The First Month Spread of COVID-19 in Madagascar

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Abstract

Using the officially published data and aware of the unclear source and inaccurate number of samples, we present a first and (for the moment) unique attempt to study the spread of the pandemic COVID-19 in Madagascar. The approach has been tested by predicting the number of contaminated persons until 20 days after fitting the inputs data collected within 15 days using standard least χ^2-fit method. Encouraged by this first test, we add the new data collected within 30 days and give prevision until 33 days. The present data show an approximate linear increase of about (4-5) infected persons per day while the analysis signals an eventual near future stronger growth. These results may also be interpreted as the lowest values of the real cases due to the insufficient number of samples (about 2200 for 20 millions of population). A comparison with some other approaches is done. Some social, economical and political impacts of COVID-19 and confinement for Madagascar and Worldwide are shortly discussed.

Keywords: Pandemic, Covid-19, Infectious disease, Virus spread, Confinement.

1. Introduction

• COVID-19 is scientifically named SRAS (Syndrome Respiraroire Aigu Severe) or SARS (Severe Acute Respiratory Syndrome)-CoV-2 or COVID-2-19 or COVID-19 in reference to the SRAS-CoV or Coronavirus pandemic (2002-2003) starting in China and propagated in 30 countries which has affected 8 000 persons and caused 774 deceased [1]. There is a slight difference between the two COVID in the genome structure of the virus thus the symbol 2.

Table 1: The first five countries having the highest numbers of contaminated persons on 15/04/2020. The data come from [3].

Rank	Country	Absolute #	# per million
1	USA	614 180	1 864
2	Spain	177 633	3 771
3	Italy	162 488	2 697
4	Germany	132 210	1 590
5	France	103 573	1 544

• Another pandemic named MERS-CoV (2012-2013) or SRAS of the MIDDLE EAST has been found for the first time in Saudi Arabia and has affected 1 589 persons and caused 567 deceased in 26 countries.

• The CORONAVIRUS are of animal origins. An asymptomatic animal transmits to another ones and then to human. It was bats for SRAS-COV and MERS-COV which transmit the virus to masked palm civets for China and to camels for Saudi Arabia as intermediates and then to humans.

Table 2: The first five countries having the relative highest numbers of contaminated persons per million of population on 15/04/2020. The data come from [3].

Rank	Country	# per million	Absolute #
1	San Marino	11 080	372
2	Andorra	8 499	659
3	Luxembourg	5 387	3 307
4	Island	4 722	1 720
5	Gibraltar	3 828	129

• COVID-19 started from the Wuhan local market (Hubei province - China) in December 2019. The origin of the transmission is not quite clear and there are many speculations about it. It may also come from bats which have transmitted the virus to the pangolin sold in the Wuhan market and then the pangolin has transmitted to human. The transmission mode from humans to humans is through saliva droplets, sneezes, coughing and contacts.

• The virus has subsequently propagated to the rest of China and contaminated up to now (15/04/2020) 82 295 persons. Today, allmost all countries of the world are now affected leading to 1 997 321 infected persons with 500 819 cured and 127 601 deceased. The 5 countries with most affected persons relative to the total number of cases and to the population density are shown in Tables 1 and 2, where one can notice that the relative number per million of infected persons is very high in small area countries.

• COVID-19 then appears as the most devastating pandemic of the 21th century [1]. To face this unexpected drama where

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[1] For a more complete but simple review on the cornavirus, see e.g. [6].

Table 3: Numbers of Contaminated Persons in Madagascar at different dates. The data from 21/03/ to 15/04/ have been communicated by the national press and TV [2] issued from the WHO / OMS agency in Madagascar and from Google [3]. Data compiled by WHO / OMS are from [4]. The added quoted errors are an estimate of about (10-20)% systematics which can be an underestimate.

Date	# of Days	# of Infected Persons	
		Ref [2]	
21/03	1	3(1)	
23/03	3	12(3)	
24/03	4	17(4)	
25/03	5	19(5)	
27/03	7	24(5)	
29/03	9	49(5)	
01/04	12	58(6)	
02/04	13	62(6)	
04/04	15	70(7)	
		Ref [2, 3]	Ref. [4]
06/04	17	80	77
07/04	18	88	77
08/04	19	93	92
09/04	20	93	93
11/04	22	102	95
12/04	23	104	104
13/04	24	106	106
14/04	25	108	–
15/04	26	110	–
16/04	27	–	117
17/04	28	–	117
18/04	29	–	117
19/04	30	120	–
20/04	31	121	121

there is no known medicine [2] and vaccine [3] to fight the virus, only urgent preventive measures have been taken by different countries.

• As the virus is quite heavy, it cannot travel more than 1 meter [4]. Its lifetime is relatively short on skin (few minutes) but long in air and copper (3-4) hours, clothes (12 hours), cartons (24 hours), woods, plastics and metals (3-9 days) [5]. So different preventive barriers have to be used (masks, soaps, hydroalcoholic gels,..) to stop the virus.

• However, in addition to these barrier precautions, drastic measures such as confinement have been taken by governments of different countries which uneluctably affect the social organizations and economic situations. Confinement may lead to a new form of society and economy, to a new way of leaving in the near future.

• Different analysis of the propagation of COVID-19 appearing in China, Europe, UK, USA and Russia have been done in different works (see e.g. various new articles in arXiv [7]) where most of them are based on Susceptible-Infected (SI) or Susceptible-Infected Recovered (SRI) models (see e.g. [8–18]) while some is a simple Gaussian fit of the data [19]. To our knowledge nothing has been yet done in African and some other developing countries. The reasons could be that, in these developing countries, the pandemic is still at the beginning of its effect and the data are not yet sufficient to make a rigourous statistical study (Gaussian law of large numbers of events) which is also complemented by the eventual non-reliability of the collected data due to the few numbers of detection tests or perhaps for some political reasons.

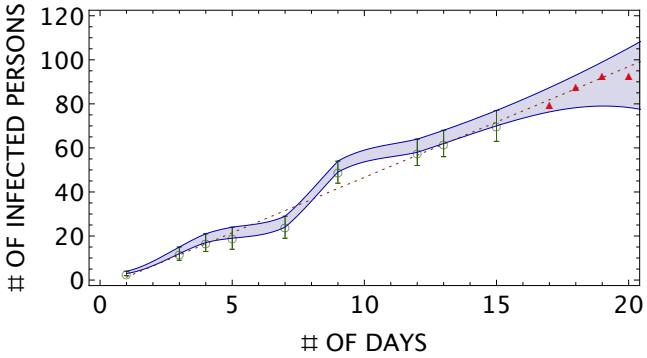

Figure 1: Number of contaminated persons versus the number of days : green circles are the input data, filled region are the predictions limited by the lower curve (central value of the data) and by the upper curve (data with added positive estimated errors). Dashed red line is the linear fit. Triangles are data received after the fitting procedure.

2. First analysis : data up to 15 days

COVID-19 enters in Madagascar on 21th March through the Antananarivo-Ivato airport via passengers from Europe and from China. The closing measure for closing the airport was too late despite the requests of many individuals or through the social networks.

• We collect, in Table 3, data from different national newspapers, medias [2] issued from the national representant of the World Health Organization (WHO) / Organisation Mondiale de la Santé (OMS).

• We use the data of the first 15 days to predict the ones from 15 to 20 days. Noting that some data do not agree each others and that the detection tests are only done for few samples of the population, we have introduced some estimated errors in order to quantify this deficit.

• The analysis is shown in Fig. 1 where the input data are the green circles. Our prediction (filled region) comes from a standard least-χ^2 fit of the data using a Mathematica Program elaborated by [5]. The central value of the data is fitted by the lowest curve while the central value $\oplus$ the estimated errors by the upper curve. The fit is extrapolated until 20 days.

• The new data points in red are inside our prediction region which we consider as an encouraging positive test of the approach based on a standard least-χ^2 fit of the data.

[2] Drugs based on chloroquine proposed by Pr. Didier Raoult - Marseille (expert in tropical diseases), which were successful against paludism are promising though under debates. Some other pists are the uses of some endemic medicinal plants such as in Madagascar where some of them contains natural chloroquine.

[3] There is some proposal from the Bill Gates foundation but doing the first tests in Africa are criticized.

[4] However, new study (French TV source) recommends a distance above 2m.

[5] The true lifetime of the virus on inert objects is still under study and needs to be confirmed.

• We also show (dotted curve) the expectation from a simple linear parametrization of the data as given by :

$$n(x) \simeq -3.67 + 5.03x \,, \tag{1}$$

where $n(x)$ is the number of infected persons as function of the number x of days. The data show a linear increase for about 5 persons per day.

3. Second analysis : data up to 30 days

• Encouraged by this positive test, we improve the analysis by adding the new data (see Fig. 2) collected from the 16th to 30th days.

• The χ^2-fit is shown by the continuous green line (green circle data from [2, 3] and dot-dashed red curve (red triangle data from [4]).

• Doing a linear fit of the data collected during 24 days, we obtain :

$$n(x) \simeq -1.42 + 4.73x \,, \tag{2}$$

while adding the data until 30 days (blue rectangles in Fig. 2), we obtain :

$$n(x) \simeq 3.5 + 4.22x \,. \tag{3}$$

The slopes of the linear curves obtained in Eqs. 2 and 3 ((blue dotted line) are consistent with the one in Eq. 1 shown in Fig. 2. This linear fit can be improved by using a quadratic fit of the data. In this way, one obtains :

$$n(x) \simeq -8.14 + 6.45x - 0.07x^2 \,. \tag{4}$$

The fits indicate an average of about (4-5) persons infected per day.

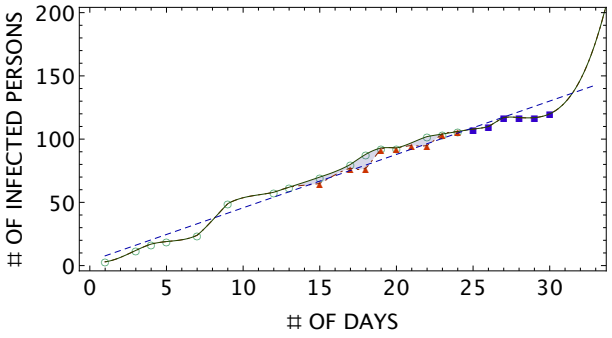

Figure 2: Number of infected persons versus the number of days : green circles are the input data from [2, 3]. The red triangles are data from [4] from the 17th day. Blue rectangles are new data [2–4] from 25th to 30th days. The continuous oliva curve is the fit from 1 to 30th days of [2, 3] data while the red dot-dashed one is the fit of [4] data which follows the red triangles data points. The dashed blue line is the linear fit given in Eq. 2.

4. Comments on the results

• The previous analyses have been done using data from [2–4]. We are aware that these data may be inaccurate as there are some periods (week-end) where the data remain stable which may due to the break of the infection tests service. These data may also underestimate the real number of infected persons due to the insufficient number of detection tests for the whole country which contains about 80% of rural population (see e.g[21]). The recent news [2] indicates that about 2200 tests have been performed. The detection tests should be extended for improving the quality and reability of the analysis.

• However, despite these warnings, the reported data can be considered as lower bounds of the real case and the results from the previous study may already be useful. The results of the analysis can be an important guide to the government for taking the right decision at the right time in order to control this tremendous pandemic.

• Our analysis concerns only the officially declared contaminated cases and does not subtract the numbers of cured and deceased persons.

• However with the last collected number (19/04/2020) for about 2 200 tested persons [2] which are relatively small compared to the 20 millions of population, one has [3, 4] 120 declared cases, 35 cured persons and 0 deceased. One can also notice that the number of cured persons increases linearly for about 2 persons per day.

5. Comparison with some other approaches

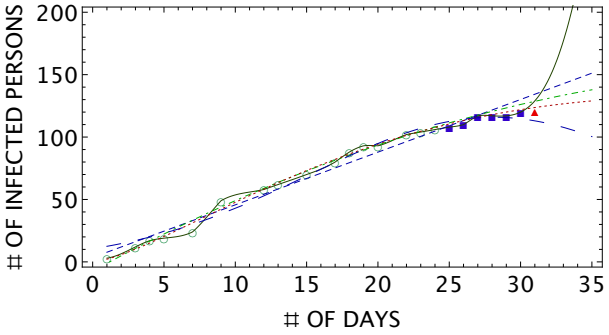

Figure 3: Data are the same as in Fig 2. New data (red triangle) is not included in the fit.The continuous oliva curve is the fit from 1 to 25th days of [2, 3] data and 25th to 30th days of data from [2–4]. The dashed blue line is the linear fit in Eq. 3 while the dot-dashed green curve is the quadratic fit given in Eq. 4. The dotdashed red curve is the fit from the SI-like model used in [8, 9]while the large dashed green curve is the one from a guassian-like fit used in [19].

• Our results from the χ^2-fit (continuous oliva line), from a linear (dashed blue line) and a quadratic (dotdashed green curve) parametrizations of the data are shown in Fig. 3.

• We shall compare your previous results with some from different approaches in Refs. [8, 9, 12, 13, 15–19], though we are aware that these models are more accurate for a large number of events.

• Among these different models and for an illustration, we choose the one in [8, 9] using a variant of the (SI) model with mixed power and exponential behaviours [20] :

$$n(x) = ax^b e^{-x/x_0} \,. \tag{5}$$

The data are fitted by the parameters : $a = 2.2$, $b = 1.5$ and $x_0 \approx 28$ days which we show in Fig. 3 (small dashed red curve). One can notice a good agreement between the quadratic polynomial fit and the one from the SI-like model of [8, 9].

• We also fit the data using a Gaussian-like function as in [19]:

$$n(x) = ae^{-\frac{(x-x_0)}{2\sigma^2}} \,. \tag{6}$$

The result is shown in Fig. 2 (large dashed green curve) for a gaussian centered at $x_0 \simeq 28$ days and a=115.9, $\sigma = 12.8$.

• One can notice that all different models indicate a slow increase of the number of infected persons which can be checked

by more forthcoming data and our Model with polynomial behaviour leads to a good fit of the data. However, the decrease shown by the Gaussian model may be unrealistic.

6. COVID-19 and Confinement for Madagascar

• As already mentioned in the introduction, in order to limit the spread of this dangerous virus which propagates via social contacts (coughing , saliva droplets,..), different countries have decided to confine the population and have asked the persons to strictly respect some barriers rules. About 3 billions of persons i.e half of the humanity are now confined.

• However, the concretization of confinement in developing countries is far to be achieved due to poverty and to the lack of education of the majority of the population :

– Due to poverty and to the bad organization of the society, most of persons have to work for finding what to eat day by day due to the informal form of the business and economy.

– In addition to that, the accompanying help measures taken by the government are insufficient while the managements of the international fund and donation are not transparent.

– Middle class also suffers as these persons are not rich enough to be autonomous and not too poor to receive any help from the state.

– Due to the lack of education, most of the people are irresponsable and are not aware about the dangerous effect of the virus. Then, they do not see the importance for respecting the barriers rules and confinement.

7. Worldwide Impacts of COVID-19 and Confinement

As a consequence, this unprecedented confinement security measure has a large impact for the :

• *Social organisation and Environments*

– We learn about tele-works, indoor at outdoor home-works.

– We re-discover the importance of a family, of the tradition and ...we re-discover ourseleves.

– We see the usefulness of solidarity, the values of health personals, , researchers, teachers, educators, firefighters,...

– Nature takes back its rights : returns of animals near cities and cetaceans near the coasts, returns of insects, birds,...).

– Pollution is decreasing : the atmospheric air is improving in megacities (Beijing, New-Delhi,...).

– Less noise in the cities.

– One observes an urban exodus in developing countries such as Madagascar,...

– However, the virus might enhance the social class inequalities like e.g the re-disappearance of middle class mentioned earlier for Madagascar.

• *Economy*

– Globalization is suffering while on-line, reduced size and local markets are developing,

– Delocalisations of manufacturers are questioning,

– Each country is looking for an independent economy.

• *Politics*

COVID-19 has pressed the leaders of each country to review the orientation of their politics to the most useful ones for the population namely :

– Health,

– Research and Education,

– Foods and way of Consuming,

– Protections of the Environments.

8. Conclusions

• We have studied the first month spread of COVID-19 in Madagascar using standard least χ^2 fit approach. We found that, for this first month, the spread of the virus per day increases almost linearly for about (4-5) persons per day. At present, there is no sign of an exponential growth of it. More data are needed for improving the analysis. A comparison of our results with some other approaches is shown in Fig. 3.

• We note that the number of infected persons are relatively low, which can be due to the reduced number of detection tests. Another factor could be that the intense UV in the country may partially neutralize the virus effects.

• We have shortly reviewed the Worldwide impacts of COVID-19 which has demonstrated the weakness of the current mondial global system . This feature might announce a change towards a new model of society and economy and for a new form of political decisions in the near future.

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9. References

[1] S. Van der Werf et al. (Institut Pasteur, CNRS, Univ. Paris VII), Fascicule de Brevet Europeen EP1 694 829 B1 (2006).
[2] Midi-Madagasikara press and Television Malagasy (TVM) daily news.
[3] Google : https://google.com/covid19-map.
[4] WHO/OMS compilation : https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.
[5] Wolfram research foundation.
[6] Santé Magazine, article of 18/03/2020.
[7] https://arxiv.org/search/?query=COVID-19.
[8] A. L. Ziff and R.M. Ziff, medRxiv 2020.02.16.20023820. and references therein.
[9] S. Maltezos, arXiv:2004.05992 [physics.soc-ph].
[10] M. Li et al., arXiv:2002.09199 .
[11] Z. Liu et al., arXiv:2002.12298 [q-bio.PE].
[12] B. Mo et al., arXiv:2004.04602 [physics.soc-ph].
[13] T. Sardar, S.S. Nadim and J. Chattopathyya, arXiv:2004.03487 [q-bio.PE].
[14] P. V. Savi, M. A. Savi and B. Borges, rXiv:2004.03495 [q-bio.PE].
[15] J. M. Carcione et al., arXiv:2004.03575 [q-bio.PE].
[16] J. Dehning et al., arXiv:2004.01105 [q-bio.PE].
[17] C. Anastassopoulou et al., https://doi.org/10.1371/journal.pone.0230405.
[18] C. Siettos and L. Russo, https://www.tandfonline.com/loi/kvir20.
[19] G. D. Barmparis and G. P. Tsironis, arXiv:2003.14334 [q-bio.PE].
[20] A. Vasquez, *Phys. Rev. Lett.* 96.038702 (2006).
[21] S. Narison, *Réflexions sur Madagascar, clin d'oeil sur le passé et vision vers le futur*, ISBN 97811796561982, amazon.com (2018).