rs-synthesis

Kendalynn Morris

2022-02-02 11:21:03

1 Results

1.1 Data Summaries

Within SRDB there were 82 studies that matched our search criteria. These included six distinct ecosystem types; wetland, forest, shrubland, savanna, grassland, and desert. By coincidence both forest and grassland ecosystems, by far the most common ecosystem types in the dataset, were represented in 34 individual studies each. 9 studies contributed data on shrublands, 4 on deserts, 3 on savannas, and 1 on wetlands. Many studies contained both increased and decreased precipitation manipulations and the number of studies and effect sizes per ecosystem and manipulation type are summarized in Table 2. Manipulated precipitation ranged from 0% to 391% of MAP, with a mean of 145% of MAP for increased precipitation studies, and 57% of MAP for decreased precipitation studies.
Study sites were distributed across the terrestrial biosphere….DESCRIPTION TO ACCOMPANY STEPH'S FIGURE…

(#tab:Studies_EffectSizes) Table 2. Studies and Effect Sizes per Ecosystem and Manipulation

	Effect Sizes		Studies	
Ecosystem	**-P**	**+P**	**-P**	**+P**
Wetland	2	NA	1	NA
Forest	38	36	21	17
Shrubland	27	5	7	3
Savanna	1	7	1	3
Grassland	55	83	15	26
Desert	7	13	2	4

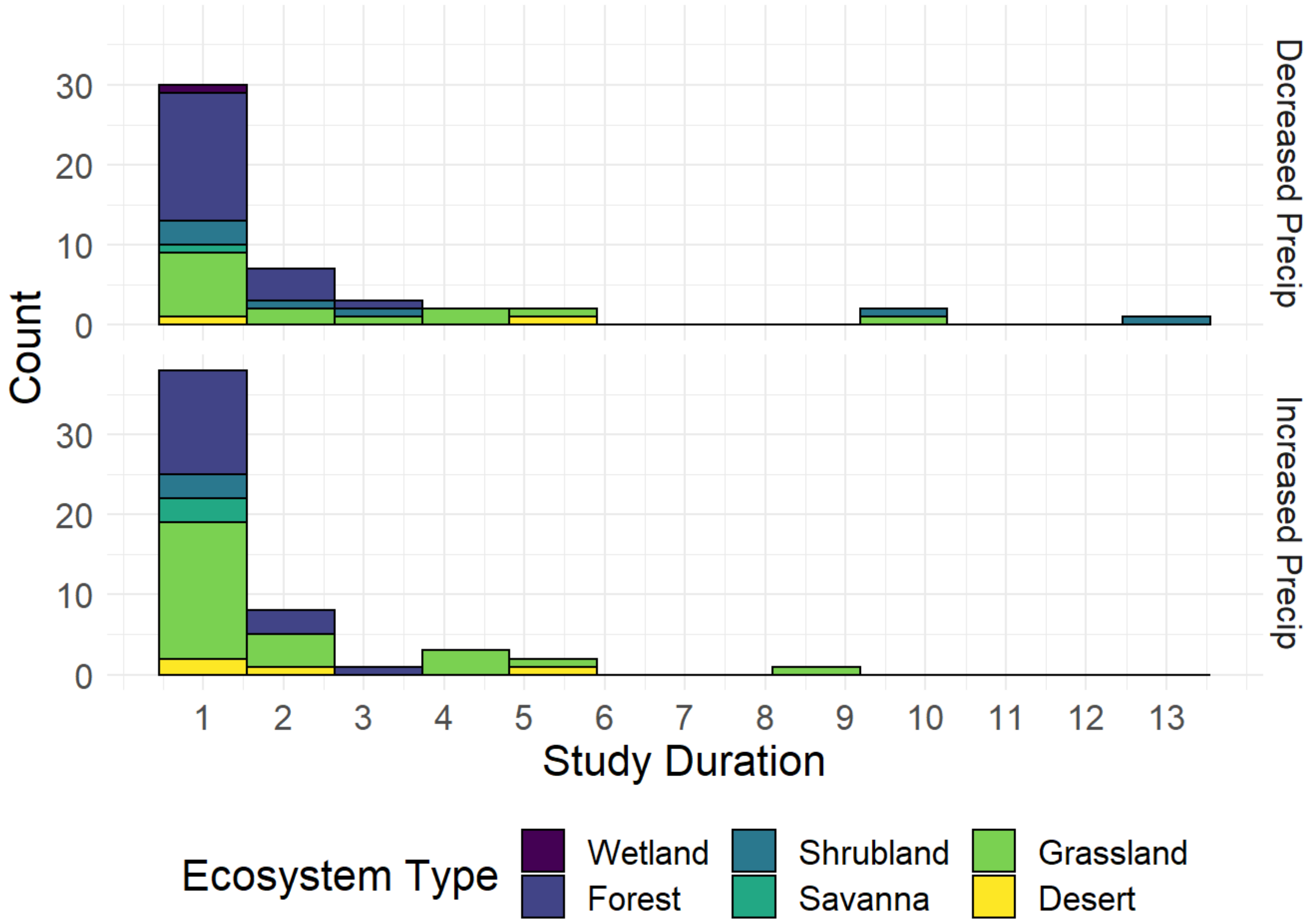
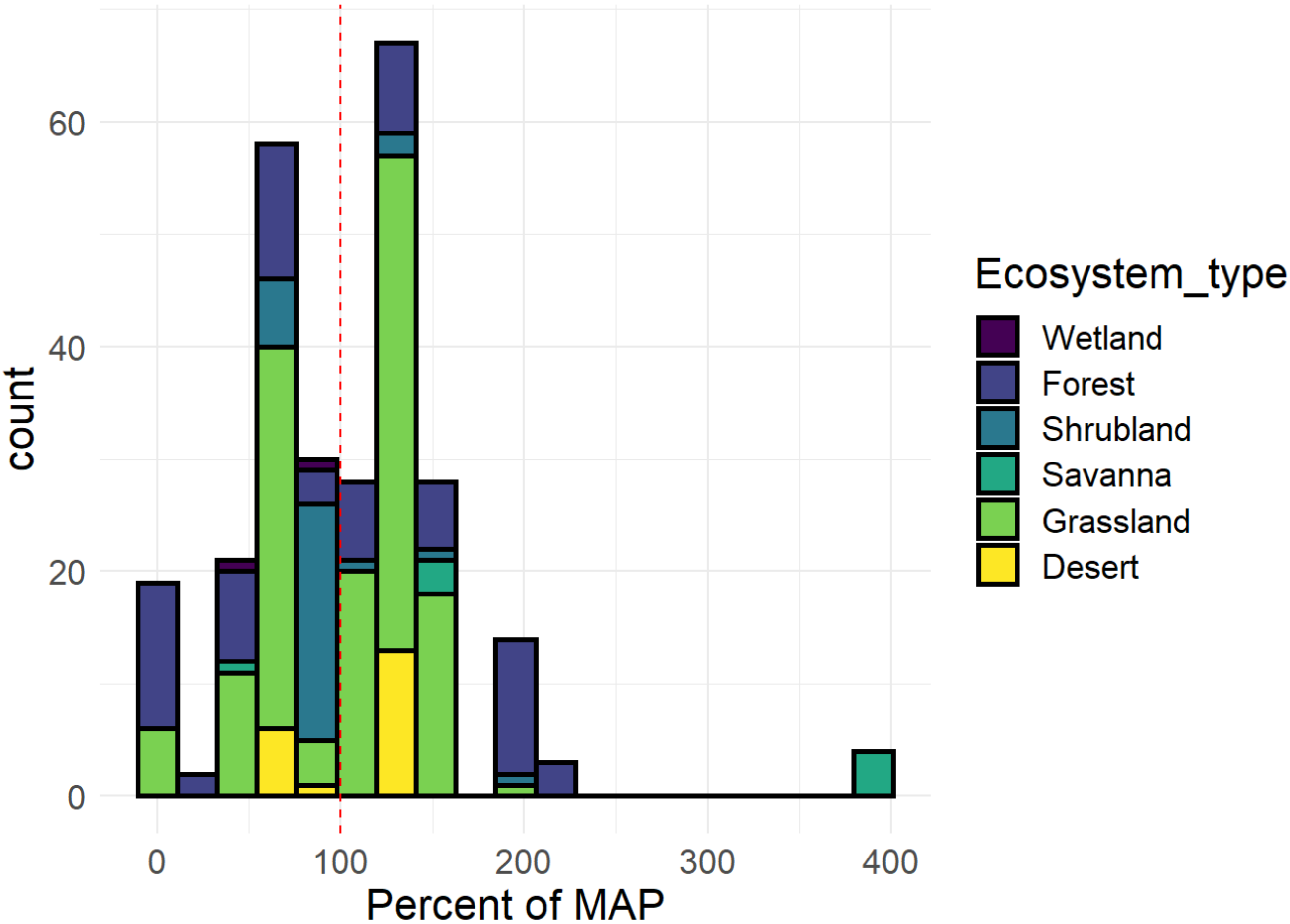


Figure 1.1: Few studies lasting >1 year

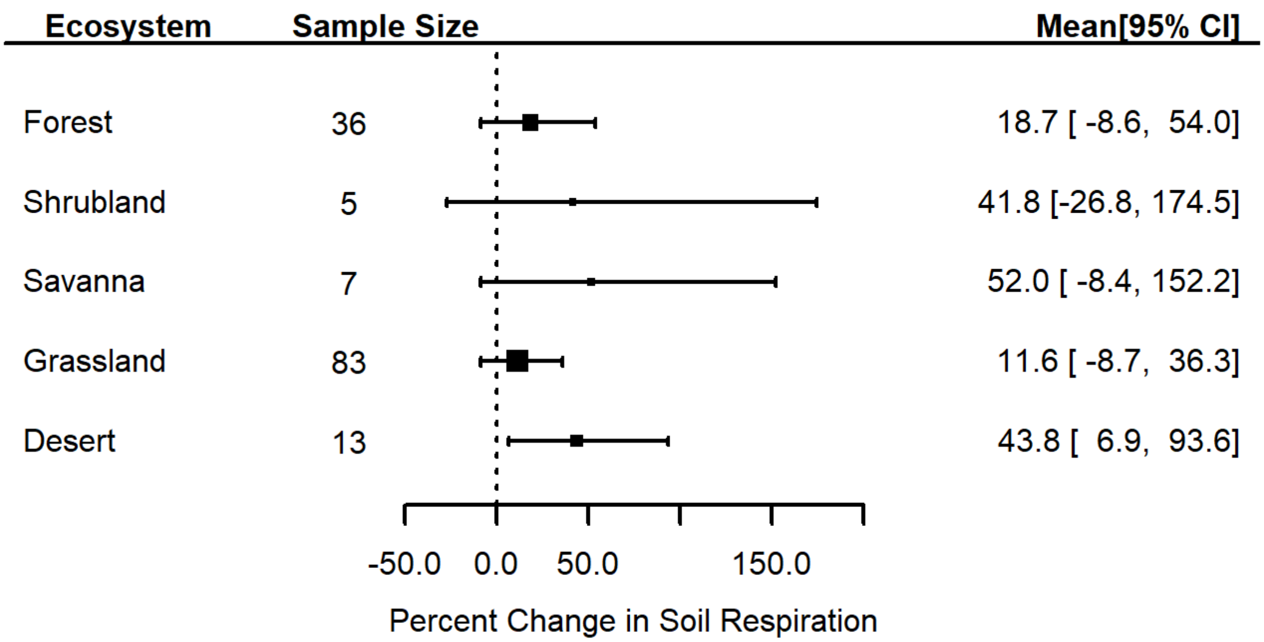
The majority of studies lasted only one year (55 of 82) and only 16% (13 of 82) were longer than two years (Figure (fig:diagnostic-plots)).

Manipulation intensity (how much a study increased or decreased precipitation) was not evenly distributed among ecosystems (Figure (fig:dist_manip)).



(#fig:dist_manip)Distribution of manipulations, dashed red line indicates break between -P and +P treatments

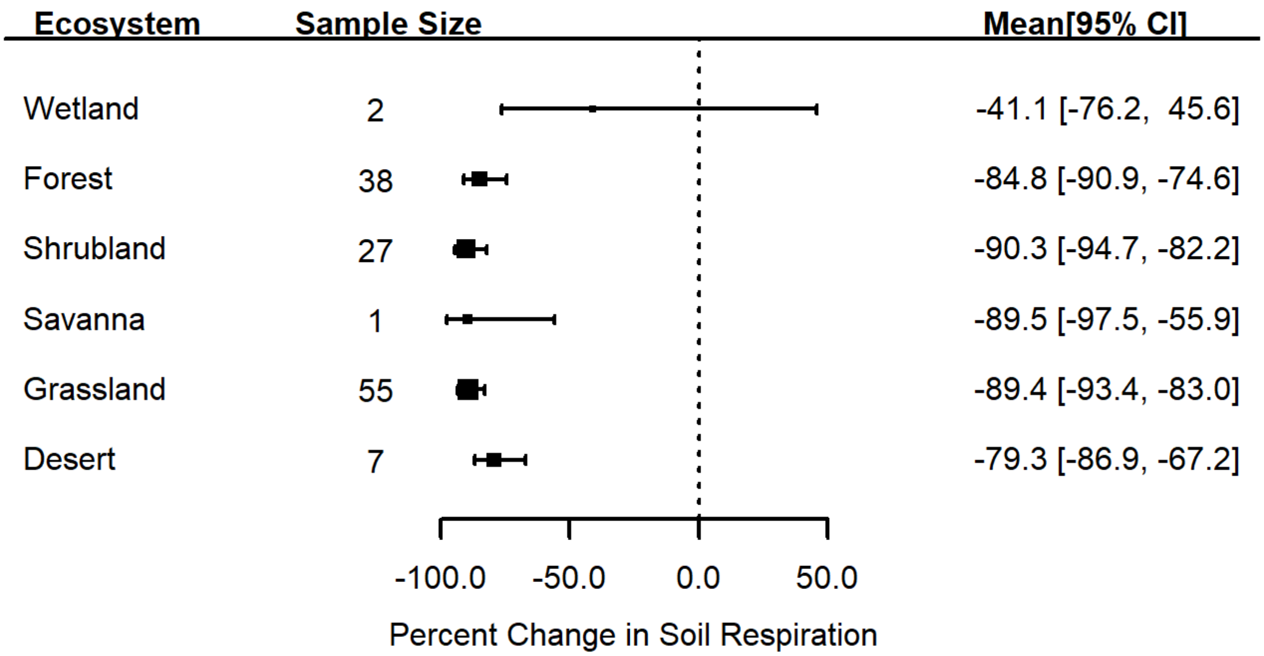
2 Ecosystem Effects



(#fig:+P_forest)Ecosystem effect for increased precipitation manipulations.

2.1 Increased Precipitation

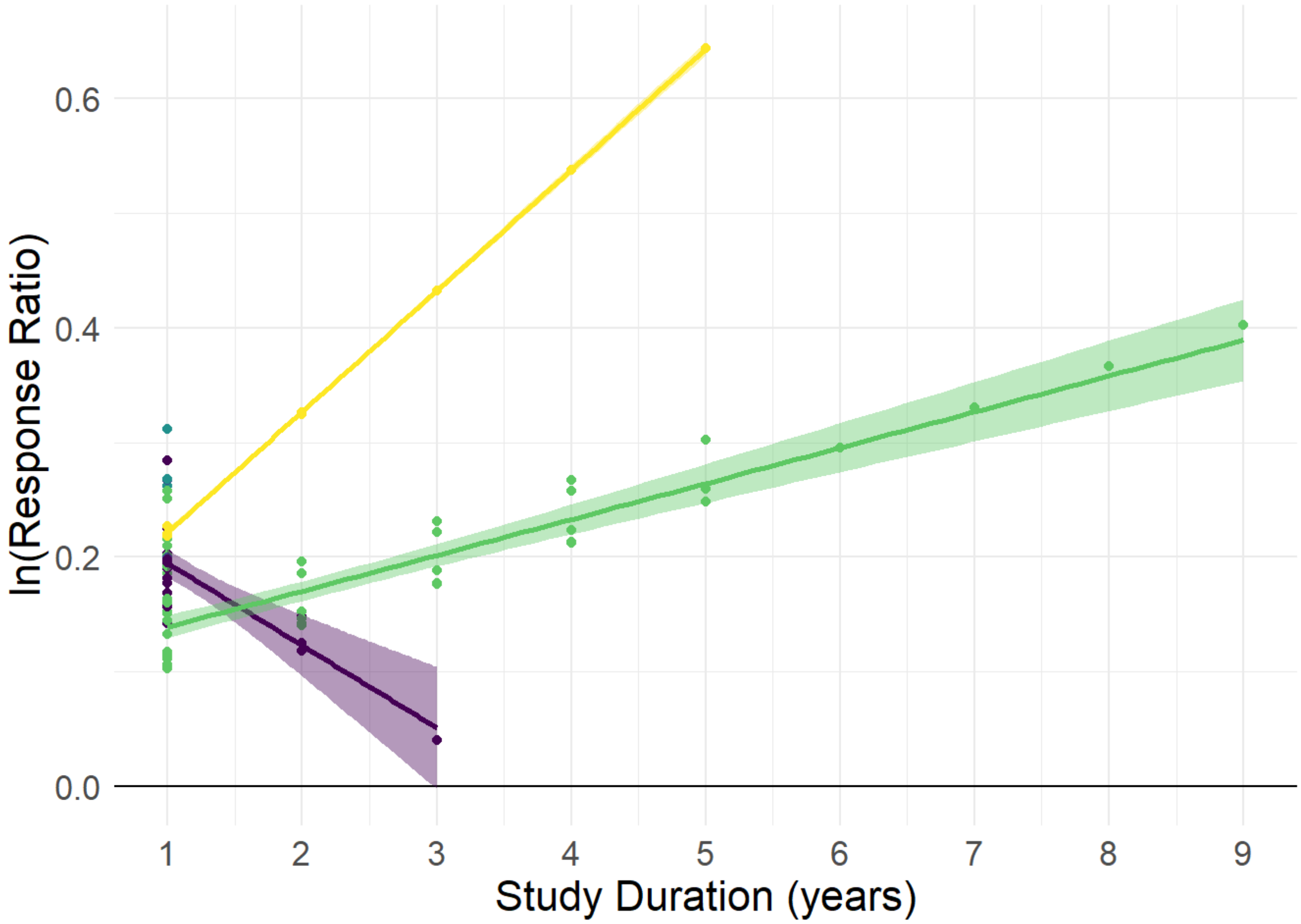
While in general soil respiration rates were greater with increased precipitation, only desert ecosystems showed a statistically significant increase (P = 0.017, Figure (fig:+P_forest)). There was a significant interaction between the duration of studies and the strength and direction of the respiration response in forest, grassland, and desert ecosystems (Figure (fig:Duration_effect_+P). The initial increase in soil respiration changed over time, decreasing strongly in forests, while increasing slightly in grasslands and strongly in deserts.



(#fig:-P_forest)Ecosystem effect for decreased precipitation manipulations.

2.2 Decreased Precipitation

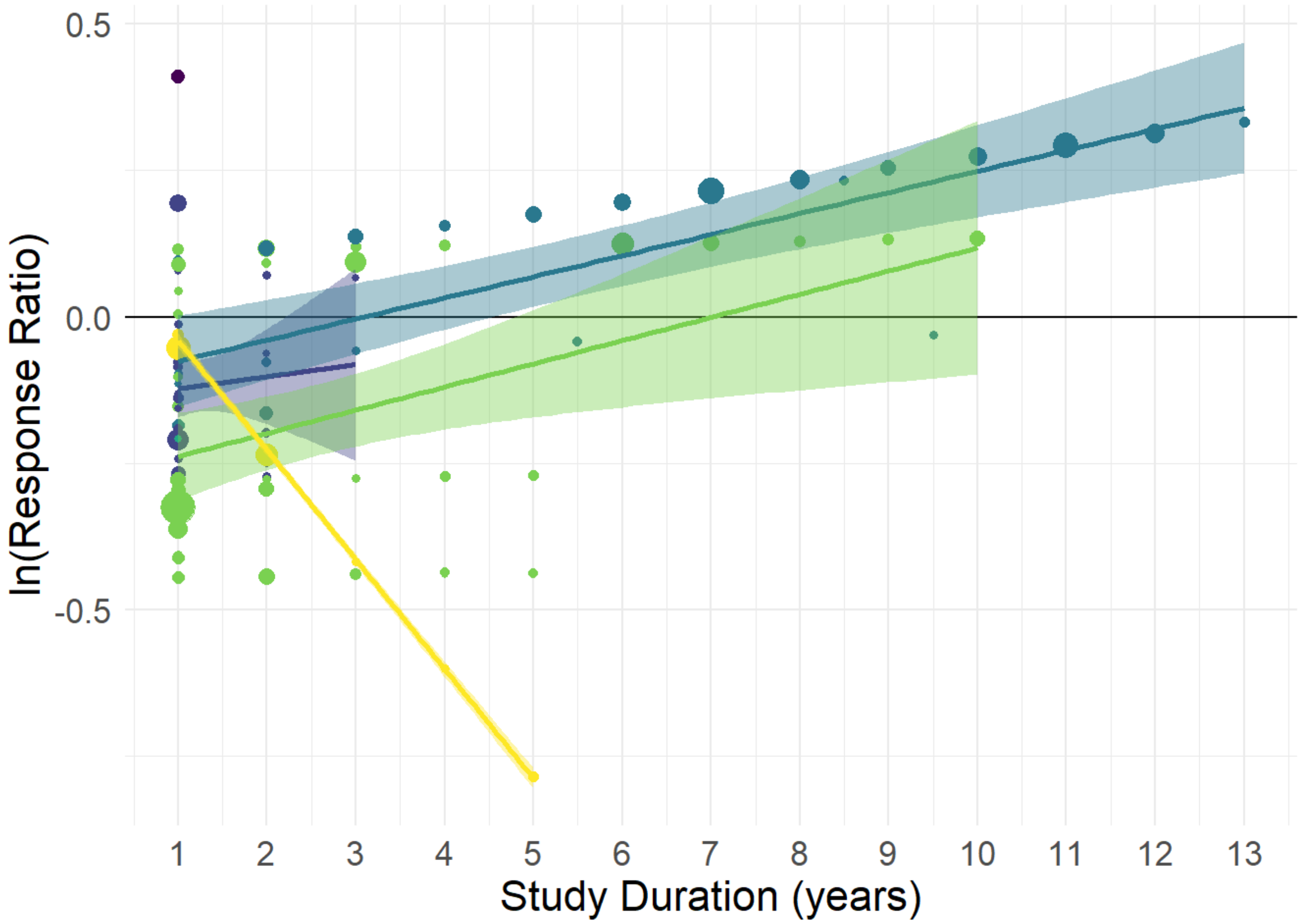
In contrast, when precipitation was decreased, soil respiration rates were lower relative to control rates (Figure (fig:-P_forest). Wetlands were an exception and showed elevated soil respiration rates although this effect was not significant.



(#fig:Duration_effect_+P)Duration +P studies

```
## Warning: Rows with NAs omitted from model fitting.
```

```
## Warning: Redundant predictors dropped from the model.
```



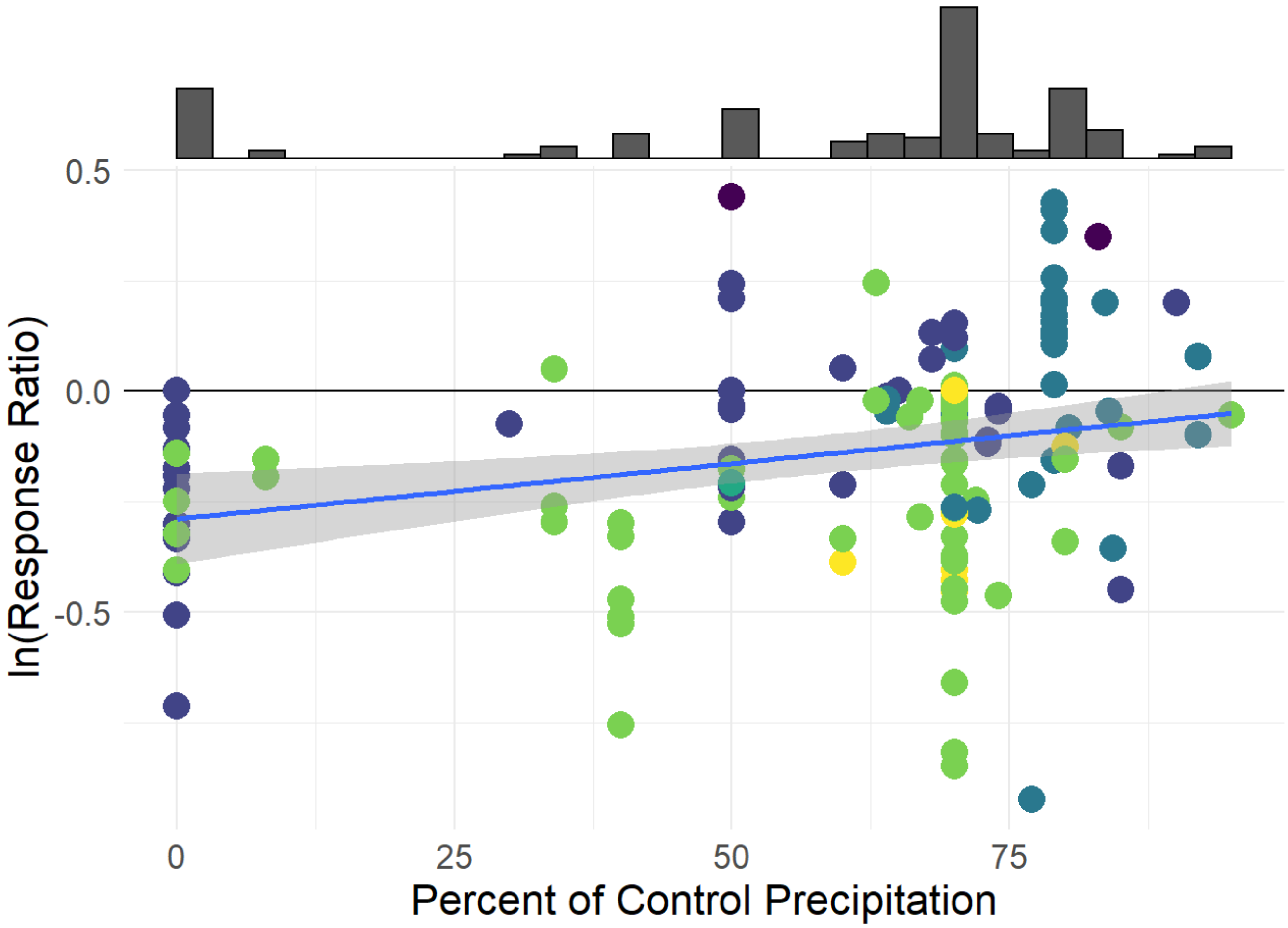
(#fig:Supplement_-P_duration_plot)Supplmental Figure

3 Effect of Duration

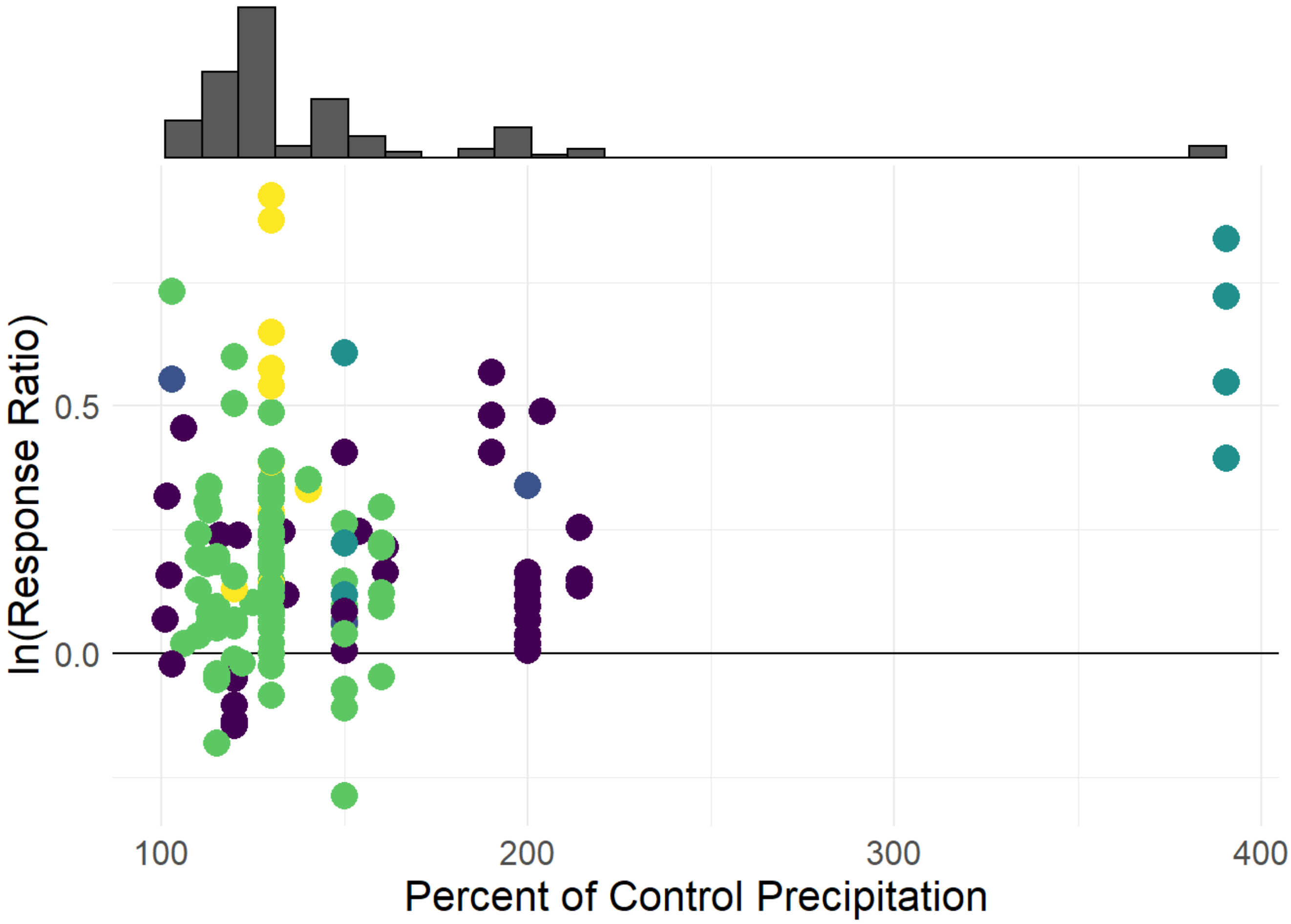
The duration of manipulations strongly effected the direction and magnitude of response of soil respiration to precipitation change. If the interaction of ecosystem type and duration are included in the meta-analytically model for decreased precipitation studies, the interaction term is significant for all ecosystems with more than two years worth of data ((Figure (fig:Supplement_-P_duration_plot). The effect of duration diverges depending on the relative water-limitation of the ecosystem being impacted. In drought simulations, forests, grasslands, and shrublands show weakening of the manipulation effect over time, leading to reversals of the initial effect. In contrast desert ecosystems have increasingly strong responses to manipulations, whether the change be an increase or decrease in precipitation.

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).

## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```



(#fig:Intensity_effect_-P)Linear regression of manipulation intensity and effect size for decreased precipitaiton studies.



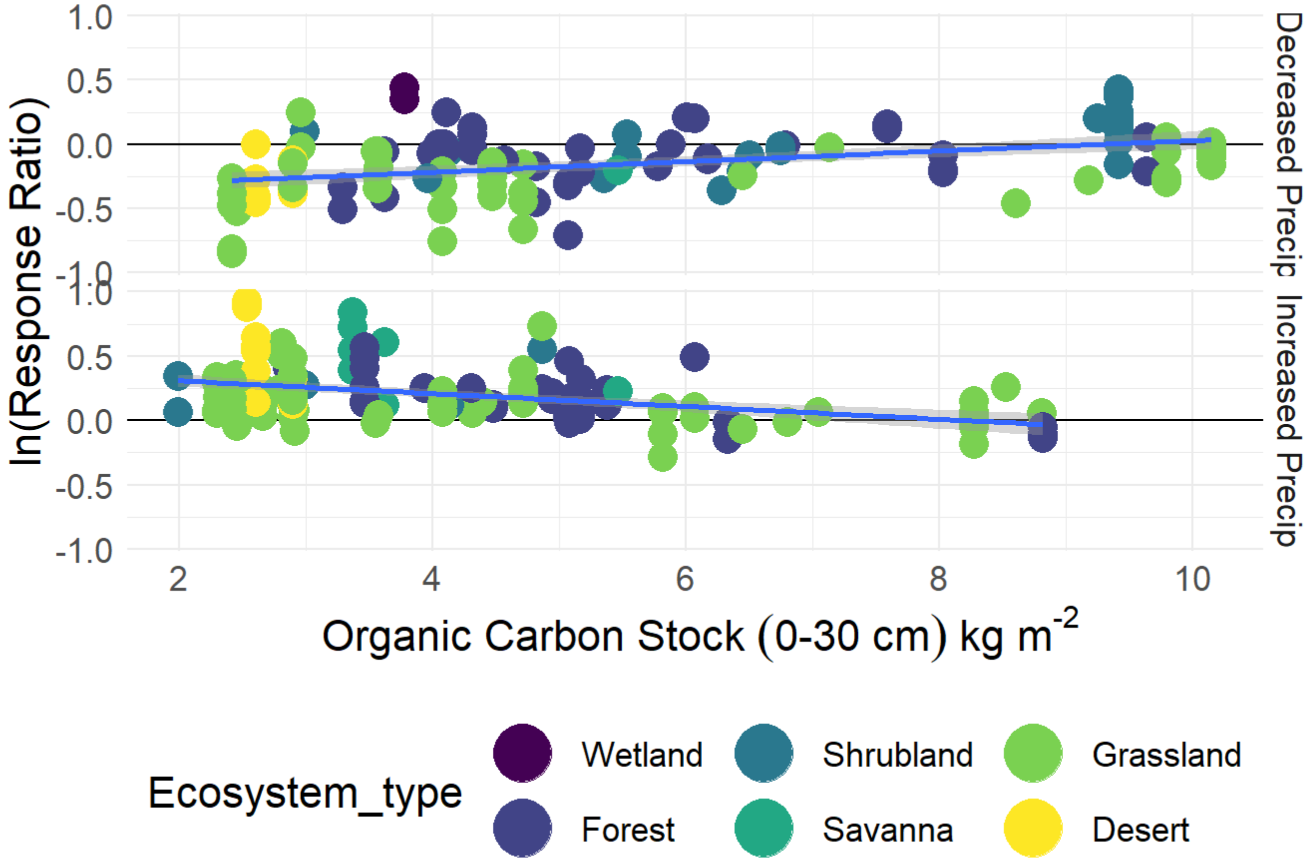
(#fig:Intensity_effect_+P)Linear regression of manipulation intensity and effect size for increased precipitaiton studies.

4 Effect of Manipulation Intensity

The intensity of the manipulation was ranked with higher importance for decreased precipitation studies (Figure (fig:Intensity_effect_-P) than those were precipitation increased (Figure (fig:Intensity_effect_+P).

The relationship is intuitive, the stronger the decrease in precipitation, the stronger the decrease in soil respiration (Figure (fig:Intensity_effect_-P)). No such relationship was found in increased precipitation studies (Figure (fig:Intensity_effect_+P)).

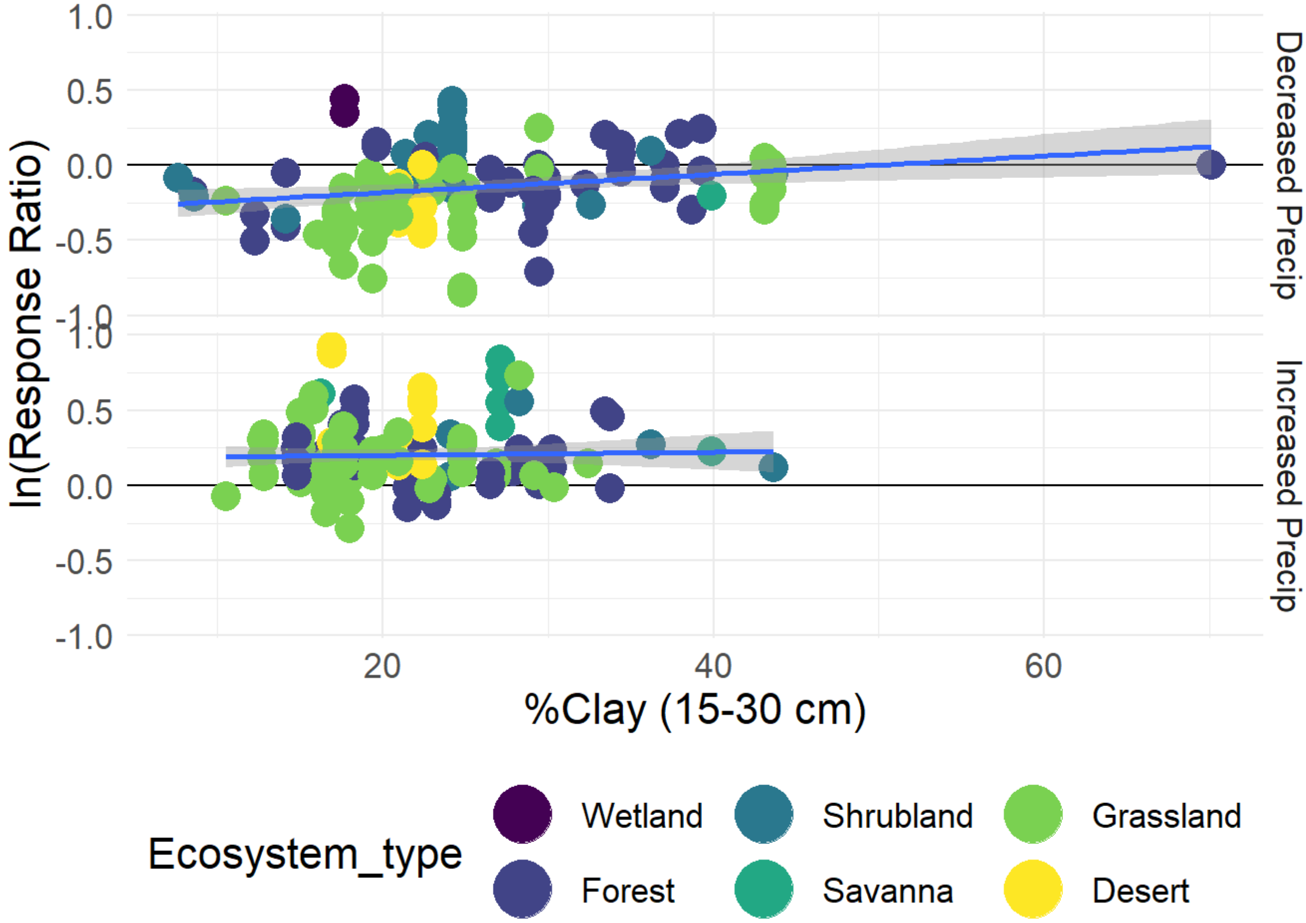
Figure 7.



(#fig:Soil_grid_ocs)Soils with higher organic C content had weaker responses to changes in precipitation.

5 Soil Content Effects

The organic C content of soil was highly significant for both manipulation types ($P < 0.001$ for -P, $P = 0.005$ for +P). The overall effect of soil organic C was positive, meaning that soils with more C had higher respiration rates in response to treatments. However, when effect sizes are plotted against organic C stocks (Figure (fig:Soil_grid_ocs)), we found that soils with the highest organic content were the most resistant to changes in precipitation.



(#fig:Soil_grid_clay)Clay content was not a strong predictor of soil respiration resonse to precipitation change.

Clay had low predictor importance for IP, high for DP. The linear regression between effect sizes and clay content supports this result (Figure (fig:Soil_grid_clay)). However, the effect was not significant in the deceased precipitation model, and clay content was not of sufficient importance to include in the increased precipitation model.

Study table

Summary of the studies included in this meta-analysis:

ID	Authors	DOI	Observations
1268	Billings et al. (1998)	10.1139/x98-145	4
1421	Borken et al. (1999)	10.2136/sssaj1999.6361848x	2
1639	Maier et al. (2000)	10.1139/x99-218	2
2694	Maier et al. (2004)	10.1111/j.1365-2486.2004.00809.x	1
2809	Vasconcelos et al. (2004)	10.1029/2003GB002210	2
2952	Harper et al. (2005)	10.1111/j.1365-2486.2005.00899.x	1
3263	Borken et al. (2006)	10.1111/j.1365-2486.2005.01058.x	1

ID	Authors	DOI	Observations
3710	Zhou et al. (2006)	10.1029/2005GB002526	1
3730	Asensio et al. (2007)	10.1016/j.atmosenv.2006.05.008	1
3978	McCulley et al. (2007)	10.2136/sssaj2006.0303	4
3983	Metcalfe et al. (2007)	10.1029/2007JG000443	2
4051	Risch et al. (2007)	10.1007/s10533-007-9148-5	5
4085	Sotta et al. (2007)	10.1111/j.1365-2486.2007.01416.x	1
4257	Chou et al. (2008)	10.1111/j.1365-2486.2008.01572.x	4
4270	Davidson et al. (2008)	10.1111/j.1365-2486.2008.01694.x	1
4412	Lellei-Kovacs et al. (2008)	10.1556/ComEc.9.2008.1.4	4
4549	Selmants et al. (2008)	10.1111/j.1365-2664.2008.01460.x	2
4564	Sowerby et al. (2008)	10.1111/j.1365-2486.2008.01643.x	2
4849	Garten et al. (2009)	10.1007/s11104-008-9851-6	2
4895	Inglima et al. (2009)	10.1111/j.1365-2486.2008.01793.x	3
5308	de Dato et al. (2010)	10.1007/s11104-009-0041-y	3
5448	van Straaten et al. (2010)	10.5194/bg-7-1223-2010	1
5536	Yan et al. (2010)	10.1111/j.1365-2486.2009.02091.x	2
5587	Misson et al. (2010)	10.1111/j.1365-2486.2009.02121.x	2
6048	Yan et al. (2011)	10.1111/j.1365-2486.2010.02365.x	2
6112	Talmon et al. (2011)	10.1111/j.1365-2486.2010.02285.x	4
6166	Cotrufo et al. (2011)	10.5194/bg-8-2729-2011	2
6168	Fay et al. (2011)	10.5194/bg-8-3053-2011	13
6185	Wu et al. (2011)	10.1007/s11104-010-0548-2	2
6248	Carter et al. (2012)	10.5194/bg-9-3739-2012	4
6272	Deng et al. (2012)	10.1371/journal.pone.0041493	3
6299	Ford et al. (2012)	10.1016/j.agrformet.2011.12.008	2
6489	Ruehr et al. (2012)	10.1016/j.agrformet.2012.05.015	1
6502	Schindlbacher et al. (2012)	10.1111/j.1365-2486.2012.02696.x	3
6505	Selsted et al. (2012)	10.1111/j.1365-2486.2011.02634.x	2
6540	Suseela et al. (2012)	10.1111/j.1365-2486.2011.02516.x	2
7046	Jia et al. (2013)	10.1007/s11104-013-1771-4	2
7048	Jiang et al. (2013)	10.5194/bg-10-3963-2013	6

ID	Authors	DOI	Observations
7115	Lai et al. (2013)	10.1371/journal.pone.0077659	2
7436	Silva Júnior et al. (2013)	10.1590/S0102-77862013000100009	1
7593	Wang et al. (2013)	NA	4
8163	Jia et al. (2014)	10.1007/s00374-014-0901-3	4
8350	McDaniel et al. (2014)	10.1007/s00442-013-2845-y	1
8401	Hagedorn et al. (2014)	10.1007/s10533-013-9881-x	3
8509	Yan et al. (2014)	10.1007/s11104-013-1944-1	6
8694	da Costa et al. (2014)	10.1080/17550874.2013.798366	2
9324	Zhang et al. (2015)	10.1007/s11104-015-2523-4	1
9557	Martins et al. (2015)	10.1016/j.soilbio.2015.03.012	1
9649	Shen et al. (2015)	10.1016/j.apsoil.2015.01.015	2
10066	Dominguez et al. (2015)	10.1007/s10533-014-0059-y	13
10104	Hinko-Najera et al. (2015)	10.1016/j.agrformet.2014.09.013	2
10404	Reynolds et al. (2015)	10.1111/gcb.12732	3
11859	Escolar et al. (2015)	10.1016/j.soilbio.2014.09.019	2
11031	Chang et al. (2016)	10.3390/f7110263	2
11064	Xu et al. (2016)	10.1038/srep34801	8
11078	Waring et al. (2016)	10.1088/1748-9326/11/10/105005	2
11261	Hoover et al. (2016)	10.1002/2015JG003256	3
10483	Han et al. (2017)	10.1002/ece3.3536	9
10526	Lu et al. (2017)	10.1038/s41598-017-15157-3	4
10816	Munir et al. (2017)	10.3390/f8030075	2
10878	Moinet et al. (2017)	10.1016/j.scitotenv.2016.11.199	1
13000	Ohashi et al. (2019)	10.1007/s11104-018-03929-3	1
13001	Rondina et al. (2019)	10.1086/701353	1
13004	Winkler et al. (2019)	10.1007/s10533-019-00548-7	4
13007	Wang et al. (2019)	10.1111/1365-2435.13256	4
13008	Vinh et al. (2019)	10.1016/j.atmosenv.2018.12.049	4
13009	Wang et al. (2019)	10.1016/j.atmosenv.2018.12.032	1
13015	Guan et al. (2019)	10.1007/s11368-018-2171-4	3
13018	Andrade et al. (2019)	10.1016/j.apgeochem.2019.02.006	8

ID	Authors	DOI	Observations
13022	de Nijs et al. (2019)	10.1111/gcb.14508	3
13024	Zhou et al. (2019)	10.1111/gcb.14533	2
13030	Leyva-Morales et al. (2019)	10.1007/s00572-019-00880-8	2
13033	Tang et al. (2019)	10.1016/j.scitotenv.2018.11.082	8
13044	Spohn et al. (2019)	10.1016/j.soilbio.2018.12.018	2
13072	Chen et al. (2019)	10.1016/j.still.2018.11.007	8
13079	Forde et al. (2019)	10.1016/j.scitotenv.2018.10.217	30
13094	Li et al. (2019)	10.1016/j.foreco.2018.10.055	1
13096	Kriiska et al. (2019)	10.1016/j.foreco.2018.11.026	1
13112	Jacotot et al. (2019)	10.1016/j.scitotenv.2018.09.093	4
13189	Reddy et al. (2019)	10.1016/j.catena.2018.08.036	4
13193	Arora et al. (2019)	10.1016/j.scitotenv.2018.08.251	2
13242	Mohamed et al. (2019)	10.4067/S0717-92002019000200163	2

6 The End

```
## R version 4.1.1 (2021-08-10)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 19042)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=English_United States.1252
## [2] LC_CTYPE=English_United States.1252
## [3] LC_MONETARY=English_United States.1252
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] bookdown_0.24              broom_0.7.11
##  [3] dmetar_0.0.9000            MuMIn_1.43.17
##  [5] PerformanceAnalytics_2.0.4 xts_0.12.1
##  [7] zoo_1.8-9                  metafor_3.0-2
##  [9] Matrix_1.3-4               DT_0.20
## [11] forcats_0.5.1              kableExtra_1.3.4
## [13] ggExtra_0.9                ggplot2_3.3.5
## [15] tidyr_1.1.4                dplyr_1.0.7
## [17] readr_2.1.1                raster_3.5-15
## [19] sp_1.4-6
##
## loaded via a namespace (and not attached):
##   [1] minqa_1.2.4        colorspace_2.0-2   ellipsis_0.3.2
##   [4] class_7.3-19       modeltools_0.2-23  mclust_5.4.9
##   [7] rstudioapi_0.13    farver_2.1.0       ggrepel_0.9.1
##  [10] flexmix_2.3-17     bit64_4.0.5        fansi_1.0.2
##  [13] mathjaxr_1.4-0     xml2_1.3.3         codetools_0.2-18
##  [16] splines_4.1.1      robustbase_0.93-9  knitr_1.37
##  [19] jsonlite_1.7.3     nloptr_1.2.2.3     cluster_2.1.2
##  [22] kernlab_0.9-29     shiny_1.7.1        compiler_4.1.1
##  [25] httr_1.4.2         backports_1.4.1    assertthat_0.2.1
##  [28] fastmap_1.1.0      later_1.3.0        htmltools_0.5.2
##  [31] tools_4.1.1        gtable_0.3.0       glue_1.6.1
##  [34] Rcpp_1.0.8         jquerylib_0.1.4    vctrs_0.3.8
##  [37] svglite_2.0.0      nlme_3.1-152       fpc_2.2-9
##  [40] xfun_0.29          stringr_1.4.0      lme4_1.1-27.1
##  [43] rvest_1.0.2        mime_0.12          miniUI_0.1.1.1
##  [46] CompQuadForm_1.4.3 lifecycle_1.0.1    terra_1.5-12
##  [49] DEoptimR_1.0-10    MASS_7.3-54        scales_1.1.1
##  [52] vroom_1.5.7        hms_1.1.1          promises_1.2.0.1
##  [55] parallel_4.1.1     meta_5.1-1         yaml_2.2.2
##  [58] pbapply_1.5-0      gridExtra_2.3      sass_0.4.0
##  [61] stringi_1.7.6      highr_0.9          poibin_1.5
##  [64] boot_1.3-28        rlang_0.4.12       pkgconfig_2.0.3
##  [67] systemfonts_1.0.3  prabclus_2.3-2     evaluate_0.14
```

```
##  [70] lattice_0.20-44    purrr_0.3.4        labeling_0.4.2
##  [73] htmlwidgets_1.5.4  bit_4.0.4          tidyselect_1.1.1
##  [76] magrittr_2.0.2     R6_2.5.1           generics_0.1.1
##  [79] DBI_1.1.2          mgcv_1.8-36        pillar_1.6.5
##  [82] withr_2.4.3        abind_1.4-5        nnet_7.3-16
##  [85] tibble_3.1.6       crayon_1.4.2       utf8_1.2.2
##  [88] tzdb_0.2.0         rmarkdown_2.11     grid_4.1.1
##  [91] netmeta_2.1-0      digest_0.6.29      diptest_0.76-0
##  [94] webshot_0.5.2      xtable_1.8-4       httpuv_1.6.5
##  [97] stats4_4.1.1       munsell_0.5.0      viridisLite_0.4.0
## [100] bslib_0.3.1        magic_1.5-9        quadprog_1.5-8
```