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 13 January. 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 19 January**.

Main conclusions

- **The development during the current week exhibits a continuing exponential epidemic dynamics but with a slightly relaxed trend.** Thus the 7-day average of daily cases for the current week has further increased to 1,925 cases/day compared to 1,562 cases/day for the week before which corresponds to a 23% increase compared to a 40% increase observed last week.
- **R_{eff} of today has increased to 1.21** compared to 1.1 on Thursday of last week (Figure 1). The 7-day average value of R_{eff} has decreased to 1.12 compared to 1.21 for the previous week.
- The last week exhibits a continuing exponential dynamic with a slightly decreased trend. A linear fitting to the cumulative cases for the last month indicates an increased slope of 1,245 cases/day compared to 809 cases/day for last week's estimate (Figure 2 and 3).
- The 7-day average for the **normal care hospitalization demands has slightly increased** compared to last week (52.9 cases on average for this week compared to 48.7 cases for last week). The average **ICU occupancies has slightly decreased** with 18 cases on average for this week compared to 20.1 cases for last week.
- Based on the slightly reduced trend of the epidemic dynamics, the current **midterm projections of daily cases indicate a continuing increase** in case numbers for the next weeks with an anticipated peak in the 7-day average of daily cases of around 2000 cases/day beginning of February similar to the projections from last week's projection (Figure 4). Note that the projections do not consider future changes in social behavior.
- The corresponding **projections for the hospitalization demands** reflect the apparently milder disease progression for the Omicron variant with a 50% reduction of normal care hospitalization and 70% reduction of ICU hospitalization, respectively for the Omicron variant in comparison to the Delta variant (previous assumptions were 40% and 60% reduction, respectively). With these adapted assumptions reflecting the current epidemiological dynamics in Luxembourg, the projections indicate a small increase in the normal care demands to around 90 beds in February compared to 140 beds from last week's projection and with the smaller reduction in the hospitalization risk for the Omicron variant (Figure 5). With the adapted assumption for disease severity, the current projection for ICU demands is rather stable with around 20 beds for the next weeks (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 fully vaccinated and remain cautious in their social interactions to prevent severe cases and an increase in hospital demands.
- The **average positivity rate has further increased** to around 33% compared to 29% for last week (Figure 7).
- The total number of **estimated active cases has further increased** to 26,318 cases compared to 19,972 cases for the previous week (Figure 8).

As expected, the increased transmissibility and partial immune evasion of the Omicron variant has led to a continuing increase in case numbers, which led to a significant epidemic rebound.. Although evidences data in Luxembourg seem to overall indicate a reduction in hospitalization rate for the Omicron variant in comparison to the Delta variant , and similarly to what is observed in Denmark, data from the USA still indicate a potential significant increase in hospital demands. As the Omicron variant is likely to lead to a further increase in the case numbers which might lead a significant short cut in different sectors, , sustained efforts in social distancing, in following hygiene measures as well as vaccination uptake, including booster shots, remain essential to mitigate the epidemic rebound.

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.
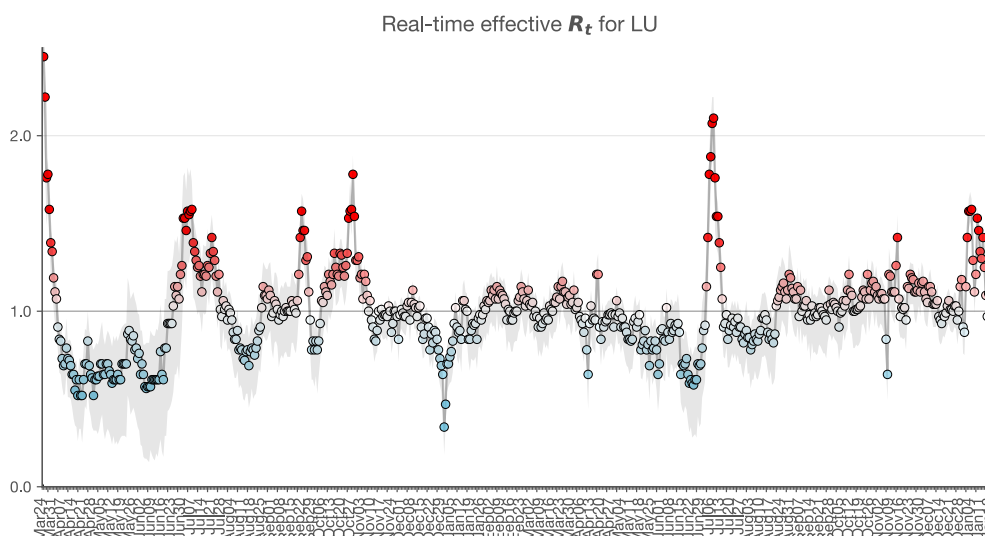

Figure 1. For the current week, the effective reproduction R_{eff} has decreased to 1.21 today compared to 1.1 on Thursday of last week. The 7-day average of the current week has decreased to 1.12 compared to 1.21 of last week but remains on a high level.
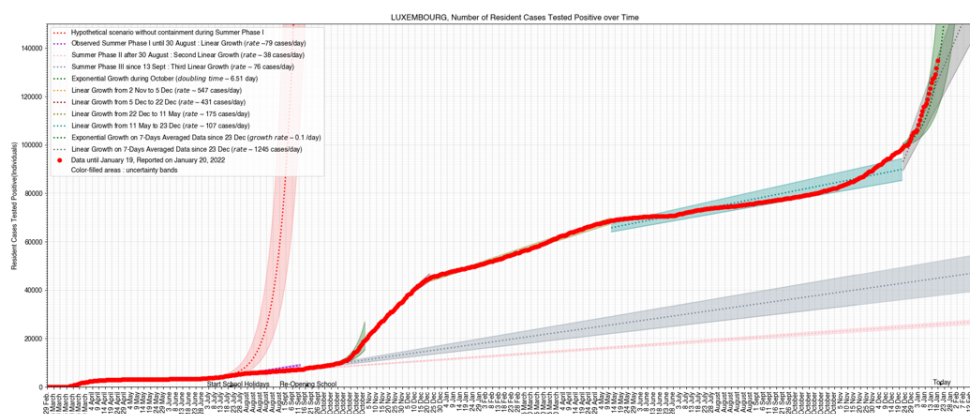

Figure 2. Official COVID-19 case numbers up to 19 January (red dots) were approximated with an adapted model for short-term forecasts for the different phases of the epidemics (color coded). After a relaxation at the end of last week, the dynamics during the current week indicate again a clear exponential (green) regime compared to the linear fit (grey) which exhibits an increased slope of 1,245 cases/day compared to 809 cases/day last week.
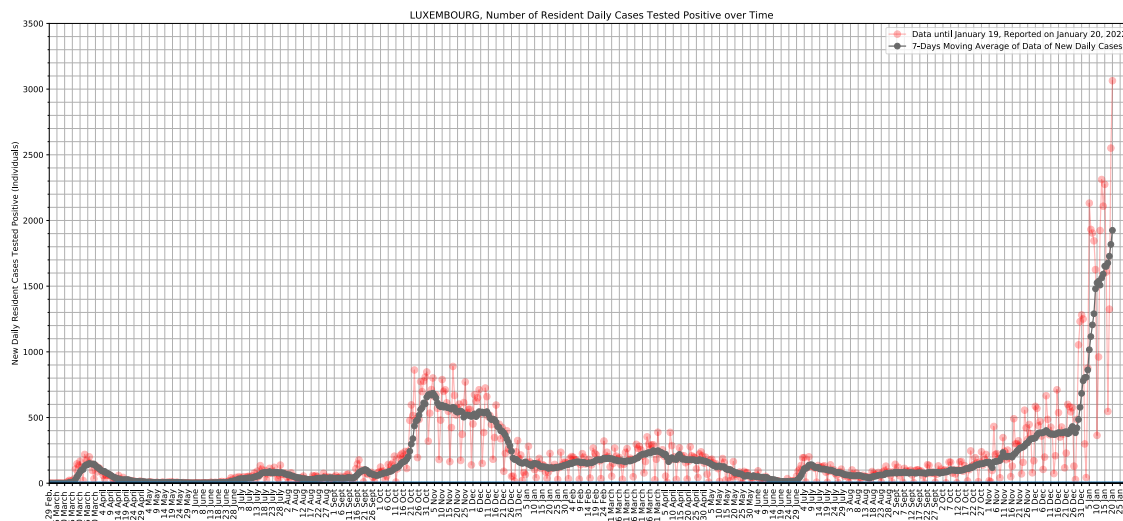
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Figure 3. *The daily COVID-19 case numbers up to 19 January (red dots) and the 7-day average (grey). Note that a linear regime is characterized by a flat curve and that an exponential behavior would correspond to a straight line.* **For the current week, the 7-day average of daily cases (grey) has further increased to 1,925 cases/day compared to 1,562 cases/day for the week before**, *which corresponds to an increase of 23% compared to a 40% increase last week.*

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 further reduced by 50% for normal care and 70% for ICU compared to the Delta variant (compared to 40% and 60% in the projections of last week). 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 6% decrease or increase in social interactions for the optimistic and pessimistic scenarios compared to 7% change in the last projections (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 slight relaxing trend and therefore the current projection for **the 7-day average of daily cases** indicates a similar anticipated peak of cases of around 2000 cases/day for the next weeks (Figure 4 left) as in last week's projections (Figure 4 right). In the pessimistic scenario, the current upper bound corresponds to a 6% increase in social interactions and indicates an epidemic rebound with a peak of around 2400 cases/day. Since data on the Omicron variant is not yet coherent and the effect of the variant can only be roughly estimated based on epidemic data from other countries, the projections are accompanied by some uncertainties. Besides the UK and the USA which exhibit a decrease in daily cases, the case numbers are still raising in most of the countries such as Denmark, France or Germany, therefore suggesting that the pessimistic projection might become a more likely scenario.
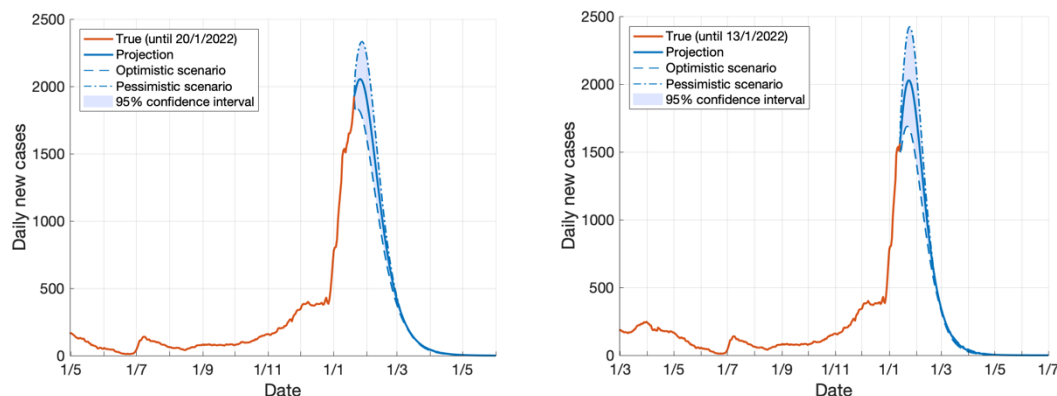
Figure 4. *Comparison of midterm projections for the 7-day average of daily cases from this week (left) and the week of 16 December (right) based on an extended epidemiological SIR model parameterized to the situation in Luxembourg data by a Kalman filter. The blue solid line represents the most likely 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 slight stabilization of the dynamics with an anticipated peak in the 7-day average of around 2000 cases/day in February similar to the projection from last week (right).**

The model **projection for normal care** assumes a 50% decrease in the hospitalization risk for the Omicron variant compared to the Delta variant. Therefore, the increase in case numbers (Figure 4) is only partially mimicked in the anticipated peak of normal care demands of around 90 beds in February compared to 140 beds in the projection from last week and based on a smaller reduction in the hospitalization risk (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 6% increase in social interactions, which could lead to an increase in hospital demands in February of around 110 cases and 130 cases based the higher and lower reduction in the hospitalization risk of last week, respectively (Figure 5 left). Note that hospitalizations strongly depend on the age distribution of cases since older people are more likely to develop severe symptoms and that booster shots are essential to push down the curve, particularly for the Omicron variant. Furthermore, a stronger reduction in the hospitalization risk for the Omicron variant compared to the Delta variant may lead to less demands. Hence, changes in the age distribution and the administration of booster shots can significantly modify the projections.
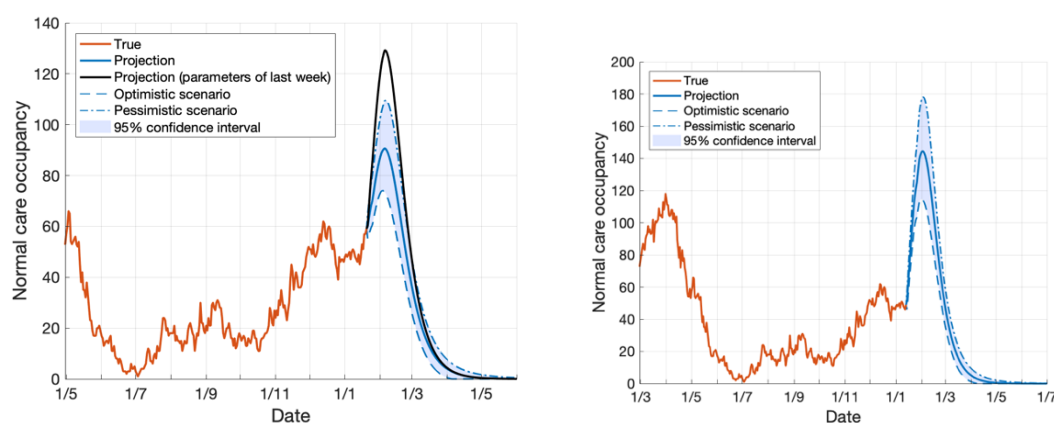

Figure 5. *Comparison of midterm projections for the 7-day average of normal care demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario whereas the optimistic (dashed line) and pessimistic scenarios (dashed-dotted line) correspond to a 6% decrease and increase in social interactions, respectively for this week, and 7% for the projections from last week.* **The comparison indicates an increase in normal care demands to around 90 beds in February (left) compared to a larger peak of 140 beds in the projections of last week (right)** *and considering the different hospitalization risks. The volatile epidemic regime could lead to a more significant increase in normal care demands as shown by the pessimistic scenario with a 6% increase in social interactions leading potentially to around 110 or 130 cases in February depending on the hospitalization risk.*

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The corresponding **projections for ICU demands** also reflect the reduced hospitalization risk for the Omicron variant. Together with the current age distribution of cases, the projections with the adapted hospitalization risk only indicate a moderate increase to around 20 ICU beds for the next weeks (Fig. 6 left) compared to a peak of around 35 beds from the projection of last week (Fig. 6 right). The pessimistic scenario with a 6% increase in social interactions indicates around 30 ICU cases in February similarly to last week considering the higher risk estimate. 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. The current data on the hospitalization risk for the Omicron variant is not yet coherent and therefore the projections are accompanied by uncertainty. In this respect, the future development might still lead to more pessimistic projections due to the typical delay between case numbers and hospitalization of around 14 days. The recent increase in normal care might therefore either reflect some fluctuation or indicate the beginning of increasing hospitalizations.
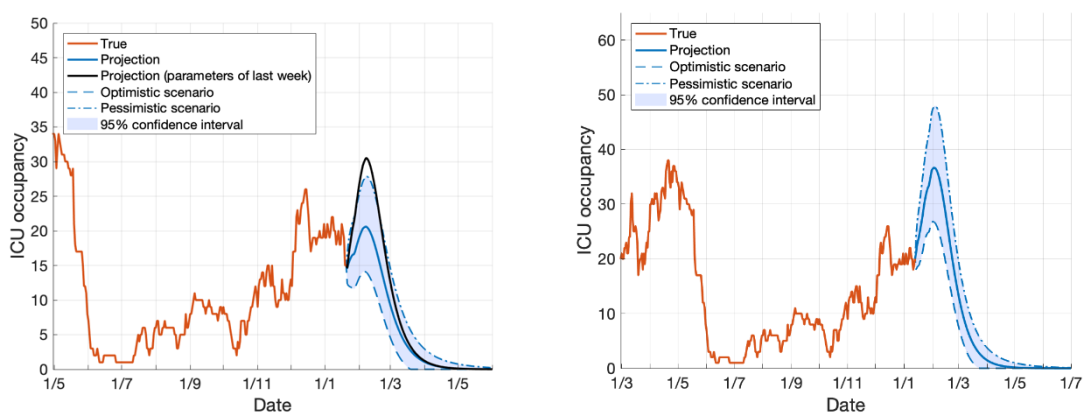

Figure 6. *Comparison of midterm projections for the 7-day average of ICU demands from this week (left) and last week (right) based on the extended epidemiological SIR model. The blue solid line represents the most likely scenario and the optimistic (dashed line) and pessimistic scenarios (dotted-dashed line) correspond to a 6% decrease and increase in social interactions, respectively for this week and a 7% change for the projection of last week.* **The comparison exhibits a rather constant ICU demands of around 20 ICU beds for the next weeks (left) compared to the peak of around 35 beds in last week's projections (right)**, *and considering different hospitalization risks. The current pessimistic scenario with a 6% increase in social interactions also shows a potential increase to around 30 ICU beds in February.*
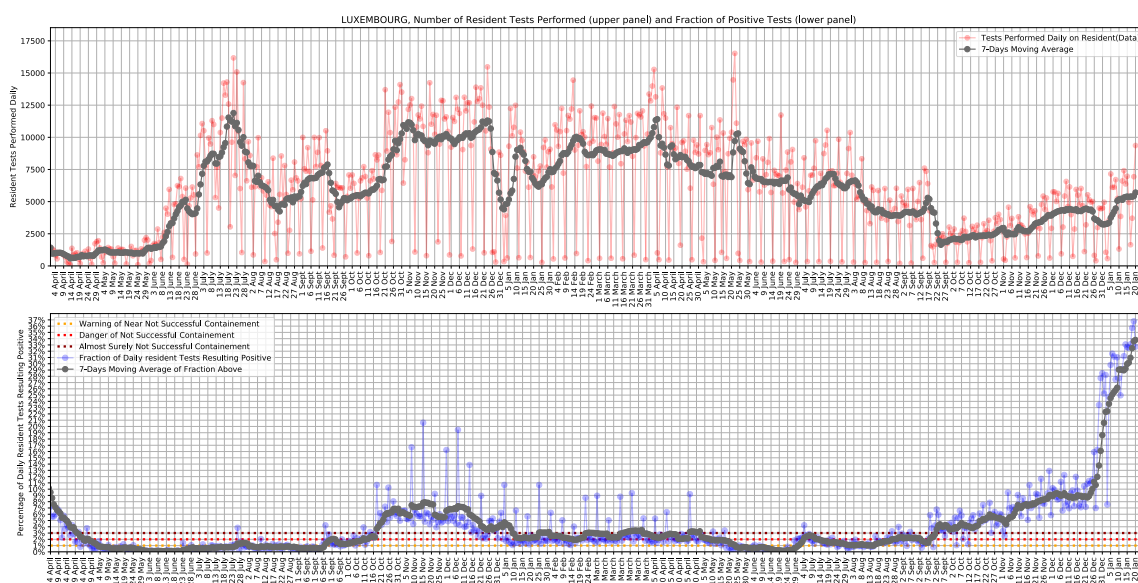

Figure 7. *Number of daily tests performed (top) and overall normalized positive tests (bottom).* **During the current week, the 7-day average of positivity rate (grey) has further increased to above 33%** *compared to around 29% last week.*
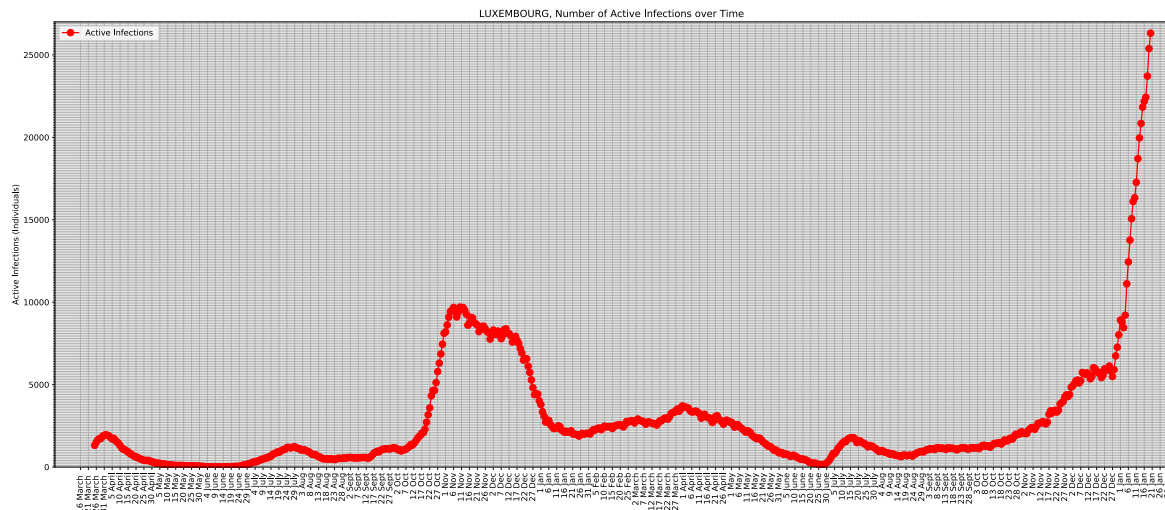
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Figure 8. During the current week, **the number of estimated active cases has further increased to 19,972 cases** compared to *12,443 cases last week.*
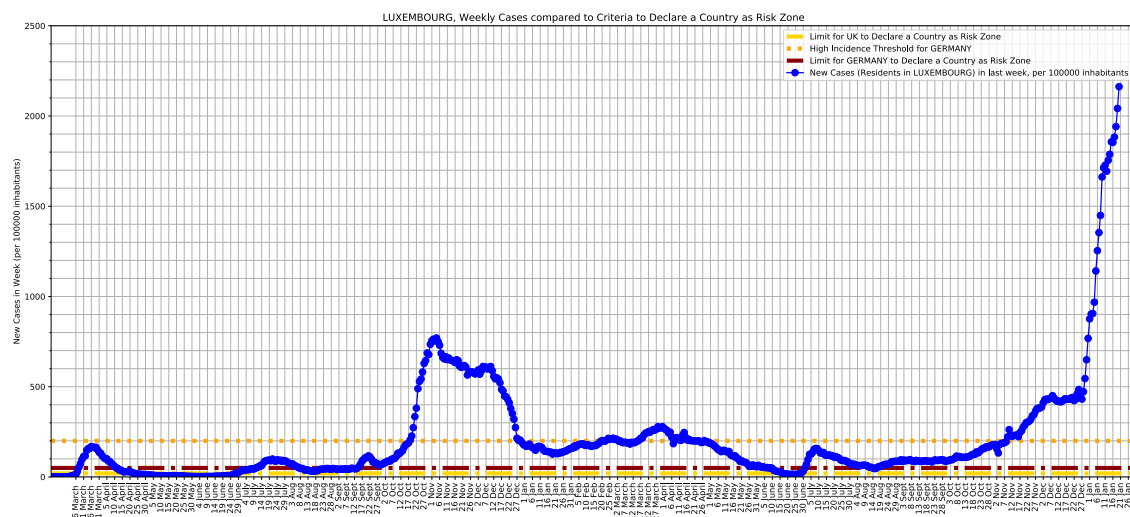

Figure 9. Number of weekly cases per 100,000 inhabitants that is used by different countries to set thresholds for risk zone definitions such as Germany with 50 cases per week and per 100,000 inhabitants (dark red line). **During the current week, the number of weekly cases per 100,000 inhabitants has again increased to nearly 2,200 cases for this week compared to around 1,750 cases last week** with some evidence of a saturation.