

Covid-19 report: Update on the current epidemic status in Luxembourg

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Background information

This report has been elaborated by the Research Luxembourg Covid-19 Task Force to inform the Luxembourg Government about the current epidemic status in Luxembourg. It gives a short update on the most important indicators and contains projections and an analysis of the current epidemic status **based on data available up to October 29** and **based on data of all cases, including commuters and travelers – not of inhabitants only (if not stated otherwise)!**

Main conclusions

- The accelerated exponential dynamics reported last week has slightly relaxed towards a constant exponential behavior during the current week. This means that the dynamics, even if it slightly relaxed, still corresponds to an exponential dynamic – and that further social efforts are needed to mitigate the current epidemic wave.
- R_{eff} has gone down, from 1.61 (last week) to 1.21, and the exponential behavior currently has a doubling time of 6.3 days (compared to 4.1 last week).
- The total number of estimated active cases has nearly doubled, from 5000 last week to 9000 this week.
- If the current trend would continue in the coming days/weeks, our mid-term model now predicts around 1300 daily new cases by mid of November (compared to 1400 cases in last week's prediction). Note that these numbers include commuters and travelers – not inhabitants only.
- **Note that this model reflects the possible evolution of the pandemic in case the current trend – and thus the current societal behavior – continues.** This model does not take into account possible societal behavior changes in the future. It should be our common goal to try to not reach those forecasted numbers. **Societal behavior can change the curve in one or the other direction.**

Analysis of the current situation

Overall, **the accelerated exponential dynamics reported last week has slightly relaxed towards a constant exponential behavior during the current week (which is still exponential and corresponds to an epidemic wave)** as shown by

- (i) an R_{eff} value of 1.21 (Figure 1) (compared to 1.61 last week) that corresponds to a doubling time of 6.3 days compared to 4.1 days last week (note again that this slight relaxation does indicate that the situation is still volatile, but that the accelerated exponential dynamics has only stabilized as a constant exponential behavior which still corresponds to an epidemic wave),
- (ii) the analysis of daily new cases and corresponding projections by curve fitting that exhibits now a stable **exponential behavior** (in contrast to the accelerated exponential dynamics the week before) (Figures 2 and 3),

- (iii) the midterm projection by an epidemiological SIR model that projects a slightly reduced amplitude of around 1300 daily new cases mid of November compared to 1400 cases/day in last week's projection (Figures 4),
- (iv) a continuing increase of the overall positivity rate to around 7% for the current week compared to 5% last week with some evidence for a potential slowing-down for the last days (Figure 5),
- (v) again a nearly doubled number of estimated active cases of around 9000 cases compared to 5000 cases last week (Figure 6)
(note that this is in agreement with the estimated doubling time).

This analysis indicates that the current epidemic situation still appears highly volatile. In particular, the development of the current week exhibits a relaxation from the accelerated exponential dynamics but **clearly exhibits an exponential dynamics of the epidemics with a doubling time of around 6 days**. Together with the high case numbers this is putting contact tracing beyond the limits and **mitigation of the epidemic wave relies on the common social effort in reducing physical interactions, respecting hygiene measures and active participation in large scale testing**. Without these efforts, the situation may culminate in a severe crisis in the healthcare system, especially if the recent trend of older people becoming infected continues.

Note that the presented analysis takes the current measures and the change in people's behavior only implicitly in consideration, based on the changes in the daily cases numbers.

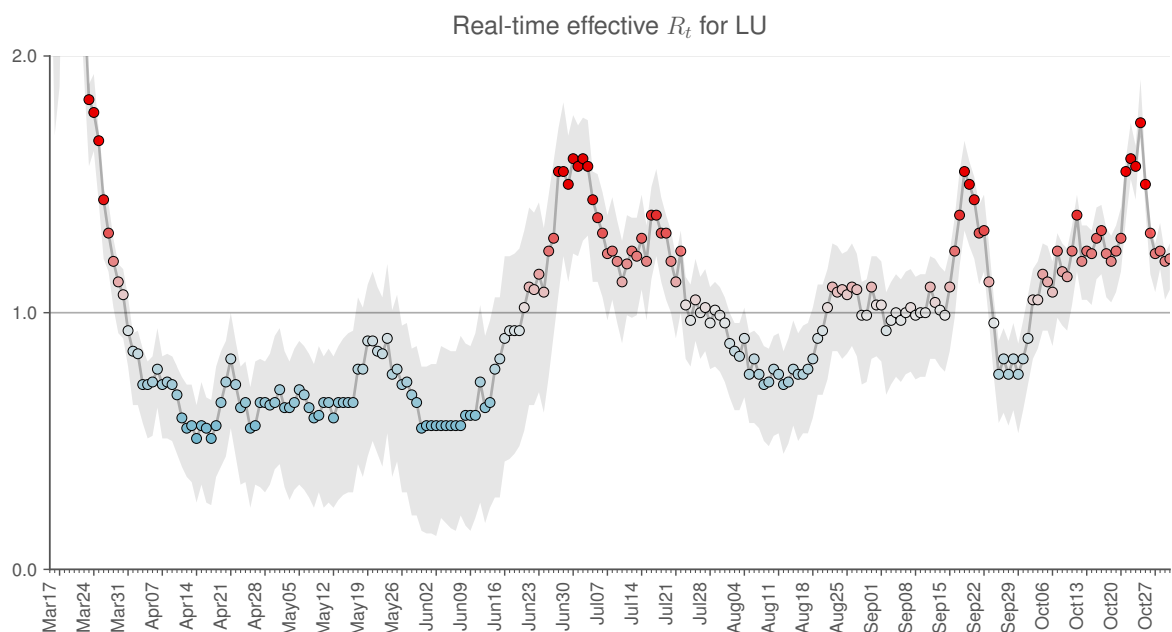


Figure 1. During the current week, the effective reproduction number in Luxembourg decreased from 1.61 to 1.21 (for inhabitants only) which corresponds now to a doubling time of 6.3 days (compared to 4.1 days last week). Note that this slight relaxation only indicates that the accelerated exponential dynamics has stabilized as a constant exponential behavior. But this still corresponds to an epidemic wave and indicates that the situation is still volatile.

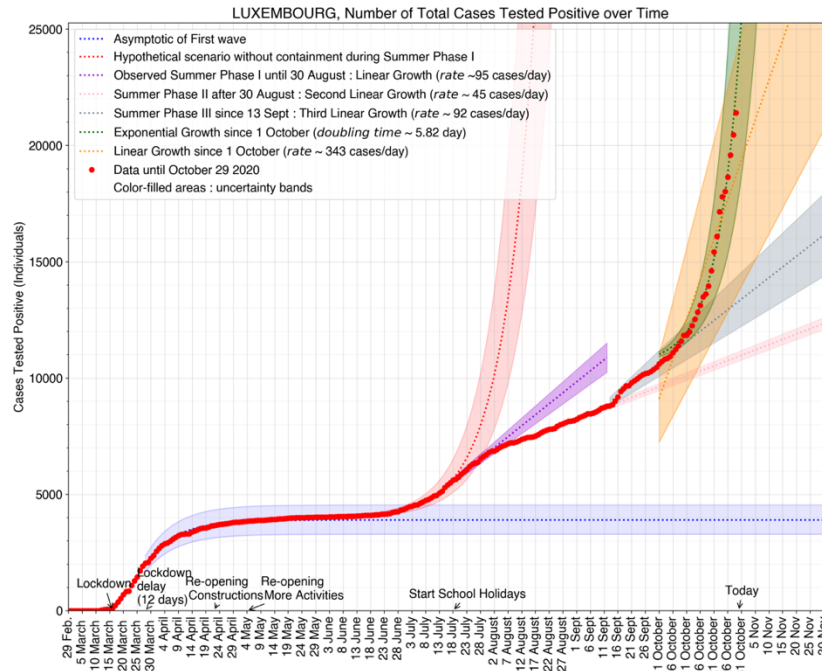


Figure 2. Official COVID-19 case numbers up to October 29 (red dots) were approximated with an adapted model for short-term forecasts. The asymptotic behavior of the first wave is based on a multi-exponential model that describes the number of cases well until the beginning of May (blue). From 14 June on an initial exponential increase was observed as a potential second wave (red line). From mid to end of July the daily increase of cases showed an increase of 95 cases/days (summer phase I, magenta line) and from beginning of August to mid of September a linear increase of 45 cases/days (summer phase II, orange line). After the end of the vacation period mid of September, the situation seemed to have a similar behavior as the summer phase I with 91 cases/day (summer phase III, grey line) until beginning of October. **The development during the last 4 weeks indicates an exponential behavior (green) and a forced linear fitting (orange) cannot describe the data well even with 343 cases/day (compared to 214 cases/day last week).** This relates to highly volatile **exponential epidemic dynamics that can only be mitigated by common social efforts.**

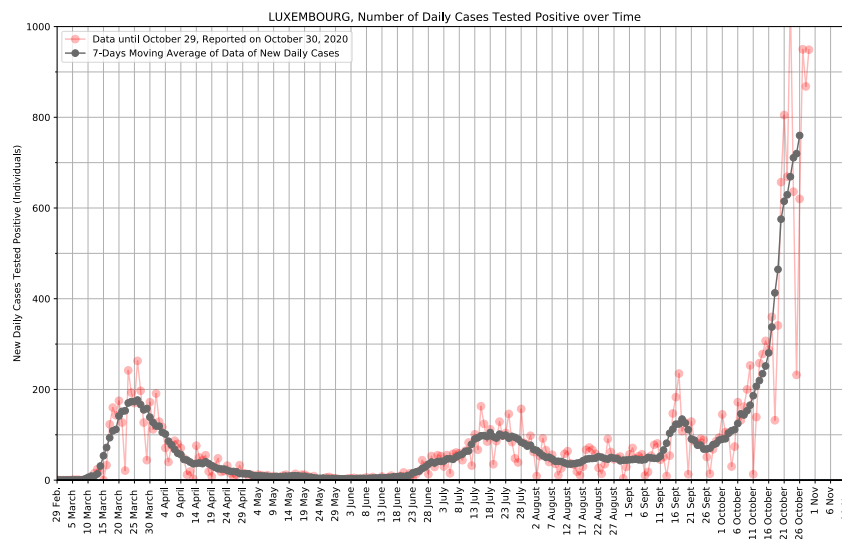


Figure 3. The daily COVID-19 case numbers up to October 29 (red dots) and the 7-day average (grey) exhibits an accelerated exponential growth since the beginning of October. Note that a linear regime is characterized by a flat curve such as during the vacation period with 45 cases/day and an exponential behavior would correspond to a straight line such as for end of September to beginning October. **From beginning of October to end of last week, the curve exhibited clearly a non-linear increase in daily cases which corresponds to an accelerated exponential dynamic.** For the current week, this has slightly relaxed towards a straight line which corresponds to a constant exponential dynamics with a doubling time of around 6 days.



To estimate the midterm dynamics, we also apply an SIR model and parameterized it by a Kalman filter. The relaxation towards a constant exponential dynamics has reduced the expected amplitude to around 1300 daily cases compared to 1400 cases from last week's projection as shown by the comparison in Figure 4 between the estimates from last week (left) the current projection (right).

Note: The hopefully beneficial effect of the new measures and a potential change in people's behavior on the epidemic dynamics is not included in these graphs.

And note that this graph is based on data available up to 29 October and based on all cases - not of inhabitants only!

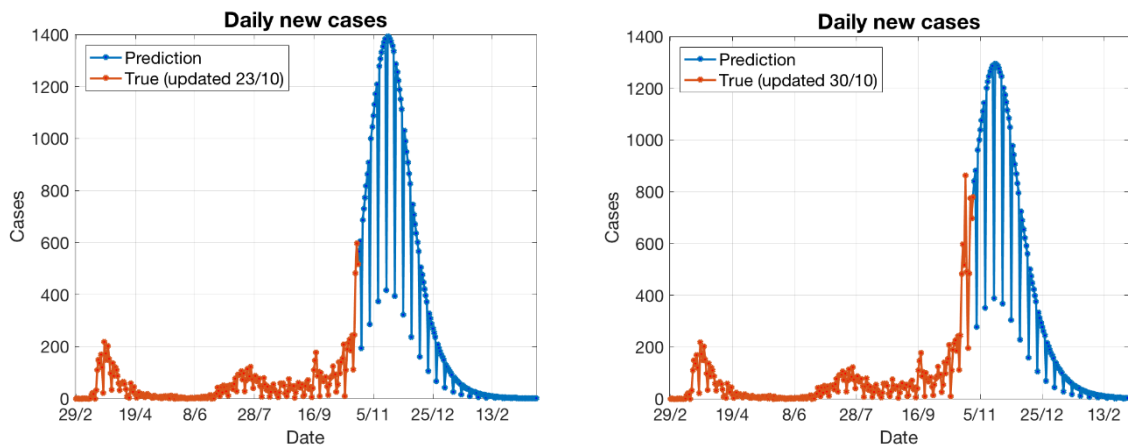


Figure 4. Comparison of midterm projections for daily cases from last week (left) and this week (right) based on an epidemiological SIR model parameterized by a Kalman filter. The comparison exhibits a slight decrease for the peak of the second wave with around 1300 cases/day by beginning of November compared to 1400 cases/day from last week's projection.

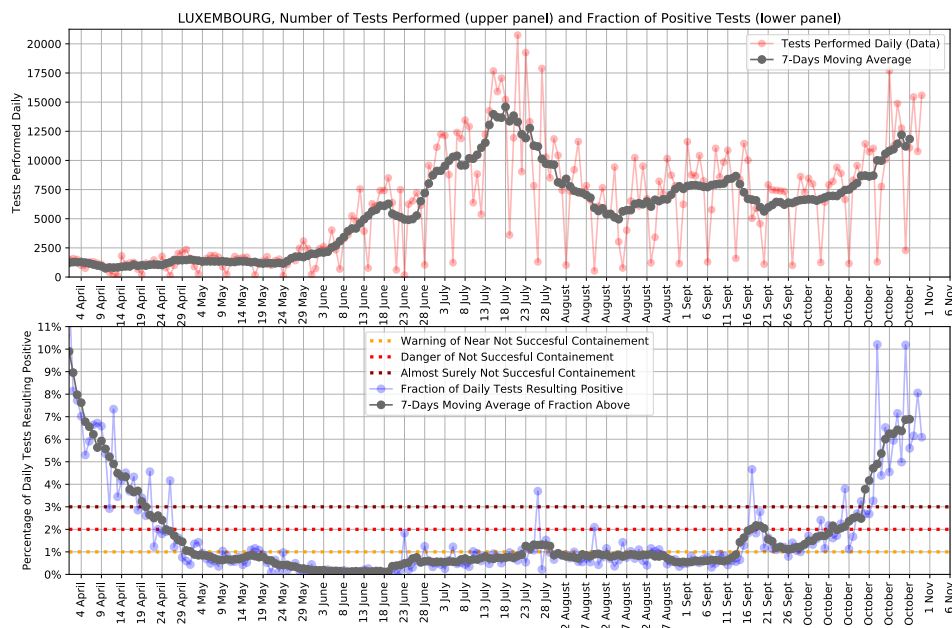


Figure 5. The number of daily tests performed (top) and overall normalized positive tests (bottom). After the intermediate relaxation to around 1% end of September, the positivity rate has continuously increased to approximately 5% at the end of last week and further increased to around 7% during the current week. This small evidence for a saturation during the last days is probably based on the relaxation from the accelerated exponential behavior to a constant exponential dynamics.

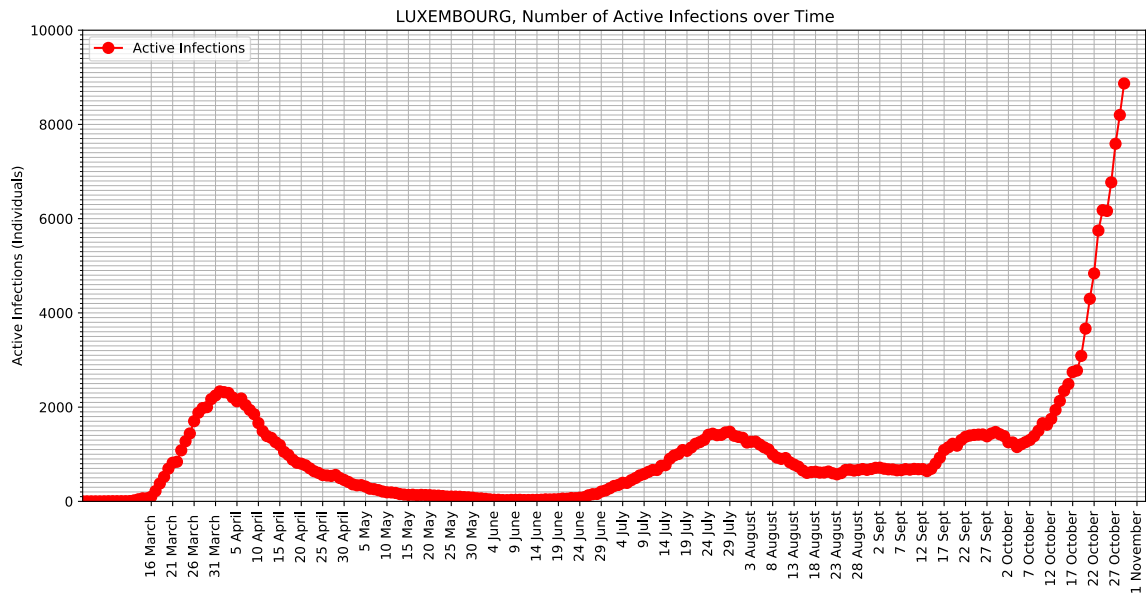


Figure 6. After some stabilization end of September and a subsequent continuous increase during the following 2 weeks, the estimated number of active infections has nearly doubled during the last week with the new record value of around 9000 active infections (compared to 5000 last week).

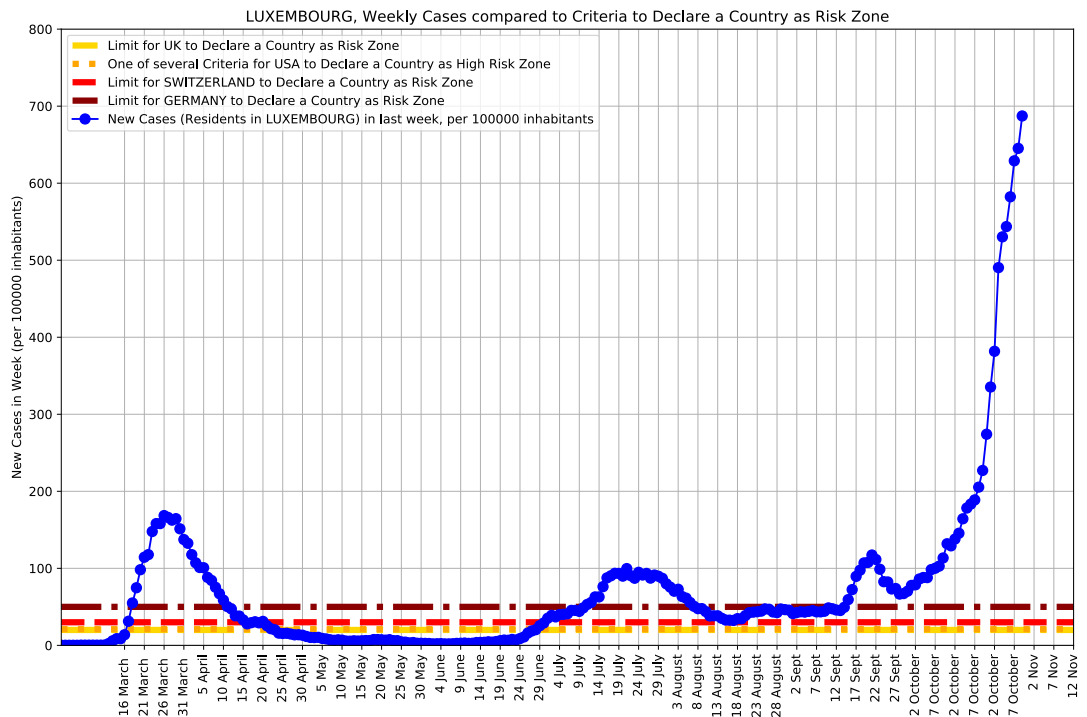


Figure 7. The number of weekly cases per 100,000 inhabitant (blue line for inhabitants only) that is used by different countries to declare thresholds for risk zone definitions such as Germany with 50 cases per week and 100,000 inhabitants (dark red line). Luxembourg has surpassed this threshold since the week of 17 September and has reached the highest values since the beginning of the epidemics with a dramatic increase during this week.