

Technical Guideline Series

Part 3 - Cartographic Guidelines

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This technical guideline will review the necessary and suggested cartographic elements for maps produced as part of IPBES assessments. The guide is split into three components, cartographic elements, disclaimers, and general suggestions and have examples of maps and the code behind them throughout. This guideline is intended for anyone involved in the process of creating maps within IPBES assessments.

Begin by loading the following packages.

```
library(sf)
library(sp)
library(dplyr)
library(magrittr)
library(rnaturalearth)
library(graticule)
library(ggplot2)
library(ggspatial)
```

I. Cartographic Elements and considerations for IPBES assessments:

A. Cartographic Elements Generally the following cartographic elements should be included within each map:

- Map with frame and legend
- Graticules (North arrow and scale are not needed when graticules are included)
- References for each of the layers used to make the map are required within each data deposit package associated with the map

Generally these elements do not need to be included with each map for assessments:

- North arrow and scale bar - do not need to be included when graticules are present
- Titles - should not be included within the map's frame, but rather included in the caption.

Here is an example of creating a world map with these elements. The following code downloads land and ocean polygons from rnaturalearth package, creates latitude and longitude labels and graticules, and then plots a global map in robinson projection.

```
robin <- sp::CRS("+proj=robin +lon_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs")

# Land polygons from rnaturalearth package
world <- rnaturalearth::ne_download(scale = 10, type = 'land', category = 'physical', returnclass = "sf"

## OGR data source with driver: ESRI Shapefile
## Source: "C:\Users\jkumagai\AppData\Local\Temp\RtmpoPIXV1", layer: "ne_10m_land"
## with 11 features
## It has 3 fields

world_robin <- sf::st_transform(world, crs = robin) # changes the projection

# ocean from rnaturalearth package
ocean <- rnaturalearth::ne_download(scale = 10, type = 'ocean', category = 'physical', returnclass = "sf

## OGR data source with driver: ESRI Shapefile
## Source: "C:\Users\jkumagai\AppData\Local\Temp\RtmpoPIXV1", layer: "ne_10m_ocean"
## with 1 features
## It has 3 fields

ocean <- sf::st_transform(ocean, crs = robin) # changes the projection
ocean <- ocean[,1]
```

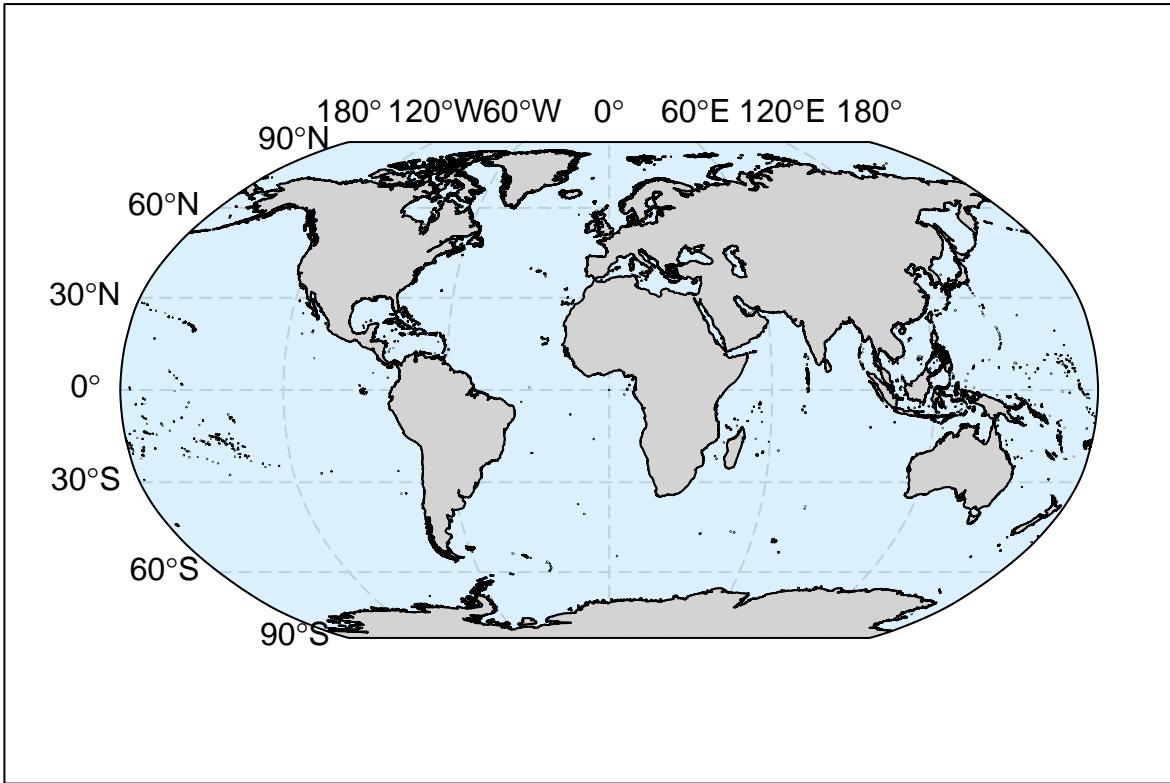
The messages describe the data and where it is downloaded locally.

```
# Creates latitude and longitude labels and graticules
lat <- c(-90, -60, -30, 0, 30, 60, 90)
long <- c(-180, -120, -60, 0, 60, 120, 180)
labs <- graticule::graticule_labels(lons = long, lats = lat, xline = -180, yline = 90, proj = robin) #
lines <- graticule::graticule(lons = long, lats = lat, proj = robin) # graticules
```

The warnings of discarding the datum can be safely ignored in this case*.

Now we set up the plotting frame, and plot the graticules, ocean, land, and latitude and longitude lines.

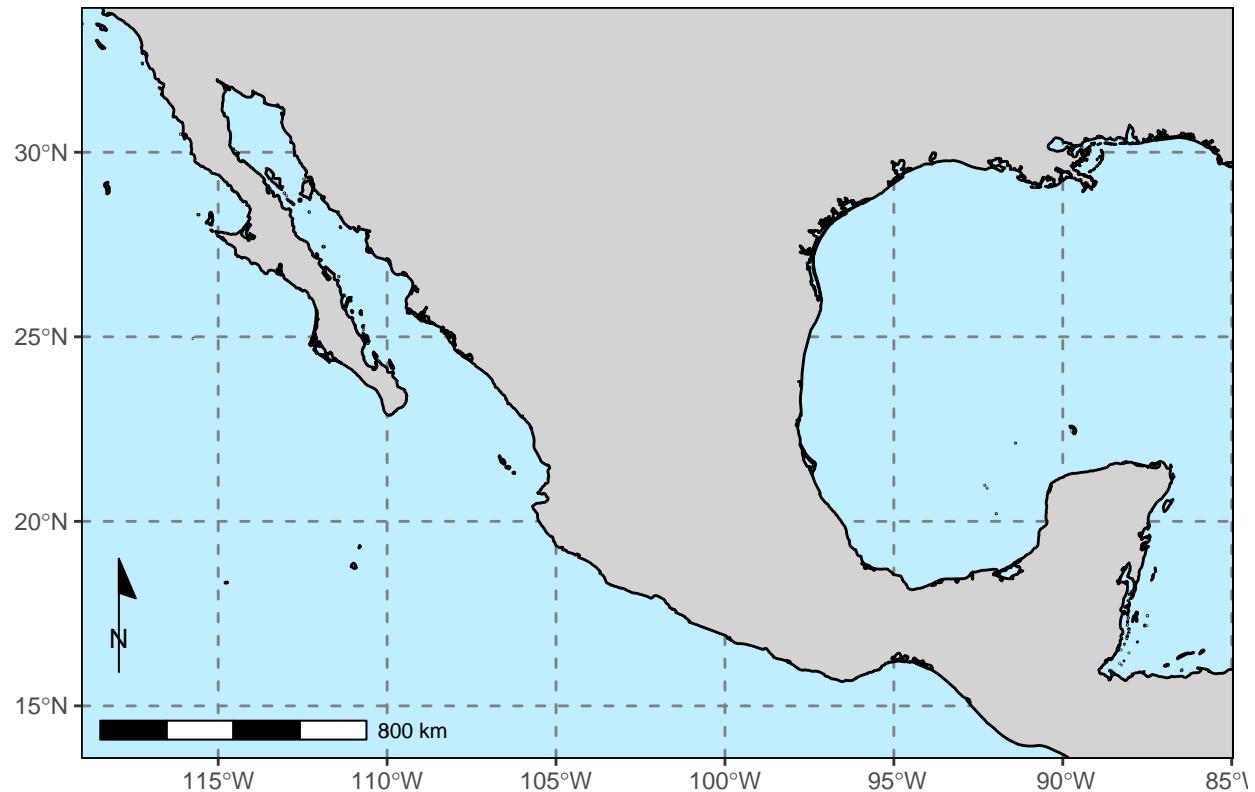
```
# Global Map
par(mar = c(0,3,0,2)) # Adjusts the edges of the frame
plot(lines, lty = 5, col = "lightgrey") # plots graticules
plot(ocean, col = alpha("lightskyblue", 0.3), add = TRUE) # plots ocean polygons
plot(world_robin[,1], col = "lightgrey", add = TRUE) # plots Land boundaries
text(subset(labs, labs$islon), lab = parse(text = labs$lab[labs$islon]), pos = 3, xpd = NA) # plots lon
text(subset(labs, !labs$islon), lab = parse(text = labs$lab[!labs$islon]), pos = 2, xpd = NA) # plots lat
box(which = "plot", lty = "solid") # Map frame
```



We can also use the ggplot package, with some additional functionality added with ggspatial, to map sf objects in R Studio such as in the following example:

```
ggplot() +
  geom_sf(data = world, color = "black", fill = "lightgrey") + # plots the land polygons
  coord_sf(xlim = c(-117.5, -86.5), ylim = c(14.5, 33.0)) + # sets the maps extent
  theme(panel.grid.major = element_line(color = gray(.5), # sets latitude and longitude lines
                                         linetype = "dashed", size = 0.5),
        panel.background = element_rect(fill = "lightblue1"), # sets background panel color
        panel.border = element_rect(colour = "black", fill=NA, size=0.5)) + # sets panel border
  ggspatial::annotation_north_arrow(location = "bl", which_north = "true", # sets north arrow
                                     style = north_arrow_minimal,
                                     pad_x = unit(-0.1, "in"), pad_y = unit(0.45, "in")) +
  ggspatial::annotation_scale(location = "bl") # sets scale bar

## Scale on map varies by more than 10%, scale bar may be inaccurate
```



B. Projections IPBES has adopted the Robinson projection for all global scale maps.

The Robinson projection balances distortions in area, direction, distance, and distortions near the poles. We encourage the use of Pacific centered maps when focused on marine or Pacific themes. The `pacificCentric` function within the `envirem` package can recenter a raster on the Pacific.

For maps of countries or regions, national or appropriate regional projections are recommended. If there is no specific country projection available, the relevant Universal Transverse Mercator zone projection is suggested.

C. Color Considerations Color is a critical key to communicating information to viewers within a map. Colors need to be used consistently in maps and figures. Often incorrect or inconsistent color schemes are used that either make it difficult for people to understand the map or bias the interpretation. For more information, please refer to the next technical guideline, Guidelines for Colour.

II. Disclaimers:

The standard disclaimers that should appear on all maps within IPBES assessments are the following:

Short form

The boundaries and names shown, and the designations used on the maps shown here do not imply official endorsement or acceptance by IPBES.

Long form

The designations employed and the presentation of material on the maps used in the assessment do not imply the expression of any opinion whatsoever on the part of IPBES concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. These maps have been prepared or used for the sole purpose of facilitating the assessment of the broad biogeographical areas represented therein and for purposes of representing scientific data spatially.

For more information on how to display disputed or contentious boundary lines and territories, please contact the TSU on knowledge and data (tsu.data@ipbes.net)

III. Suggestions:

Streamlining the design of maps allows for better comparison and integration. Therefore, to facilitate the standardization of maps within IPBES, we recommend the following:

- Avoid country borders, if needed country borders are black, continuous, and 0.2 in size
- Include all continents in global maps, including Antarctica
- Use color schemes and projections consistently throughout the chapter, if possible throughout the assessment.
- Color schemes should be consistent with the ones used for figures.
- No data is symbolized with the color grey (BBBBBB; RGB:187, 187, 187)
- White or light sky blue (87CEFA; RGB: 135, 206, 250) is used for the ocean
- Do not add excessive labels which interfere with interpretation of the map as a whole

Here we also include some popular resources for global scale spatial data:

- Administrative borders: <https://gadm.org/data.html>
- Marine regions: <https://www.marineregions.org/downloads.php>
- Coast lines, land, and ocean boundaries: <https://www.naturalearthdata.com/downloads/>

Your feedback on this content is welcome. Let us know what other useful material would you like to see here by emailing tsu.data@ipbes.net

*The warnings of discarding the datum but preserving the `+towgs1984 = values` stem from an update from PROJ4 to PRROJ6 but is not worrisome in this case. The `+datum=` part is deprecated from GDAL >3 and sf, rgdal, and raster packages use GDAL to read files. There is a stackoverflow thread with more information here