Global analysis of Covid-19 in Europe*

Tomás Urdiales and Pablo Palaciso
Department of Physics, Universitat Politècnica de Catalunya (UPC-BarcelonaTech), C. Jordi Girona, 1-3, 08034 Barcelona, Catalonia, Spain
(Dated: June 19, 2020)

I. INTRODUCTION

The COVID-19 pandemic of 2020 [1] has highlighted the importance of high-quality data processing in situations of crises. In the face of a new, completely unstudied virus, empirical models have proven capable of providing essential predictions that serve as a scientific guide to policy. While most countries were implementing lock-down measures and carrying out radical sanitary operations, proper data processing allowed for damage assessment and prevention, and will continue to be a vital tool in tracking potential future outbreaks all throughout the world as restrictions are lifted.

In this paper we present the work carried out by UPC's Computational Biology and Physics departments [2] (among others) to estimate and track the state of the pandemic through an empirical model and how we have collaborated with them over the past three months. Three main numerical indexes have been designed and developed over time as more information was available and analysis techniques adapted to the situation. They quantify propagation and estimated real cases to accurately determine the risk level of each country. Furthermore, a number of graphs and diagrams have been created to act as visual tools to easily display data and results. During most of our time working with the researchers we have helped to code the programs used, as well as taken part in the creation of said graphs. The team's main end products have been global analysis reports sent to the European Centre for Disease Prevention and Control, which we have been contributing to daily since the end of March.

II. DATA SOURCES AND MATERIALS

A. Data sources

All data for global analysis (EU countries and others) has been obtained from the ECDC [3]. Nevertheless, we have also carried out studies at a regional level for which other sources have been needed. In the case of Spain and Italy, for example, we have relied on the data provided by [4] and [5].

It must also be mentioned that the global data provided by the ECDC was updated daily but presented a delay of two days. This is due to the fact that the numbers of a given day are usually made available by each country the following day. Furthermore, each one publishes it at a different time (due to different time-zones and timetables) and it takes the ECDC another day to recompile all of them.

B. Software tools

Three main software tools were used to carry out our work with the team. They are explained in the order they would typically be used to produce our part of the daily reports and an example can be observed in Figure 3.

1. Matlab

Most data processing was done using MatLab codes we programmed for each specific application and the data input would usually come from an Excel file. After being read and exported onto MatLab, we performed all the operations and wrote the results onto another Excel file to then be formatted into tables. Graphs, however, were mostly created directly from MatLab using its graphical capabilities. To facilitate the making of tables and figures on a daily basis, many codes were automated so that as soon as new data was available one could just execute the program and obtain the results.

2. Excel

After the data had been processed, it was built into a set of different Excel tables and formatted. We ordered them and applied matching color scales so that one table could easily be compared to another without looking at the numbers in depth. These ended up being an important part of the team's reports as they provided a useful summary of the situation.

3. IrfanView

This program was used to convert the PDF files obtained from Excel into high-resolution PNG images. This

* Though their work now covers many different countries around the globe, here we will only focus on Europe since it is where the team's main efforts have gone into and where we have contributed primarily.

step ended up being quite useful as the pictures were easily included in the report and could also be used to share the team's results in a public medium such as their official Twitter account. It became apparent in the first days of our collaboration with the team that these images required a high level of detail because the tables became bigger in size and included lots of relevant numbers. After some research we ended up switching to IrfanView. It is a free graphic-viewer that allows us to quickly crop PDF files and render them as pictures in adjustable resolution.

III. METHODS

A. Indexes and parameters

While collaborating with the team, the crux of our work has had its backbone in the three numerical indexes presented here. These indexes have been in constant development all throughout the first months of the pandemic and have been adapted to best represent the situation in the face of new findings and data. The way they are explained here is how they have remained for the weeks prior to the writing of this document and how they are being used at present.

1. *14-day attack rate, A_{14}*

This index is designed to represent the number of people per every 10000 inhabitants of a given area who are likely to still be infectious after having tested positive for COVID-19. A period of 14 days has been chosen based on the general conclusions of most medical authorities and researchers regarding the treatment of coronavirus disease [6] [7]. It is taken as the average amount of time that a confirmed case will be infectious. Therefore in order to calculate the A_{14} of a given day we work from a data-sheet of cumulative cases over time and subtract the number of cases that there were fourteen days ago to the number of cases of the day we are studying. Since this index is calculated in relation to the total population, the calculation becomes:

$$A_{14}(t) = \frac{N(t) - N(t-14)}{population} \cdot 10^5$$

Needless to say, there are multiple practical limitations to the accuracy of this index since most health authorities report their data in a different manner. Some of the most relevant variables when it comes to reporting cases are: type of test reported, reporting frequency, update of reported data temporal series, number of available tests, percentage of diagnosed cases, biased subpopulations that are over/under diagnosed, etc. Despite the influence these have on A_{14}, the index is still useful and reliable given that it represents the density of infectious people in a given population based exclusively on official empirical data about confirmed cases. It does not depend on any theoretical assumptions other than the 14-day period of contagiousness.

2. *Propagation rate, ρ*

The 'rho' parameter is defined as the growth rate in the amount of daily new confirmed cases and serves to quantify the degree to which a given area is controlling the spread of the virus. To understand the physical meaning of the possible values of this index one must observe how it is computed:

$$\rho(t-1,\tau) = \frac{nc(t-2) + nc(t-1) + nc(t)}{nc(t-2-\tau) + nc(t-1-\tau) + nc(t-\tau)}$$

where nc(t) is the number of new confirmed cases at time t, and τ is the incubation period, which for COVID-19 case is estimated to be around 5 days [11]. Thus, it is calculated as the number of newly infected in the last three days divided by the number of newly infected during the three days τ days ago. A value of $\rho > 1$ implies that the epidemic is growing, because the number of new cases today is bigger than what it was five days ago and a value of $\rho < 1$ implies the opposite, that the number of new cases is decreasing. Naturally, at a value of $\rho = 1$ the epidemic remains at a constant level. For this reason the value of 1 is used as a benchmark for countries that are struggling to stop the spread of the virus to assess the effectiveness of their control measures.

An interesting phenomena has been observed regarding the reporting of confirmed cases of coronavirus disease. That is the fact that weekends alter significantly the amount of new cases. One can expect a substantial decrease during Saturday and Sunday and a sharp rise during the first week days. Despite the fact that this occurrence can surely be explained taking into account factors such as health centre activity on different days, the team's methodology is empirical and is not so concerned with the causes as much as it is with its impact on data. Furthermore, the ρ index is inherently unstable because of how it is computed, particularly for not so large numbers of new cases. Given the importance of this parameter in the estimation of risk for a given population, a three-day average of ρ values was required to smooth out the peaks and provide a much more plausible behaviour over time. After careful examination and study, it was determined that a 7-day average worked best to soften both the weekend effect and the inherent instability. Thus, all reports and further calculations since April have made use of this ρ_7 parameter instead of ρ_3.

To compute this index for any given day it is necessary to obtain the number of new cases over time. In some cases official health authorities will directly supply this information but usually it is obtained from the aforementioned data-sheet of confirmed cases over time by subtracting to each day the number of cases of the previous day. The calculation of this and of the ρ parameter have been carried out on MatLab.

3. *Effective Potential Growth*

EPG, the last index, is a direct quantification of risk. It is calculated by simply multiplying the A_{14} and ρ_7 of a given point in time:

$$EPG(t) = A_{14}(t) \cdot \rho_7(t)$$

It is not enough to know just how many active cases there are or how fast the number of new cases is growing, but when both factors are taken into account, one obtains an index that provides the full picture. Naturally, high EPG values point towards an increasingly worrisome situation or even a full blown wave of infections. Once the ρ index has been smoothed out by taking a multiple day average, it usually behaves within values of 0.5 up to a maximum of 2 (for highly populated areas with considerable confirmed cases, i.e. Barcelona). As a consequence, one expects EPG to usually be anywhere from 0 to 1000. This exact interval has been utilised for things such as color scales in data representation and can be observed in Figure 3.

All three indices have been calculated for a number of locations: countries of Europe, provinces of Spain, regions of Italy, etc. For areas where the data was regularly updated and readily available, these parameters where recalculated on a daily basis to be used for analysis and reports.

B. Estimation

An important part of the team's work has also been that of estimating the 'real' magnitude of the previously explained parameters.

It quickly became apparent that most affected countries had incredibly low diagnostic rates in proportion to their total population. As a result, only a fraction of infected people were ever tested and represented as confirmed cases in the data. Thus, the mortality rate always turned out to be much higher that what it was expected to be [8] and health institutions and citizens knew that the official numbers of the spread of contagions did not display the full scope of the situation.

The team's researchers developed a model that later proved to be successful in correctly estimating diagnostic rate, real A_{14} and real EPG. Essentially, it is built upon the assumption of a global 1% mortality rate. This number has been widely accepted by the medical community and is based on studies conducted on the outbreak on the Diamond Princess cruise ship [9] [10] and on the early days of the epidemic in South Korea (where high diagnostic rates were achieved). Furthermore, one can take what has been accepted as the general time between diagnosis and death (18 days) and estimate the real number of contagions at that point in time based on the number of deaths at present. By calculating the correlation between estimated and official confirmed cases as the estimated is shifted in time, it is possible to estimate diagnosis delay (the average time between developing symptoms and being diagnosed with coronavirus by a country's health authorities). Many more conclusions can be derived from working with said estimation but for brevity reasons it is not possible to go more in depth into this procedure here and we must refer you to our original paper [11].

Another element of the team's research has been using Gompertz's model to estimate final number of cases, containment measures' efficiency, etc. It was discovered early on that the spread of COVID-19 could be modelled using Gompertz's function and by fitting the data to this curve it is possible to make a number of important estimations. As more data has been made available over time, these predictions have become more reliable and accurate. They are an important part of the team's global analysis and risk assesment.

IV. RESULTS

A. Evolution

Since the beginning of the epidemic, several changes of the paradigm have occurred. From the initial Chinese cluster, the mean focus then moved to Europe, reaching the grade of pandemic. Now the heart of it seems to be located in America. Therefore the object of study has also changed from only focusing on Europe (particularly Italy and Spain) to a more global analysis. However, these indexes have proven to be efficient parameters in describing the state and evolution of the pandemic throughout the globe.

All relevant has been recompiled for EU and EFTA countries, as well as regionally for Belgium, Spain and Italy. Furthermore, other countries have been included in the study as of late, since, as mentioned before, the focus has moved on to other continents. In Figure 3 it is shown how these have been monitored since the beginning of the pandemic. These tables allow a comparative perspective of the situation in several countries, and therefore of the global propagation and state of the pandemic. The data displayed on these tables is basically the previously explained indexes and parameters plus the most relevant figures, such as the accumulated cases and deaths and the incidence and mortality rate per 10^5 inhabitants. The color scale has been chosen as seen in

Figure 3 from worst to best for the reported data. However, the indexes' color scales have been chosen according to a visual representation of actual risk, with the limits described previously. As an example of the evolution of the EPG index in Spain, on 28 March, when the confinement had already been implemented for around 2 weeks, the EPG index reached its maximum of 217, while on 15 July it was situated at 13 [2]. Even the estimated EPG was below that level (143), showing clearly that the situation had been controlled although there was still risk of new outbreaks.

Furthermore, one of the most visual tools to show the evolution of the pandemic over time are 'risk diagrams'. These are useful to visualize the evolution of a region in terms of ρ_7 (y-axis), A14 (x-axis) and EPG (background colour), either with reported or with estimated data. The color-code is related with the ability of a country or region to do contact tracing, setting at 1000 estimated real cases the red as the threshold where it is impossible to carry it out [12], which for a 10% diagnostic rate, as in the case of Spain [11], would correspond to an EPG of 100, hence this has been set as the limit for high risk situations in the non-estimated risk diagrams (e.g. figure 1).

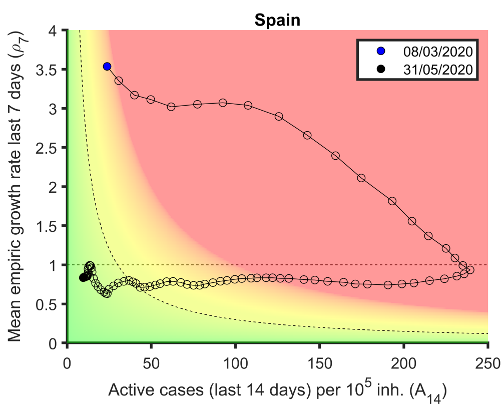

FIG. 1. Risk diagrams for Spain using reported cases. Each point represents a different day. Starting and final days are marked by date. Colour code depends on Effective Potential Growth.

As an example of the typical evolution described by risk diagrams, we will analyse figure 1, corresponding the risk diagram of Spain. In the beginning of the pandemic, on March 8, the ρ_7 was quite large, since the pandemic was rapidly growing but the number of cases was low. However the situation rapidly escalated from the yellow zone to a high risk scenario, entering the red zone. The confinement measures allowed the ρ_7 to reach levels below one, and the situation the pandemic started then to improve going towards a lower number of cases, finally reaching the desirable green zone, with a low number of active cases and a ρ_7 below or around one. Most countries have followed this evolution, however, we have observed the emergence of new outbreaks in some regions that have truncated the correct evolution of the pandemic presenting risk diagrams with loops (see [13]).

Furthermore, since these diagrams don't allow us to see the exact numbers of the indexes that show the evolution of the pandemic, another tool, quite similar to the risk diagrams, has been developed, the **risk dashboards**. However these tables might be quite overloaded when studied for a lot of countries or regions. Consequently, they have been used for more specific purposes such as the analysis of the evolution of the different Catalonian sanitary regions and their process of de-confinement, also for Spanish and Italian regions and lately to see the evolution of countries at highest risk (figure 4).

B. Biocom Cov Degree

According to the new state of the pandemic, the need for new parameters of control has become more relevant, since, when the cases are too low, the ρ_7 might lose its meaning. Therefore a new index has been incorporated to the daily tables [14]. This new index has been called Biocom Cov Degree and it is an adaptation of the Douglas and Richter-like scale [15] [16]. It evaluates the current risk of a region from the daily new incident cases per 10^5 inhabitants, classifying the different risks from level 0 to level 9. In Figure 2 it can be seen which countries were on highest risk on June 1. These countries with risk levels between 7 and 9 are still in high risk situations as it is shown in the latest reports [13]. Nevertheless the case of Qatar is quite different from others since they seem to be diagnosing with a very high efficiency, as the number of deaths is very low when compared to the number of cases[3].

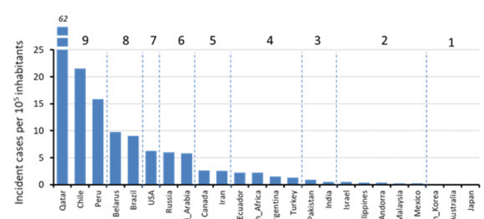

FIG. 2. Biocom-Cov Degree as on June 1. In the x axis the different countries for which it has been evaluated in order from highest to lowest degree. On the y axis the number of incident cases per 10^5 inhabitants. Data from [3]

.

V. CONCLUSION

We have proved ρ_7 and A_{14} to be two relevant and solid figures for the study of the situation and evolution of the pandemic. In addition, we have incorporated a new index, the EPG, based on these two, to evaluate the current risk and therefore apply policies conditioned by its value.

Country	Reported data								Indexes		
	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.	Estimated active cases (last 14 days)	Estimated 14-day attack rate /10^5 inh.	ρ_7	EPG_{REP}	EPG_{EST}
United States of America	1,577,287	476.5	94,702	28.6	320,315	96.8	2,104,747	635.9	1.01	98	642
Brazil	310,087	145.9	20,047	9.4	174,981	82.3	1,444,359	679.5	1.45	119	985
United Kingdom	250,908	369.6	36,042	53.1	44,193	65.1	661,072	973.8	0.76	49	739
Spain	233,037	495.5	27,940	59.4	9,819	20.9	117,591	250.1	0.66	14	164
Italy	228,006	377.1	32,486	53.7	12,148	20.1	175,873	290.9	0.77	16	225
Germany	177,212	211.5	8,174	9.8	9,912	11.8	48,617	58.0	0.84	10	48
Turkey	153,548	182.1	4,249	5.0	19,827	23.5	56,700	67.2	0.88	21	59
France	144,163	220.9	28,215	43.2	6,384	9.8	134,187	205.6	0.91	9	187
Iran	129,341	154.0	7,249	8.6	26,206	31.2	157,794	187.9	1.21	38	228
Peru	108,769	329.9	3,148	9.5	50,243	152.4	172,374	522.8	1.28	196	671
China	84,079	5.8	4,638	0.3	103	0.0	571	0.0	0.93	0	0
Canada	81,313	215.4	6,152	16.3	16,391	43.4	149,029	394.9	0.96	42	377
Mexico	59,567	46.2	6,510	5.0	29,951	23.2	433,997	336.6	1.25	29	419
Netherlands	44,700	260.9	5,775	33.7	2,926	17.1	38,828	226.6	0.78	13	176
Ecuador	35,306	200.1	2,939	16.7	5,008	28.4	53,893	305.5	1.41	40	432
Sweden	32,172	318.6	3,871	38.3	7,549	74.7	100,545	995.6	0.94	71	939
Switzerland	30,611	353.7	1,637	18.9	568	6.6	3,058	35.3	0.74	5	26
Portugal	29,912	293.3	1,277	12.5	3,197	31.4	14,401	141.2	1.13	35	160
Ireland	24,391	494.0	1,583	32.1	2,006	40.6	13,370	270.8	0.62	25	167
Poland	20,143	53.2	972	2.6	5,096	13.5	28,757	76.0	0.97	13	74
Romania	17,585	91.4	1,151	6.0	3,086	16.0	21,712	112.9	0.84	13	95
Japan	16,513	13.1	796	0.6	966	0.8	4,917	3.9	0.59	0	2
Austria	16,332	181.3	633	7.0	659	7.3	2,617	29.1	0.99	7	29
Denmark	11,182	193.1	561	9.7	1,099	19.0	5,625	97.1	0.82	16	80
Czech Republic	8,754	81.7	306	2.9	723	6.8	2,752	25.7	1.35	9	35
Norway	8,268	152.5	234	4.3	273	5.0	792	14.6	0.69	3	10
Finland	6,493	117.2	306	5.5	820	14.8	4,227	76.3	0.95	14	72
Hungary	3,678	38.1	476	4.9	500	5.2	6,996	72.4	1.07	6	78
Greece	2,853	27.4	168	1.6	175	1.7	1,063	10.2	0.99	2	10

Scale										
Worst	Worst	Worst	Worst	Worst	Worst	Worst	Worst	2.0	100	1000
Best	Best	Best	Best	Best	Best	Best	Best	0.0	0	0

FIG. 3. Table with last indexes and reported cases value as 22 May 2020. Left to right columns are: country, cumulative reported cases, number of total cases per 10^5 inhabitants (attack rate), cumulative number of reported deaths, number of deaths per 10^5 inhabitants, reported number of new cases last 14 days (active cases), reported active cases per 10^5 inhabitants (14-day attack rate), estimated number of new cases last 14 days (active cases), estimated active cases per 10^5 inhabitants (14-day attack rate), 7-day moving average empiric reproduction number (ρ_7), effective potential growth of reported cases (EPGREP) and estimated effective potential growth (EPGEST). Each column has its own colour scale as seen at the bottom of the figure. Data was obtained from [3] at 23 May 2020

.

	USA			Brazil			Russia			Argentina			Belarus			Peru		
	ρ_7	IA_{14}	EPG	ρ_7	IA_{14}	EPG	ρ_7	IA_{14}	EPG	ρ_7	IA_{14}	EPG	ρ_7	IA_{14}	EPG	ρ_7	IA_{14}	EPG
04-04-20	1.71	78	134	1.81	4	7	3	3	8	1.15	2	3	8.51	3	26	2.23	4	9
05-04-20	1.64	86	142	2.02	4	9	2.88	3	9	1.08	3	3	11.65	3	39	2.3	4	10
06-04-20	1.56	91	142	2.1	5	9	2.6	3	9	1.14	3	3	12.42	5	64	2.21	6	13
07-04-20	1.48	97	144	2.08	5	10	2.33	4	9	1.14	3	3	13.27	7	87	2.28	7	15
08-04-20	1.4	104	145	1.97	5	11	2.18	5	10	1.26	3	4	12.07	8	100	2.34	8	18
09-04-20	1.34	110	147	1.87	6	12	2.11	5	12	1.23	3	4	11.79	10	122	2.59	11	30
10-04-20	1.28	115	147	1.79	7	13	1.99	6	13	1.25	3	4	9.59	15	142	2.92	14	41
11-04-20	1.22	120	146	1.7	8	13	1.96	7	15	1.15	3	3	6.55	20	131	3.12	16	50
12-04-20	1.14	122	140	1.5	8	12	1.93	8	16	1.12	3	3	3.89	23	88	3.3	19	62
13-04-20	1.09	125	137	1.43	8	12	1.97	10	19	1.02	3	3	3.46	26	91	3.25	20	66
14-04-20	1.04	126	131	1.38	9	12	2	11	23	1.03	3	3	2.86	30	85	3.07	20	61
15-04-20	1	127	127	1.34	9	12	2.05	13	26	0.96	3	3	2.61	33	86	2.88	28	81
16-04-20	0.96	128	123	1.28	10	13	2.08	15	31	0.97	3	3	2.39	38	91	2.52	31	78
17-04-20	0.95	129	122	1.25	11	13	2.08	17	35	0.97	3	3	2.09	42	87	1.89	34	64
18-04-20	0.93	128	120	1.27	12	15	2.01	19	38	0.99	3	3	1.77	47	83	1.61	36	58
19-04-20	0.95	128	121	1.35	12	17	1.97	22	43	1.04	3	3	1.45	46	67	1.5	38	58
20-04-20	0.95	128	122	1.43	13	19	1.96	26	50	1.05	3	3	1.2	45	53	1.36	40	55
21-04-20	0.98	127	124	1.48	13	20	1.93	28	54	1.1	3	3	1.12	59	66	1.35	42	56
22-04-20	1.01	129	130	1.5	14	21	1.88	31	58	1.1	3	3	1.14	62	71	1.27	45	57
23-04-20	1.02	124	127	1.47	14	21	1.8	34	61	1.19	3	4	1.23	66	81	1.24	45	56
24-04-20	1.01	122	124	1.42	15	21	1.7	36	61	1.21	3	4	1.31	69	91	1.18	47	56
25-04-20	0.98	118	115	1.31	16	21	1.57	39	61	1.22	3	4	1.63	72	117	1.15	48	55
26-04-20	0.97	124	120	1.26	18	22	1.46	42	61	1.23	4	4	1.69	78	132	1.2	56	67
27-04-20	0.96	123	119	1.28	19	24	1.34	45	60	1.21	3	4	1.79	83	149	1.34	61	81
28-04-20	0.98	123	121	1.39	20	28	1.26	47	60	1.22	4	5	1.75	89	155	1.52	64	97
29-04-20	0.97	122	118	1.47	22	32	1.2	50	60	1.19	4	4	1.74	94	165	1.6	63	101
30-04-20	1	121	121	1.58	23	37	1.17	51	60	1.22	4	5	1.7	100	170	1.68	68	114
01-05-20	1	120	120	1.64	26	42	1.15	54	62	1.2	4	5	1.63	104	169	1.65	74	123
02-05-20	1.03	121	125	1.7	27	46	1.16	56	66	1.25	4	5	1.28	107	137	1.68	82	137
03-05-20	1	120	121	1.63	28	46	1.2	60	72	1.16	4	5	1.2	117	141	1.55	85	132
04-05-20	1.02	120	123	1.52	29	45	1.25	63	78	1.14	4	5	1.17	126	148	1.49	92	137
05-05-20	1	119	119	1.39	32	44	1.31	67	88	1.01	4	4	1.16	119	138	1.36	94	128
06-05-20	1	115	114	1.32	34	44	1.37	70	96	1	4	4	1.08	123	133	1.33	101	135
07-05-20	0.95	117	110	1.26	37	47	1.42	74	105	0.9	4	4	1.03	127	130	1.23	108	132
08-05-20	0.94	117	111	1.26	40	51	1.44	78	112	0.95	4	4	1	129	129	1.22	114	139
09-05-20	0.94	119	111	1.31	43	57	1.44	82	117	1.02	5	5	0.99	130	129	1.19	122	145
10-05-20	0.95	112	107	1.38	46	63	1.4	85	119	1.15	4	5	0.99	132	131	1.22	120	147
11-05-20	0.93	110	102	1.43	47	68	1.33	88	118	1.18	4	5	1.01	132	133	1.15	121	139
12-05-20	0.91	109	99	1.43	48	68	1.25	92	115	1.22	4	5	1.03	134	137	1.11	122	135
13-05-20	0.9	108	97	1.4	50	70	1.17	95	111	1.34	5	7	1.05	134	140	1.05	124	130
14-05-20	0.89	106	95	1.35	52	70	1.1	98	107	1.46	6	8	1.06	134	142	1.03	129	133
15-05-20	0.9	105	95	1.3	55	72	1.05	100	104	1.56	6	9	1.06	135	143	1.01	132	134
16-05-20	0.92	103	94	1.23	60	73	1.02	102	103	1.63	7	11	1.06	136	144	1.05	134	140
17-05-20	0.94	101	95	1.23	64	79	0.99	101	101	1.72	7	12	1.05	136	143	1.09	140	152
18-05-20	0.95	99	95	1.27	66	84	0.97	101	98	1.66	7	11	1.04	137	142	1.18	141	166
19-05-20	0.98	99	97	1.33	69	92	0.94	100	93	1.64	8	13	1.02	138	142	1.23	144	178
20-05-20	0.99	98	97	1.37	74	101	0.92	99	91	1.54	8	13	1.01	139	141	1.27	146	187
21-05-20	1.01	98	98	1.43	78	112	0.9	98	88	1.5	9	14	1.01	139	140	1.29	149	192
22-05-20	1.01	97	98	1.45	82	119	0.89	96	86	1.47	10	15	1	140	140	1.28	152	196
23-05-20	1.02	96	98	1.46	87	128	0.89	95	84	1.54	11	17	0.99	140	139	1.23	151	186

FIG. 4. Risk dashboard for different countries. ρ_7, I.A.$_{14}$ and EPG are shown for all countries. Colour code for the Effective Potential Growth is the same as the one used in risk diagrams. ρ_7 goes from green being 0 to red being 2. For I.A.$_{14}$ the limit (red) is situated in 100, while the greenest also corresponds to 0.

High values of these index could indicate the need for new control measures, but it could also be used, when lowering, to control the deescalation process. Furthermore, the current state of the pandemic has also enforced us to develop a new index, complementary to the EPG, named as Biocom Cov-Degree, that takes into account possible new outbreaks. Nevertheless, these indexes could mislead to wrong comparisons between countries or regions, as the diagnosis rate changes among them. Therefore, we have also elaborated an estimation method to evaluate the actual state of the pandemics in the region, allowing us to calculate the EPG$_{est}$.

Moreover, more visual tools have been developed in order to get an easy and general view of the evolution of the pandemic in each region, the risk diagrams. For the reason explained before, underestimation in diagnosis, we have also developed the estimated risk diagrams to asses the real situation of the pandemic. Finally, to give numbers to these risk diagrams, we have elaborated another tool called risk dashboards. All together, these parameters and diagrams give a proper picture for policymakers to evaluate the different measures that may need to be applied.

VI. CITATIONS & REFERENCES

[1] Jüni P, Rothenbühler M, Bobos P, Thorpe KE, da Costa BR, Fisman DN et al. Impact of climate and public health interventions on the COVID-19 pandemic: A prospective cohort study. Cmaj; Jan 1 2020.

[2] Català M, Cardona PJ, Prats C, Alonso S, Álvarez-Lacalle E, Marchena M et al. Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries. Universitat Politècnica de Catalunya; 2020.

[3] European Centre for Disease Prevention and Control (ECDC). Coronavirus disease 2019 (COVID-19) in the EU/EEA and the UK. European Centre for Disease Prevention and Control; 2020.

[4] Instituto de Salud Carlos III [Internet]. Situación de COVID-19 en España.

[5] Ministerio della Salute Republica Italiana. COVID-19, i casi in Italia.

[6] Backer JA, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Eurosurveillance. 2020 Feb 6;25(5):2000062.

[7] Lauer SA, Grantz KH. Qifang Bi, Forrest K Jones, Qulu Zheng, Hannah R Meredith et al. The incubation period of coronavirus disease 2019 (COVID-19) from publicly reported confirmed cases: estimation and application. Annals of internal medicine; March 3 2020.

[8] European Center for Disease Prevention and Control (ECDC). COVID-19 surveillance report. 21 May 2020.

[9] Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro Surveill 2020; 25(10):pii=2000180. 2020;doi:10.2807/1560-7917.

[10] Russell T, Hellewell J, Jarvis C, van Zandvoort K, Abbott S, andet al RR. Estimating the infection and case fatality ratio for coronavirus disease (COVID-19) using age-adjusted data from the outbreak on the Diamond Princess cruise ship, February 2020. Euro Surveill 2020; 25(12):pii=2000256. 2020;doi:10.2807/1560-7917.ES.2020.25.12.2000256

[11] Català M, Pino D, Marchena M, Palacios P, Urdiales T, Cardona PJ, Alonso S, Lopez-Codina D, Prats C, Alvarez Lacalle E. Robust estimation of diagnostic rate and real incidence of COVID-19 for European policymakers; 2020.

[12] Català M, Cardona PJ, Prats C, Alonso S, Álvarez-Lacalle E, Marchena M et al. Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries. Universitat Politècnica de Catalunya; Report 66; May 20 2020.

[13] Català M, Cardona PJ, Prats C, Alonso S, Álvarez-Lacalle E, Marchena M et al. Universitat Politècnica de Catalunya; Report 66; June 10 2020.

[14] Català M, Cardona PJ, Prats C, Alonso S, Álvarez-Lacalle E, Marchena M et al. Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries. Universitat Politècnica de Catalunya; Report 66; June 02 2020.

[15] Douglas scale; Encyclopædia Britannica; June 22, 2018.

[16] David M. Boore, The Richter scale: its development and use for determining earthquake source parameters, Tectonophysics, Volume 166, Issues 1–3, 1989, Pages 1-14, ISSN 0040-1951.