COVID-19 Projections: Sudan

Report Date: 18 Jan 2021

This report summarizes the COVID-19 model results for Sudan, developed by the OCHA Centre for Humanitarian Data in partnership with the Johns Hopkins University Applied Physics Laboratory. These projections are based on COVID-19 cases and deaths data up to 18 January 2021. The data is sourced from World Health Organization (WHO) and the country's Ministry of Public Health (MOPH). For dynamic updates to this data and more, see the HDX COVID-19 Map Explorer. For additional information, please contact Leonardo Milano at: leonardo.milano@un.org.

1. Key Messages

Current Situation (as of 18 Jan 2021)

- No data has been reported since 31 Dec 2020 (MOPH) and since 4 Jan 2021 (WHO), which means that we have not received any new information since our last report. Please keep mind that the current assessment of the situation and all projections depend on complete, accurate data. The model might underestimate the crisis even after accounting for some underreporting.
- Per the WHO, a total of 26,279 cases and 1,603 deaths have been reported.
- The number of current severe cases requiring hospitalization is estimated at 2,222 - 2,728.
- Case Fatality Rate stands at a concerning 6.1%, which may partly due to underreporting. We note that the WHO has reported significantly more deaths than the MOPH.
- A study by Imperial College London estimates that only 2% of deaths due to COVID-19 were reported in official reported mortality numbers between April and September 2020, suggesting that the total number of deaths would be markedly higher than reported above. More on the study here: https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/report-39-sudan/
- According to the data reported by the MOPH and WHO, while some regions are on track for containment with fewer than 1 case per 100,000 people, many regions are seeing community or accelerated spread (yellow and orange risk levels.) Khartoum is in the highest level of risk (red, Tipping Point) with an estimated incidence at 50.9 cases per 100,000 people.
- We note the following measures as currently in place: limits on public gatherings (25% compliance), border closings (25% compliance), and partial lockdown (25% compliance). Please email us (leonardo.milano@un.org) if this information is inaccurate or incomplete as it affects the accuracy of projections.
- The data reported by the authorities suffers from concerning gaps and displays significant variation from day-to-day. This might reflect challenges in data collection and/or batching where multiple days' worth of data are reported at once. For these reasons it is difficult to assess the stability of trends.

National Projections (in the next 4 weeks or by 15 Feb 2021)

- In 4 weeks, we project that an additional 4,164 - 6,064 cases and 229 - 330 deaths will be reported if current NPIs are maintained. The curve is projected to climb sharply, indicating a rapid deterioration of the situation.
- Lifting the NPIs would lead to a larger increase in cases and deaths (up to 3,188 more cases and up to 140 more deaths; see sections 2 and 3 for details). Due to the lag between cases and deaths, a larger number of cases will ultimately result in higher deaths 2 - 4 weeks later.
- The number of active severe cases requiring hospitalization is projected to decrease by 457 - 642 assuming NPIs are maintained, and to stay roughly constant if they are lifted (see section 3).

Subnational Projections (in the next 2 weeks or by 01 Feb 2021)

- In two weeks incidence is projected to increase or stay constant in White Nile, North, West, and Central Darfur, and Abyei PCA.
- For the regions projected to see a decline in incidence, many are still expected to have community spread present (yellow risk level.)
- We note a highly concerning projected incidence in Khartoum, which would maintain the region in the highest level of risk (red; see section 4).

2. Current Situation (as of 18 Jan 2021)

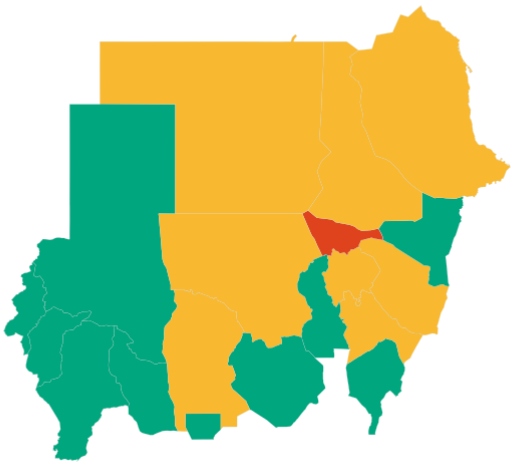
Containment Progress

This report leverages a framework to provide guidance in the interpretation of incidence rates so decision-makers can more readily understand how effective the response has been in containing the virus. The framework was devised by experts from the Harvard Global Health Institute, Harvard's Edmond J. Safra Center for Ethics, and a network of research and policy organizations (more about the collaborative framework here).

The framework defines risk levels that indicate whether a region is on track for containment and can help decision-makers know where they are at the moment. The levels do not in themselves provide information about how to respond but do communicate the intensity of effort needed for control of COVID at varying levels of community spread. In addition to paying attention to the levels, decision-makers should pay close attention to direction of trend and rate of change (see section 4 for those metrics at the subnational level).

The map below illustrates regional risk levels as defined by estimated total incidence rate (daily new cases per 100,000 people as of 18 Jan 2021). Total cases are estimated from case reporting rate to adjust for underreporting. The table details the cutoffs for each risk level along with strategies of disease response needed for containment.

Current Estimated Total New Daily Cases
Per 100,000 People



Risk Level	Case Incidence*	Status	Intensity of Control Effort Needed
Red	25+	Tipping Point	Stay-at-home orders necessary
Orange	10-25	Accelerated Spread	Strategic choices must be made about which package of non-pharmaceutical interventions to use for control. Stay-at-home orders are advised, unless viral testing and contact tracing capacity are implementable at levels meeting surge indicator standards.
Yellow	1-10	Community Spread	Strategic choices must be made about which package of non-pharmaceutical interventions to use for control
Green	<1	On Track for Containment	On track for containment, conditional on continuing use of viral testing and contact tracing for surveillance and to contain spikes and outbreaks.

*Daily new cases per 100,000 people as reported by MOPH
See Key Metrics for COVID Suppression for additional guidance on control effort needed.

Key Figures: Current Cases and Deaths[1][2][3]

	Cases		Deaths	
	Daily New Cases	Cumulative	Daily New Cases	Cumulative
Based on MOPH data	NA	25,729	NA	1,256
Based on WHO data	0	26,279	0	1,603

”Daily new cases” in this table is the average over the last 7 days.

Most recent data from MOPH: 2020-12-31

Key Figures: Current Severe Cases

	Active
	Severe Cases Requiring Hospitalization
Estimate	2,222 - 2,728

Note on data reliability

The limitations of COVID-19 reported data should be taken into consideration when interpreting metrics and projections. Sources may diverge in the counts they report (see WHO vs MOPH figures above); data reports may lag by several days or be missing altogether on certain days (see date of latest data above); cases and deaths are almost certainly underreported and their numbers are affected by testing practices. Scenario modelling (NPI vs non-NPI projections) relies on the freshness and accuracy of the information provided in the ACAPS database (see footnote 3). We strongly encourage the reader to ensure the database is up to date and to contact the Centre for Humanitarian Data with any suggestions of additional data sources or improvements to existing ones.

These are common limitations. This report aims to help the reader understand the situation on the ground through comparing and contrasting multiple data sources and estimates. For instance, we present data reported by the WHO and the MOPH, projected cases and deaths, and incidence of total cases, an estimate of the true number of cases factoring in the case reporting rate (ie., how many cases are likely unreported.) The projections are best estimates based on available data.

[1] **Reported cases** refers to the number of infections expected (current situation) or expected to be reported (projections). Projections take into account the **case reporting rate** which corresponds to the estimated number of COVID-19 infections that are actually tested, confirmed and reported. The case reporting rate is calculated based on the number of deaths and cases reported by the WHO in the last 30 days.

[2] **Severe cases** refers to the number of people which will have severe symptoms and may require healthcare support. Projections are calculated as a proportion of the reported cases, and are based on planning parameters for case severity and the vulnerability of a given region.

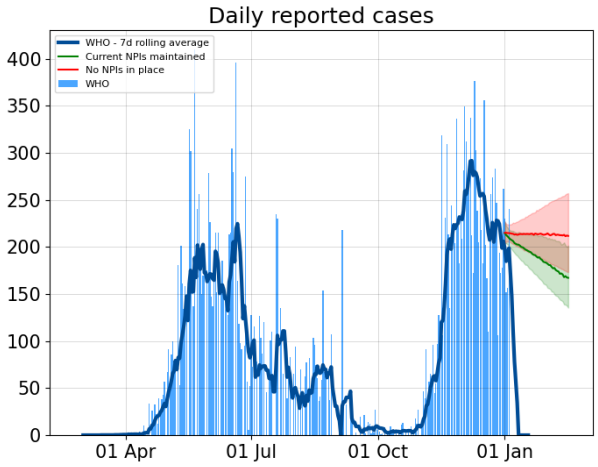
[3] **Case Fatality Rate** refers to the estimated proportion of deaths compared to the total number of people diagnosed with the disease.

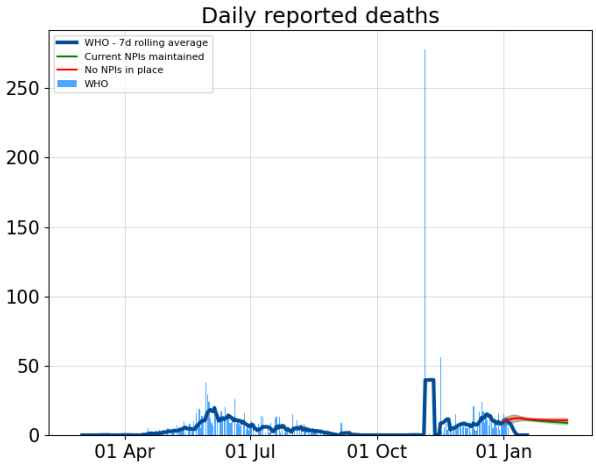
3. National Projections[4][5] (for the next 4 weeks or by 15 Feb 2021)

Projected Cases and Deaths

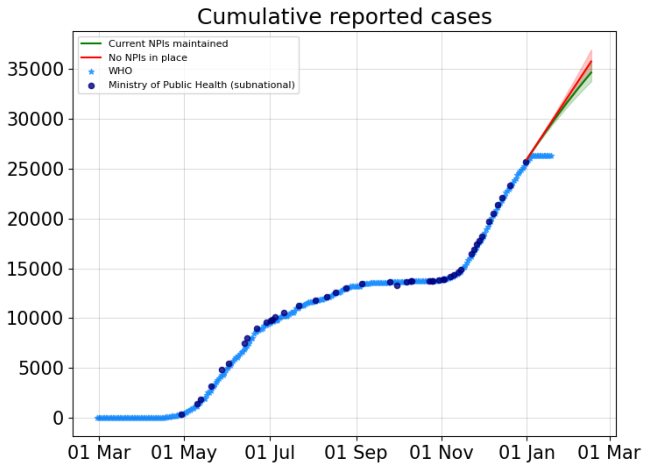
	Change	
	Added Cases	Added Deaths
With current NPIs maintained	4,164 - 6,064	229 - 330
With no NPIs	5,106 - 7,352	261 - 369

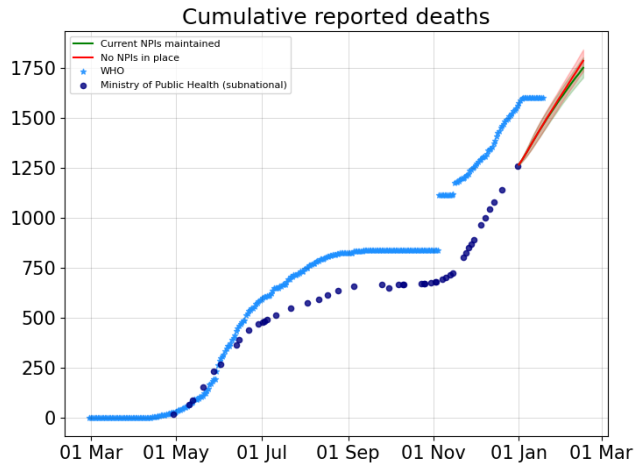
The figures below present the historical data on daily new cases and deaths, and their projected trends. Trends are represented by a green line for the "Current NPIs maintained" scenario and a red line for the "No NPIs in place" scenario. Note that deaths typically lag reported cases by 2-4 weeks.





The figures below show the comparison between two data sources: national level data from WHO in light blue and subnational data from the Ministry of Public Health in dark blue.





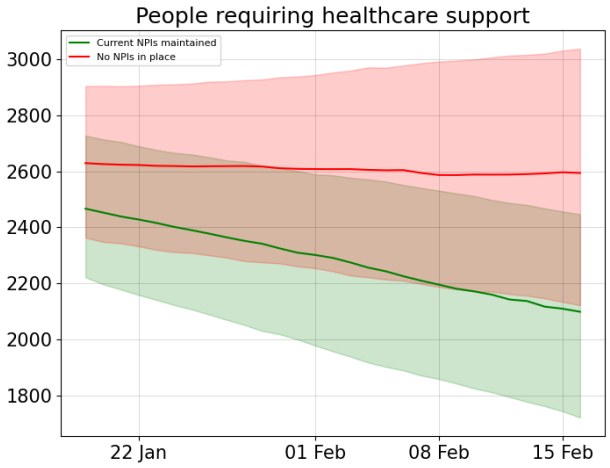
[4]The regional data provided by the Ministry of Public Health are used to generate projections at the subnational level, which are then aggregated to the national level.

[5]**Non-pharmaceutical interventions - NPIs** are all measures implemented by different actors with the aim of reducing the spread and the impact of COVID-19. The NPIs currently in place are extracted from the ACAPS database and complemented with additional contextual information provided by our partners in the country.

Projected Severe Cases

The figures below show the projected trends for active severe cases requiring hospitalizations. In green are the projections under the “Current NPIs maintained” scenario while in red are the projections under “No NPIs in place” scenario.

	Active Severe Cases
With current NPIs maintained	1,721 - 2,447
With no NPIs	2,122 - 3,038

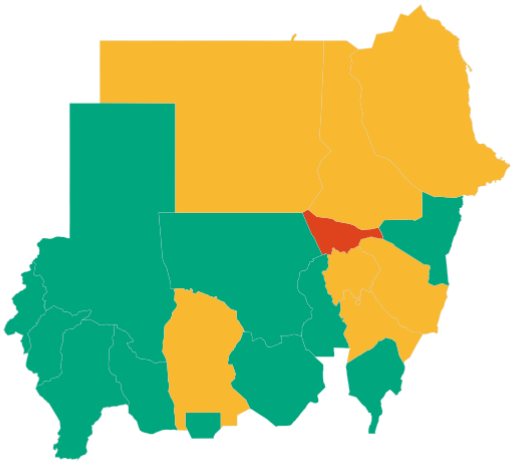


4. Subnational Projections (for the next 2 weeks or by 01 Feb 2021)

Projected Incidence

The map below displays the projected risk level of every ADMIN1 region, assuming the current NPIs are maintained. It represents the projected total cases as estimated from case reporting rate to adjust for underreporting. See Section 1 for detail on the relationship between risk level and progress towards virus containment.

Projected Estimated Total New Daily Cases
Per 100,000 People



Risk Level	Status
Red	Tipping Point
Orange	Accelerated Spread
Yellow	Community Spread
Green	On Track for Containment

Projected Changes In Incidence

Below are the projected incidence rates (= projected daily new cases per 100k people on 01 Feb 2021) and projected absolute changes in incidence between then and today for every region. These metrics do not include adjustments for underreporting.

Regions are ordered in decreasing order of change magnitude, from largest increase to largest decrease. Note that Incidence Rates are rounded to the third decimal; therefore a 0.000 incidence rate may mean that no new daily cases are projected or that fewer than 1 cases per 100 million people are projected.

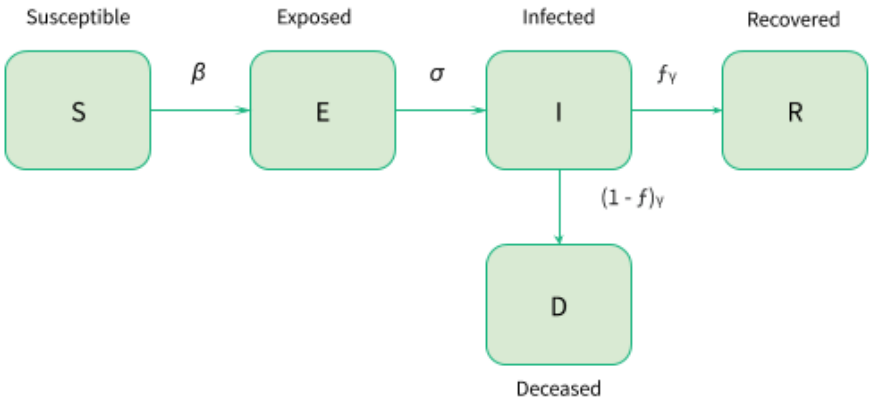
While the magnitude of change may signal how successful mitigation strategies are projected to be, it should be evaluated in conjunction with incidence when considering adding or lifting suppression strategies. For instance, a region may be projected to show a large decrease but remain at a concerning high level of incidence that require intense control efforts.

Region	Projections in cases per 100k people Change	Incidence
Increasing or Stable		
White Nile	+0.05	0.845
North Darfur	0	0.057
West Darfur	0	0.000
Central Darfur	0	0.001
Abyei PCA	0	0.008
Decreasing		
South Kordofan	-0.01	0.444
Northern	-0.03	1.956
West Kordofan	-0.03	1.088
East Darfur	-0.05	0.131
Blue Nile	-0.05	0.156
Sennar	-0.05	3.253
Red Sea	-0.06	2.378
River Nile	-0.08	5.068
South Darfur	-0.09	0.260
Kassala	-0.15	0.446
North Kordofan	-0.31	0.905
Gedaref	-0.46	1.403
Aj Jazirah	-1.37	4.575
Khartoum	-2.72	47.958

Background on Model Methodology

The Centre established a partnership with the Johns Hopkins University Applied Physics Laboratory to develop a COVID-19 model which provides projections and insights related to the **scale** of the crisis, the **duration** of the crisis in a specific location, and how different response **interventions** are expected to impact the epidemic curve.

The team is using an **SEIR (Susceptible, Exposed, Infectious, Recovered)** model of infectious disease dynamics which is considered the simplest and most effective technique used in the literature. The model is based on a progression from susceptible to either recovered or dead. Inputs include the reproduction rate (Ro), case fatality rate (CFR), and estimated probabilities that an individual person may contract COVID-19. The model then simulates an outbreak and provides estimates for cases, severe cases/hospitalizations, and deaths.



Parameters
R_0 (β/γ) = Basic reproduction number
β = Transmission rate
1/γ = Infectious period
f = Probability of recovery
(1-f) = Case Fatality Ratio (CFR)
1/σ = Latent period after exposure

Limitations
- Multi-strain systems
- Time-varying infectivity
- Heterogeneous population
- Capturing pockets of an outbreak

The key features of the model include:

- **Tuning on reported data** The estimation of the main parameters (mainly the reproduction rate R0 and the case reporting rate) is tuned according to the observed recent trends in reported COVID-19 cases.
- **Subnational** The model provides COVID-19 projections at the subnational level, matching the administrative level at which COVID-19 cases are reported.
- **Spatial spread** The density of roads is used to estimate the expected mobility patterns and to simulate the spread of COVID-19 between administrative units.
- **Population stratification** The model fidelity is increased by taking into consideration:
  - The age structure of the population at the subnational level
  - The expected probability of contact between populations of different age groups, including contacts expected to happen at work, school, home and everywhere else (social mixing)
  - Vulnerability factors such as food insecurity and household air pollution.
- **Non-pharmaceutical interventions (NPIs)** The model simulates the expected impact of NPIs at the subnational level, and also how the outbreaks is influenced by changing NPIs implemented over time. The NPIs currently implemented can be categorised in three main groups:
  - Mobility based NPIs, which would limit the spread of disease between administrative units (e.g. border closures)
  - Contact based NPIs, which reduce the probability of contact between specific groups (e.g. shielding of the elderly, closing schools)
  - R0 based NPIs, which reduce the overall reproduction rate (e.g. awareness campaigns, curfews)