Household-level chlorine residual tests

```
library(stringr)
library(sf)
```

```
## Linking to GEOS 3.12.2, GDAL 3.9.3, PROJ 9.4.1; sf_use_s2() is TRUE
```

```
library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.4.3
```

```
## Warning: package 'ggplot2' was built under R version 4.4.3
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v purrr     1.0.2
## v forcats   1.0.0     v readr     2.1.5
## v ggplot2   3.5.2     v tibble    3.2.1
## v lubridate 1.9.3     v tidyr     1.3.1
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```
library(modelsummary)
```

```
## Warning: package 'modelsummary' was built under R version 4.4.3
```

```
library(fixest)
```

```
## Warning: package 'fixest' was built under R version 4.4.3
```

```
library(janitor)
```

```
##
## Attaching package: 'janitor'
##
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```
library(kableExtra)
```

```
##
## Attaching package: 'kableExtra'
##
## The following object is masked from 'package:dplyr':
##
##     group_rows
```

```
path_box <- file.path(Sys.getenv("BOX"), "i-h2o-takeup")
path_git <- file.path(Sys.getenv("GITHUB"), "i-h2o-takeup")
theme <-
  theme_minimal() +
  theme(
    strip.background = element_rect(
      fill = "gray90",
      color = "gray90"
    ),
```

```
    plot.title = element_text(hjust = 0.5),
    text = element_text(size = 11, family = "Times"),
    plot.caption = element_text(
      hjust = 0,
      size = 10,
      color = "gray40"
    ),
    legend.position = "bottom"
  )

knitr::opts_chunk$set(echo = FALSE, warning = FALSE, message = FALSE)
```

Prepare data

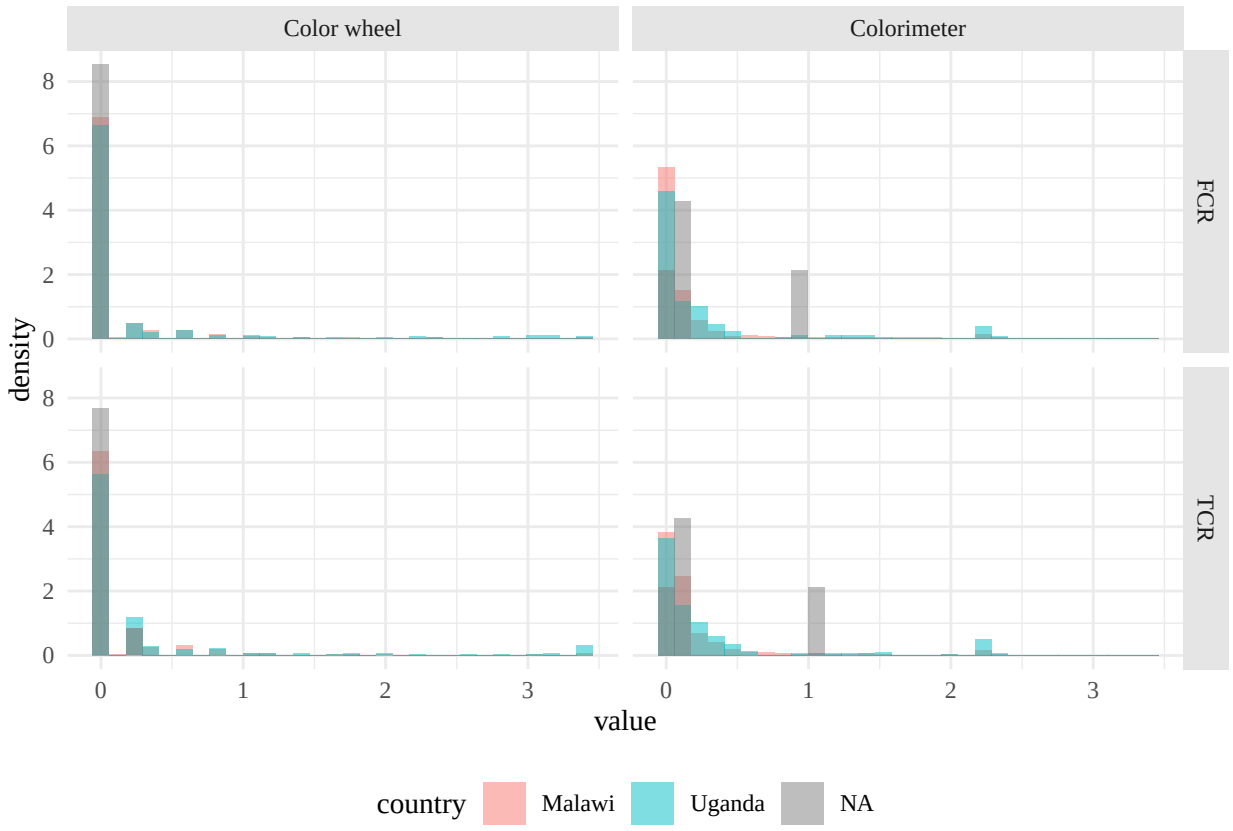
Number of observations

Survey	Households	Water points	Villages	Color wheel		Colorimeter	
				TCR	FCR	TCR	FCR
Malawi							
Household Survey	1967	400	99	1913	1914	867	862
Monitoring Survey	732	285	95	716	716	345	345
Uganda							
Household Survey	1209	182	60	1059	1058	225	225
Monitoring Survey	460	164	60	400	400	116	115
Unmatched							
NA	10	1	1	10	10	4	4

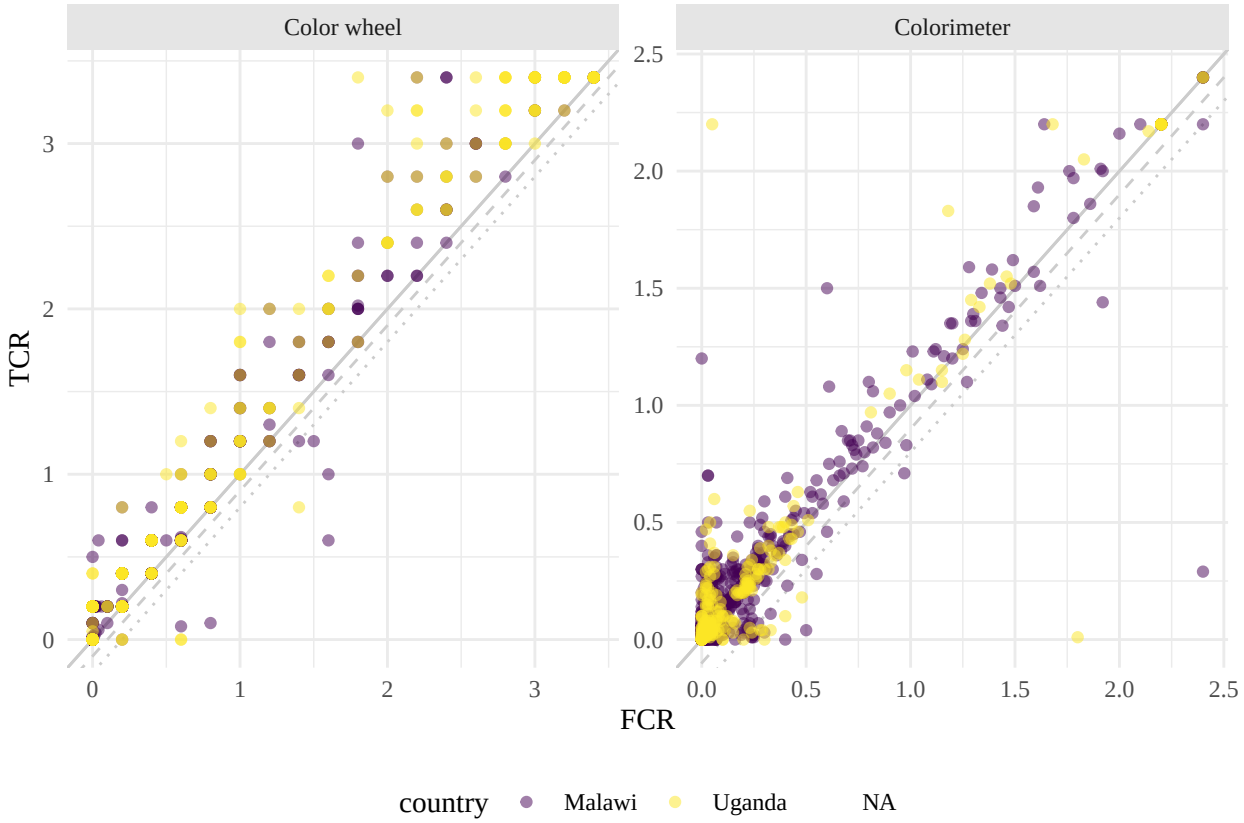
Descriptives

Distribution of readings

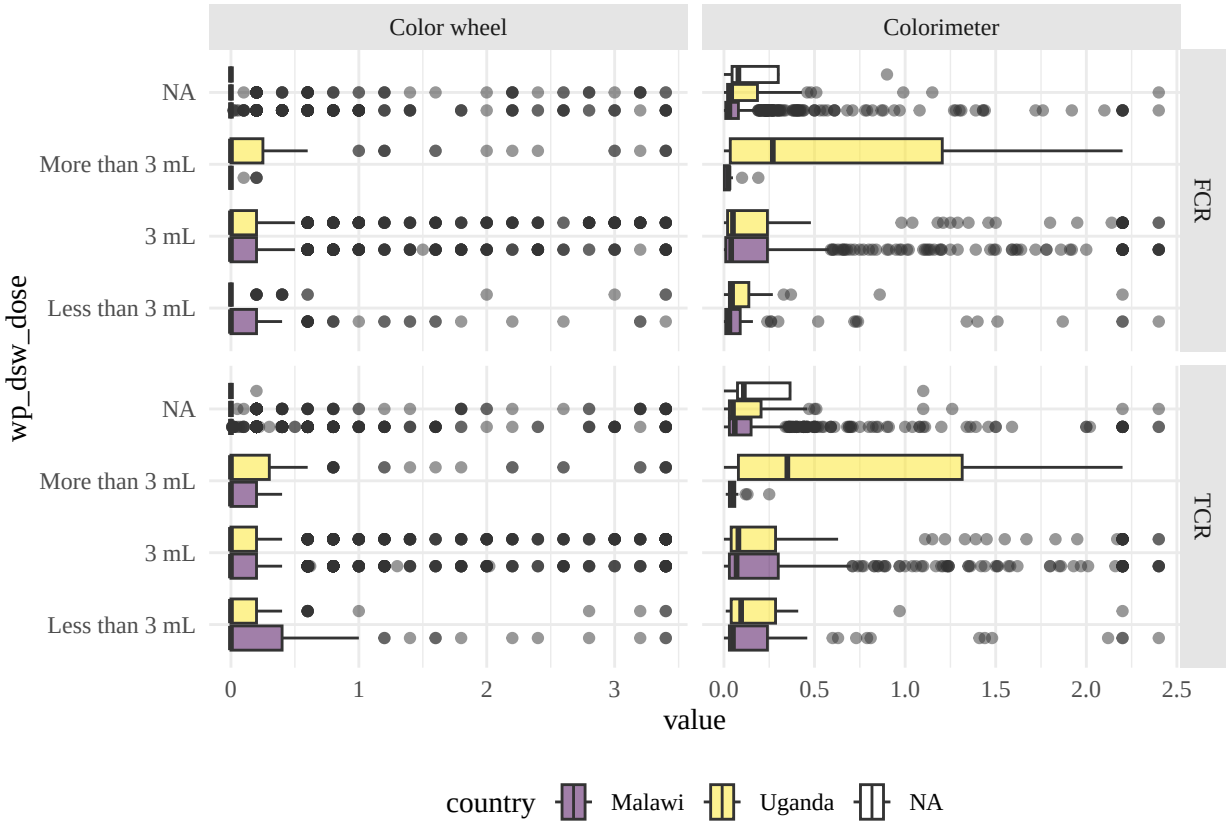
The maximum value in the color disc is 3.5, and in the colorimeter it's 2.2. When readings exceed 2.2, the colorimeter threw an error. These observations are replaced with 2.4.


Color wheel
Colorimeter
FCR
TCR
density
value
0
2
4
6
8
0
1
2
3
country
Malawi
Uganda
NA

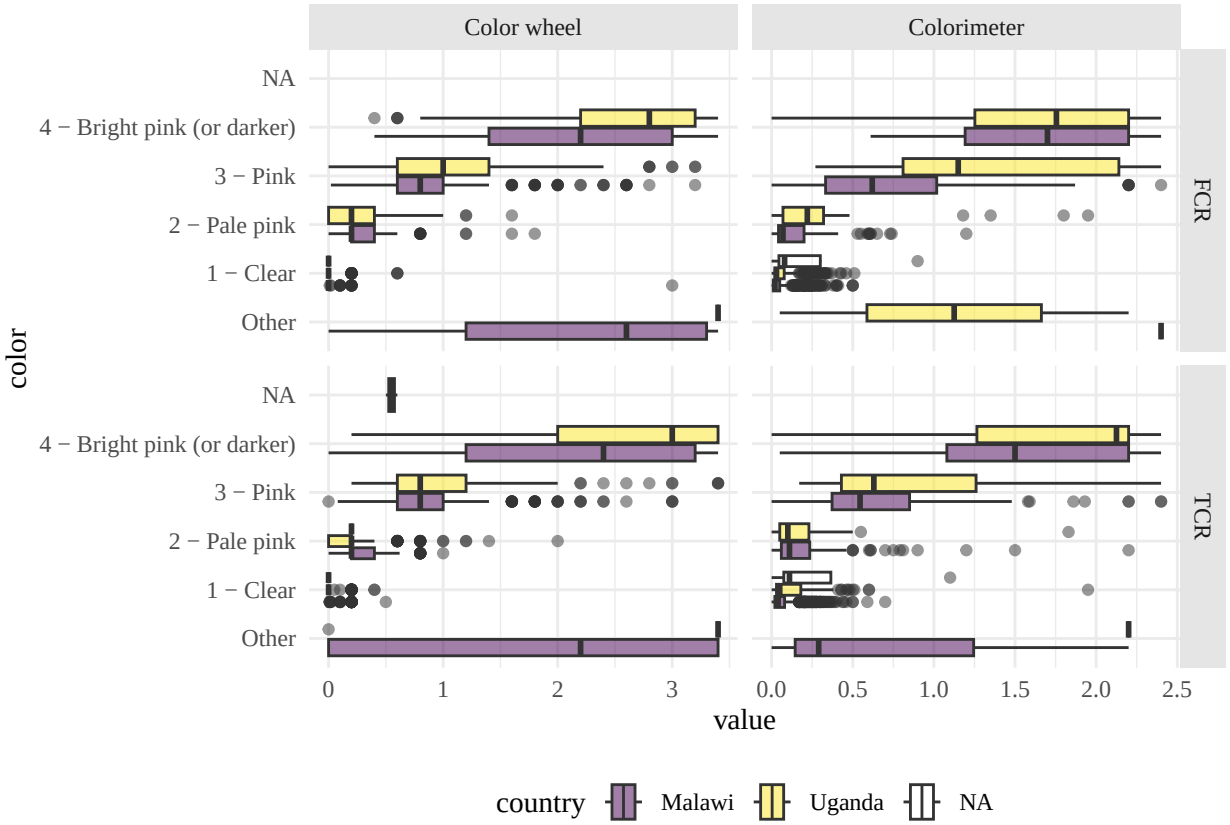
TCR and FCR readings



Dosage and chlorine residual

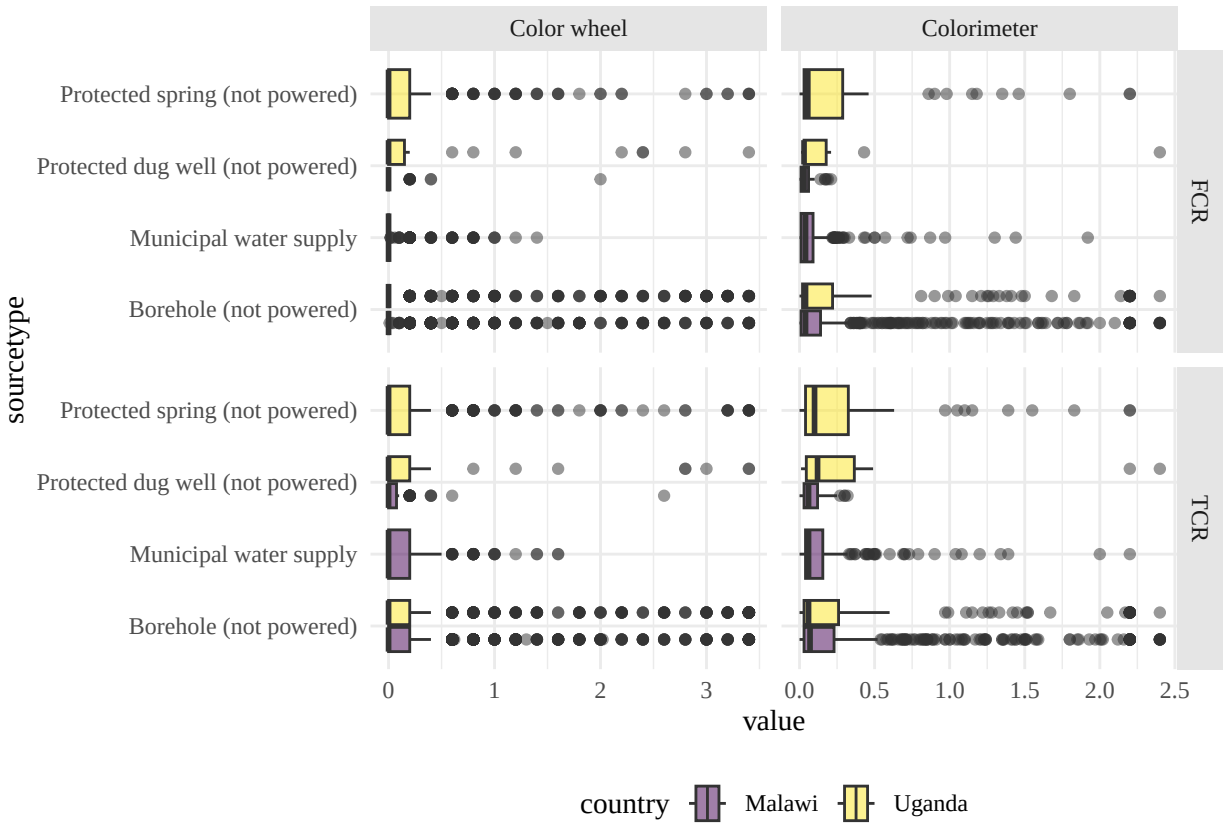


Reported color and chlorine residual



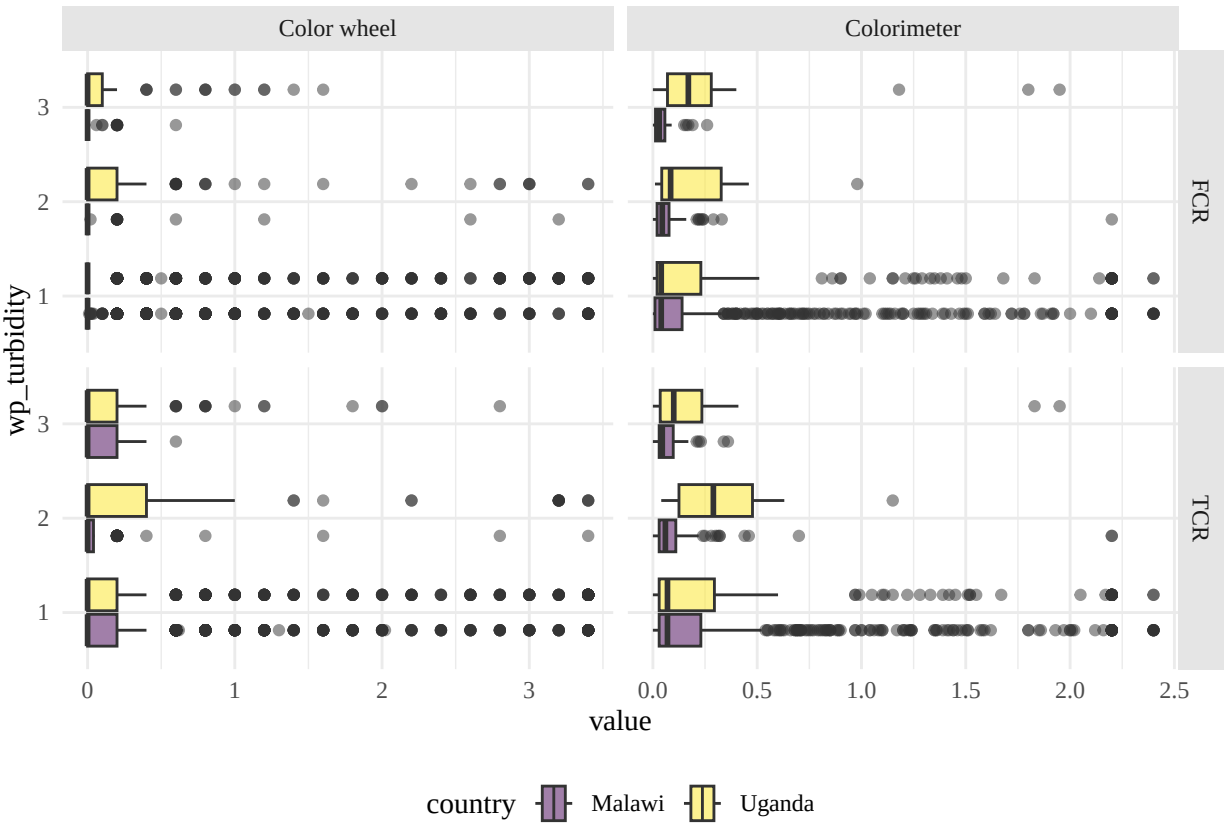
Reported source type and chlorine residual

	Malawi		Uganda	
Source type	Color wheel	Colorimeter	Color wheel	Colorimeter
Borehole (not powered)	1657	759	904	197
Municipal water supply	553	251	20	5
Protected spring (not powered)	8	7	350	86
Protected dug well (not powered)	82	42	46	11
Unprotected spring	46	18	27	5
Flowing water source	31	13	23	18
Standing water source	3	2	24	7
Other	23	9	NA	NA
Borehole (powered)	13	11	22	3
Unprotected dug well	17	10	2	0
Protected dug well (powered)	13	8	2	0



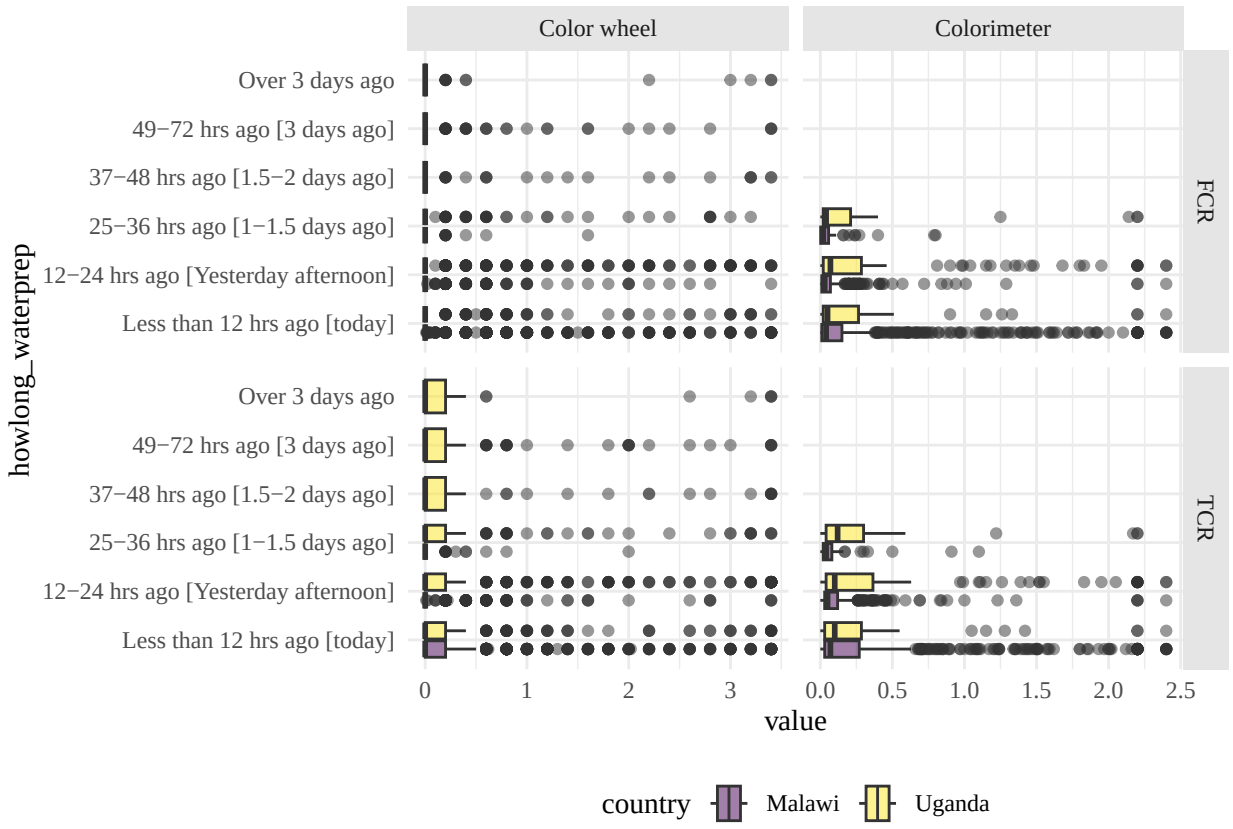
Turbity and chlorine residual

	Malawi		Uganda	
Turbidity	Color wheel	Colorimeter	Color wheel	Colorimeter
1	1862	870	1081	263
2	165	74	126	22
3	94	38	105	19
4	NA	NA	11	3



Time since chlorination

	Malawi		Uganda	
Source type	Color wheel	Colorimeter	Color wheel	Colorimeter
Less than 12 hrs ago [today]	1646	774	323	80
12-24 hrs ago [Yesterday afternoon]	848	369	613	135
25-36 hrs ago [1-1.5 days ago]	101	53	177	46
49-72 hrs ago [3 days ago]	7	4	146	37
37-48 hrs ago [1.5-2 days ago]	17	8	122	28
Over 3 days ago	8	4	75	15

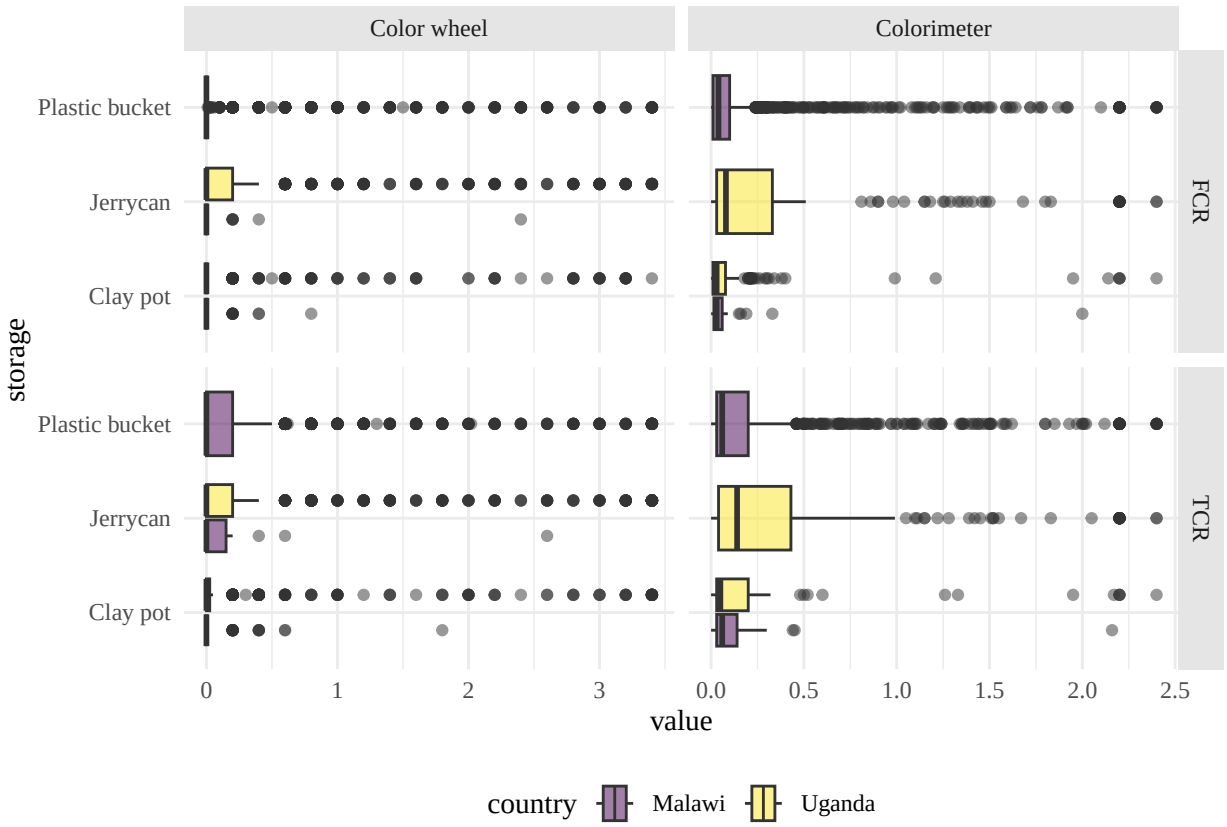

Color wheel
Colorimeter
FCR
TCR
howlong_waterprep
Over 3 days ago
49−72 hrs ago [3 days ago]
37−48 hrs ago [1.5−2 days ago]
25−36 hrs ago [1−1.5 days ago]
12−24 hrs ago [Yesterday afternoon]
Less than 12 hrs ago [today]
0
1
2
3
0.0
0.5
1.0
1.5
2.0
2.5
value
country
Malawi
Uganda

Source of tested water

	Malawi		Uganda	
Source type	Color wheel	Colorimeter	Color wheel	Colorimeter
From the water point primary water point (${wp_name_pl})	2398	1106	1270	294
From another water point inside the village	155	67	99	24
From another water point outside the village	53	24	42	11
Rainwater	1	1	33	9
Other (specify)	14	6	8	1
Piped water into the household	8	8	7	2

Storage

	Malawi		Uganda	
Source type	Color wheel	Colorimeter	Color wheel	Colorimeter
Plastic bucket	2454	1137	10	1
Jerrycan	34	16	823	208
Clay pot	101	43	615	130
Other plastic container	24	11	7	1
Dish/basin	6	2	NA	NA
Metal bucket	5	2	NA	NA
Bottle	2	0	NA	NA
Drum	1	0	NA	NA

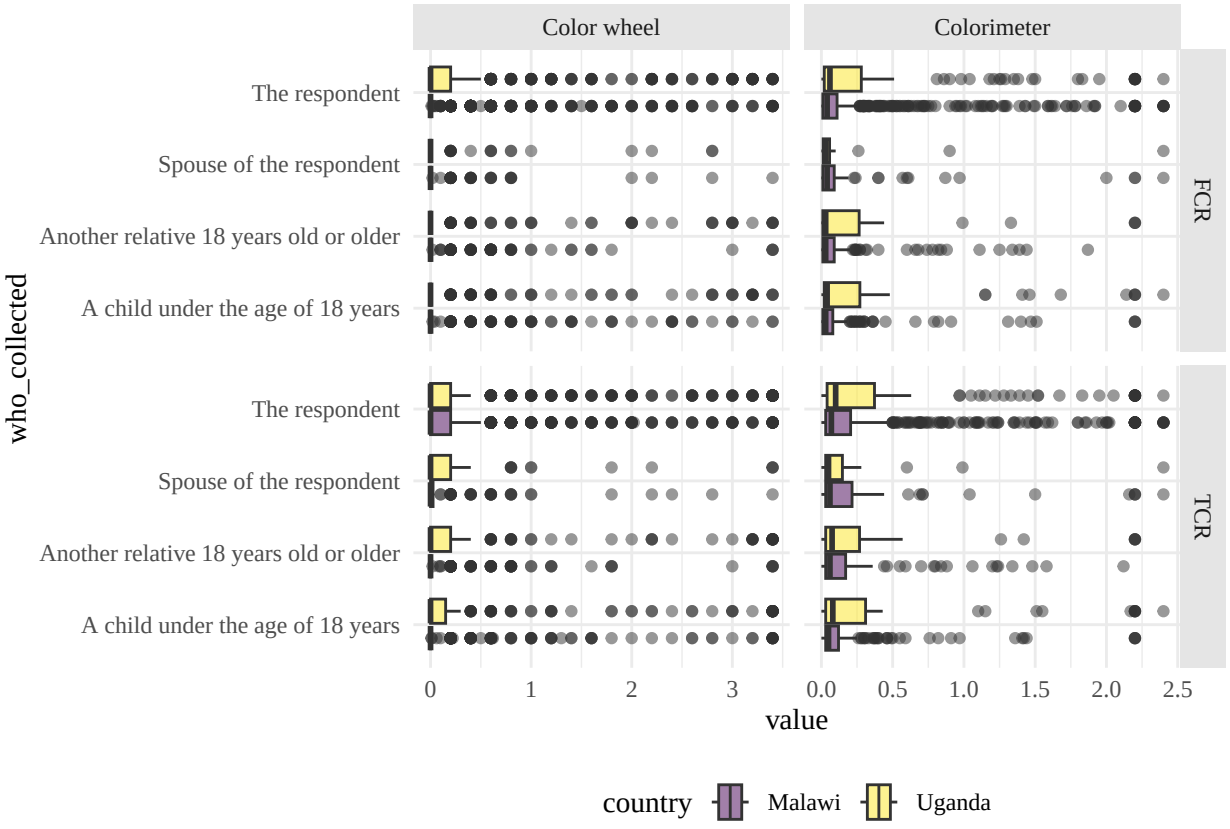


Water fetched by children

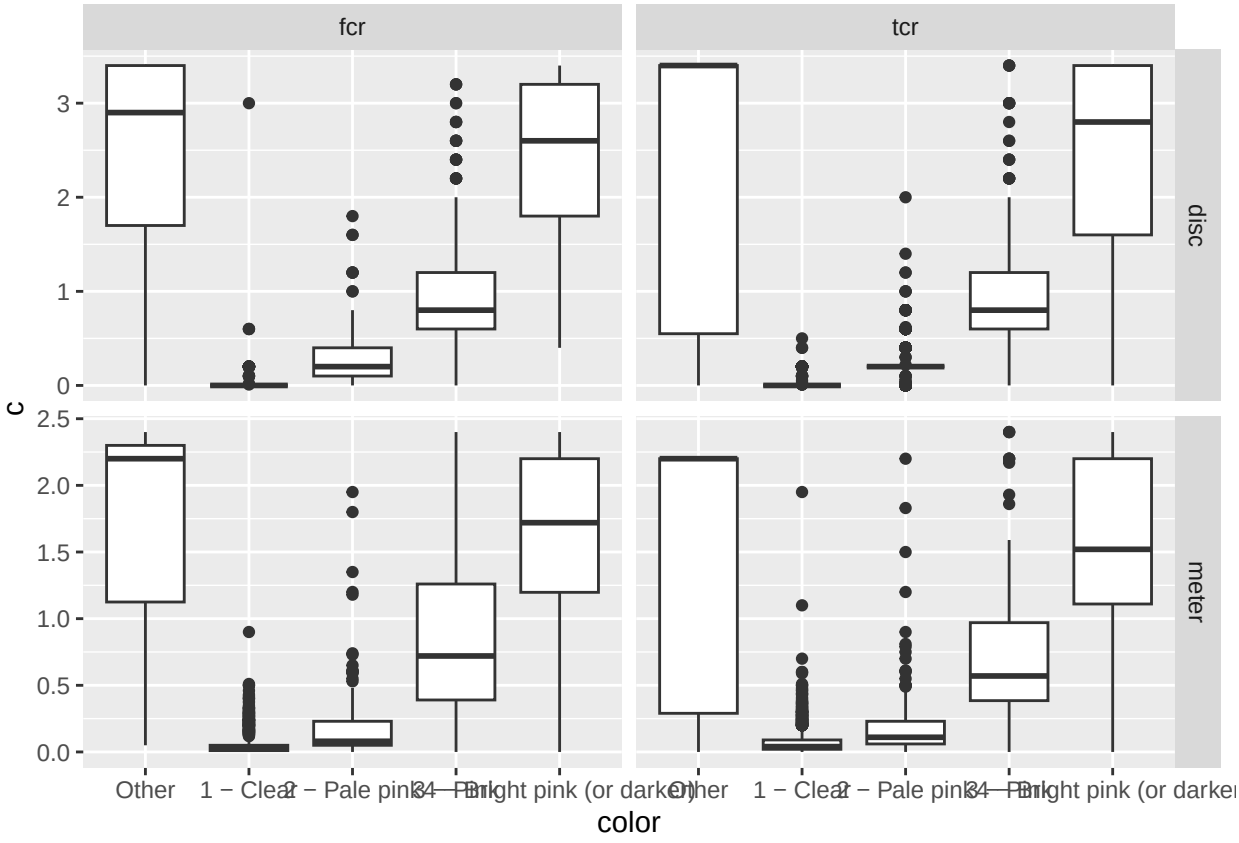
	Malawi		Uganda	
Source type	Color wheel	Colorimeter	Color wheel	Colorimeter
The respondent	1653	787	775	180
A child under the age of 18 years	469	189	375	77
Another relative 18 years old or older	360	163	198	48
Spouse of the respondent	140	72	94	26

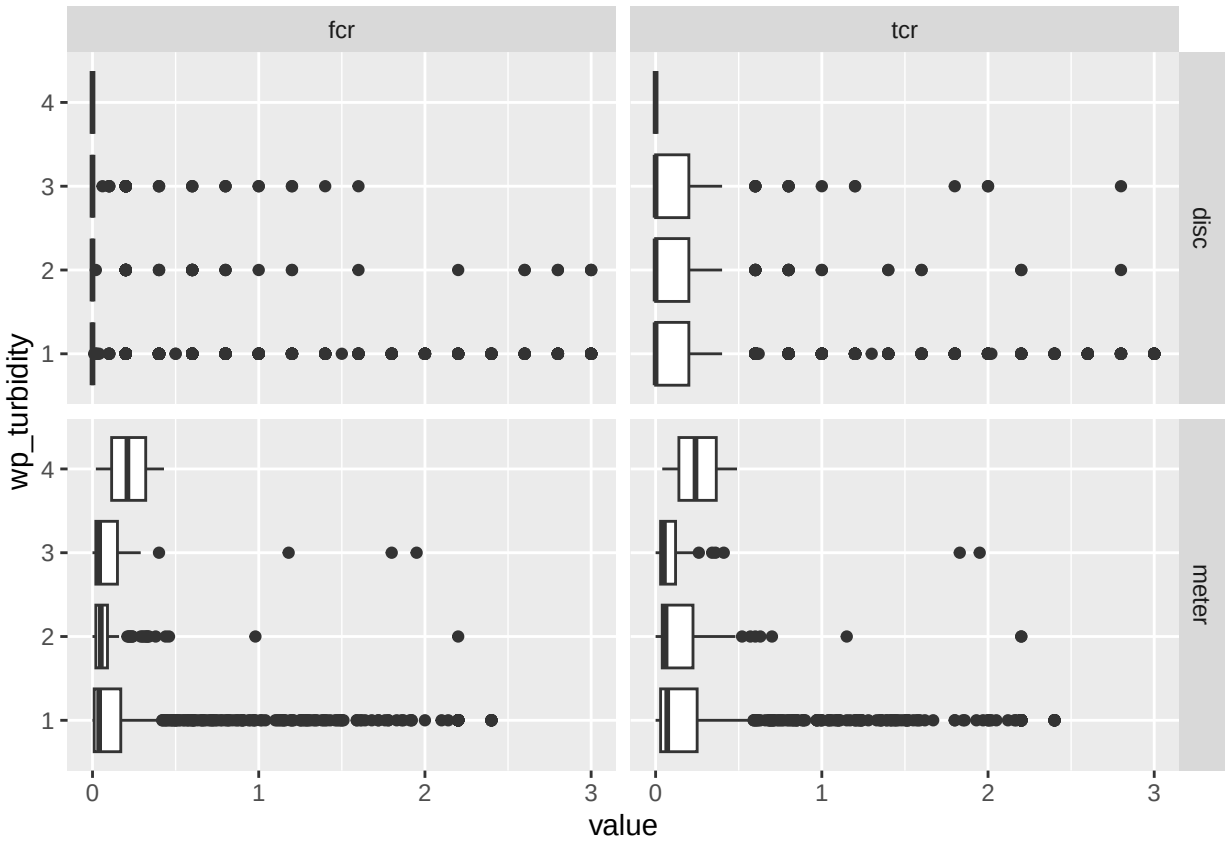
	Color wheel TCR	Color wheel FCR	Colorimeter TCR	Colorimeter FCR
(Intercept)	2.300***	2.343***	1.550***	1.378***
	(0.095)	(0.081)	(0.146)	(0.123)
color1 - Clear	−2.297***	−2.337***	−1.498***	−1.297***
	(0.095)	(0.081)	(0.147)	(0.123)
color2 - Pale pink	−2.037***	−2.109***	−1.370***	−1.199***
	(0.095)	(0.082)	(0.147)	(0.124)
color3 - Pink	−1.293***	−1.368***	−0.674***	−0.618***
	(0.096)	(0.083)	(0.148)	(0.126)
color4 - Bright pink (or darker)	0.082	0.106	0.086	0.206
	(0.097)	(0.083)	(0.149)	(0.126)
Num.Obs.	4098	4096	1551	1557
R2 Adj.	0.788	0.794	0.710	0.692

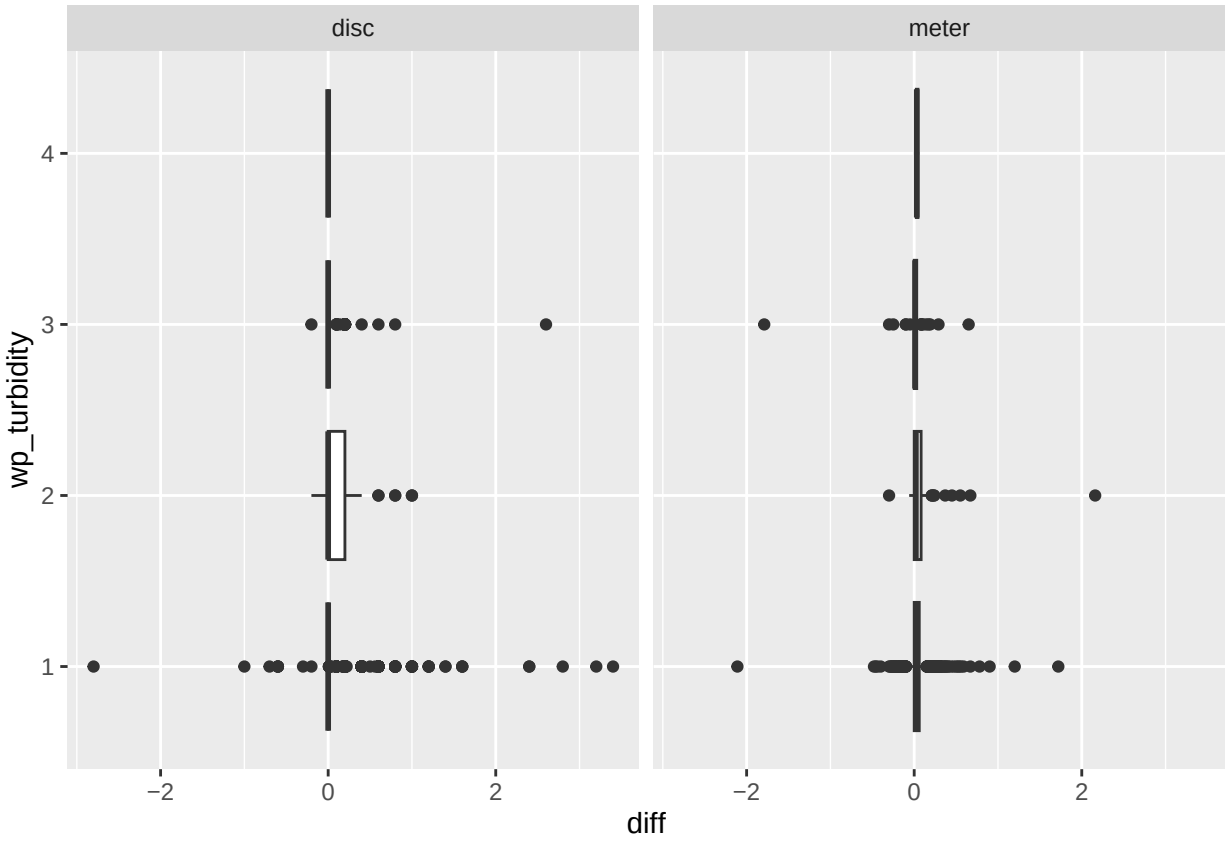
+ p <0.1, * p <0.05, ** p <0.01, *** p <0.001



Test wait time and chlorine residual



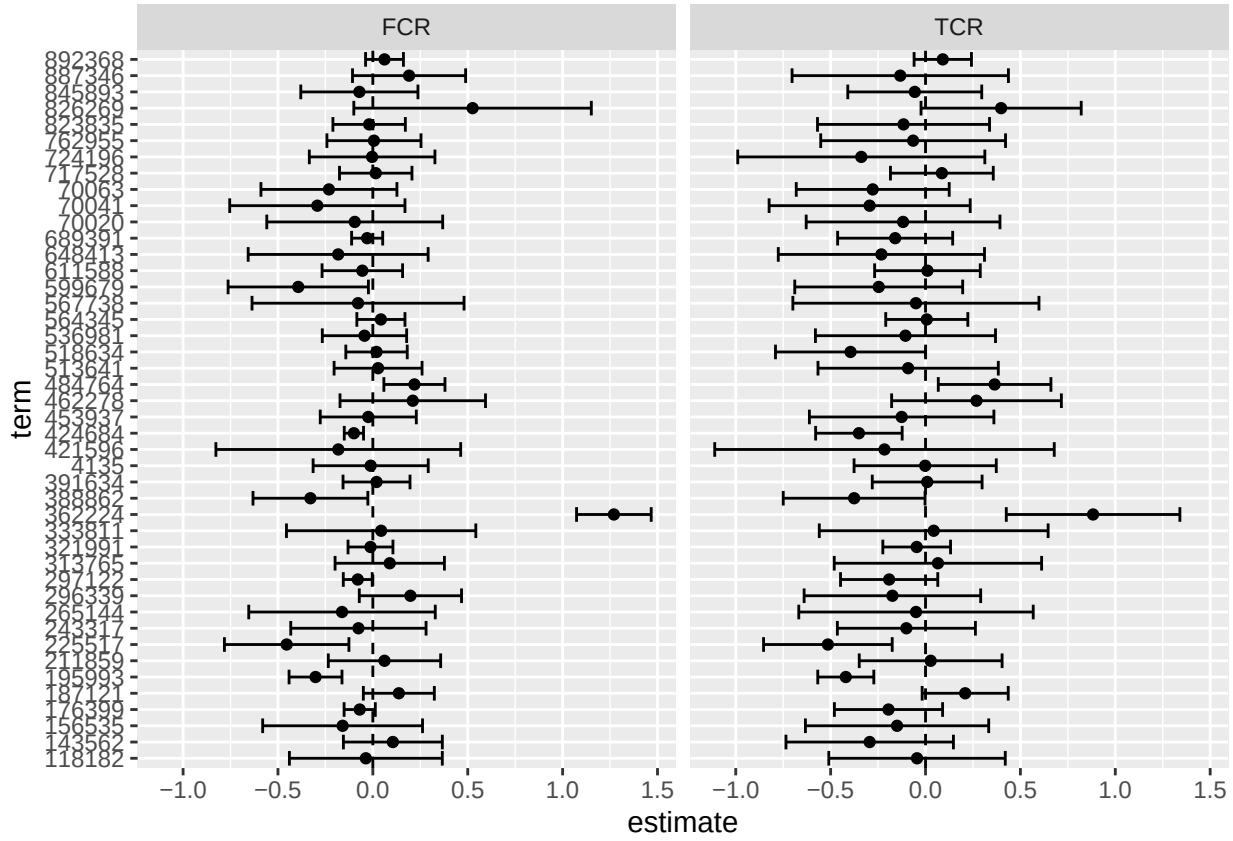

fcr
tcr
disc
meter
wp_turbidity
4
3
2
1
0
1
2
3
value


disc
meter
wp_turbidity
4
3
2
1
−2
0
2
diff

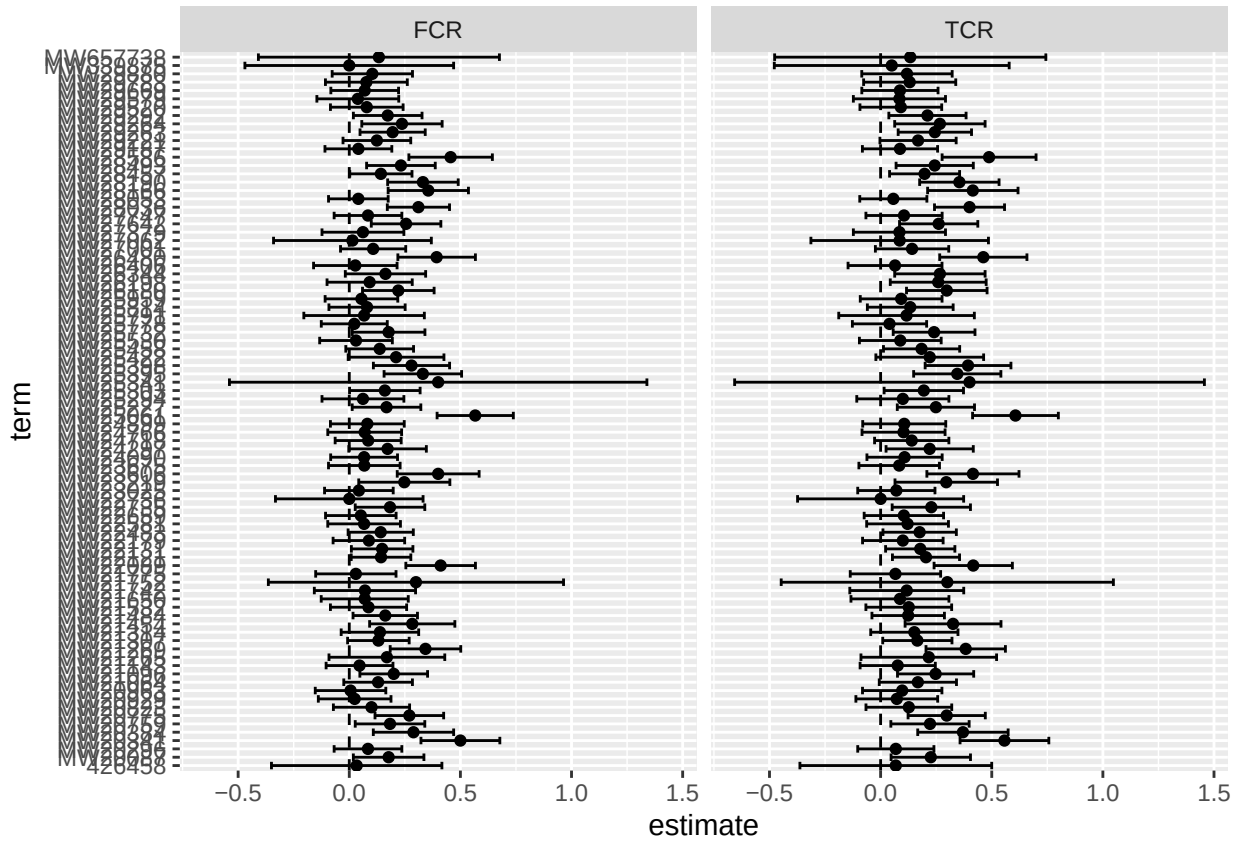
Fixed effect

Enumerator

Color wheel

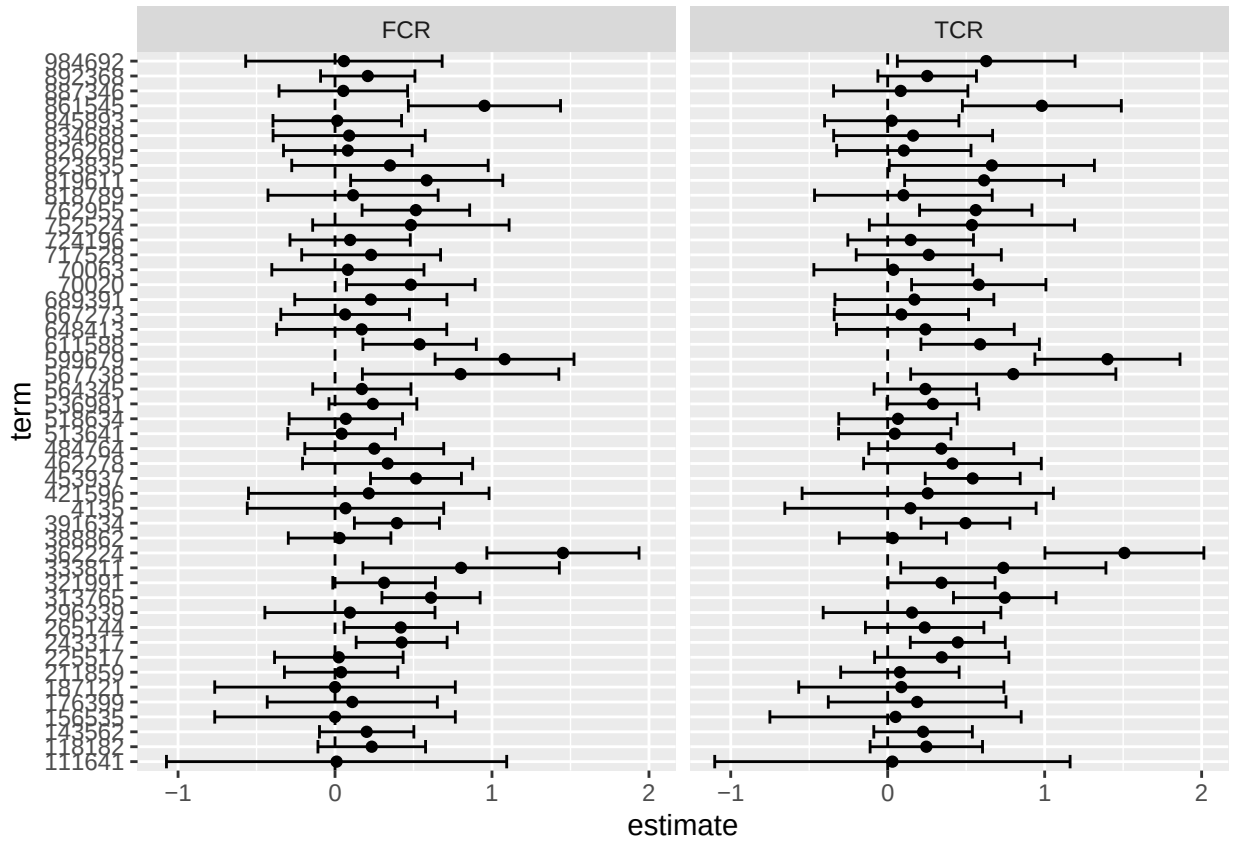


Uganda

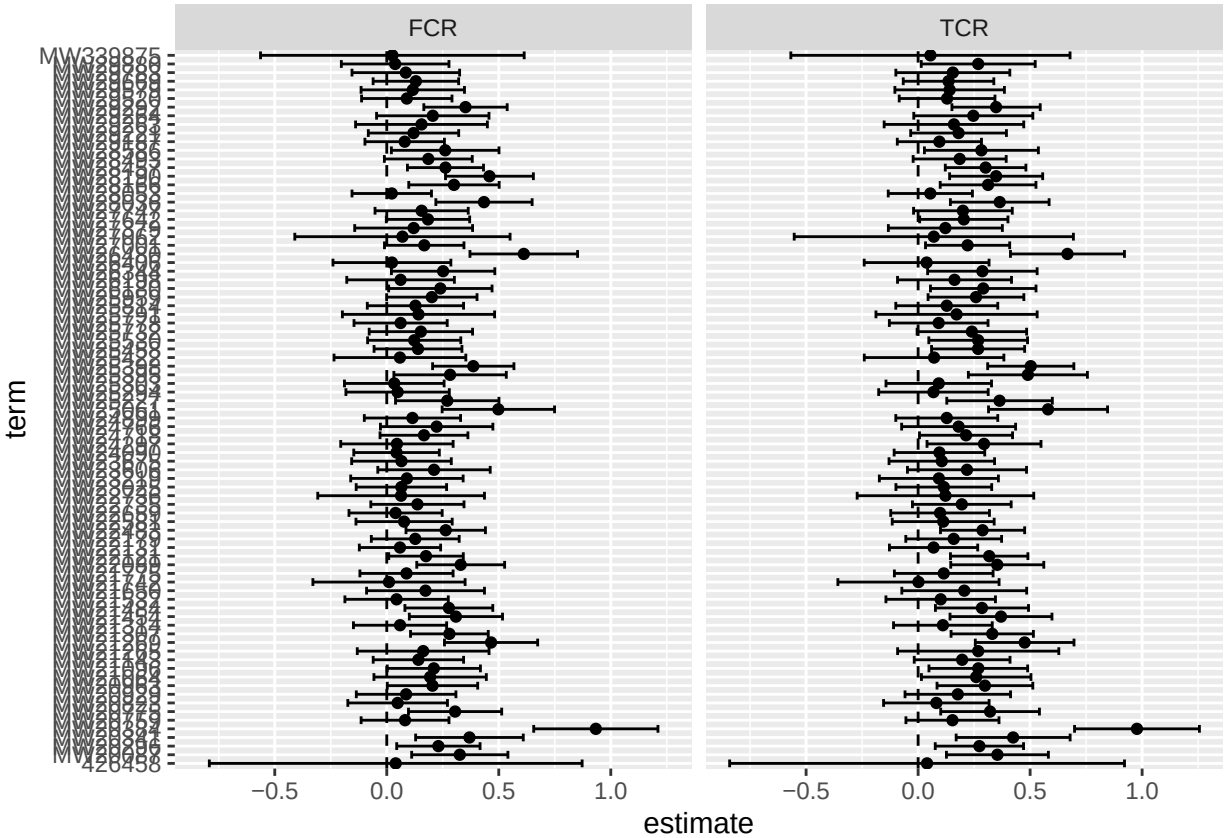


Malawi

Colorimeter

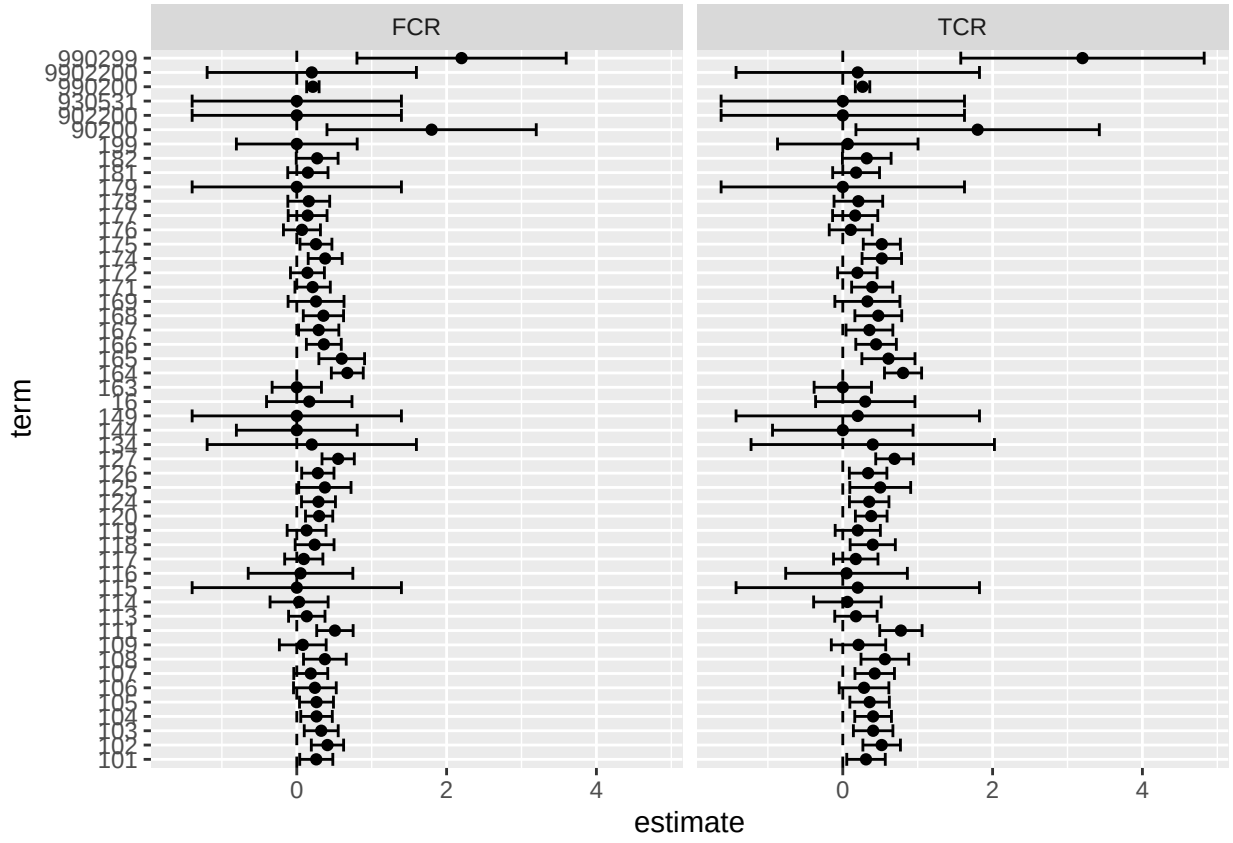


Uganda

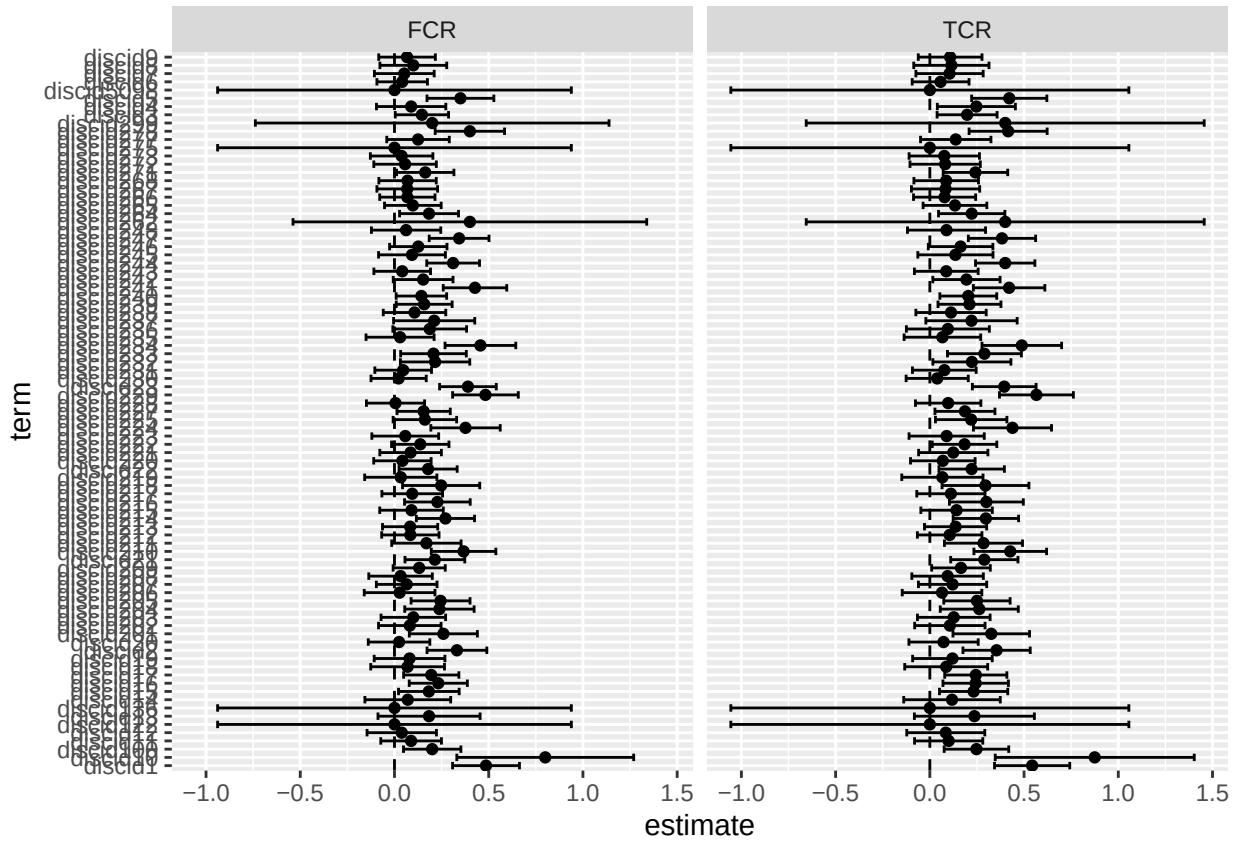


Malawi

Color wheel ID

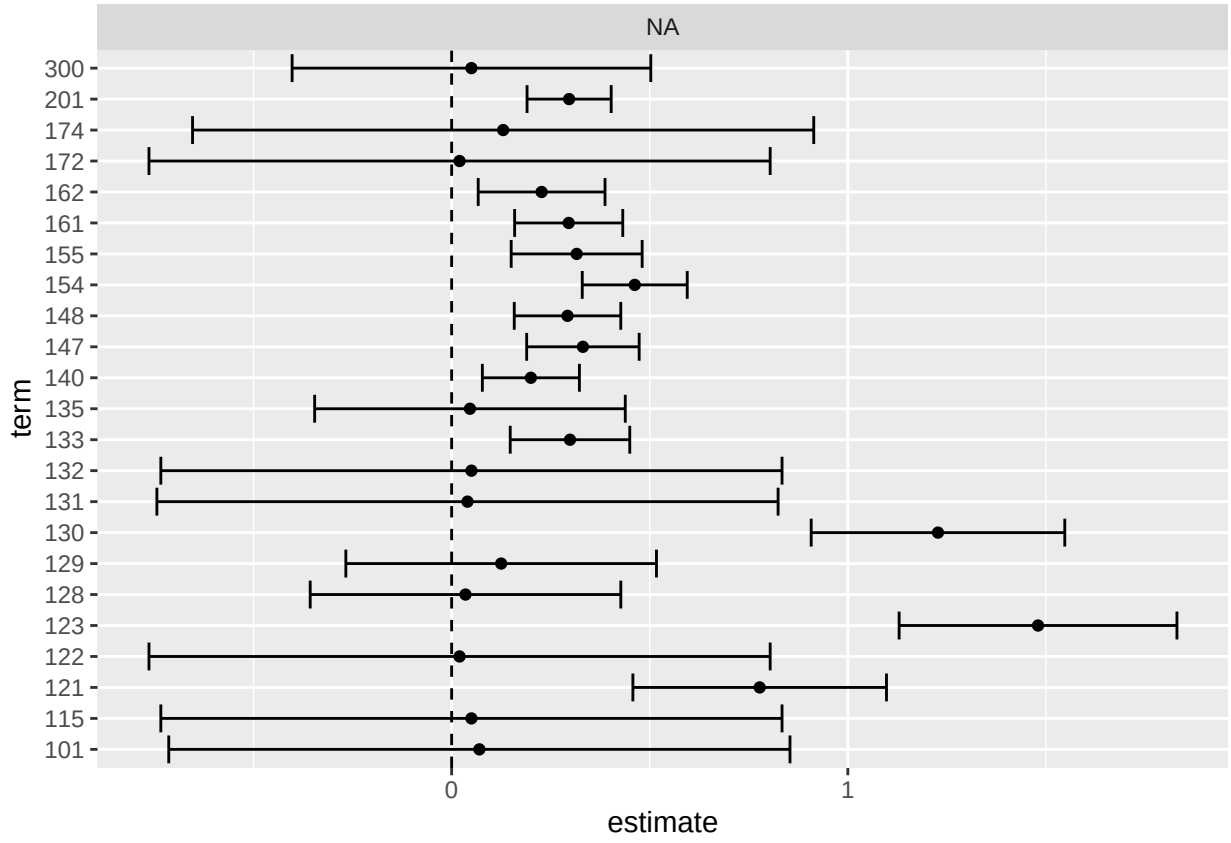


Uganda

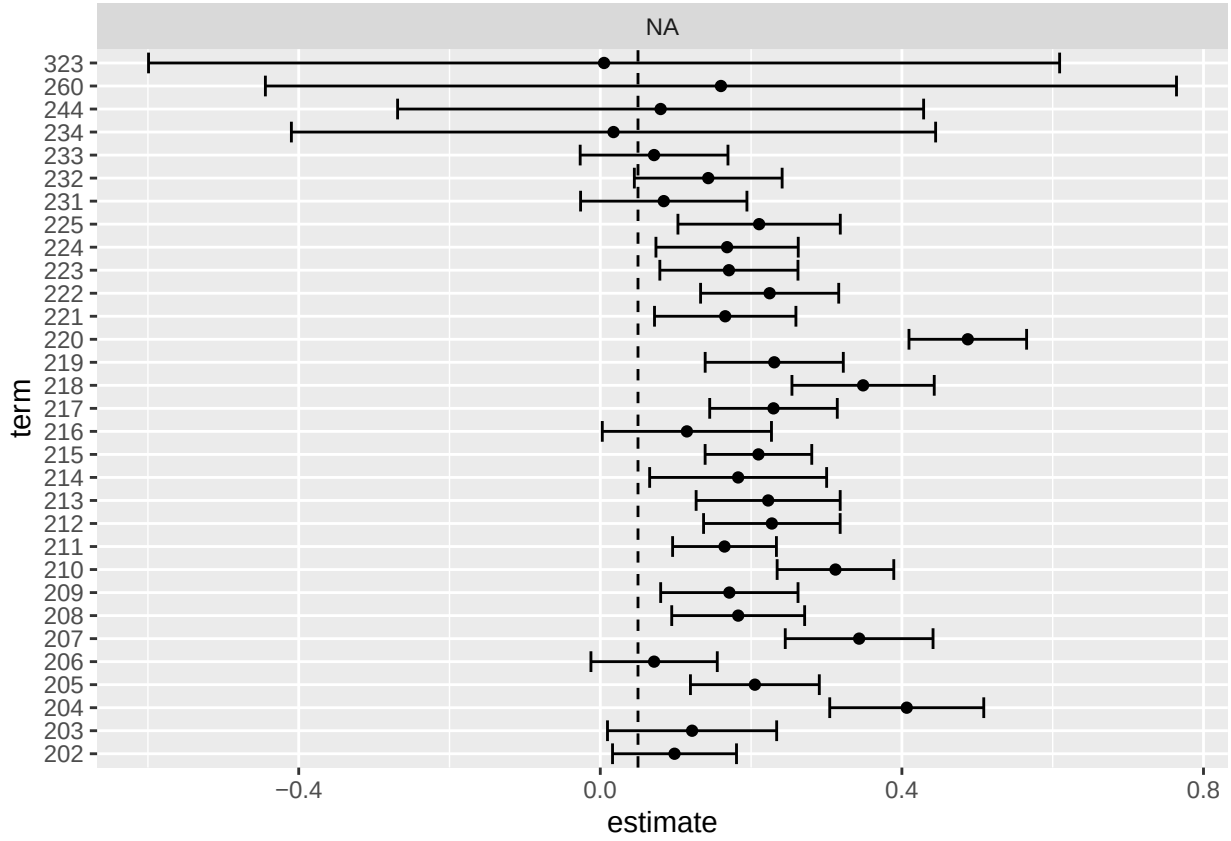


Malawi

Colorimeter ID



Uganda


NA
323
260
244
234
233
232
231
225
224
223
222
221
220
219
218
217
216
215
214
213
212
211
210
209
208
207
206
205
204
203
202
term
−0.4
0.0
0.4
0.8
estimate

Malawi