

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 the last report from 2 December. It gives a short overview on the most important epidemic indicators and contains projections for the current epidemic status **based on data available up to 8 December**.

Main conclusions

- **The exponential epidemic dynamics reported last week has further continued during the current week with some indications of a relaxing trend in the still exponential regime.** Thus, the 7-day average of daily cases for the current week has still increased to 389 cases/day compared to 366 cases/day for last week but the increase is smaller than anticipated.
- **R_{eff} of today has reduced to 0.98** compared to 1.14 on Thursday of last week, and also the **7-day average value of R_{eff} has slightly decreased to 1.06** compared to 1.11 of last week (Figure 1).
- The exponential trend has slightly reduce during the current week and the doubling time increase to 32 days compared to 22 days from last week's estimate (Figure 2 and 3).
- The 7-day average for the **normal care hospitalization demands** has remained rather constant (50.6 cases on average for this week compared to 48.4 cases for last week) whereas **the average ICU occupancies** has, as anticipated last week, strongly increased (19.7 cases on average for this week compared to 11.1 cases for last week).
- Based on the volatile level of the epidemics and the slight relaxation of the current regime, the current **midterm projections of daily cases** indicate a rather similar epidemic dynamics compared to last week's projections, with an anticipated peak of around 420 daily cases on average in the next weeks similar to last week's projections (Figure 4). Based on the development of this week, the current pessimistic scenario exhibits a reduction of a possible peak of around 650 cases in January compared to above 700 cases from last week's pessimistic scenario. Note that these projections do not consider future changes in social behavior or in more transmissible virus variants explicitly.
- The corresponding **projections of the hospital demands** exhibit also a stabilization for normal care at around 70 cases in January from the current projections compared to 75 cases from last week's projection (Figure 5). The projection for intensive care units remained rather constant and indicate around 26 cases in January compared to 28 cases in the projections from last week (Figure 6). For the more pessimistic scenario, these peaks increase to more than 120 cases for normal care and 45 cases in ICU. Note that hospitalization and specifically ICU demands depend strongly on the age structure of the cases and the vaccination status of the population. Hence, it is particularly important that vulnerable people are vaccinated and remain cautious in their social interactions to prevent severe cases and an increase in hospital demands.
- The average **positivity rate** has stabilized at around 9% (Figure 7).
- The total number of **estimated active cases** has further increased to 5662 cases for this week compared to 4920 cases for last week (Figure 8).

Together with the dominant prevalence of the Delta variant of 100% and the anticipated increase of the Omicron variant, the continuing exponential regime indicates a volatile level despite the recent evidence for a relaxation in the epidemic dynamics. Thus, the currently high case numbers reflect

the inherent potential for a significant epidemic rebound, which still bears the danger that contact tracing cannot break infection chains efficiently. Hence, sustained efforts in social distancing, in following hygiene measures as well as vaccination uptake (including booster shots) remain essential to stabilize the epidemic situation. This is also particularly important with respect to potential 'escape variants' for which vaccines might be less effective and with respect to waning immunity of vaccinated people. Thus, continued monitoring of breakthrough infections, virus variants and assessing their transmissibility will be a key element for sustained mitigation of the pandemic during the up-coming months.

Graphical analysis of epidemic indicators

Below, the epidemic indicators are visualized and analyzed in more detail including the midterm projections for daily cases and hospitalization.

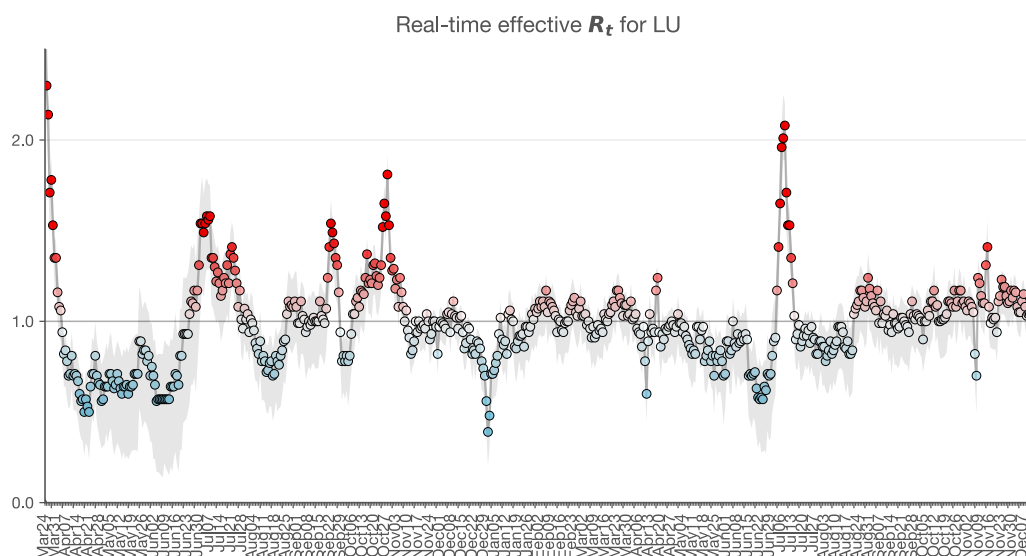


Figure 1. For the current week, the effective reproduction R_{eff} has decreased to 0.98 today compared to 1.14 on Thursday of last week. The 7-day average of the current week has also slightly decreased to 1.06 compared to 1.11 of last week. Note that effective mitigation requires values below 0.8.

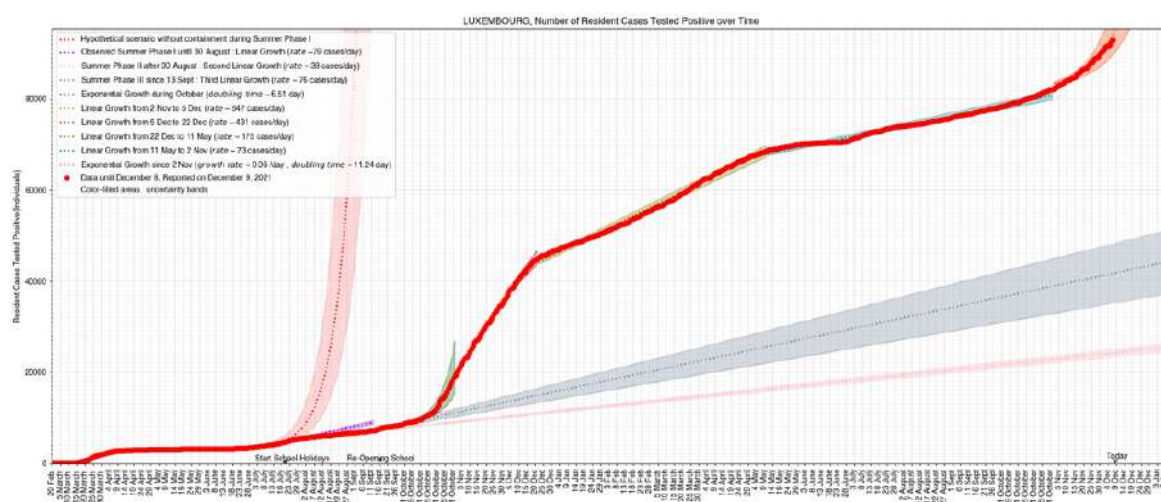


Figure 2. Official COVID-19 case numbers up to 8 December (red dots) were approximated with an adapted model for short-term forecasts for the different phases of the epidemics (color coded). For the current week, the linear fitting for the last month indicates an increased slope with 306 cases/day compared to 261 cases/day from the corresponding estimate of last week. The continuing increase in the slope is actually indicating the exponential behavior as shown by the corresponding exponential fit (orange).

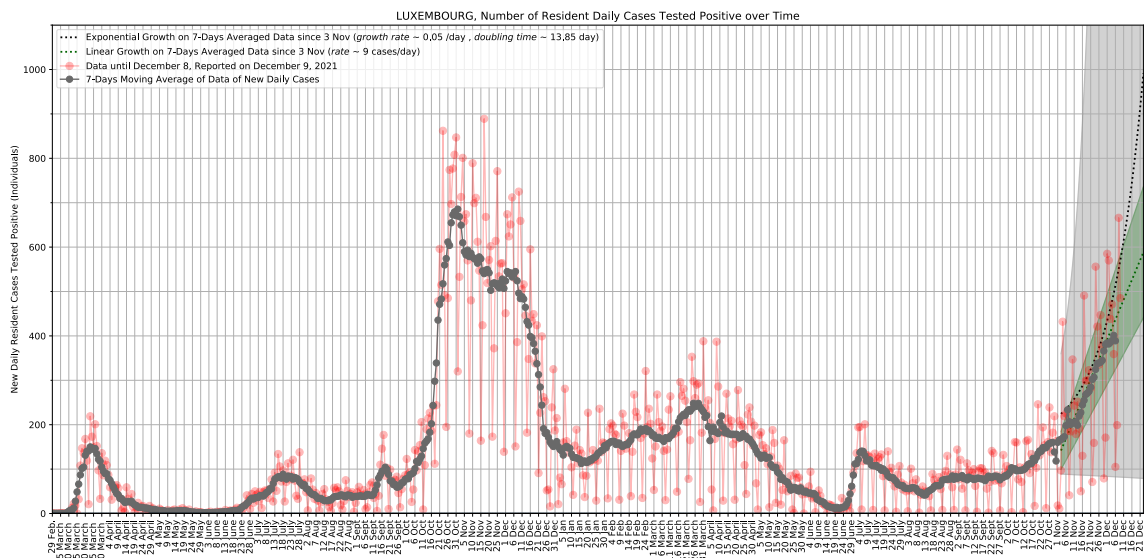


Figure 3. The daily COVID-19 case numbers up to 8 December (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve and that an exponential behavior would correspond to a straight line. **For the current week, the 7-day average of daily cases (grey) increased to an average of 389 cases/day for the last 7 days compared to 361 cases/day for the week before.** The observed linear behavior indicates the exponential dynamics.

To assess the future epidemiological development in Luxembourg, we parameterized an extended epidemiological SIR model with data from Luxembourg by a Kalman filter. The model considers high and low risk groups, the number of vaccinated people of 70% of the entire population (including minors) is vaccinated. Furthermore, the vaccine efficacy against transmission is inferred from Luxembourg data as 44% and 68% for the first and the second dose, respectively, and the efficacy against severe outcome as 74% and 85%, respectively. Based on these assumptions and the current age-distribution of infected persons of the last two weeks, the model integrates the dynamics of daily cases, hospitalizations and ICU occupancy and projects the future development of the epidemics. Note that the model does not consider future changes in social behavior or vaccine efficacies explicitly and that the projections are accompanied by uncertainties as shown by the confidence intervals, which currently correspond to a 10% decrease or increase in social interactions for the optimistic and pessimistic scenarios, respectively (Figures 4 to 6).

The midterm **projections of the 7-day average of daily new cases** (Figure 4) estimate the current level of social interactions and consider the vaccination status. The current projections reflect the stabilization of the exponential behavior of the epidemic dynamics. Thus, the current projections for **the 7-day average of daily cases** for the next weeks exhibit a peak of around 420 cases/day in January and a subsequent slow decay (Fig. 4 left) similar to last week's projections (Fig. 4 right). In the currently volatile epidemic regime, small changes in social interactions can have a significant impact as shown by the optimistic and pessimistic scenarios. In the pessimistic scenario, the current upper bound corresponds to a 10% increase in social interactions and shows that an epidemic rebound with a peak of around 650 daily cases could occur in January compared to the anticipated peak of nearly 800 cases/day from the projections of last week. This reduction in the current projections reflects the stabilization of the epidemic situation which exhibits still an exponential dynamics potentially induced by immunity waning of vaccinated people.

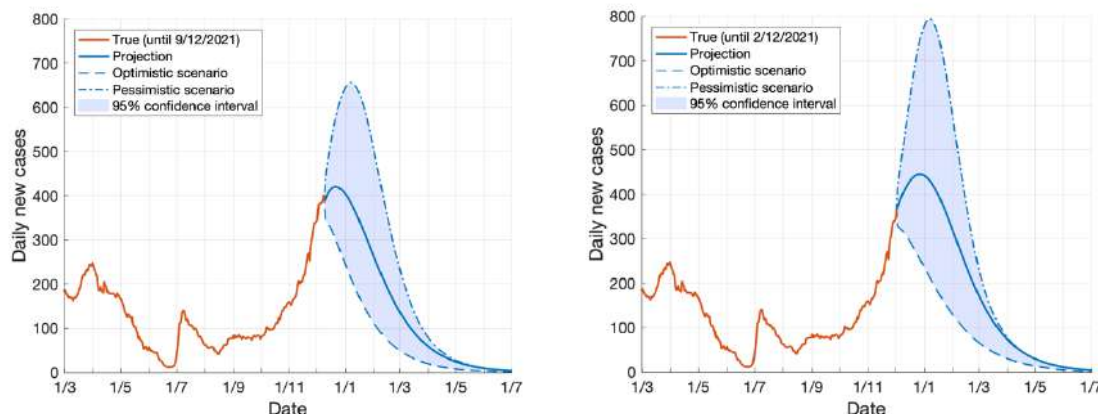


Figure 4. Comparison of midterm projections for the 7-day average of daily cases from this week (left) and last week (right) based on an extended epidemiological SIR model parameterized to the situation in Luxembourg data by a Kalman filter. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 10% decrease and increase in social interactions for this week's and last week's projections, respectively. **The comparison indicates a stabilization in the epidemic dynamics with an anticipated peak in January of around 420 cases/day on average from this week's projection (left) similar to the projection from last week (right).**

The model **projection for normal care** also reflects the increased epidemic dynamics observed within the current week (Fig. 5) where the current projection (Fig. 5 left) indicates a slight decrease in the normal care demand with a peak of around 70 beds in January and a subsequent decreasing trend compared to around 75 beds from last week's projection (Fig. 5 right). This dynamic is based on the case numbers shown in Figure 4 and the current age distribution of cases. For the normal care demands, the volatile epidemic level bears also the potential for a significant increase in hospitalizations as shown by the pessimistic scenarios with a 10% increase in social interactions, which could lead to an increase in hospital demands of around 120 beds in January (Fig. 5 left) compared to 140 beds from the pessimistic scenario of last week (Fig. 5 right). Note that hospitalizations depend strongly on the age distribution of cases since older people are more likely to develop severe symptoms and that changes in the age structure can induce changes in the projections accordingly.

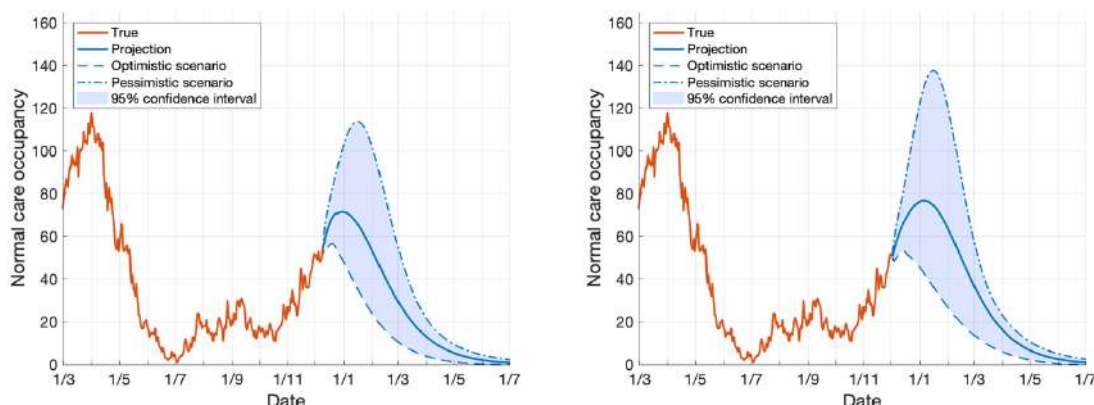


Figure 5. Comparison of midterm projections for the 7-day average of normal care demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 10% decrease and increase in social interactions, respectively for this week. **The comparison indicates a slight decrease in the peak of normal care demands of around 70 beds in January (left) compared to 75 beds in the projections from last week (right).** The volatile epidemic regime could lead to a significant increase in normal care demands as shown by the pessimistic scenario with a 10% increase in social interactions leading potentially to nearly 120 cases in January.

The corresponding **projection for ICU demands** also show a stable behavior in terms of the future development of case numbers and normal care demands. The current projection indicate a potential demand of 26 ICU beds in January (Fig. 6 left) compared to 28 beds from the projection of last week (Fig. 6 right). The volatile epidemic level also bears the potential for a more significant increase in ICU demands as shown by the pessimistic scenario with a 10% increase in social interactions, which could lead to more than 43 ICU cases in January (compared to more than 50 beds from the estimate of the pessimistic scenario of last week's projection). Note that hospitalization and specifically ICU demands depend strongly on the age structure and vaccination status of cases. Hence, it is particularly important that vulnerable people are vaccinated and remain cautious in their social interactions to prevent severe cases.

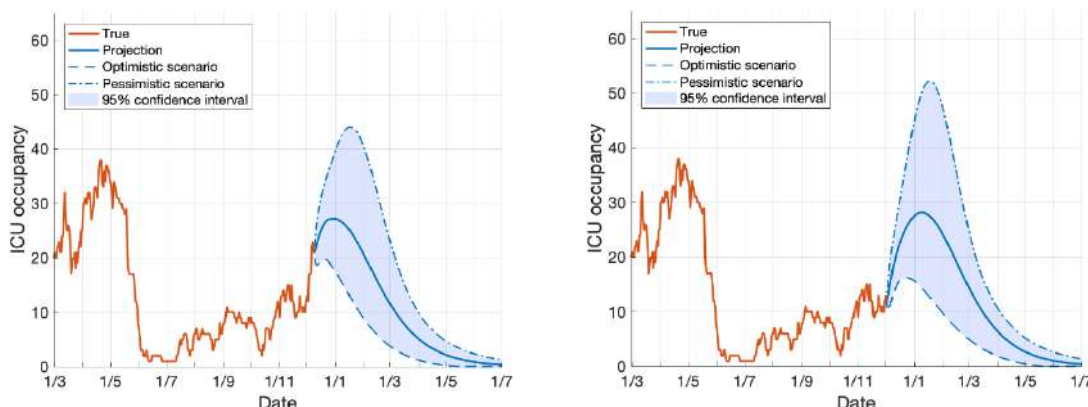


Figure 6. Comparison of midterm projections for the 7-day average of ICU demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario and the optimistic (dashed line) and pessimistic scenarios (dotted-dashed line) correspond to a 10% decrease and increase in social interactions, respectively for this week. **The comparison exhibits a rather constant ICU demand of anticipated 26 ICU beds in January from projections of this week (left) compared to 28 beds for last week's projections (right).** The current pessimistic scenario with a 10% increase in social interactions also shows a potential increase to more than 43 ICU beds in January.

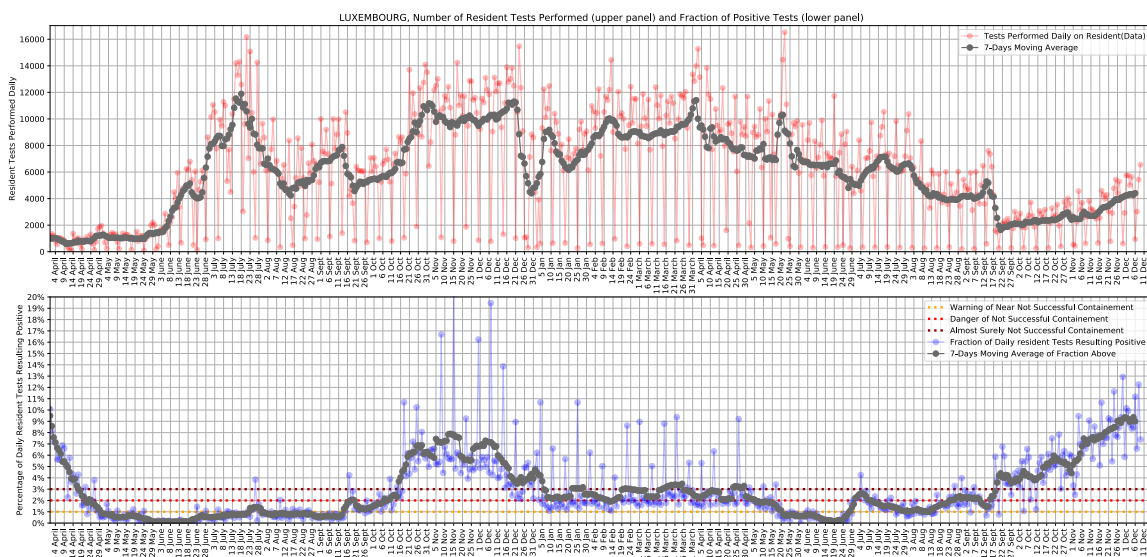


Figure 7. Number of daily tests performed (top) and overall normalized positive tests (bottom). **During the current week, the 7-day average of the positivity rate (grey) stabilized at around 9% compared.**

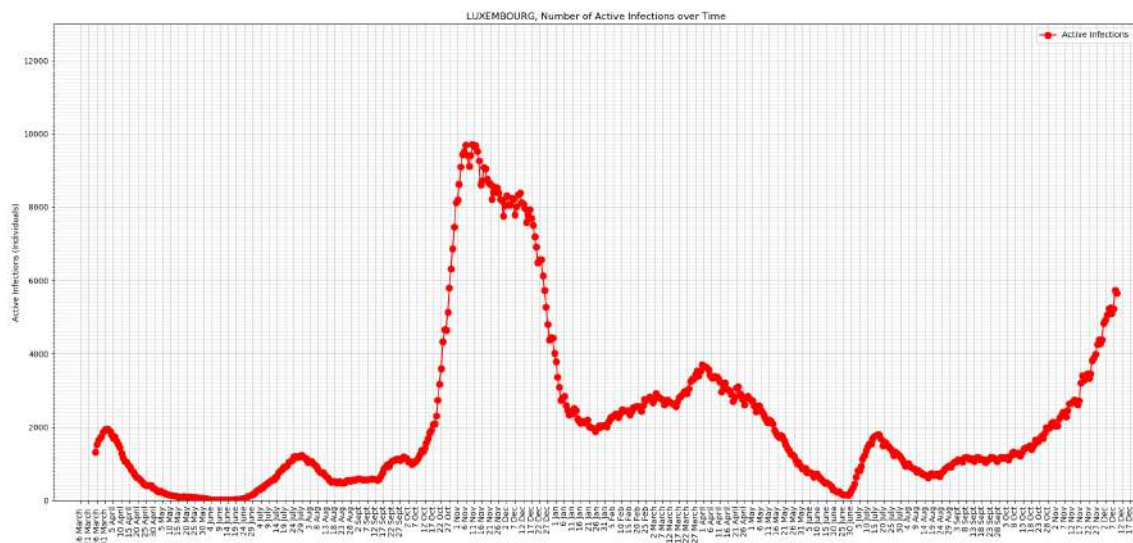


Figure 8. During the current week, the number of estimated active cases has further increased to 5662 cases compared to 4920 cases for last week.

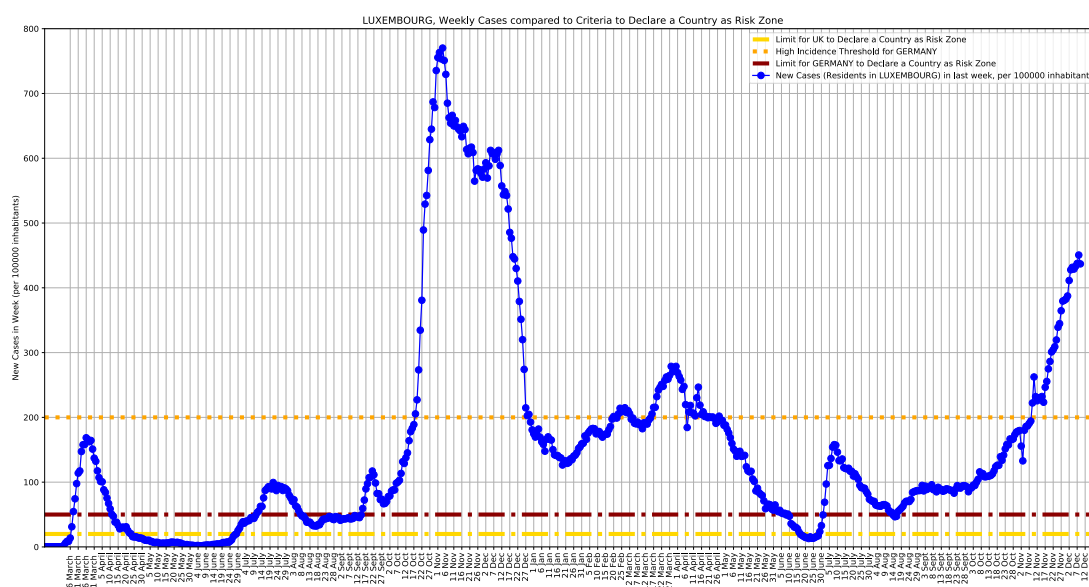


Figure 9. Number of weekly cases per 100,000 inhabitants that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and per 100,000 inhabitants (dark red line). During the current week, the number of weekly cases per 100,000 inhabitants has just increased with a slight saturation above 440 cases for this week compared to around 400 cases for last week.