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# Part 1: How to use your data to fight COVID-19, a roadmap for countries in Sub-Saharan Africa

Cooper/Smith  [Follow]

Apr 14 · 7 min read

We are working with Malawi's Ministry of Health to help them prepare for and fight COVID-19. Here is what we did — other countries might find this useful as well:

### 1. Identify the most important information for decision-makers

2. **Take stock of their available data**

3. **Consider new sources of information**

4. **Pull the information together in an easy-to-use way**

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1. **Identify the most important information for decision-makers.** As COVID-19 began to spread in neighboring countries, officials at the Ministry of Health wanted to know:

A) What will COVID-19 look like in Malawi (i.e., what is the epidemiological model for Malawi)?

B) What areas of Malawi are most at risk (down to the highest geographical resolution possible)?

C) When and where will we need to make resources (PPE, testing) available?

2. **Take stock of the data that is already available.**

Every country can access these publicly available datasets:

- **World Pop Data** - High resolution (1km) information on total population by age band (5 year increments) and sex.

- **Humanitarian Data Exchange** shape files - Administrative geo-spatial layers of varying specificity.

- **WHO Global Health Workforce Statistics** — data on health workers and hospital bed capacity in each country.

The Ministry of Health in Malawi also has access to, or the ability to access, certain country-specific and non-public data sets. This is likely the case for most countries in Sub-Saharan Africa. These include:

*Country-specific data:*

- Latest census data (population, age, sex)

- Master Health Facility Registry (data about Malawi's health facilities)

- Surveillance data (for COVID-19, as it becomes available)

- Food insecurity, poverty, weather, etc.

*Non-public data sets:*

- Aggregated, anonymized Call Detail Record data (through existing, government-approved, public health research initiatives)

- Disease burden & health outcome data (usually housed in DHIS2)

- Case-based surveillance

- Commodity data (OpenLMIS)

**3. Consider new sources of data.** We also looked at previously untapped sources of data that can be used to predict the spread of COVID-19. For example:

- **Google Community Mobility Reports:** These reports chart movement trends over time across different categories of places, such as retail and recreation, groceries and pharmacies, transit stations, and workplaces.

With this data, we can gain insights into the effects of policies implemented to fight COVID-19.

To help create a model for Malawi, we examined the effects in other African countries of three recently recommended COVID-19 prevention policies

currently in use around the world (these categories correspond to those being considered by the government of Malawi):

1. Social distancing

2. Social distancing plus additional limited-movement guidelines (e.g., work from home, limiting gatherings to 10 or fewer attendees);

3. Enforced population restrictions (e.g., shelter-in-place, closing non-essential businesses and reducing public transit, prohibiting virtually all gatherings).

First, we identified other African countries implementing policies in each of these categories (as of March 29).

We then used **Google Mobility Reports** to see how much the restrictions in force in each country reduced interpersonal contact.

Google Mobility Reports breaks down its data by categories: Retail and Recreation, Grocery & Pharmacy, Parks, Transit Stations, and Workplaces. But we wanted to give policymakers an *overall* estimate of how much these restrictions would reduce interpersonal contact, across the population.

To turn that category-specific data into overall estimates, we made some simple assumptions about how often a person would go to each of these places each week, under each set of restrictions.

Combining Google's category-specific data with those assumptions, we calculated a weighted, *overall* **"reduction-in-contact rate"** for each country. For example:

- **Zambia**, employing social distancing, reduced contact by **15%**.

- **Kenya**, using social distancing plus additional restrictions, reduced contact by **37%**

- **Rwanda**, with enforced population restrictions, reduced contact by **57%**.

By doing this across multiple countries, **we were able to estimate a "contact-reduction range" to help policymakers anticipate the likely effect of each category of restrictions**:

- **Social distancing** would be expected to reduce contact by **10–20%**.

- **Social distancing plus additional guidelines** would be expected to reduce contact by **30–40%.**

- The strictest category, **enforced population restrictions**, would be expected to reduce contact by **40–60%.**

These are rough estimates, based on assumptions, and many caveats apply. But these estimates, however imperfect, have a foundation in observed behavior, making them a reasonable basis to inform policy-making. Here is more information on our approach.

More data will help make these models more precise. Next steps could include high frequency data collection from health facilities and feedback on behavioral interventions KAP (using tools such as the Unicef rapid survey: ureport).

**4. Pull the information together in an easy-to-use way.** Now that we've identified our "use cases" (most important questions for our decision-makers) and our available data , we can start to bring it together to answer our three questions.

> **A) What will COVID-19 look like in Malawi?**

**The next step is to use these estimates to model the spread of COVID-19 in Malawi under different sets of restrictions.** To estimate the

incidence and mortality of COVID-19, we used closed, deterministic and compartmental susceptible-exposed-infected-recovered (SEIR) model with mild, hospitalized, and critical care sub-states within the infected state. (More methodological detail is included at the end, and in a forthcoming paper.)
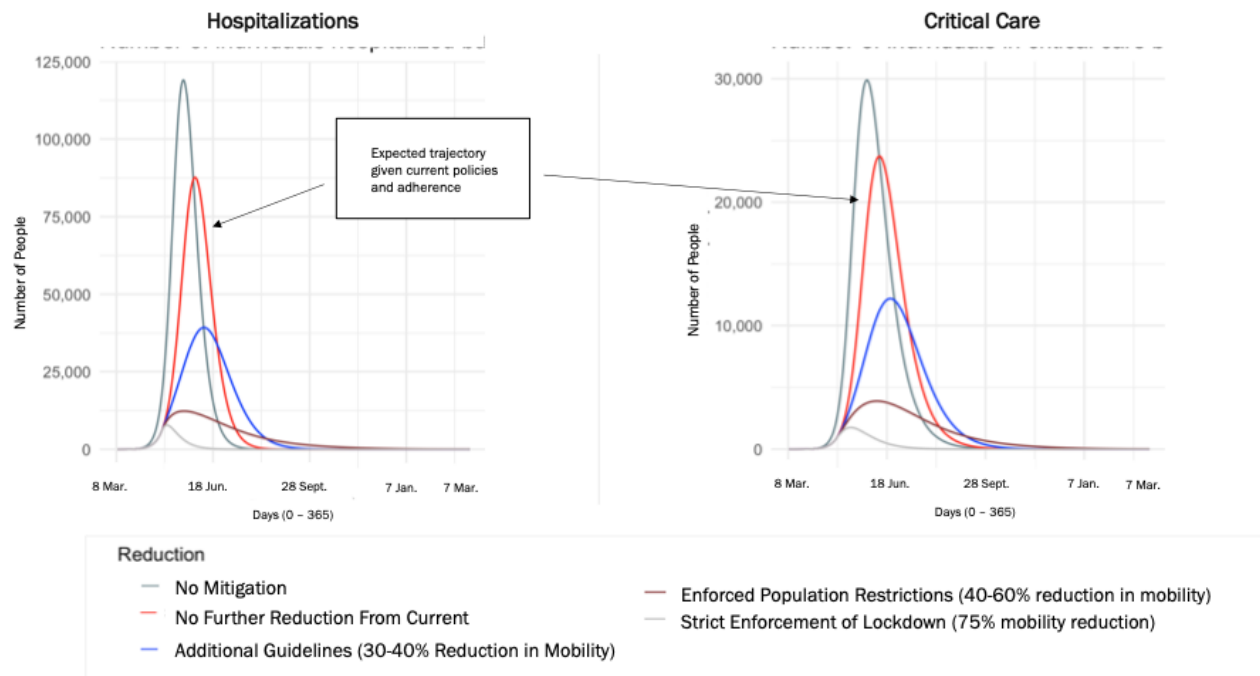
**First, we projected infections and deaths from COVID-19 in each scenario:**
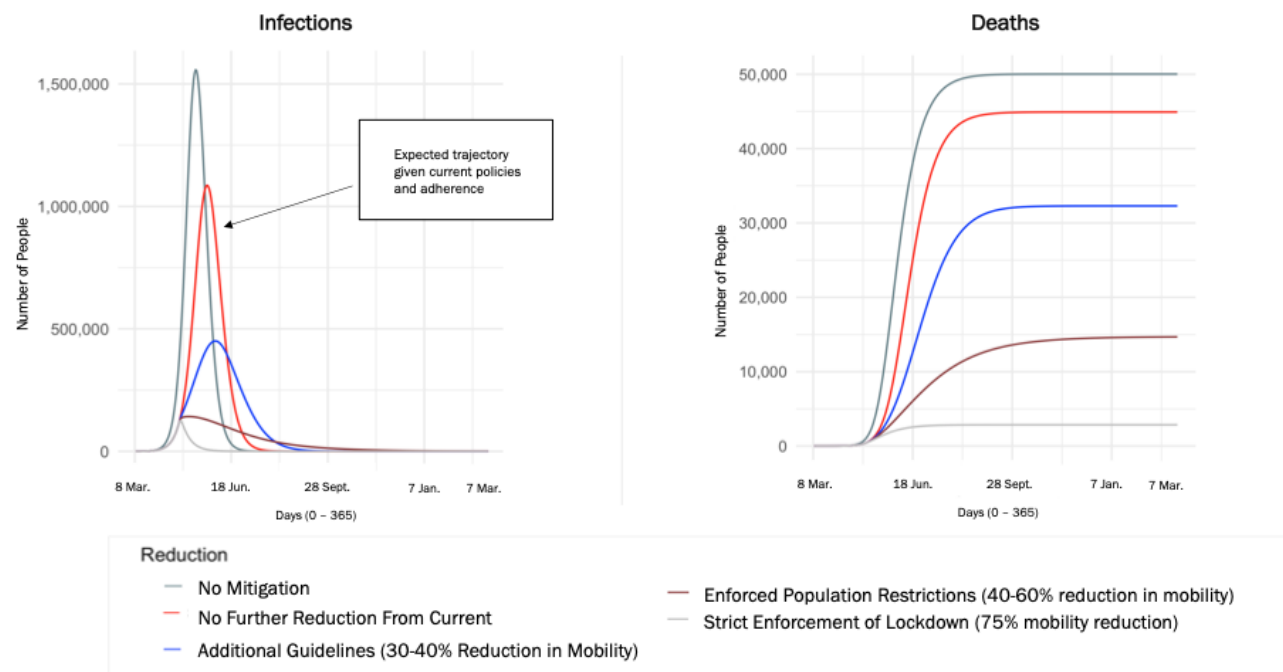
Then we projected how many people would be hospitalized and require critical care:



We can also project how much each mitigation scenario would reduce COVID-19 infections:

Now to answer questions B and C:

> B) What areas of Malawi are most at risk (down to the highest geographical resolution possible)?
>
> c) When and where will we need to make resources (PPE, testing) available?

Next, we modeled the effects of these scenarios within Malawi. (Again, more information on our methodology is at the end, and in a forthcoming paper.)

First, we used data about population density, percentage of residents over 65, access to health facilities, and current infections to identify the areas of Malawi at greatest risk:



Then we used knowledge about population movements, drawn from aggregated cell-site location information, to anticipate how the end of the rainy season in May might affect the spread of the disease within Malawi:

In closing, we offer some thoughts for those conducting similar analysis in other countries:

- **Know and use your publicly available data.** Most of the data sets that we used, or their local analogues, should be available for every country.

- **Present the data in a way that is useful to decision-makers.** That means finding out what questions *they* want answered, and adapting the model to the parameters or categories that are being considered for

policy. (For example, here we adopted the Malawian government's trichotomy of potential restrictions on movements.)

- **Incorporate local conditions.** In Malawi, the onset of the rainy season in May produces major shifts in population. In other countries, recurring climatic, cultural, or political events may have comparable effects. Historical cell-site data, securely aggregated to protect privacy, can be used to build these events into COVID-19 modeling.

- **Refresh as often as possible.** We plan to rapidly and regularly update our models as more information becomes available.

- **Document and share as much as you can.** Share on github, write up results, and document and publish approaches, so that other can replicate, improve, and share.

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**For the epidemiological model:**

We simulated an outbreak in each of Malawi's Traditional Authorities (a sub-district, or TA) as the result of a single-seed infection, with individuals progressing through states as determined by a series of epidemiological and

behavioral parameters estimated daily using a series of ordinary differential equations.

We calculated the age distribution in each TA in ten-year age bands up to 79, and then 80 and greater using World Pop data. We then estimated age-standardized hospitalization, critical care, and fatality rates using age-stratified estimates of severity of disease from China, Hong Kong, and Macau from the literature, which were adjusted for censoring, demographics, under-ascertainment, and prevalence.

We parameterized the model using other model inputs from peer-reviewed literature, as well as estimates of population mobility from Google Community Mobility Reports.

We then summarize the expected number of infections, peak and cumulative hospitalization and critical care need, and total deaths.

We've also explored the potential impact of mitigation scenarios on the epidemic outlook, similarly drawing on data from neighboring countries in sub-Saharan Africa who have implemented social distancing or lockdown policies.

**For the risk model:**

We generated a risk model using publicly available data in the form of World Pop & humanitarian data exchange shapefiles to identify base level vulnerability (i.e. population density & population > 65 years of age).

We used country specific data to further inform the model and built-in current infection location and an associated proximity effect (distance decay model) along with overarching health facility information (availability within a 5km radius) and more detailed readiness assessments (availability of commodities & services at a given site).

Then we used novel data sources to help identify where the population is currently residing using the call record data to understand migration patterns given time of year. This data was used in conjunction with the population estimates to develop a more informed density calculation. In addition, this data will give us insights into travel and movement.

Covid 19      Africa      Data

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# Part 2: Physical distancing saves more than hospital beds, it saves lives. Considerations for Africa.

Cooper/Smith   Follow

May 4 · 5 min read  ★

Should countries in Sub-Saharan Africa consider physical distancing?

Many African countries have already imposed physical-distancing measures. The Government of Malawi, which we are supporting with

predictive modeling, recently announced a three-week partial lockdown. (That order is tied up in court.)

**Some commentators argue that physical distancing measures are useless or impractical in low-resource settings.** They raise two basic objections:

1. The point of physical distancing, they argue, is to keep the number of severe cases within the health system's capacity to treat them. (This is the horizontal line on the ubiquitous "flatten the curve" chart.) There's no hope of achieving that in countries where ICU capacity is minimal and the health care system is overstretched to begin with.

2. Countries with many people on the edge of subsistence can't afford to constrain mobility drastically enough to make a difference.

For those of us with deep experience in sub-Saharan Africa (SSA), these theories resonate and follow conventional wisdom. However, a deeper look into the data and epidemiology of COVID-19 suggest these hypotheses are short-sighted and lack the nuance needed to design optimal policies and strategies in local context.

The first objection rests on the flawed premise that flattening the curve is *only* about protecting healthcare capacity, by spreading out the same number of infections over a longer time.

Protecting the health system is important, of course, but it's not the whole story.

**Flattening the curve also reduces the number of people who *ever* become infected.** We explain why below.

The second objection overlooks that **even a modest intervention** — far less drastic (and thus less effective) than those imposed in the U.S. and Europe **— still saves many lives.** Short-term physical distancing can't suppress the virus altogether, but it can save lives at an economic cost that may be more bearable for low-resource countries. (It's also important not to forget the economic and social costs of allowing a frightening epidemic to run uncontrolled through society.)

In this post, we explain why, using modeling we've conducted for the Government of Malawi.

—

How does physical distancing reduce the *total* number of infections (rather than just spreading the same number of cases out over a longer time)?

The key factor is **how fast the population reaches herd immunity.**

Herd immunity occurs when enough people have been infected and recovered and thus achieved some degree of immunity. As the remaining infectious carriers encounter fewer and fewer vulnerable people, the virus runs out of new hosts and reaches a dead end.

Herd immunity eventually ends the epidemic (after many deaths), but — counterintuitively — **we don't want to get there too fast.**

(To be clear: **this is not an argument for choosing a "herd immunity" approach** over suppressing the epidemic, in any situation where suppression is possible. **Our point is that even if long-term lockdowns are taken off the table because of resource constraints, short-term physical distancing measures are still much better than doing nothing.**)

Left unchecked, the new coronavirus can tear through a population at incredible speed — apparently much faster than its well-known relatives,

SARS and MERS. People can be highly contagious but have few or no symptoms. "Stealth transmission" by outwardly normal people makes the spread much harder to stop.

This virus moves fast, and — if R0 is above 2 — it expands exponentially. A fast-growing epidemic does not simply stop at the theoretical herd-immunity threshold — that is, the level of immunity in a population that would prevent a *new* outbreak from taking root. The reason is that the huge group of people carrying the virus at the peak of the epidemic continues to infect many others, even if the overall number of infections begins to decline.

The result is that **the overall infection rate in a raging epidemic can land far above the theoretical herd-immunity threshold**. Modelers call that extra portion of the population that gets infected "overshoot."

**With no mitigation, our model predicts that the virus would infect 85% of Malawi's population before herd immunity kicks in.** That is far more than the 55% that we predict would provide herd immunity against a new outbreak (assuming that R0 is 2.2).

With distancing, the virus moves through the population more slowly. **With three weeks of modest physical distancing[1], only 60% of the population eventually becomes infected.** This is shown in the chart below by the green line, labeled "additional restrictions":

The "Current Policies" include installing hand-washing stations at markets and water pumps; early closures of bars; prohibitions on wedding parties, sporting events, and church gatherings larger than 100 attendees; and guidance on maintaining 1-meter distance in social interactions. (*Additional details on the categories is in the table below*.)
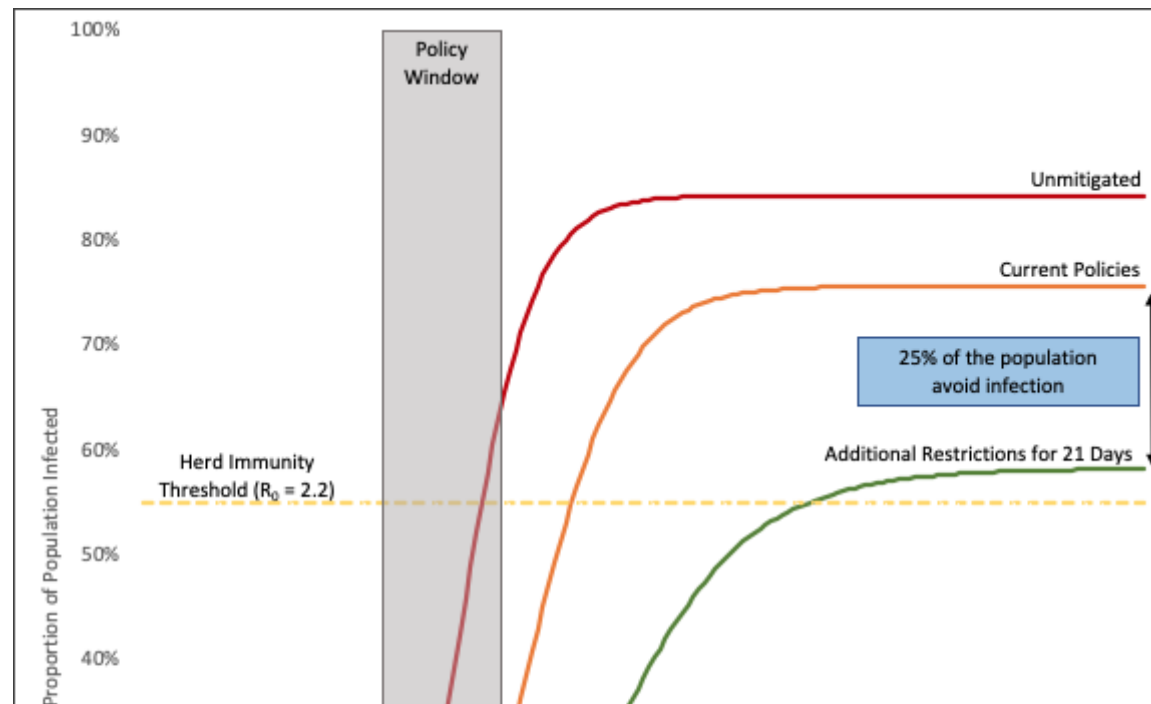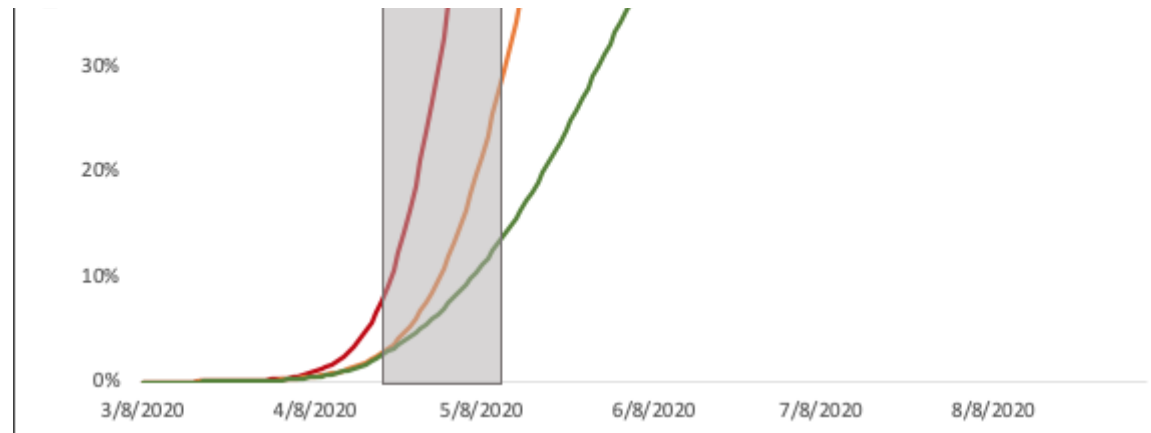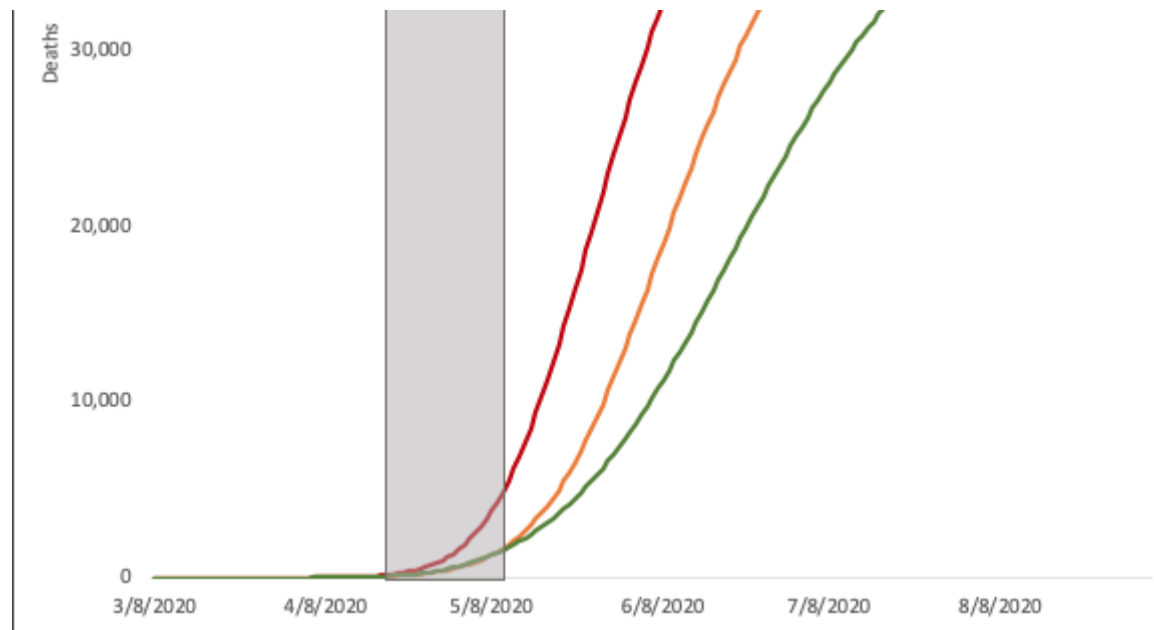
Across a population of more than 18 million, that means millions of fewer infections.

And as you would expect, **preventing millions of infections prevents thousands of deaths (10% of deaths averted):**
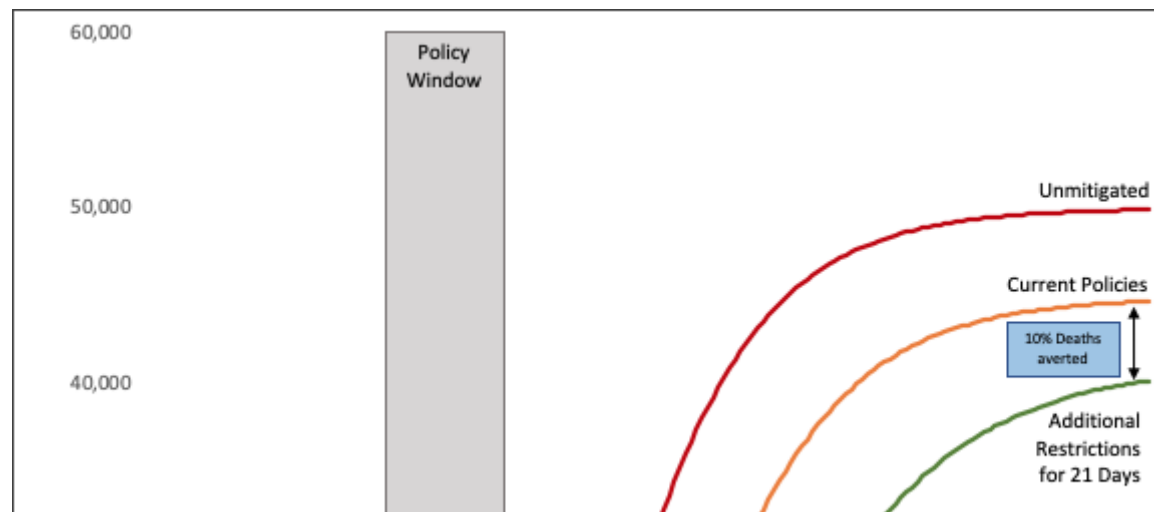
Note that this reduction in deaths has nothing to do with reducing strain on health-system capacity, the most commonly cited reason for physical distancing.

We also found that this effect is durable — these deaths never occur, as long as governments maintain less-invasive mitigation measures (see "Current Policies" category above) once additional restrictions end.

—

What does this mean for Sub-Saharan Africa?

The bottom line is that **even a short period of physical distancing can save many lives.**

Governments in low-resource countries, like their counterparts in wealthy countries, must weigh the benefits of various interventions against their economic and social costs. As we will explain in our next post, **granular, localized data on economic and social vulnerability can help governments mitigate the consequences of targeted lockdowns and other distancing measures.**

Local experts, armed with this data, are best placed to judge what measures are sustainable and appropriate for their own people. Many African governments, including the Government of Malawi, are using predictive

modeling and other advanced techniques to develop COVID-19 plans that reflect local conditions.

**African governments need more resources to fight COVID, but they also bring their own strengths to this challenge**. Past epidemics, including HIV and Ebola, have left many countries with hard-won experience in testing, contract-tracing, and explaining public-health measures to their people. Some of their approaches could be models for state and local governments in the United States, which face significant resource constraints of their own.

*More information about our team and our work can be found here.*

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[1] These additional restrictions would entail rotational work schedules, capping the number of passengers in public-transit vehicles, and requiring self-quarantine for those returning from overseas, and restricting gatherings to fewer than 100.

Covid 19     Africa     Physical Distancing     Global Health

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# Part 3: The Third Way. How Hyper-Targeted COVID Policies Can Save Lives (and Livelihoods) in Africa

Cooper/Smith   Follow

May 7 · 6 min read

What should African governments do in response to COVID-19?

Two competing narratives have emerged in the debate over policies aimed at reducing COVID transmission in sub-Saharan Africa.

**Public health experts warn that an unabated epidemic could wreak havoc in sub-Saharan Africa**, overwhelming already stretched health systems and challenging hard-won gains against other diseases like HIV, tuberculosis, and malaria. Epidemic models (here and here) predict millions will be infected and hundreds of thousands will die. These sobering figures have led many African countries to adopt physical distancing measures to slow transmission and buy time to prepare.

**The second narrative focuses on the detrimental effect that mitigation policies have on vulnerable populations**. For those living at the edge of subsistence, mobility restrictions and business closures can lead to malnutrition and lack of basic necessities. Critics of physical distancing argue that "lockdowns" would do more harm in low-resource countries than COVID-19.

These tension between slowing the epidemic and economic activity are being played out across the globe, but in sub-Saharan Africa the stakes are much higher. With millions already living in poverty, the trade-offs are stark: Lives lost to unmitigated COVID-19 must be weighed against lives lost to the effects of pushing people into abject poverty.

**For African leaders, these competing narratives about COVID-19 offer an impossible Sophie's Choice.** Take coronavirus seriously, impose physical distancing policies, and see your economy tank and many people starve? Or prioritize the economy, accept COVID-19 infections and deaths as inevitable, and endure the suffering until herd immunity arrives?

**We think there's a third way** that can blunt the epidemic at manageable economic and social cost: **Using hyper-targeted physical distancing policies, coupled with targeted interventions to mitigate any resulting social and economic harms.**

In our most recent post, we showed how physical distancing can save lives in sub-Saharan Africa by reducing the total number of infections, not just by minimizing pressure on stretched health systems. Our post also noted that policymakers can use granular, localized              omic and social vulnerability to mitigate those consequences.

This post looks at how to do that, using existing data to model the likely spread of the epidemic *and* assess how vulnerable different areas are to economic and social disruption.

Let's see what this kind of modeling looks like in Malawi:

## Epidemiological Model

Previously, we shared some initial analyses conducted in support of Malawi's Ministry of Health. The Ministry is providing us with continual feedback, which we incorporate into each iteration of our epidemiological model.

We've now added the capability to apply policies at the district level. This means that **we can predict the health effects of enforcing lockdowns or other measures in certain districts**, but not others.

These charts show the predicted effects of applying restrictions in different areas across the country. The blue and brown lines reflect the effect of imposing targeted physical-distancing restrictions in different sets of major urban centers.

As we can see, **sustained social distancing in a few urban centers would significantly improve nationwide outcomes:**

## Geographic Prioritization Outcomes– Infections & Deaths

| Infections | Deaths |
|---|---|
| 1,500,000 | 50,000 |

Reduction

— No Mitigation
— No Further Reduction From Current

— Enforced Restrictions in Lilongwe, Blantyre, Chikwawa, & Nkhotakota
— Enforced Restrictions in above + Salima, Mzuzu, Zomba, Mzimba, & Mangochi
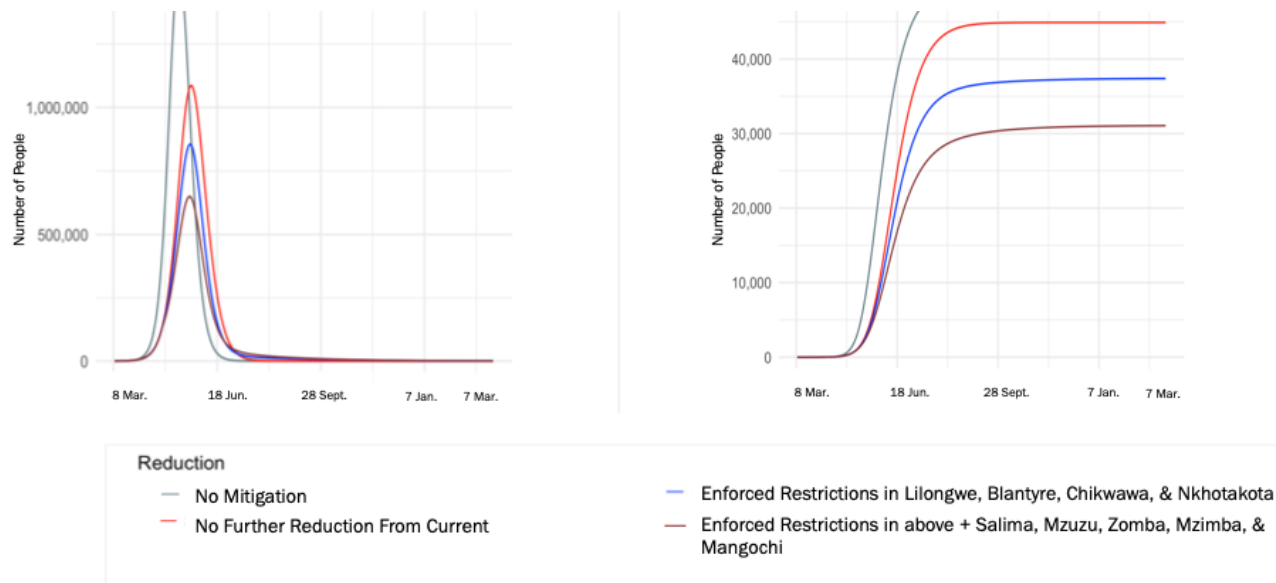
## Geographic Prioritization Outcomes– Hospitalizations & Critical Care



Reduction

— No Mitigation
— No Further Reduction From Current

— Enforced Restrictions in Lilongwe, Blantyre, Chikwawa, & Nkhotakota
— Enforced Restrictions in above + Salima, Mzuzu, Zomba, Mzimba, & Mangochi
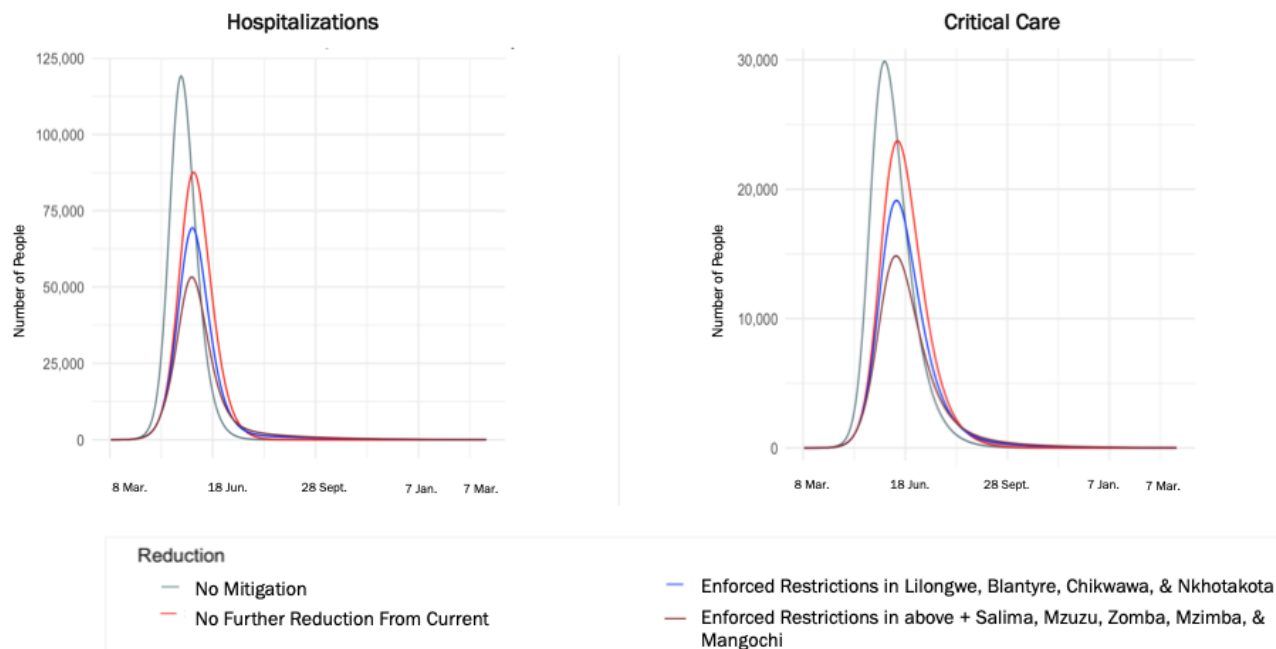
Focusing distancing measures on the highest-risk areas would be more feasible than a nationwide lockdown and would enable policymakers to precisely target the limited resources available for social support.

A key point here is that **the choice facing governments of low-resource countries is not between doing nothing and full national lockdowns**. Hyper-local data allow analysts to model, and policymakers (at all levels, from national authorities down to districts) to choose, narrowly tailored measures that reduce collateral social damage.

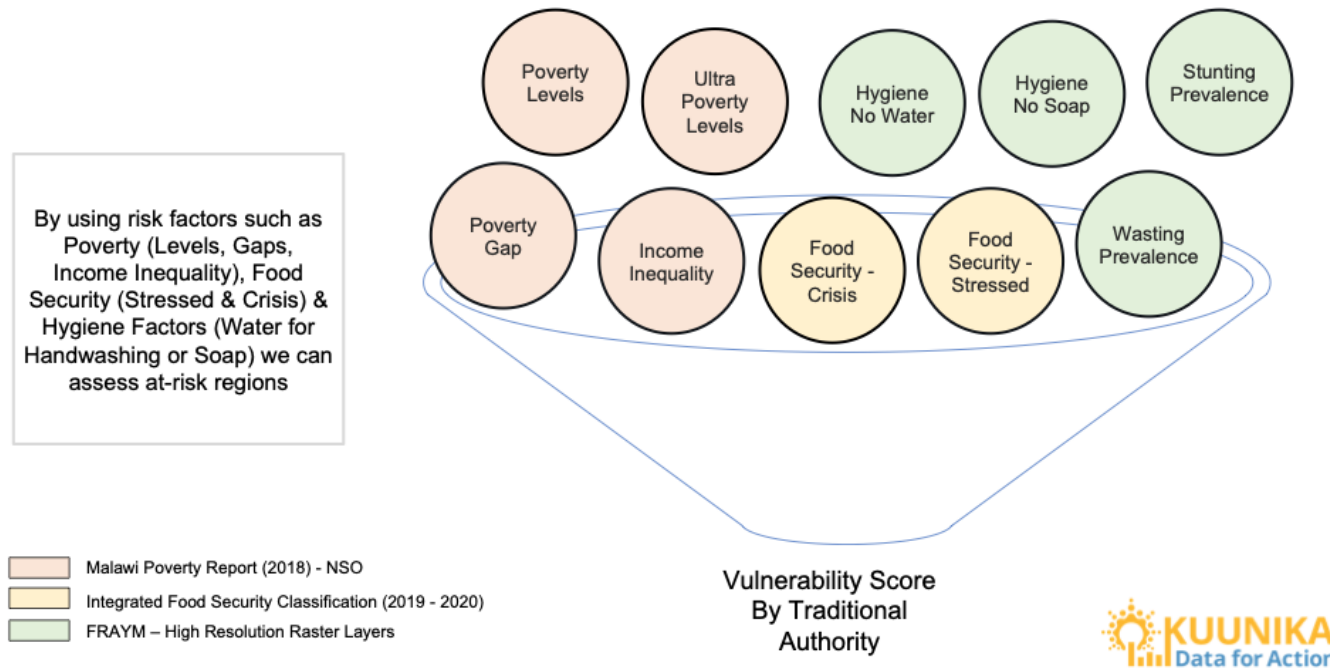Next, let's bring the population's vulnerability to the economic and social consequences of COVID-related restrictions into the analysis.

**Vulnerability Model**

For this model, we created an economic vulnerability index to assess, at a high geographic resolution, those areas which might be most vulnerable to the effects of lockdowns, movement restrictions, or closure of essential businesses.

Our model used these inputs:



## Current data elements in the model

We start with poverty data, which we use to rank districts within the country:
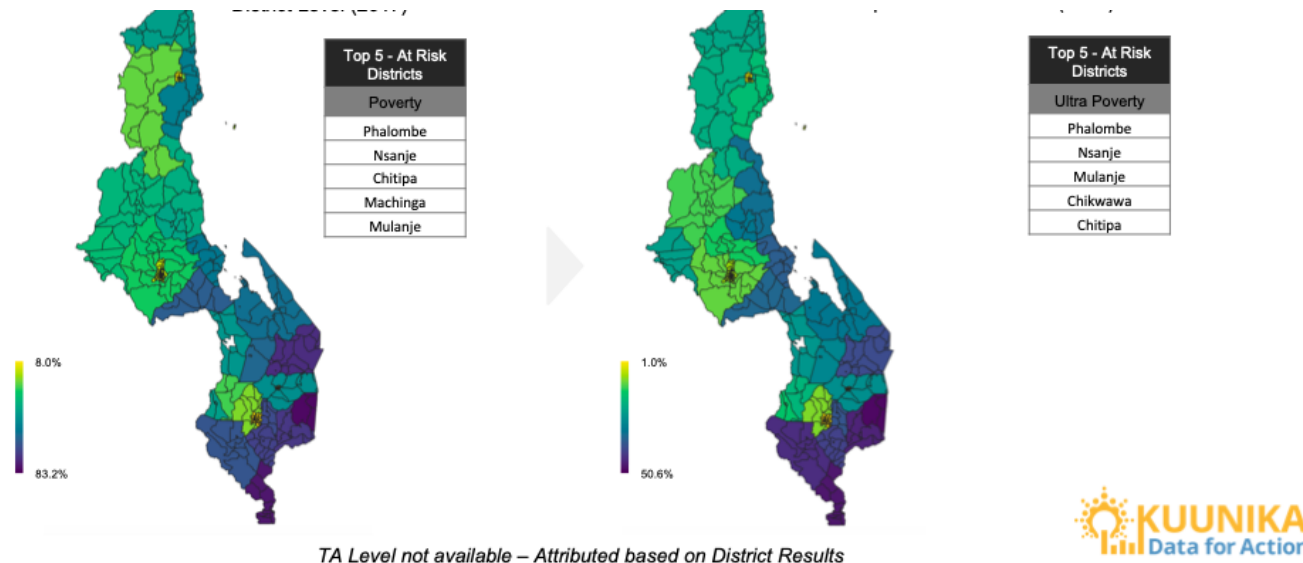
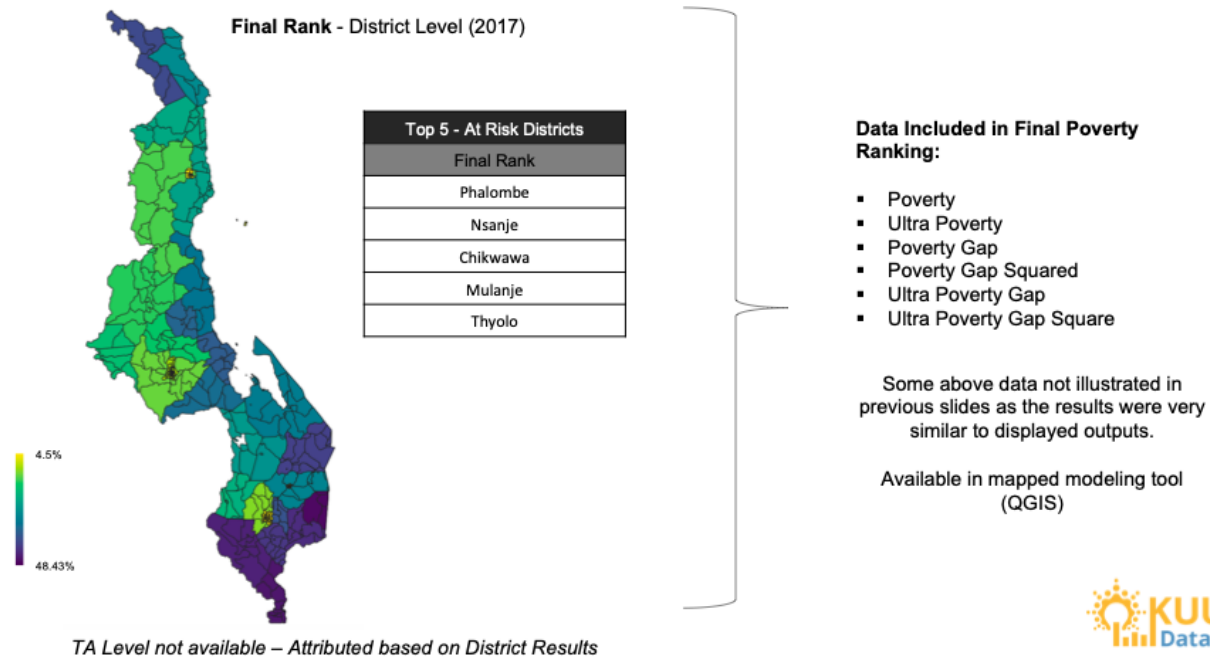| Top 5 - At Risk Districts |
| --- |
| Poverty |
| Phalombe |
| Nsanje |
| Chitipa |
| Machinga |
| Mulanje |

8.0%

83.2%

| Top 5 - At Risk Districts |
| --- |
| Ultra Poverty |
| Phalombe |
| Nsanje |
| Mulanje |
| Chikwawa |
| Chitipa |

1.0%

50.6%

*TA Level not available – Attributed based on District Results*



# Poverty Levels - Final Rank

**Final Rank** - District Level (2017)

| Top 5 - At Risk Districts |
| --- |
| Final Rank |
| Phalombe |
| Nsanje |
| Chikwawa |
| Mulanje |
| Thyolo |

4.5%

48.43%

*TA Level not available – Attributed based on District Results*

**Data Included in Final Poverty Ranking:**

- Poverty
- Ultra Poverty
- Poverty Gap
- Poverty Gap Squared
- Ultra Poverty Gap
- Ultra Poverty Gap Square

Some above data not illustrated in previous slides as the results were very similar to displayed outputs.

Available in mapped modeling tool (QGIS)

Next, let's bring in food security, availability of soap and water, and wasting and stunting data . (Fraym is providing the last four free of charge for COVID-19 support in Malawi.)
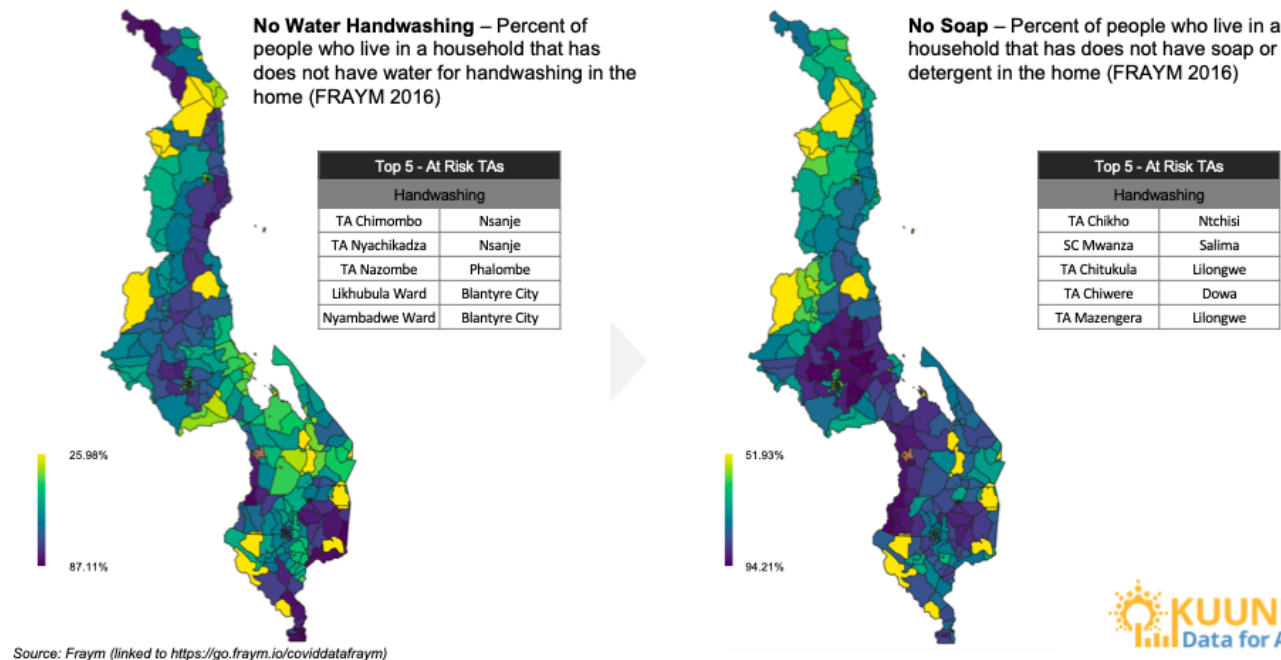
**These data will go into our vulnerability index, but they're also useful on their own**: Policymakers can use these data to better target food relief or to provide hand-washing facilities as a public-health intervention.
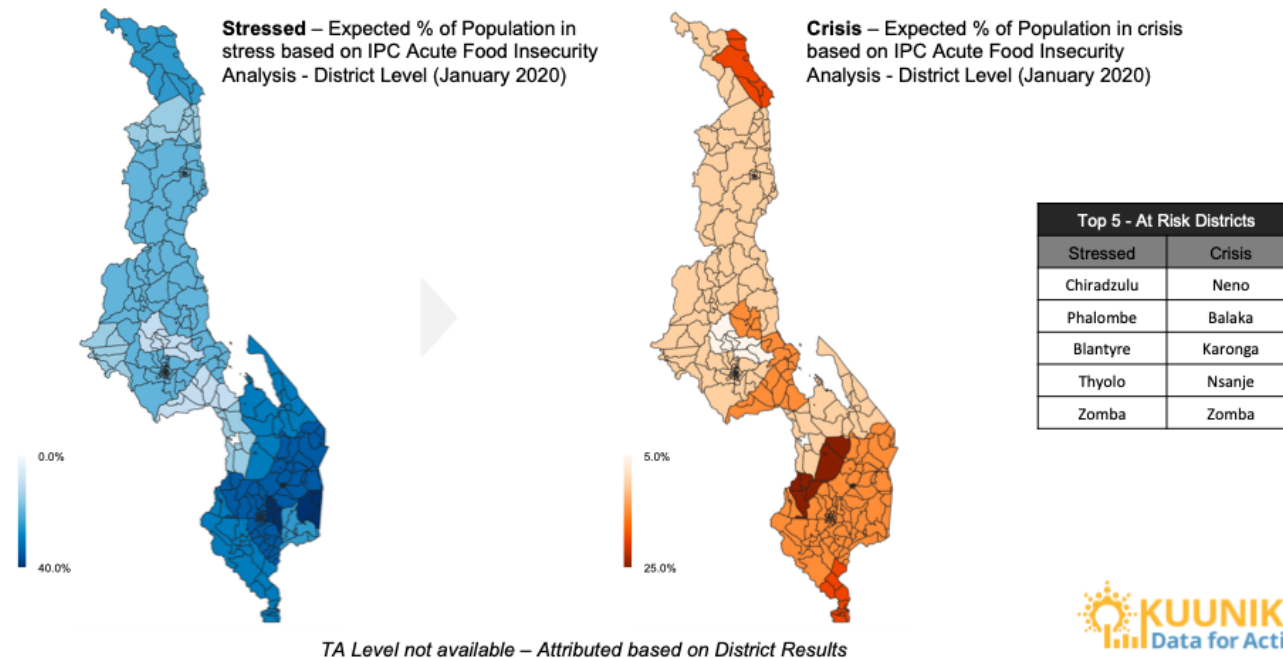
It's worth highlighting one nuance in the choice of inputs here. The poverty data is available only down to the District level — a fairly large administrative unit (there are 28 in the country). Fraym's data on availability of water, soap, stunting, and wasting, by contrast, is available at square-kilometer resolution. **Adding hygiene, stunting, and wasting as additional proxies for vulnerability allowed us to achieve more granular geographic resolution.**



Source: Fraym (linked to https://go.fraym.io/coviddatafraym)

# Wasting & Stunting Prevalence – Under 5

**Wasting Prevalence** – % of children (0-5)
that are wasting (FRAYM 2016)

**Stunting Prevalence** – % of Children (0-5)
who are stunted (FRAYM 2016)

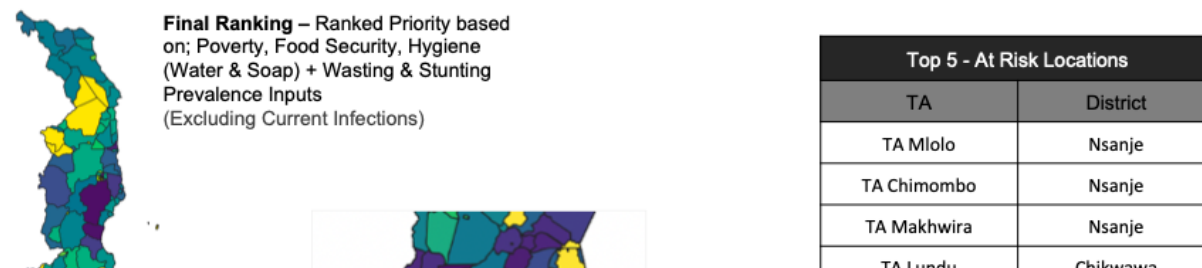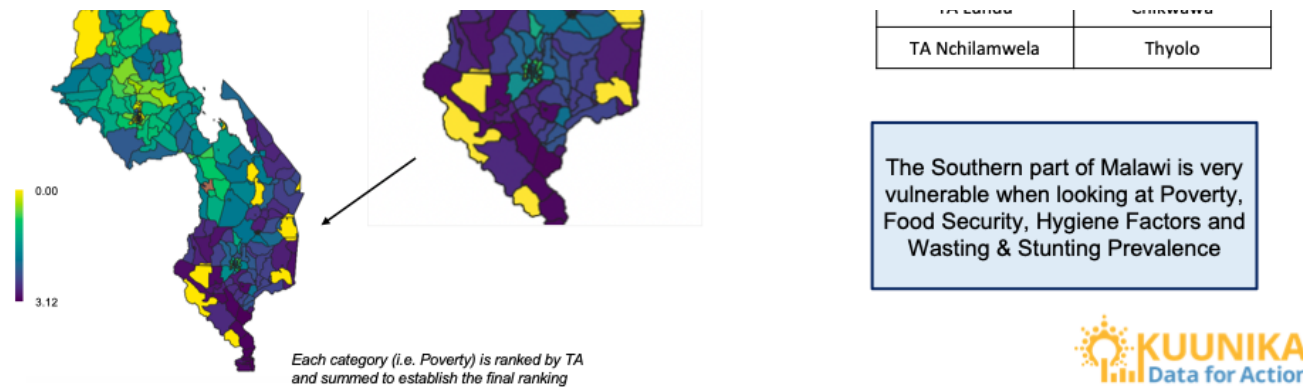| Top 5 - At Risk TAs | |
|---|---|
| **Wasting** | |
| Area 7 | Lilongwe City |
| TA Nyachikadza | Nsanje |
| TA Mlolo | Nsanje |
| TA Lundu | Chikwawa |
| Zolozolo Ward | Mzuzu City |

| Top 5 - At Risk TAs | |
|---|---|
| **Handwashing** | |
| Mulanje Boma | Mulanje |
| Limbe East Ward | Blantyre City |
| TA Chitukula | Lilongwe |
| TA Nchilamwela | Thyolo |
| TA M'Mbelwa | Mzimba |

0.00%

13.67%

0.00%

51.20%

KUUNIKA
Data for Action

Source: Fraym (linked to https://go.fraym.io/coviddatafraym)

Putting these indicators together, we can generate an **overall ranking of areas by economic vulnerability**:

# Poverty, Food Security, Hygiene & Stunting Rank

**Final Ranking** – Ranked Priority based
on; Poverty, Food Security, Hygiene
(Water & Soap) + Wasting & Stunting
Prevalence Inputs
(Excluding Current Infections)

| Top 5 - At Risk Locations | |
|---|---|
| **TA** | **District** |
| TA Mlolo | Nsanje |
| TA Chimombo | Nsanje |
| TA Makhwira | Nsanje |
| TA Lundu | Chikwawa |

| TA Lunda | Chikwawa |
| TA Nchilamwela | Thyolo |

The Southern part of Malawi is very vulnerable when looking at Poverty, Food Security, Hygiene Factors and Wasting & Stunting Prevalence

0.00

3.12

Each category (i.e. Poverty) is ranked by TA and summed to establish the final ranking

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Now, we can align estimates of economic vulnerability with epidemiological predictions of severity: current infections and the percentage of population at high risk for severe COVID-19 (darker areas are at higher risk).

# Economic, High Risk Pop & Current Infections



Economic Vulnerability Rank

High Risk Population Rank

Current Infections Location (As of 04.24)
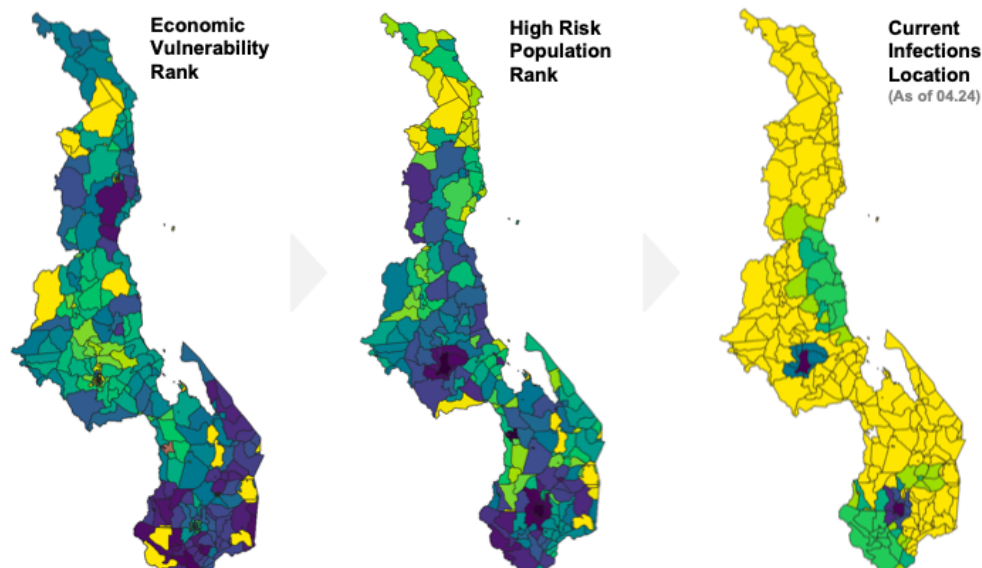
These maps can help policymakers assess **where the epidemic poses the greatest risk** *and* **how vulnerable each of those areas would be to economic disruption from lockdowns or physical distancing**. Policymakers can use that knowledge to conduct cost-benefit analysis and to mitigate economic consequences by targeting food aid and other relief.

And these interventions can be hyper-local: The data allows us to pinpoint specific areas *within a district* where we can conduct targeted testing, tracing, and physical distancing approaches and corresponding economic and social support that are *contextually relevant for each community*. These interventions can be developed in consultation with community leaders, using the data and their insights to develop shared approaches.

We welcome your comments. For more information about our approach click here.

Covid 19     Global Health     Malawi

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