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ANSWERS TO THE COMMENTS ON THE ARTICLE "MONITORING COVID-19 IS LIKE INSTRUMENT FLYING" SUBMITTED BY DAVID D. POKRAJAC

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Background

The authors of the article mentioned in the title received a Letter to the Editor submitted by Mr. David Pokrajac, on June 11, 2021 (Pokrajac, 2021). Mr. Pokrajac and the wider public and readers must take into consideration the following facts:

1. This paper[1] was submitted for printing on April 30, 2020,

2. A pre-final version was submitted about 15 days before the final submission, and

3. Some mathematical models, originally developed by the authors, were not published in this article nor on the website of the team of the authors, because the model did not show stability at the time of publishing. During the process of writing this paper, we expected that some data for relevant countries would show better fitting, but this did not happen until April 15, 2020. (Kočović et al, 2021)

Momentum 1

The Covid-19 pandemic in the world, on 15th of April, 2020 A.D., showed the following:

1. In the world, this was the 86th day of the pandemic,

2. In Serbia, this was the 41st day of the pandemic, and

3. In some countries, following the World Health Organization (WHO) guidelines, the counting of the number of infected people was

[1] In this paper, six new instruments were published. At the time of publishing the original paper, only two were published.

changed. In China, this happened on February 17, 2020, when they reported 17,778 cases after 2,450 on average before, and 226 after the change, Figure 1.

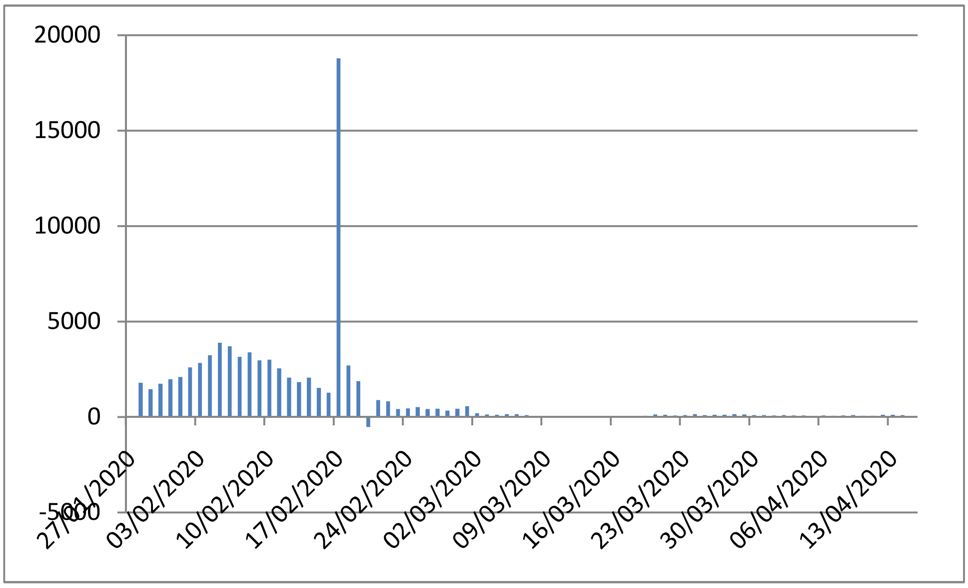

Figure 1 – Histogram of the infected people on a daily basis in China in January 27-April 15, 2020

The same situation happened in Columbia on April 25, 2020, Figure 2.

4. After we had submitted this paper, some countries (e.g. the UK and France) reported a much lower number of infected people, and they kept this smaller number as a new start point. Strange. Although we expected a dramatic reduction in the number of the infected, it did not happen until the submission of our paper (Kočović et al, 2020).

So, our first calculations presented in this paper were basic. What does this mean?

We used only the basic Gauss-Laplace equation/distribution that can be found everywhere. Our main literature sourcebook was Prem Mann (Mann, 1994) which shows the application of the Gauss Normal distribution in many situations, two of them being: i) distribution sales process and ii) the swine flu pandemic monitoring in 2008-2009. We took Figure 4 in our paper from Wikipedia. All figures from Wikipedia are free for borrowing and publishing in all types of papers and almost all publishing houses accept this. The same situation is with Figure 5 in our paper.

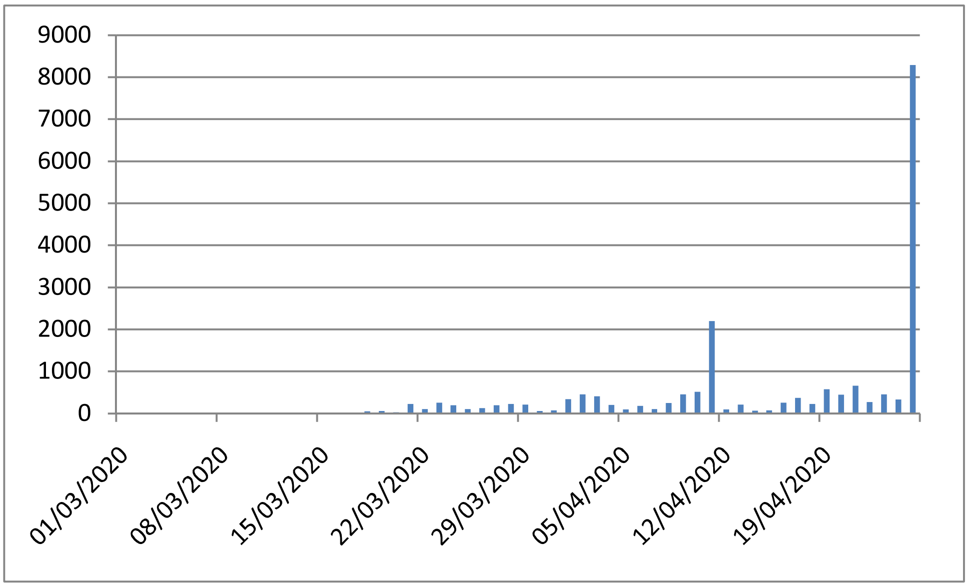

Figure 2 – Histogram of the infected people on a daily basis in Colombia in March 1-April 25, 2020

What had we already prepared in our mathematical model, but did not publish?

We studied all well-known distributions: Binary, Binomial, Fisher, and Student. Only the Gaussian distribution satisfied specified criteria at that time for our forecasting model, but we understand that we will have problems in the future. We developed our model, but we did not know how to call it. At the time, we understood that we had just one part of the distribution (from the beginning to the specific point, left-side) and that for another part we had to calculate using the Method of Least Squares. What first came to our mind was the Kirlian model, named after Soviet inventor Semyon Kirlian who made his famous set of photos where he "added" missing parts. However, giving personal names was not a good idea. We found the "Back-of-the-Envelope" theory developed by Enrico Fermi. Looking for a good name of the technique, the authors thought that this was a good name for the task we had done. Very soon, the authors found new methodology, the Levenberg-Marquardt algorithm[2] (Wikipedia, 2021). The Levenberg-Marquardt algorithm was the best that the authors found for the non-linear least-squares minimization and curve fitting.[3] When this algorithm was published as a Python library – the authors did not have a dilemma to use this one. Today, but not at the moment of writing the paper, the authors are using two other algorithms. In order to avoid confusion, it should be mentioned that, before publishing the paper, the authors found that two other teams were working using the same model:

1. The University of Singapore (their web site was last seen around May 1, 2020). The authors did not know what mathematical model they used, but a set of data was not equal. The results were very similar to ours. (SUTD Data-Driven Innovation Lab, 2020)
2. Governor Andrew Cuomo's (New York State, USA) speech about the Covid-19 situation (McKinsey, 2020). In his speech, Cuomo discussed possible future pandemic flow and measures that will be used in the future. He used the McKinsey methodology based on the Gaussian Normal distribution.

What did we not publish in our paper? What was not clear at that moment?

Using the Least Squares Minimization Method, we calculated the end of the wave. At that time, it was not clear whether there would be multiple waves. So our statement that the wave will be finished until the publishing date was not correct. Even China did not exit from wave 1. Today we know that all countries are in different phases/waves (from one to four) but at that time this was not visible. In the next months, we adjusted the residual number using our method. This method is shown in Figure 3 below. This is our INSTRUMENT 2.

[2] At the moment of publishing, the Levenberg-Marquardt algorithm was just one of the considerations for the fitting techniques.

[3] Today, but not at the moment of writing the paper, the authors are using two other algorithms: SciPy and Astropy (LMFIT.github, 2021). Also, the SciPy library has some improvements after the publishing of the paper and our calculations are more precise than at the beginning.

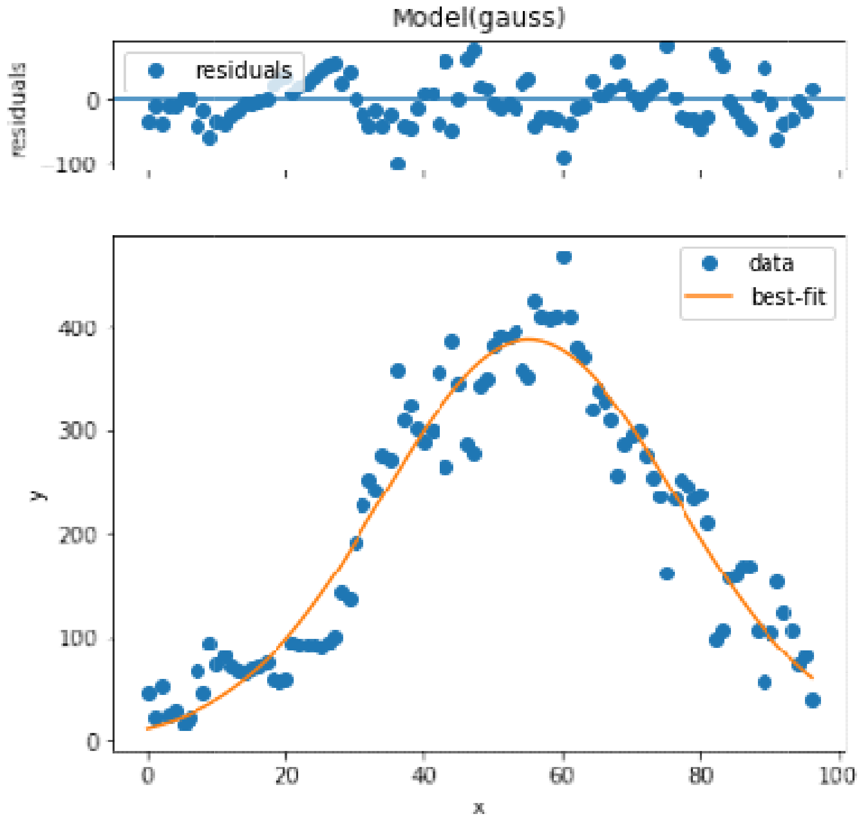

Figure 3 – INSTRUMENT 2: Fitting a Gaussian curve using residuals. Example – Serbia, May 13-August 31, 2020

At the very beginning, we used Microsoft Excel libraries. Soon we shifted to the programing language Python that has additional mathematical libraries for Machine Learning. Figure 3 is the result of our development. The only thing we adjusted during the time is a residual value.

The Sigmoid or S-curve was calculated simply. Calculating a Gaussian curve for every single day in the histogram, and smoothing the S-curve after the 3 SIGMA can be carried out very easily: we can add values to the existing 3SIGMA values, Figure 4.

At the time of writing the paper, the authors thought that a good way of presenting data is to use a log-log curve. In a similar way, a velocity trajectory is presented in mechanics. The base for calculations is the 7-day average number of infected people. The same results are obtained if a logarithmic function is first calculated over the data which are then plotted on the diagram. More details are given in the video (Kočović, 2020a) which explains why this technique is good when we compare several countries.

Momentum 2

Between 80 and 100 days from the beginning of a wave (in some cases duration was up to 300 days), the wave ended. The next day after a wave ended, a new wave began. As a general rule (defined by the WHO), the pandemic in each particular country will end when 28 days have passed without a new infected case. Some countries, like Spain or Sweden, did not report cases every day. Saturdays and Sundays were the days off for their bio-informatic personnel, so the WHO did not publish results on a daily equidistant basis. To resolve this conflict, we introduced moving averages based on 5 days. But a new question arises: which country is more infected if we want to compare two countries? We accept the criterion of the ECDC (European Centre for Disease Prevention and Control):
„calculation using the sum of infected people in previous 14 days on the base of 100,000 citizens“

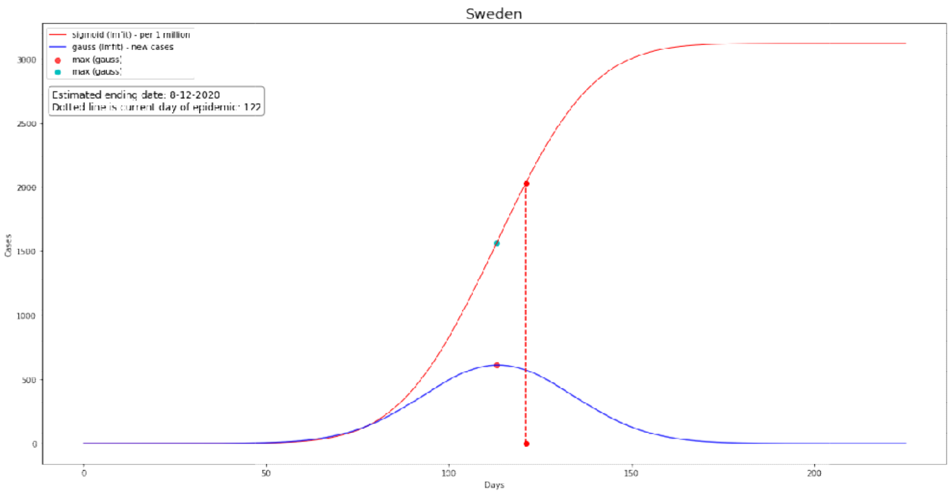

Figure 4 – Gaussian (blue) and Sigmoid (red) curves are plotted in one diagram.

This definition does not divide the sum with 14 (days). Instead, the algorithm keeps the sum for 14 days, Figure 5. Reason? Sums give us better perception! Using this index, the ECDC defined 3 zones:

Green – ECDC (0-15),
Yellow – (16-30), and
Red – (31-50).

The authors extended this definition with the next 9 zones:

51-100 – Red-violet,
101-150 -Violet,
151-300 – Deep violet,
301-500 – Popstar,[4]
501- 1000 – Grey,
1001 – 3,000 – Black,
3,001- 5000 – Onyx Black,
5,001 – 10,000 - Vanta Black, and
10,001+ - MIT Black.

Maldives and the Seychelles reached 2,900 indexes, as the highest in this pandemic until the moment of the publication of this answer!

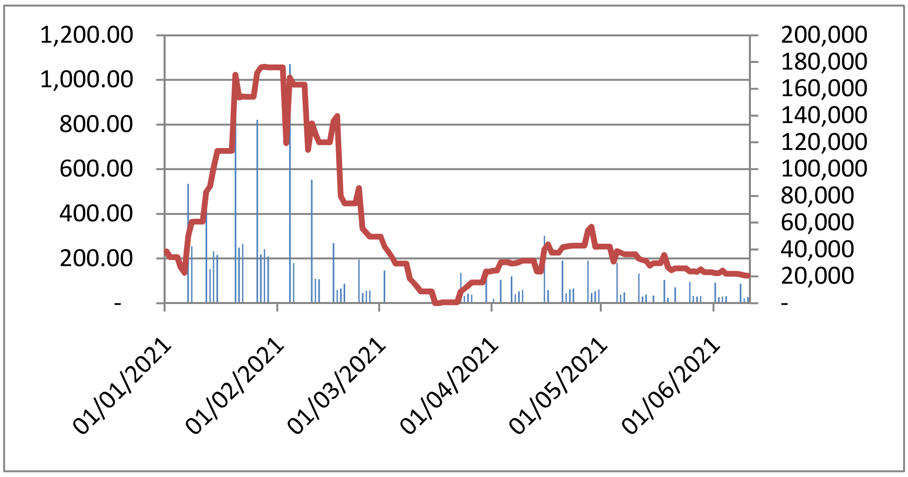

Figure 5 – Spain in the period Jan1-August 11, 2021. The blue bars are the daily numbers of infected people. The red line is the ECDC index. Note that the Spanish Ministry of Health report four days of cases, followed by the next 3 days without reported cases.

[4] See Pantone scale

The line with the ECDC coefficient is much smoother than the daily histogram. But, for better forecast, the authors still used the right-side, nonvisible Gaussian curve fitting model for predicting the end of the wave. So, here is a new, state-of-the-art presentation in the field of visual presentations, Figure 6.

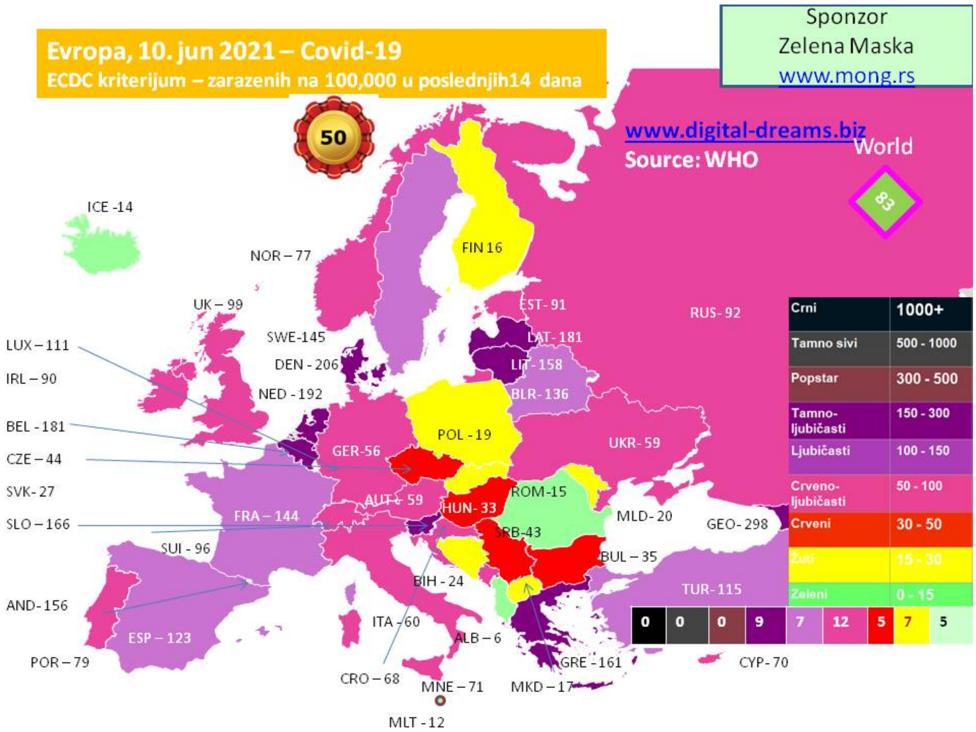

Figure 6 – INSTRUMENT 3: ECDC coefficient for each European country

Vaccination

Vaccination started in December 2020. Until June 11, 2021, 208 countries started with vaccination (Kočović et al, 2021b). Monitoring vaccination is an especially hard task because no authority is collecting data.

The authors developed a special crawler to collect such data from the National Health Bodies from every single country. Few websites such as Our World of Data (Our World in Data, 2021) are collecting data about vaccination but there are small differences in the number of vaccinated people with the first or second dose.

There is also a difference between our and their last records of collected data.

An example of vaccination with the first and second dose compared with the ECDC coefficient, using the Serbian data, is shown in Figure 7.

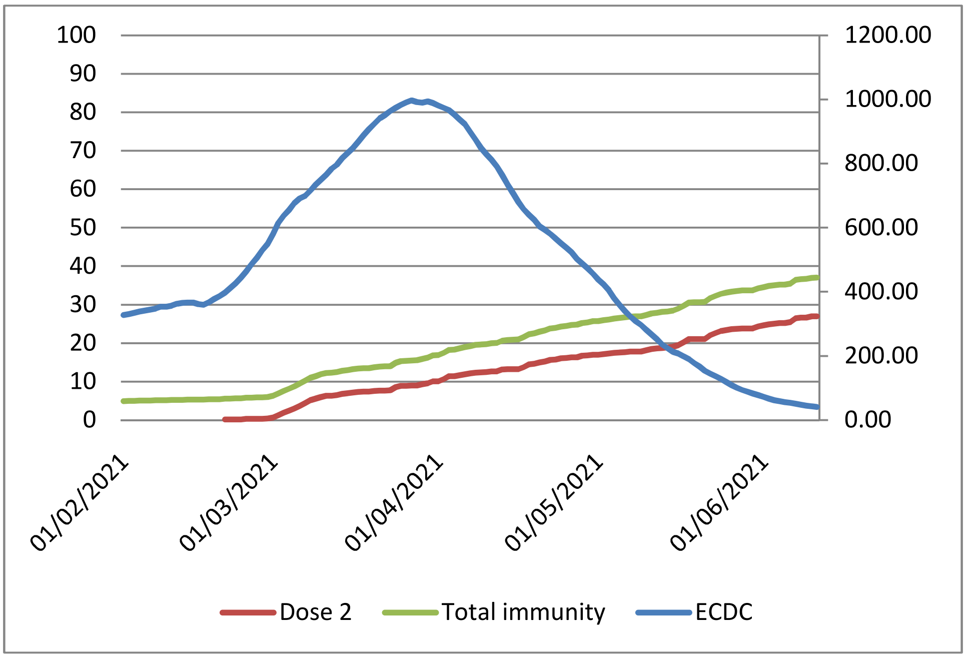

Figure 7 – INSTRUMENT 4: Immunization process in Serbia. Total immunity represents the number of the vaccinated with dose 2 plus the number of those recovered from Covid-19

The leader in vaccination was Israel and this country is the template for comparing the data between two or more countries globally.

To monitor the tempo of vaccination, and for a comparison between two or more countries, the authors have developed a mathematical model based on two-factor regression, Figure 8.

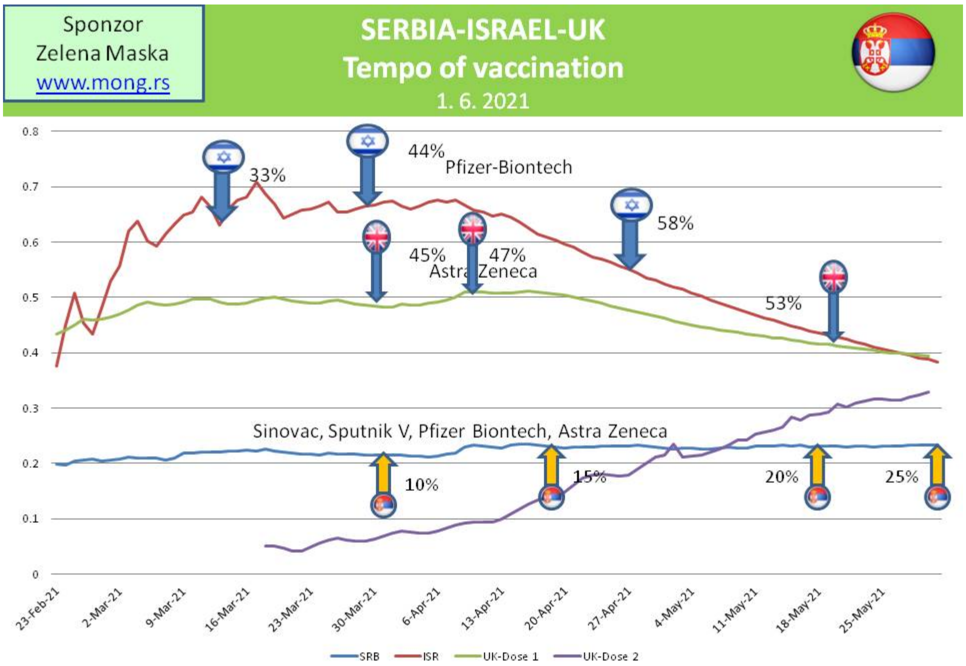

Figure 8 – INSTRUMENT 5: Israel vs the UK vs Serbia. Every line is two-factor regression data calculated for every single day. The period shown in the Figure is February 25-June 1, 2021. The arrows represent the points when Israel and the UK reached 33%, 44% and other important days in both countries when the mentioned countries removed special lockdown measures. In the case of Serbia, the arrows represent the dates when the country reached 10%, 15%, 20%, and 25% of the immunized population. (Note: Astra Zeneca takes 12 weeks between the first and second dose, Sinovac takes 4 weeks after the second dose. All other vaccines need 3 weeks after the second dose to reach full immunization.)

Momentum 3 – Extension of the mathematical model

The idea of the authors was to extend the existing mathematical models and to offer papers with the proven data to the *Military Technical Courier*. One of the basic ideas was an analysis of a wider look at the problem of the Covid-19 virus circulation in the coming months. The analysis consists of finding some correlations between the minimum sunspot number, CO_2 emission, and the start of the pandemics from 1900 until 2020 (Spanish flu, swine flu, avian flu (H5N1), and a Covid-19 storm).

The authors offered the paper with this specific topic to the *Military Technical Courier*, but the Editorial Board rejected it because it is out of the scope of the *Courier*. The authors uploaded the paper onto the ResearchGate.net website (Kocovic, 2020b).

The study analyzes the relation between the sunspot numbers and the start and the end (duration) of the specific pandemics in 20 and 21st centuries, as well as the link between CO_2 emissions. The sunspot numbers and the duration of each specific pandemic are presented in Figure 9.

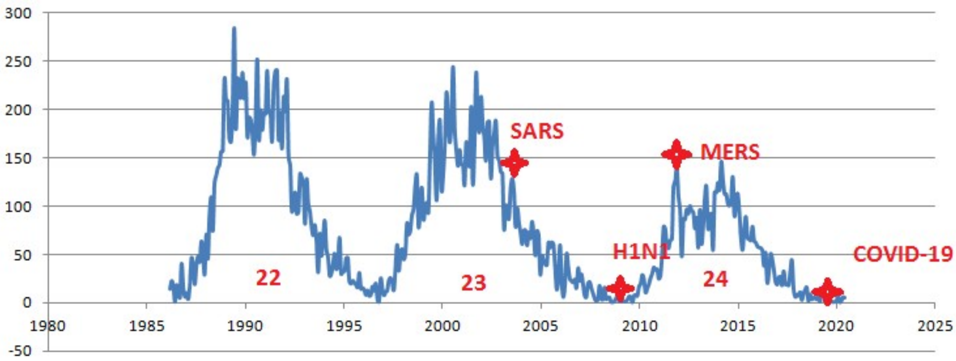

Figure 9 – Outbreaks of SARS, H1N1, MERS, and Covid-19 and their relation with the sunspot numbers and the 11-year intervals

The paper also puts into correlation CO_2 emission with the number of sunspots and possible problems during the winter season in the Northern Hemisphere. At that time, vaccines were under development.

At the beginning of autumn 2020, Covid-19 infection exploded in the Northern Hemisphere (populated by 87% of the world population), Figure 10. As stated in this paper, sunspots, which were on the decline, will take effect in the coming months. The Sun starts to emit more electromagnetic energy from an increasing number of sunspots (which was expected, see Figure 9) from the beginning of May 2021, and the number of the infected (expressed by the ECDC index) starts to drop dramatically.

Because of vaccination, a kind of a compound index was formed. This compound index consists of two parts: i) the percentage of the people vaccinated with the second dose, and ii) the percentage of the population affected by the UV rays class C+x rays rate that came to the Earth from the Sun. Sunspots appear on the Sun presenting an electromagnetic emission of protons and neutrons, visible from the Earth, and, in the spring and summer season, from the Sun's southern hemisphere. Reason: explosions on the Sun can hit the Earth at the end of spring and during summer if they come from the Sun's southern hemisphere. For example, in the period from May 2nd until June 11th, 2021, in Serbia, the situation was as follows: a Gauss curve was not showing real data. The number of infected people declined more than the Gauss distribution showed. But, if we extract the number of vaccinated people with the 2nd dose (that was between 17 and 27 doses per hundred – there was still between 8 (around May 1st) and 14 (around June 10th) percent fewer of those infected than the Gauss distribution shows. This offset between 8 and 14% was the result of the Sun activity. The authors had only 45 days and did not find the right correlation, and an average of 11% was applied for a better calculation of the infected people. Also, the relation of 7-day sunspot numbers is in correlation with many EU countries (except Spain, Sweden, San Marino, and a few others, which report the number of the infected on a non-daily basis). Figure 10 shows the correlation between swine flu and Covid-19, taking into account only monitoring sunspots in the period 2004-2021.

The authors cannot develop a mathematical model for an exact duration of the pandemic, but the comparison between the last two solar cycles shows an idea about the end of the pandemic of Covid-19.

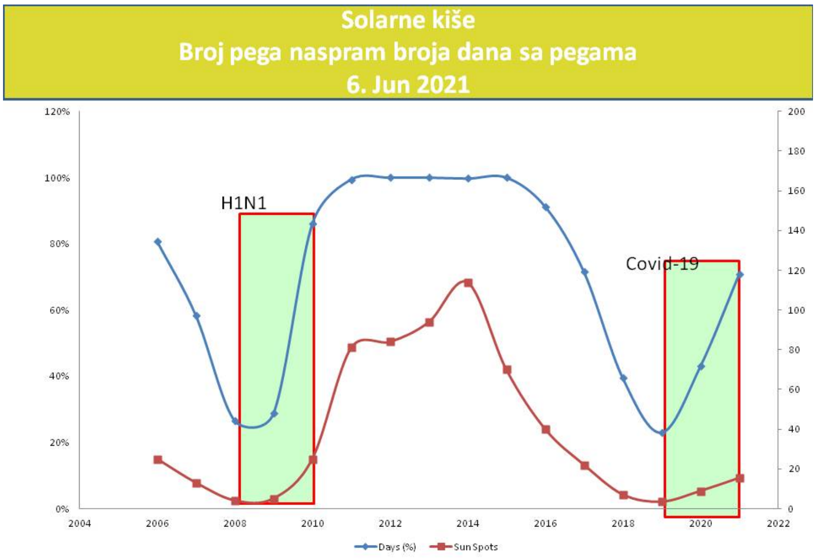

Figure 10 – INSTRUMENT 6: Sunspot numbers in the period 2004-2021. The blue line represents the number of days with sunspots. Note that a cycle of rising and declining in the number of sunspots is approximately 11 years.

Kočović, P., Answers to the Comments on the article "Monitoring COVID-19 is like instrument flying" submitted by David D. Pokrajac. pp.734-748

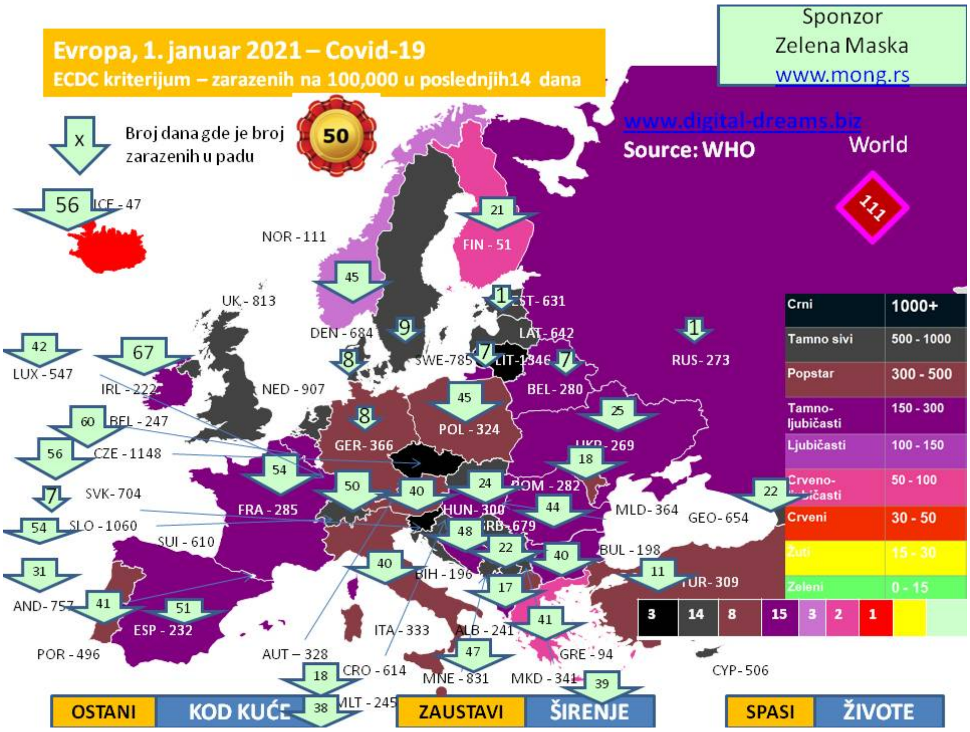

Figure 10 – ECDC coefficients for European countries on January 1, 2021. Compare this figure with Figure 6

Conclusion

The mathematical model presented in the *Military Technical Courier* was only the first approach to the problem. The authors knew that new algorithms had to be developed for monitoring pandemics. And they did it. The results were reported in all Serbian media.

It seems that a mathematical model that will include sunspot numbers and electromagnetic emission can be developed for monitoring the end of the pandemic. A team of authors carefully monitors this correlation and some results will be published when the correlation is found.

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ОТВЕТ НА КРИТИЧЕСКИЙ ОБЗОР «MONITORING COVID-19 IS LIKE INSTRUMENT FLYING», ПРЕДСТАВЛЕННЫЙ ДАВИДОМ Д. ПОКРАЯЦЕМ

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27.43.51 Применение теоретико-вероятностных и статистических методов
ВИД СТАТЬИ: письмо редактору

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