RESEARCH LUXEMBOURG
COVID-19 Task Force

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 16 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 5 January**.

Main conclusions

- The development during the Christmas to New Year vacation period shows the impact of the Omicron virus variant which has led, as projected, to a significant epidemic rebound. Thus the 7-day average of daily cases for the current week has strongly increased to 1,116 cases/day compared to 578 cases/day for the week before and 385 cases/day reported on 16 December.
- R_{eff} of today has increased to 1.42 compared to 1.05 on December 16 and slightly decreased compared to Thursday of last week at 1.53 (Figure 1). However, the 7-day average value of R_{eff} has also increased to 1.39 compared to 1.17 for the week before and to 0.98 on December 16.
- The last week exhibits an exponential trend. A linear fitting to the cumulative cases for the last month indicates a slope of 532 cases/day compared to 367 cases/day reported on 16 December (Figure 2 and 3). However, the testing during the vacation period has led to strong fluctuation and therefore a reliable exponential analysis is not presently possible.
- The 7-day average for the normal care hospitalization demands has remained constant compared to last week (48.1 cases on average for this week compared to 45 cases for last week) and decreased compared to December 16 (59 cases). The average ICU occupancies has also remained constant with 19.85 cases on average for this week compared to 19 cases last week and 19.7 cases for the week of December 16.
- Based on the recent increase in the epidemic dynamics, the current midterm projections of daily cases indicate a strong epidemic rebound with a potential peak in the 7-day average of daily cases with more than 1,400 cases/day end of January compared to a peak of around 400 cases/day on December 16 (Figure 4), and which did not yet include the potential impact of the Omicron variant. Note that these projections do not consider future changes in social behavior or in even more transmissible virus variants explicitly.
- The corresponding projections for the hospital demands also exhibit an increase for the next weeks despite the assumption of a 40 % decrease for normal care and a 60 % reduction of ICU hospitalization for the Omicron variant compared to the Delta variant. With these assumptions, the projections indicate a normal care demand of 120 beds and an ICU demand of around 40 beds (Figure 5 and Figure 6). 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 (including booster shots) and remain cautious in their social interactions to prevent severe cases and an increase in hospital demands.
- The average positivity rate has significantly increase to more than 25% (Figure 7).
- The total number of estimated active cases has strongly increased to 12,443 cases compared to 7,266 cases for the previous week and 5,965 cases for the week of 16 December (Figure 8).

As anticipated, the presence of the Omicron variant with its increased transmissibility and partial immune evasion has led to a significant epidemic rebound. Currently, the data on the properties of the Omicron variant is still limited and therefore its potential effects on hospitalization can only be roughly estimated. Nevertheless, the Omicron variant is likely leading to a further increase in the case numbers and will become the dominant variant in the next weeks. Hence, sustained efforts in social distancing, in following hygiene measures as well as vaccination uptake, including booster shots, will be essential to mitigate the epidemic rebound. In this respect, continued monitoring of breakthrough infections, virus variants and assessing their transmissibility will be a key element for future mitigation of the pandemic during the up-coming weeks and 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.

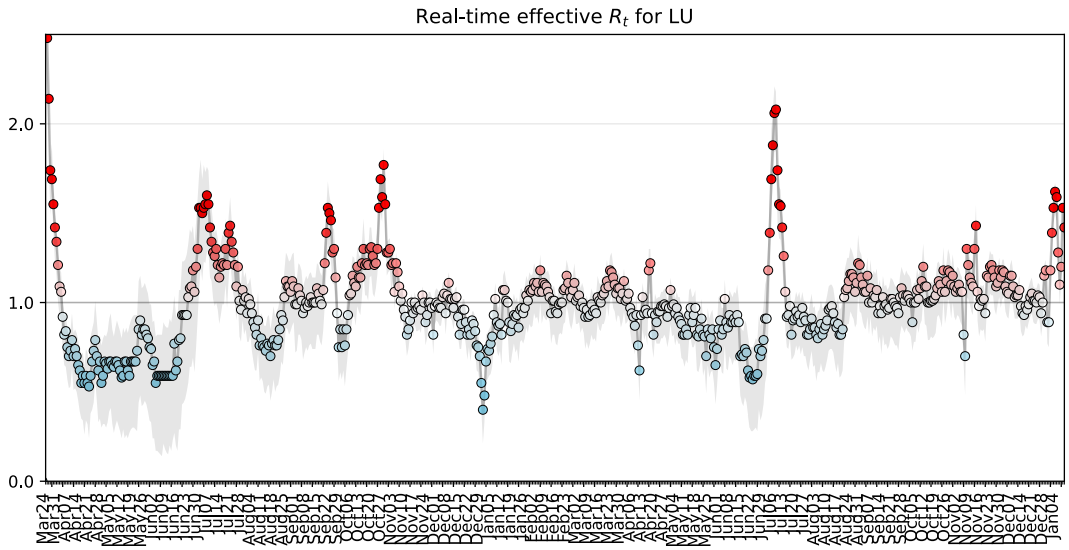

Figure 1. *For the current week, the effective reproduction R_{eff} has increased to 1.42 today compared to 1.05 on December 16 and only slightly decreased as compared to Thursday of last week with 1.53. The 7-day average of the current week has significantly increased to 1.39 compared to 1.17 of last week and to 0.98 on 16 December.*

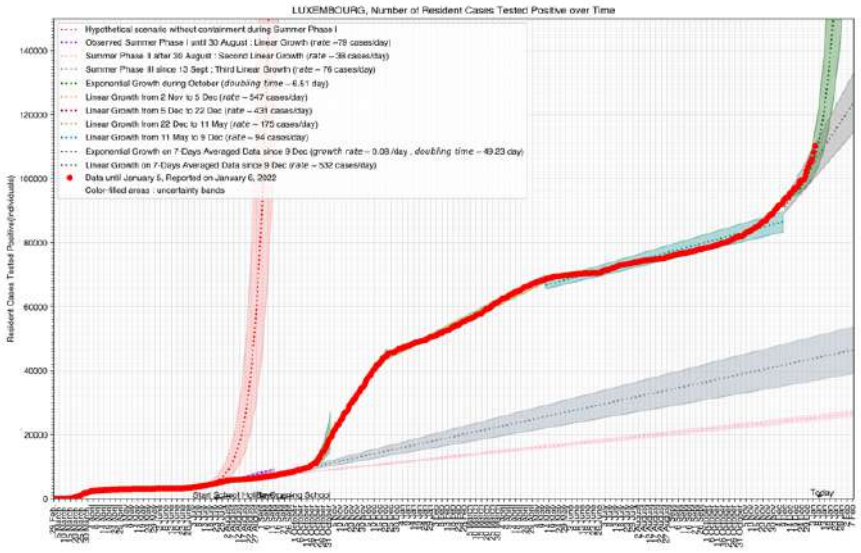

Figure 2. *Official COVID-19 case numbers up to 5 January (red dots) were approximated with an adapted model for short-term forecasts for the different phases of the epidemics (color coded). During the last weeks, an exponential dynamics was observed (green) with an increasing trend due to the Omicron variant.*

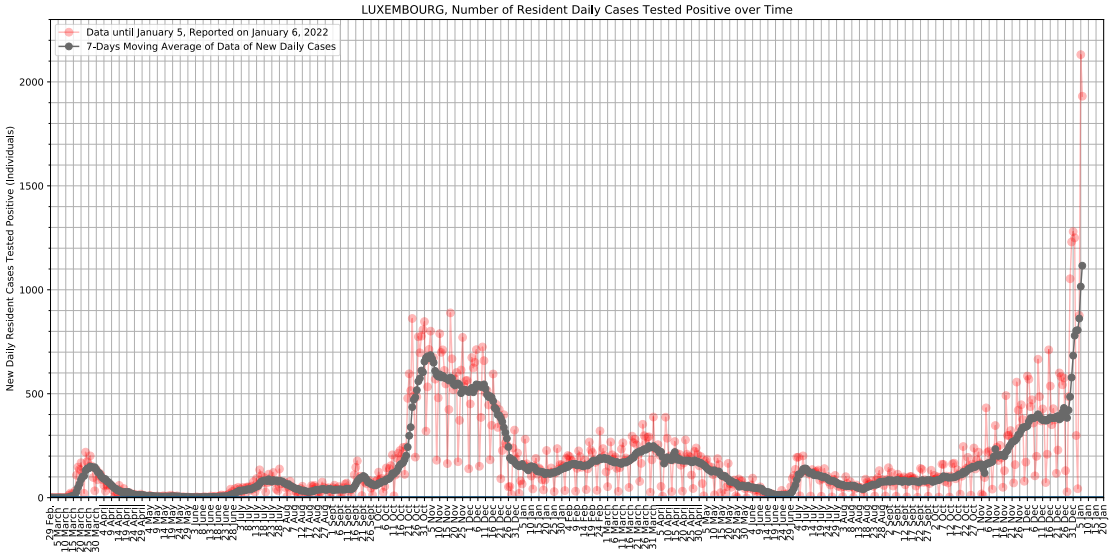

Figure 3. *The daily COVID-19 case numbers up to 5 January (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve and that an exponential behavior would correspond to a straight line.* ***For the current week, the 7-day average of daily cases (grey) has strongly increased to 1116 cases/day compared to 587 cases/day for the week before and to 385 cases/day for the week of 16 December.*** *This strong increase was anticipated due to the Omicron variant as stated in the report of 16 December.*

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 current state of vaccination, and the vaccine efficacy against transmission for the Delta variant 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. For the Omicron variant, the transmissibility is increased by roughly 200%. However, the hospitalization risk is reduced by 40% for normal care and 60% for ICU compared to the Delta variant. 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 7% decrease or increase in social interactions for the optimistic and pessimistic scenarios and compared to 10% decrease or increase for the projections form 16 December, 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 anticipated effect of the more transmissible Omicron variant. Thus, the current projection for **the 7-day average of daily cases** indicates a more than 4-fold increase in the anticipated peak of cases of around 1400 cases/day for the next weeks (Figure 4 left) compared to a rather constant level of around 400 cases/day from the projections of 16 December. Note that the previous projections did not include the expected effect of the Omicron variant but anticipated preliminary projections such as a strong increase although only for mid to end of January. In the pessimistic scenario, the current upper bound corresponds to a 7% increase in social interactions and indicates an epidemic rebound with a peak of more than 1600 cases/day. Due to the different testing behavior over the holiday period, the current data is not yet very reliable and therefore the projections are accompanied by some uncertainties. Currently, the effect of the Omicron variant can only be roughly estimated based on epidemic data from other countries and cannot be directly adapted to the situation in Luxembourg. Corresponding projections are currently in preparation.

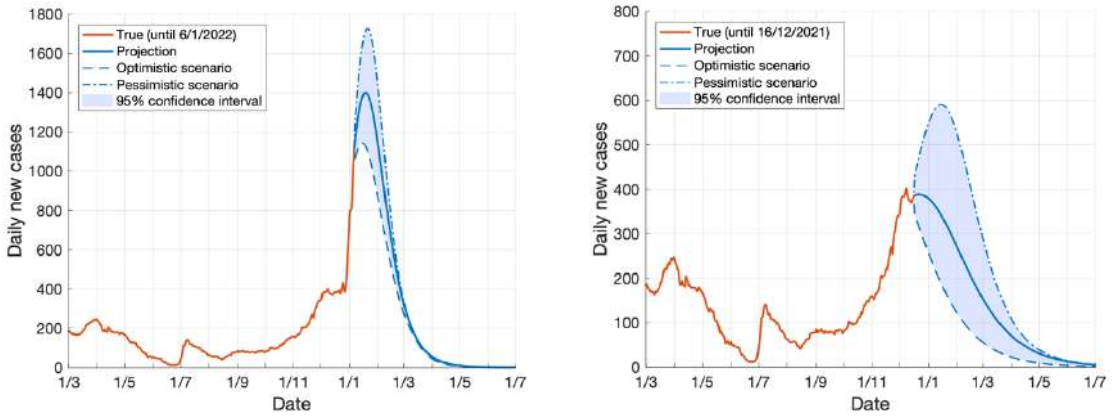

Figure 4. *Comparison of midterm projections for the 7-day average of daily cases from this week (left) and the week of 16 December (right) based on an extended epidemiological SIR model parameterized to the situation in Luxembourg data by a Kalman filter. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 7% decrease and increase in social interactions for this week's and 10% for last week's projections, respectively.* ***The comparison indicates a strong epidemic rebound driven by the Omicron variant with a more than 4-fold increase of anticipated cases in February with 1400 cases/day compared to 420 cases/day in the projection from 16 December (right).***

The model **projection for normal care** assumes a 40% decrease in the hospitalization risk for the Omicron variant compared to the Delta variant. Therefore, the 4-fold increase in cases numbers (Figure 4) only leads to a doubling of anticipated normal care demands of around 120 beds in February compared to 60 beds in the projection from December 16 (Figure. 5). 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 epidemic rebound might still lead to a more significant increase in hospitalizations as shown by the pessimistic scenarios with a 7% increase in social interactions, which could lead to an increase in hospital demands of around 160 beds in February (Figure. 5 left). Note that hospitalizations depend strongly on the age distribution of cases since older people are more likely to develop severe symptoms and that in particular for the Omicron variant booster shots are essential to push down the curve. Hence, changes in the age structure and admission of booster shots can induce changes in the projections accordingly.

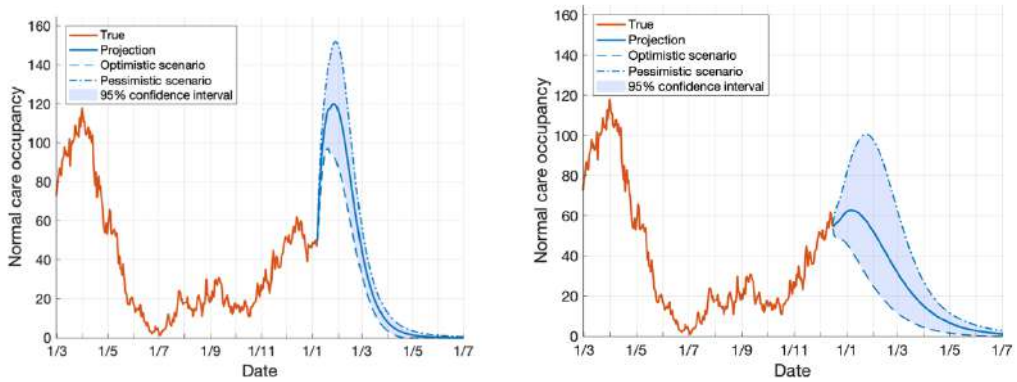

Figure 5. *Comparison of midterm projections for the 7-day average of normal care demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 7% decrease and increase in social interactions, respectively for this week and 10% for the projections from 16 December.* ***The comparison indicates a strong increase in normal care demands to around 120 beds in February (left) compared to a peak of 60 beds in January in the projections from 16 December (right).*** *The volatile epidemic regime could lead to more significant increase in normal care demands as shown by the pessimistic scenario with a 7% increase in social interactions leading potentially to nearly 160 cases in February.*

The corresponding **projections for ICU demands** also show the effect of the Omicron driven epidemic rebound where the evidence for reduction in severe cases for the Omicron variant and the current age distribution of cases exhibit only a mild increase to 33 ICU beds for the next weeks (Figure. 6 left) compared to a peak of around 25 beds from the projection of 16 December (Figure. 6 right). The pessimistic scenario with a 7% increase in social interactions indicates more than 40 ICU cases in February similarly to the estimate of the pessimistic scenario of the projection from 16 December. 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 (including booster shots) and remain cautious in their social interactions to prevent severe cases. With the strongly increasing number of cases, the protection of the vulnerable people becomes more challenging and requires frequent testing.

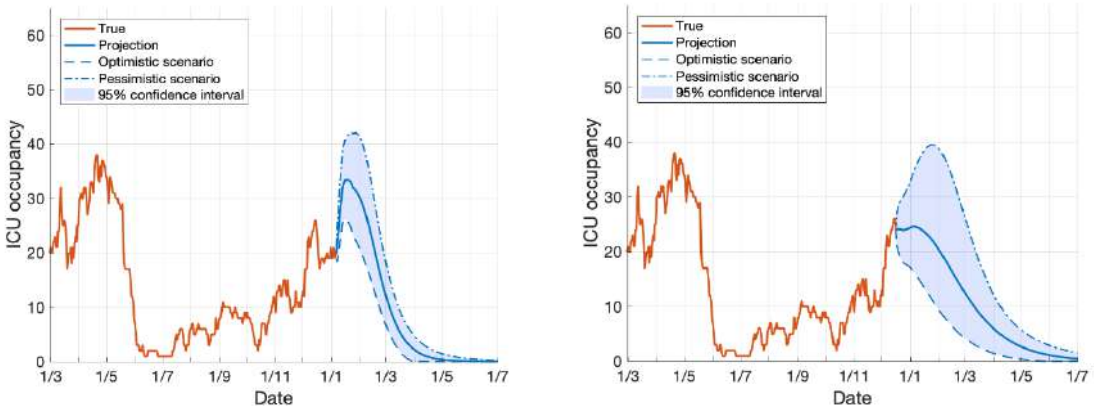

Figure 6. *Comparison of midterm projections for the 7-day average of ICU demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario and the optimistic (dashed line) and pessimistic scenarios (dotted-dashed line) correspond to a 7% decrease and increase in social interactions, respectively for this week and a 10% decrease and increase for the projection of 16 December.* ***The comparison exhibits a rather constant ICU demand of around 25 ICU beds during the next weeks (left) compared to a peak of around 28 beds in January in last week's projections (right).*** *The current pessimistic scenario with a 7% increase in social interactions also shows a potential increase to around 40 ICU beds in January. Note that the potential effects of the Omicron variant can only be roughly estimated at the moment given the limited available data..*

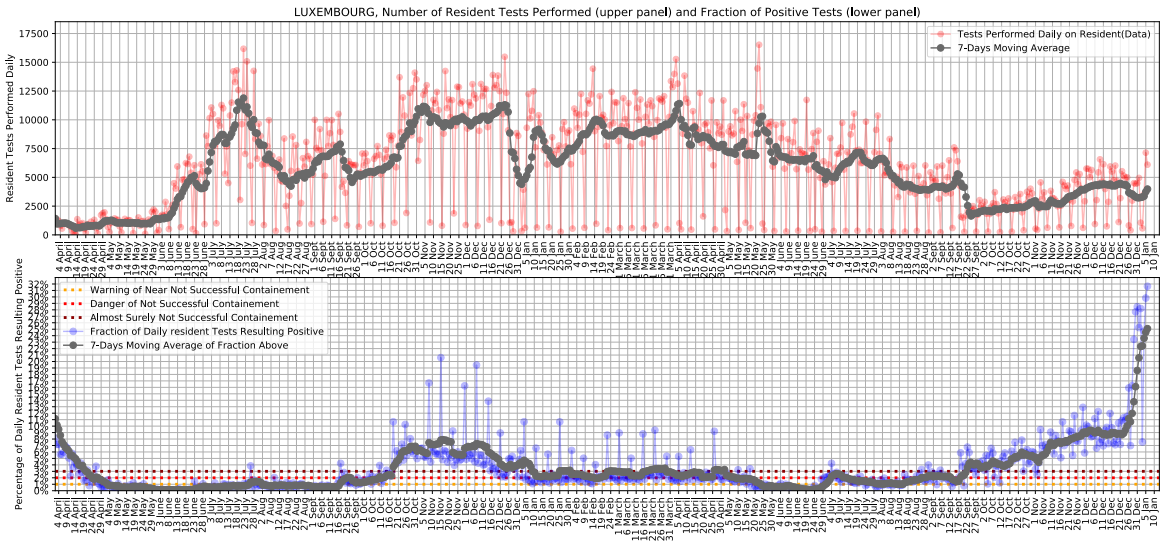

Figure 7. *Number of daily tests performed (top) and overall normalized positive tests (bottom).* ***During the current week, the 7-day average of positivity rate (grey) has strongly increased to above 25%*** *compared to around 9% before Christmas.*

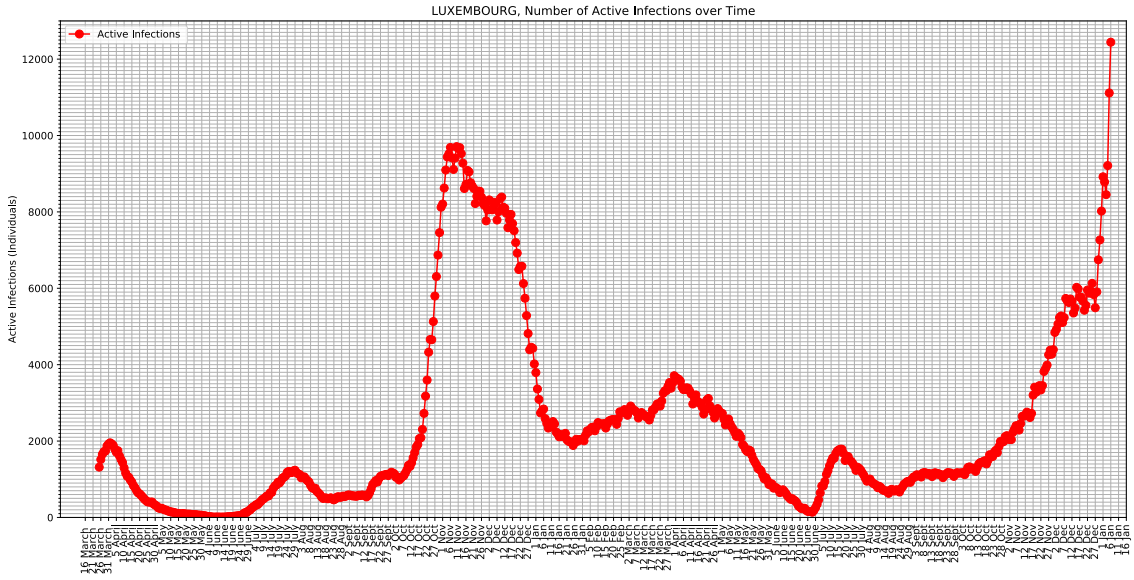

Figure 8. *During the current week,* ***the number of estimated active cases has significantly increased with 12443 cases*** *compared to the rather constant level before Christmas (5965 cases).*

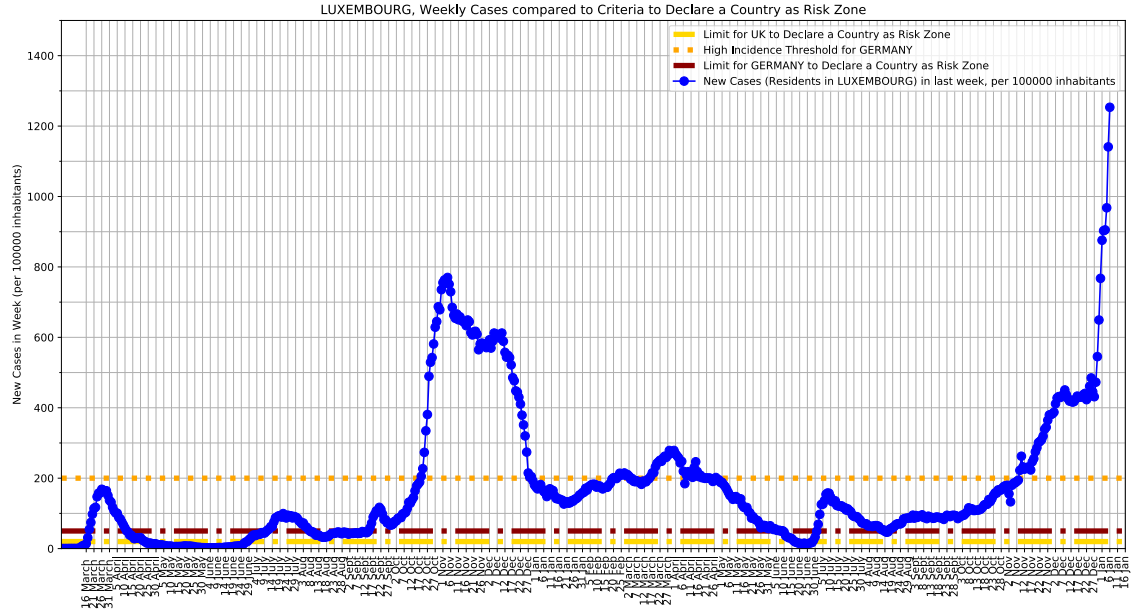

Figure 9. *Number of weekly cases per 100,000 inhabitants that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and per 100,000 inhabitants (dark red line)****. During the current week, the number of weekly cases per 100,000 inhabitants has strongly increased to 1250 cases for this week compared to around 440 cases before Christmas.***