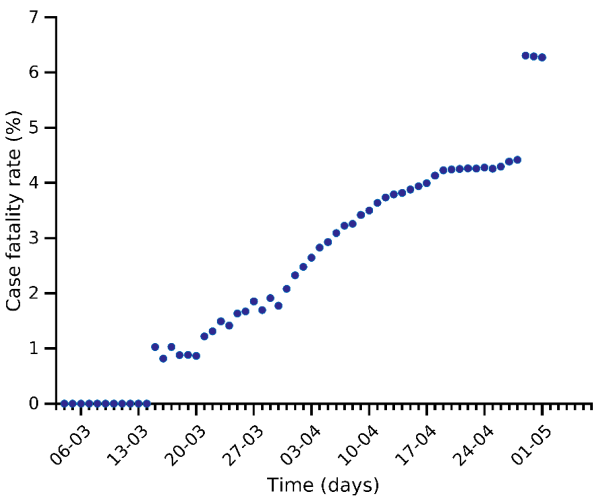




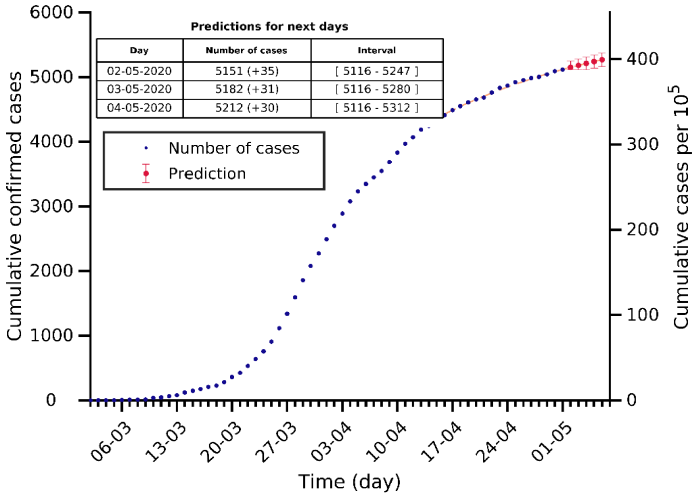


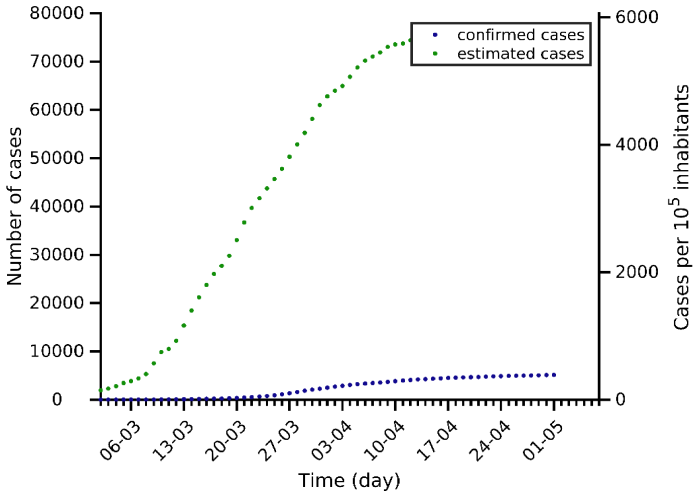


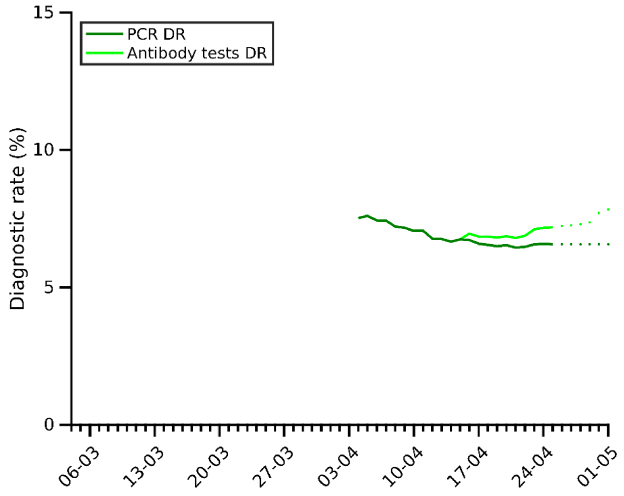


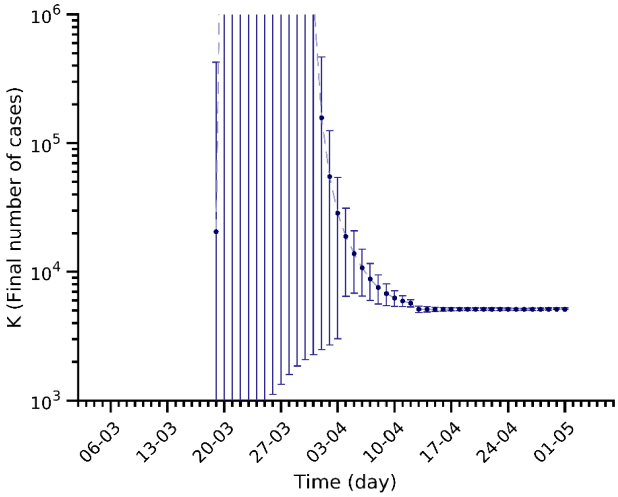


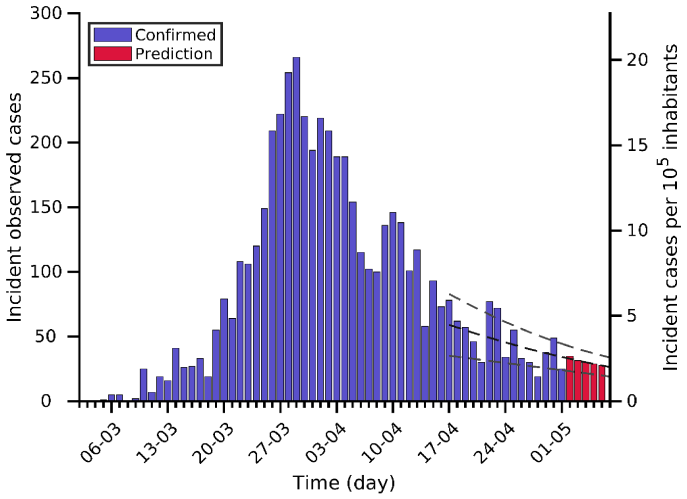
Aragon 01-05-2020. Population: 1.3M. Current cumulated incidence: $388/10^5$

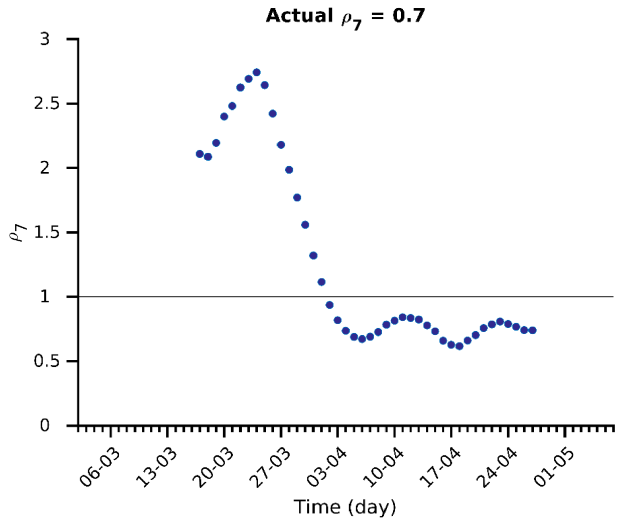


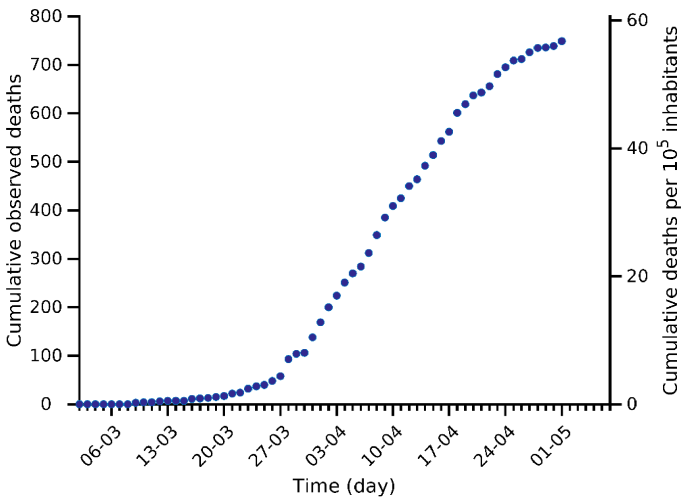


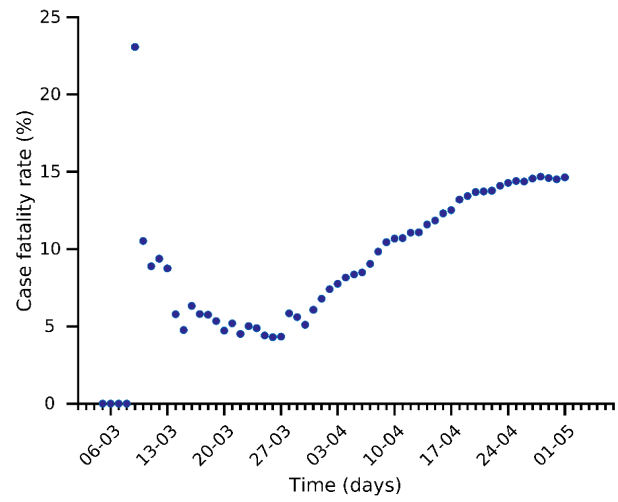




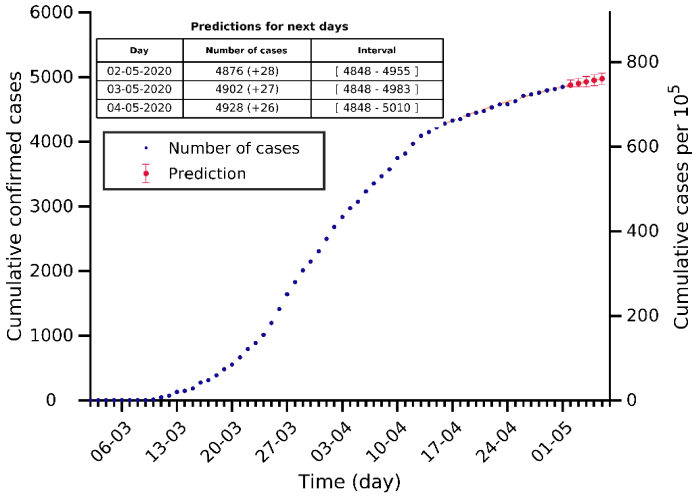


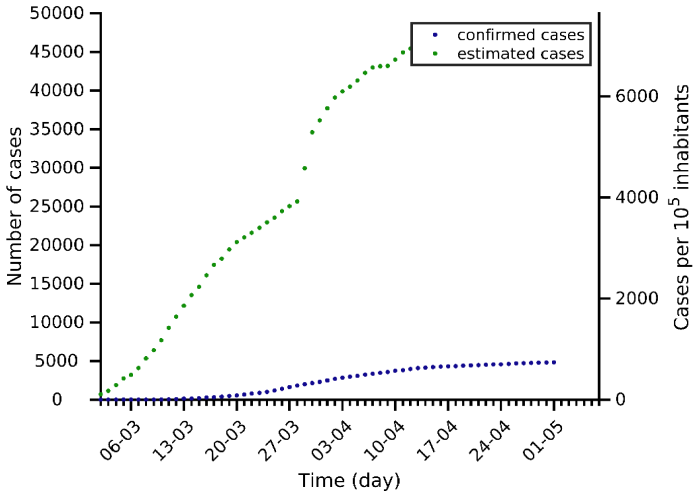


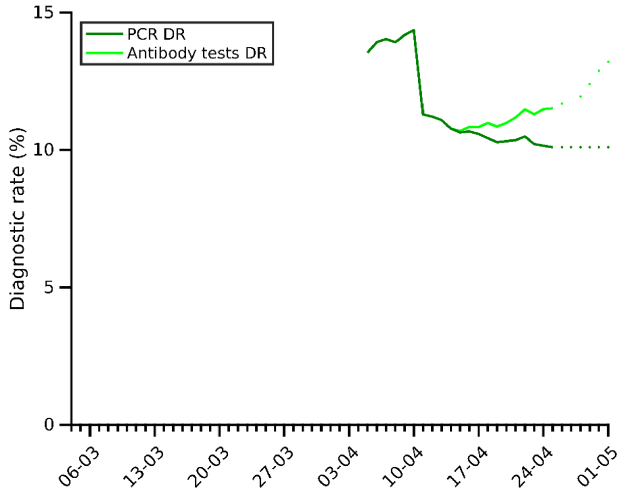


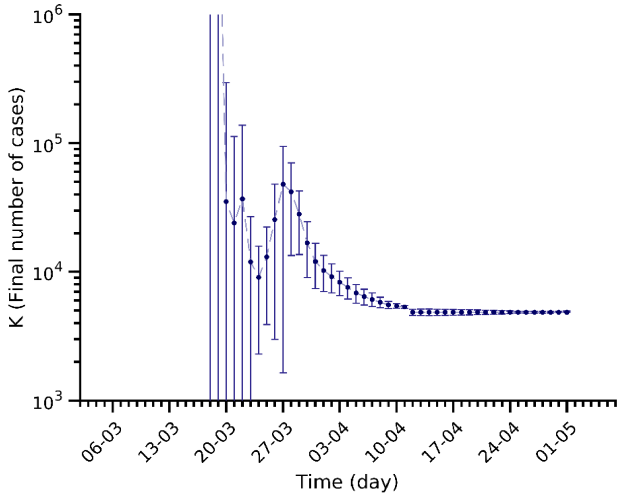


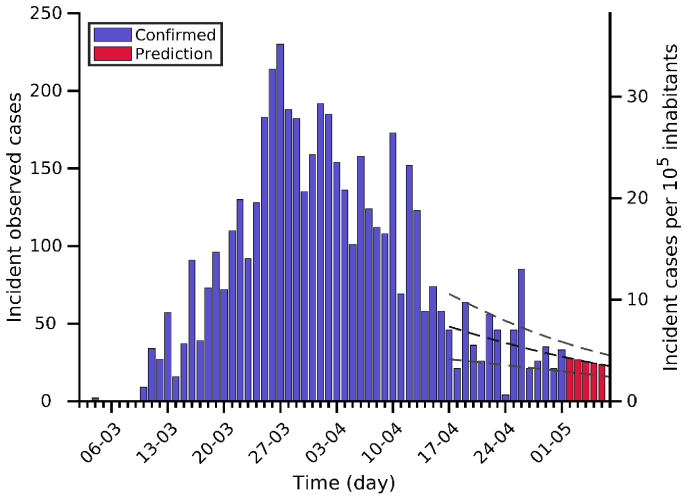
Navarra 01-05-2020. Population: 0.7M. Current cumulated incidence: 741/10^5

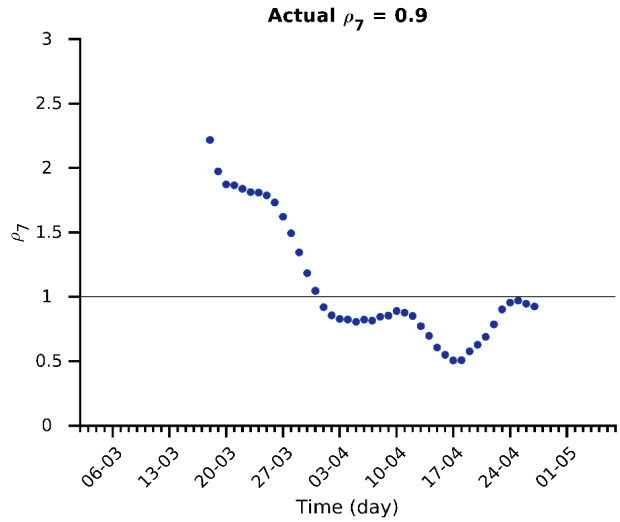


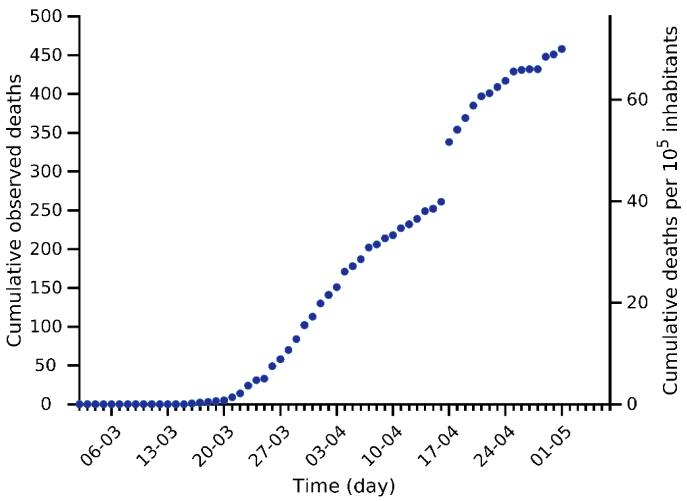


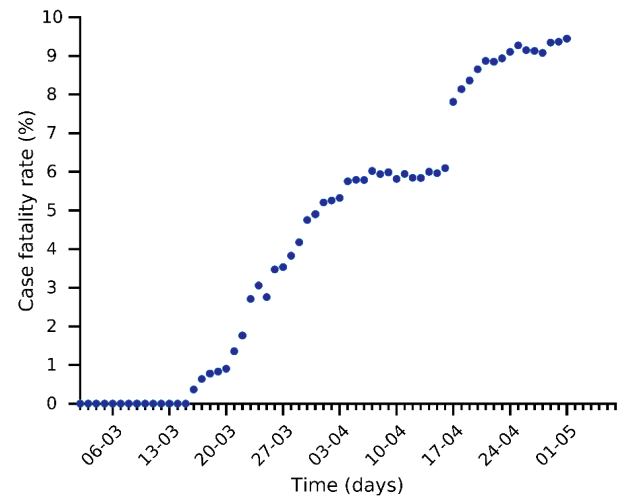




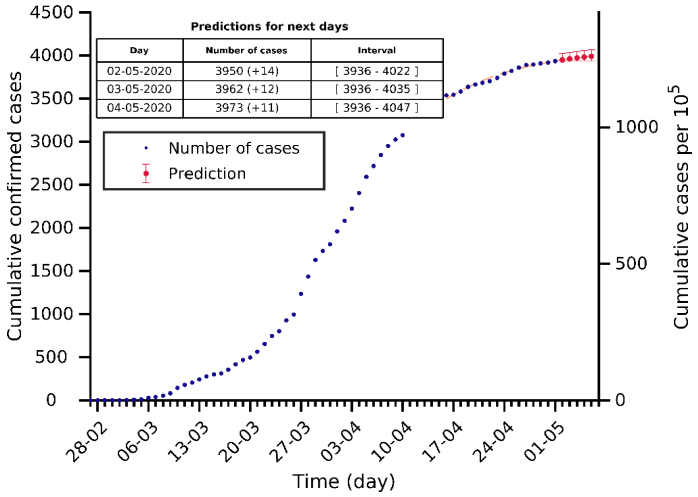


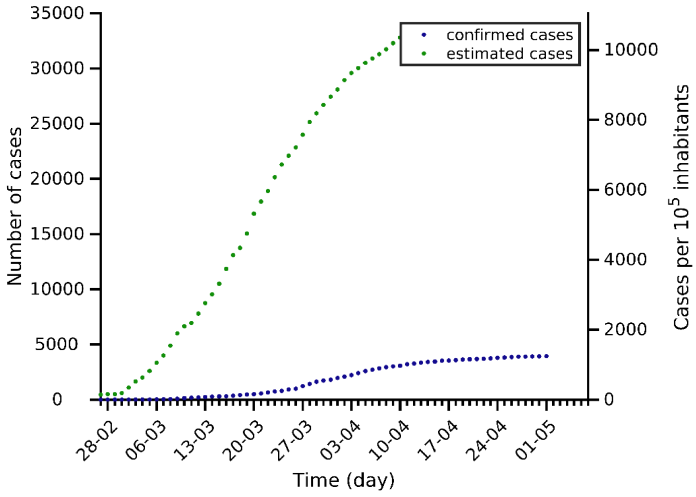


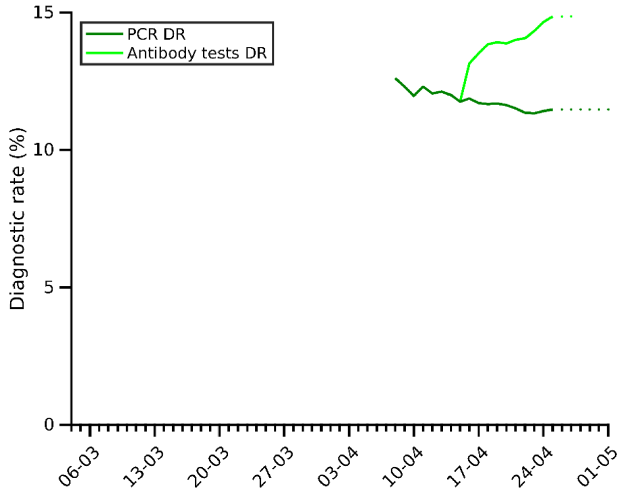


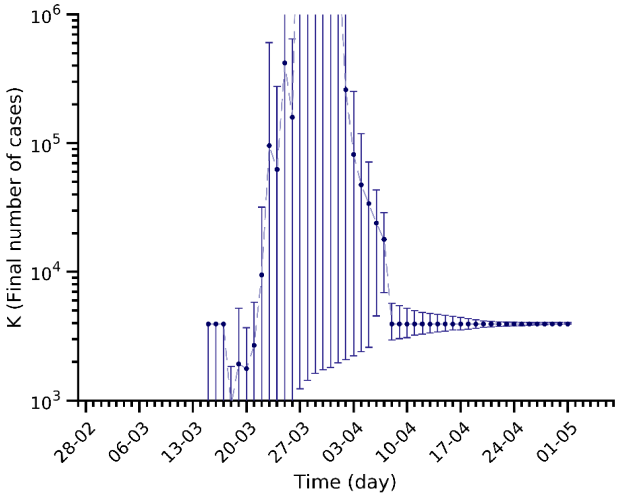


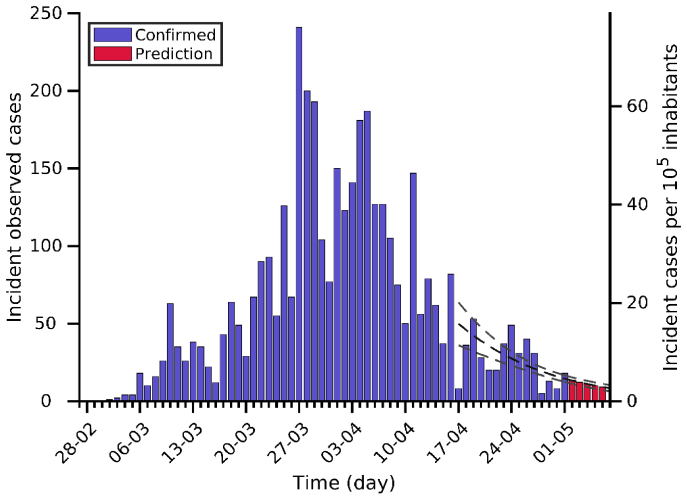
La Rioja 01-05-2020. Population: 0.3M. Current cumulated incidence: 1242/10⁵

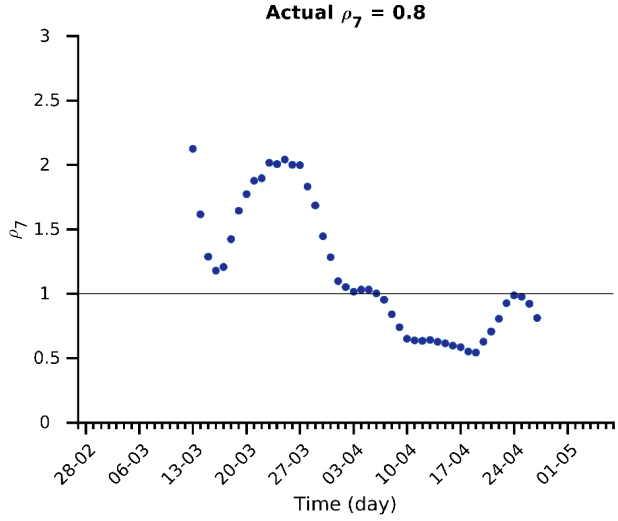


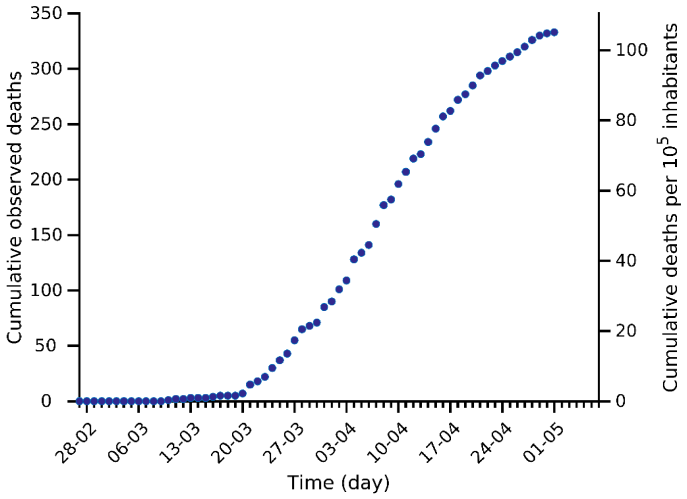


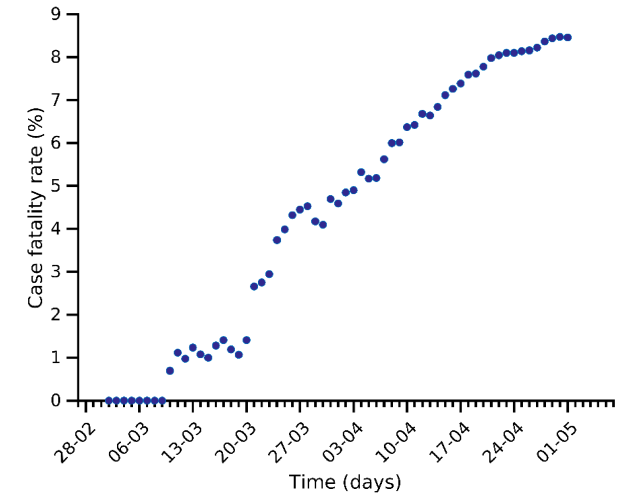




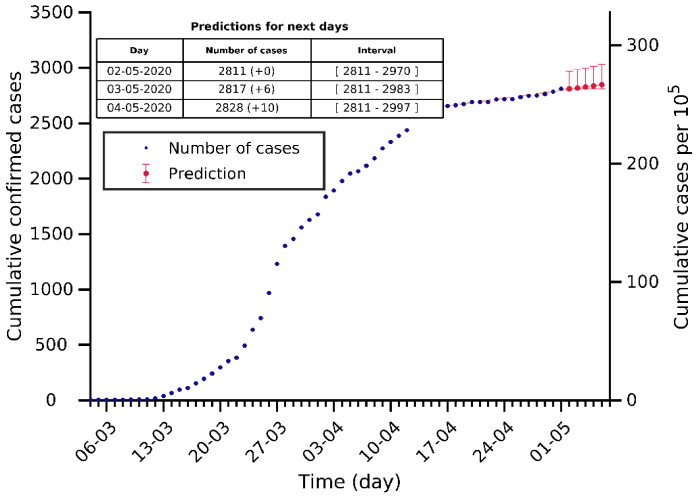


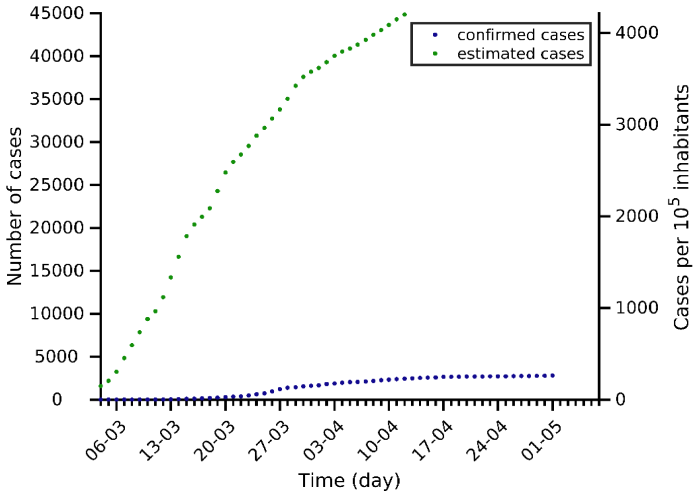


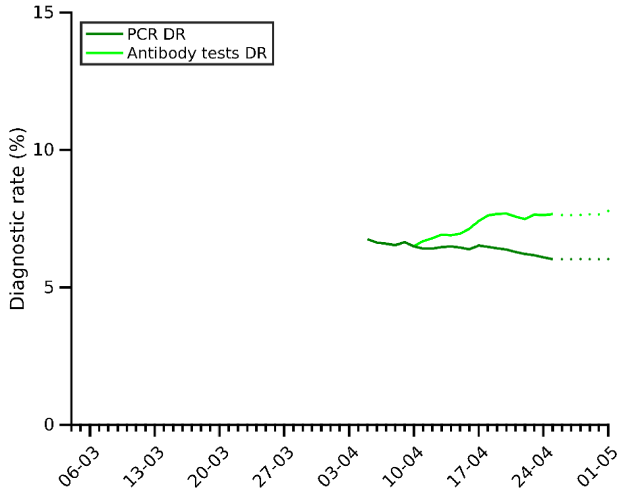


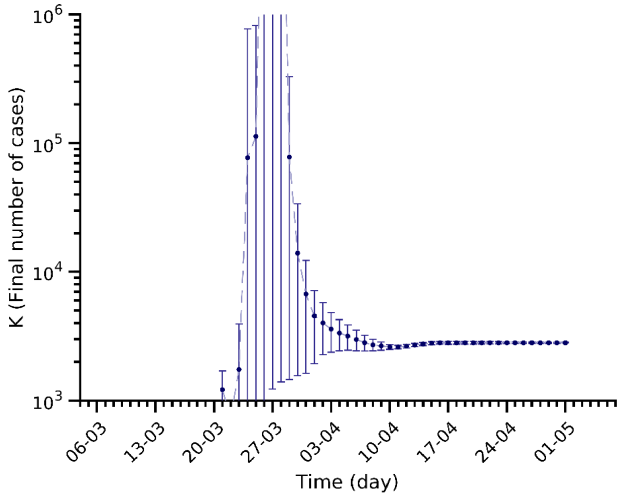


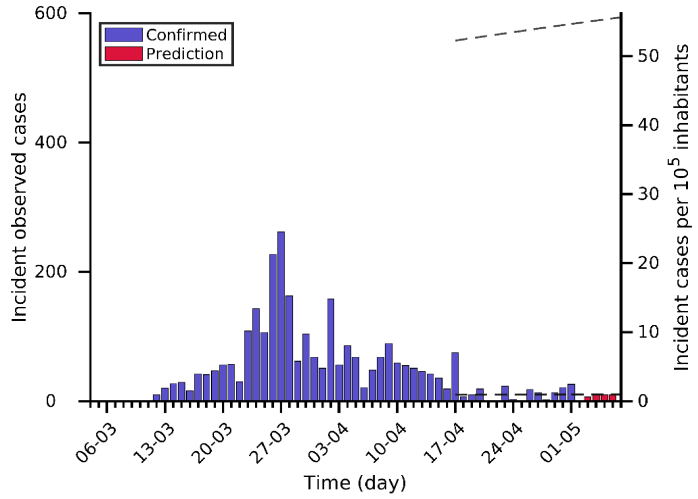
Extremadura 01-05-2020. Population: 1.1M. Current cumulated incidence: 263/10^5

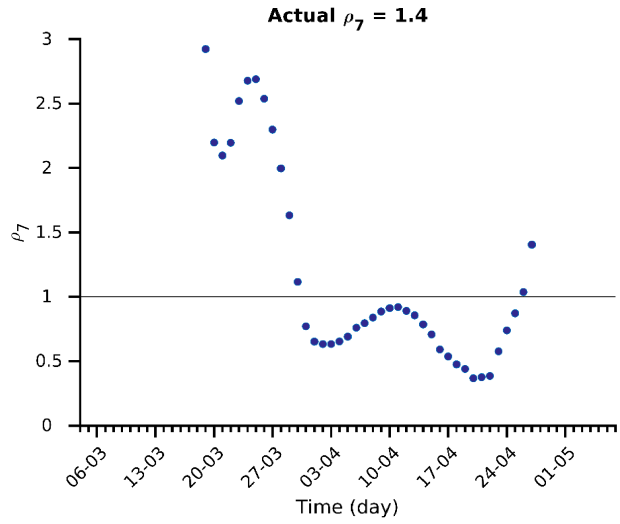


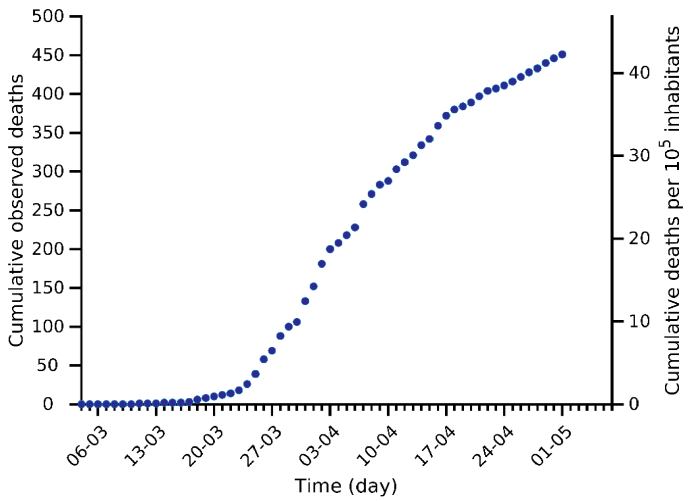


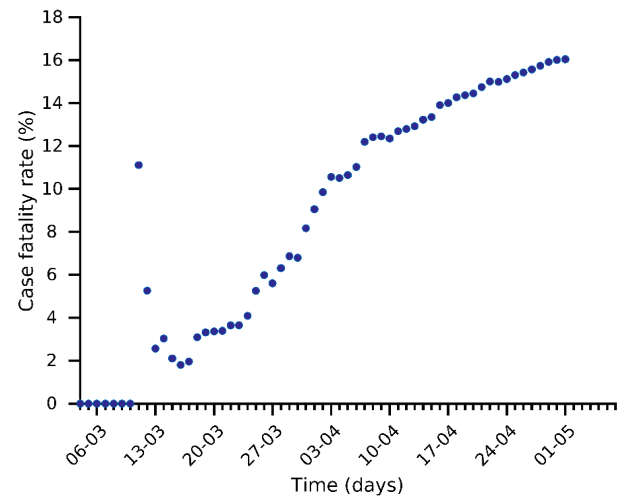




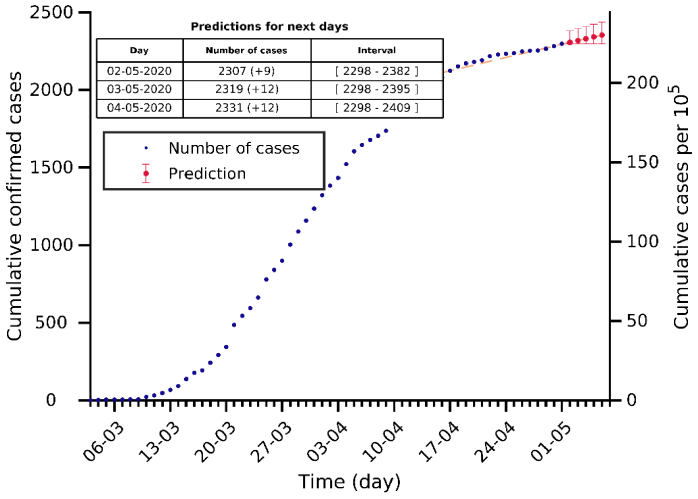


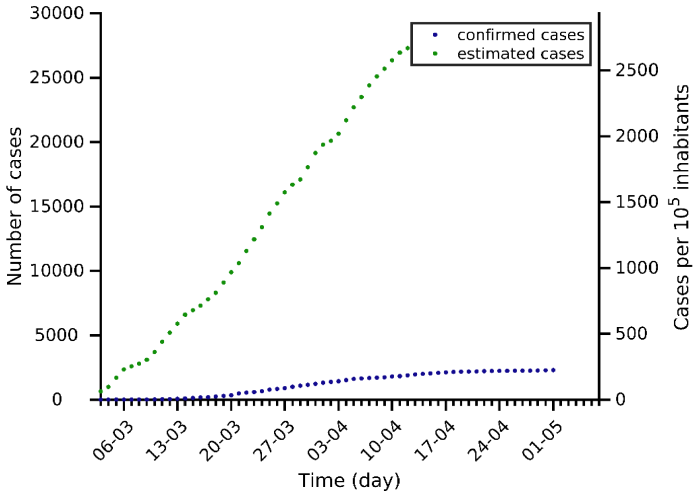


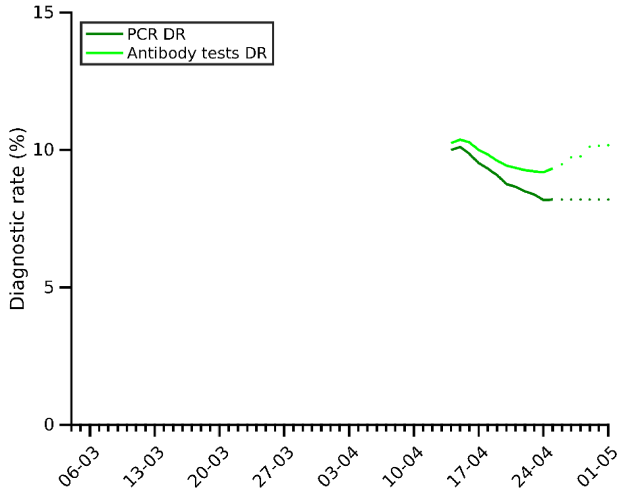


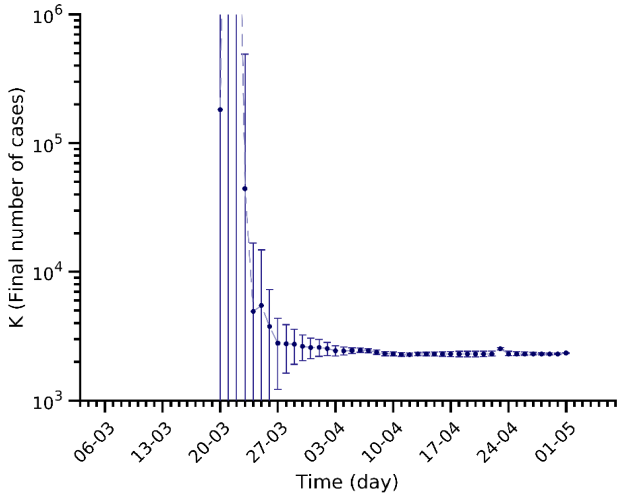


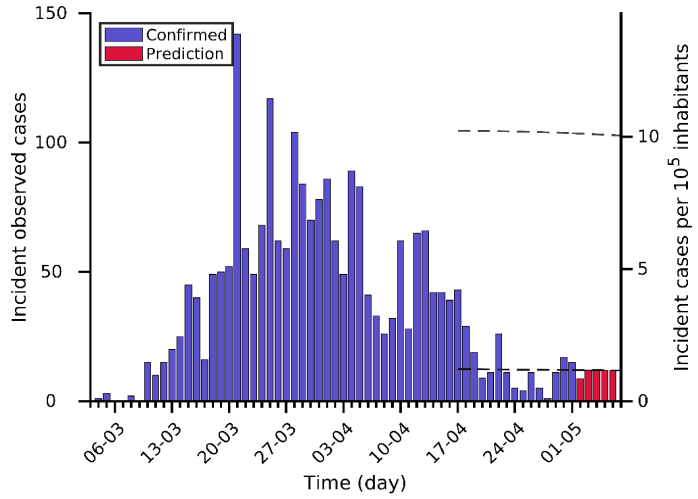
Asturias 01-05-2020. Population: 1.0M. Current cumulated incidence: 225/10⁵

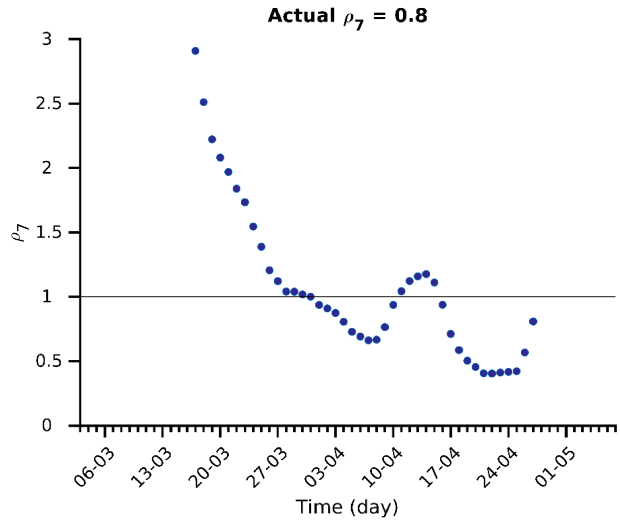


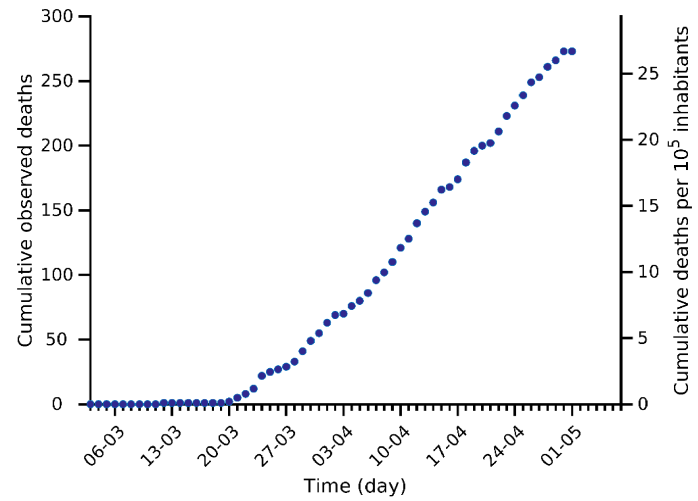


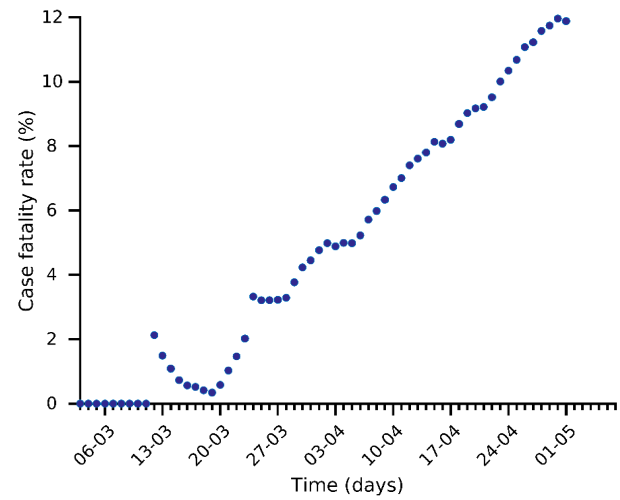




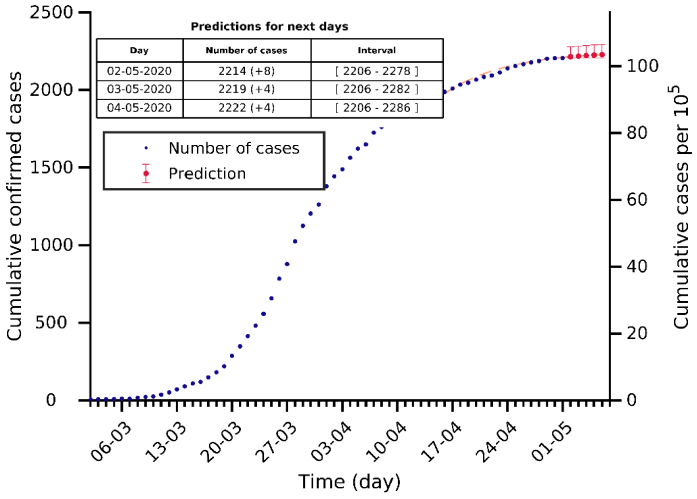


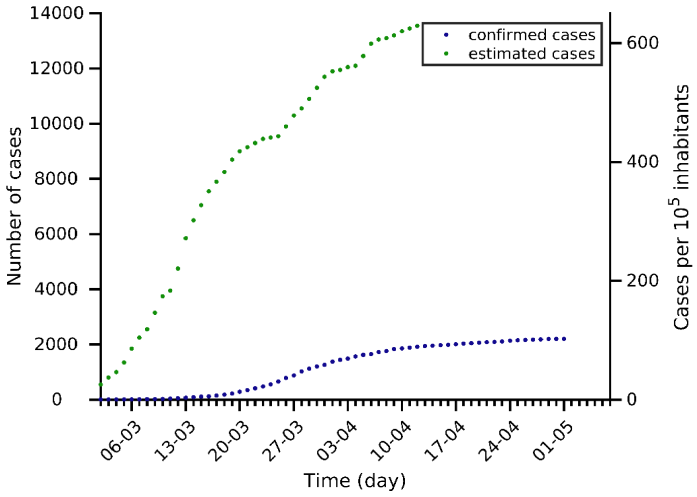


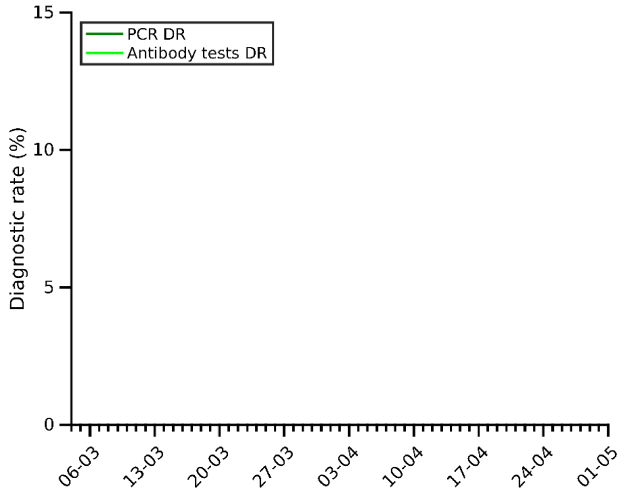


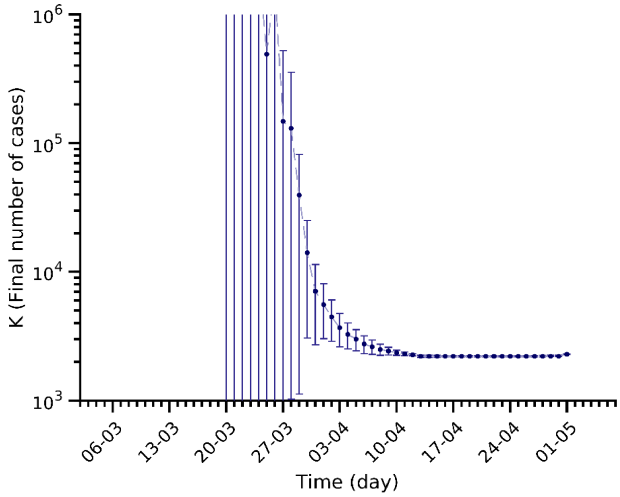


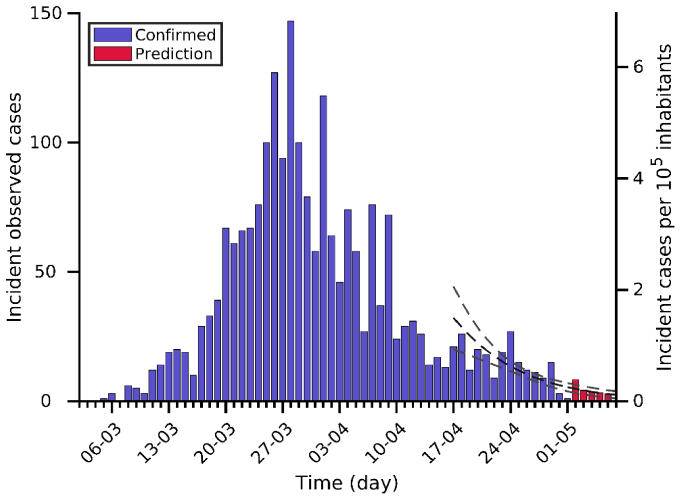
Canarias 01-05-2020. Population: 2.2M. Current cumulated incidence: 102/10^5

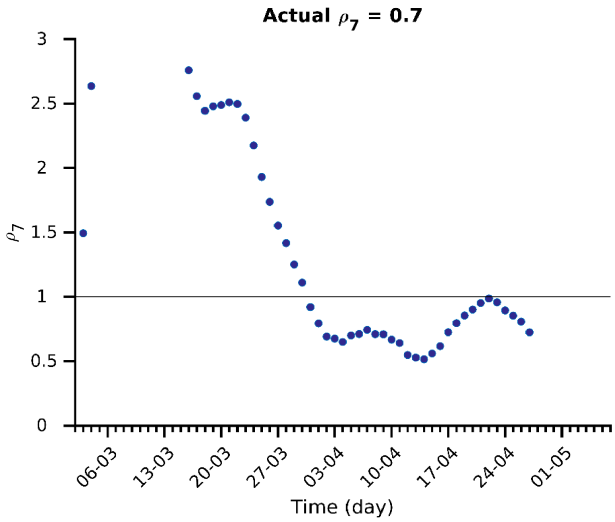


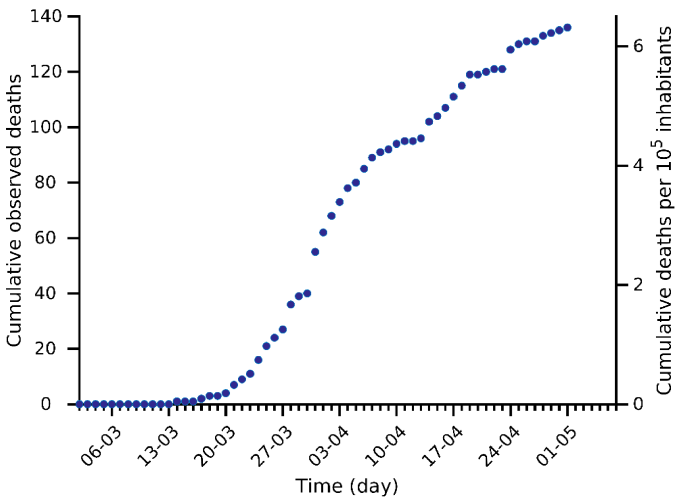


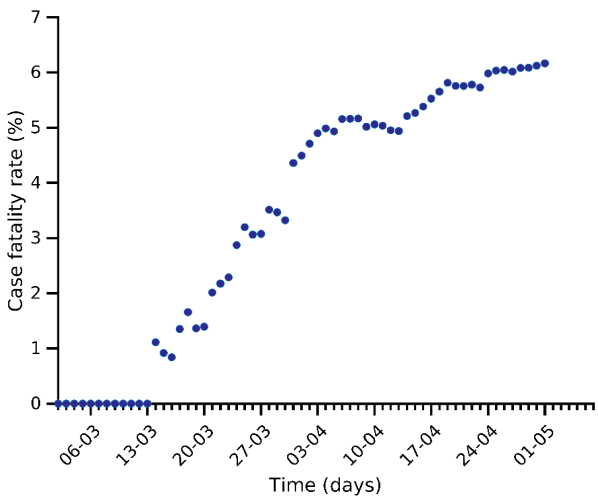




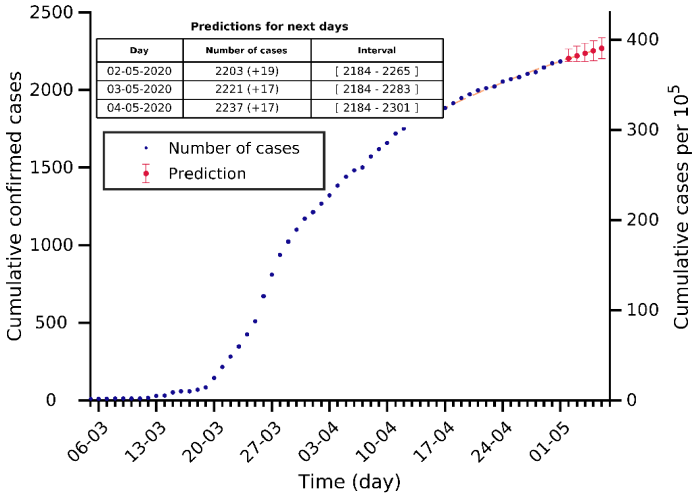


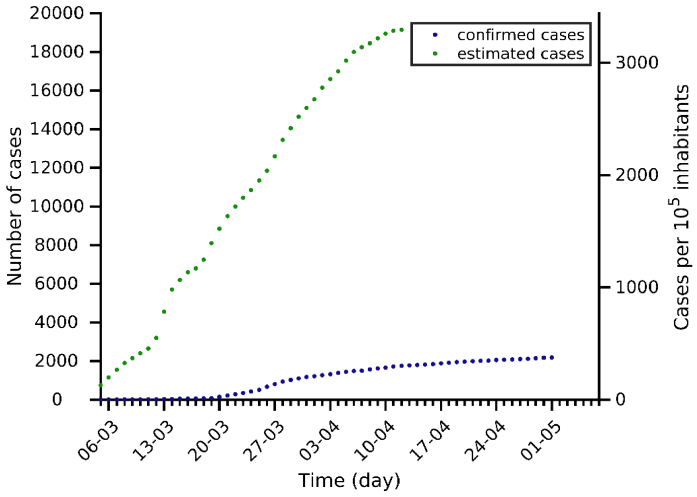


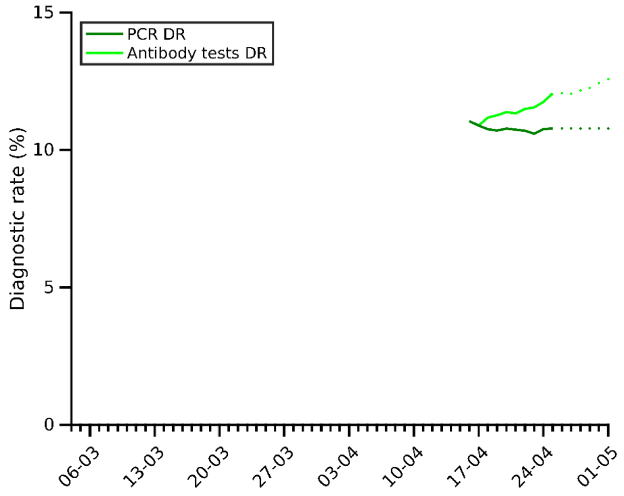


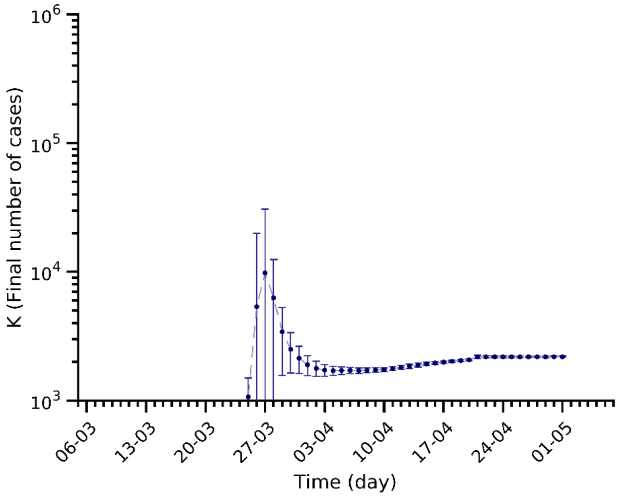


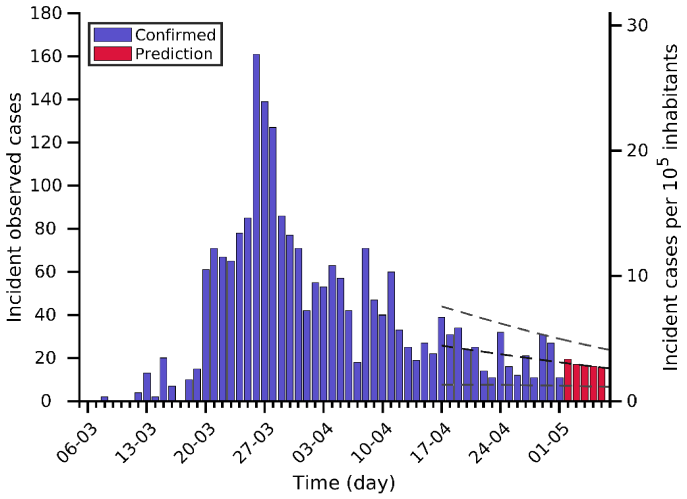
Cantabria 01-05-2020. Population: 0.6M. Current cumulated incidence: 376/10⁵

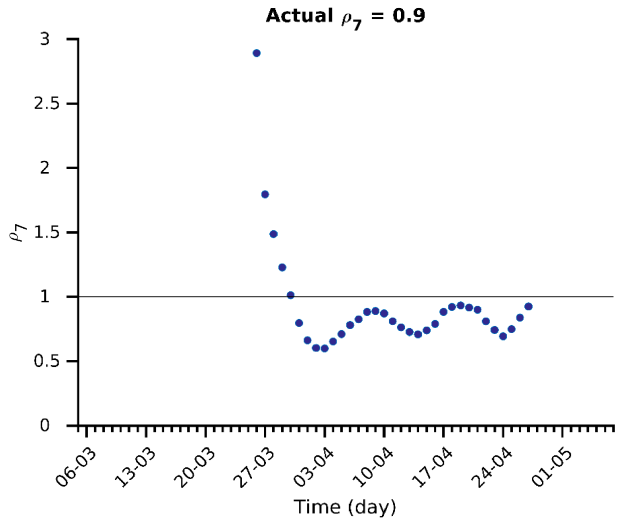


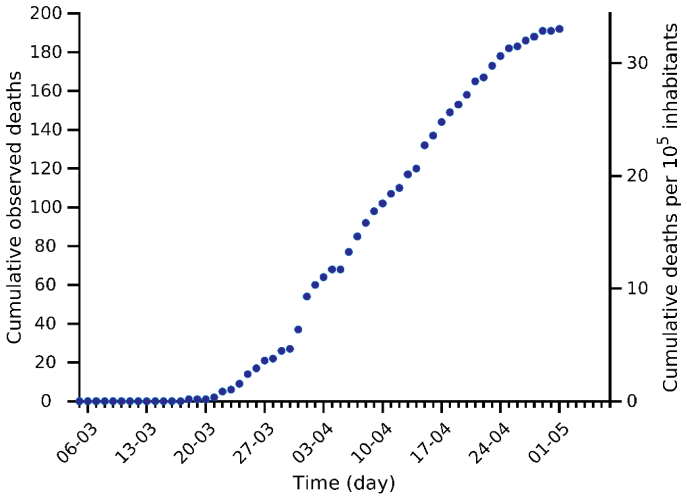


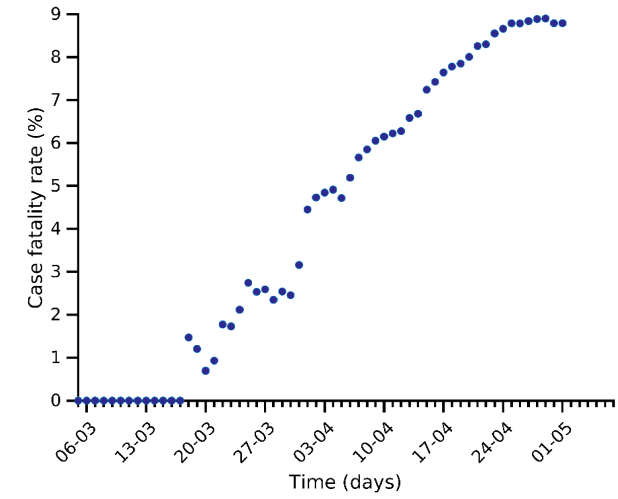




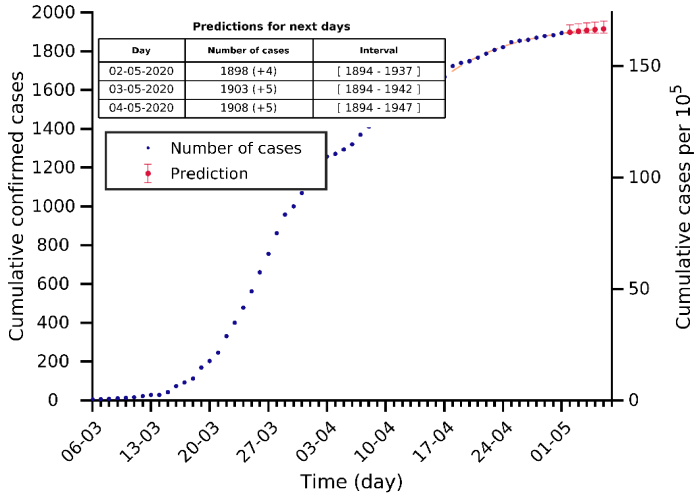


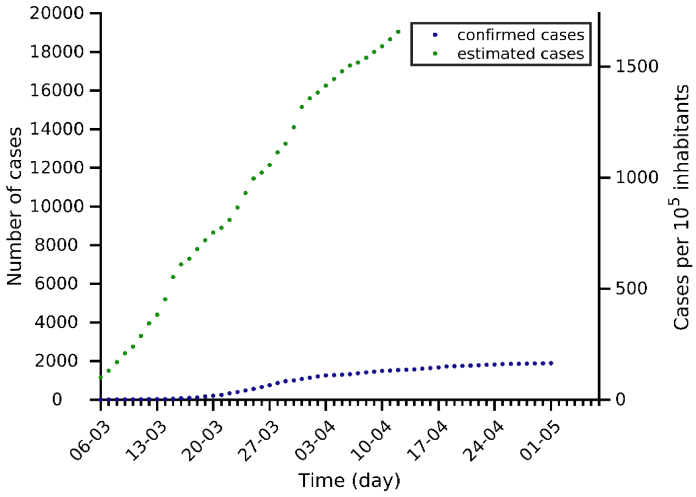


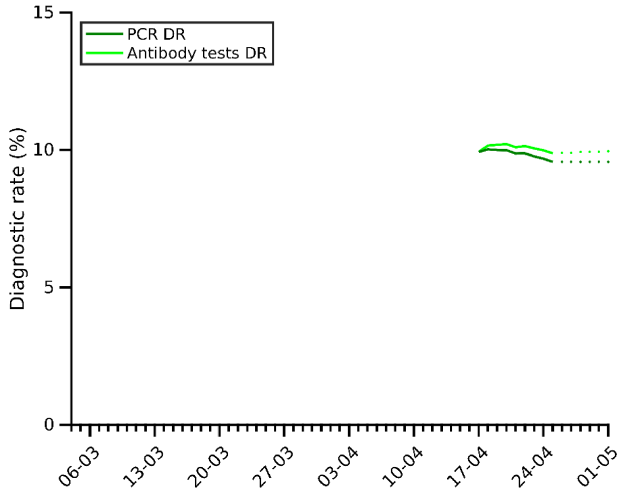


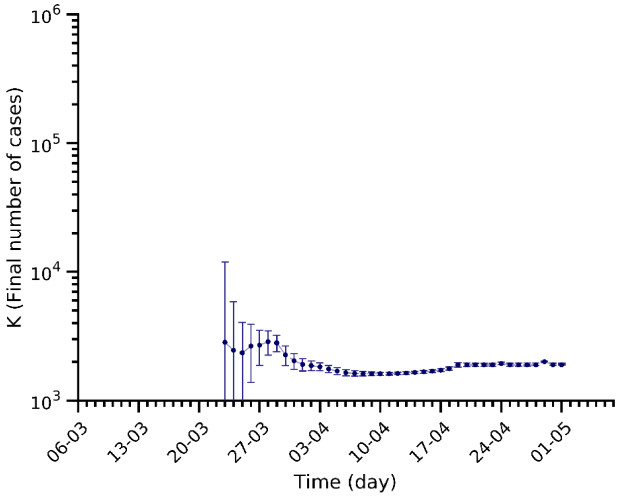


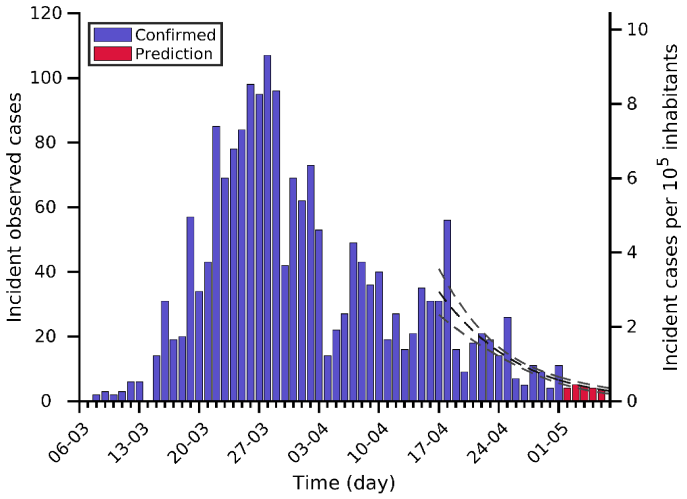
Baleares 01-05-2020. Population: 1.1M. Current cumulated incidence: 165/10^5

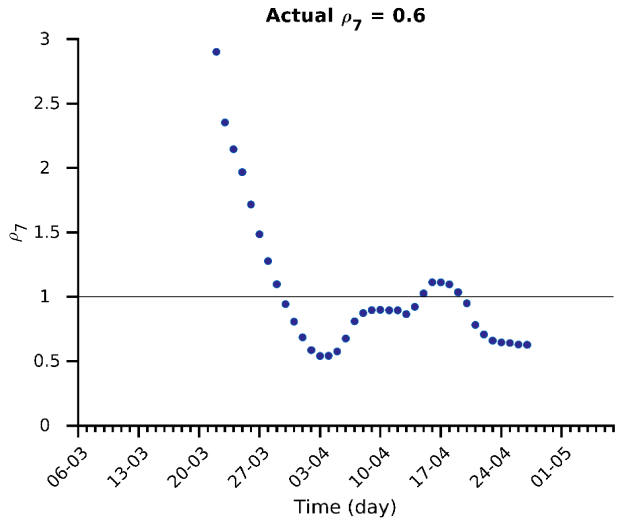


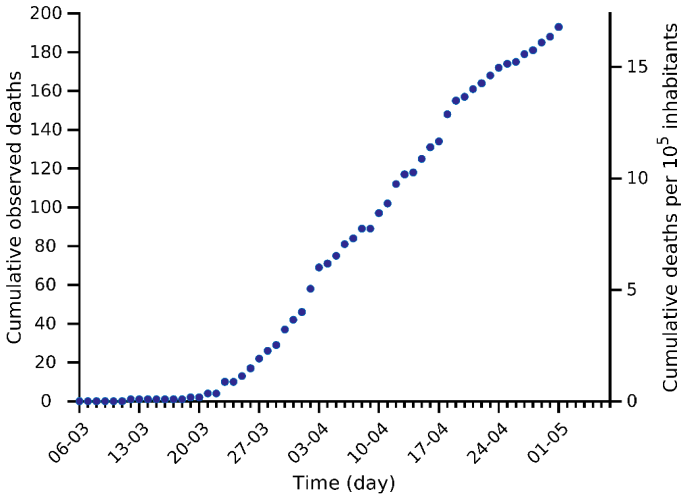


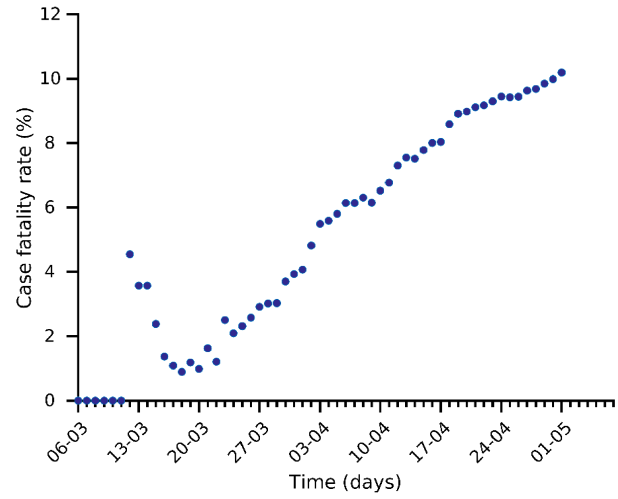




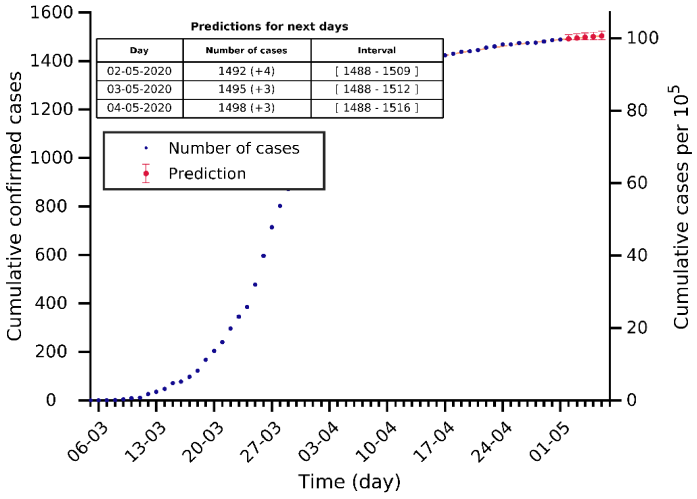


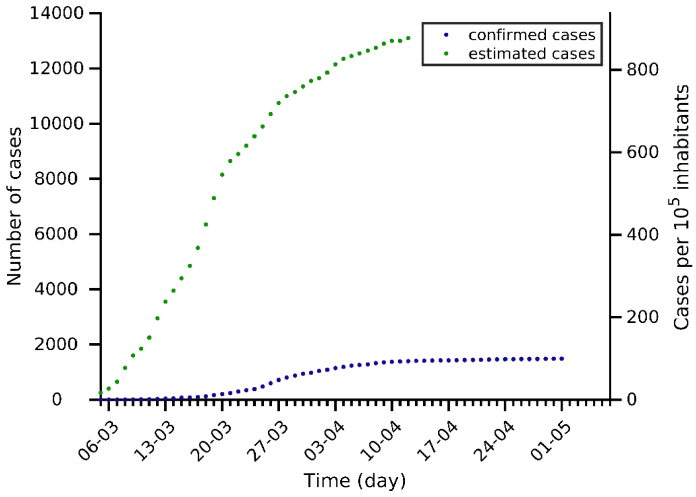


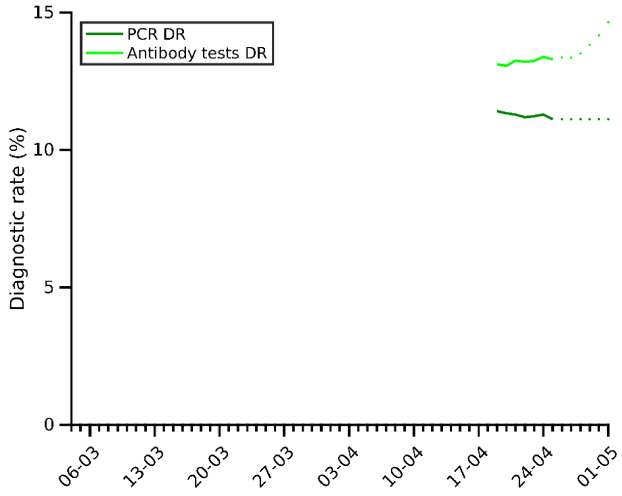


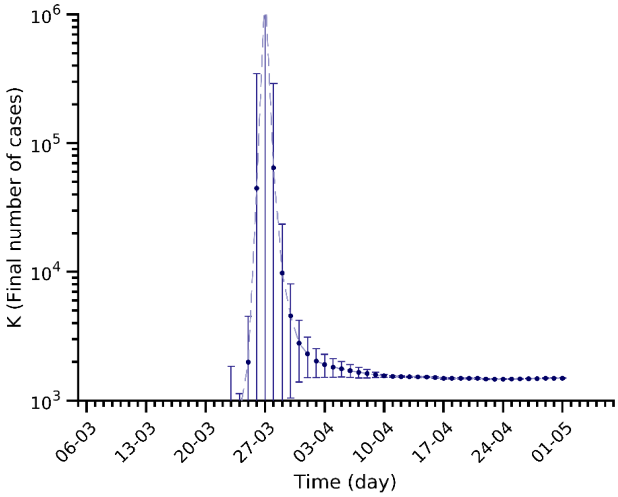


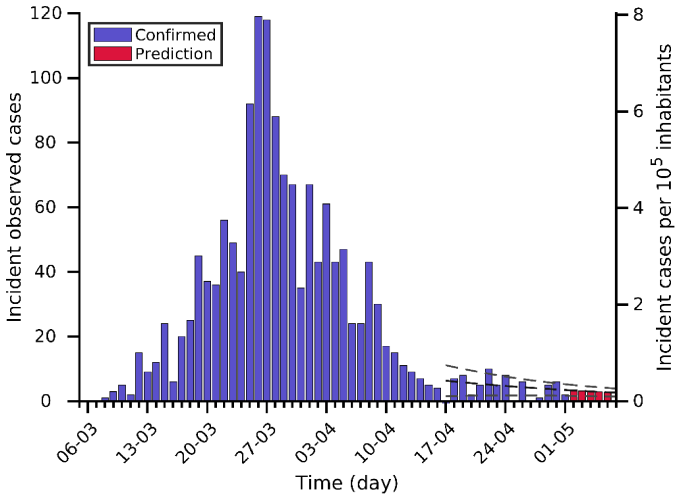
Murcia 01-05-2020. Population: 1.5M. Current cumulated incidence: 100/10^5

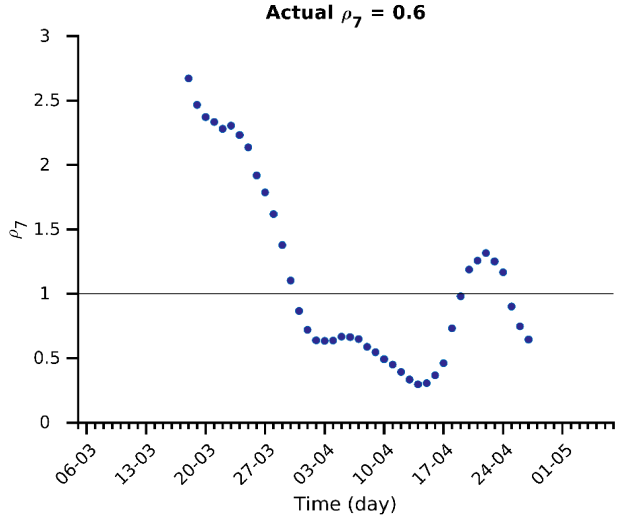


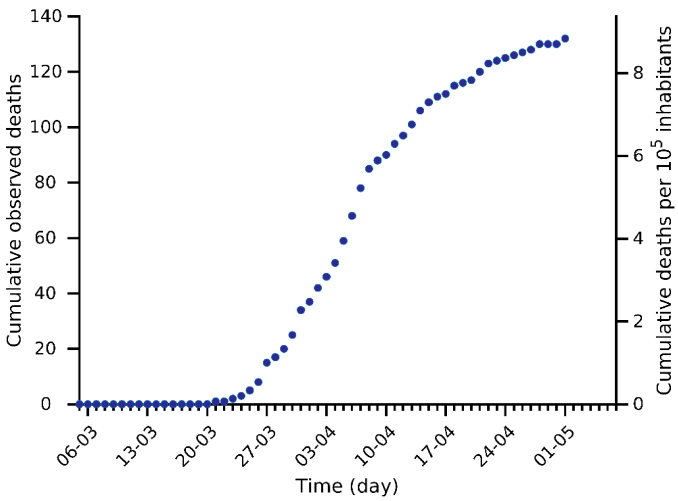


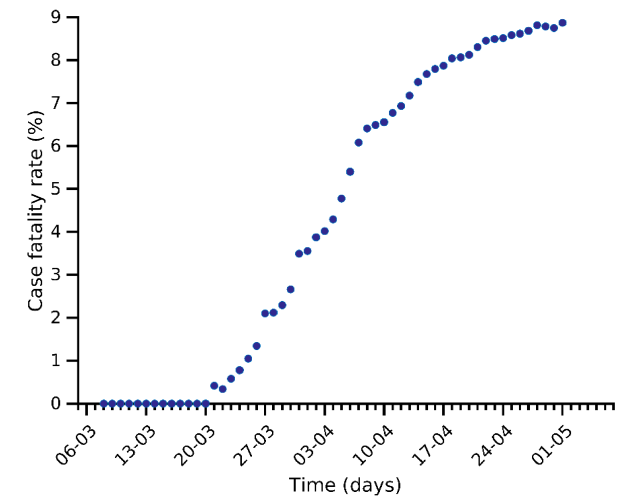








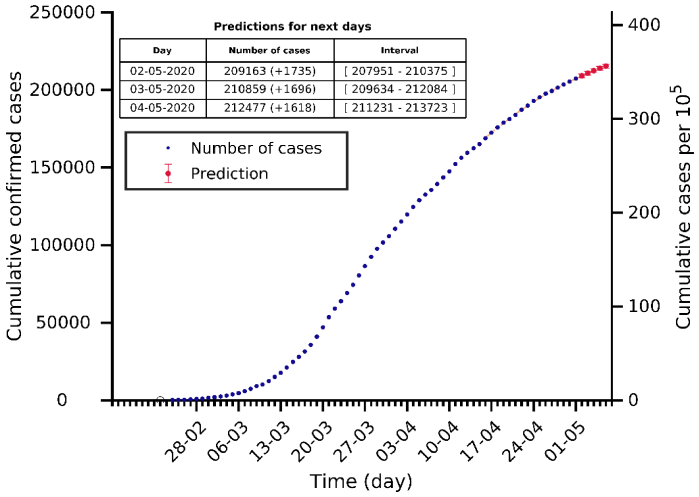


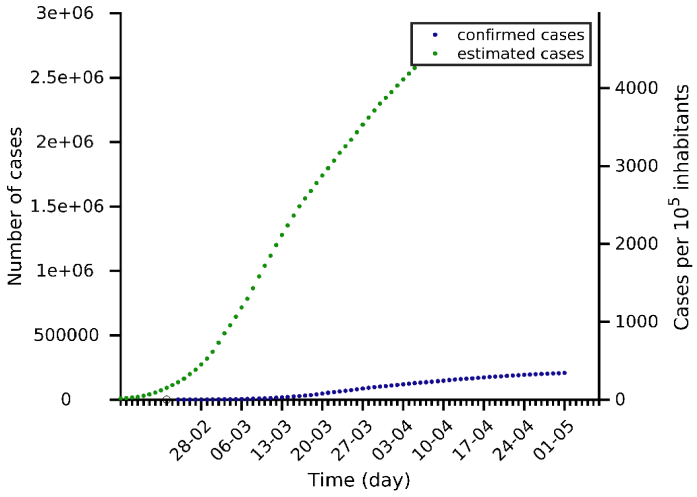


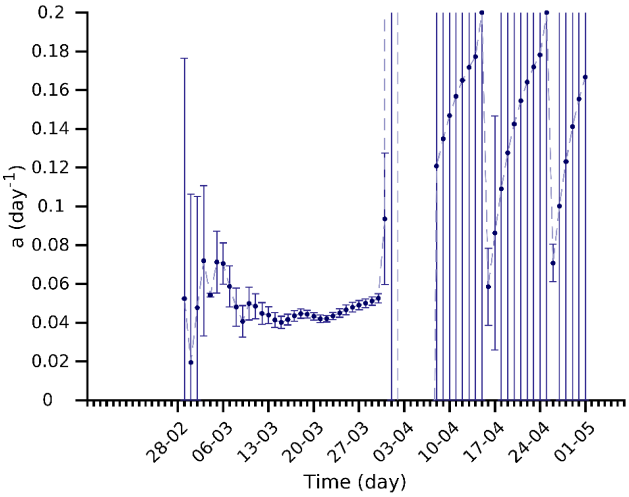
(4) Analysis and prediction of COVID-19 for Italy and its regions

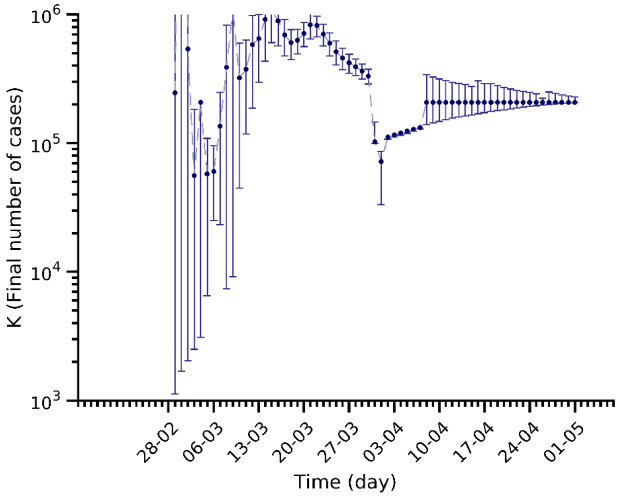
Data obtained from: https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale

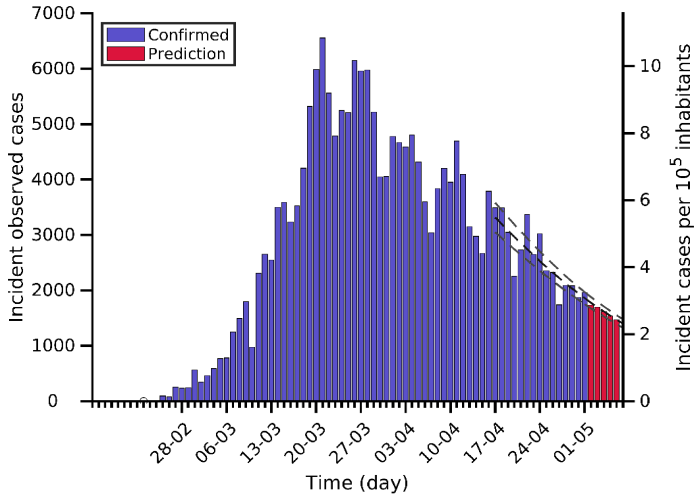
Italy 01-05-2020. Population: 60.5M. Current cumulated incidence: 343/10^5

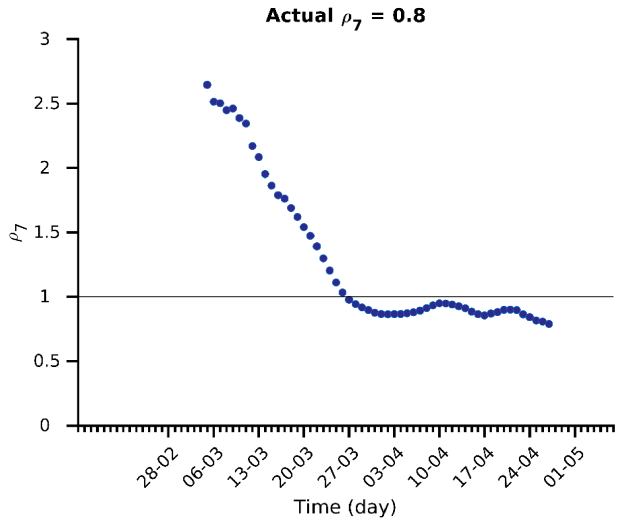


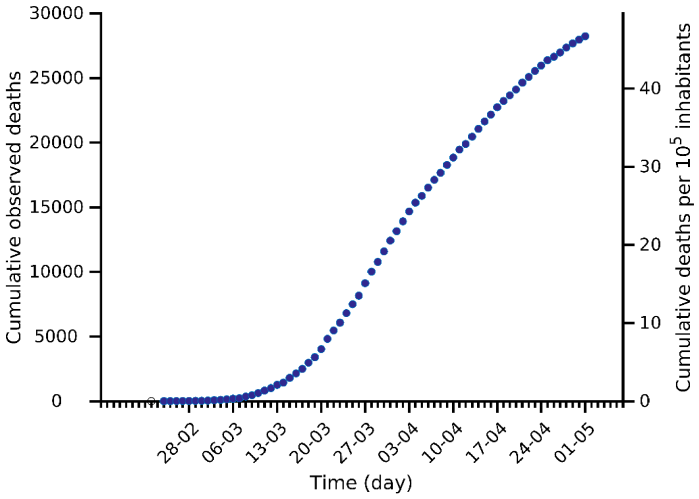


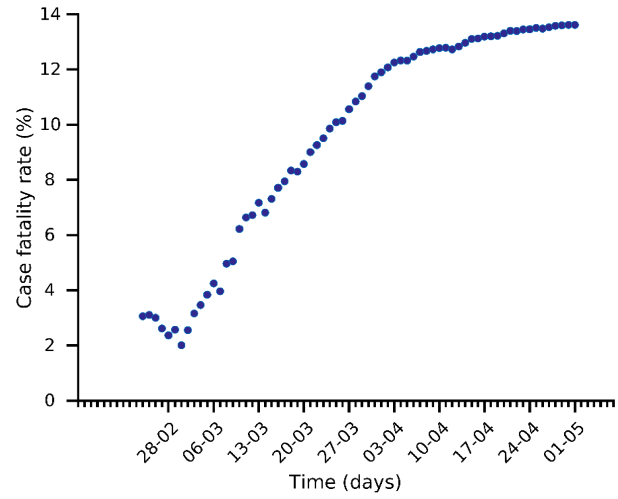




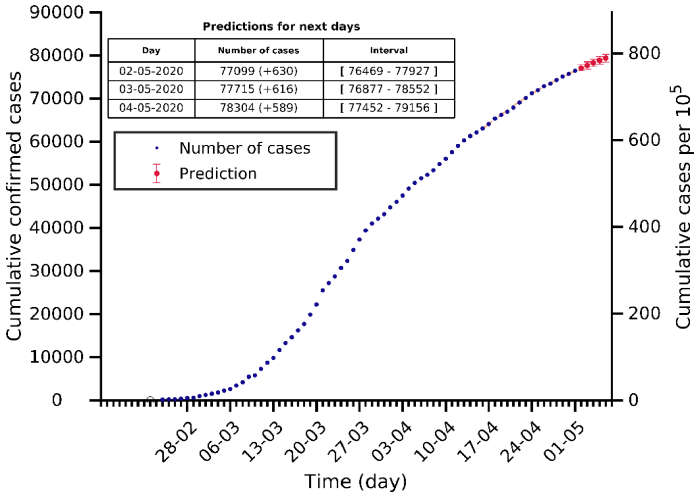


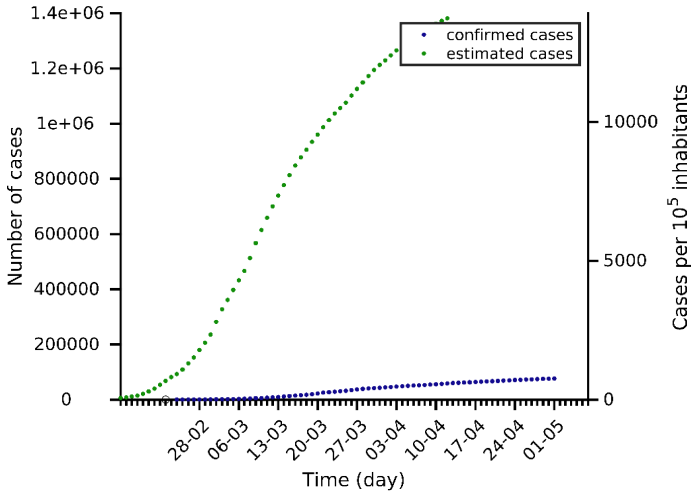


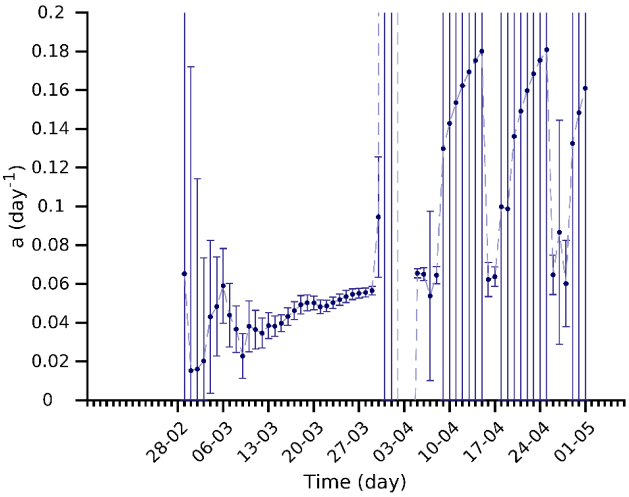


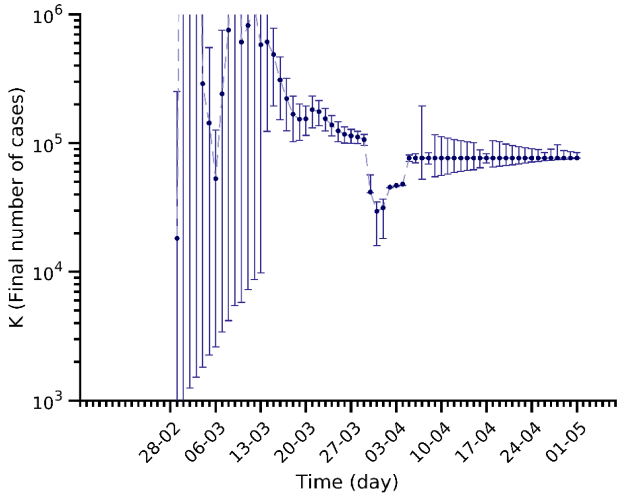


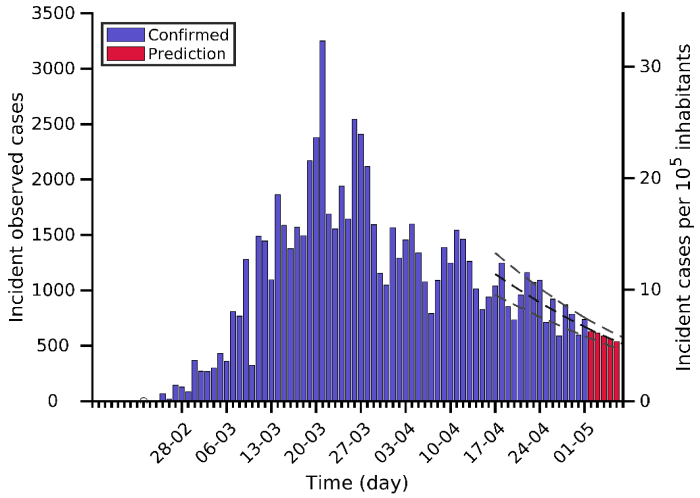
Lombardia 01-05-2020. Population: 10.1M. Current cumulated incidence: 760/10^5

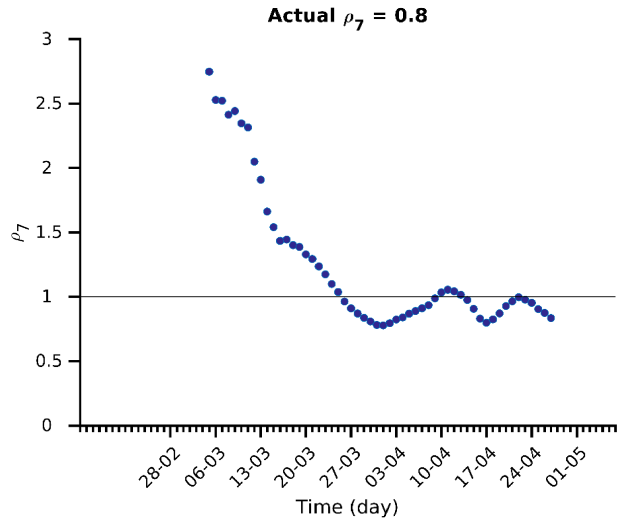


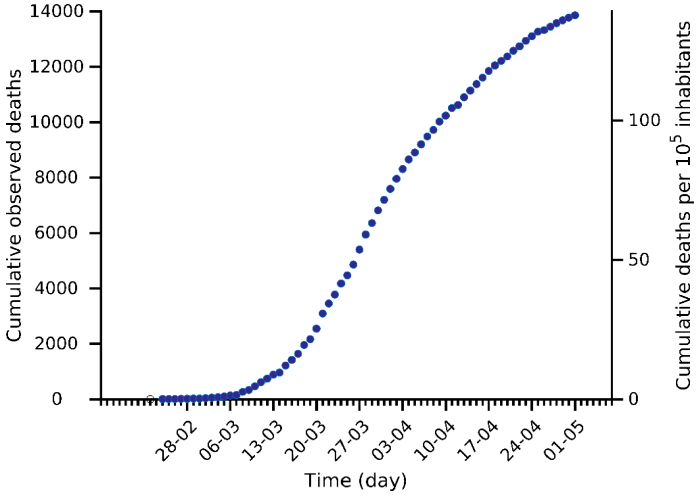


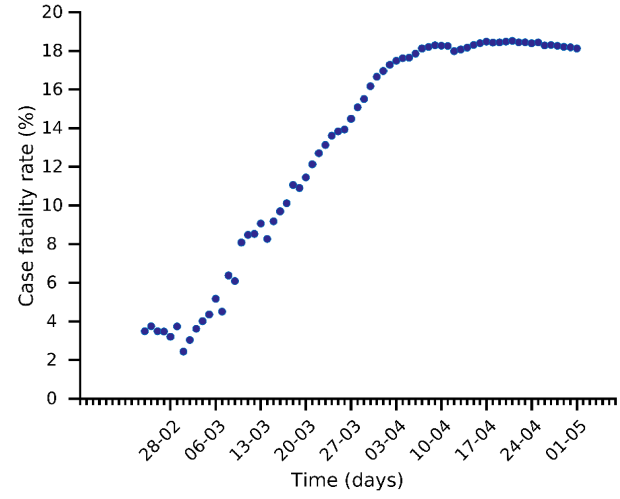




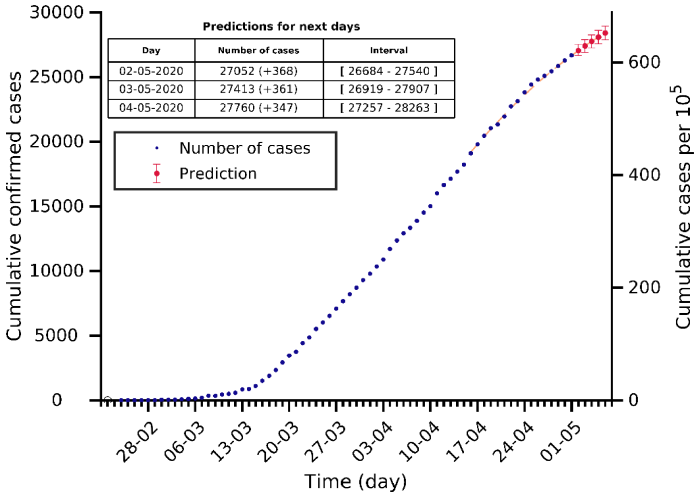


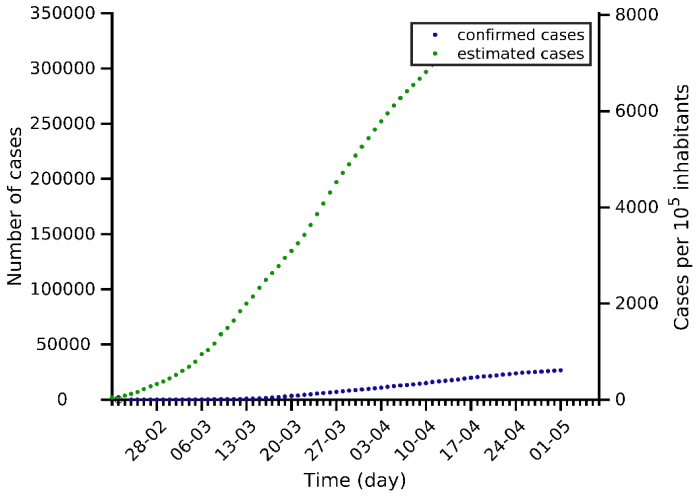


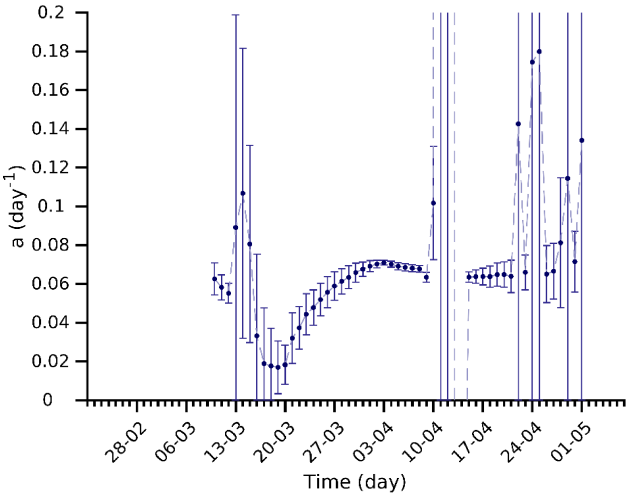


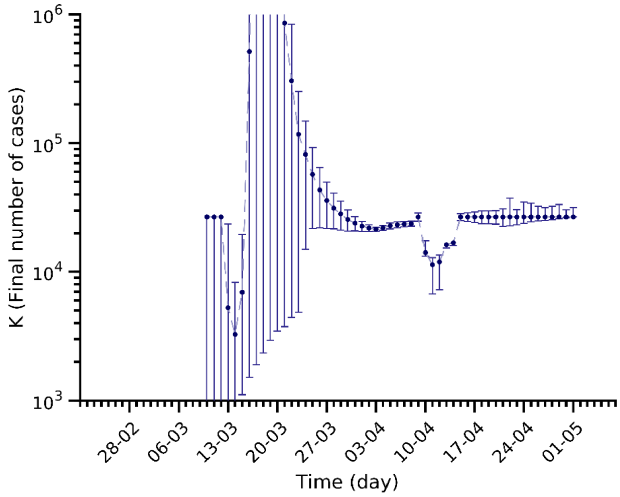


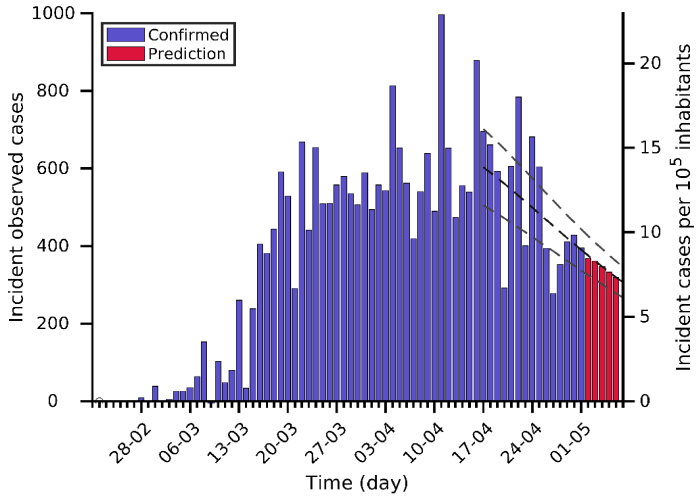
Piemonte 01-05-2020. Population: 4.4M. Current cumulated incidence: 613/10^5

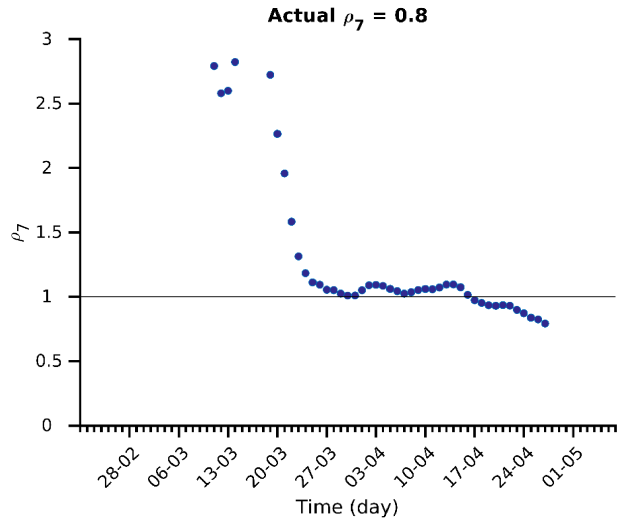


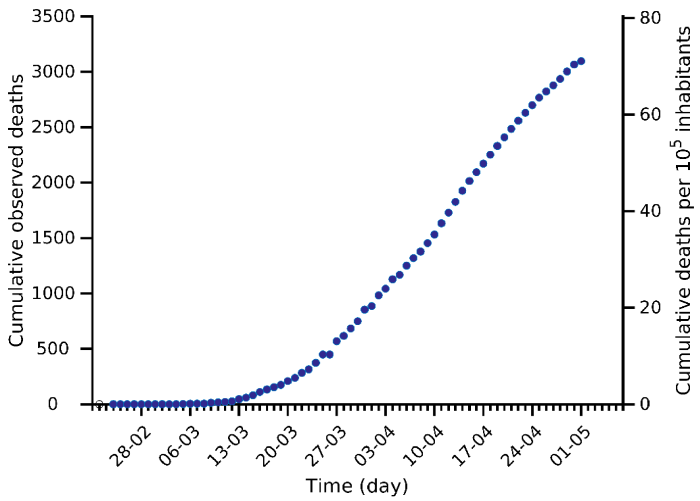


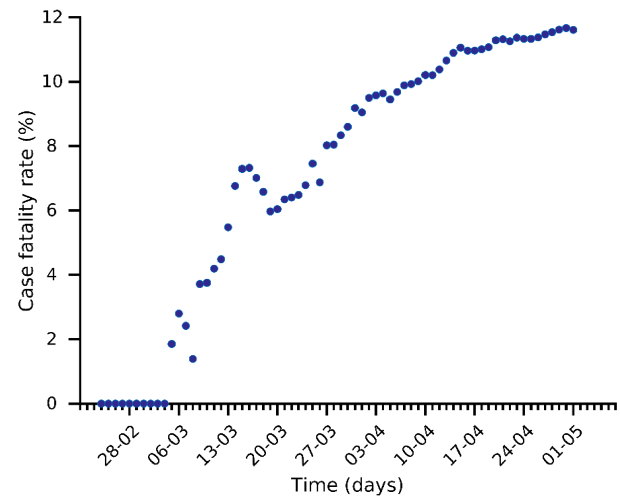




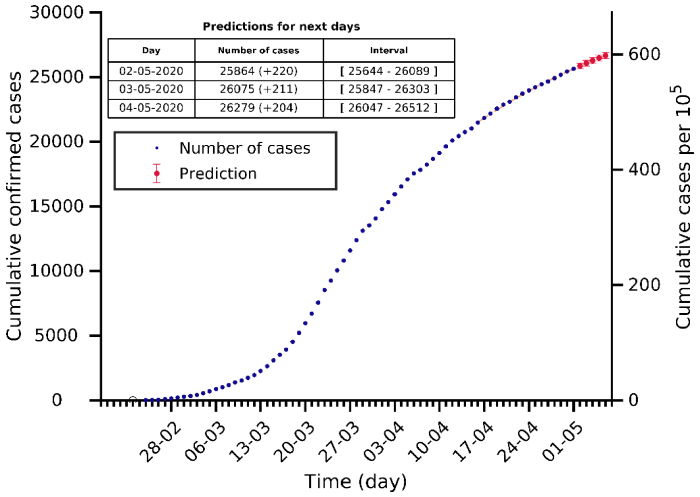


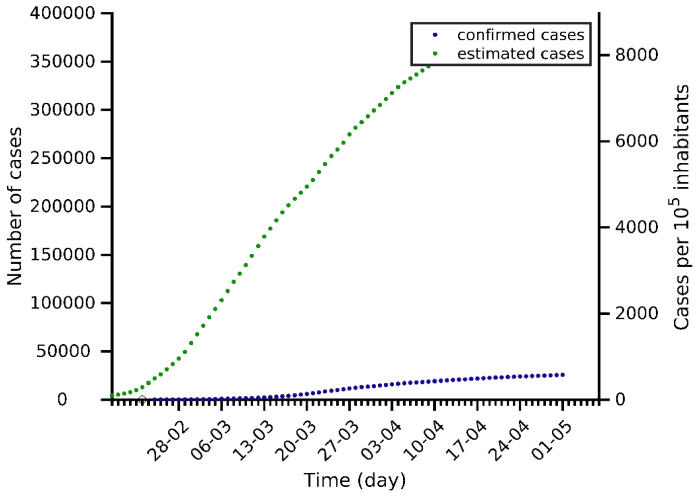


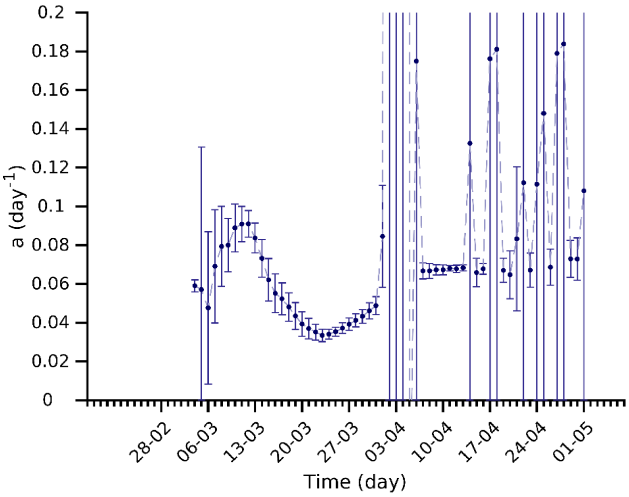


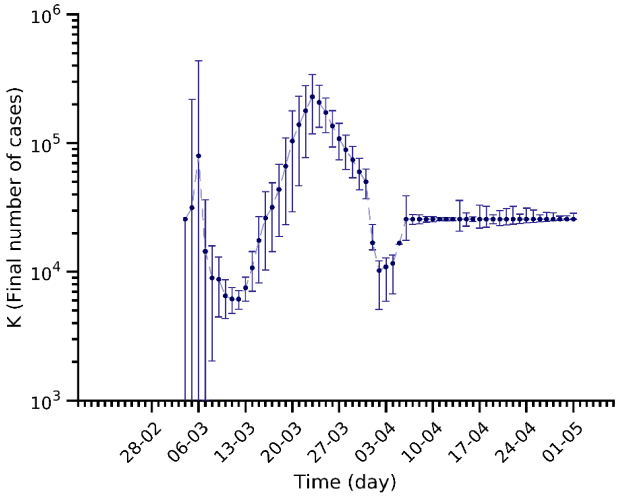


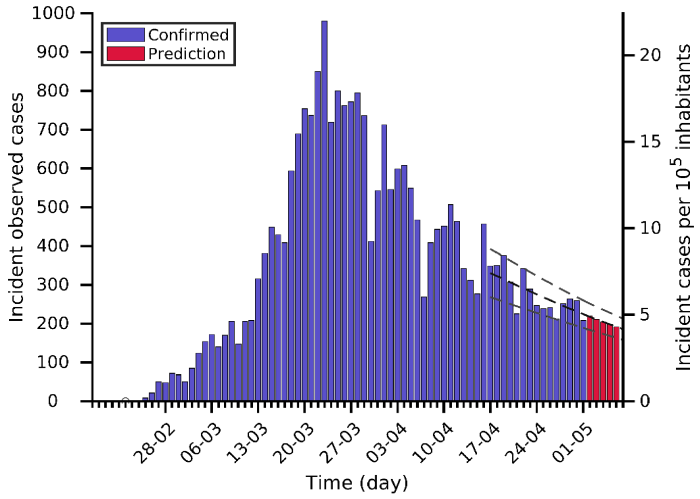
Emilia Romagna 01-05-2020. Population: 4.5M. Current cumulated incidence: 575/1

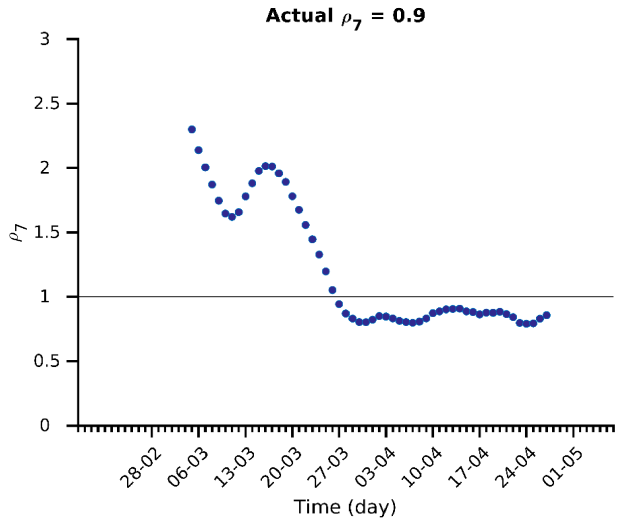


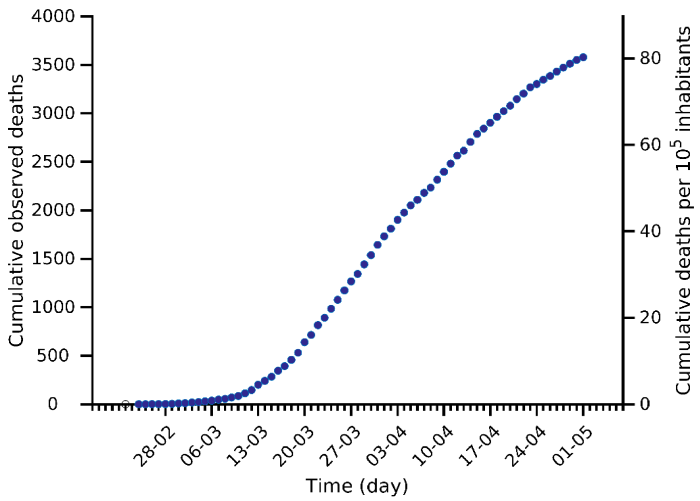


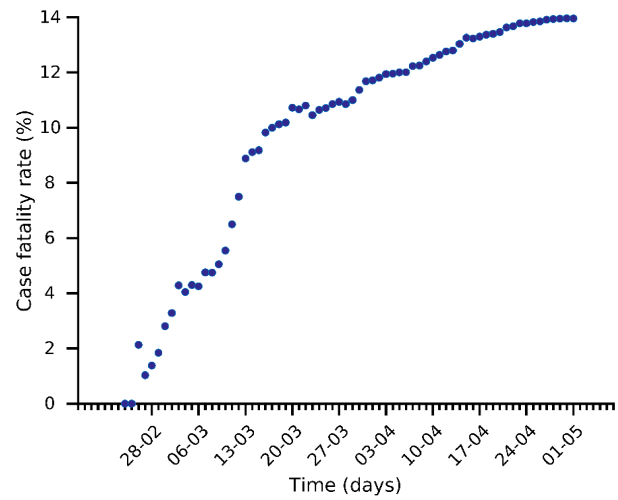




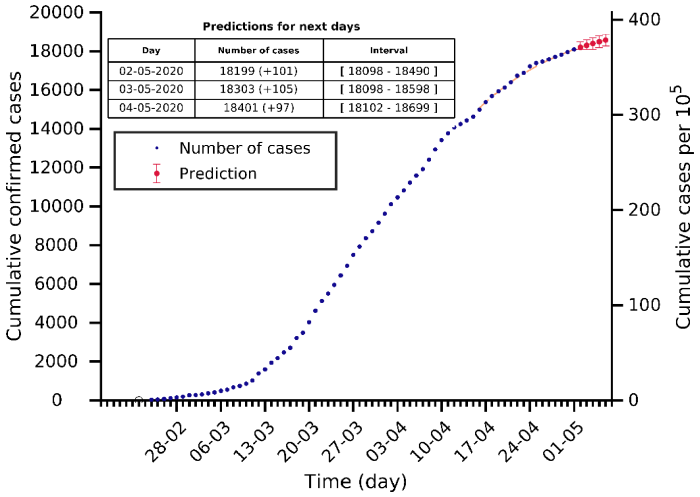


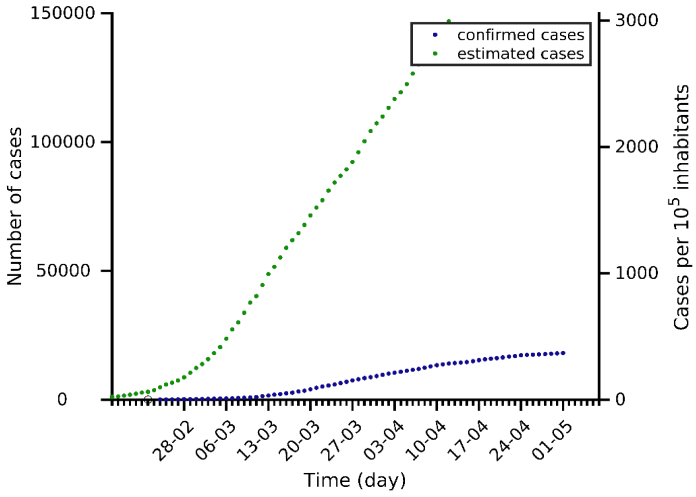


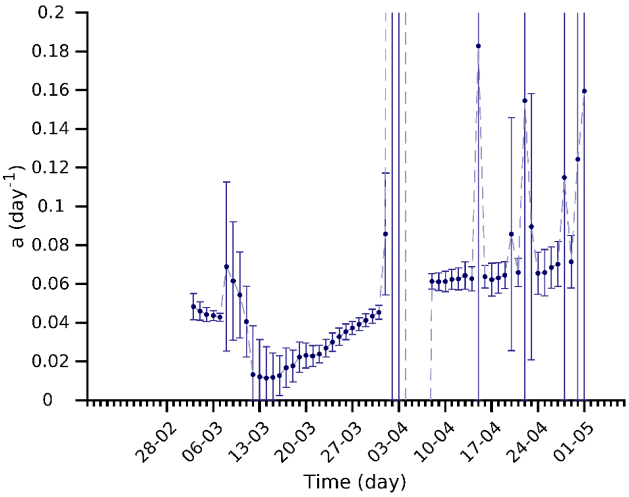


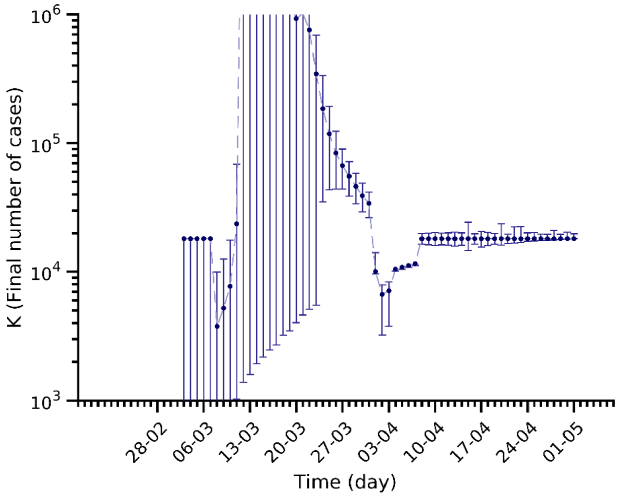


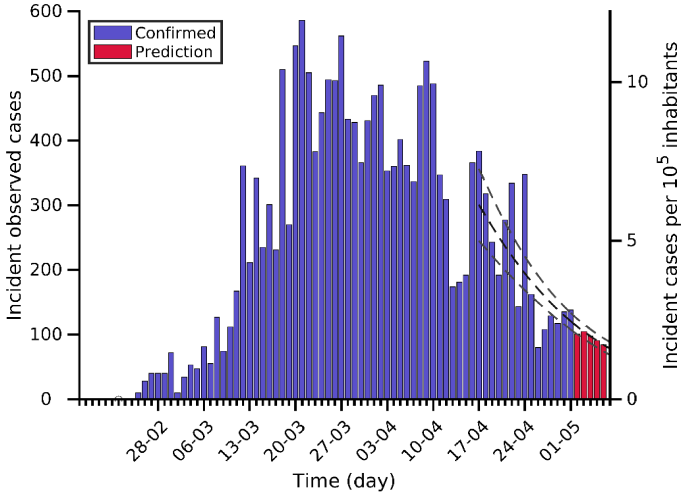
Veneto 01-05-2020. Population: 4.9M. Current cumulated incidence: 369/10^5

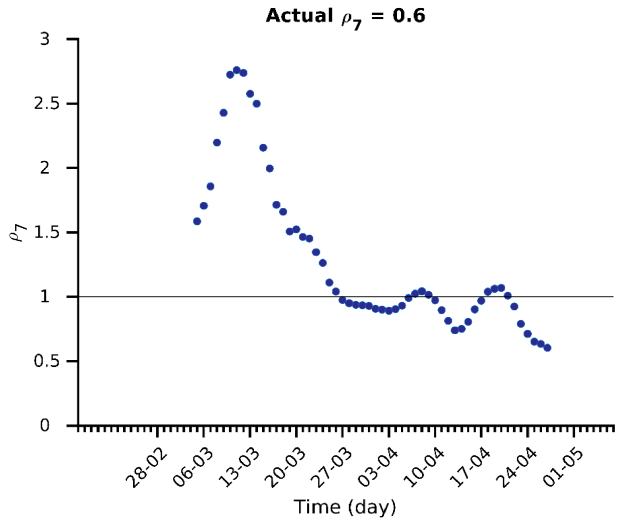


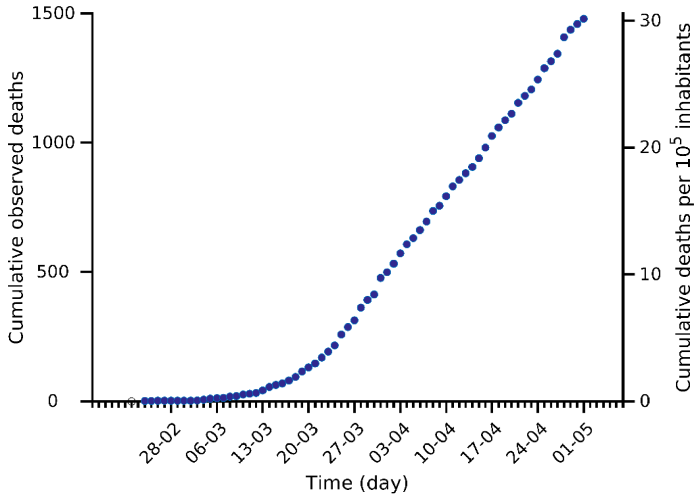


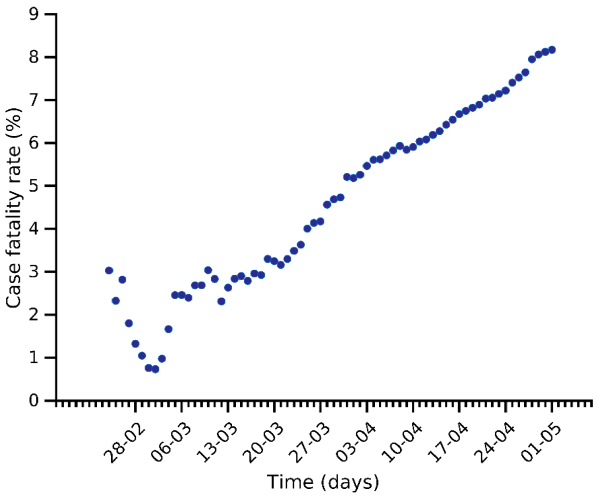




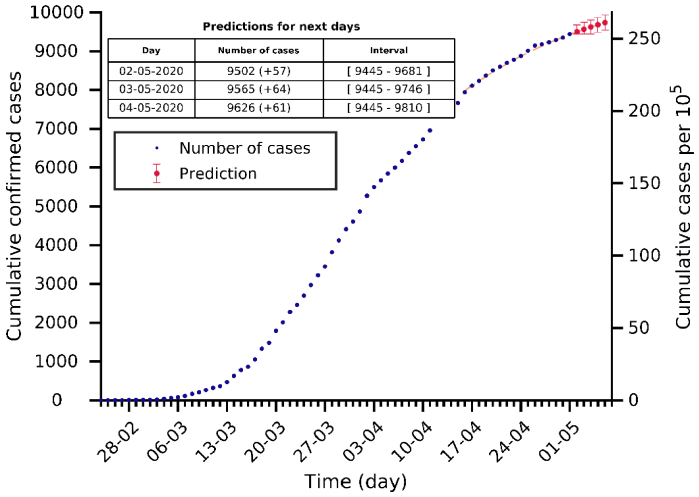


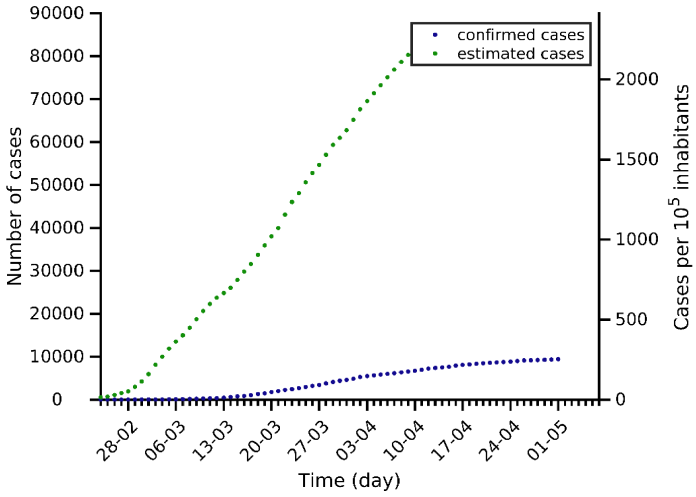


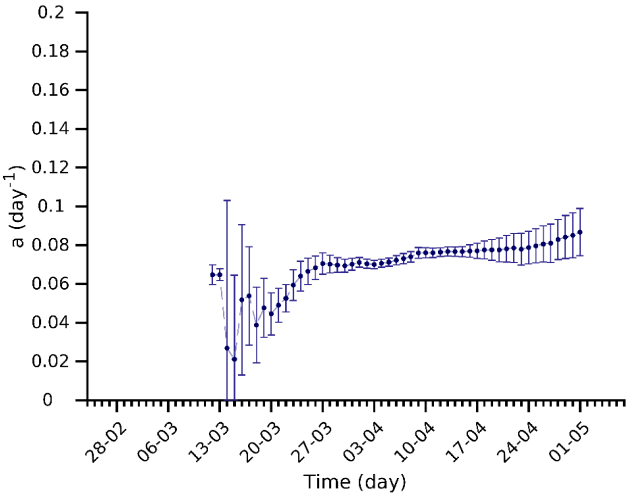


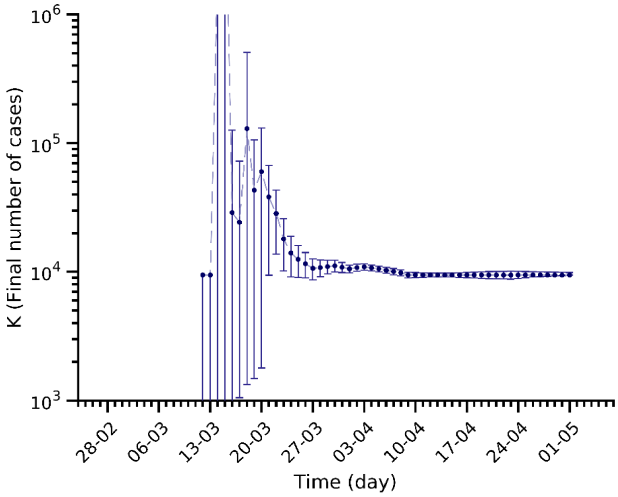


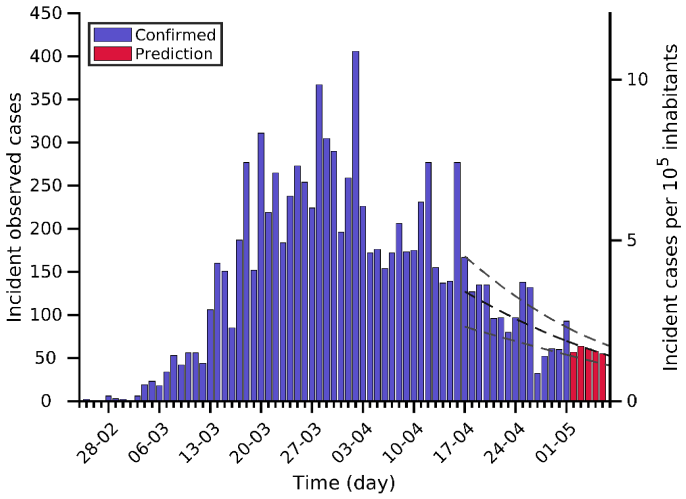
Toscana 01-05-2020. Population: 3.7M. Current cumulated incidence: 253/10⁵

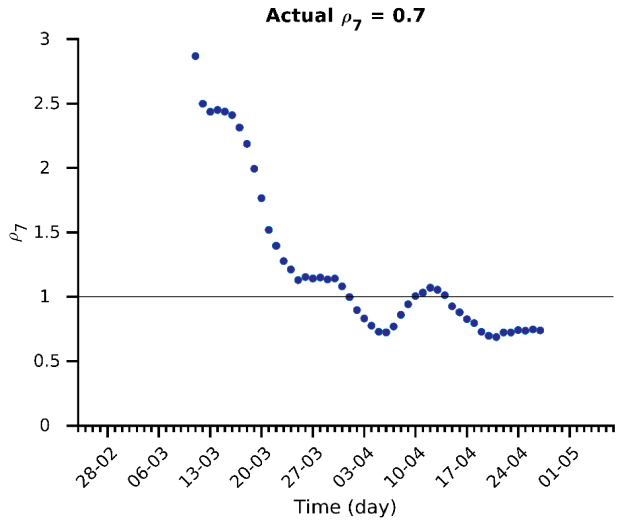


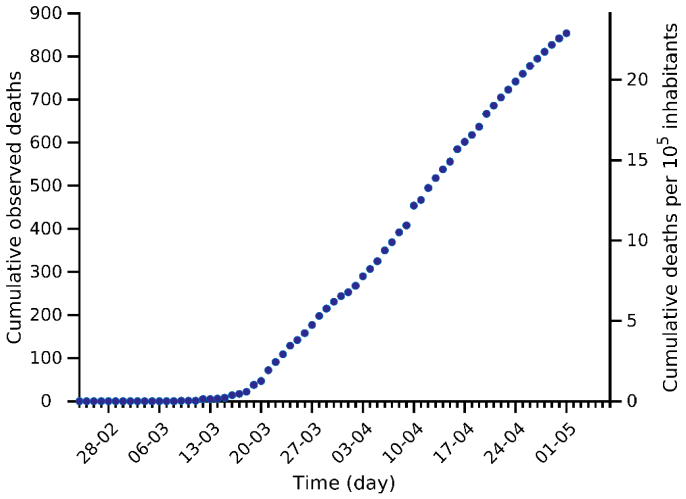


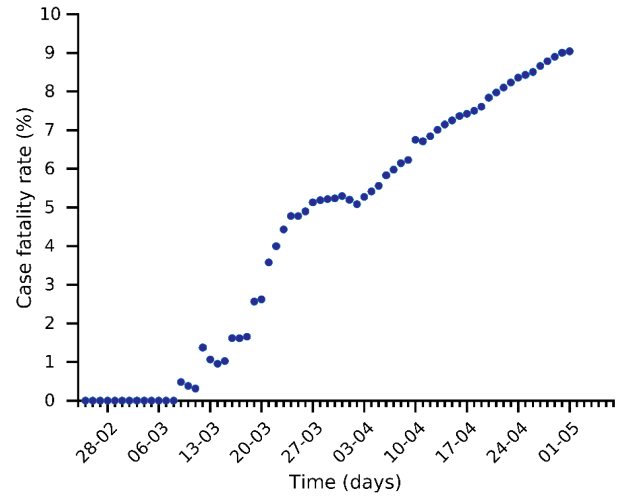




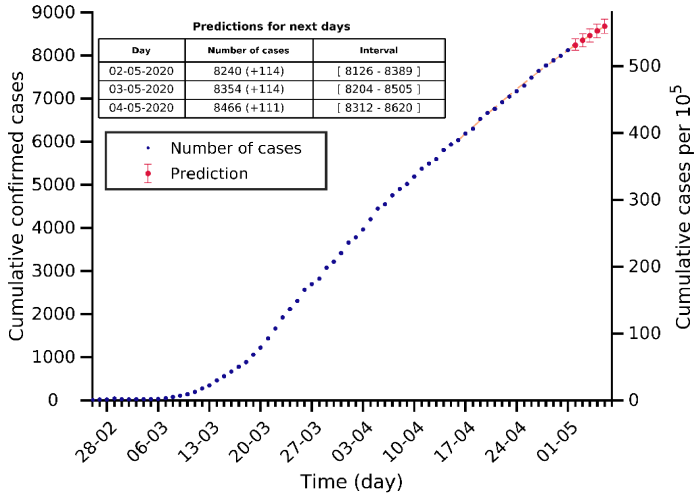


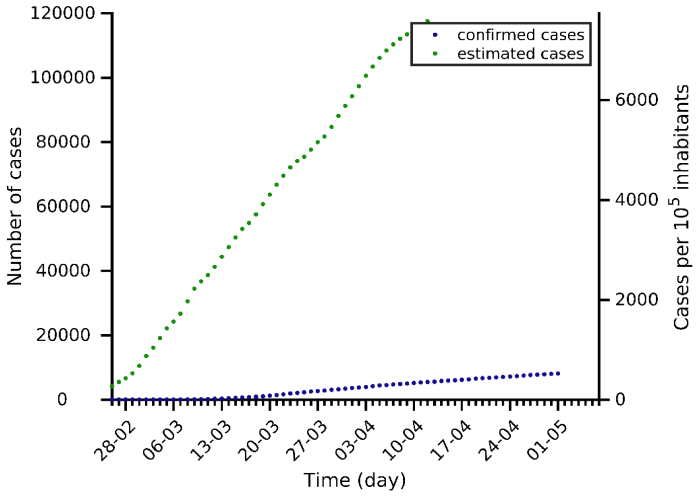


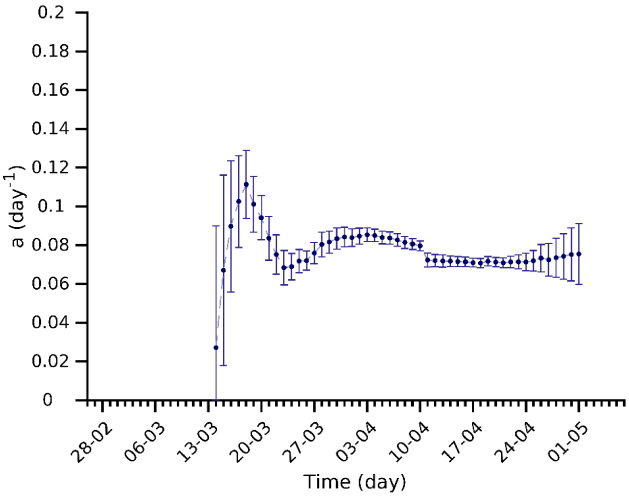


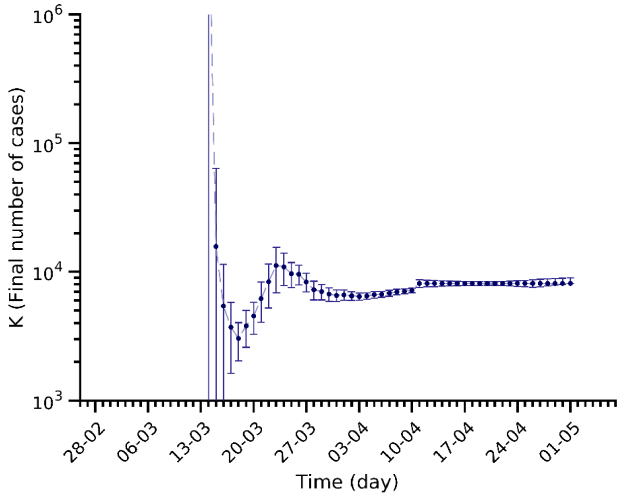


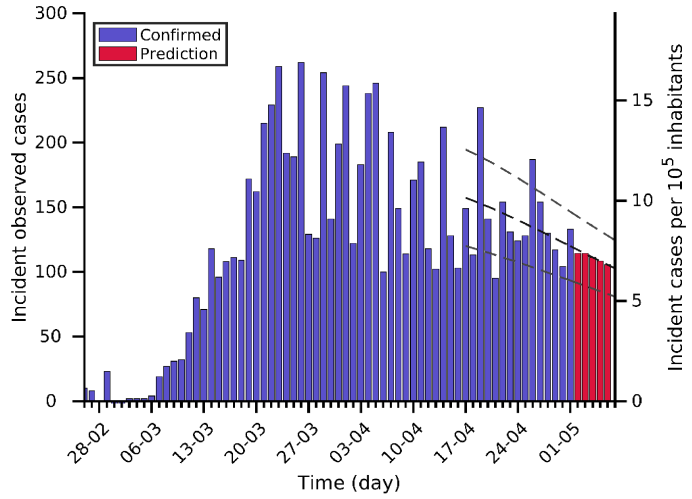
Liguria 01-05-2020. Population: 1.6M. Current cumulated incidence: $524/10^5$

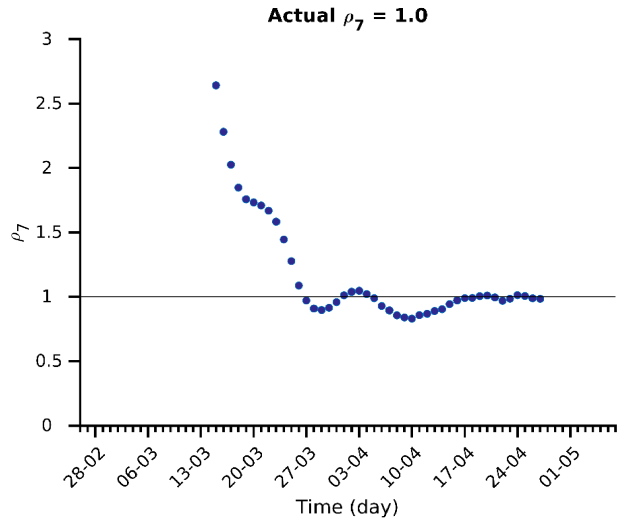


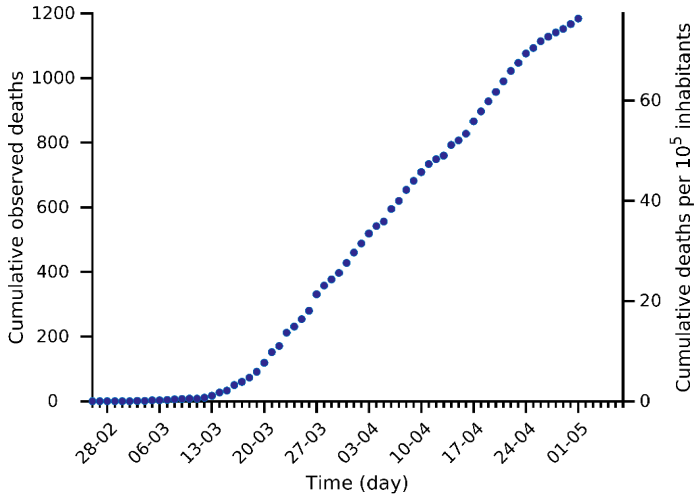


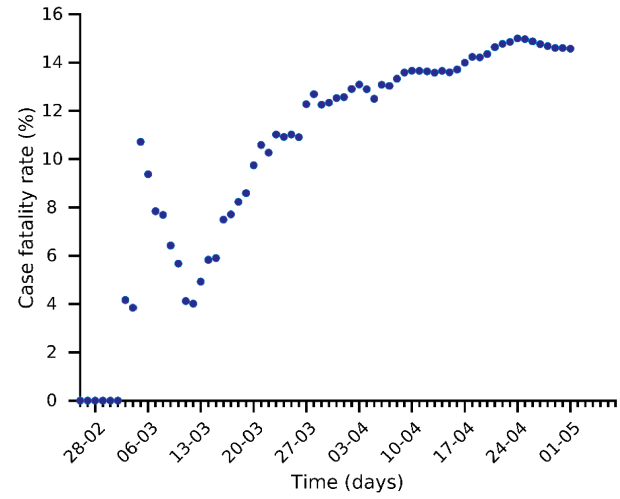




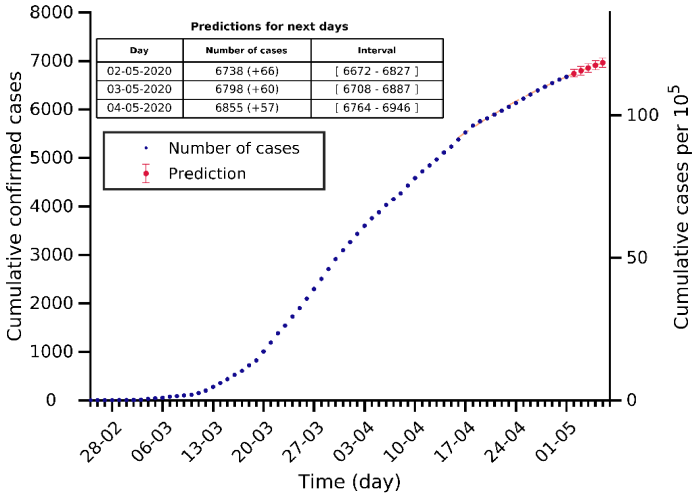


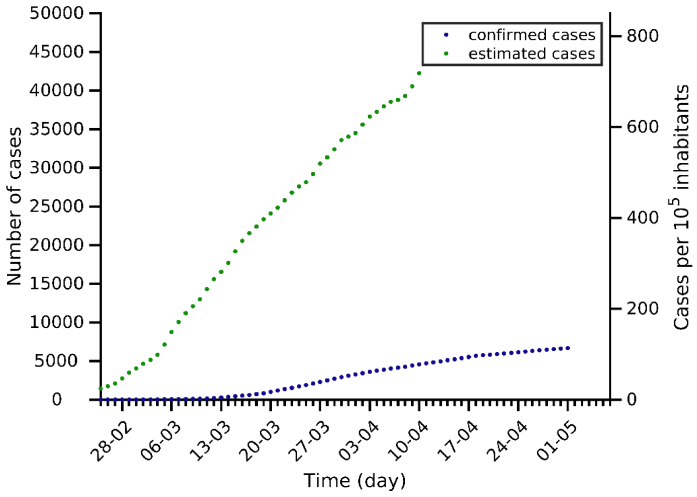


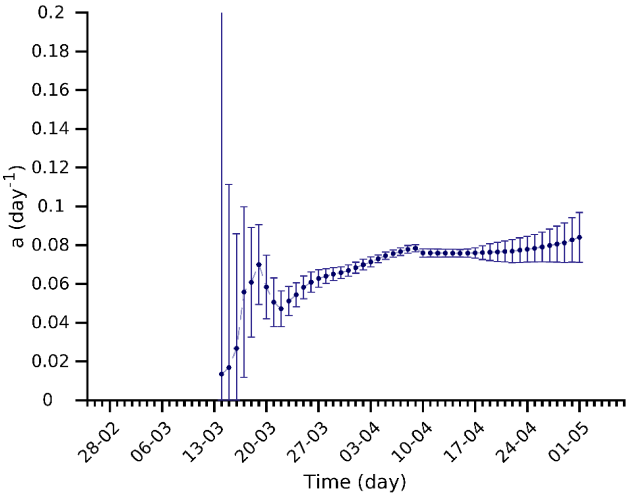


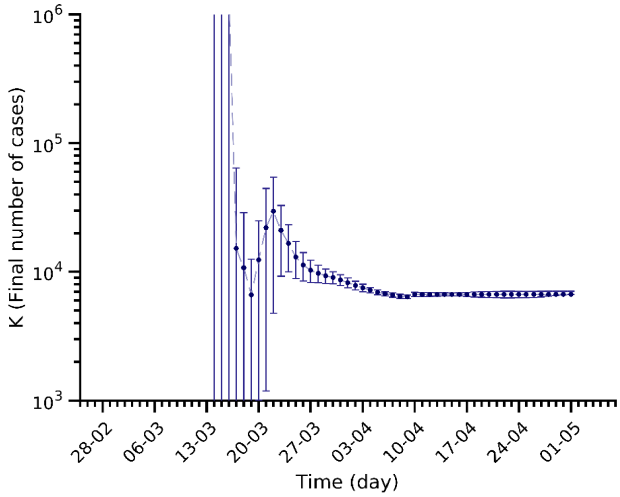


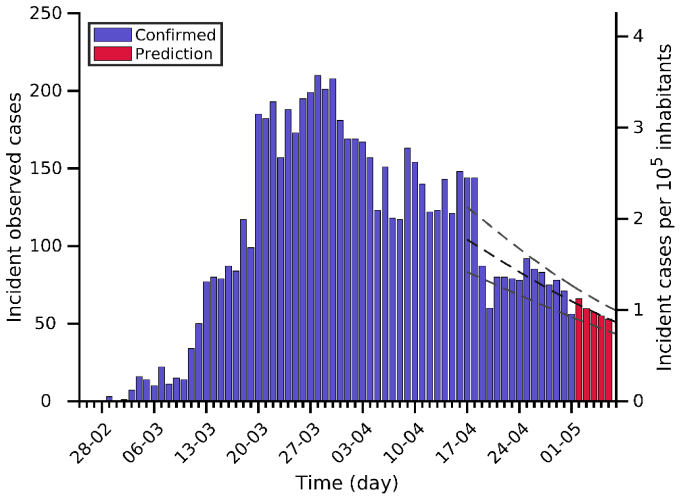
Lazio 01-05-2020. Population: 5.9M. Current cumulated incidence: 113/10^5

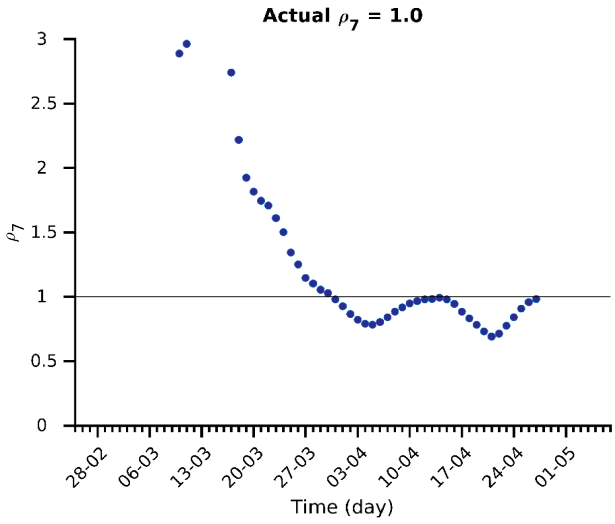


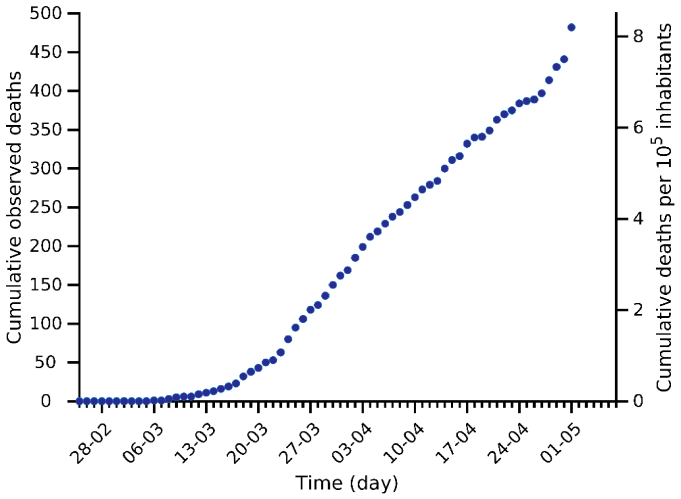


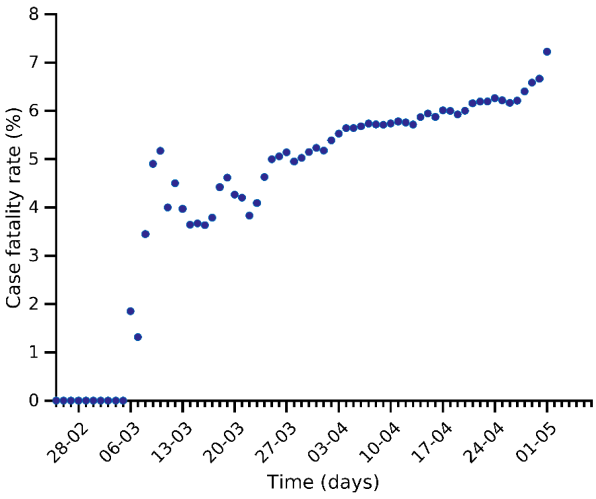




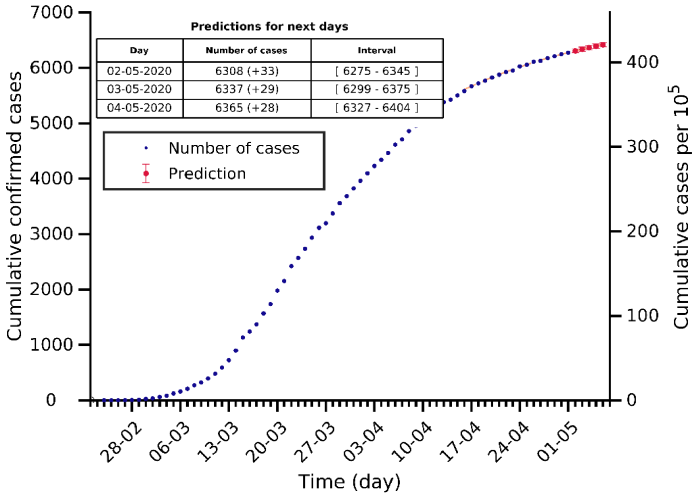


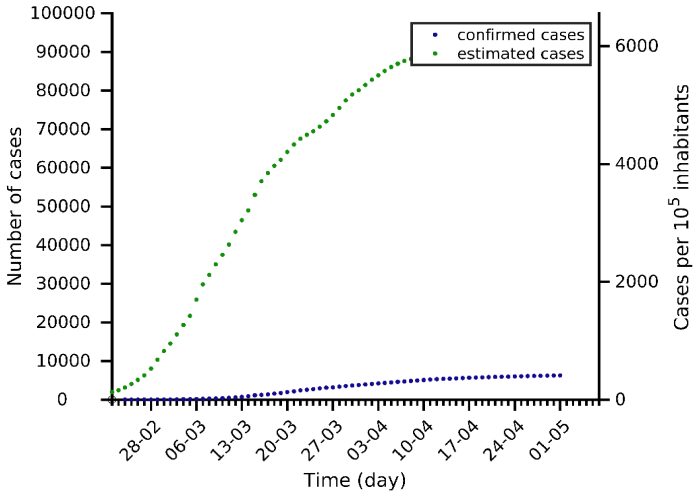


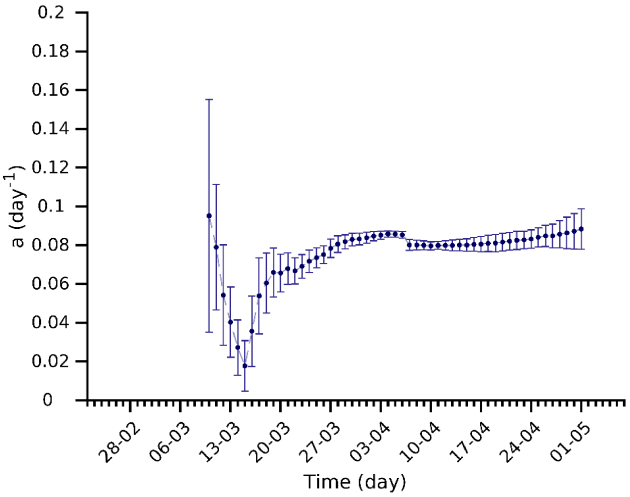


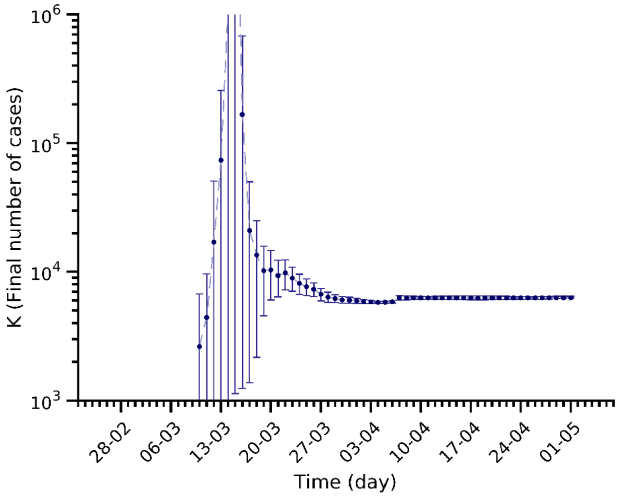


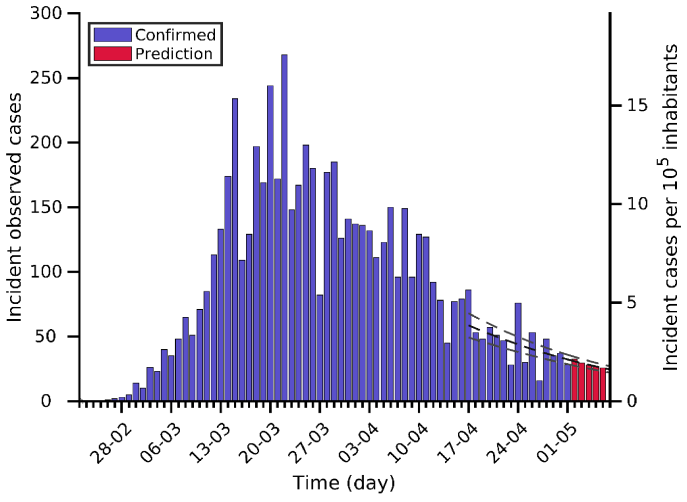
Marche 01-05-2020. Population: 1.5M. Current cumulated incidence: $411/10^5$

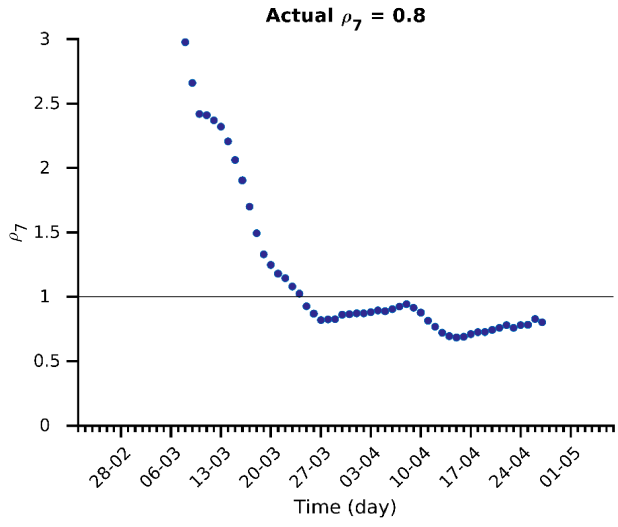


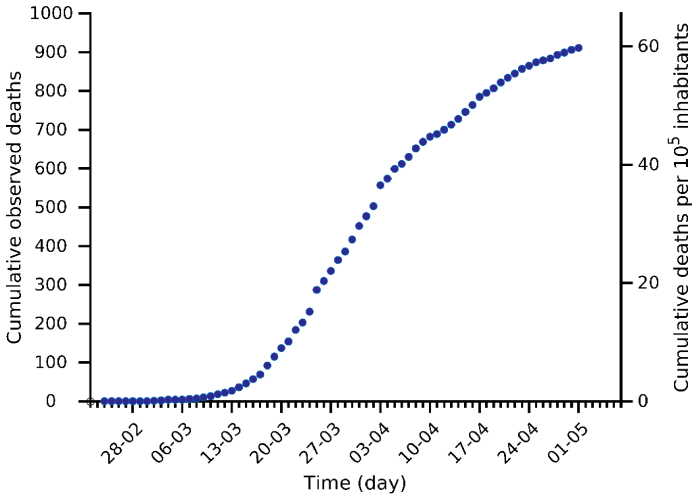


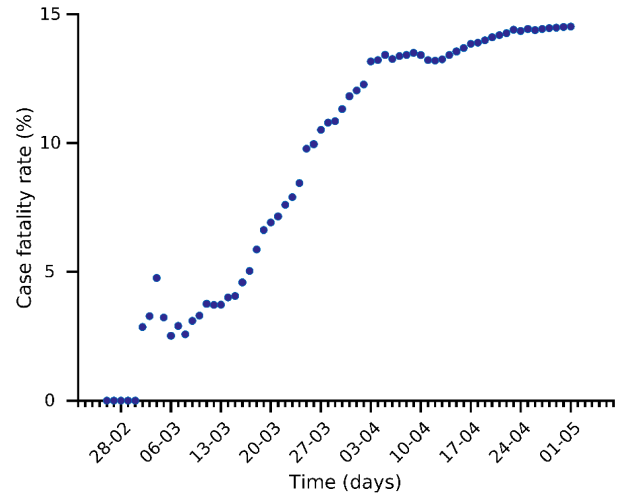




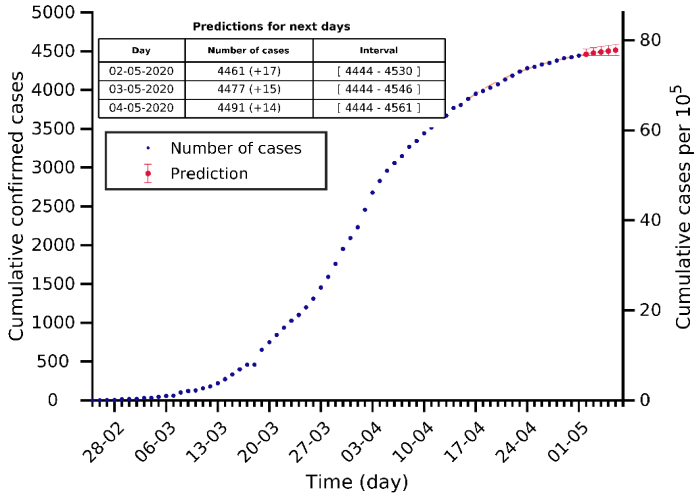


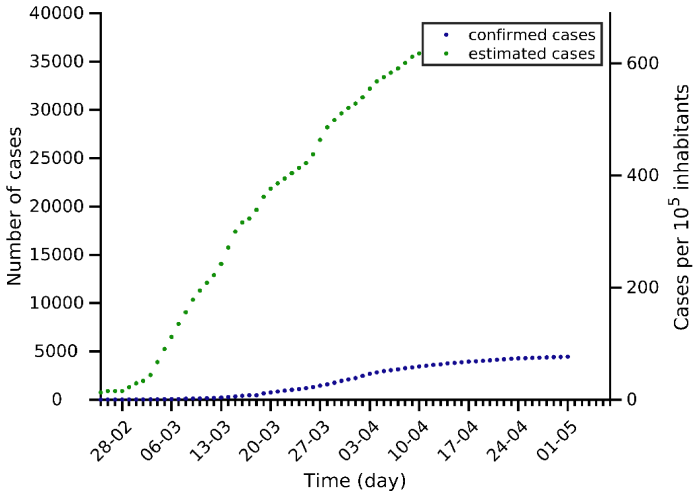


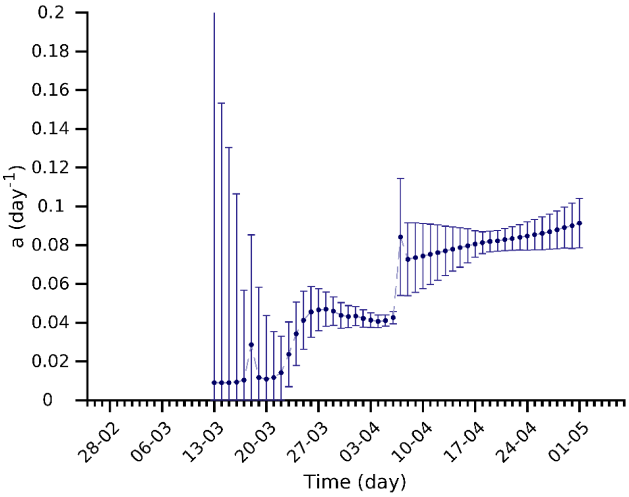


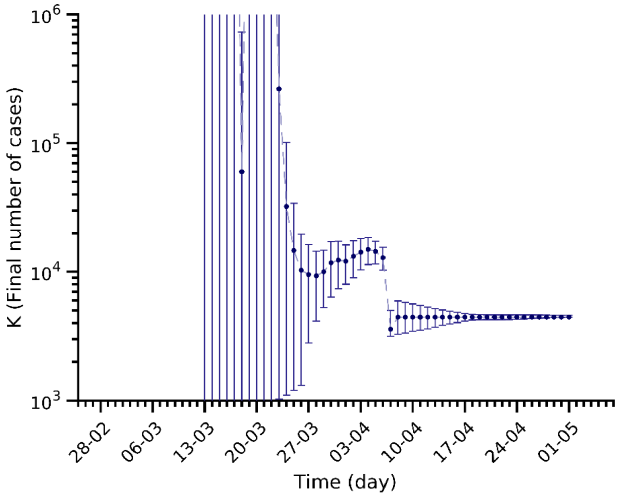


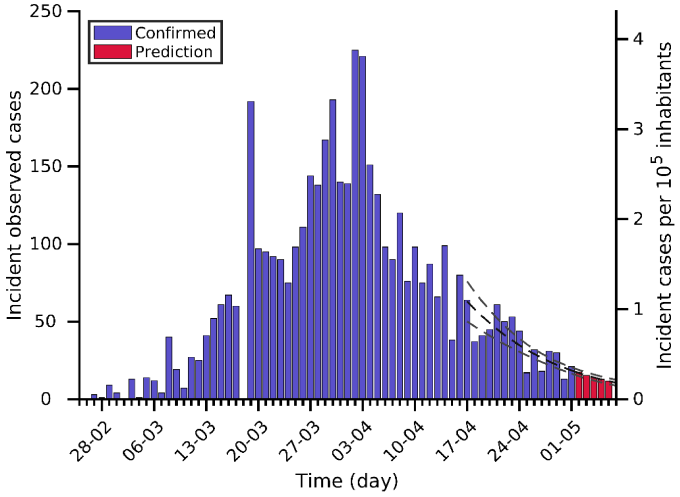
Campania 01-05-2020. Population: 5.8M. Current cumulated incidence: $77/10^5$

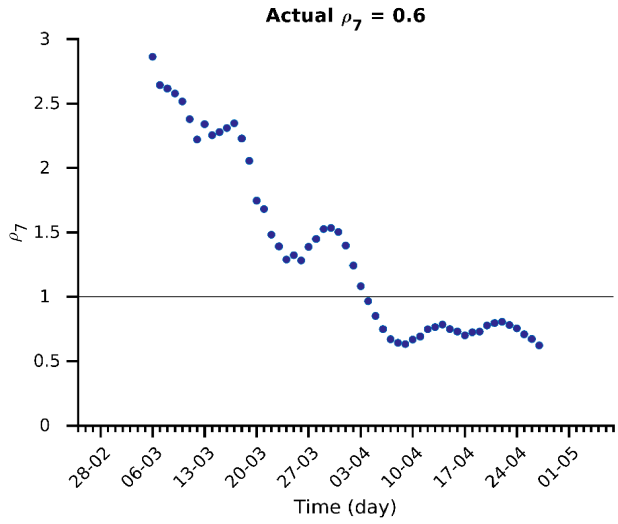


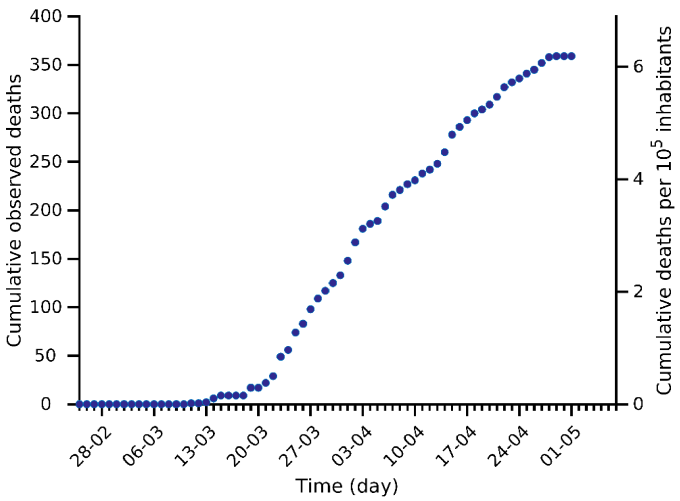


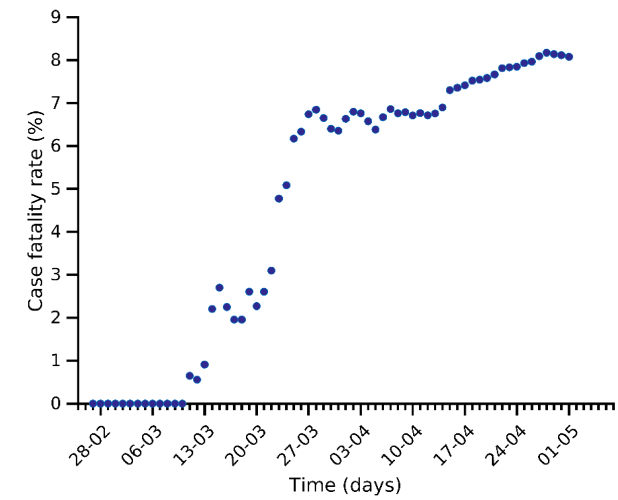




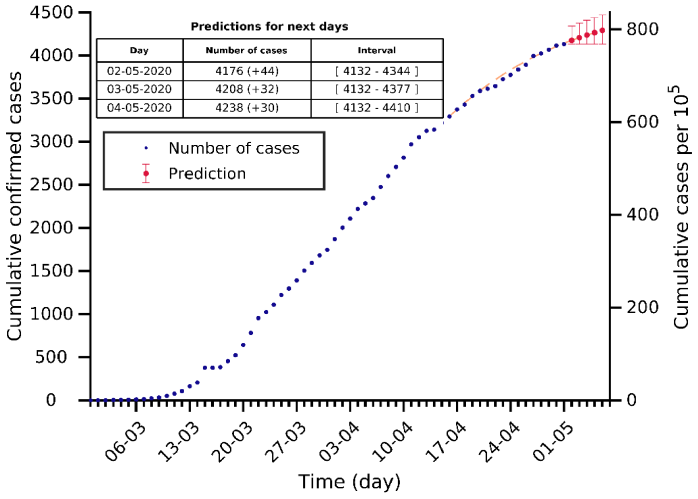


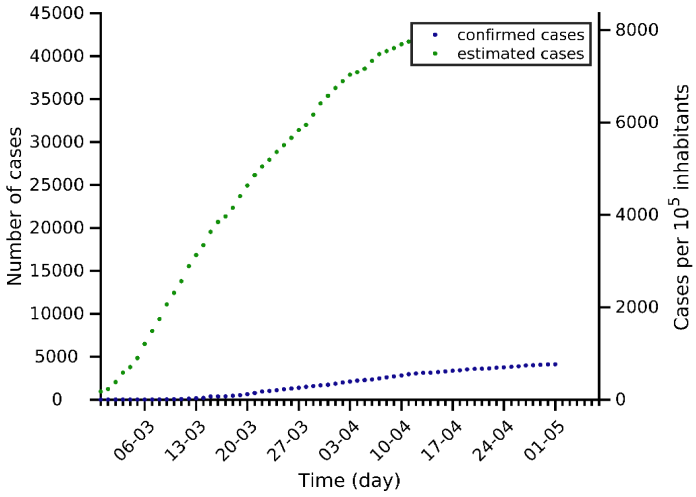


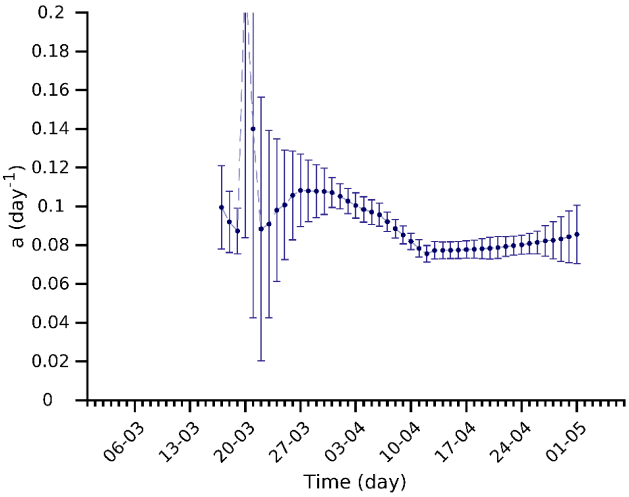


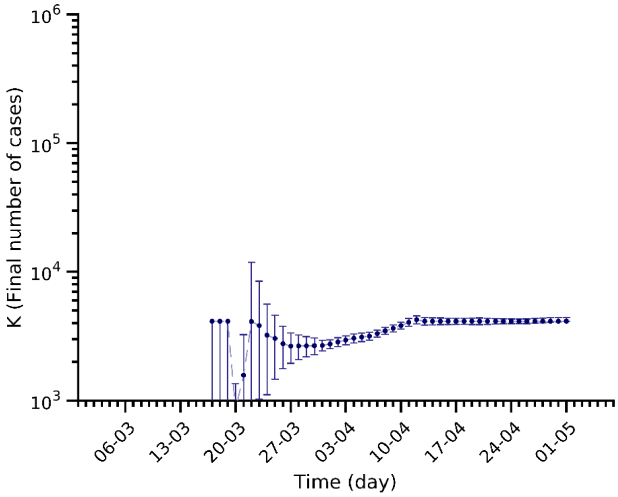


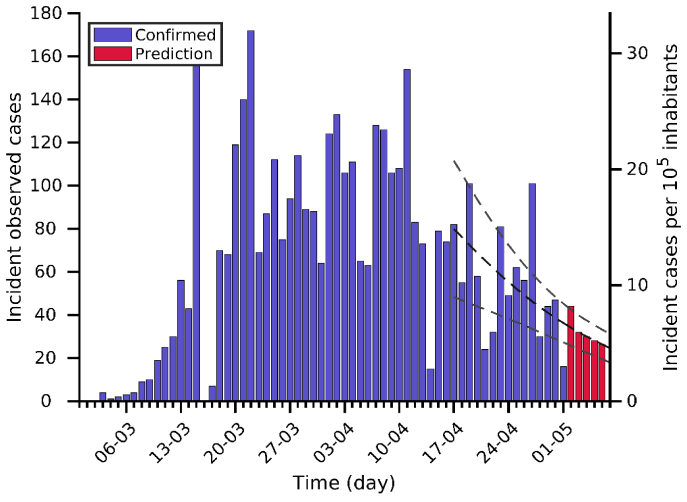
Trento 01-05-2020. Population: 0.5M. Current cumulated incidence: $768/10^5$

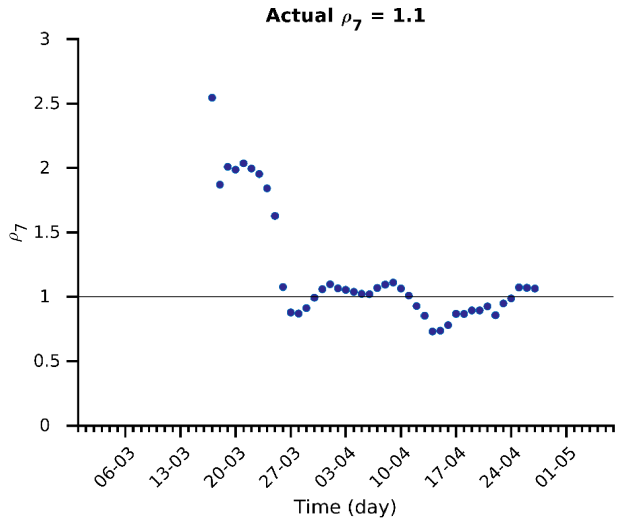


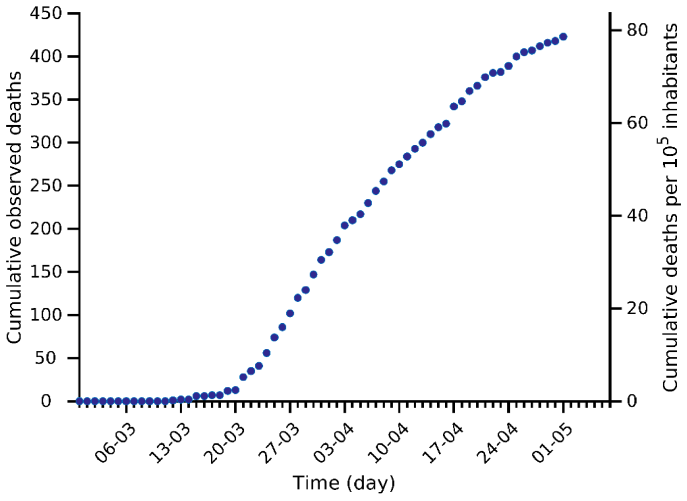


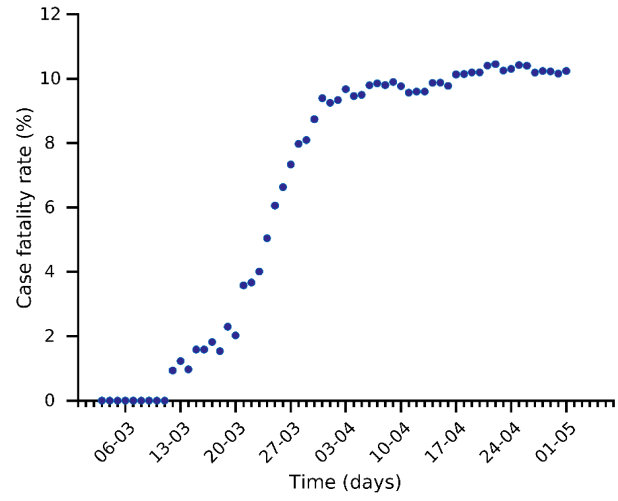




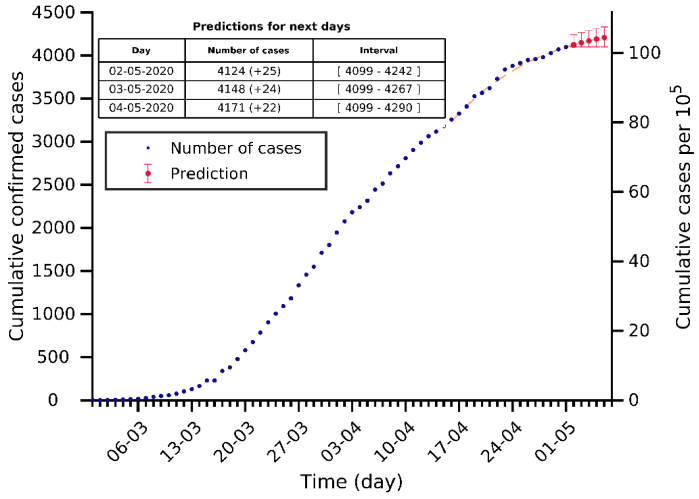


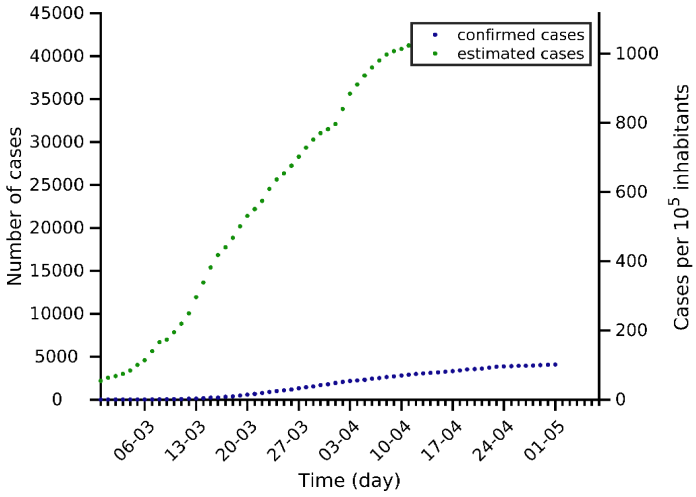


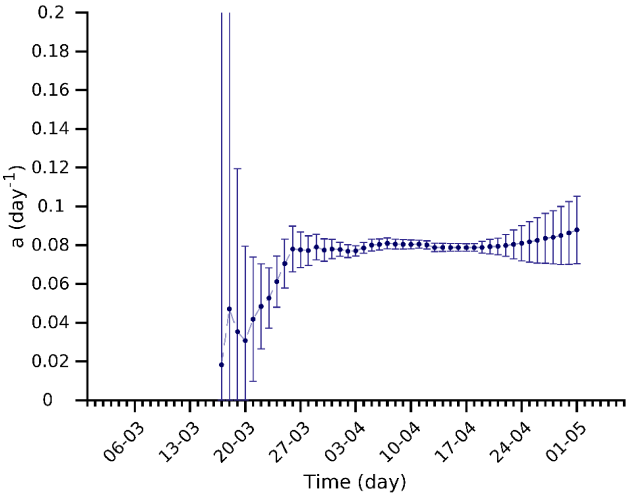


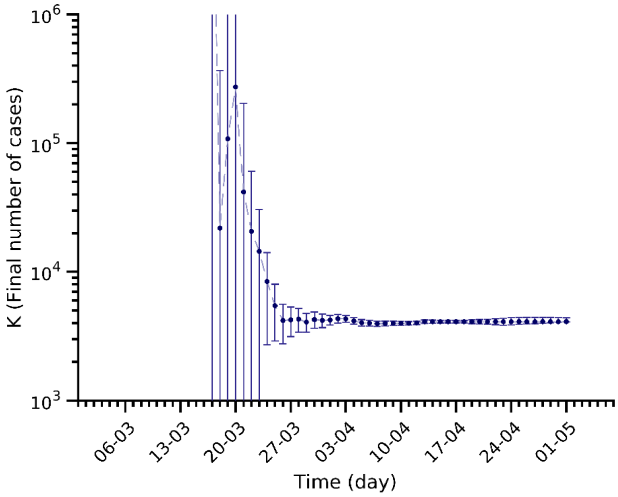


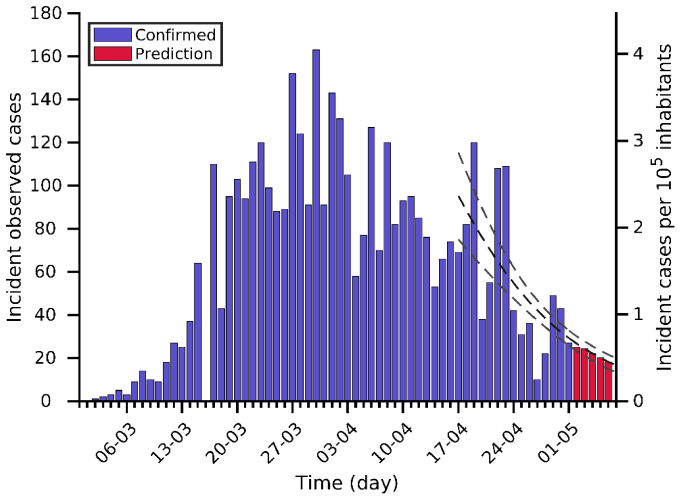
Puglia 01-05-2020. Population: 4.0M. Current cumulated incidence: $102/10^5$

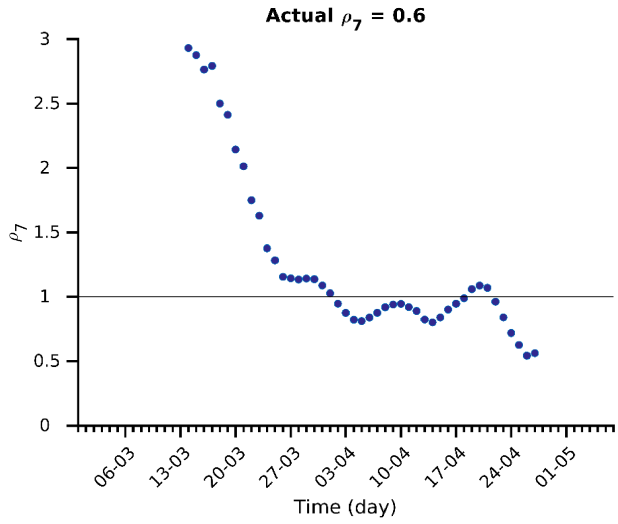


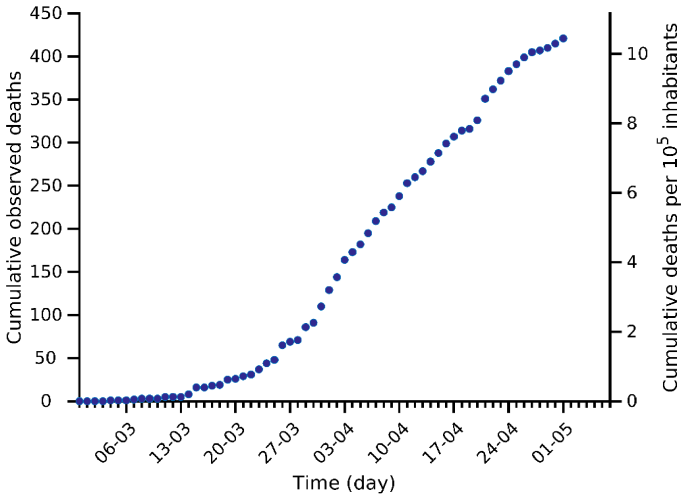


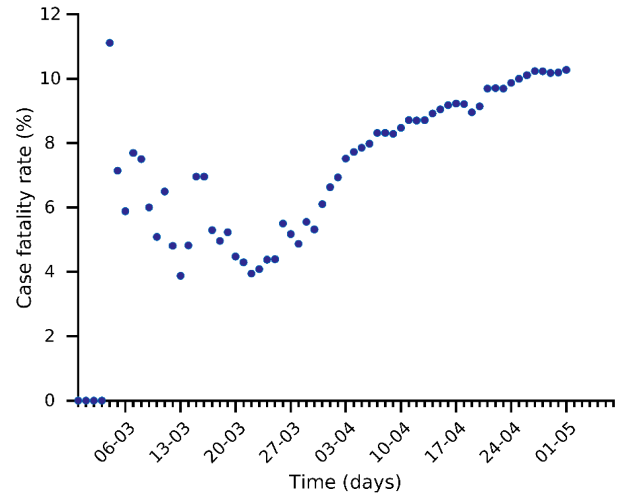




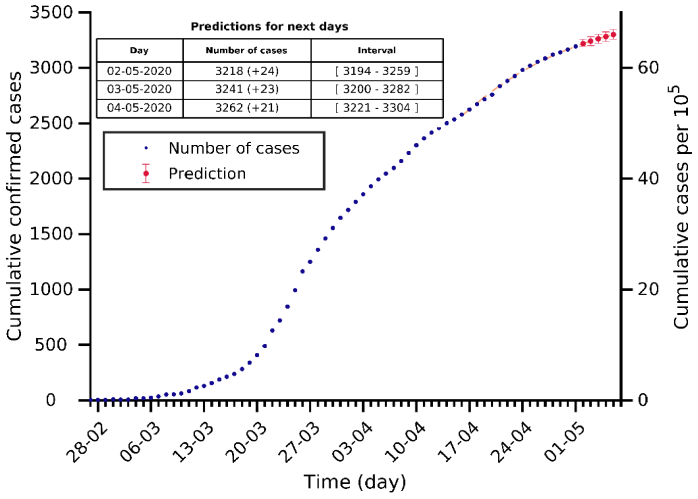


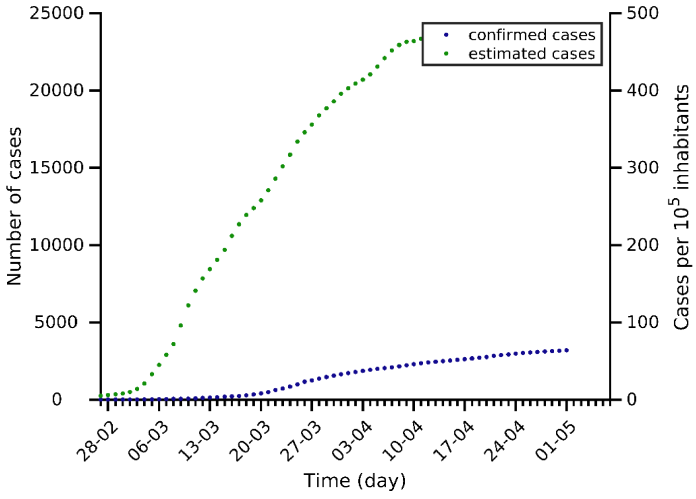


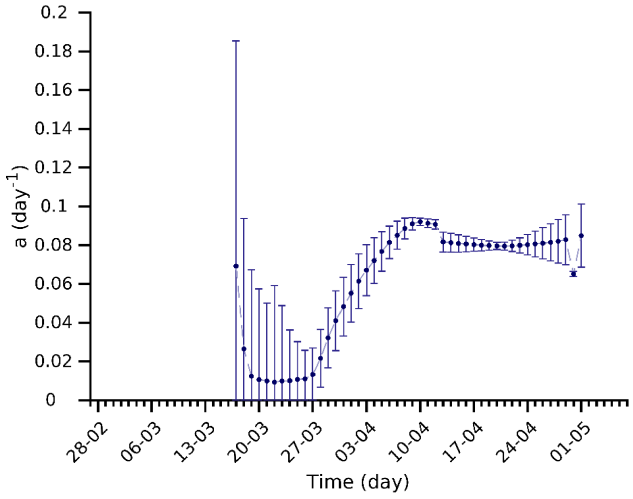


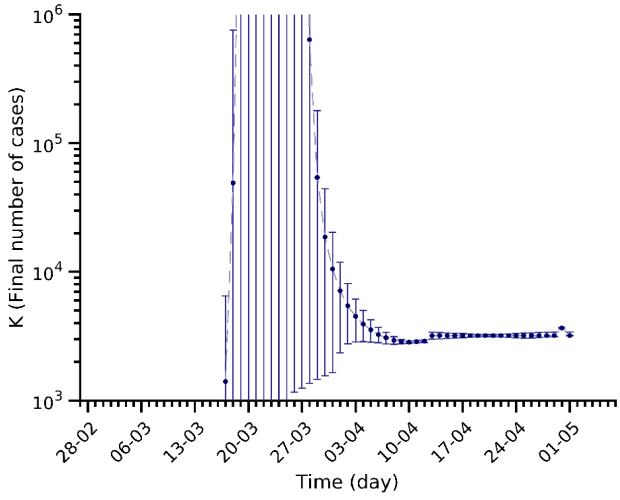


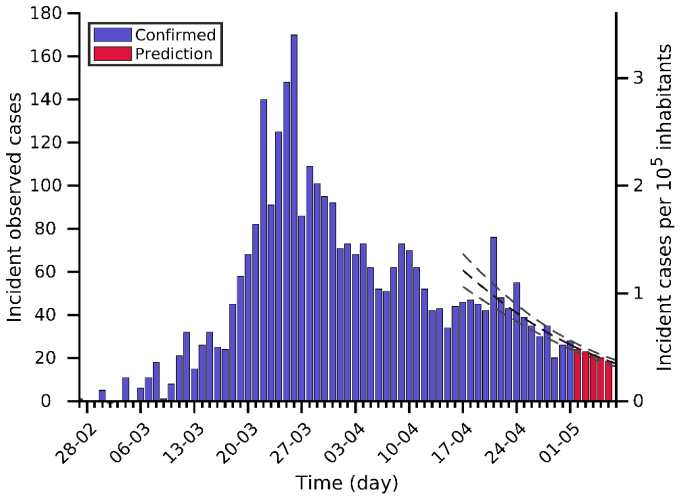
Sicilia 01-05-2020. Population: 5.0M. Current cumulated incidence: 64/10⁵

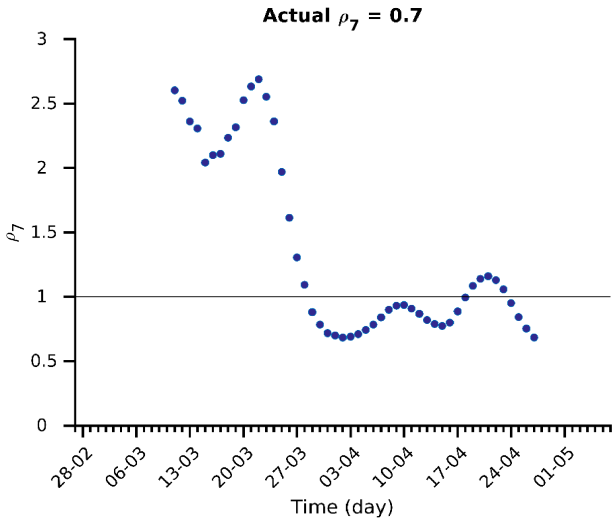


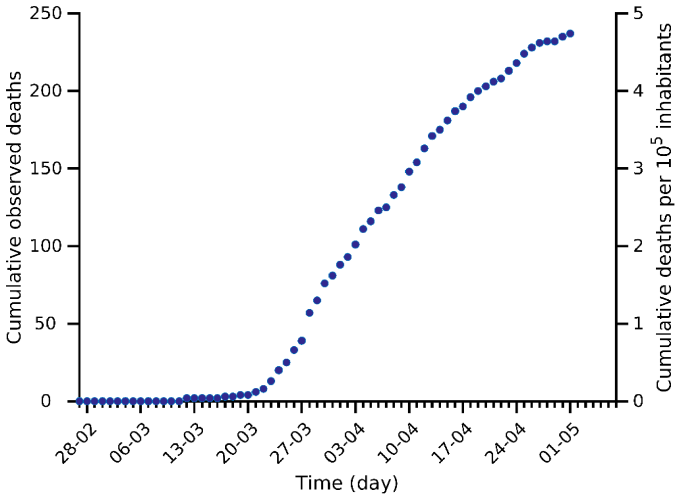


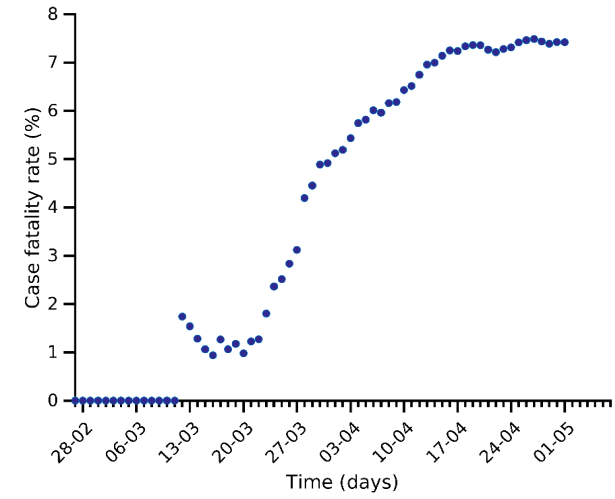




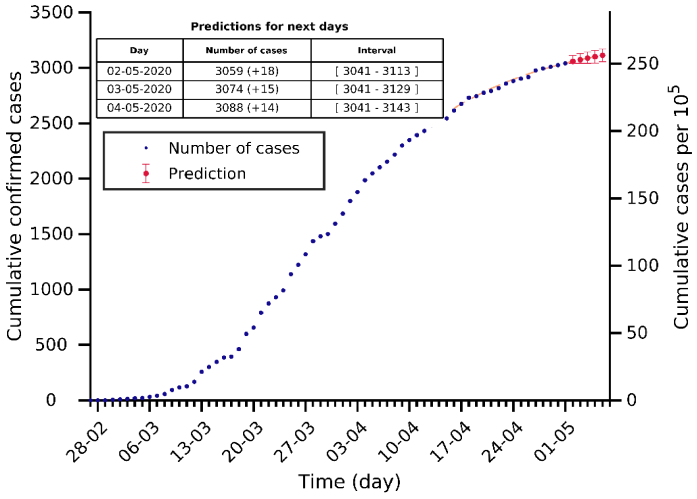


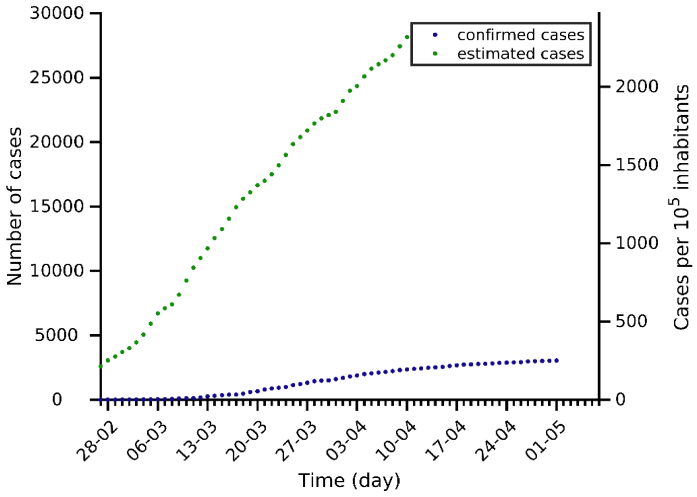


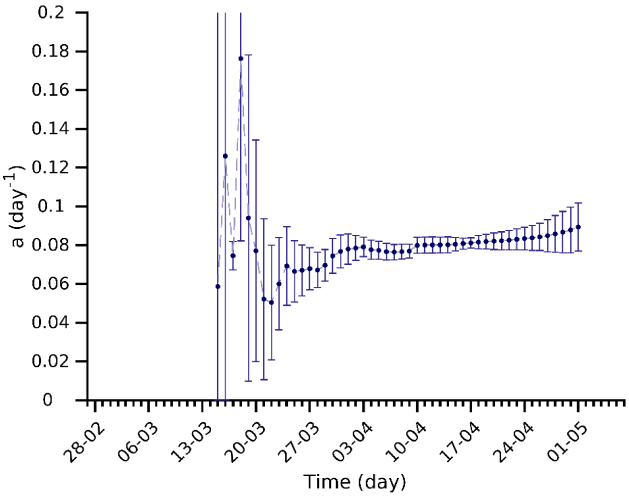


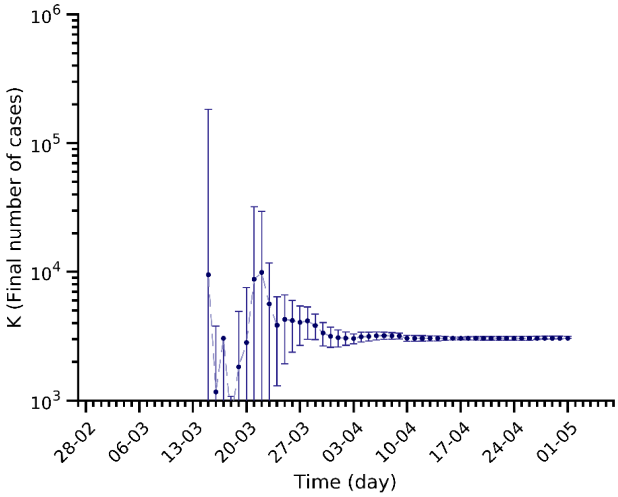


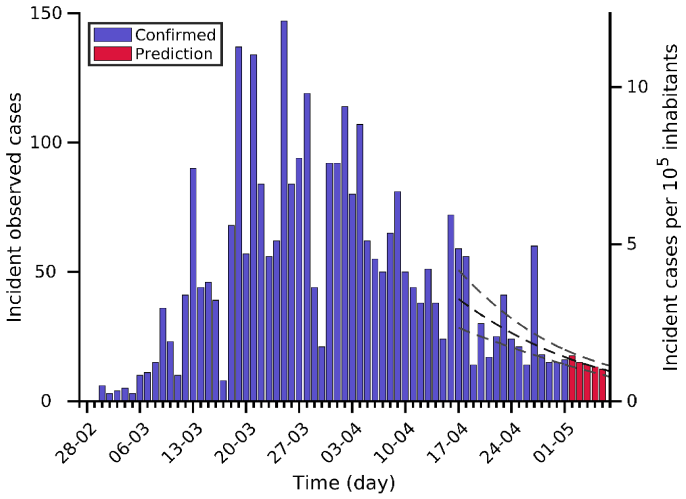
Friuli Venezia Giulia 01-05-2020. Population: 1.2M. Current cumulated incidence: 2

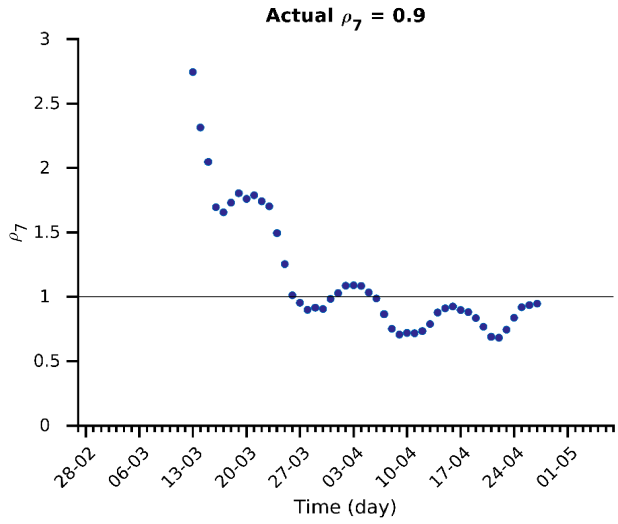


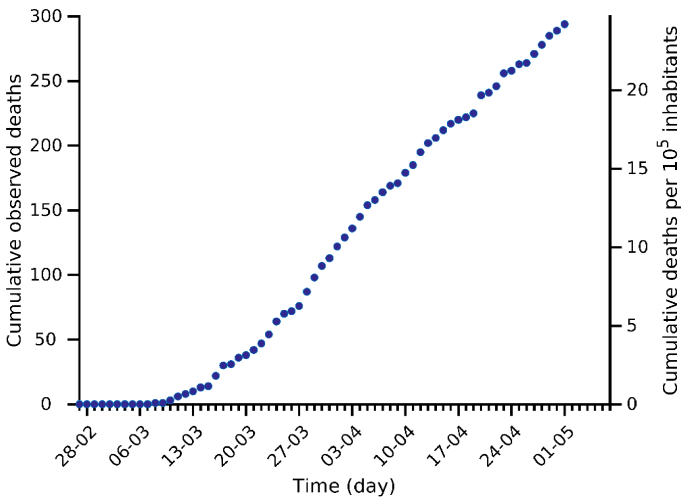


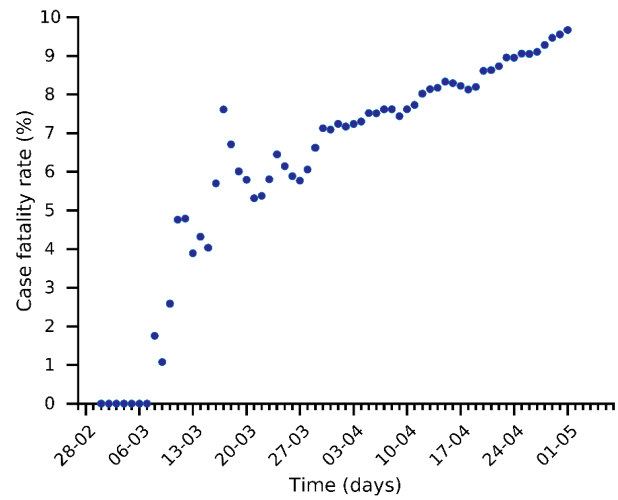




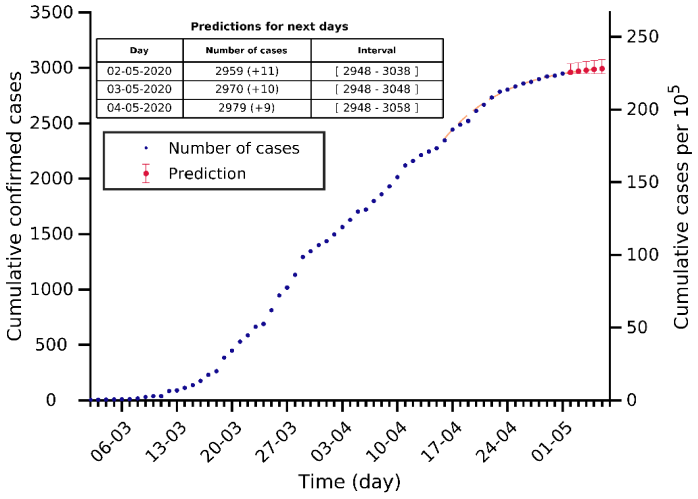


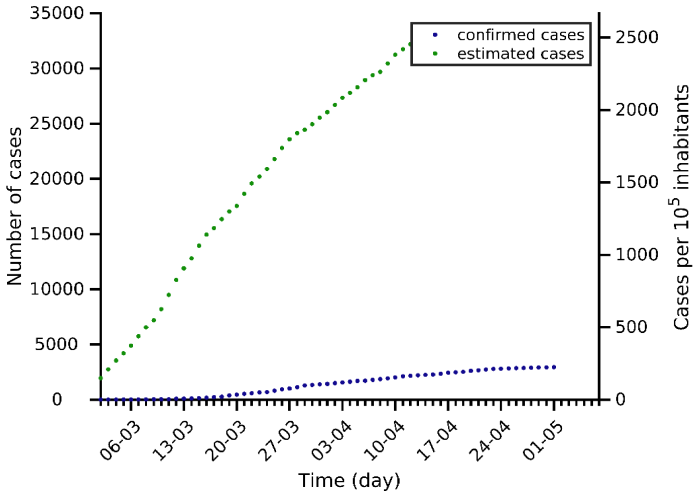


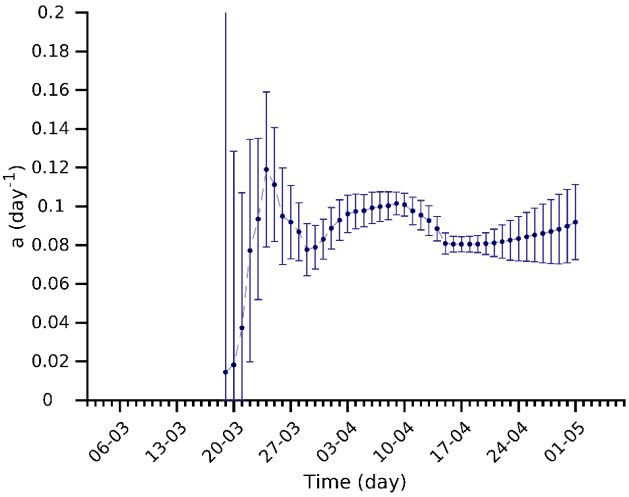


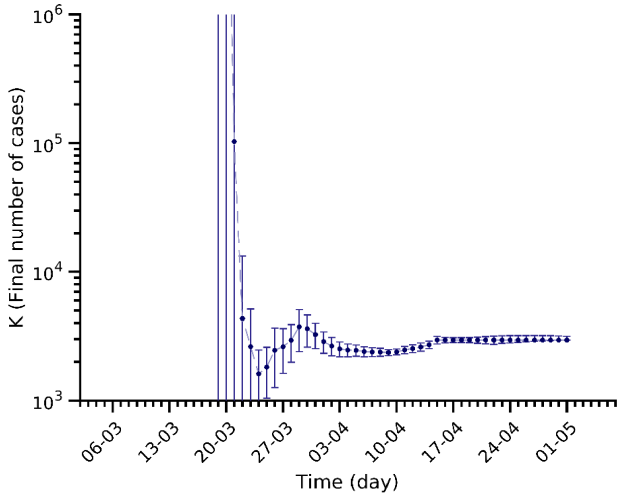


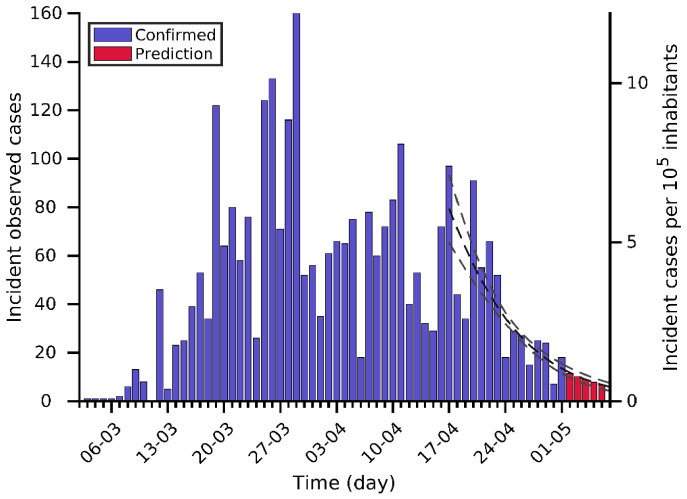
Abruzzo 01-05-2020. Population: 1.3M. Current cumulated incidence: 225/10^5

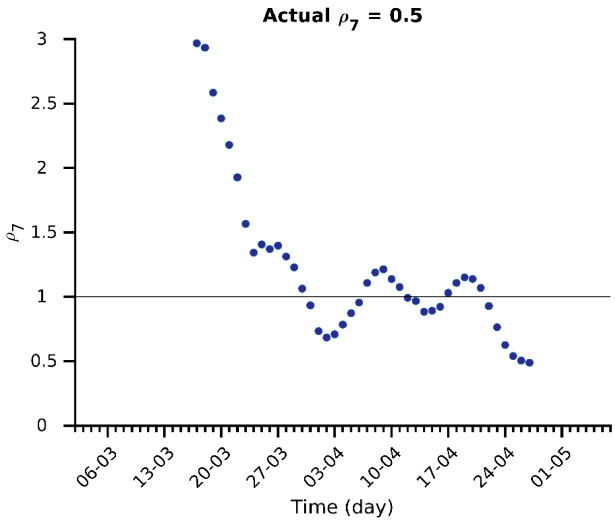


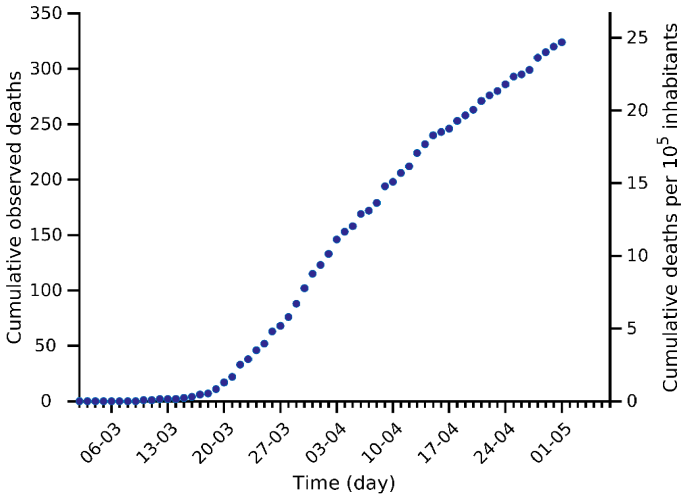


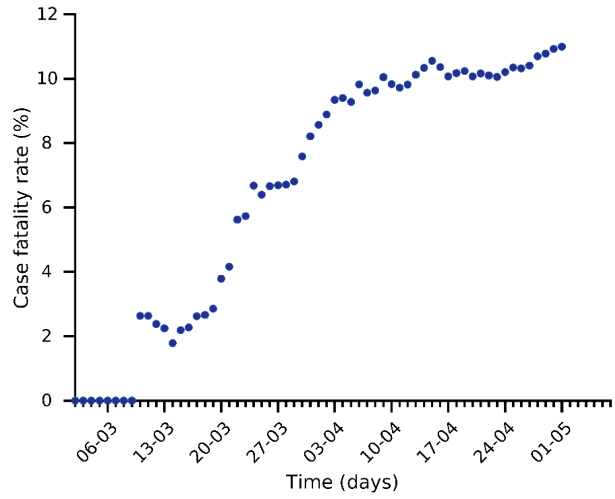




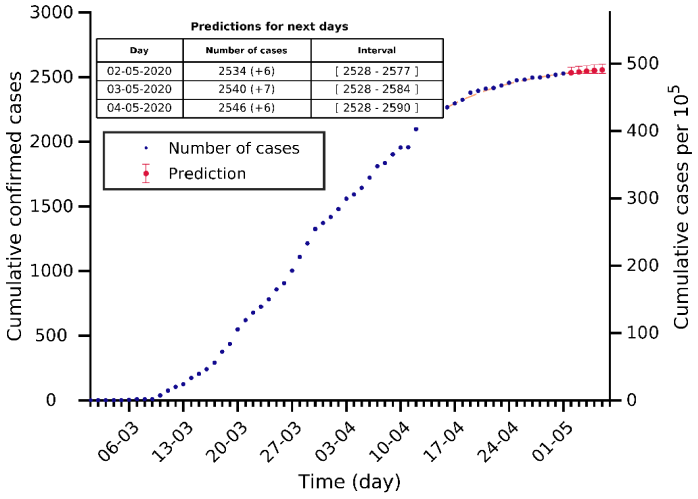


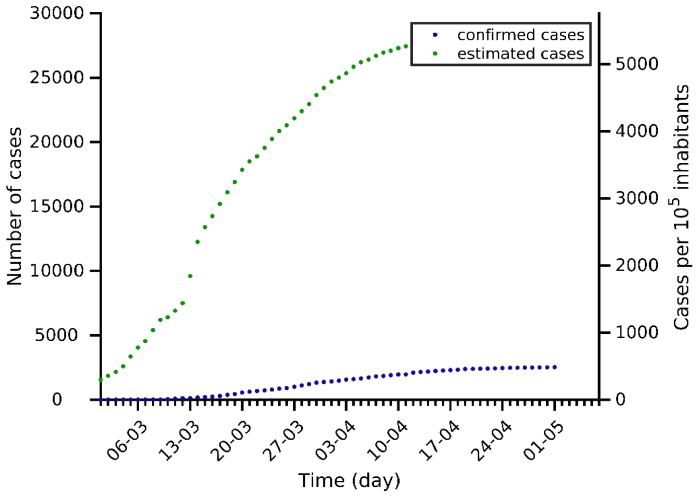


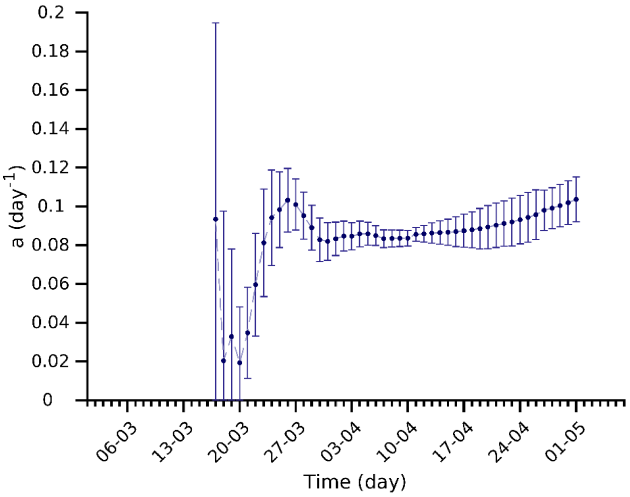


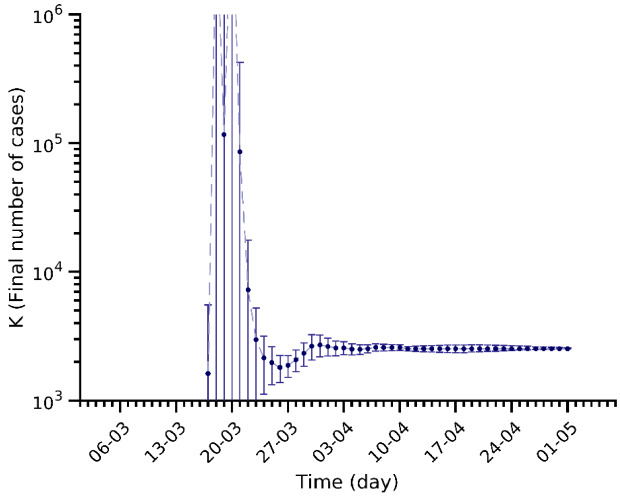


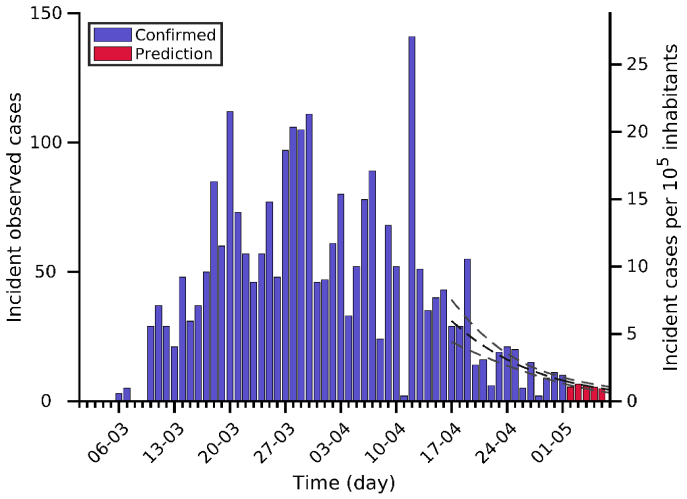
Bolzano 01-05-2020. Population: 0.5M. Current cumulated incidence: $485/10^5$

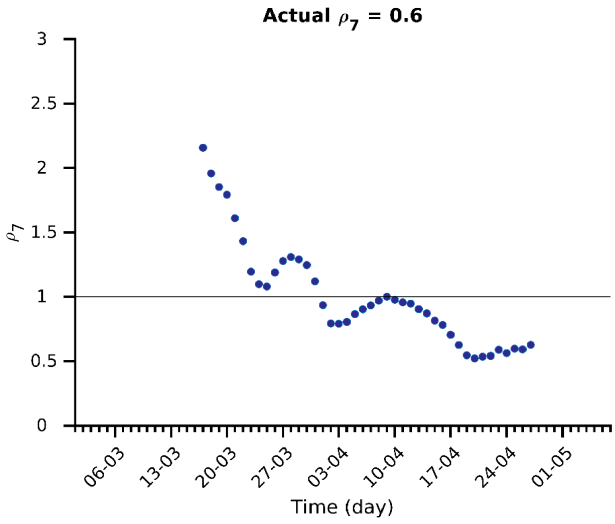


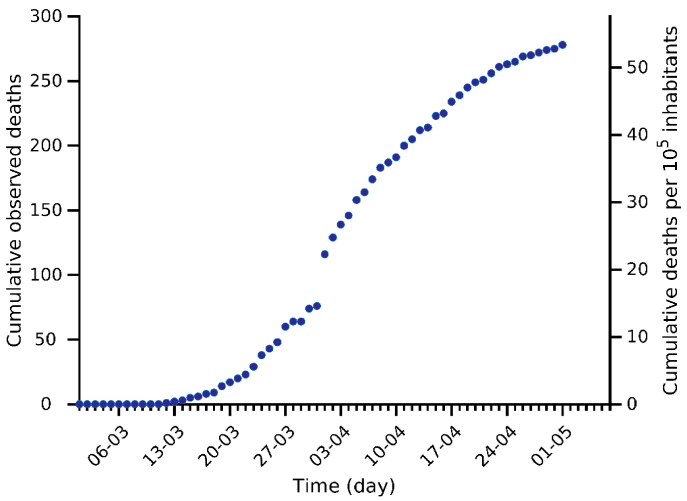


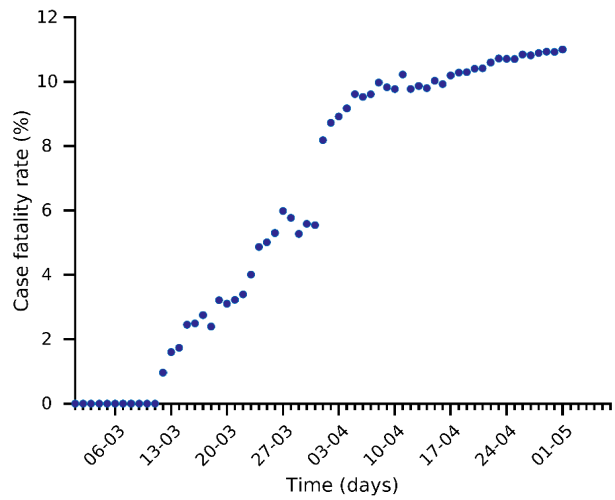




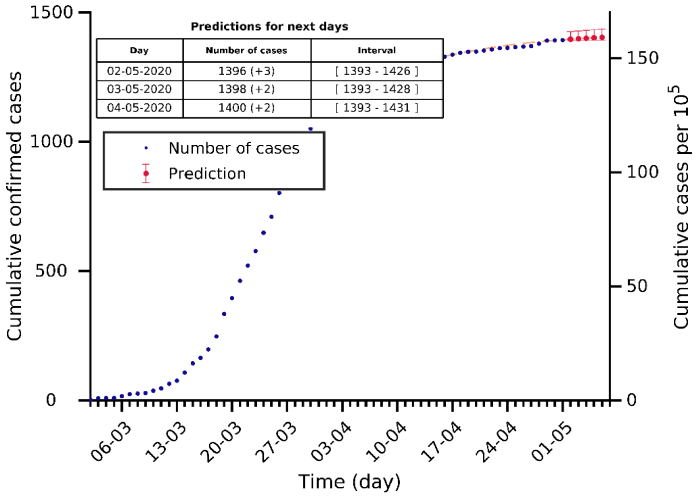


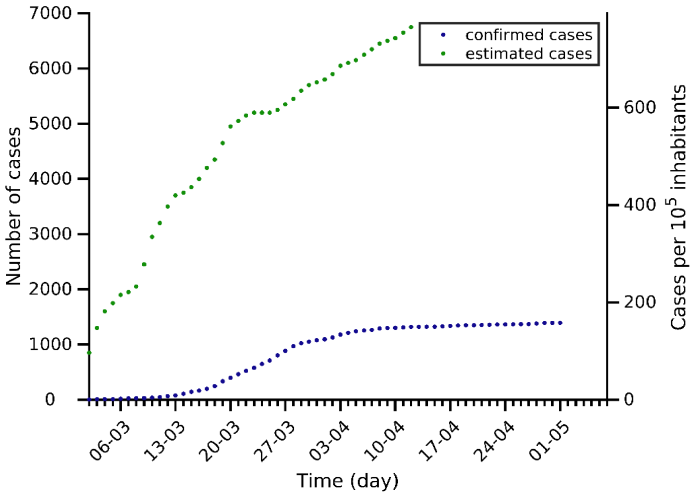


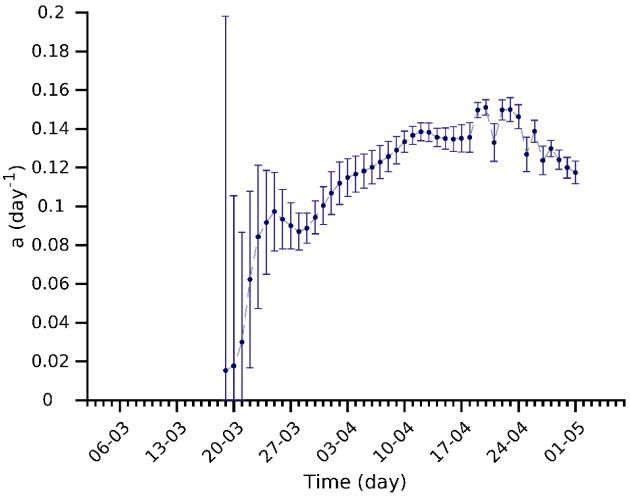


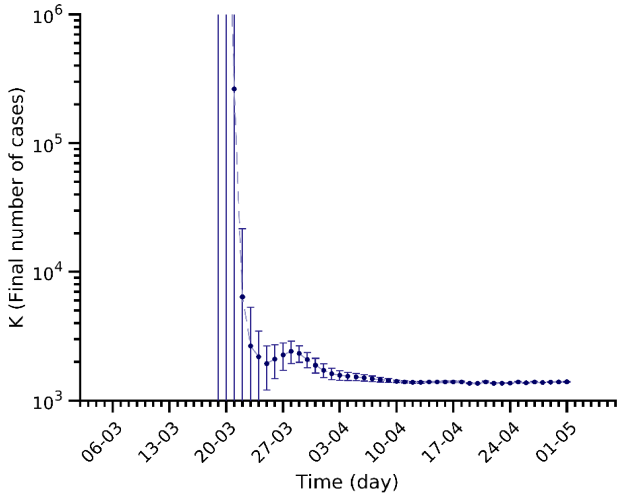


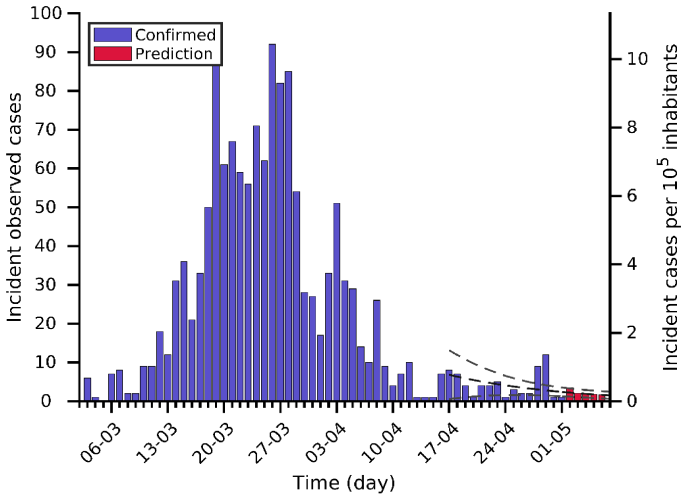
Umbria 01-05-2020. Population: 0.9M. Current cumulated incidence: $158/10^5$

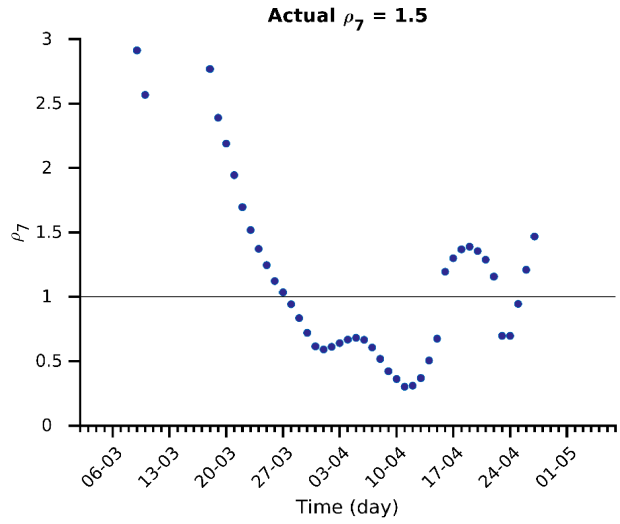


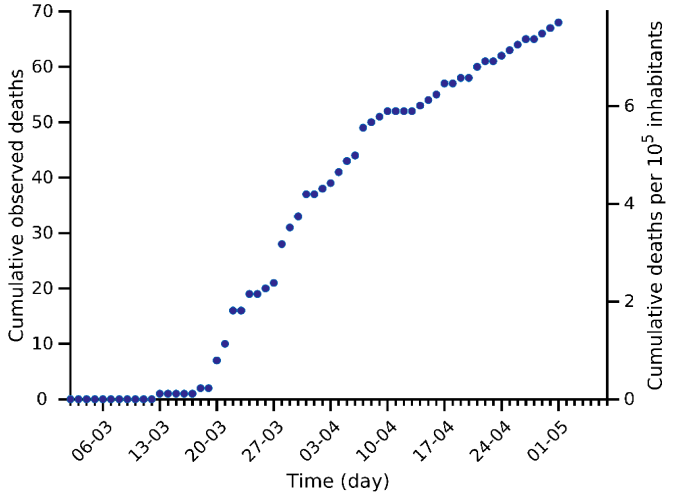


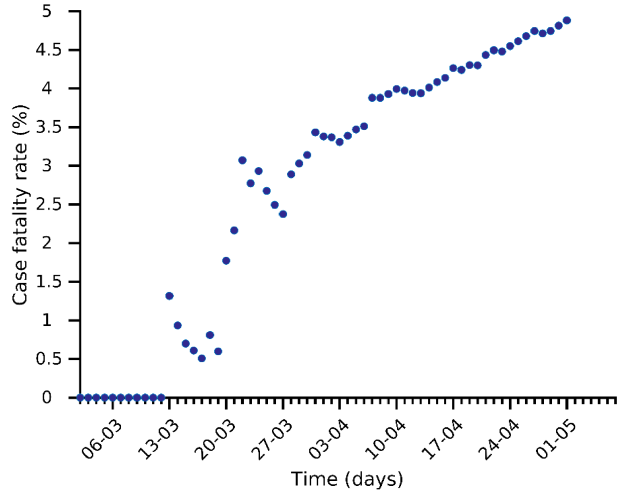




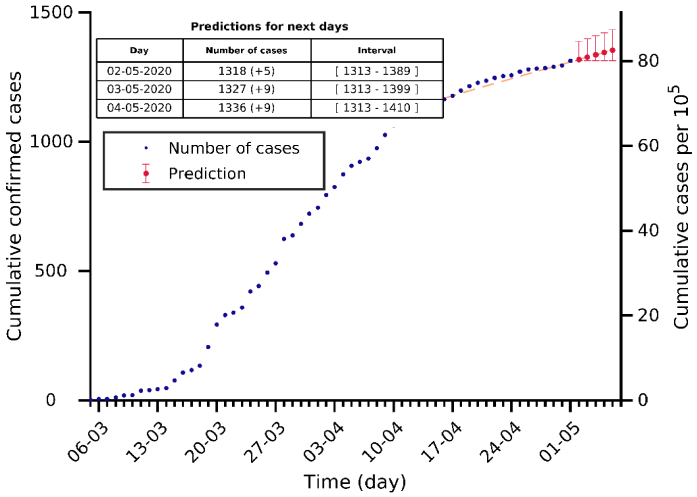


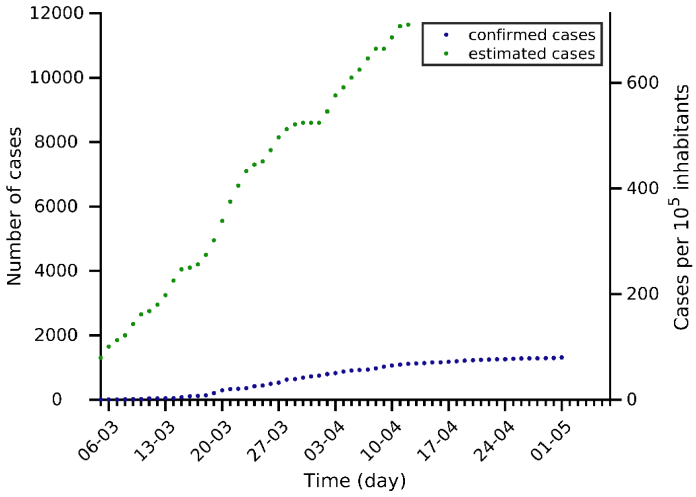


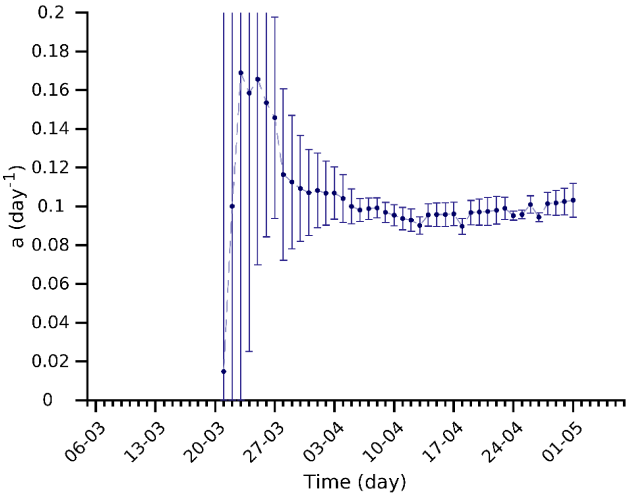


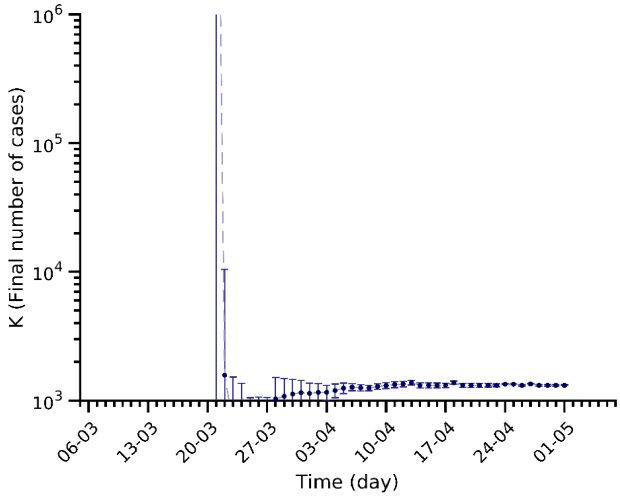


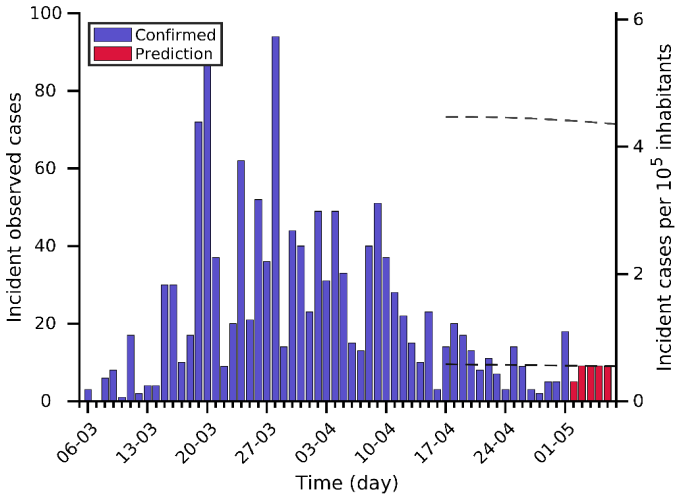
Sardegna 01-05-2020. Population: 1.6M. Current cumulated incidence: $80/10^5$

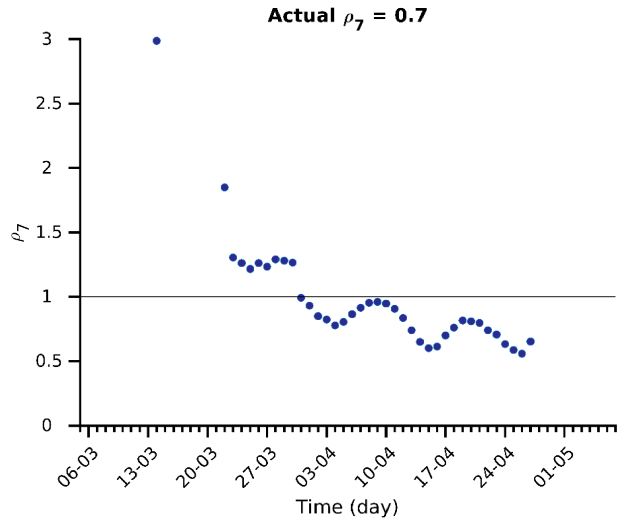


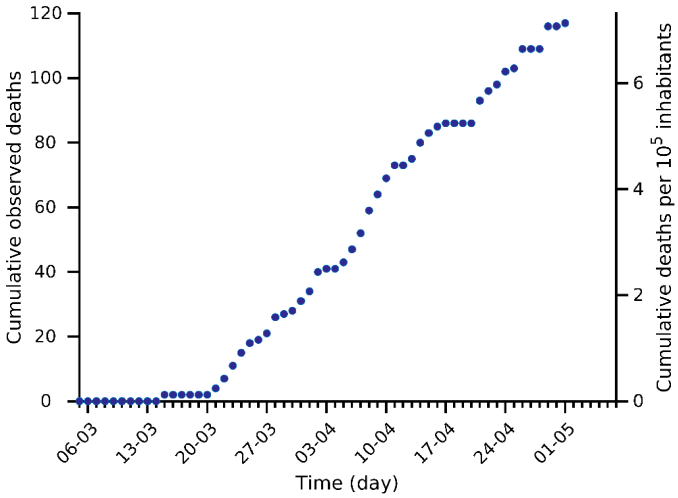


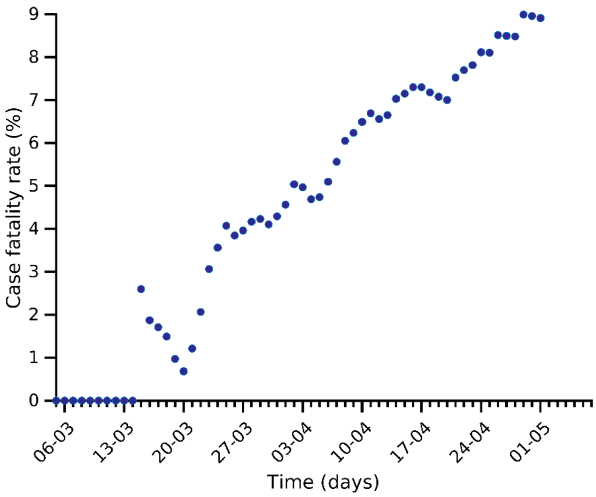




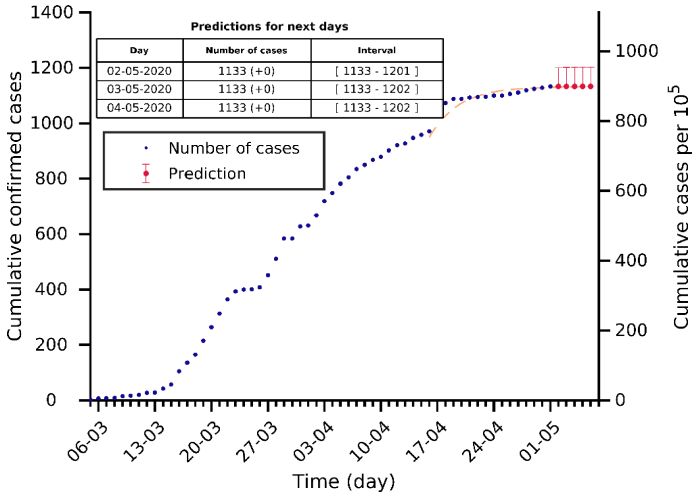


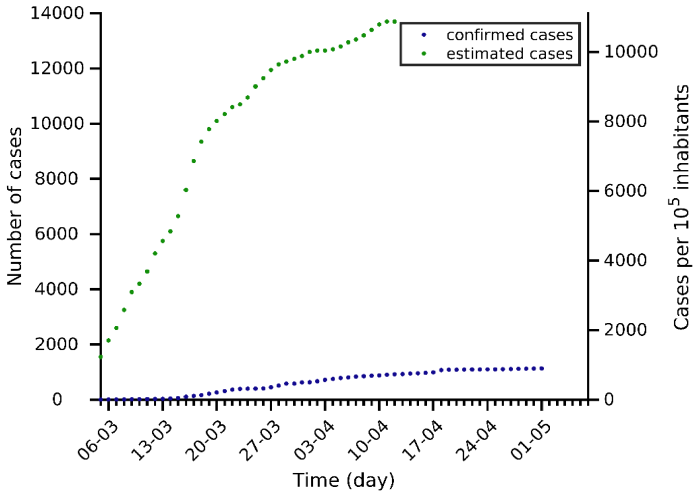


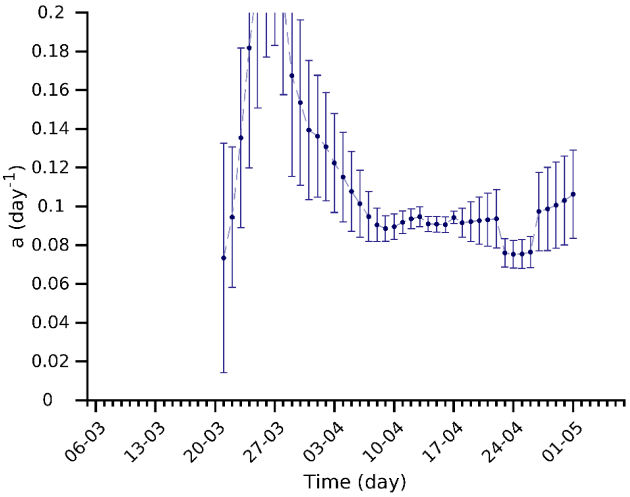


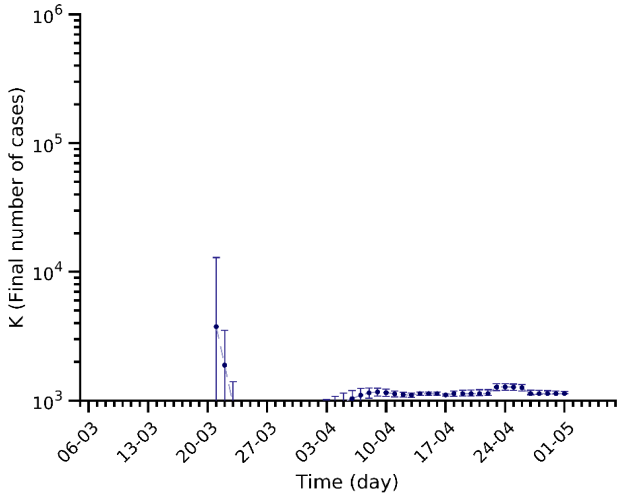


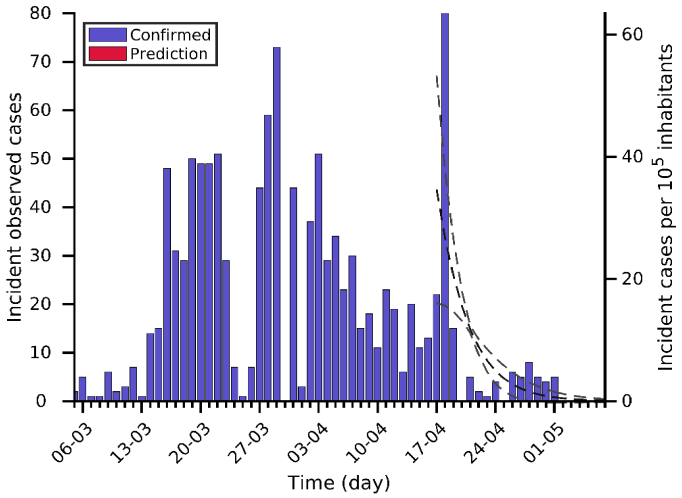
Valle dAosta 01-05-2020. Population: 0.1M. Current cumulated incidence: 899/10^5

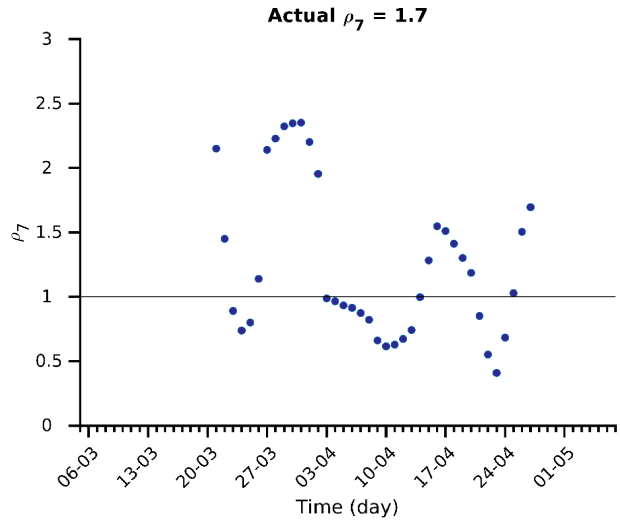


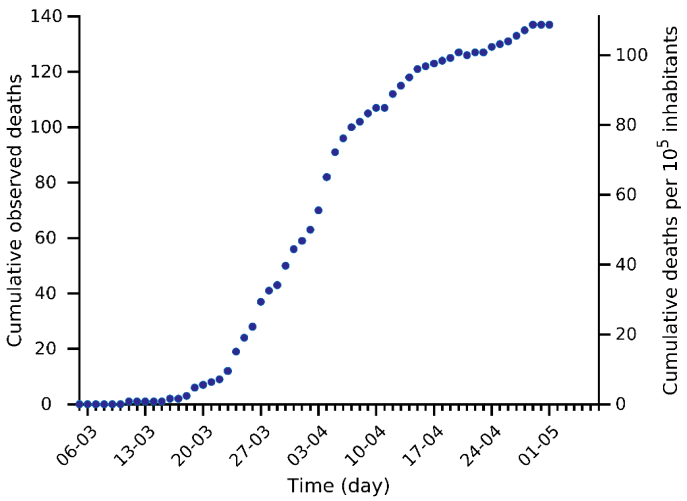


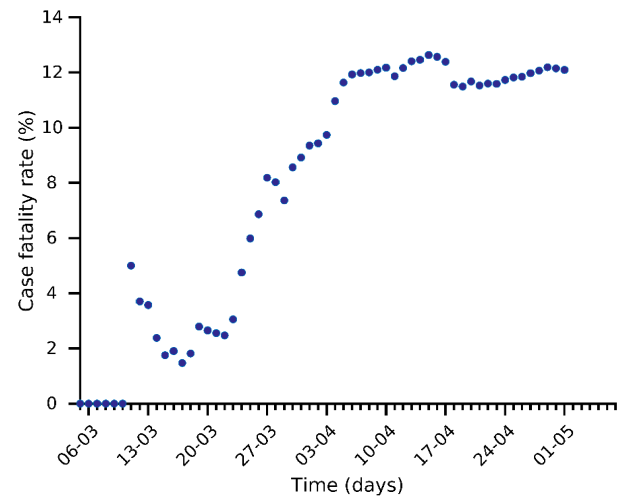




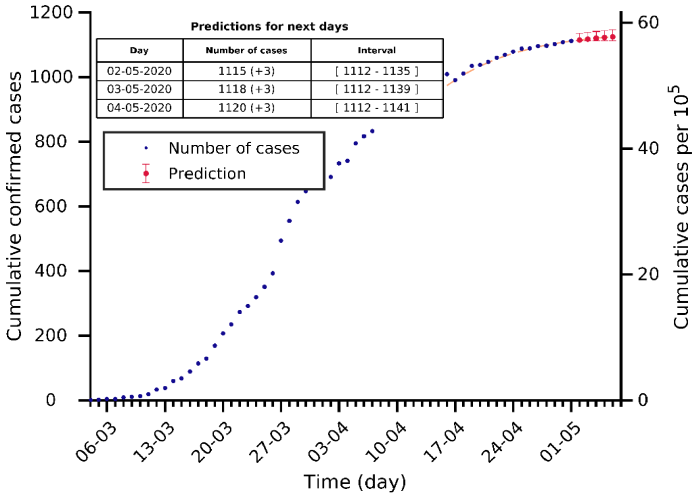


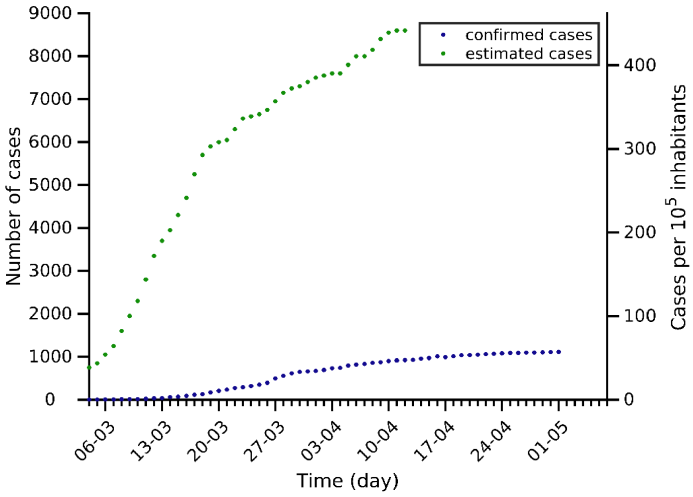


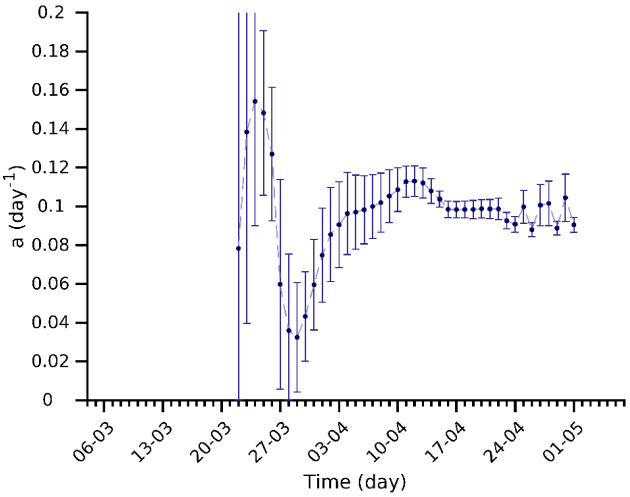


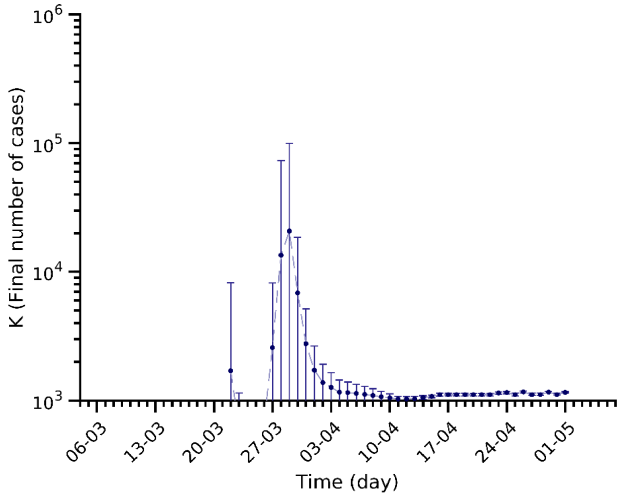


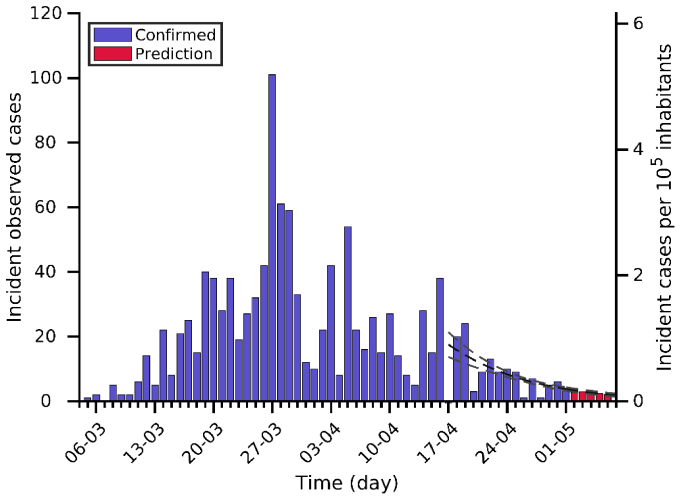
Calabria 01-05-2020. Population: 1.9M. Current cumulated incidence: $57/10^5$

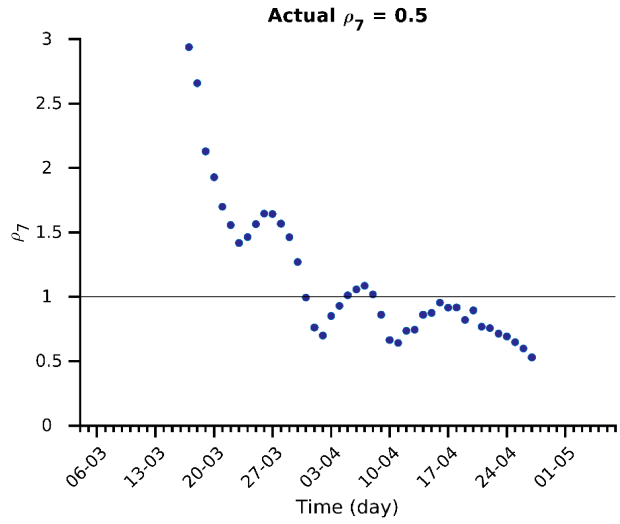


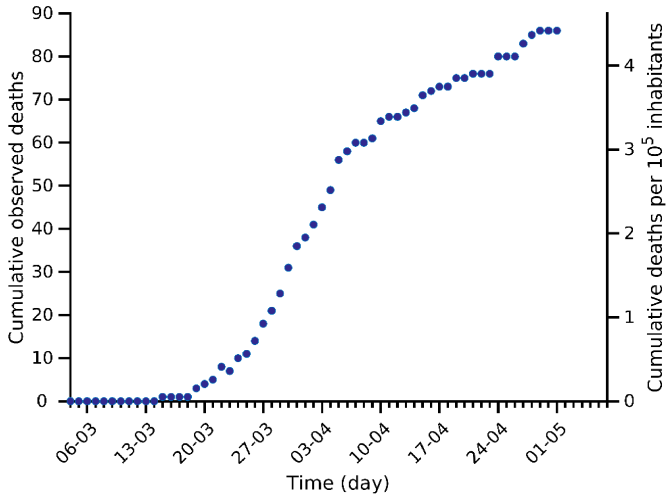


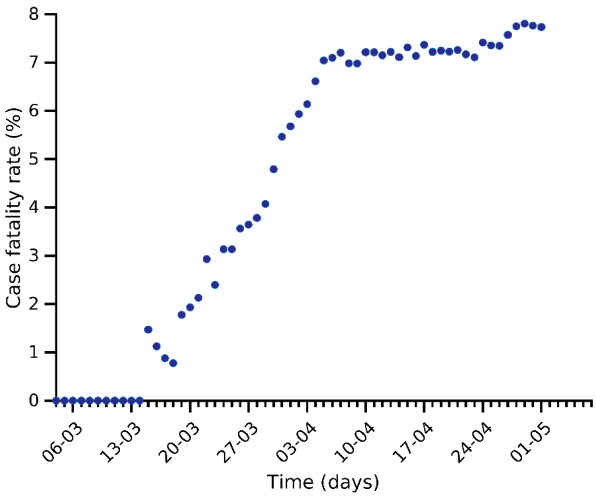




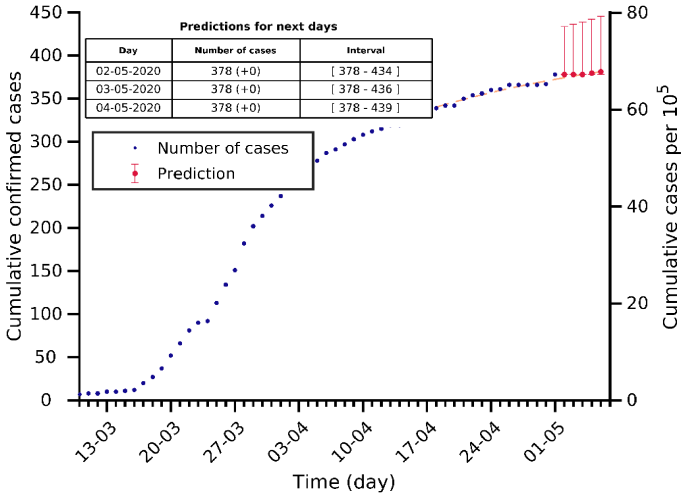


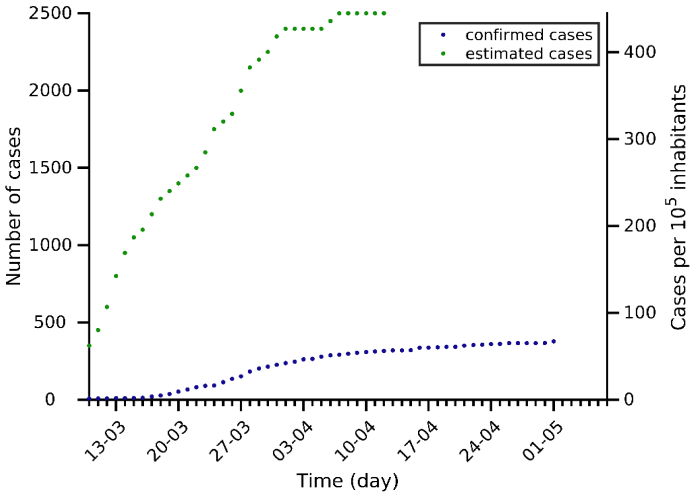


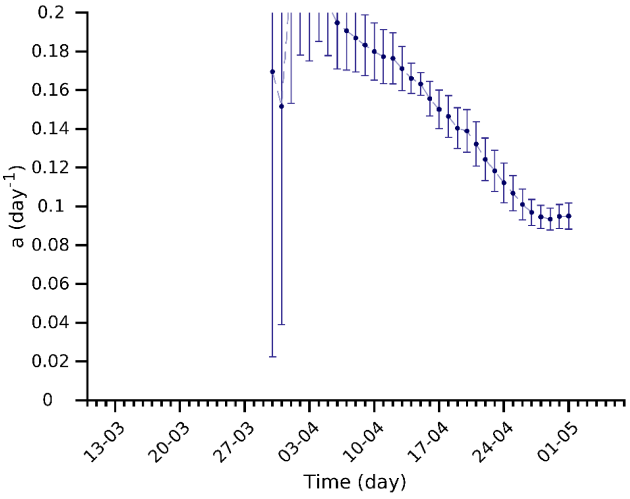


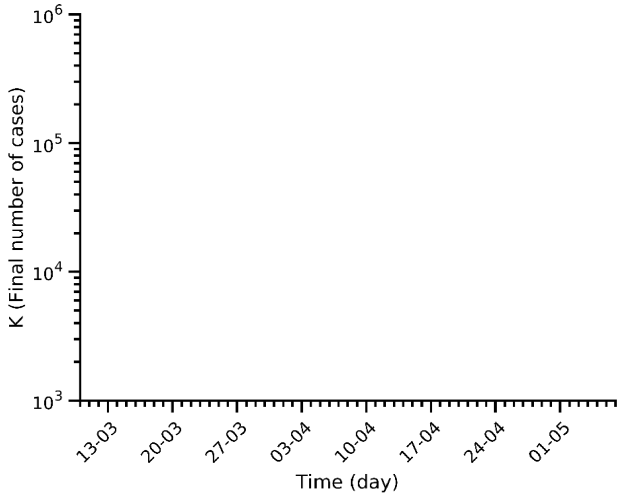


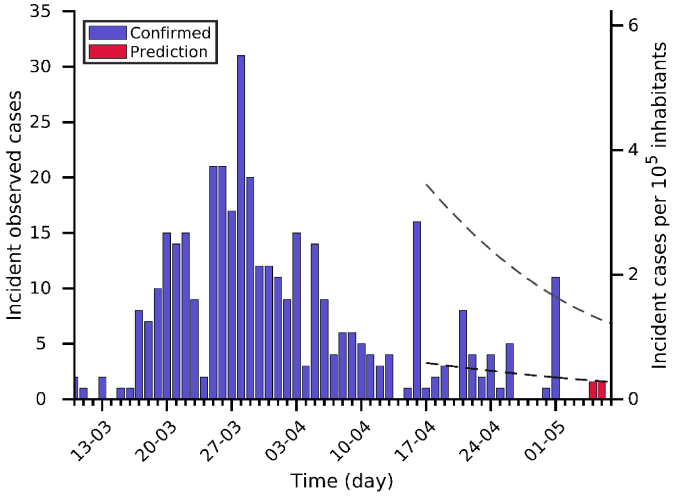
Basilicata 01-05-2020. Population: 0.6M. Current cumulated incidence: 67/10^5

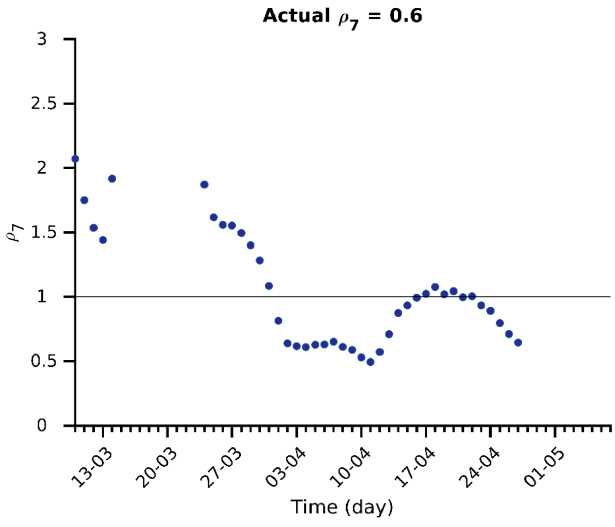


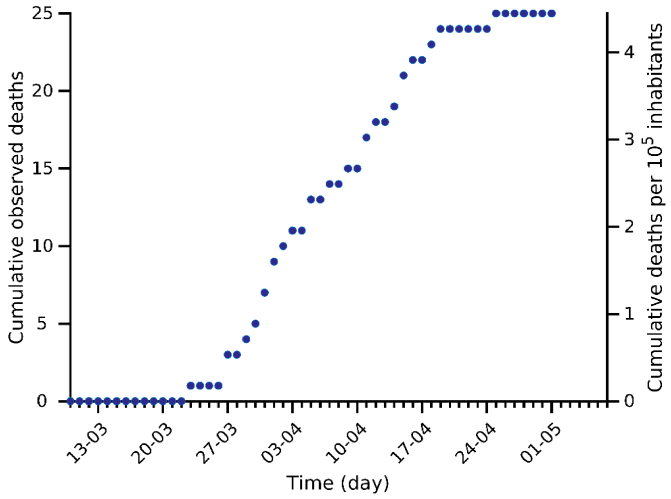


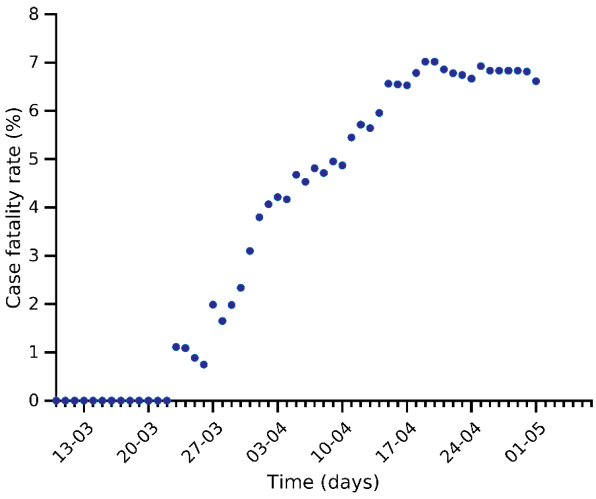




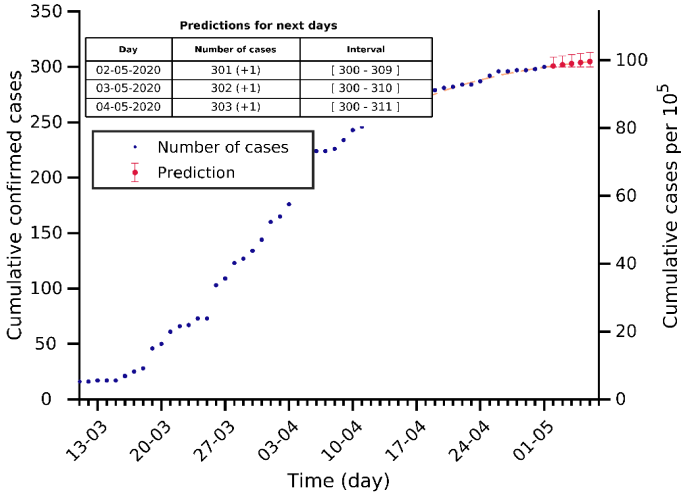


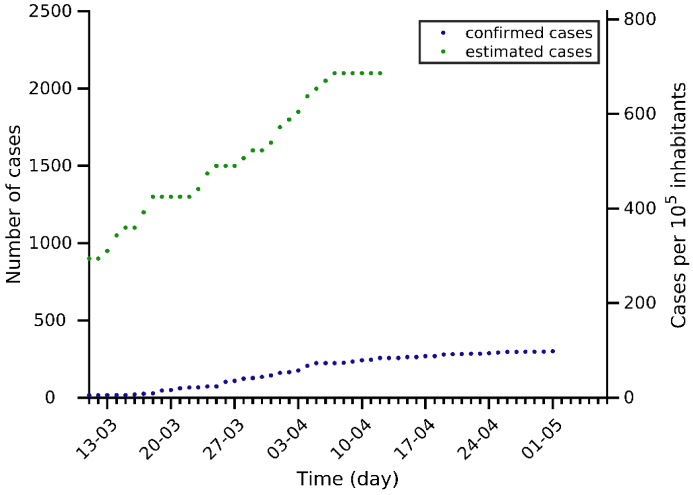


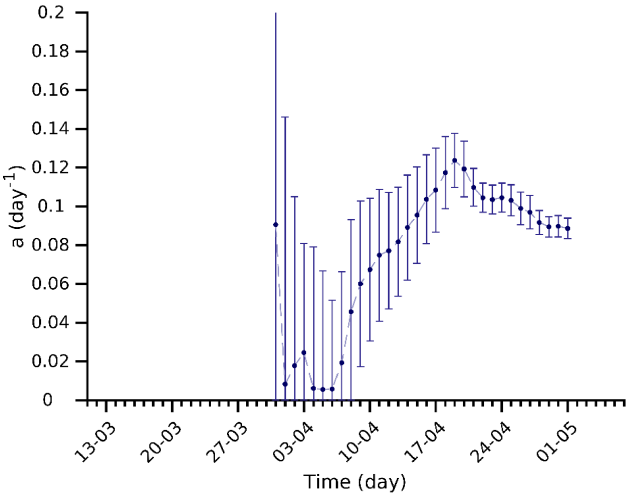


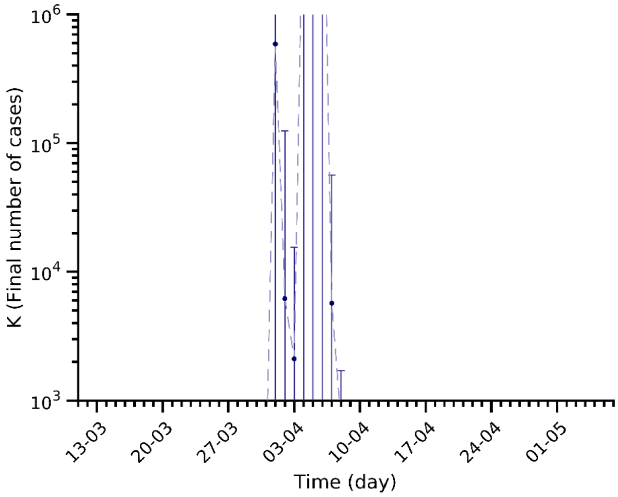


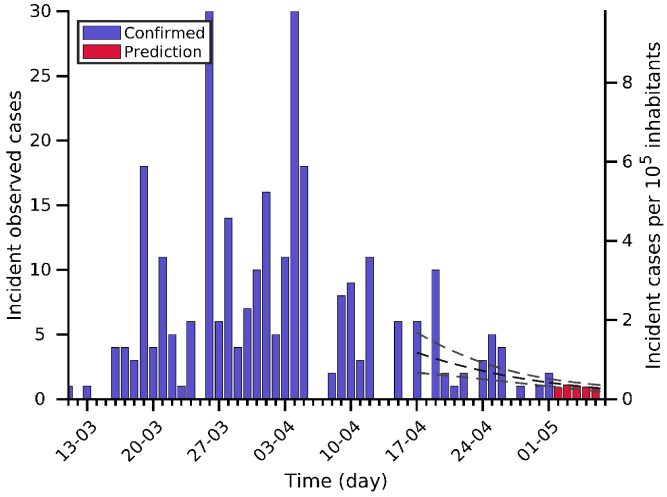
Molise 01-05-2020. Population: 0.3M. Current cumulated incidence: 98/10^5

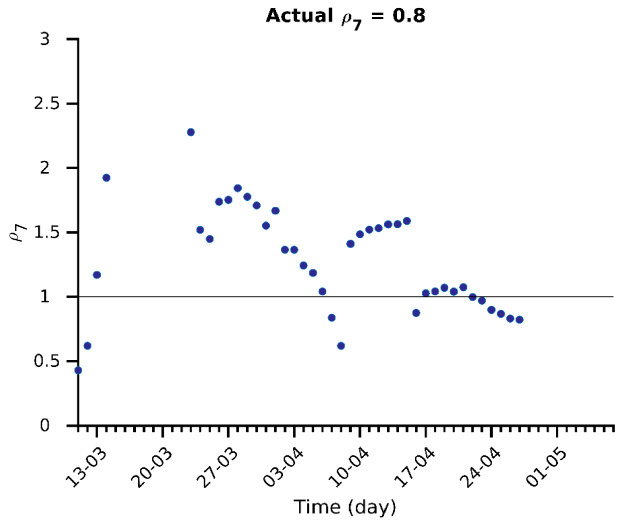


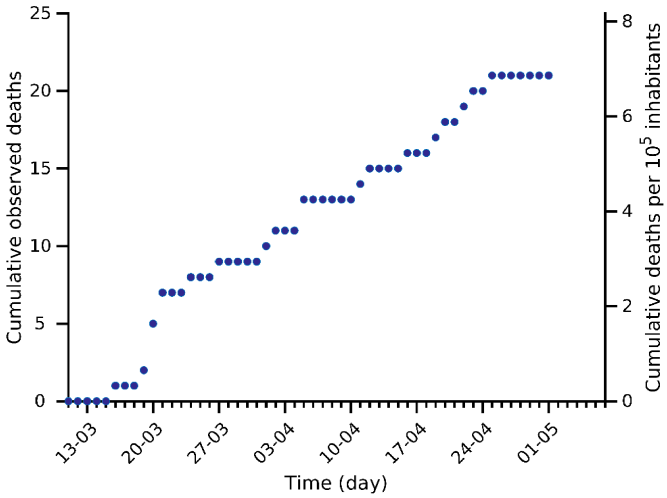


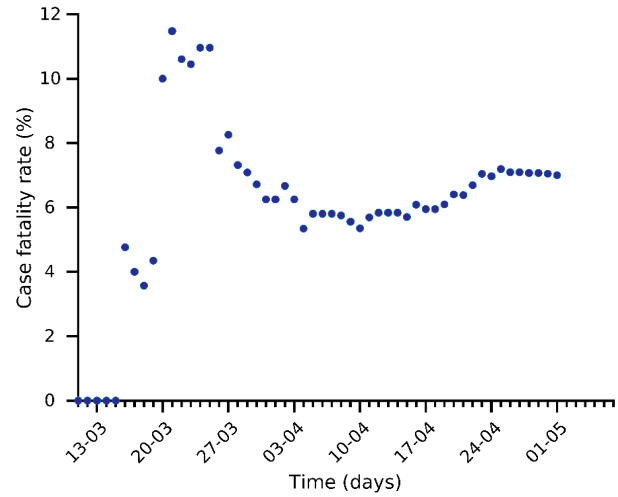












Methods

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:

[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