Cleaning and Analysis Set-Up

Cooperatives Working Group

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Load packages

```
suppressPackageStartupMessages({
  library(here)
  library(raster)
  library(tmap)
  library(sf)
  library(scales)
  library(cowplot)
  library(tidyverse)
})
```

Read fish type data

```
fish_type <- read.csv(here("raw_data", "fishtype.csv"),
                      stringsAsFactors = F,
                      strip.white = T)
```

Read coordinate data

```
coords <- read.csv(here("raw_data", "cooperative_coordinates.csv"),
                   stringsAsFactors = F,
                   strip.white = T) %>%
  filter(!duplicated(.))
```

Read species suceptibility (Jones & Cheung)

```
jones_cheung <- read.csv(here("raw_data", "Jones_Cheung_SDATA.csv"))

jones_cheung_genus <- jones_cheung %>%
  mutate(genus = stringr::str_extract(string = Complete_Name, pattern = "([^\\s]+)")) %>%
  group_by(genus) %>%
  summarize_if(is.numeric, mean) %>%
  dplyr::select(genus, genusV = VulnerabilityIndex, genusR = RiskOfImpact)
```

Read species scientific names and generate species suceptibility

```
species_suceptibility <- read.csv(here("raw_data", "spp_sci_name.csv"))  %>%
  mutate(genus = stringr::str_extract(string = Complete_Name, pattern = "([^\\s]+)")) %>%
  left_join(jones_cheung) %>%
  left_join(jones_cheung_genus) %>%
  mutate(Vulnerability = ifelse(is.na(VulnerabilityIndex), genusV, VulnerabilityIndex)) %>%
  dplyr::select(Original_Order, Vulnerability) %>%
  janitor::clean_names()
```

Extract temperatures

```
proj2 <- "+proj=longlat +datum=WGS84 +ellps=WGS84 +towgs84=0,0,0"
data(World)
World <- as(World, "sf") %>%
  sf::st_transform(proj2) %>%
  mutate(N = 1) %>%
  sf::st_union(by = N) %>%
  sf::as_Spatial()
```

```
# The script in scripts/change_in_temperature produces this RDS file. Run from command line for faster

r <- readRDS(file = here("data", "tsdiff.rds"))
```

```
saltwater <- coords %>%
  left_join(fish_type, by = "fishery_id") %>%
  filter(!fish_type %in% c("freshwater", "freshwater & diadromous")) %>%
  group_by(fishery_id) %>%
  summarize(lon = mean(lon, na.rm = T), lat = mean(lat, na.rm = T)) %>%
  rbind(data.frame(fishery_id = 0, lon = -31.427525, lat = -71.6063907)) %>%
  filter(!is.na(lon))

xy <- data.frame(X = saltwater$lon, Y = saltwater$lat)
coordinates(xy) <- c("X", "Y")
proj4string(xy) <- proj2  ## for example
xy <- SpatialPointsDataFrame(xy, saltwater, proj4string = proj2)
```

```
temps <- raster::extract(r, xy, buffer = 50000, fun = mean)
```

```
coords <- cbind(xy, temps)
colnames(coords@data) <- c("fishery_id", "lon", "lat", "temperature_change")
coords <- coords@data
```

Get all together

```
coop <- read.csv(here("raw_data", "master_coop.csv"),
                 stringsAsFactors = F,
                 strip.white = T,
                 na.strings = c("N/A", "NA", "999")) %>%
  dplyr::select(fishery_id= Fishery_ID, original_order = Original_Order, target_species= Target_species
  mutate(
    # no poverty index for developed countries so for now I'm replacing them with a zero. We may need t
    poverty_index= ifelse(is.na(poverty_index), 0, poverty_index),
```

```
    # transforming catch use for subsistance in numeric
    short_catch_use_numeric = case_when(short_catch_use == "Subsistence" ~ 1,short_catch_use == "Local
    # creating a variable that adds the number of known coop behaviors (NAs are not considered)
    number_coop_behaviors = rowSums(.[8:25], na.rm=TRUE),
    # creating a variable that adds the number of services known to be provided by the goverment (NAs a
     number_gov_services = rowSums(.[26:31], na.rm=TRUE),
    # creating a binary variable for more than one type of fishing gear (note that these are prodiminan
   multiple_gears = ifelse(gear_type %in% c("Artisanal", "Gillnet / Entangling net / Long-line", "Artis
   # how old is the cooperative? (I'm assuming they are still operating bt 2013, when the paper was pub
   years_coop = 2013 - coop_formation_date,
   # Is the fishery being managed?The opposite of OA
  managed_fishery = ifelse(open_access == 1, 0, 1)) %>%
  filter(!fish_type %in% c("Freshwater", "Freshwater & Diadromous")) %>%
  left_join(coords, by = "fishery_id") %>%
  left_join(species_suceptibility, by = 'original_order') %>%
  select(-c(fish_type, short_catch_use, coop_marketing, coop_profit_sharing, coop_coordinated_harvest,

#What's this?
coop$temperature_change[62] <- coords$temperature_change[coords$fishery_id == 0]

coop_text <- coop %>%
  dplyr::select(original_order, fishery_id, host_country, target_species, lon, lat)

coop_numbers <- coop %>%
  dplyr::select(-c(original_order, fishery_id, host_country, target_species, lon, lat)) %>%
  mutate_all(as.numeric) %>%
  mutate_all(rescale)
```

```
coop_clean <- cbind(coop_text, coop_numbers) %>%
        # Indicators
  mutate(social_capital = (hdi +  number_coop_behaviors + umbrella_organization)/3,
         diversification = (number_of_species + multiple_gears)/2,
         change_anticipation_adaptation = (msc_certification + stock_assesment)/2,
         govermental_support = (number_gov_services + rule_of_law + contract_enforcement_rank)/3,
         material_style_of_life =- poverty_index,
         economic_dependence = percent_of_gdp_from_fishing,
         food_dependence = short_catch_use_numeric,
         #number_people_depending = short_participants,
         habitat_susceptibility = sea_temp_vulnerability,
         overfishing = recorded_closure,
         species_suceptibility = vulnerability,
         temperature_change = temperature_change,
         recovery_potential = recovery_potential, # Recovery potential puede venir de SST recov
         mpa= mpa,
         managed_fishery = managed_fishery,
         # Indicators
         social_adaptive_capacity = (social_capital + diversification + change_anticipation_adaptation
         social_sensitivity = (economic_dependence + food_dependence)/2,
         ecological_exposure = temperature_change,
         ecological_sensitivity = (habitat_susceptibility + species_suceptibility + overfishing)/3,
         ecological_recovery_potential = (recovery_potential + managed_fishery)/2,
         ecological_vulnerability = ecological_exposure + ecological_sensitivity - ecological_recovery_
         # Final score
  score = ecological_vulnerability + social_sensitivity - social_adaptive_capacity)
```

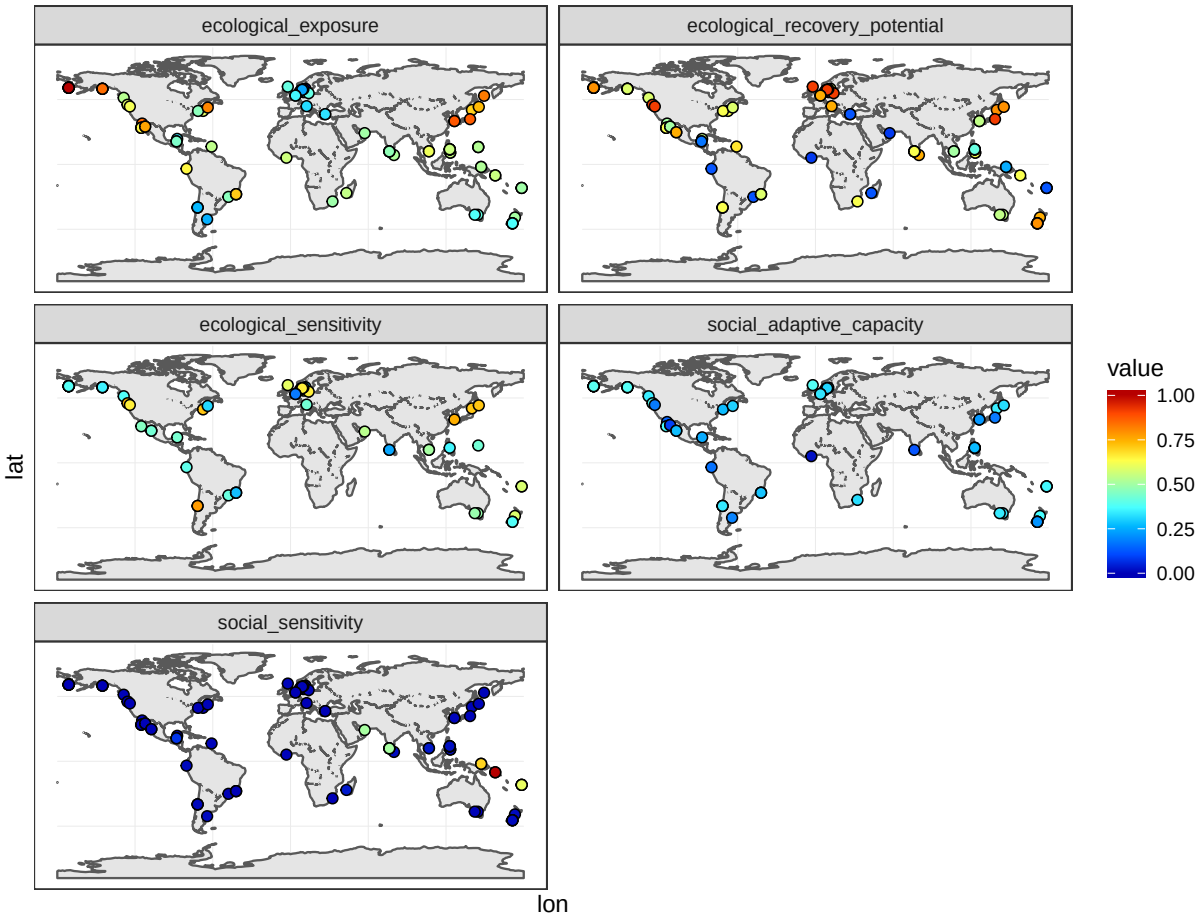
```
coop_clean %>%
  dplyr::select(score) %>%
  drop_na() %>%
  dim()
```

```
## [1] 41  1
```

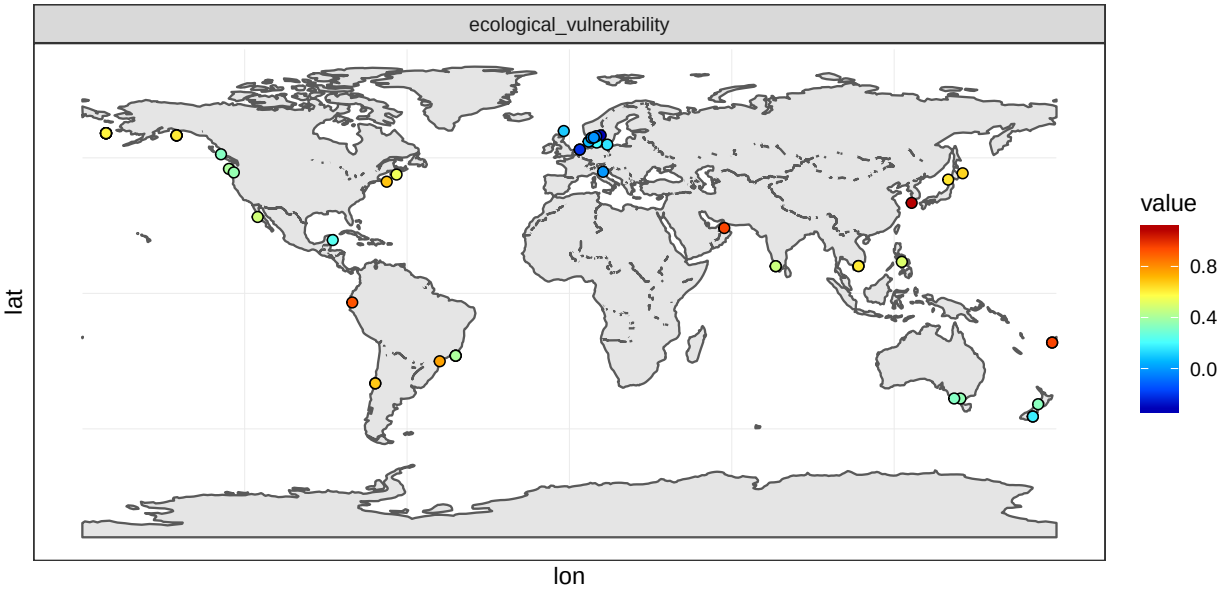
```
coop_clean %>%
  filter(!is.na(score)) %>%
  dplyr::select(fishery_id) %$%
  unique(fishery_id) %>%
  length()
```

```
## [1] 31
```

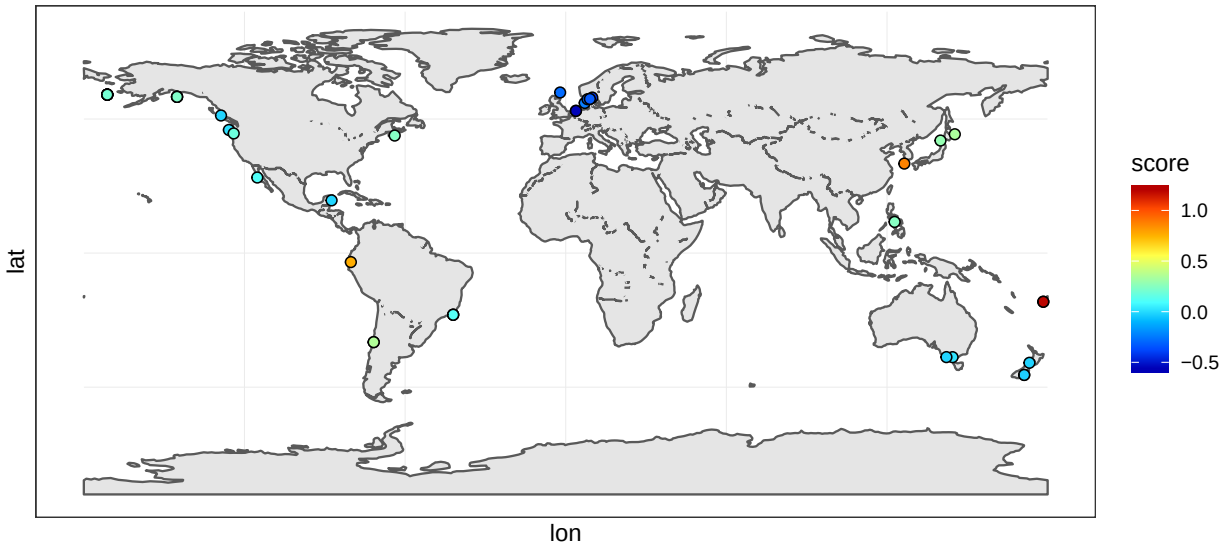
```
World2 <- sf::st_as_sf(World)

coop_clean %>%
  dplyr::select(lon, lat, social_adaptive_capacity, social_sensitivity, ecological_sensitivity, ecologi
  gather(variable, value, -c(lon, lat)) %>%
  drop_na() %>%
  ggplot() +
  geom_sf(data = World2) +
  geom_point(aes(x = lon, y = lat, fill = value), shape = 21, size = 2) +
  theme_bw() +
  scale_fill_gradientn(colours = colorRamps::matlab.like(20)) +
  facet_wrap(~variable, ncol = 2)
```



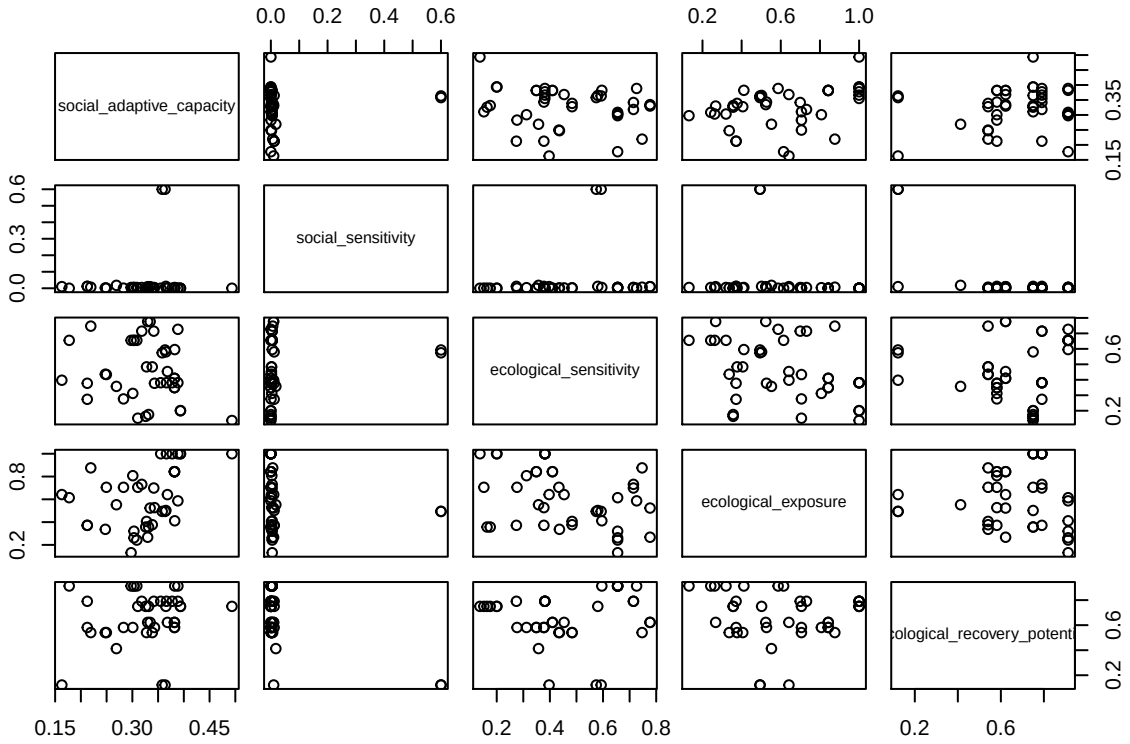

```
coop_clean %>%
  dplyr::select(lon, lat, ecological_vulnerability) %>%
  gather(variable, value, -c(lon, lat)) %>%
  drop_na() %>%
  ggplot() +
  geom_sf(data = World2) +
  geom_point(aes(x = lon, y = lat, fill = value), shape = 21, size = 2) +
  theme_bw() +
  scale_fill_gradientn(colours = colorRamps::matlab.like(20)) +
  facet_wrap(~variable, ncol = 2)
```



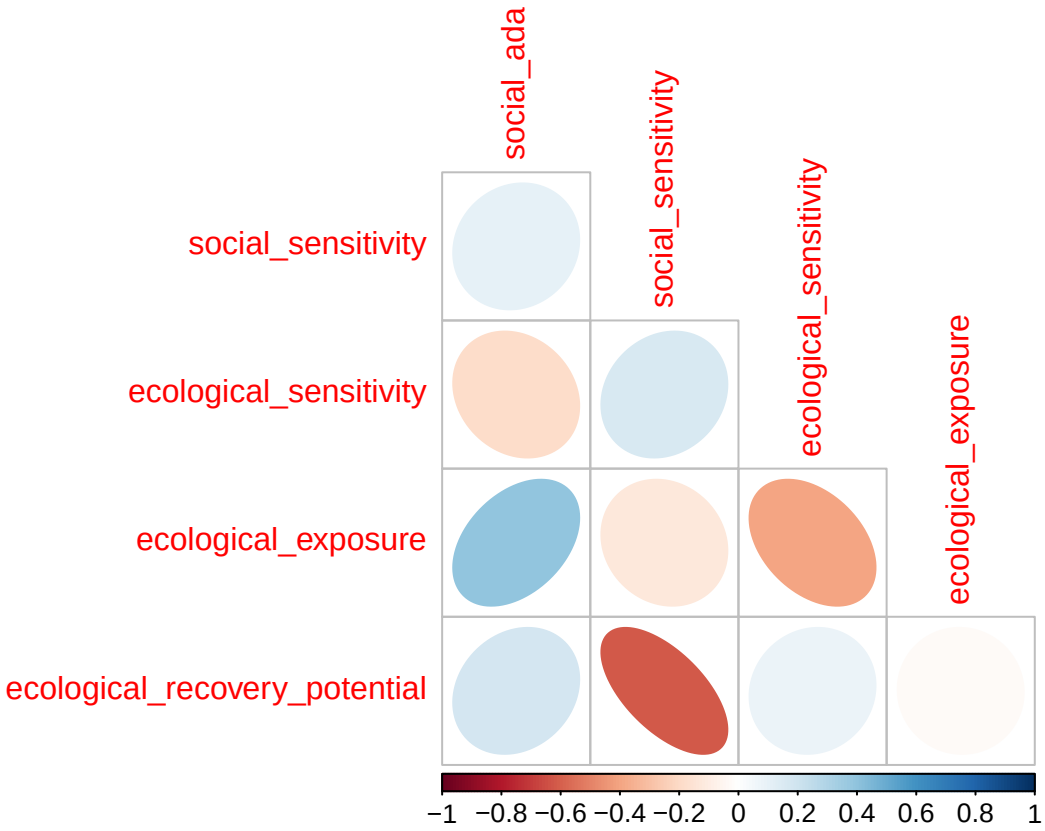

```
coop_clean %>%
  dplyr::select(lon, lat, score) %>%
  drop_na() %>%
  ggplot() +
  geom_sf(data = World2) +
  geom_point(aes(x = lon, y = lat, fill = score), shape = 21, size = 2) +
  theme_bw() +
  scale_fill_gradientn(colours = colorRamps::matlab.like(20))
```




```
coop_clean %>%
  dplyr::select(social_adaptive_capacity, social_sensitivity, ecological_sensitivity, ecological_exposu
  drop_na() %>% plot()
```

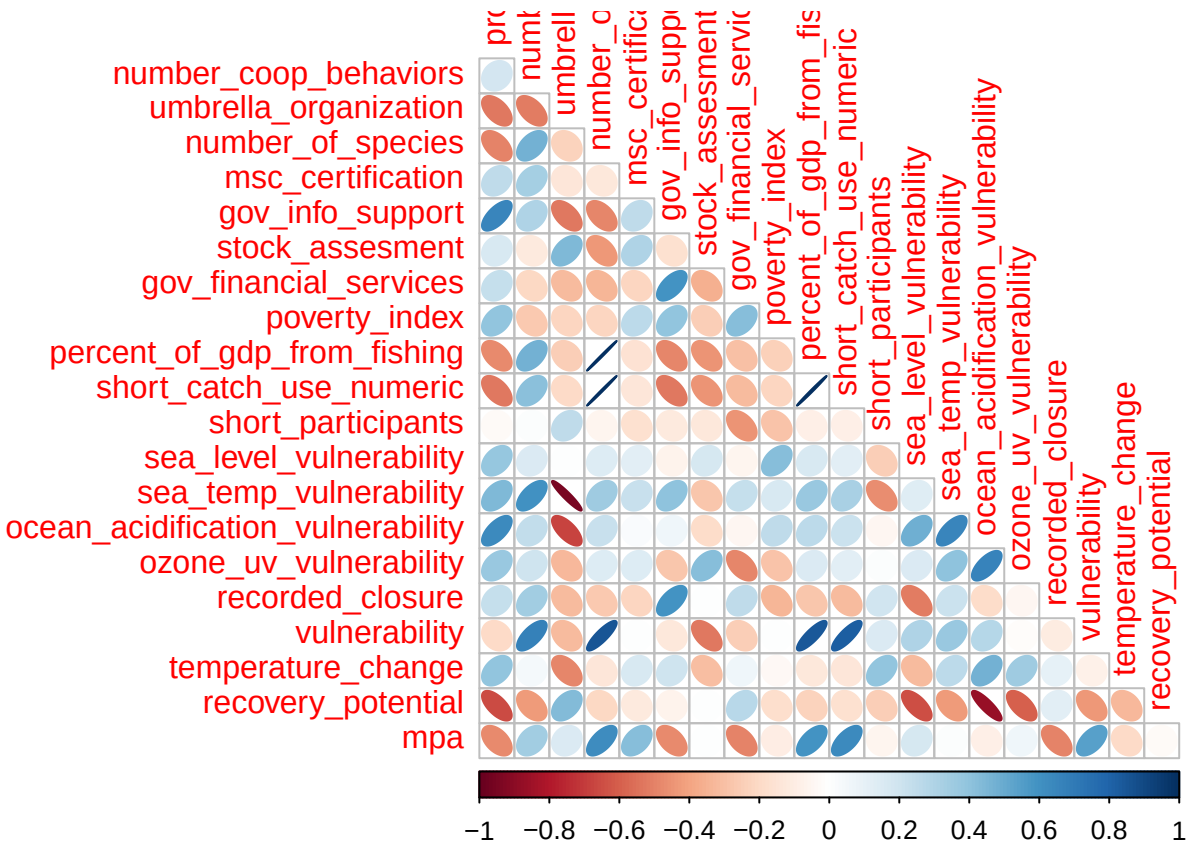



```
library(corrplot)

coop_clean %>%
  dplyr::select(social_adaptive_capacity, social_sensitivity, ecological_sensitivity, ecological_exposu
  drop_na() %>%
  as.matrix() %>%
  cor() %>%
  corrplot(type = "lower", method = "ellipse", diag = F)
```




```
pca_data <- coop_clean %>%
  magrittr::set_rownames(value = paste(.$original_order,
                                       .$fishery_id,
                                       .$host_country,
                                       sep = "-")) %>%
  dplyr::select(programs_for_coop_formation,
                number_coop_behaviors,
                umbrella_organization,
                number_of_species,
                msc_certification,
                gov_info_support,
                stock_assesment,
                gov_financial_services,
                # legal_gov_support,
                # enforcement_gov_support,
                poverty_index,
                percent_of_gdp_from_fishing,
                short_catch_use_numeric,
                short_participants,
                sea_level_vulnerability,
                sea_temp_vulnerability,
                ocean_acidification_vulnerability,
                ozone_uv_vulnerability,
                recorded_closure,
                vulnerability,
                temperature_change,
```

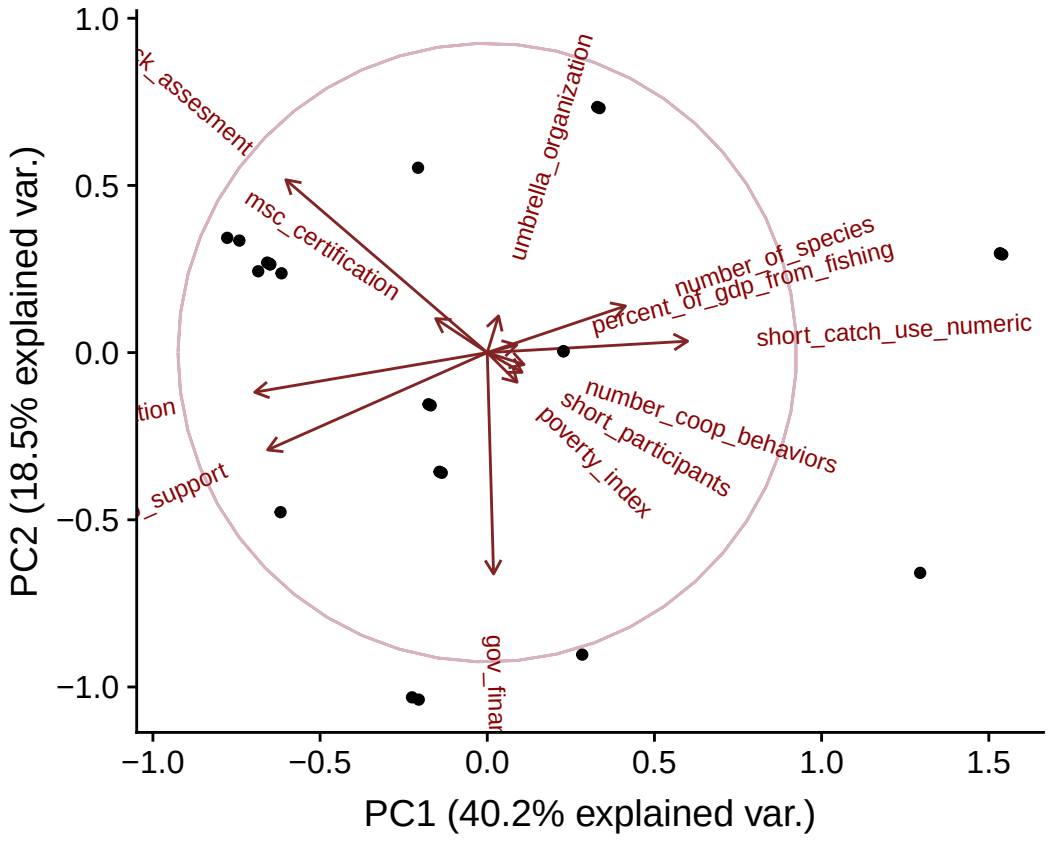
```
                recovery_potential,
                mpa)

pca_data %>%
  drop_na() %>%
  cor() %>%
  corrplot::corrplot(type = "lower", method = "ellipse", diag = F)
```



PCA for Social

```
pca_data %>%
  dplyr::select(programs_for_coop_formation,
                number_coop_behaviors,
                umbrella_organization,
                number_of_species,
                msc_certification,
                gov_info_support,
                stock_assesment,
                gov_financial_services,
                # legal_gov_support,
                # enforcement_gov_support,
                poverty_index,
                percent_of_gdp_from_fishing,
                short_catch_use_numeric,
```

```
                short_participants) %>%
  drop_na() %>%
  as.matrix() %>%
  prcomp() %>%
  ggbiplot::ggbiplot(obs.scale = 1, var.scale = 1, circle = TRUE)
```




```
pca_data %>%
  dplyr::select(vulnerability,
                sea_level_vulnerability,
                sea_temp_vulnerability,
                ocean_acidification_vulnerability,
                ozone_uv_vulnerability,
                recorded_closure#,
                # ecological_exposure,
                # ecological_recovery_potential
                ) %>%
  drop_na() %>%
  as.matrix() %>%
  prcomp() %>%
  ggbiplot::ggbiplot(obs.scale = 1, var.scale = 1, circle = TRUE)
```

How many points would we have by removing a single variable?

```
nas <- numeric(length = dim(pca_data)[2])

for (i in 1:length(nas)){
  testing <- pca_data[,-i]
  nas[i] <- dim(pca_data)[1] - sum(apply(testing, 1, function(x){any(is.na(x))}))
}

nas %>%
  magrittr::set_names(value = colnames(pca_data)) %>%
  as.data.frame() %>%
  magrittr::set_colnames(value = "points")
```

```
##                                   points
## programs_for_coop_formation           13
## number_coop_behaviors                 12
## umbrella_organization                 12
## number_of_species                     13
## msc_certification                     12
## gov_info_support                      16
## stock_assesment                       12
## gov_financial_services                12
## poverty_index                         12
## percent_of_gdp_from_fishing           13
## short_catch_use_numeric               12
## short_participants                    24
## sea_level_vulnerability               12
## sea_temp_vulnerability                12
## ocean_acidification_vulnerability     12
## ozone_uv_vulnerability                12
## recorded_closure                      12
## vulnerability                         17
## temperature_change                    14
## recovery_potential                    12
## mpa                                   17
```

```
coop_clean <- coop_clean %>%
  dplyr::select(-c(7:48))

write.csv(coop_clean, file = here::here("data", "clean_cooperatives_data.csv"), row.names = F)
```