VERSE
VACCINE ECONOMICS RESEARCH FOR SUSTAINABILITY AND EQUITY

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VERSE Equity Tool

How to analyze DHS data

Project team

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JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

INTERNATIONAL VACCINE ACCESS CENTER

How to use the VERSE Equity Tool

Get the Equity Tool

Connect R-Studio to the VERSE Equity GitHub repository or download it. Then, set it up.

Edit the model inputs

Review the country, year, vaccines of interest, and any other relevant parameters.

Run successfully

Run VERSE.R and know what to do when errors happen.

Generate the results

Call general and specific results in R-Studio.

Interpret the results

Interpret the metrics, figures and graphs generated by the tool.

Translate to policymaking

Communicate your findings in government reports and academic publications.

1. Get the VERSE.R program

Connect R-Studio to the VERSE Equity GitHub repository or download it. Then, set it up.

IVAC

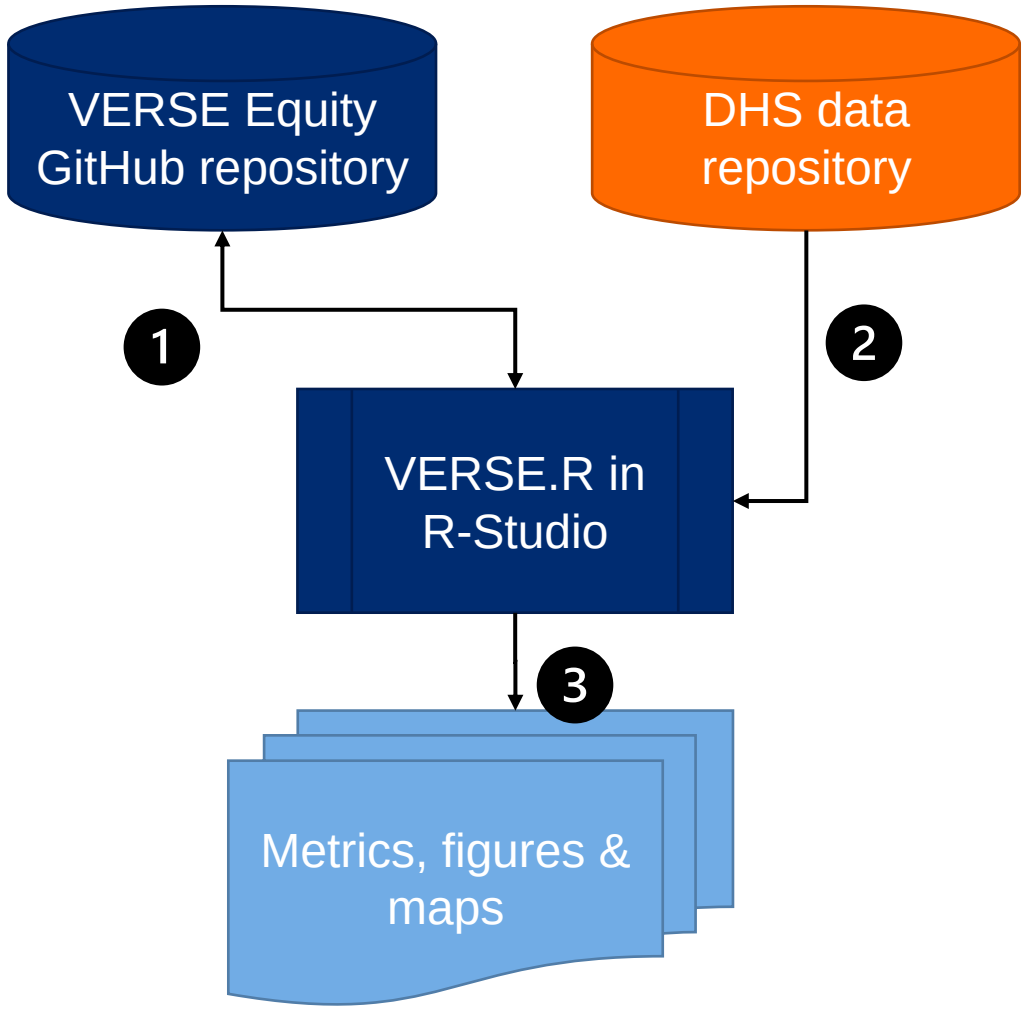
Before you start…

- You must have **R** and **R-Studio** installed on your computer and up-to-date
  - Download R: https://cran.r-project.org/bin/windows/base
  - Download R-Studio: https://www.rstudio.com/products/rstudio/download
    Note: the free open-source license is enough
  - Download Git-for-Windows: https://gitforwindows.org (for Method 1: Connecting to GitHub)
- You must be connected to the **Internet**

How is VERSE.R set up?

The VERSE Equity Tool is simple to set up:

1. If you connect it to GitHub, R-Studio can get the latest version of the VERSE.R program before you run it.
2. When you run it, the program gets the specified survey dataset from the DHS database directly.
3. After running it successfully, the metrics, figures and maps are generated on your computer.



Get the VERSE.R program

Method 1: Connect to GitHub

GitHub is a software/program repository we use to host the VERSE programs.

R-Studio & GitHub work beautifully together: you can always get the latest version of the tool right in R-Studio. **We recommend this method**.

You can read more about this here: https://happygitwithr.com/rstudio-git-github.html

Method 2: Download the program file

You can download and save the program file(s) directly from the VERSE webpage (*upcoming*).

You would need to check for updates on the webpage occasionally.

Method 1: Connect to GitHub

As of 28 March 2022, the VERSE Equity repository is **private** and access to it must be requested to gdebroucker@jhu.edu

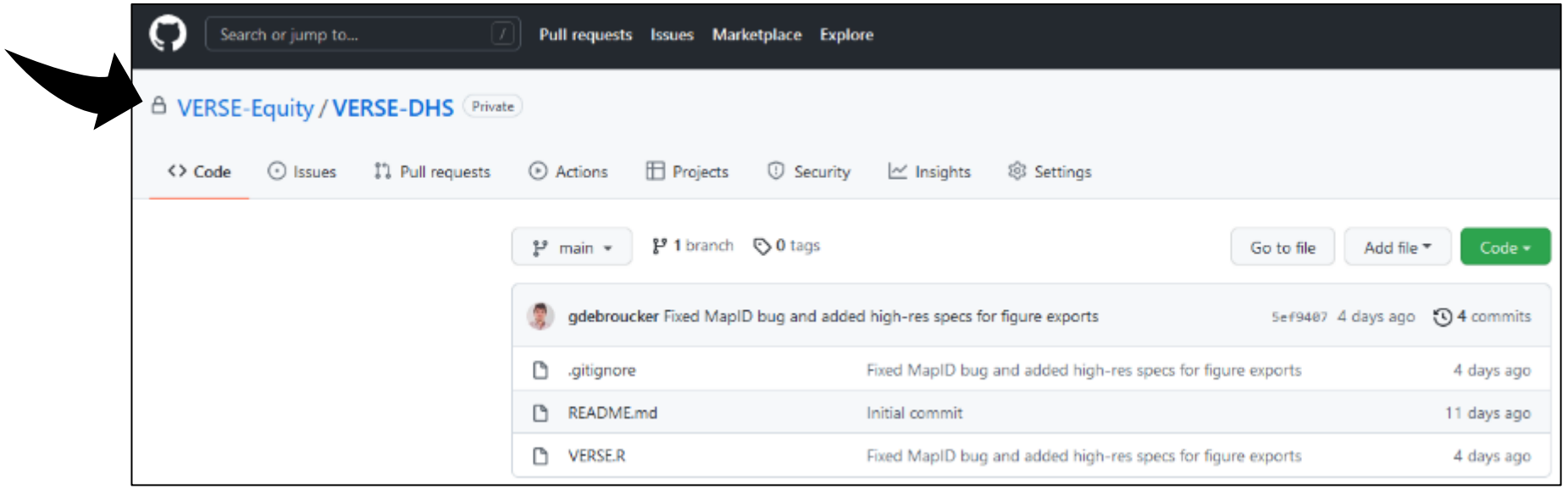
You will need a GitHub account and share it by email.

Sign up here (it's free): https://github.com

Method 1: Connect to GitHub

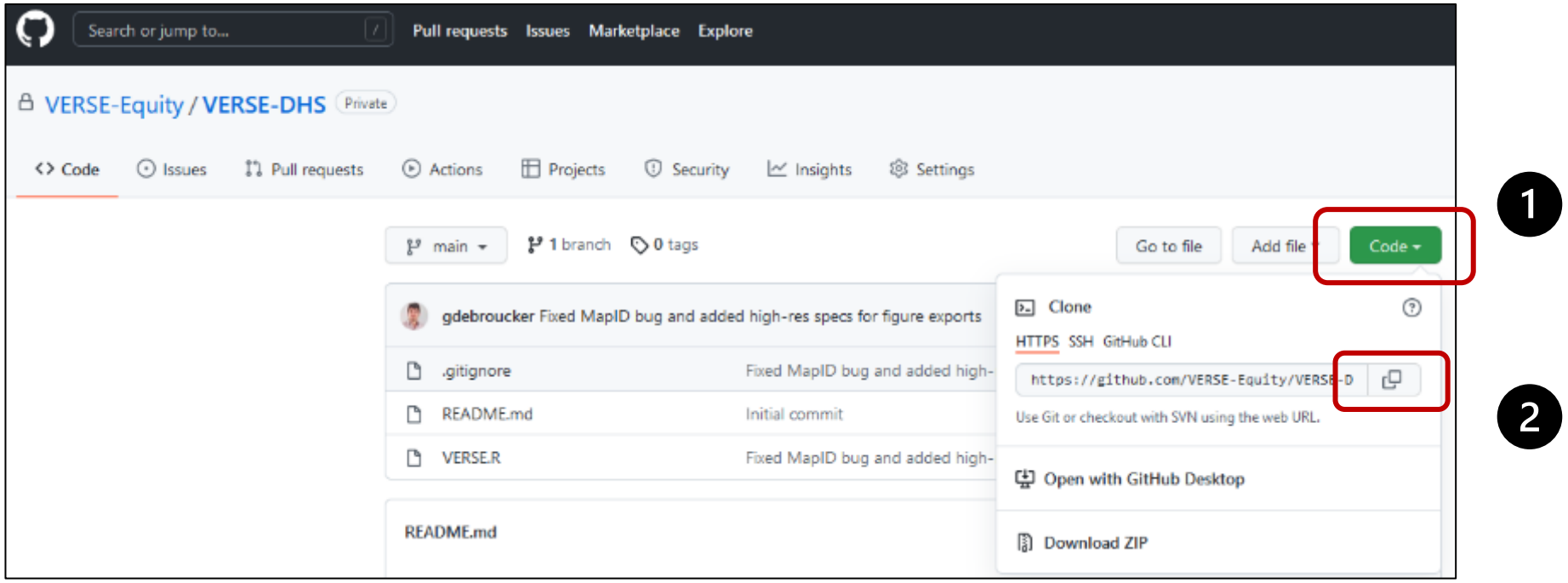
If Bryan or Gatien provided you with a specific link to GitHub, please use your link. Your link may be giving you editing privileges.

Otherwise, follow this link to access the VERSE-Equity/VERSE-DHS GitHub repository: https://github.com/VERSE-Equity/VERSE-DHS



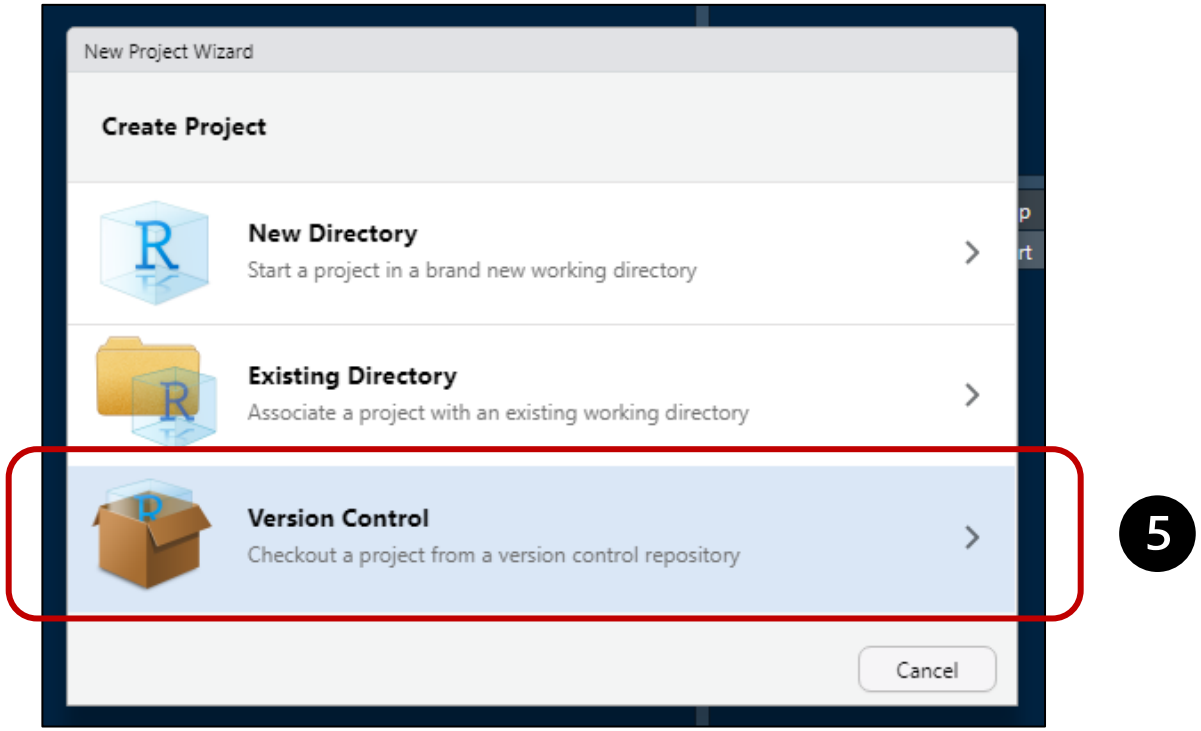
Method 1: Connect to GitHub

1) Left-click on the green *Code* button
2) Copy (or left-click on the “copy” button) the web URL to the repository



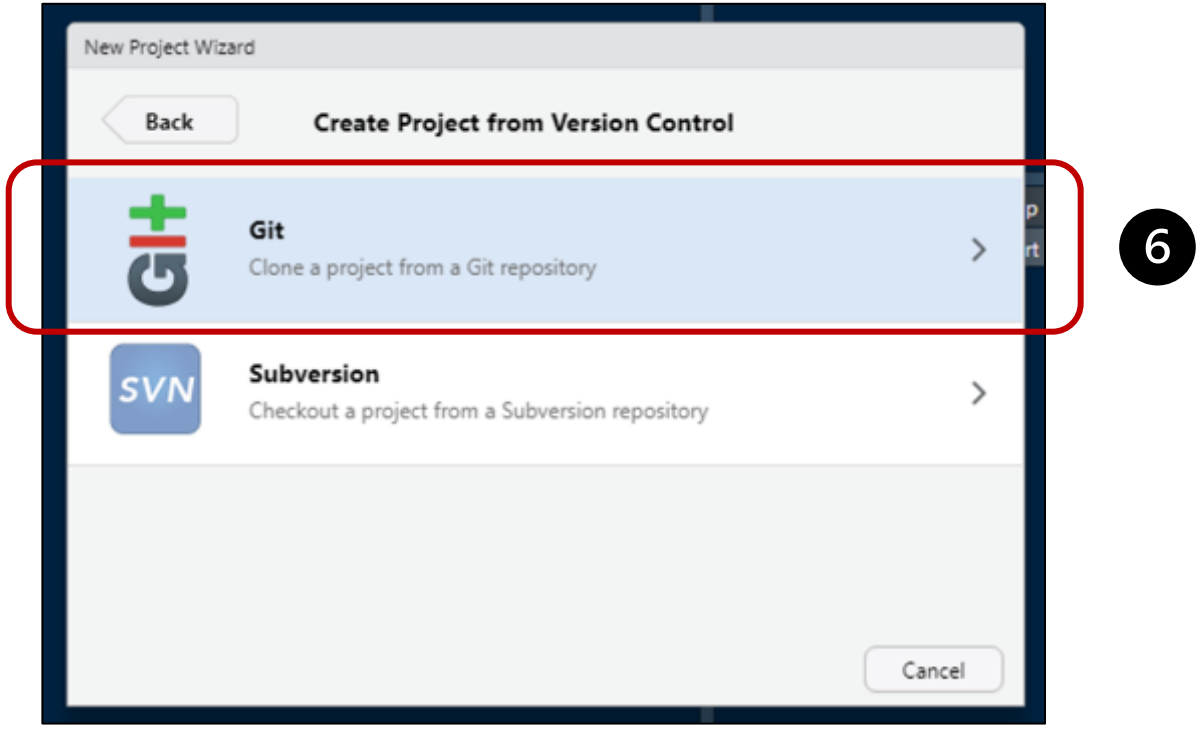
Method 1: Connect to GitHub

3) Open R-Studio
4) Left-click on *File* and *New Project…*
5) In the New Project Wizard, left-click on *Version Control*



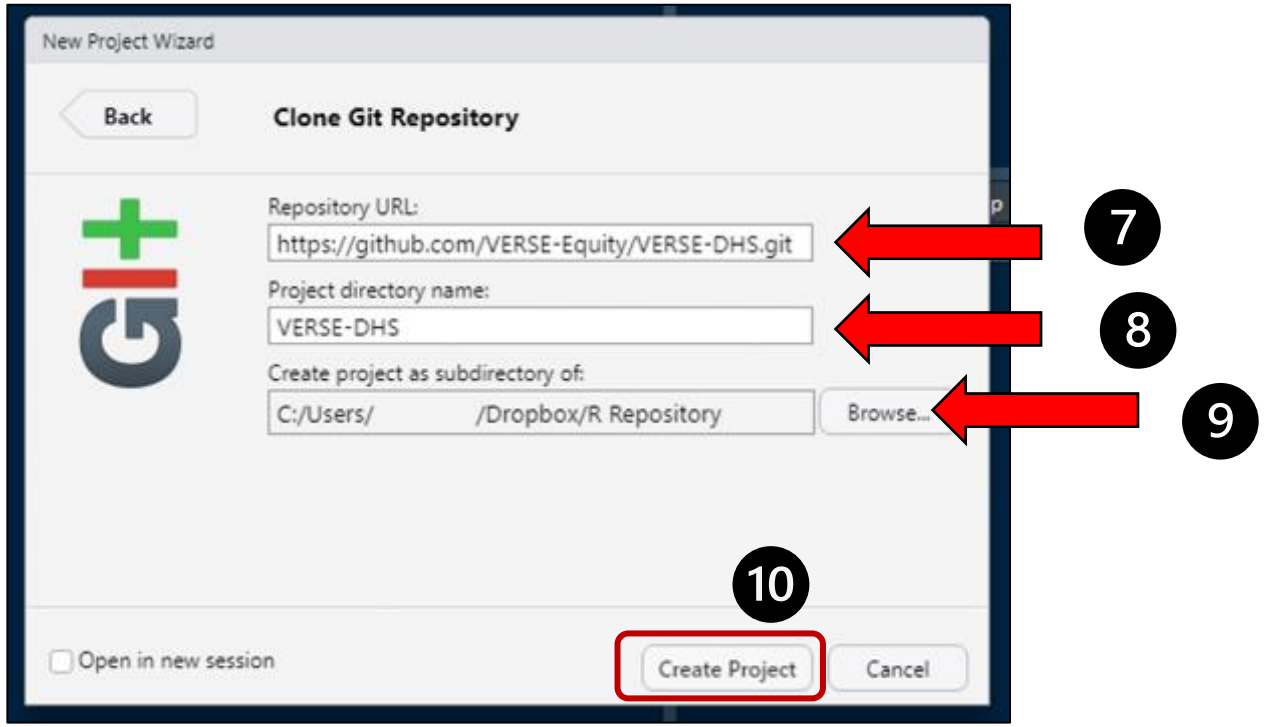
Method 1: Connect to GitHub

6) Left-click on *Git* to create a clone project (an exact copy of the VERSE-Equity/VERSE-DHS repository on your computer)



Method 1: Connect to GitHub

7) Paste the web URL you copied from GitHub in *Repository URL*
8) (Optional) You may change the project directory name
9) Set a folder on your computer where R-Studio will copy the repository files
10) Left-click on *Create Project*



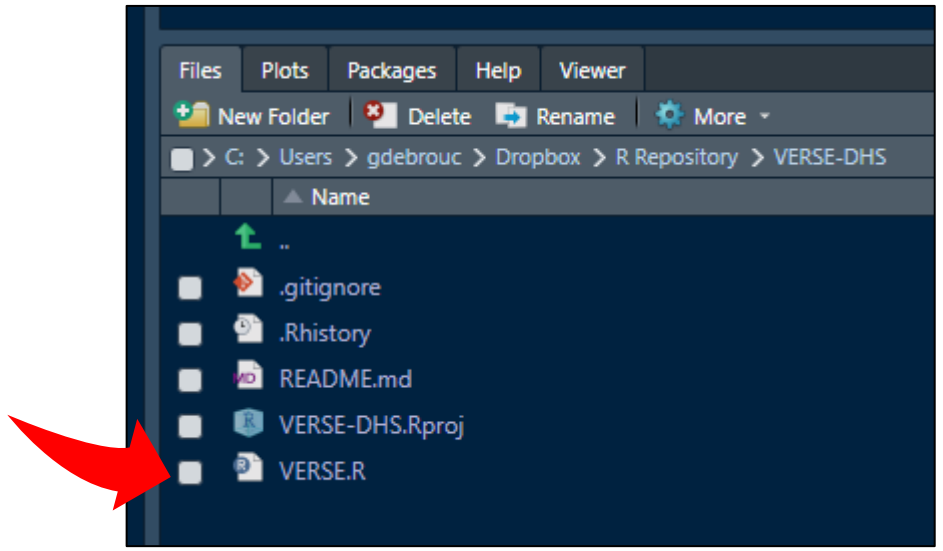
Method 1: Connect to GitHub

Congratulations, you are all set up!

Your computer now has a “clone” of the VERSE GitHub repository: you have a copy of the program on your computer.

You can access these files offline.

In your new project in R-Studio,
open the file *VERSE.R*



2. Edit the model inputs

Review the country, year, vaccines of interest, and any other relevant parameters.

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VERSE Equity Tool inputs

Before running the VERSE Equity Tool, there are a few places in the VERSE.R program that require your input or review.

The next slides explain those inputs.

You can easily search everywhere your input is needed by searching for “ACTION NEEDED” in VERSE.R:

1) Press Ctrl + F (or Cmd + F for Mac)
2) Search for “ACTION NEEDED”
3) Left-click on *Next* to go through all occurrences

VERSE Equity Tool inputs

Several inputs are specific to your analysis query:

- What is your working directory?

The working directory determines where you want the VERSE outputs to be stored on your computer. It should be different from the clone repository, which only stores the program.

- Which country do you want to analyze?
- What year of the DHS?

For both questions above, you should review the availability of DHS data using the following link: https://dhsprogram.com/Countries

- Which vaccines to include?

Only select vaccines that were included in the national immunization schedule the year the DHS survey was performed.

- Do you want to generate maps?

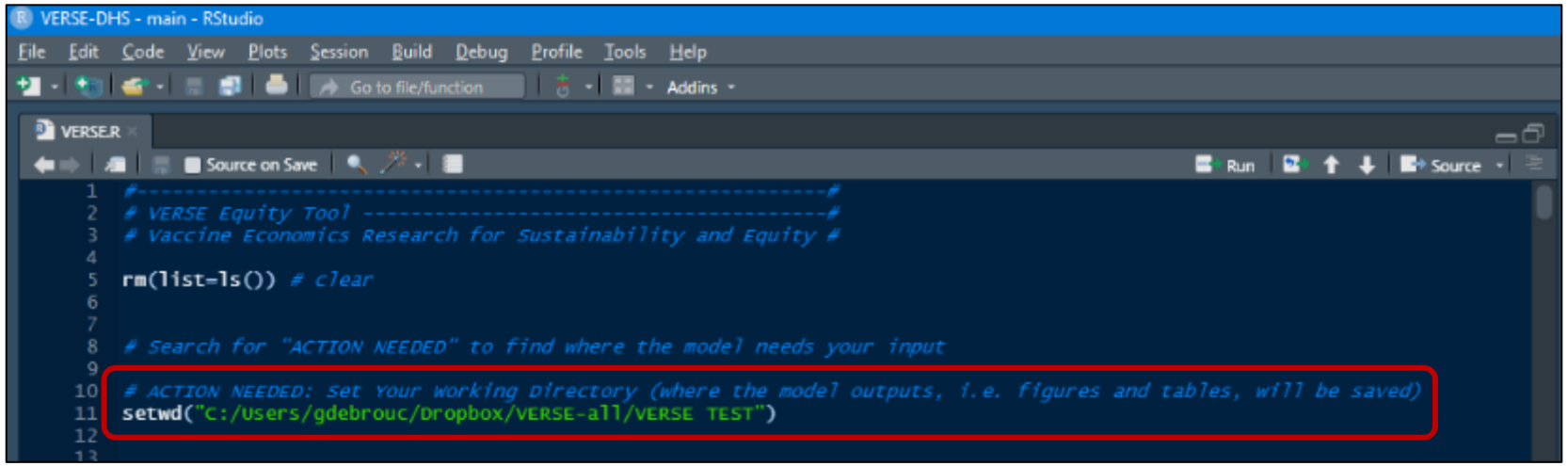
Maps convey excellent insights on geographic disparities, but they add to the analysis time. You can deactivate them to make the program run faster.

Working directory

On line 11, specify your working directory.

It can be any location* on your computer or network and should be different from where the program is cloned.

** The outputs generated do not contain sensitive or confidential data and there is no security requirement for the working directory to use the VERSE Equity Tool.*

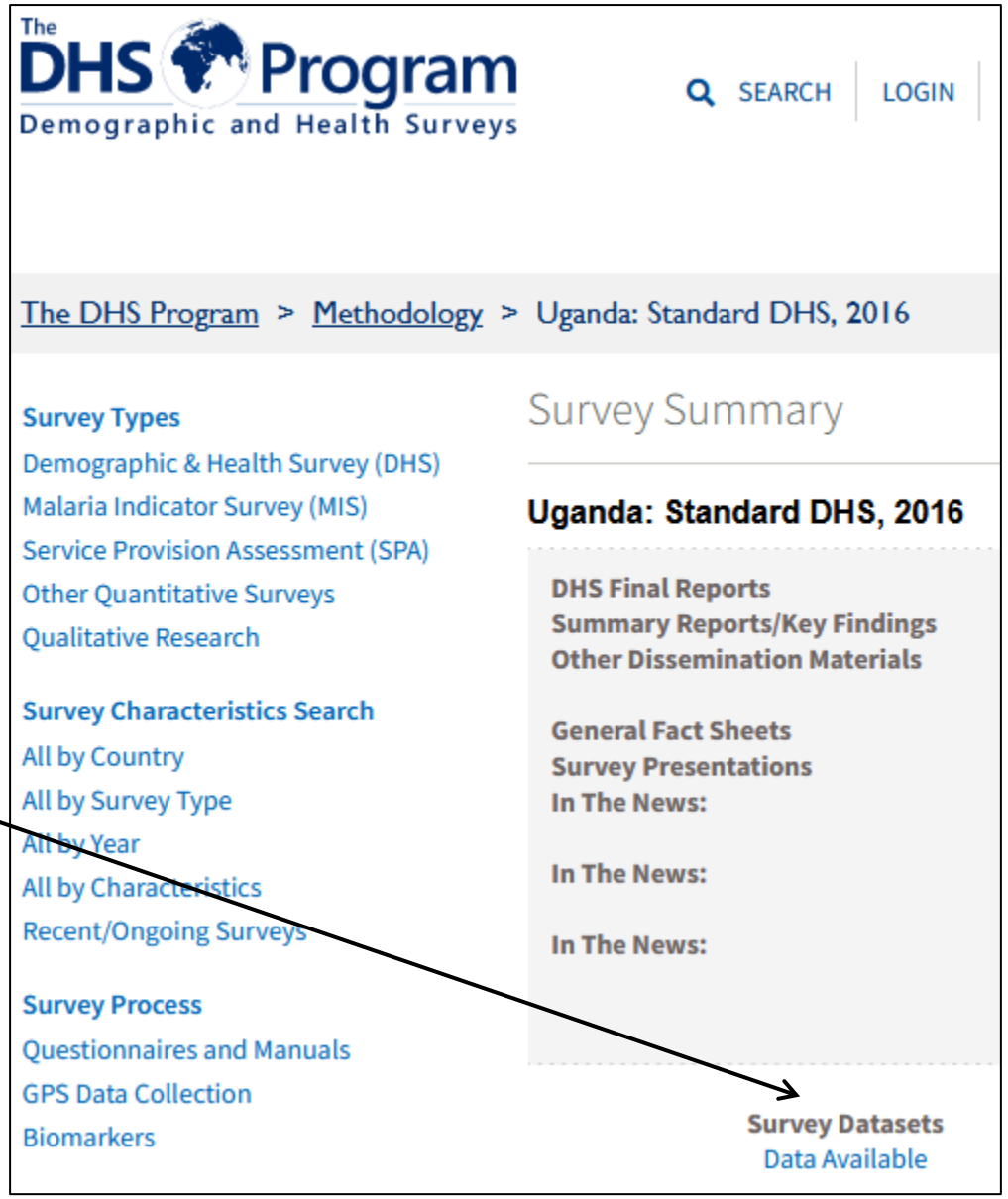


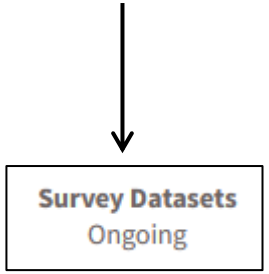
Country and year

You must specify the country and (survey) year that you want to analyze.

To know what is the latest year with available DHS survey data:

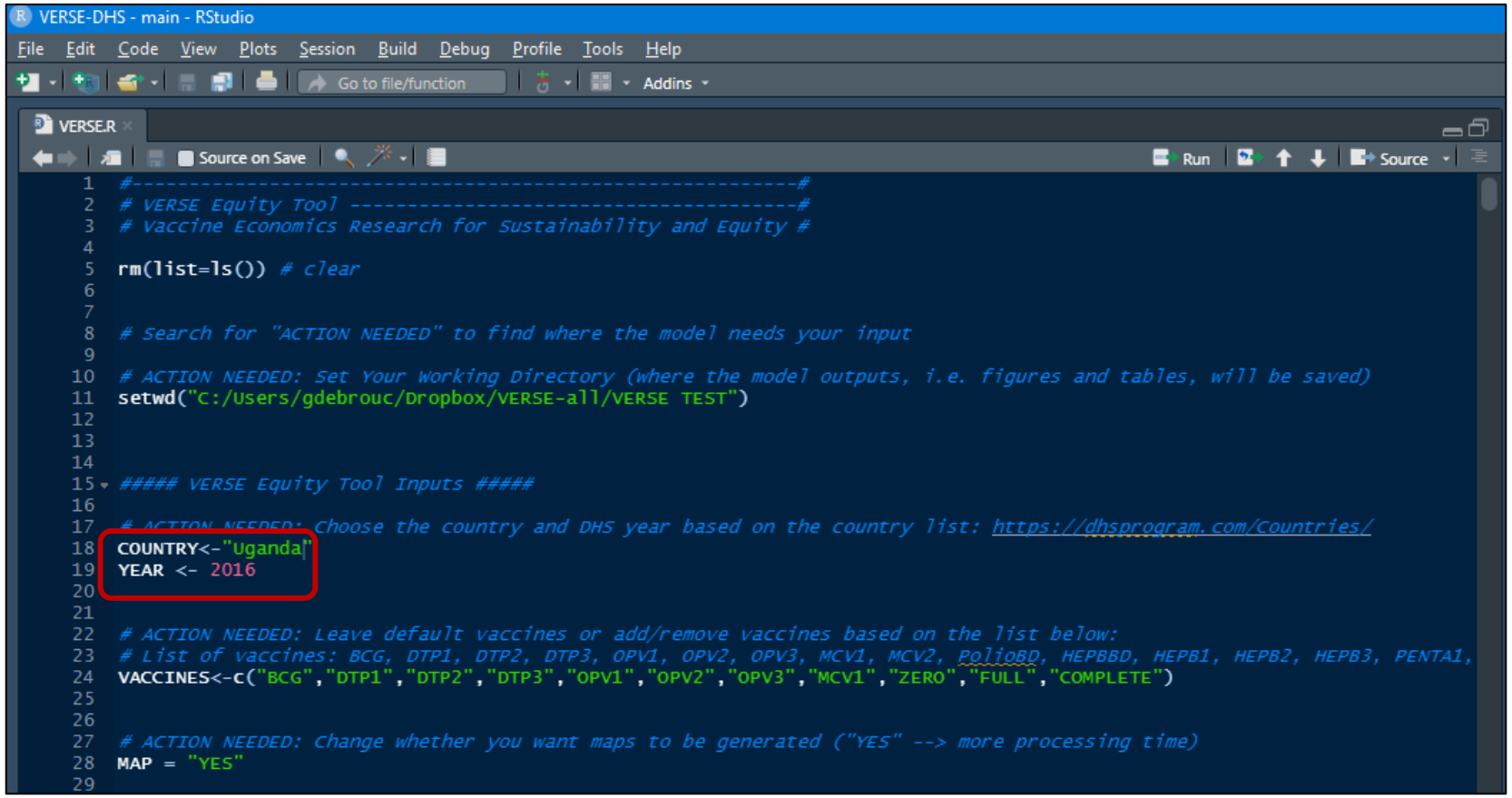
1) In a country profile, left-click on one of the DHS surveys
2) If data are available for this country & year, it will show "data available" under *Survey Datasets* in the survey page
3) If data are not (yet) available, "Ongoing" will show instead





Country and year

On lines 18-19, specify the country (between quotation marks “”) and the (survey) year. If the survey year is 2015-2016, enter “2016”.



Vaccines

Only select vaccines that were included in the national immunization schedule the year the DHS survey was performed.

For instance, while the rotavirus vaccine (ROTA1-3) is currently in Uganda's immunization schedule, it wasn't so when the 2015-16 DHS was performed and should not be included.

Currently, the VERSE Equity Tool can accommodate the following vaccines (labeled by dose) and health statuses: BCG, DTP1, DTP2, DTP3, OPV1, OPV2, OPV3, MCV1, MCV2, PolioBD, HEPBBD, HEPB1, HEPB2, HEPB3, PENTA1, PENTA2, PENTA3, PCV1, PCV2, PCV3, ROTA1, ROTA2, ROTA3, HIB1, HIB2, HIB3, IPV1, IPV2, IPV3, FULL, ZERO, COMPLETE

Vaccines

Three health statuses are available:

- **ZERO**: a child is “zero-dose” when they did not receive either BCG, DTP1, OPV1 or MCV1 by 12 months of age.
- **FULL**: a child is considered “fully immunized for age” if they received all scheduled vaccines for their age.
- **COMPLETE**: a child has “completed” the immunization schedule if they received all scheduled vaccines.

All other inputs are related to specific vaccines and doses.

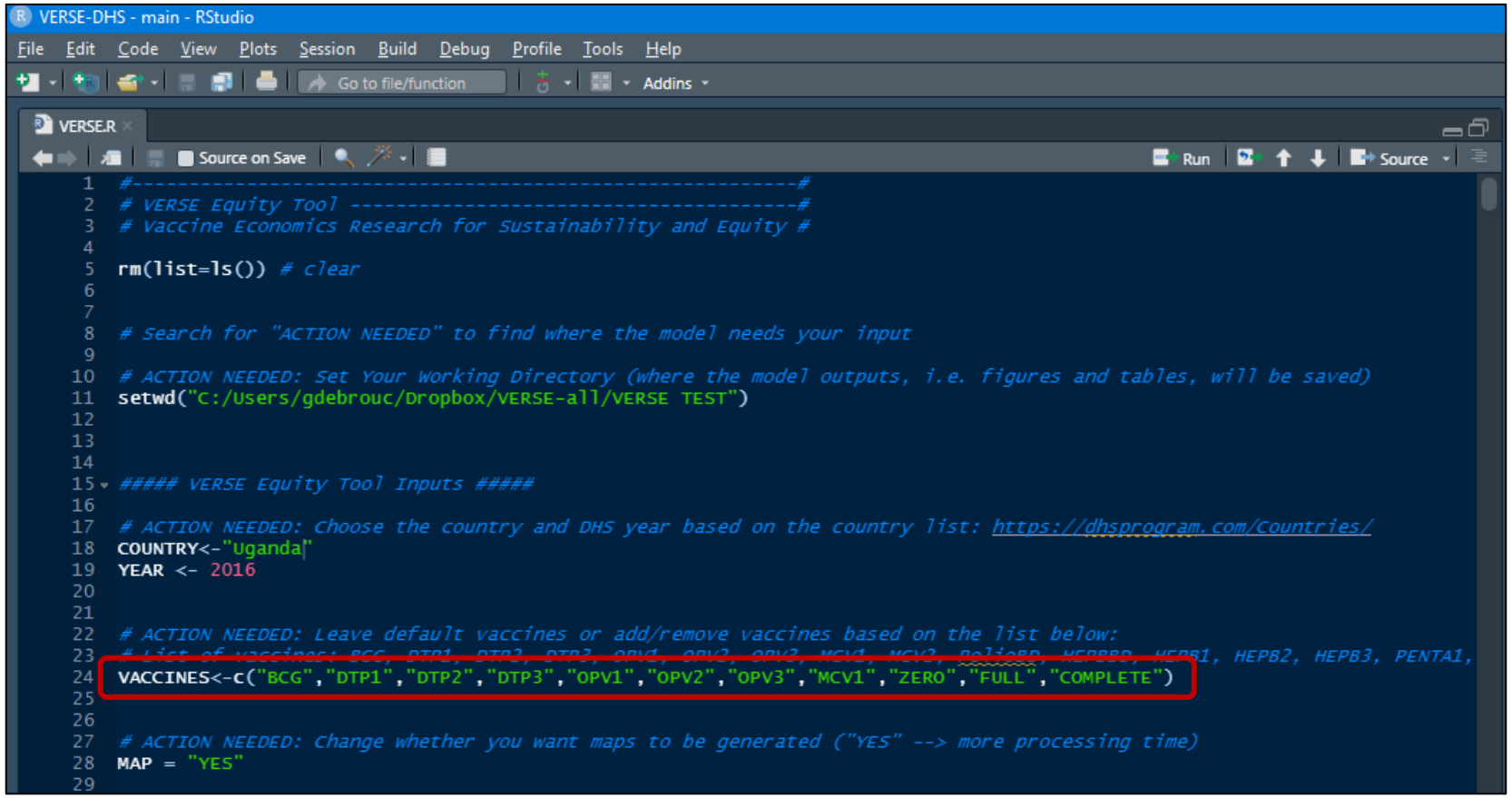
For most countries, we suggest using the following (default) selection:

```
VACCINES <- c(BCG, DTP1, DTP2, DTP3, OPV1, OPV2, OPV3, MCV1, FULL,
ZERO, COMPLETE)
```

Note that OPV1-3 also considers whether IPV is provided instead of OPV.

Vaccines

On line 24, add or remove vaccines and health statuses as needed. You can also keep the default selection for a first run.

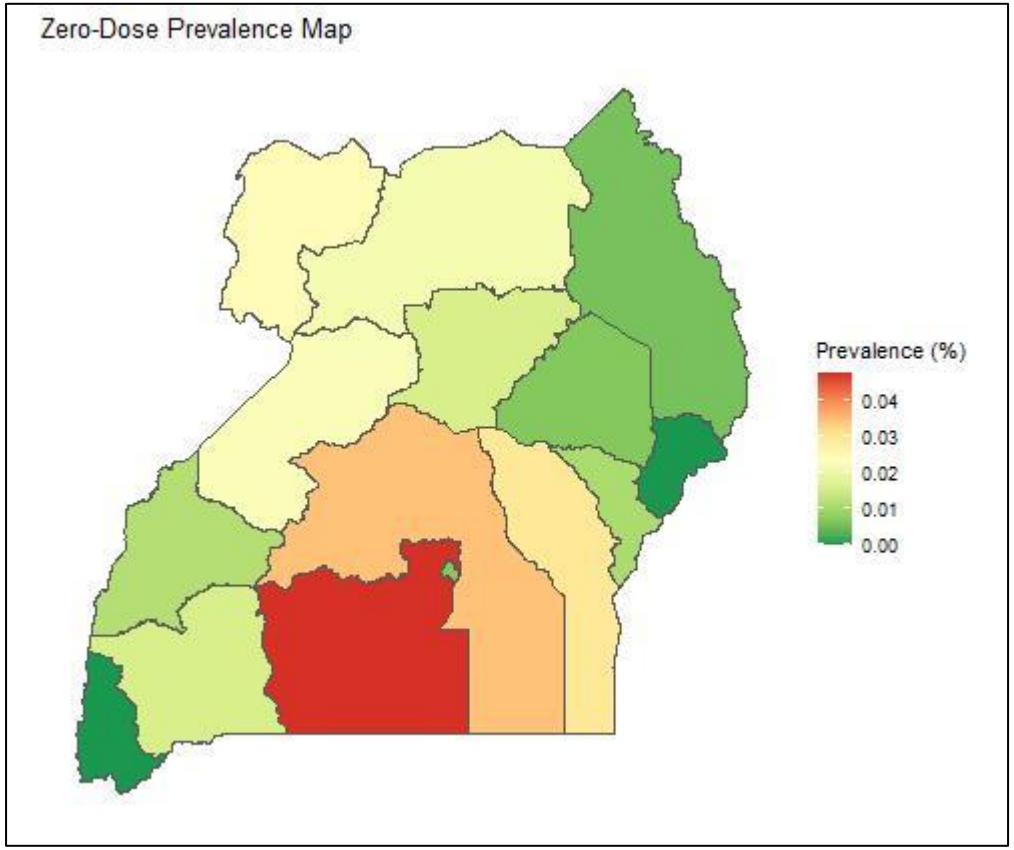


Maps

You have the option to disable/enable maps in the VERSE Equity Tool.

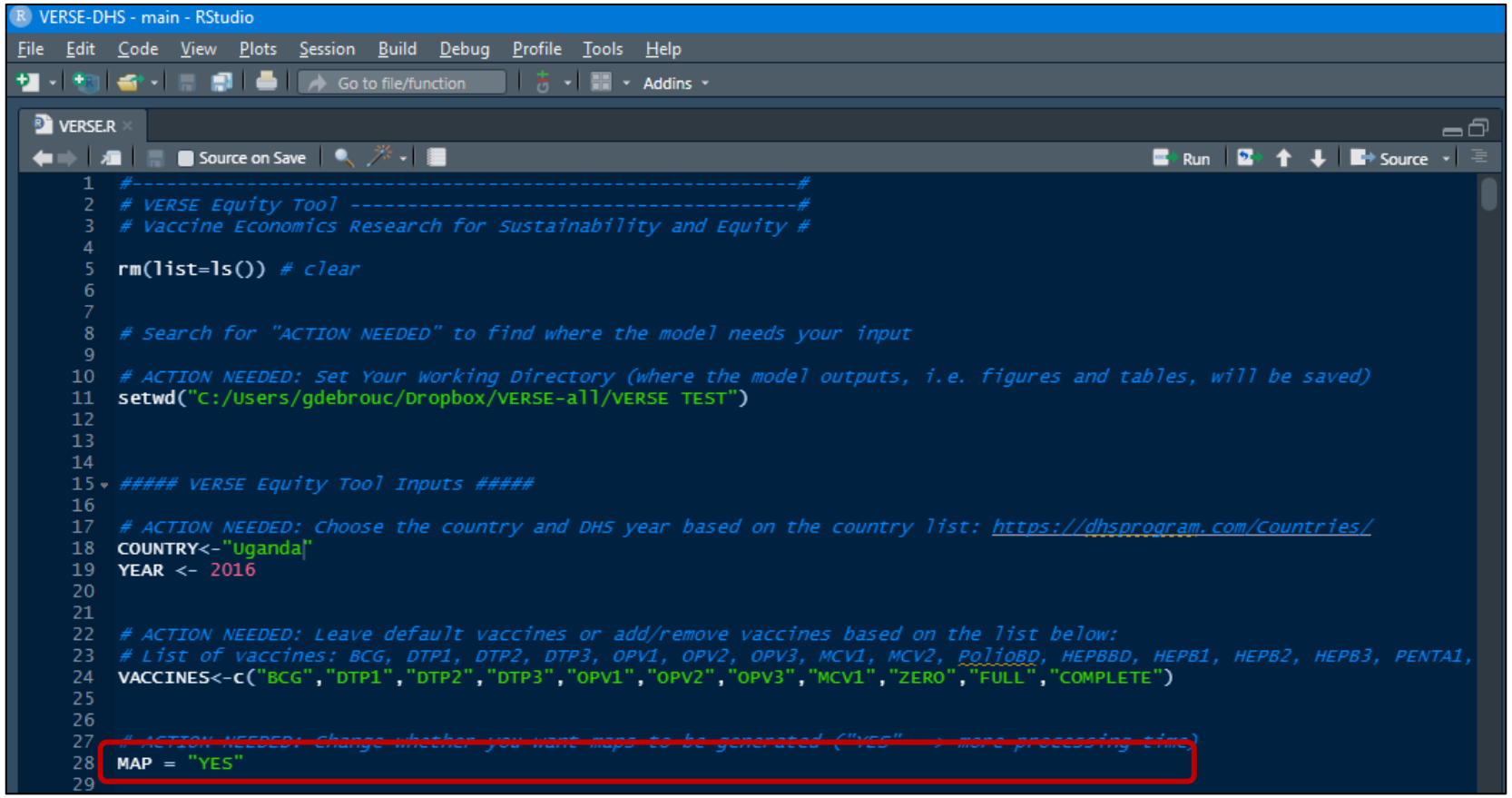
Maps can add a significant amount to time to running the program (between 2-10 minutes), especially if more than 5 vaccines/health statuses are selected.

Disabling/enabling maps does not change anything in the analysis.



Maps

On line 28, choose whether you want mapping enabled (“YES”) or not (“NO”).



VERSE Equity Tool inputs

Congratulations, your model inputs are set up!

Next, we will run the program and troubleshoot as needed.

3. Run successfully

Run VERSE.R and know what to do when errors happen.

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Run the program successfully

Once you click on “Run” (or Ctrl/Cmd + Shift + Enter), the program runs in four steps, with two that may require your input (*):

1. The program install and loads the required R packages
2. * It accesses the DHS database and retrieves the data
3. It creates the VERSE R function
4. It runs the VERSE R function with the specified inputs (country, year…) and generates results and outputs

1. Installing and loading R packages

The program will search, download, install and load the necessary R packages.

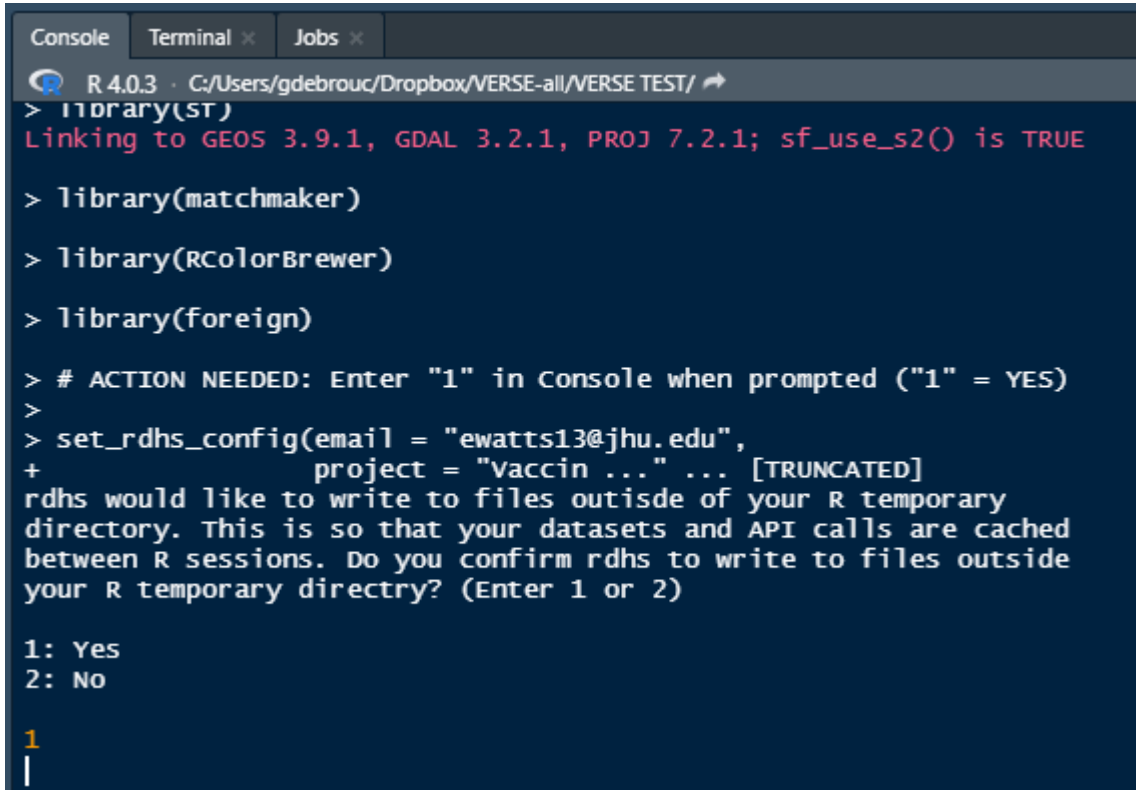
Once the R packages are installed, they don’t need to be installed again (they may need to be updated). To run the program faster, add a hashtag (#) before each `install.packages()`.

2. Retrieve DHS data – *your input needed*

The program will search and download the dataset for the specified country and year from the DHS database online (you must have Internet access).

The program may ask you two questions:

1) Do you confirm rdhs to write to files outside your R temporary directry?
   – *Asked in the R Console*
   - In the R Console, you must type "1" and press Enter

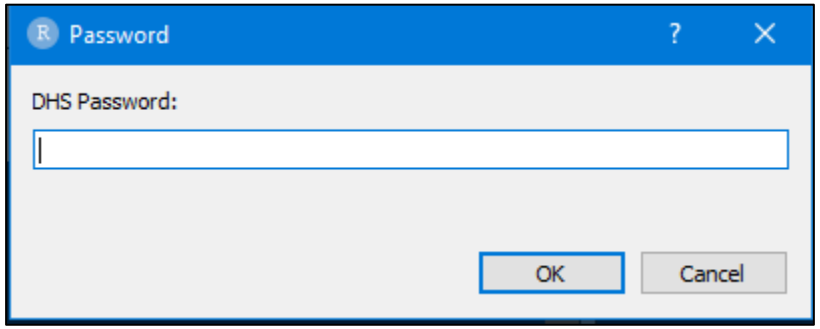


2. Retrieve DHS data – *your input needed*

The program will search and download the dataset for the specified country and year from the DHS database online (you must have Internet access).

The program may ask you two questions:

2) Enter the DHS Password – *Asked in a separate prompt*
   - In the text field, you must type “verseteam” and left-click *OK*



3. Create the VERSE function

The program will create a VERSE function.

Do not make any edits in the code.

4. Run the VERSE function

The program will run the VERSE function with the specified inputs and:

- Show results in the R Console
- Show figures and maps in the R Plots
- Generate CSV files with national and state level metrics
- Generate figures and maps as high-quality JPEG files

Troubleshoot

While the program was thoroughly reviewed and tested, error messages may appear. Most of them can be resolved by:

- Closing and restarting R-Studio
- Updating R and R-Studio to the latest version
- Updating the required R packages

A common issue and its resolution are presented on the next slide.

If you encounter any other error, do let us know:
bpatenaude@jhu.edu

Troubleshoot

A common issue: the program stops running and you receive an error message in the R Console (screenshot on the next slide):

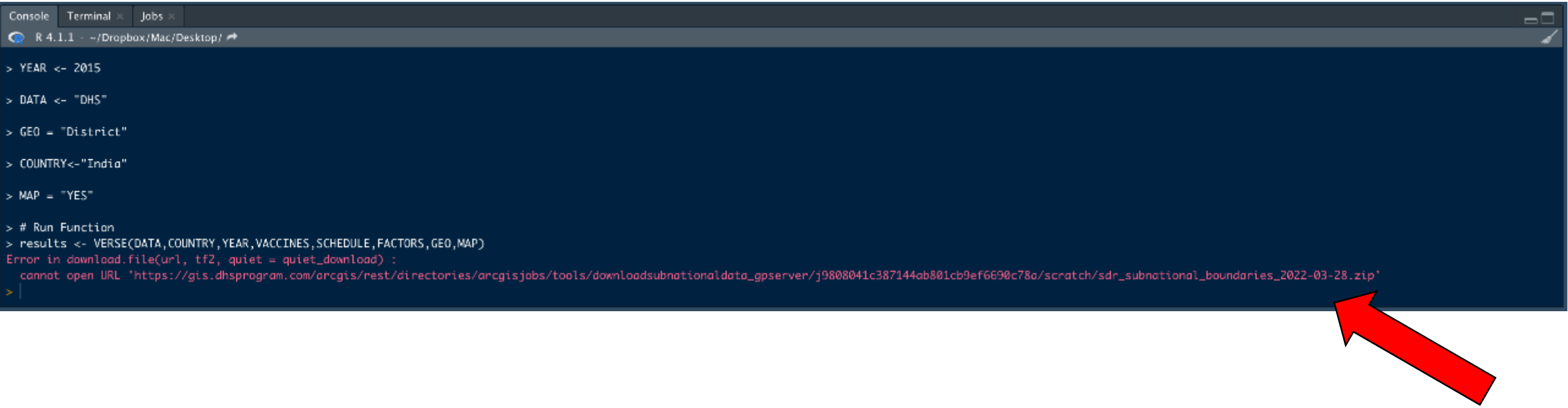
```
Error in download.file(url, tf2, quiet = quiet_download) :  cannot
open URL
'https://gis.dhsprogram.com/arcgis/rest/directories/arcgisjobs/tools/
downloadsubnationaldata_gpserver/j3d3334c368334492902fa8a86a81666e/sc
ratch/sdr_subnational_boundaries_2022-02-11.zip'
```

To resolve it, simply run directly in your R Console the following code, then close and restart R-Studio:

```
get_available_datasets(clear_cache=TRUE)
```

Troubleshoot

Screenshot of the common issue:



4. Generate the results

Call general and specific results in R-Studio.

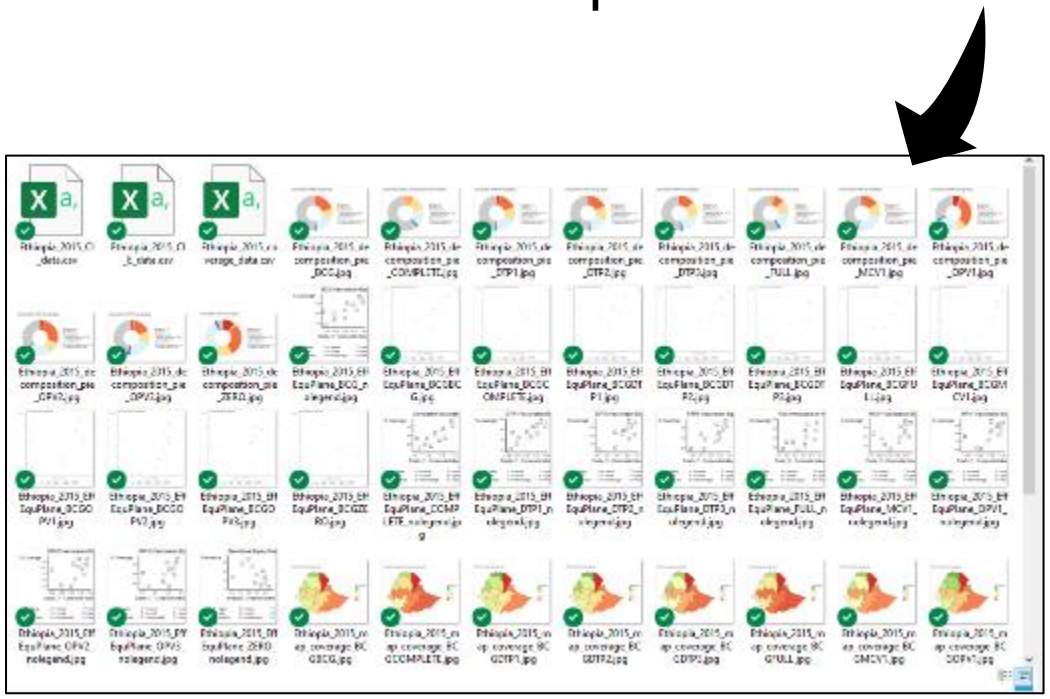
IVAC

VERSE Equity Tool outputs

The program generates several results at the national and subnational (e.g., state or district) levels. Key results are exported in CSV (data) and JPEG (image) files and can be accessed in your **working directory**.

You can examine the data, maps and figures and use the interpretation guide presented later in this section.

Next, we will introduce the different metrics and review the results as they appear in R-Studio.



VERSE Equity Tool outputs

Otherwise, a more comprehensive set of results can be called to the R Console by typing `results$` and selecting the desired result from the dropdown list that appears.

`results$`**`CI_Results`**

`results$`**`CI_E_GEO_BCG`**

Efficiency or equity metric (presented next)
E.g., **`CI_`** = Concentration Index
`CI_E_` = Concentration Index with Erreyger's correction

Results specification (presented later)
E.g., **`Results`** = Equity metric for each specified vaccines and health outcomes at the national level
`GEO_BCG` = Equity metric for BCG at the subnational level (for each state/district)

Available results

The following slides will showcase each metric generated by the program:

- Efficiency metric
  - Vaccine coverage and health outcome prevalence
- Equity metrics
  - Concentration indices (without and with Erreyger's correction) (CI and CI_E)
  - Absolute Equity Gap (AEG)
  - Relative Equity Gap (REG)
  - Slope Index of Inequity (SII)
  - Relative Index of Inequity (RII)

Efficiency metric

In the DHS data analysis, the VERSE tool generates an “efficiency” metric, which allows users to judge how well is the national immunization program performing at the subnational level and for each vaccine or health outcome.

The efficiency metric is interpreted slightly differently when it is for a vaccine or a health outcome:

Vaccine coverage shows the proportion of children who received a specific vaccine (*e.g.*, BCG, OPV1, ROTA2).

Health outcome prevalence shows the proportion of children affected or benefiting from a specific health outcome (*e.g.*, being “zero-dose” or “fully immunized for age”)

Call coverage values: `results$Coverage_Results`

Equity metric: CI and CI_E

The Concentration Index denotes whether the vaccine coverage benefits most more privileged households (positive value) or disadvantaged households (negative).

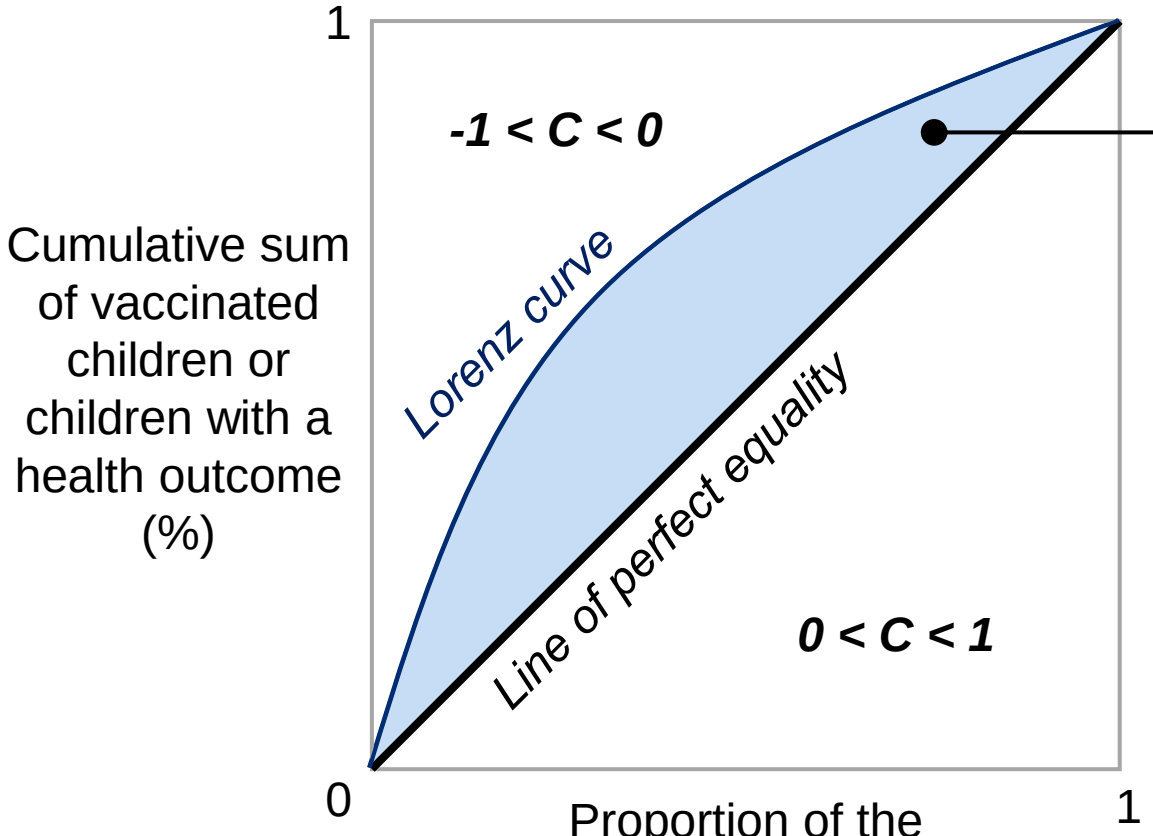
The concentration index increases significantly when the specified vaccine or health outcome is mostly prevalence among the extremes (most disadvantaged/privileged). For instance, we noted that the “zero-dose” outcome in countries where few children have this status, was mostly present in the most disadvantaged group, hence producing a significant CI. In such case, reviewing the AEG metric may provide better insights.

The Concentration Index with Erreyger’s correction is interpreted in the same way and is less sensitive to the issue noted above.

Call CI and CI_E values, respectively: `results$CI_Results` and `results$CI_E_Results`

*Larger CI and CIE mean that the distribution of vaccines is **less** equitable.*

Equity metric: CI and CI_E



Area between the Lorenz curve and line of perfect equality is the concentration index:

$$C = \frac{2}{\mu} cov(h, r)$$

Where μ is the average benefit across wealth ranks, *cov(h,r)* the covariance between the vaccination coverage or health outcome (*h*) and the relative privilege rank (*r*).

C = 0, perfect equality

0 < C < 1, most of the vaccination coverage or health outcome is **allocated to the more privileged households**

-1 < C < 0, most of it is **allocated to the more disadvantaged households**

Equity metric: AEG

The Absolute Equity Gap quantifies the difference in vaccine coverage between the 20% most privileged ($group_P$) and the 20% most disadvantaged households ($group_D$).

$$AEG = Outcome(group_P) - Outcome(group_D)$$

Call AEG values: `results$AEG_Composite_Results`

*A larger AEG means that the distribution of vaccines is **less** equitable between the most disadvantaged and most privileged groups.*

Equity metric: REG

The Relative Equity Gap quantifies the relative difference in vaccine coverage between two groups. Those two groups are defined based on one of the following binary unfair factors of inequity: health insurance, sex of the child, whether in a rural area.

$$REG = \frac{Outcome(group_P)}{Outcome(group_D)}$$

Call REG values: `results$REG_Insurance_Results`

Note that for REG, the result specification must include one of the following (binary) unfair factors of inequity: health insurance, sex of the child, whether in a rural area.

*A larger REG means that the distribution of vaccines is **less** equitable between the most disadvantaged and most privileged groups.*

Equity metric: SII

The SII represents the absolute difference in estimated values of a health indicator between the 20% most advantaged ($group_P$) and 20% most disadvantaged households ($group_D$), while accounting for other subgroups.

$$SII = v(group_P) - v(group_D)$$

Call SII values: `results$SII_Region_Results`

Note that for SII, the result specification must include one of the following (categorical) unfair factors of inequity: region, socioeconomic status and maternal education.

*A larger SII means that the distribution of vaccines is **less** equitable between the most disadvantaged and most privileged groups.*

Equity metric: RII

The RII represents the relative difference in estimated values of a health indicator between the 20% most advantaged ($group_P$) and 20% most disadvantaged households ($group_D$), while accounting for other subgroups.

$$RII = \frac{v(group_P)}{v(group_D)}$$

Call RII values: `results$RII_Region_Results`

Note that for RII, the result specification must include one of the following (categorical) unfair factors of inequity: region, socioeconomic status and maternal education.

*A larger RII means that the distribution of vaccines is **less** equitable between the most disadvantaged and most privileged groups.*

Results specification

After selecting the efficiency or equity metric, you must specify whether you want the metric for:

- Subnational level comparison (*vs. national level*)
- A specific unfair factor of variation (*isolated vs. combined factors*): region, urban/rural residence, sex of the child, maternal education, socioeconomic status, and health insurance
- A specific vaccine or health outcome

The next slides show the range of possibilities for each metric.

Results specification: coverage

[VACCINES] should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	`results$Coverage_Results`	`results$Coverage_Results_GEO_[VACCINES]`
Isolated factors	N/A	N/A

Results are presented by **[VACCINES]** at the national level.

Results are presented by subnational region (**GEO**) and **[VACCINES]** must be specified.

Results specification: CI and CI_E

[VACCINES] should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	results$CI_Results results$CI_E_Results	results$CI_GEO_[VACCINES] results$CI_E_GEO_[VACCINES]
Isolated factors	results$CI_Wealth_Results results$CI_E_Wealth_Results	results$CI_Wealth_Results_GEO_[VACCINES] results$CI_E_Wealth_Results_GEO_[VACCINES]

Results are presented by [VACCINES] at the national level.

Results are presented by subnational region (GEO) and [VACCINES] must be specified.

Results specification: AEG

[VACCINES] should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	results$AEG_**Composite_Results**	N/A
Isolated factors	results$AEG_**Insurance_Results** results$AEG_**Rural_Results** results$AEG_**Sex_Results**	results$AEG_**Insurance_Results_GEO_[VACCINES]** results$AEG_**Rural_Results_GEO_[VACCINES]** results$AEG_**Sex_Results_GEO_[VACCINES]**

Results are presented by **[VACCINES]** at the national level.

Results are presented by subnational region (**GEO**) and **[VACCINES]** must be specified.

Results specification: REG

[VACCINES] should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	N/A	N/A
Isolated factors	results$REG_**Insurance_Results** results$REG_**Rural_Results** results$REG_**Sex_Results**	results$REG_**Insurance_Results_GEO_[VACCINES]** results$REG_**Rural_Results_GEO_[VACCINES]** results$REG_**Sex_Results_GEO_[VACCINES]**

Results are presented by **[VACCINES]** at the national level.

Results are presented by subnational region (**GEO**) and **[VACCINES]** must be specified.

Results specification: SII

`[VACCINES]` should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	N/A	N/A

Isolated factors	`results$SII_Education_Results`
	`results$SII_Region_Results`
	`results$SII_Wealth_Results`
		`results$SII_Education_Results_GEO_[VACCINES]`
		`results$SII_Region_Results_GEO_[VACCINES]`
		`results$SII_Wealth_Results_GEO_[VACCINES]`

Results are presented by `[VACCINES]` at the national level.

Results are presented by subnational region (`GEO`) and `[VACCINES]` must be specified.

Results specification: RII

`[VACCINES]` should be replaced by a vaccine selected from the vaccine input list.

	National level	Subnational level
Combined factors	N/A	N/A

Isolated factors	`results$RII_Education_Results`
	`results$RII_Region_Results`
	`results$RII_Wealth_Results`
		`results$RII_Education_Results_GEO_[VACCINES]`
		`results$RII_Region_Results_GEO_[VACCINES]`
		`results$RII_Wealth_Results_GEO_[VACCINES]`

Results are presented by `[VACCINES]` at the national level.

Results are presented by subnational region (`GEO`) and `[VACCINES]` must be specified.

Exercise #1 (in R-Studio)

In R-Studio, after running the program successfully for Uganda (2016), call the results to generate the following metrics:

a) What is the vaccine coverage level for DTP1 at the national level?

b) What is the concentration index for DTP1 at the national level?

c) What is the concentration index associated with socioeconomic status only for DTP1 at the national level?

d) Fill the table below with national level estimates. Is the distribution of DTP1 **less equitable** than the distribution of children fully immunized for age?

Vaccines	**Coverage (%)**	**Concentration index (without Erreyger's correction)**	**Absolute Equity Gap**
DTP1			
FULL			
COMPLETE			

5. Interpret the results

Interpret the metrics, figures and graphs generated by the tool.

Interpreting the VERSE metrics

The interpretation of the different efficiency and equity metrics is **standardized**. If you used them before, the only change to their interpretation is that we compare more disadvantaged and more privileged households (rather than poorer and wealthier).

Next, we will show an example on how to interpret them and propose two exercises.

Afterward, we will discuss the interpretation of the graphical outputs.

Interpreting the VERSE metrics

The following table summarizes the estimates for Ethiopia (2015) for DTP1 and MCV1 at the national level. We selected urban/rural residence as factor* for REG, and region for SII and RII.

VERSE metric	**Metrics values**			**Interpretation** (nationally)
	DTP1	MCV1	Factor*	
Coverage (%)	69.6%	54.5%		DTP1 coverage is greater than MCV1 coverage.
CI	0.185	0.218		Both DTP1 and MCV1 are unequally distributed.
CI_E	0.481	0.358		Both DTP1 and MCV1 are unequally distributed.
AEG	0.464	0.337		DTP1 and MCV1 coverage is 46.4% and 33.7% lower, respectively, in the group of 20% most disadvantaged compared to the group of 20% most privileged.
REG	1.388	1.491	Rural	Residents of urban areas had a vaccine coverage for DTP1 and MCV1 respectively 1.39 and 1.49 times higher than residents of rural areas.

Interpreting the VERSE metrics

The following table summarizes the estimates for Ethiopia (2015) for DTP1 and MCV1 at the national level. We selected urban/rural residence as factor* for REG, and region for SII and RII.

VERSE metric	**Metrics values**			**Interpretation** (nationally)
	DTP1	MCV1	Factor*	
SII	0.292	0.178	Maternal education	The difference between coverage in the 20% households with the highest level of maternal education and 20% with the lowest level is 29.2% for DTP1 and 17.8% for MCV1, adjusting for the distribution of coverage over all regions.
RII	1.881	2.147	Wealth	The wealthiest 20% households have absolute value (|1-1.881|)*100 percent (i.e., 88.1%) more DTP1 coverage than the poorest 20% households, adjusting for the distribution of coverage over all regions.

Exercise #2

Report your results from Exercise #1 in the table below.

Interpret the results generated in Exercise #1 for Uganda (2016) and answer the following questions or requests:

a) Compare the prevalence of FULL and COMPLETE.
b) What does the CI say about DTP1, FULL and COMPLETE?
c) What does the AEG say about children fully immunized for age ("FULL")?
d) Is DTP1 more equitable than all other vaccines grouped together?

Vaccines	Coverage (%)	Concentration index (without Erreyger's correction)	Absolute Equity Gap
DTP1	92.6%	0.020	0.106
FULL	43.4%	0.108	0.208
COMPLETE	45.7%	0.120	0.257

Exercise #3

Table 1: National-level coverage and equity metrics for India (2015)

Vaccine or health outcome [1]	Proportion of the population covered by the vaccine or outcome	Concentration index		Absolute Equity Gap
		Base	Erreyger [2]	
	Coverage_Results	*CI_Results*	*CI_E_Results*	*AEG_Composite_Results*
BCG	89.5%	0.052	0.183	0.194
DTP1	86.1%	0.058	0.193	0.226
DTP2	81.8%	0.072	0.224	0.265
DTP3	74.6%	0.099	0.273	0.322
OPV1	87.2%	0.045	0.154	0.172
OPV2	82.0%	0.059	0.184	0.221
OPV3	67.4%	0.089	0.226	0.282
MCV1	81.7%	0.075	0.203	0.232
ZERO	7.9%	0.404	0.115	0.12
FULL	54.1%	0.140	0.298	0.371
COMPLETE	57.6%	0.144	0.330	0.41

Notes: [1] ZERO, the child didn't receive any vaccine; FULL, the child is fully immunized for their age; COMPLETE, the child is above 24 months and completed the routine pediatric immunization schedule.
[2] See reference for details on the Erreyger's correction.

Using the results generated for India in 2015, answer the questions:

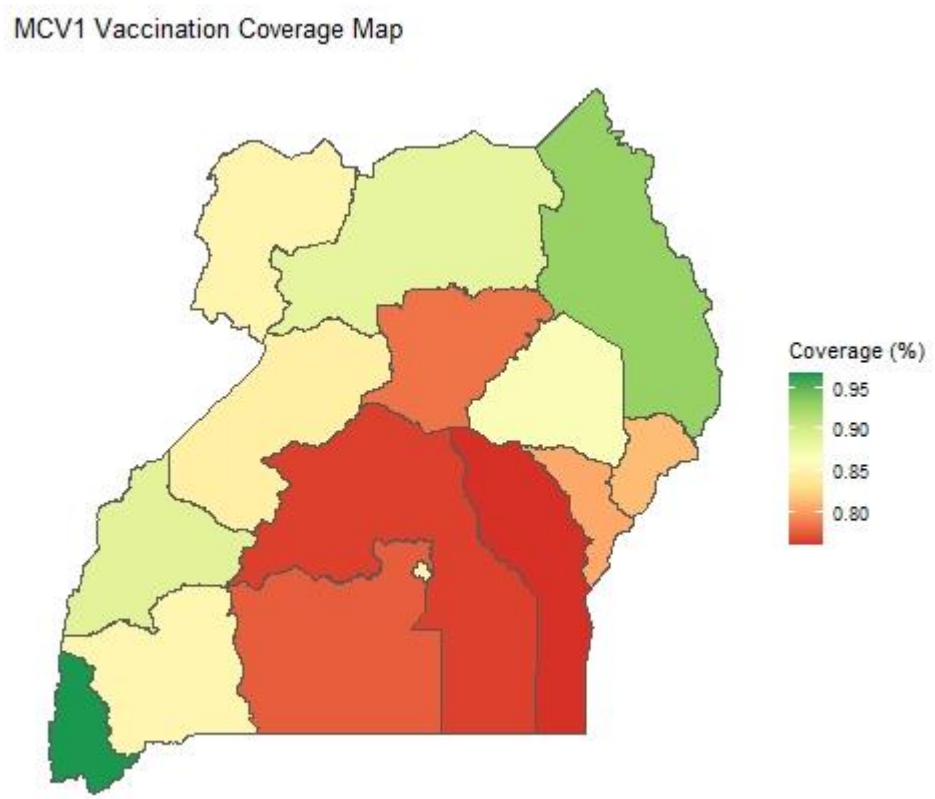
a) What proportion of children received the 2nd dose of DTP vaccine in India?

b) Compare the vaccine coverage and equity between DTP1-3 and OPV1-3 (all three doses for both).

c) Are most children receiving all their scheduled vaccines on time?

d) Which vaccine presents the largest gap between the most disadvantaged and most privileged households in India?

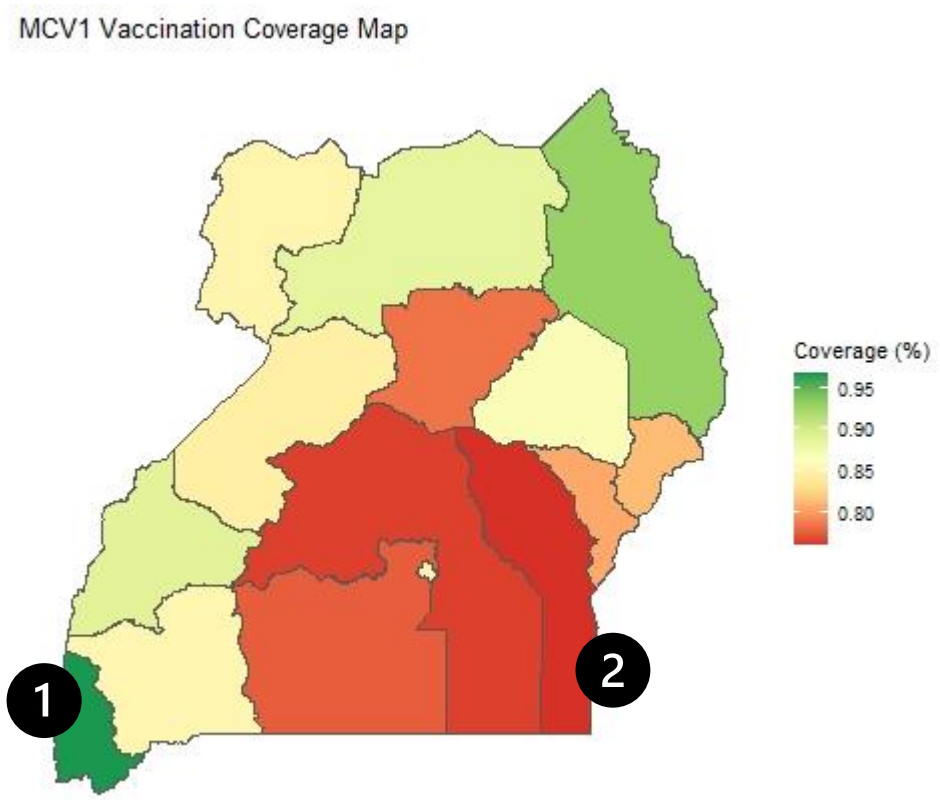
Interpreting maps: Coverage Map



The coverage map showcases the coverage rate for the selected vaccine or health outcome at the subnational level based on the DHS data.

The color scale is anchored to 1 as maximum value and adjusts automatically the minimum value to what is observed for the country for the selected vaccine. It means that **the reader must pay close attention to the scale** before interpreting orange- and red-colored regions. This is meant to appropriately contrasts regions with the highest and lowest coverages.

Interpreting maps: Coverage Map

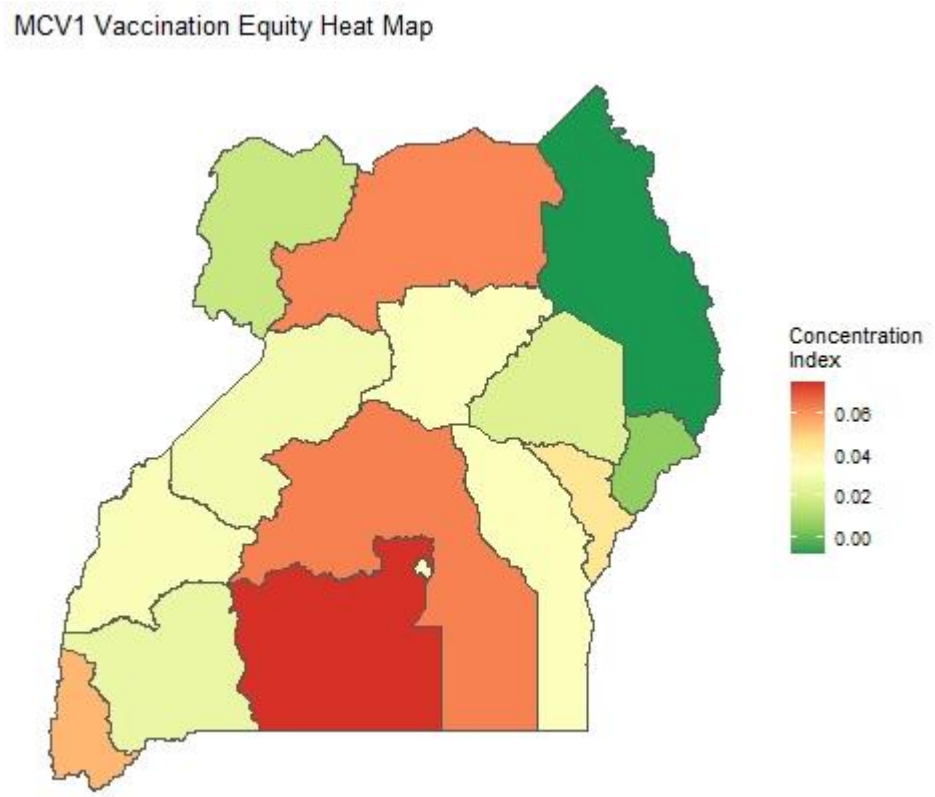


What the map says:

- The Northern and Western regions of Uganda have the highest coverage for the first dose of measles containing vaccine (MCV1).
- The Central and Eastern regions have the lowest coverage.

1) Kigezi region has the highest coverage.
2) Busoga region has the lowest coverage.

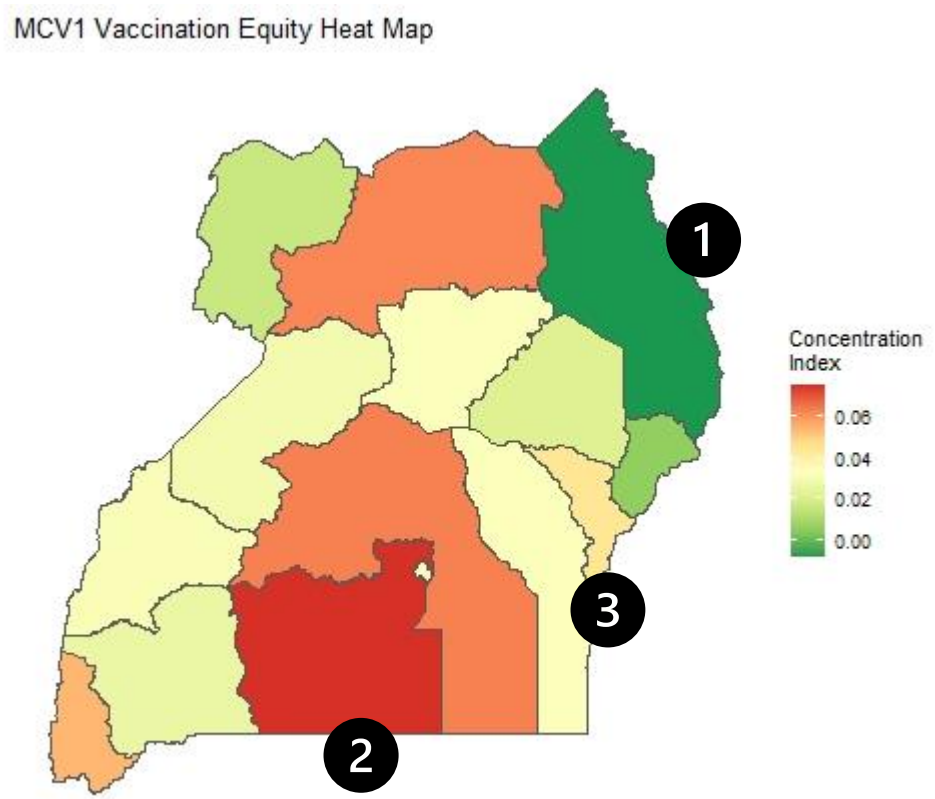
Interpreting maps: Equity Heat Map



The equity heat map presents the concentration index for the selected vaccine or health outcome at the subnational level based on the DHS data.

The color scale is anchored to 0 as minimum value and adjusts automatically the maximum value to what is observed for the country for the selected vaccine. It means that **the reader must pay close attention to the scale** before interpreting orange- and red-colored regions. This is meant to appropriately contrasts regions with the highest and lowest CI.

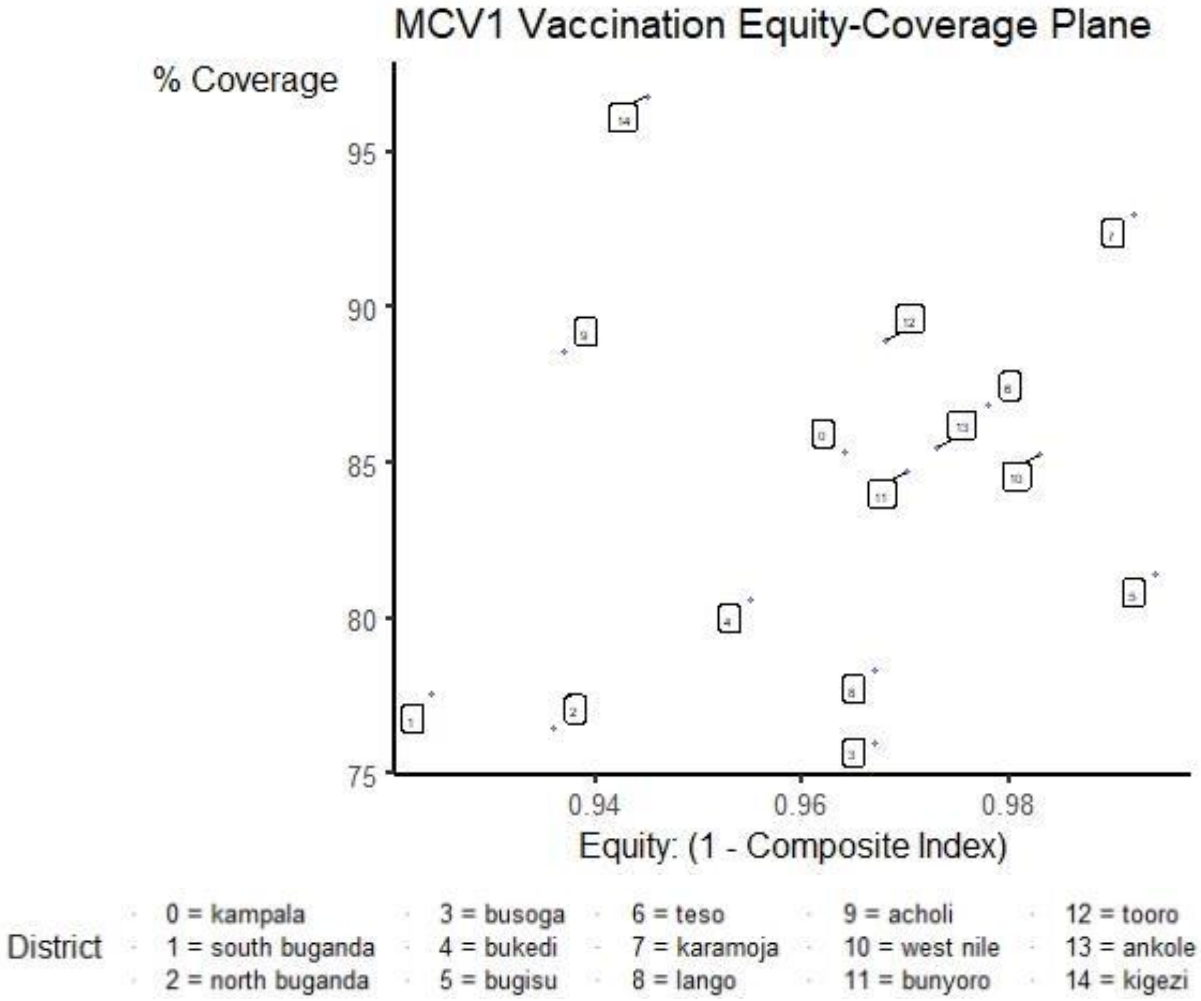
Interpreting maps: Equity Heat Map



What the map says:

1) The first dose of a measles containing vaccine (MCV1) is equitably distributed in Karamoja region in the Northern region.
2) The South Buganda/Central region (in the Central region) has the least equitable distribution of MCV1.
3) Despite lower coverage [*showed in the Coverage map*], the Eastern region has relatively equitable MCV1 coverage.

Interpreting the Equity-Coverage Plane



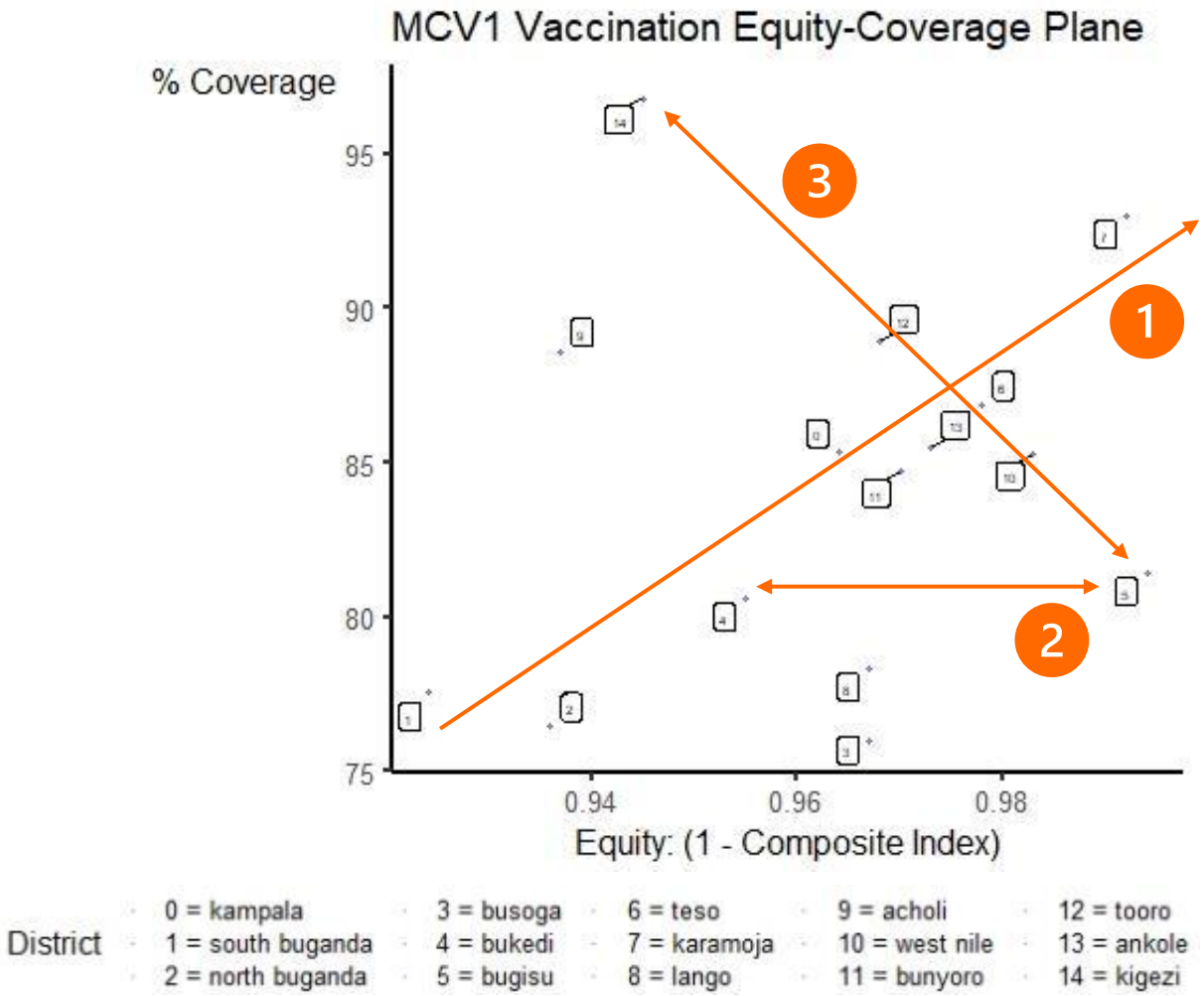
The equity-coverage plane draws the coverage against a measure the equity (1 – CI) for the selected vaccine or health outcome by region.

It enables the reader to visualize the potential tradeoff between

A. Increasing vaccine coverage or health outcome prevalence
B. Improving how equitably vaccines are distributed

and compare the regions' performances. If this analysis was performed with earlier data, it allows for comparison across time.

Interpreting the Equity-Coverage Plane



Note the different scales for coverage and equity: the differences in level of equity for Uganda may not be significant for MCV1.

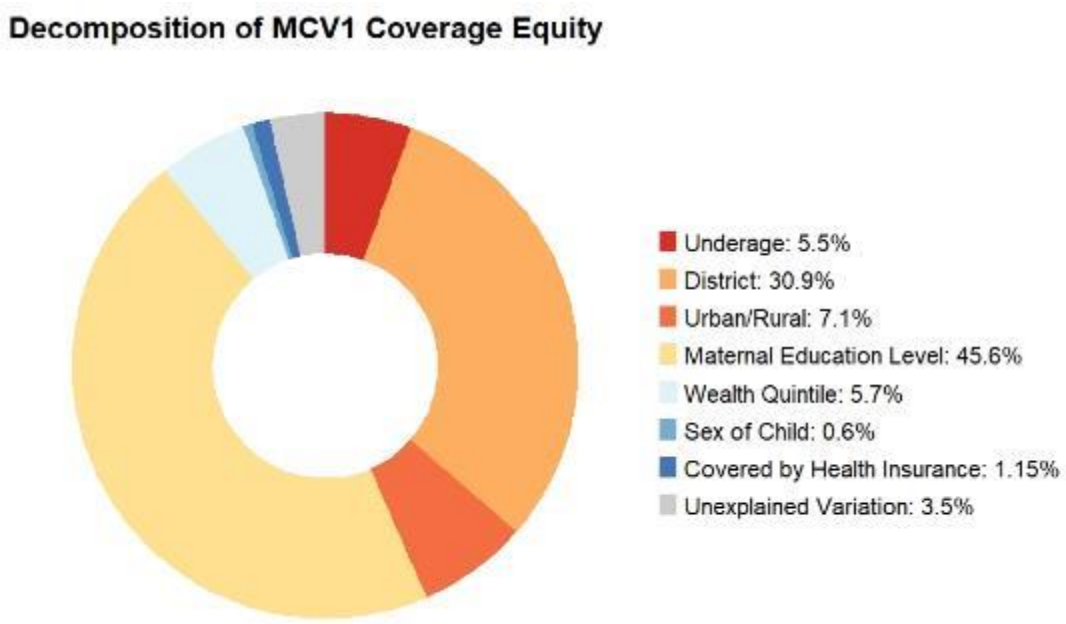
A few discussions points from the figure:

1) Generally, as MCV1 coverage increased, equity increased as well. South Buganda/Central (1) has low coverage and equity. Karamoja (7) has high coverage and equity.

2) Bugisu (5) and Bukedi (4) have the same MCV1 coverage but achieved different levels of equity.

3) Kigezi (14) has high coverage but lower level of equity and Bugisu (5) lower coverage but almost perfect equity.

Interpreting the Decomposition Pie Chart



The decomposition pie chart presents the contribution of different *fair* and *unfair* parameters to inequity for the selected vaccine or health outcome at the national level and what is left unexplained by them:

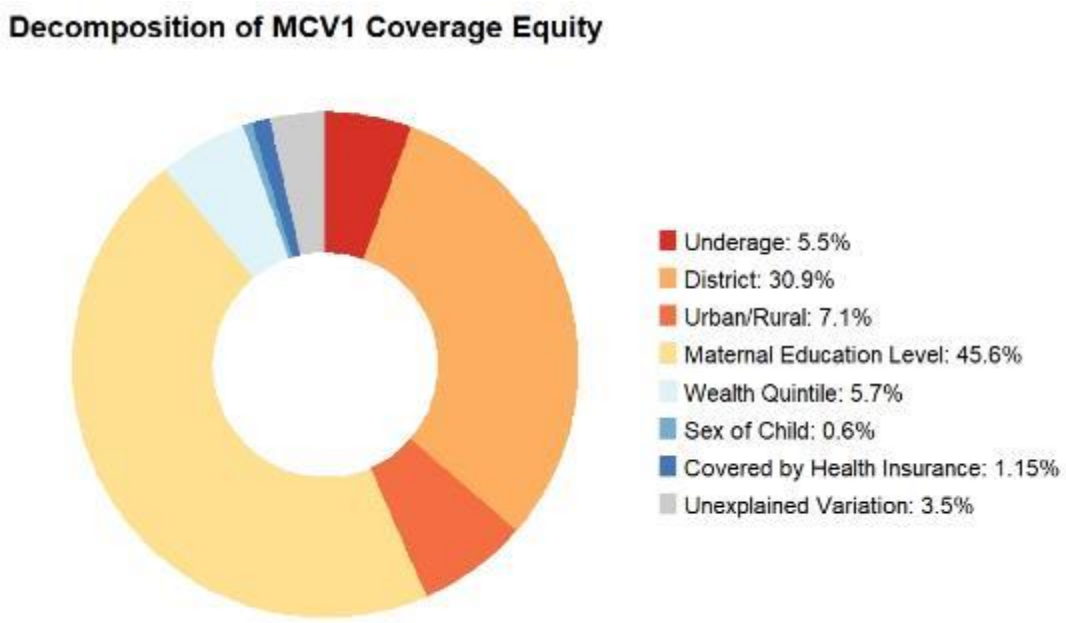
Fair factor of variation in vaccine status:

- Being **underaged** to receive the selected vaccine

Unfair factors of variation in vaccine status:

- Region (“**district**”) of residence
- Whether living in an **urban or rural** area
- Level of **maternal education**
- Socioeconomic status (as **wealth quintiles**)
- **Sex of the child**
- Whether the household is covered by health insurance (government or private)

Interpreting the Decomposition Pie Chart



What the figure says:

- A significant number of children weren't vaccinated for measles due to being underaged (5.5%)
- Living in different regions ("district") has a strong influence (30.9%) on MCV1 coverage, indicating possible supply constraints.
- Living in a rural area (compared to urban) also plays a significant role in MCV1 status (7.1%).
- The child's mother's education level is the dominant factor of the variation in measles vaccination status, first dose (45.6%).
- Poverty is also a significant factor of variation (5.7%).
- The sex of the child and whether the household had health insurance did not influence much the children's measles vaccination status.
- Only 3.5% of the variation in MCV1 coverage is left unexplained.

6. Translate to policym

Communicate your findings in c orts and academic publications.

UPCOMING

IVAC

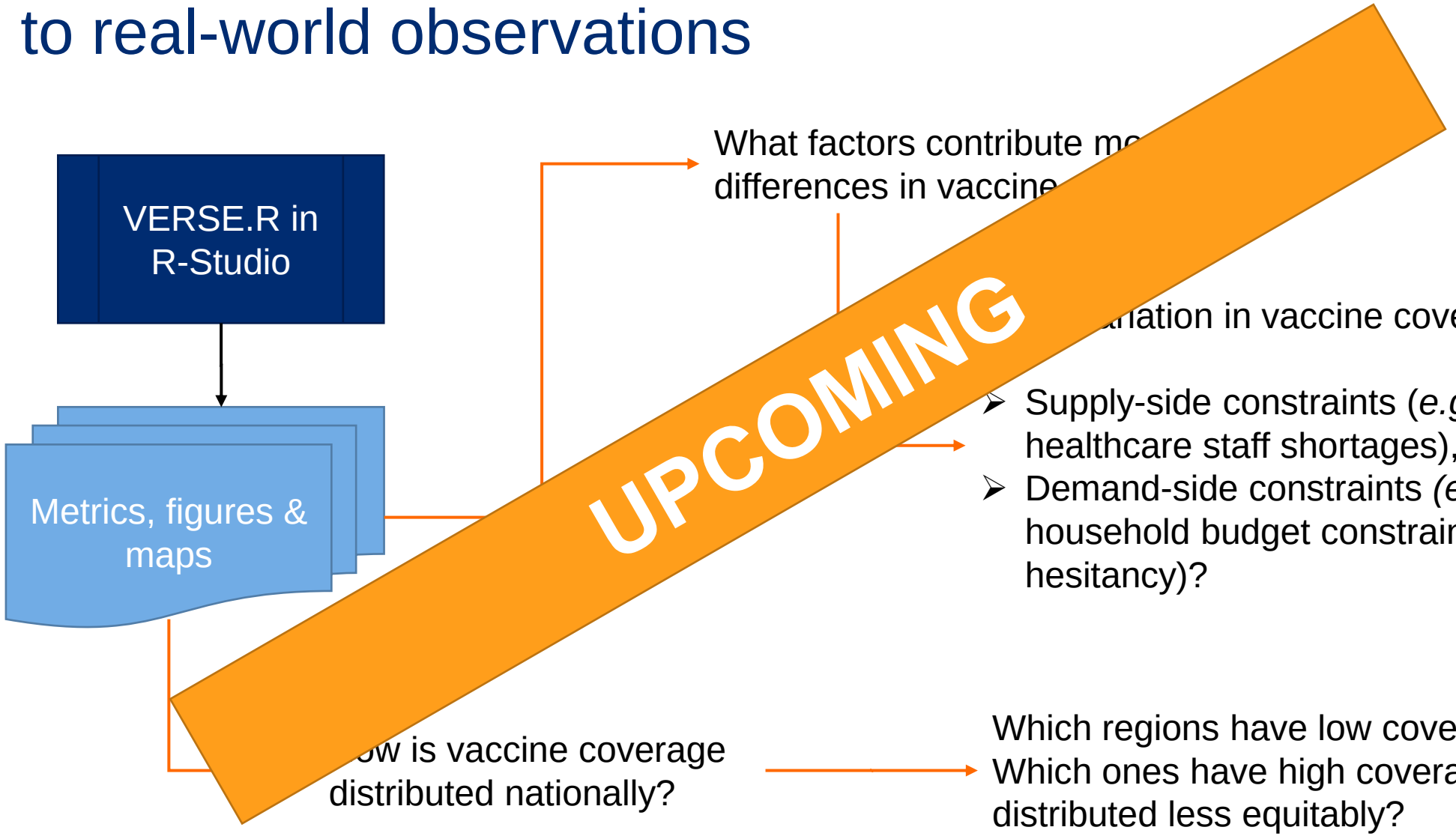
Translating to policymaking

The VERSE Equity Tool provides **quan** **easures** of efficiency (vaccine coverage or he me prevalence) and equity.

As such, these m ble us to **compare and rank** vaccines (ar utcomes), regions and factors to articula and **policy priorities**.

UPCOMING

Connecting the VERSE quantitative outputs to real-world observations



Reference to the VERSE Methodology

When sharing VERSE outputs, please provide the following article as reference:

Patenaude, Bryan; Odihi, Deborah; Sriudomporn, Salin; Mak, Joshua; Watts, Elizabeth; de Broucker, Gatien. *A Standardized Approach for Measuring Multi-Dimensional Equity in Vaccination Coverage, Cost-of-Illness, and Health Outcomes: Evidence from the Vaccine Economics Research for Sustainability & Equity (VERSE) Project* [Internet]. Rochester, NY: Social Science Research Network; 2021 Oct [cited 2022 Feb 25]. Report No.: ID 3945450. Available from: https://papers.ssrn.com/abstract=3945450