

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 as an update to last week's report from 24 June. It gives a short overview on the most important indicators and contains projections and an analysis of the current epidemic status **based on data available up to 30 June**.

Main conclusions

- **The development during the current week highlights the strong effect social interactions can still have on the epidemic dynamics despite the advancing vaccination as shown by the strong increase in daily case numbers during the last days, which are likely to be driven by infection clusters.** Hence, the significant increase in the 7-day average of daily cases to 48 cases/day compared to 15 cases/day for the week before represents a major challenge for the current epidemic situation. Social distancing, compliance with hygiene measures and effective contact tracing will be essential to stabilize the situation again.
- **R_{eff} has increased to 1.79 today** compared to 0.7 on Thursday of last week. Also, the 7-day average value of R_{eff} increased to 1.1 (compared to 0.64 of last week) due to the strong increase of cases observed during the last days.
- The linear trend of cumulative cases estimated by curve fitting since May 21 exhibits still a rather constant slope of 30 cases per day compared to 35 cases/day last week because it is not as sensitive to the recent increase.
- The total number of estimated active cases has significantly increased to 351 cases compared to 213 cases last week.
- Based on the further increasing prevalence of the Delta-variant of 54.3% for week 24 compared to 30.9% for week 23 and the recent strong increase in daily case numbers, **the midterm models assuming a 40%-50% increase in the transmissibility of this variant compared to the Alpha-variant (UK variant) show a potential for a significant epidemic rebound.** These projections are driven by the strong increase of the last three days and by potential infection clusters, which demonstrates the still fragile regime where super-spreading events can set off a new wave.
- The large prevalence of the Delta variant and the strongly increased case numbers of the last days may lead to an epidemic rebound as currently observed for e.g. in the UK and also Israel. **Hence, sustained efforts in social distancing and following hygiene measures will be essential to stabilize the situation again and prevent increases in hospital demands until herd immunity is reached by vaccination.** This is also particularly important with respect to potential 'escape variants' for which vaccines might be even less effective. Thus, monitoring virus variants and assessment of their transmissibility will be a key element for sustained mitigation of the pandemic during the up-coming next months.

Analysis of the current situation

After the continuing relaxation of the epidemic dynamics during the last weeks, the development of the current week exhibits strong indications for a potential epidemic rebound driven by increased social interactions and potential infection clusters as shown by

- (i) a strong increase in R_{eff} value to 1.79 (compared to 0.7 last Thursday). Also the weekly average has increased to 1.1 compared to 0.64 of last week's level (Figure 1),
- (ii) the analysis of daily new cases and corresponding projections by linear curve fitting since 21 May exhibits still a rather constant trend of 30 cases/day compared to 35 cases/day from last week's projection since it is not as sensitive to the recent increase (Figures 2 and 3),
- (iii) the midterm projections of the epidemiological SIR model considering the more transmissible Delta-variant of the virus and changes in social interactions indicate a potential significant epidemic rebound if social interactions and compliance to hygiene measures do not improve (Figures 4, 5 and 6),
- (iv) an increase in the overall positivity rate to around 1% (compared to < 0.2% last week) (Figure 7),
- (v) an increase in the number of estimated active cases to 351 compared to 213 cases last week (Figure 8).

The analysis indicates a significant **increase in social interactions during the last 7 days leading to a tripling of daily cases** (with the 7-day average of daily cases increased to 48 cases/day for the current week compared to 15 cases/day for the previous week). This increase is also driven by infection clusters originating from events where social distancing and hygiene measures were not respected such as e.g. during the National day. Together with the increasing prevalence of the Delta-variant of the virus (B.1.617.2) of 54.3% for week 24 compared to 30.9% for the week before, this **increase in daily cases can lead to a significant epidemic rebound as anticipated in the previous projections considering super-spreading events (Fig. 5 right) where the recent numbers suggest an even stronger rebound (Fig. 5 left)**. Note that from the current data the impact of the infection clusters can only be roughly estimated and the corresponding projections are associated with a rather high uncertainty. Despite this uncertainty, all projections indicate, at least temporarily, increasing daily case numbers, which are further triggered by the increased transmissibility of 40-50% of the Delta-variant reported in the literature. **Hence, minimizing social interactions, complying to hygiene measures and breaking infections chains by contact tracing and large scale testing are now essential to stabilize the epidemic regime again until herd immunity is reached by vaccination.** Otherwise, the infection cluster may trigger a significant epidemic rebound as currently also observed in the UK and Israel despite 60% of vaccinated population, which may also increase the stress in the healthcare system again. Therefore, a strict monitoring of the epidemic dynamics and representative data on the virus variants over the next weeks will be important.

Real-time effective R_t for LU

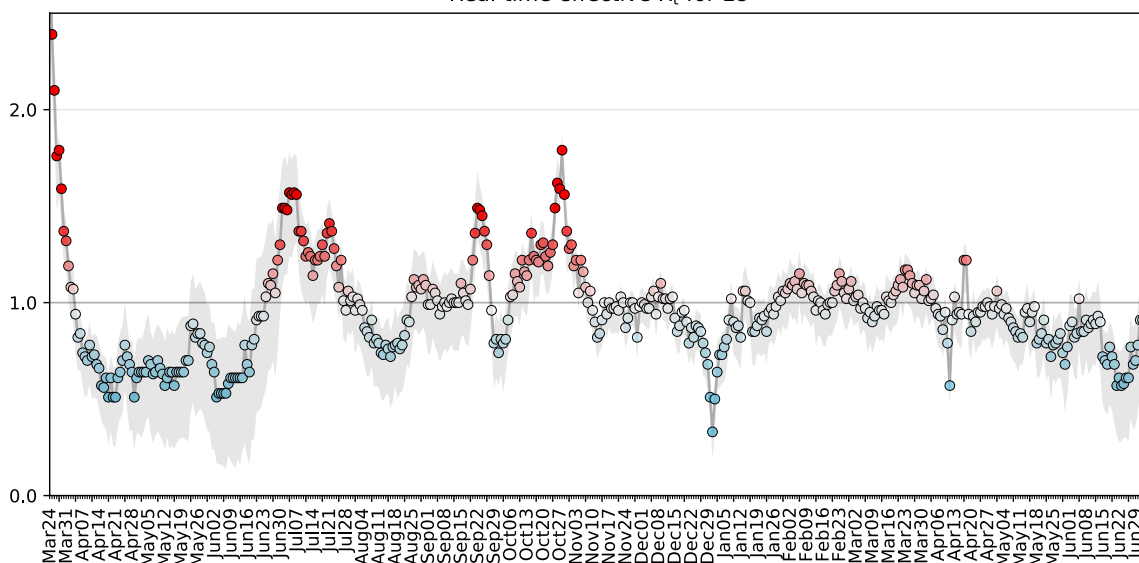


Figure 1. For the current week, the effective reproduction R_{eff} has increased to 1.79 today compared to 0.7 on Thursday of last week. Also, the 7-day average of the current week has increased to 1.1 (compared to 0.64 of last week). Note that this fast increase is indicating infection clusters which could trigger a significant epidemic rebound if infections chains cannot be broken. Effective mitigation requires values of R_{eff} below 0.8.

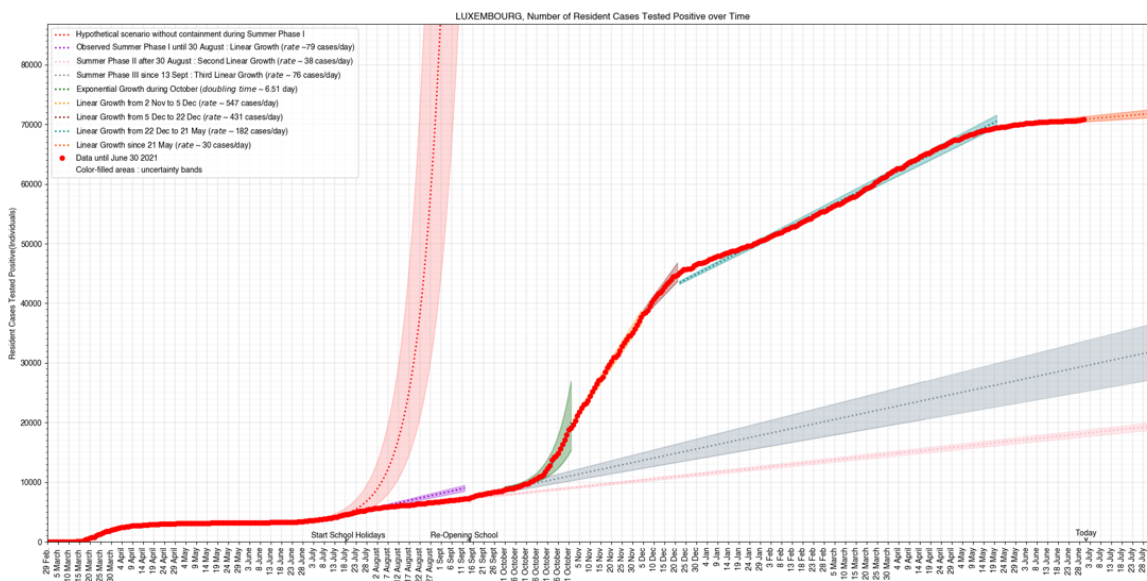


Figure 2. Official COVID-19 case numbers up to June 30 (red dots) were approximated with an adapted model for short-term forecasts. From 14 June on, an initial exponential increase was observed as a second wave (red line). From mid to end of July, the daily increase of cases showed an increase of 80 cases/days (summer phase I, magenta line) and from beginning of August to mid of September, a linear increase of 38 cases/days (summer phase II, red 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 76 cases/day (summer phase III, grey line). The dynamics during October indicated an accelerated exponential behavior (green) with a high number of daily cases. During November, the dynamics exhibited a linear behavior (orange line) with a rather constant but high number of 548 cases/days. For beginning to mid of December, the independent fit showed a reduced rate of 431 cases/day (magenta). A fit to the data from 22 December to 21 May (cyan) indicated a reduced slope of 182 cases/days. For the current period since May 21, the fitting still indicates a rather constant slope of 30 cases/day (orange) compared to last week's projections with a slope of 35 cases/day since it is not very sensitive to the latest increases.

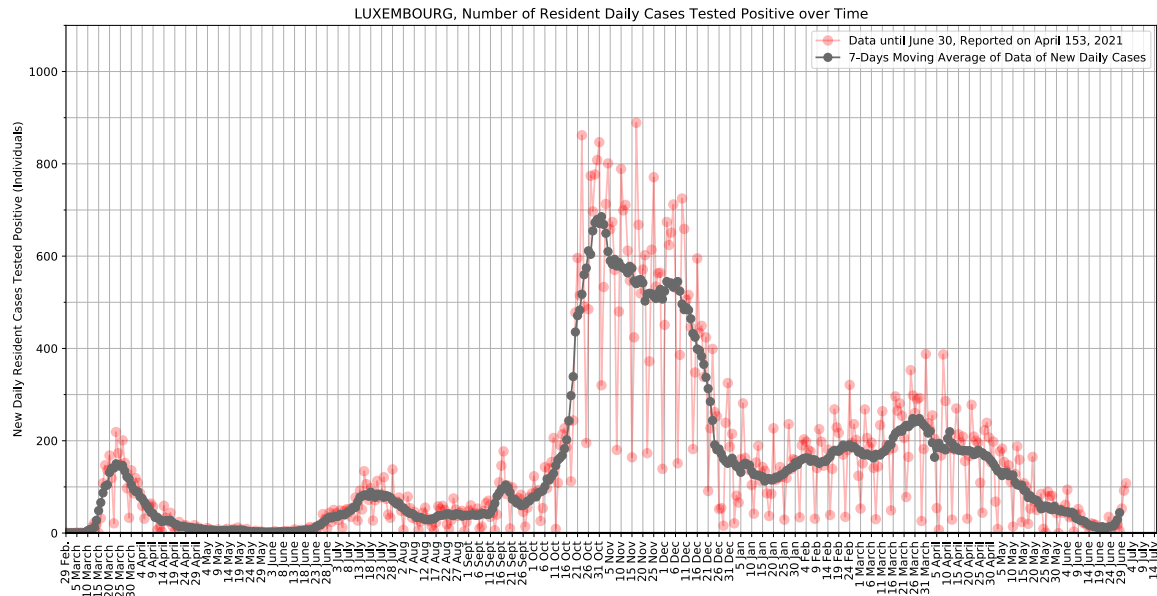


Figure 3. The daily COVID-19 case numbers up to June 30 (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve such as during the vacation period with 38 cases/day and an exponential behavior would correspond to a straight line such as for end of September to beginning October. During October, the curve clearly exhibited a non-linear increase in daily cases which corresponds to an accelerated exponential dynamics. For the first weeks in November, the numbers exhibited a small but consistently decreasing trend. After the stagnation during November and beginning of December, the number of daily cases has consistently decreased during December but was also amplified by the reduced testing over the holidays. **For the current week, the 7-day average of daily cases (grey) has increased to an average of 48 cases/day for the last 7 days compared to 15 cases for the week before.**

To estimate the midterm dynamics and particularly the potential effect of the more transmissible Delta-variant of the virus, we applied an epidemiological SIR model and parameterized it by a Kalman filter. The increase in the Delta-variant prevalence of 54.3% for week 24 compared to 30.9% for week 23 is in agreement with an increased transmissibility of 40-50% of the Delta-variant compared to the Alpha-variant (UK) of the virus reported in the literature based on the epidemic dynamics in the UK. The large increase in the case numbers indicates a strong increase in the effective social interactions, which is to some extent probably driven by infection clusters associated to superspreading events as previously considered in the more pessimistic scenarios (Fig. 5 right). **To evaluate the potential impact of the increased social interactions and infection clusters, we considered in the midterm projections the increased transmissibility of the Delta-variant explicitly and assumed that 100 cases during the last 3 days originated from infection clusters (superspreading events) and not from regular social interactions.** Note that the explicit assumption of the infection cluster reduces the peak of the anticipated epidemic rebound and that the current number of 100 represents only a rough estimate. Therefore, the projection exhibits a rather high uncertainty but demonstrates nevertheless the potential danger of a rebound.

The midterm projection in Figure 4 estimates the effect of the current level of social interactions without the effect of future vaccinations while the current vaccination level is implicitly considered by the data fitting of the Kalman filter. The 40% increased transmissibility of the Delta variant and the increased daily case numbers of the current week lead to a significant epidemic rebound (Fig. 4 left) with an earlier peak in October and an increased amplitude of 480 cases/day compared to the projection from last week with a peak of 220 cases/day in beginning of next year (Fig. 4 right). Note that these projections do not consider any future vaccinations and that the peak height would be more than doubled without the infection cluster assumptions. Hence, these projections are rather unrealistic but are still shown for comparison and coherence reasons.

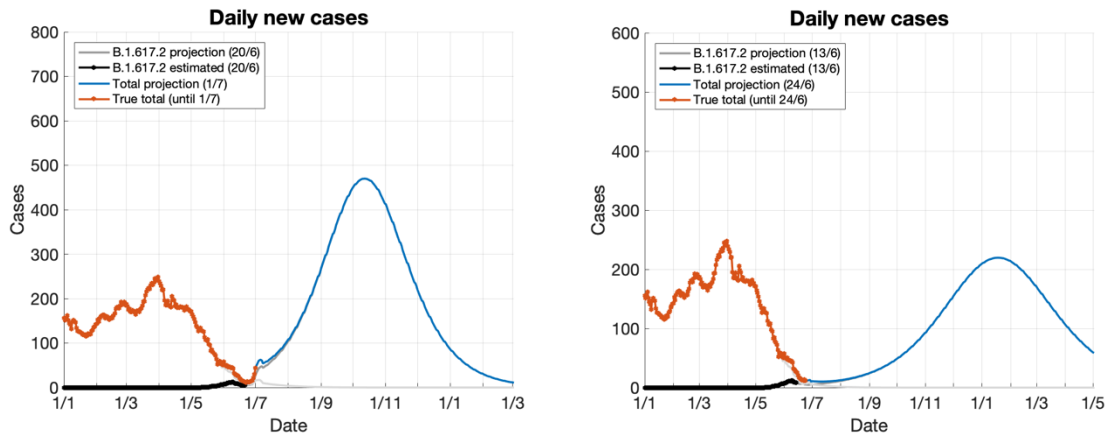


Figure 4. Comparison of midterm projections for daily cases considering the increased transmissibility of the Delta-variant with current effective social interactions (left) and interaction estimated of last week (right). Based on the epidemic dynamics of observed cases (red line for 7-day average), the projections show the overall dynamics (blue) and the contribution of the variants of concern (black). **Left:** Considering the reported prevalence of the Delta-variant (black line) with a 40% increased transmissibility compared to the Alpha-variant, 100 cases of the last 3 days associated to infection clusters and resulting from current social interactions with **no future vaccinations**, the projection exhibits a potential rebound with an increased peak of around 480 cases/day compared to the peak of 220 cases/day from last week's projection (right). **Right:** Projections from last week exhibited smaller peak of 220 cases/day, indicating a significantly lower level of effective social interactions. **Note that the effect of advancing vaccination will dampen the rebound as shown in Fig. 5 and Fig. 6.**

The more realistic scenarios considering the future vaccinations and estimated social interactions are shown in Fig. 5 and Fig. 6 and exhibit a flattening of the curves by on average 2360 administered vaccine doses per day (corresponding to 75% of expected vaccine deliveries of 22,000 doses per week). Furthermore, we assume that 50% of the doses are used for first vaccinations and 50% for second vaccinations. The vaccine efficacy against transmission was assumed to be 30% after the first dose and 60% after the second dose. Note that this efficacy against transmission is smaller than for developing symptoms and can currently only be roughly estimated. The assumed levels represent conservative estimates for the efficacy.

The pessimistic scenario from last week (Fig. 5 right) considered a 50% increased transmissibility of the Delta-variant and in addition to cases originating from base-level social interactions 300 cases over 19 days based on some superspreading events. A comparison with the current daily case numbers shows that these assumptions might not to be too far off. **For the currently increased case numbers and the explicit assumption that 100 cases of the last 3 days are associated to infection clusters, the corresponding estimate of social interactions leads to a stronger rebound with 360 cases/days in September** (Fig. 5 left). As mentioned above, the number of cases associated to infection clusters is currently only a rough estimate and are associated with high uncertainty of the corresponding projections. Nevertheless, **this comparison shows that the development observed during the last week has led to an epidemic dynamics similar to the level of the pessimistic assumptions of last week and further highlights the impact of social interactions.** Note that these projections do not consider a potentially reduced level of social interactions during the summer vacation period, which would push down the curves.

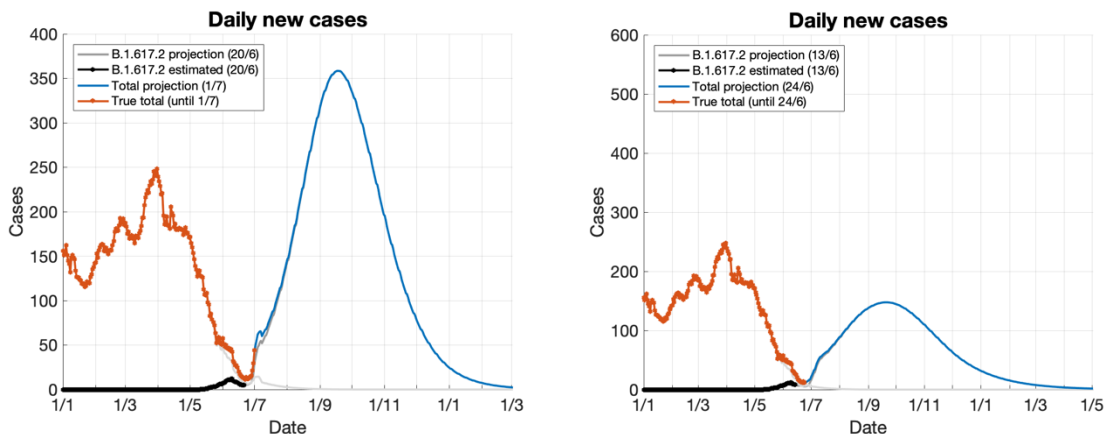


Figure 5. Midterm projections for daily cases for a more pessimistic scenario considering a 50% increased transmissibility of Delta-variant compared to the Alpha-variant, advancing vaccinations, social interactions as of this week (left) and last week (right). Based on the projections shown in Fig. 4, the scenarios consider advancing vaccinations with a rate of 2360 doses/day and resulting efficacies against transmission of 30% and 60% after the first and second dose, respectively. **Left:** Considering the reported prevalence of the Delta-variant, the 100 cases of the last 3 days associated to infection clusters and the resulting current social interaction estimates **with future vaccinations**, the projection exhibits a reduced peak of a potential epidemic rebound as shown in Fig. 4 left. The strongly increased social interactions of the current week lead to an increased peak of around 360 cases/day compared to last week's projection (right). **Right:** Projections from last week with the assumption of additional 300 cases over the next 19 days (as for e.g. induced by super-spreading events) and estimated social interactions of last week showed a smaller epidemic rebound with a peak of around 150 cases/day in September. **Note that the projections do not consider a potential decrease in social interactions during the summer period, which would push the curves further down.**

The comparison of the **more optimistic assumption of a 40% increased transmissibility of the Delta-variant in Fig. 6** shows that the increased social interactions of the current week might induce an **epidemic rebound despite advancing vaccinations**. In the current scenario (Fig. 6 left), we again assumed that 100 cases of the last 3 days were associated to infection clusters. Despite these assumptions, the projections indicate increased social interactions which would lead to an epidemic rebound although only with a peak of around 160 cases/day in September. Based on last week's estimate of social interactions, the corresponding projections exhibited a rather constant level of around 15 daily cases (Fig. 6 right).

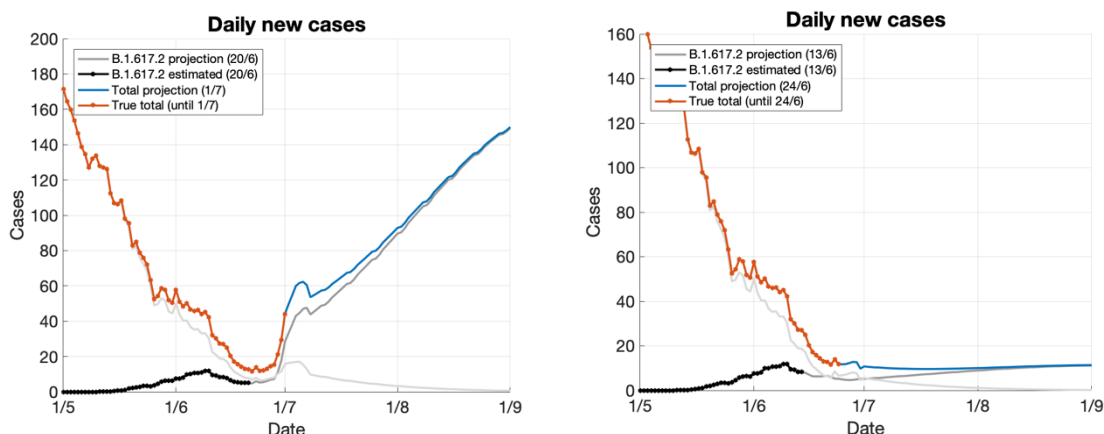


Figure 6. Zoom-in into the current timeframe for the more optimistic projections of the effect of the Delta-variant with a 40% increased transmissibility. **Left:** Considering 100 cases of the last 3 days associated to infection clusters and the resulting current social interaction estimates as of today, the strongly increasing case numbers would lead to continuing increasing cases during the next two months despite the advancing vaccinations. **Right:** Corresponding projections with social interactions as of last week would lead to a rather constant daily case numbers below 20. **Note again that both projections do not consider a potential decrease in social interactions during the summer period.**



Overall, these simulations demonstrate that the interplay between vaccination and social interactions will determine the future effect of the more transmissible Delta-variant and the advancing vaccinations. The strong increase in daily case numbers and the associated infection clusters have led to more pessimistic projections, highlighting the strong impact social interactions still have on the epidemic dynamics. Currently, the **effect of the infection clusters can only be roughly estimated, resulting in a rather large uncertainty in the projections**, but the analysis in Fig. 5 on the more pessimistic scenarios may give an upper limit for the future development. Although the anticipated reduced social interactions during the summer vacation period will probably push down the curve, the **social distancing and hygiene measures are now crucial to prevent a significant epidemic rebound as currently observed in the UK and Israel.**

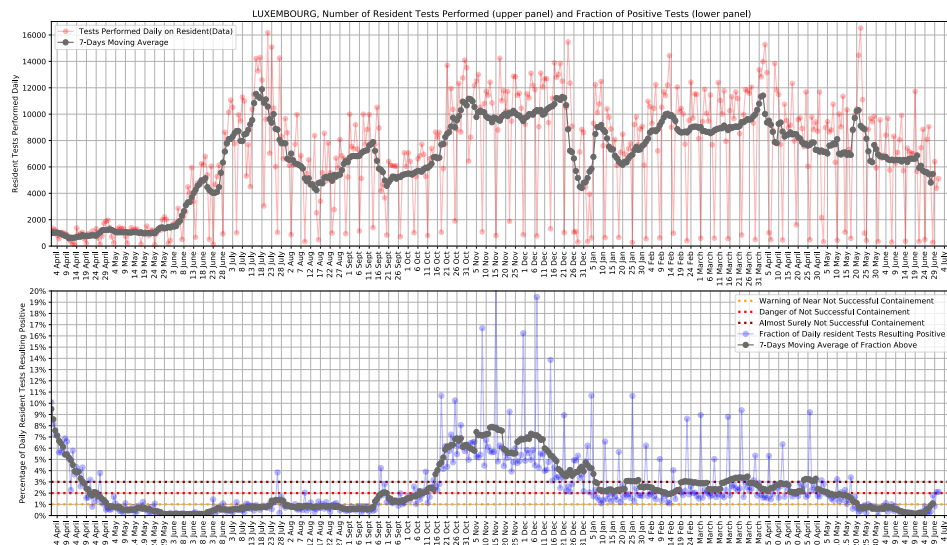


Figure 7. The number of daily tests performed (top) and overall normalized positive tests (bottom). During the current week, the 7-day average positivity rate (grey) has increased to 1% (compared to <0.2% last week).

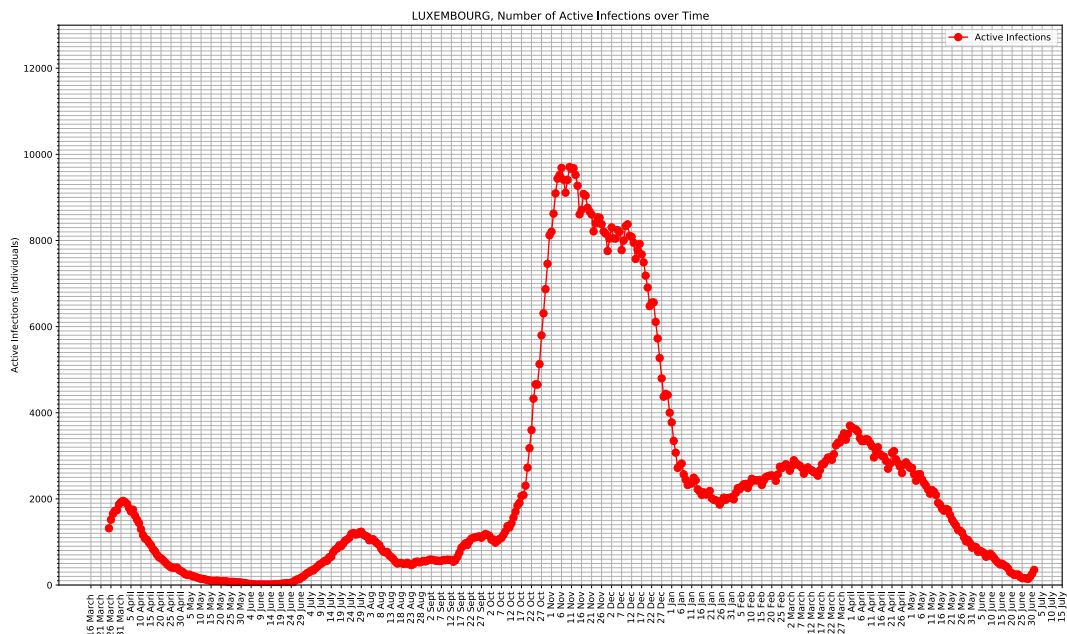


Figure 8. During the current week, the number of estimated active cases has further decreased to 351 cases compared to 213 cases last week.

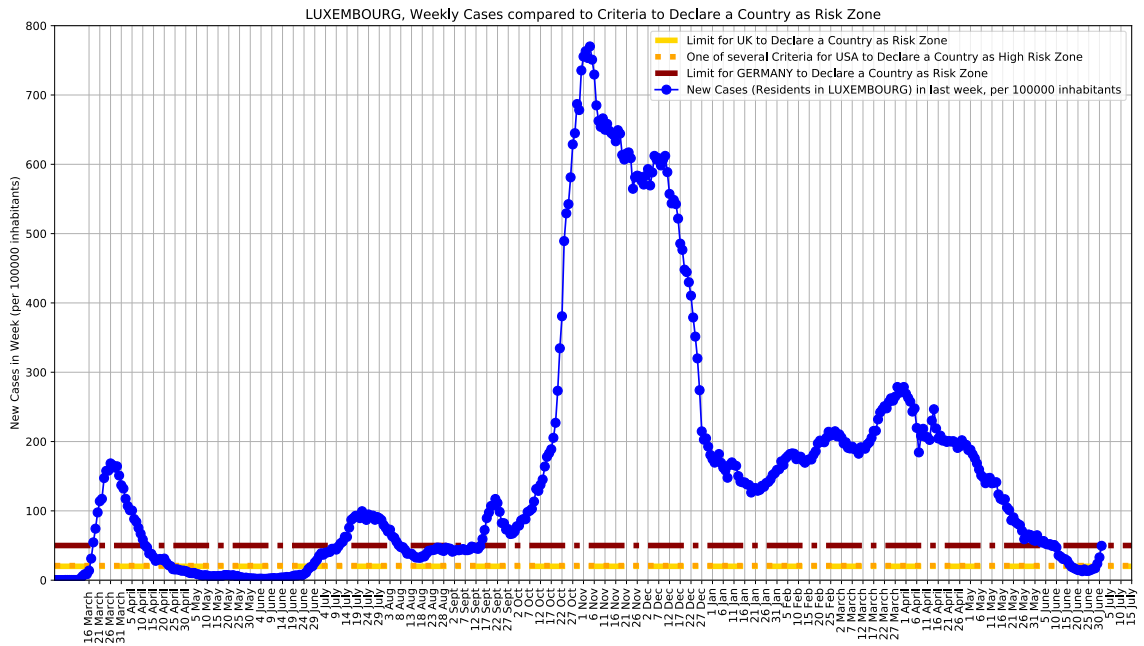


Figure 9. The number of weekly cases per 100,000 inhabitant that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and 100,000 inhabitants (dark red line). Luxembourg has surpassed this threshold since the week of 17 September and has reached more than 700 cases per week and 100,000 inhabitants beginning of November. **During the current week, the number of weekly cases per 100,000 inhabitants has reached again 50 cases compared to 20 cases last week.**