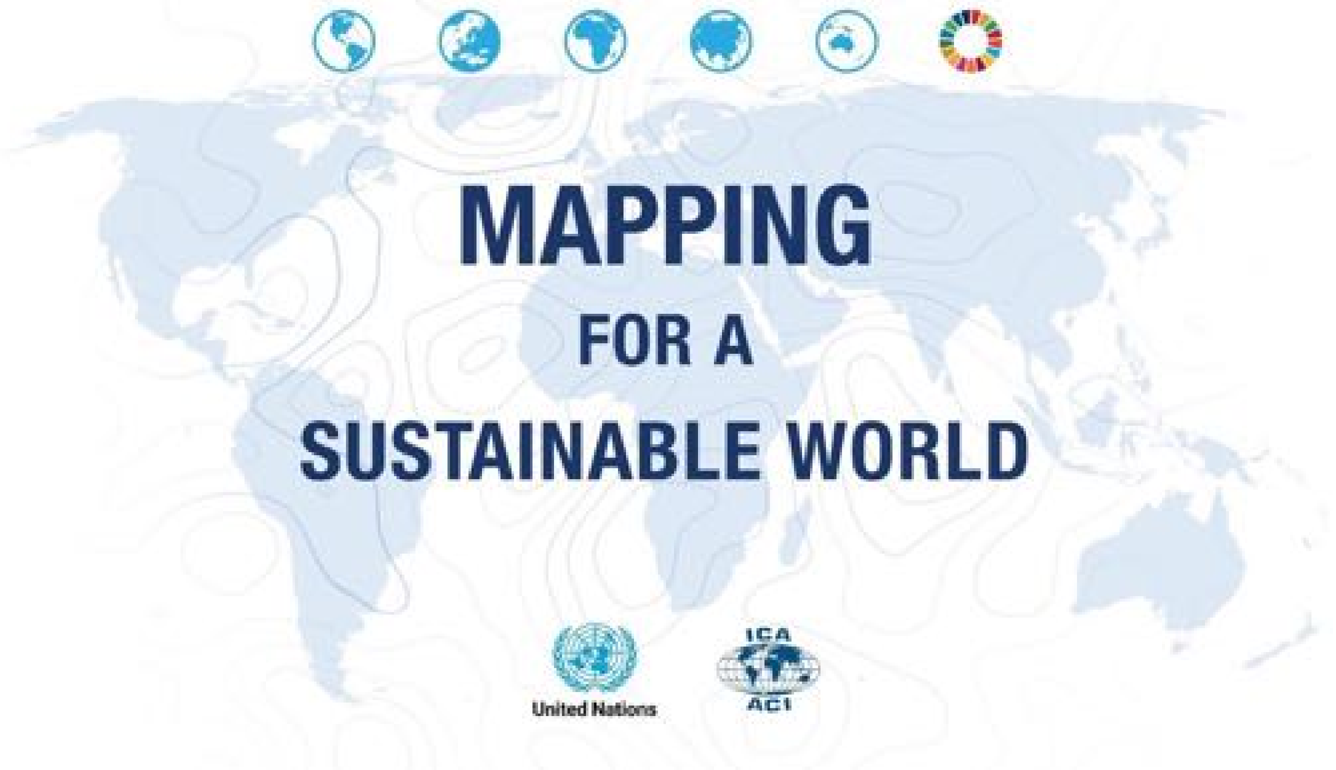
UN-GGIM Geospatial Societies

side event 10-08-2021

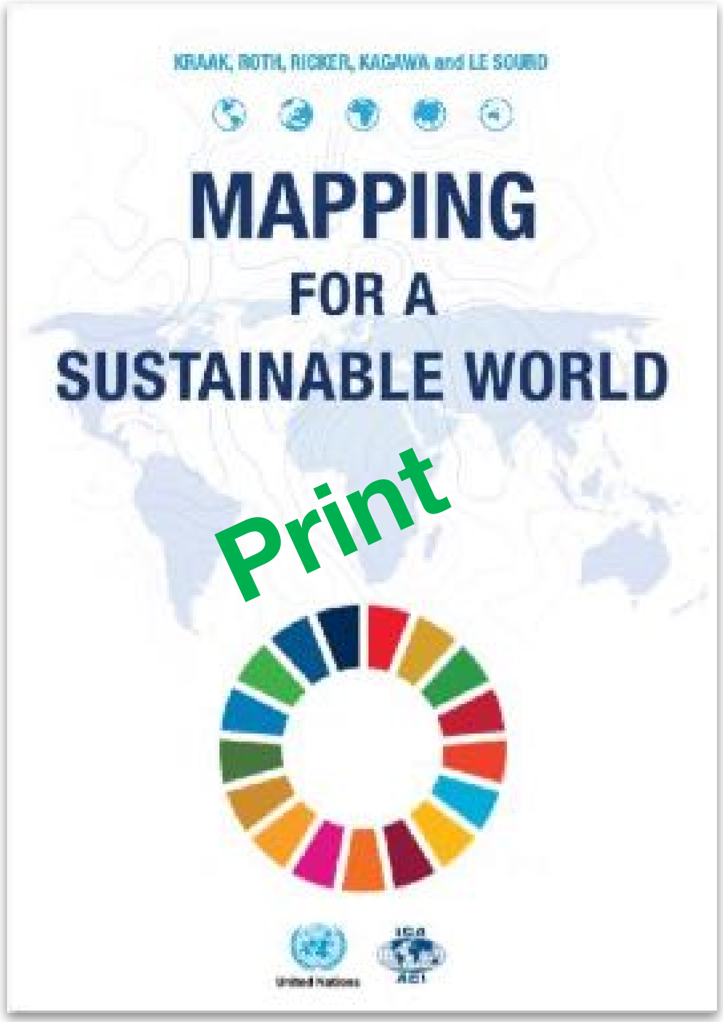


Our project

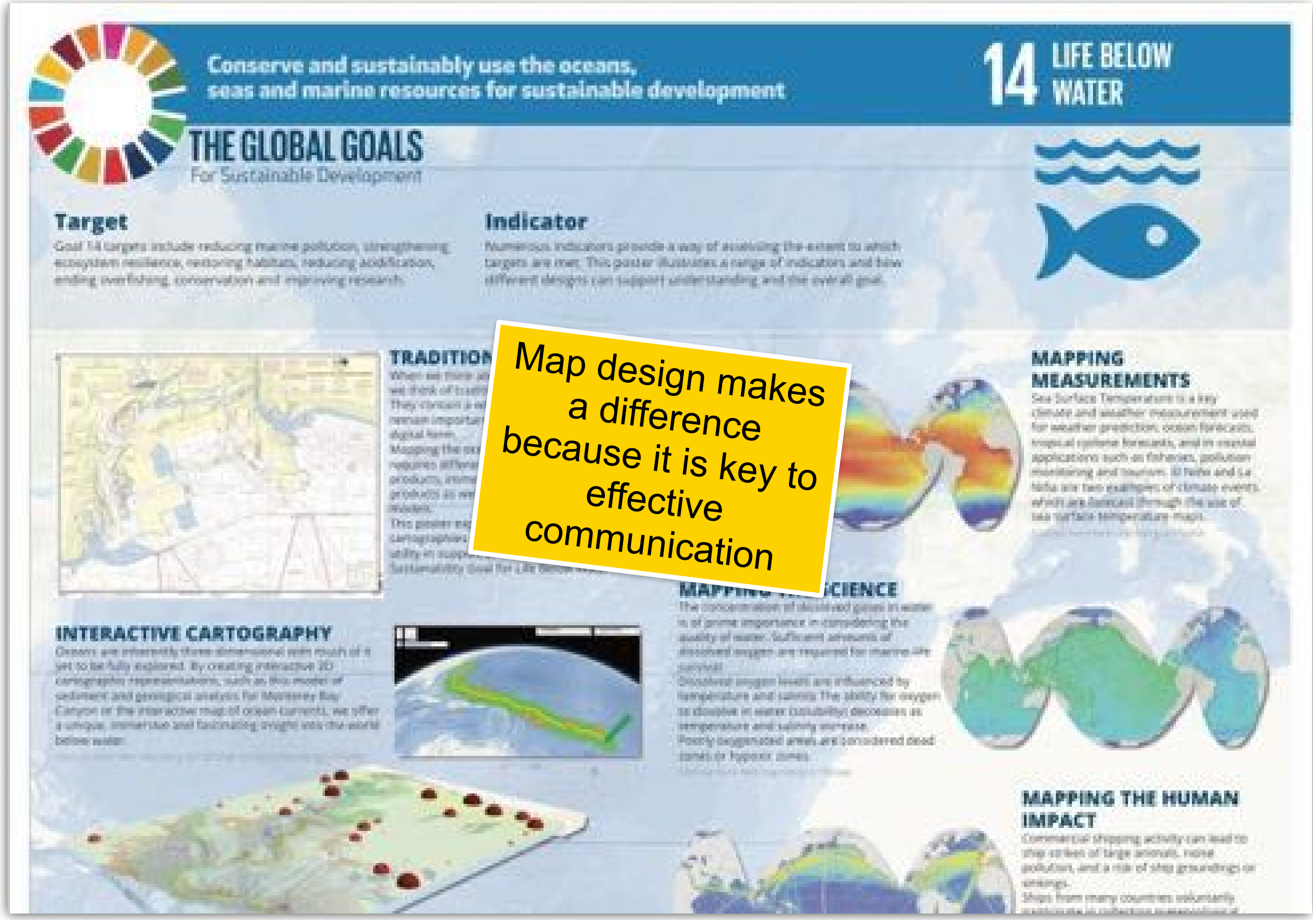
https://www.un-ilibrary.org/content/books/9789216040468

Kraak, Roth, Ricker, Kagawa, and Le Sourd
Mapping for a Sustainable World
New York: United Nations (2020)

UNIVERSITY OF TWENTE.



What we did before

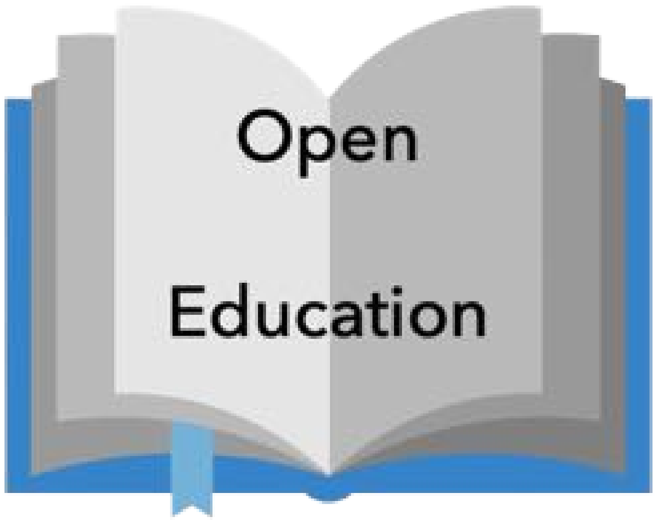


Map design makes a difference because it is key to effective communication

UN-GGIM

UN-GGIM › Bureau

Open Access


Open
Education


13 CLIMATE ACTION
14 LIFE BELOW WATER
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Content

- SDGs & Geospatial Data
- Map design considerations
- Maps & diagrams
- Map Use Environments

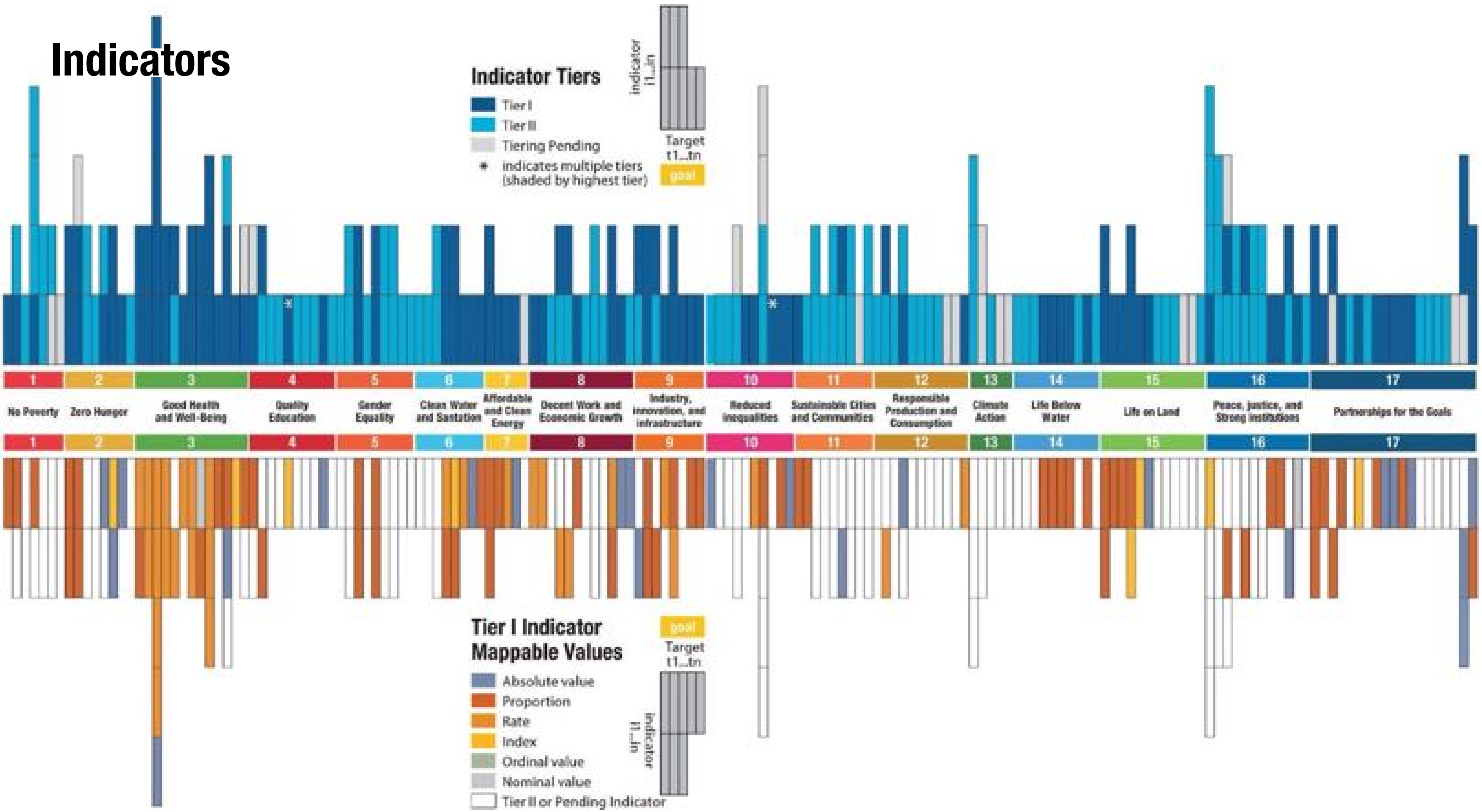
Structure & Table of Contents

The book comprises four sections. Section 1 introduces the SDGs and their relation to geospatial data, describing SDG indicators and data transformations for mapping. Section 2 describes foundational design decisions in the cartographic workflow including projections, scale, generalization, symbolization, typography, and visual hierarchy among others. Section 3 introduces common map types (e.g., choropleth maps, proportional symbol maps, dasymetric maps, bivariate maps, cartograms) and diagrams (e.g., bar charts, scatterplots, timelines) for representing the SDG indicators. Finally, Section 4 discusses considerations for map use environments such as audiences, user interfaces and interaction operators, mobile and web media, storytelling versus exploration, and open access.

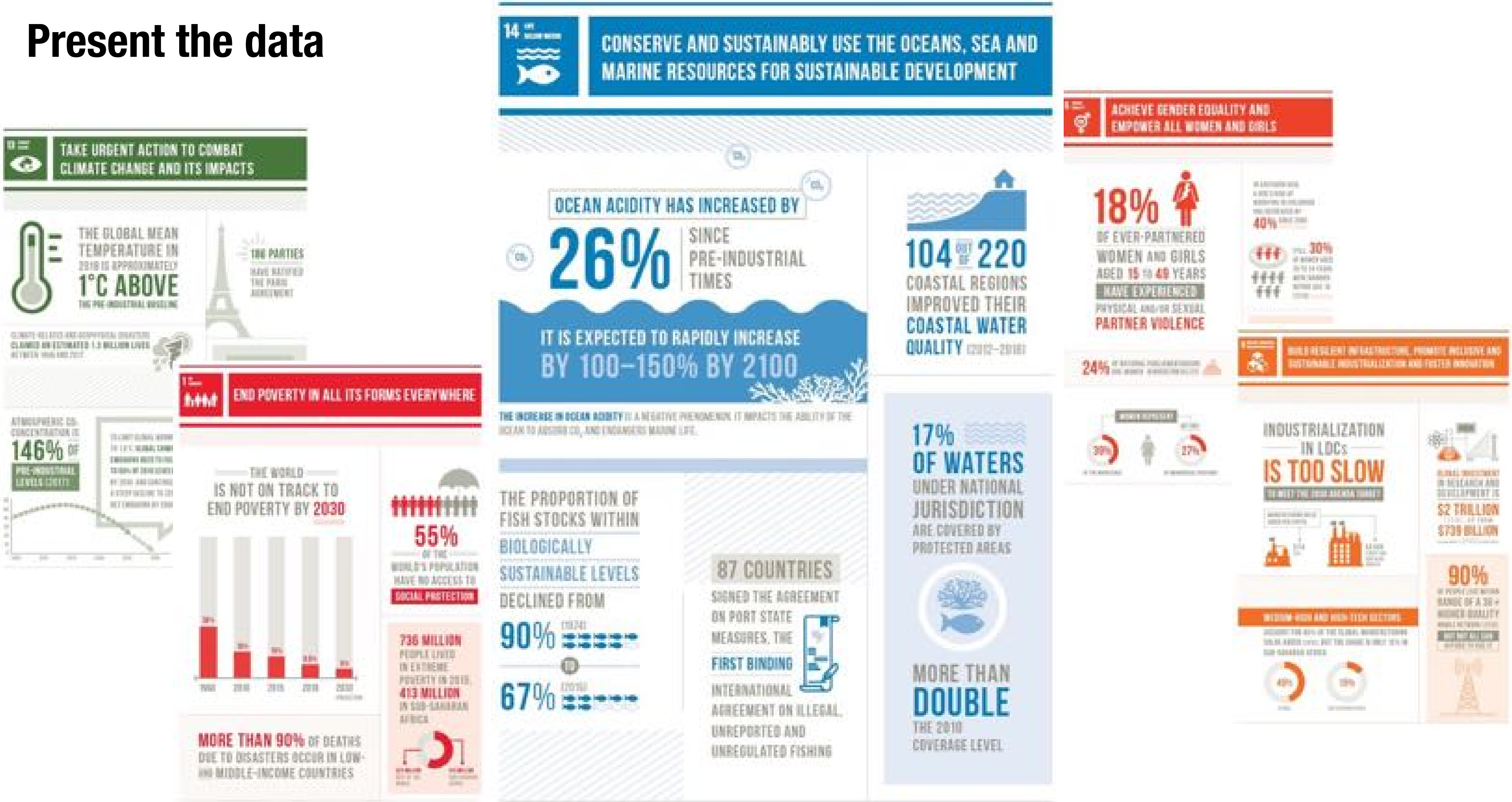
Women in Politics: 2012


SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Indicators


Indicator Tiers
Tier I
Tier II
Tiering Pending
* indicates multiple tiers (shaded by highest tier)
indicator t1...tn
Target t1...tn
goal
No Poverty
Zero Hunger
Good Health and Well-Being
Quality Education
Gender Equality
Clean Water and Sanitation
Affordable and Clean Energy
Decent Work and Economic Growth
Industry, Innovation, and Infrastructure
Reduced Inequalities
Sustainable Cities and Communities
Responsible Production and Consumption
Climate Action
Life Below Water
Life on Land
Peace, Justice, and Strong Institutions
Partnerships for the Goals
Tier I Indicator Mappable Values
Absolute value
Proportion
Rate
Index
Ordinal value
Nominal value
Tier II or Pending Indicator

Present the data



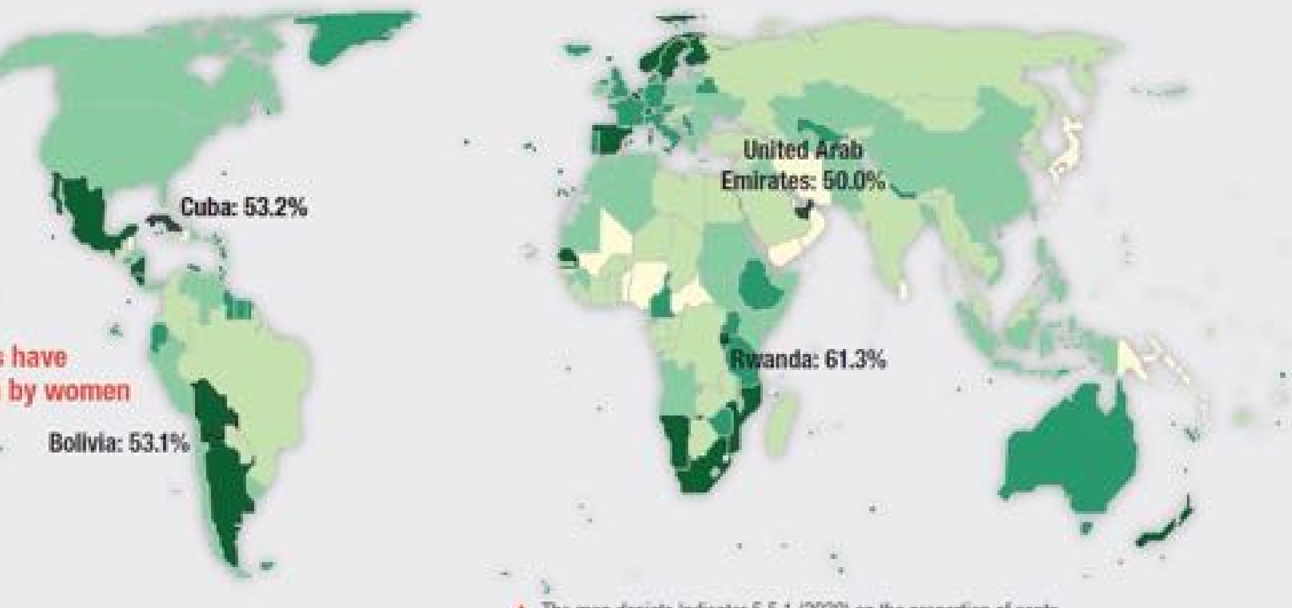
GOAL 5: ACHIEVE GENDER EQUALITY AND EMPOWER ALL WOMEN AND GIRLS

SDG Target 5.5

Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making

► **Only 24% of parliamentary leaders were women in 2020**

► **Only four national parliaments have 50% or greater representation by women**



▲ The map depicts Indicator 5.5.1 (2020) on the proportion of seats held by women in national parliaments as a choropleth map. Countries for the choropleth map are highly generalized to show only the overall thematic patterns, simplifying the message. This style also increases the visual weight of smaller nations. UN Women promotes this basemap for its publication on "Women in Politics."

Although simplified, the map remains projected in the Eckert IV equivalent projection used throughout the book, allowing for comparison of areas in the choropleth. The choropleth map uses an equal interval classification for the uniform attribute distribution and a sequential colour scheme that crosses yellow to green colour hues but primarily relies on the ordered visual variable colour value.

◄ Wide view of the opening meeting of the sixty-fourth session of the Commission on the Status of Women (CSW). Member States adopted a political declaration in which they pledged to step up action to fully implement the landmark Beijing Declaration and Platform for Action on gender equality, agreed to 25 years ago. (Source: UN Photo/Loey Felipe, 2020)

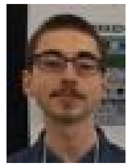
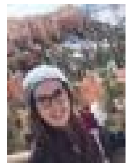
5 GENDER EQUALITY

Cartography lab - UWM

Tanya Buckingham Andersen
Creative Director

Student Cartographers:



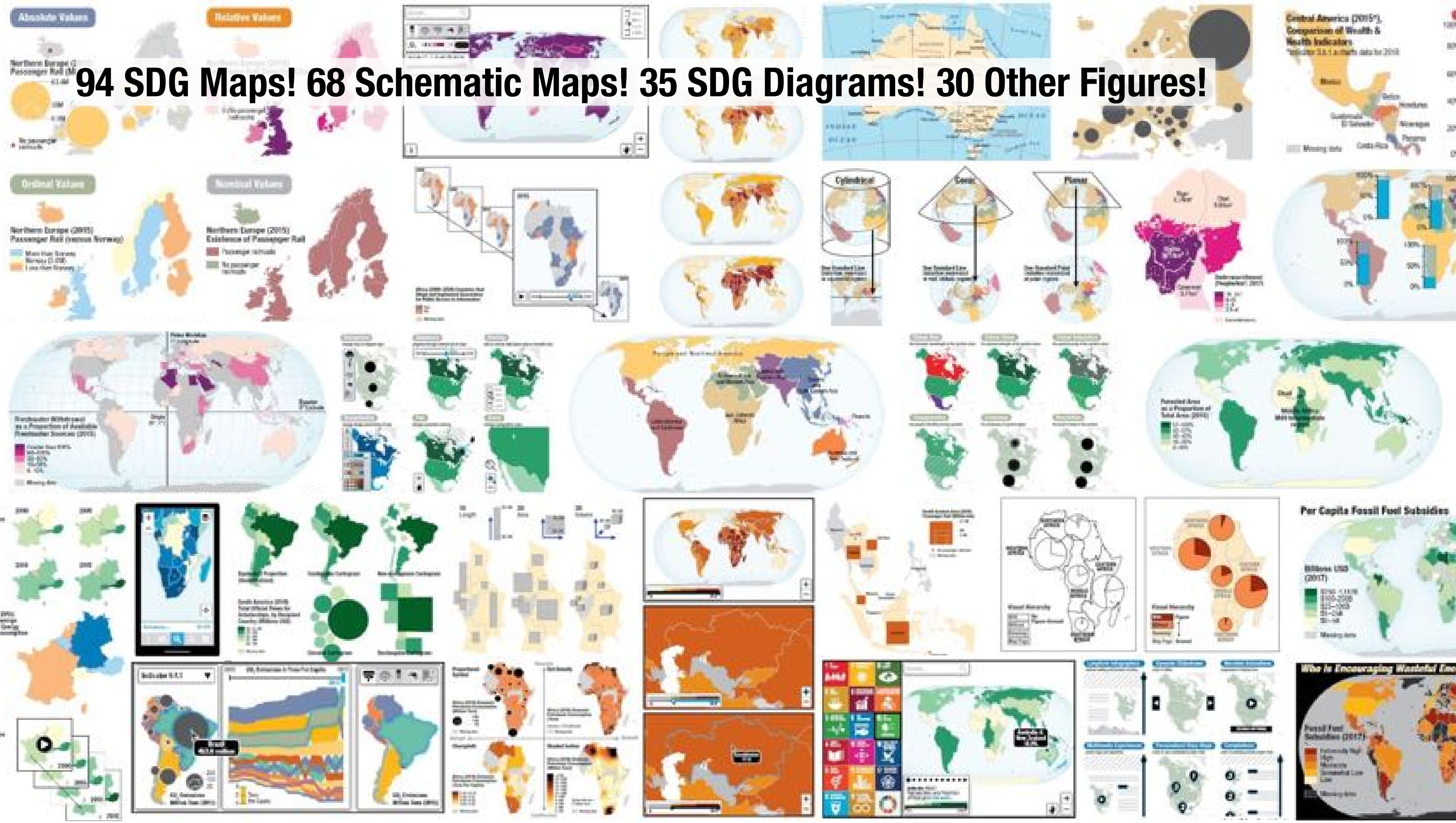
Alicia Iverson (PhD)

Chris Archuleta (BSc)

Gareth Baldrica-Franklin (MSc)

Megan Roessler (MSc)

94 SDG Maps! 68 Schematic Maps! 35 SDG Diagrams! 30 Other Figures!



GOAL 1: END POVERTY IN ALL ITS FORMS EVERYWHERE

SDG Target 1.1
Eradicate extreme poverty for all people everywhere

► 736 million people lived in extreme poverty in 2015

► Most people that earn less than 1.90 USD per day live in Sub-Saharan Africa

Proportion of Population Living Below the International Poverty Line (Most Current Value; 2012–2018)

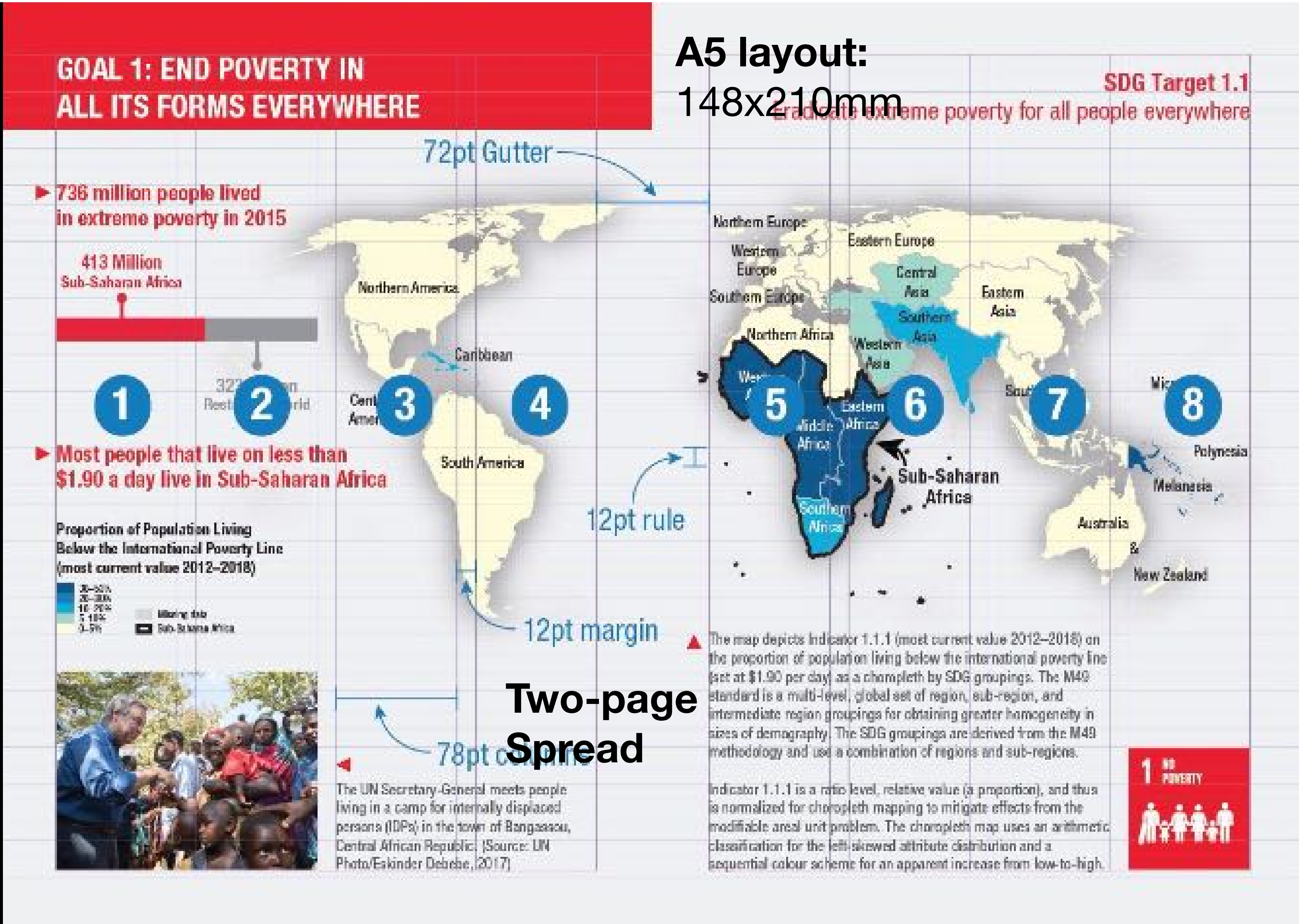
Missing data
Sub-Saharan Africa

▲ The map depicts Indicator 1.1.1 (most current value for 2012–2018) on the proportion of population living below the international poverty line (set at 1.90 USD per day) as a choropleth by SDG groupings. The M49 standard is a multi-level, global set of region, sub-region, and intermediate region groupings for obtaining greater homogeneity in sizes of demography. The SDG groupings are derived from the M49 methodology and use a combination of regions and sub-regions.

Indicator 1.1.1 is a ratio level, relative value (a proportion) and, thus, is normalized for choropleth mapping to mitigate effects from the modifiable areal unit problem. The choropleth map uses an arithmetic classification for the left-skewed attribute distribution and a sequential colour scheme for an apparent increase from low to high.

◄ The UN Secretary-General meets people living in a camp for internally displaced persons (IDPs) in the town of Bangassou, Central African Republic. (Source: UN Photo/Eskinder Debebe, 2017)

1 NO POVERTY

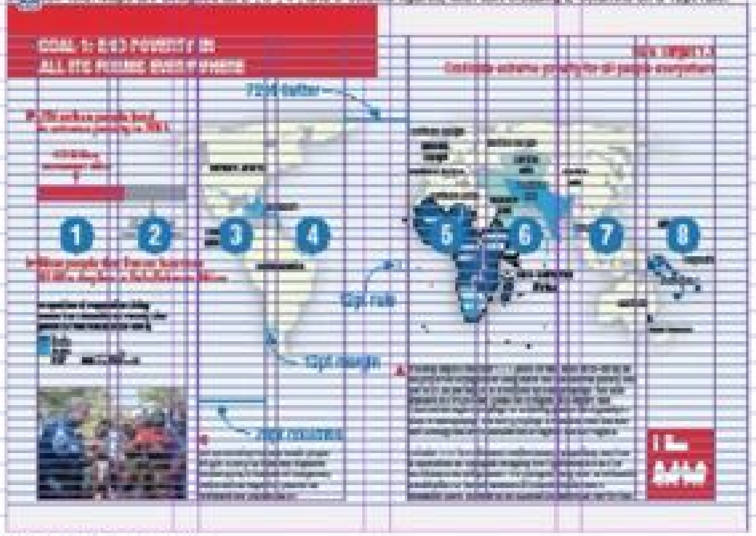

A5 layout:
148x210mm
Two-page
Spread
GOAL 1: END POVERTY IN
ALL ITS FORMS EVERYWHERE
SDG Target 1.1
Eradicate extreme poverty for all people everywhere
72pt Gutter
12pt rule
12pt margin
78pt columns
736 million people lived
in extreme poverty in 2015
413 Million
Sub-Saharan Africa
Most people that live on less than
$1.90 a day live in Sub-Saharan Africa
Proportion of Population Living
Below the International Poverty Line
(most current value 2012–2018)
1
2
3
4
5
6
7
8
Northern America
Caribbean
South America
Northern Europe
Eastern Europe
Western
Europe
Southern Europe
Central
Asia
Eastern
Asia
Southern
Asia
Northern Africa
Western
Asia
Eastern
Africa
Southern
Africa
Sub-Saharan
Africa
Polynesia
Melanesia
Australia
&
New Zealand
The map depicts Indicator 1.1.1 (most current value 2012–2018) on the proportion of population living below the international poverty line (set at $1.90 per day) as a choropleth by SDG groupings. The M49 standard is a multi-level, global set of region, sub-region, and intermediate region groupings for obtaining greater homogeneity in sizes of demography. The SDG groupings are derived from the M49 methodology and use a combination of regions and sub-regions.
Indicator 1.1.1 is a ratio level, relative value (a proportion), and thus is normalized for choropleth mapping to mitigate effects from the modifiable areal unit problem. The choropleth map uses an arithmetic classification for the left-skewed attribute distribution and a sequential colour scheme for an apparent increase from low-to-high.
The UN Secretary-General meets people living in a camp for internally displaced persons (IDPs) in the town of Bangassou, Central African Republic. (Source: UN Photo/Eskinder Debebe, 2017)
1 NO POVERTY

4.11 Atlases

An ***atlas*** is an intentional sequence of maps, text, and other graphic elements depicting different dimensions of geographic phenomena and processes. Many atlases focus into a specific subject, such as a particular thematic domain (*who/what*), time period (*when*), or location (*where*) (see Section 2.1). Atlases serve a variety of purposes, including general reference or geographic education as well as awareness and outreach. An atlas's editorial board contributes to its authority, especially for national atlases.

Atlas design depends heavily on the presentation medium. Traditional atlases are published as printed books. Here, each map is arranged as a two-page layout for folded printing, called a ***spread***, with a vertical gap, or ***gutter***, in the centre to account for the book-fold (**Figure 4.11-1**). Projections should be centred so that the gutter slices the map in negative space (see Section 2.5), such as the ocean for a world map on land-based SDG indicators. The atlas spread also should be organized into a regular ***grid*** of columns and/or rows, such as the 8-column grid used in this smaller A5-size book or a 12-column grid for larger print publications and responsive design for mobile maps (see Section 4.6). Using a grid improves the layout and balance of maps, text, and negative space in more complex atlas spreads (see Section 2.13).

Figure 4.11-1: Traditional atlas spread. The 8-column grid used in this book is shown beneath the Section 1.3 two-page spread. Each column is 78pt with a 12pt margin, with a 72pt gutter expanding the Atlantic Ocean to account for the book-fold. Maps are designed as 2-, 3-, 4-, and 6-column figures, with text crossing 2-columns on a 12pt rule.



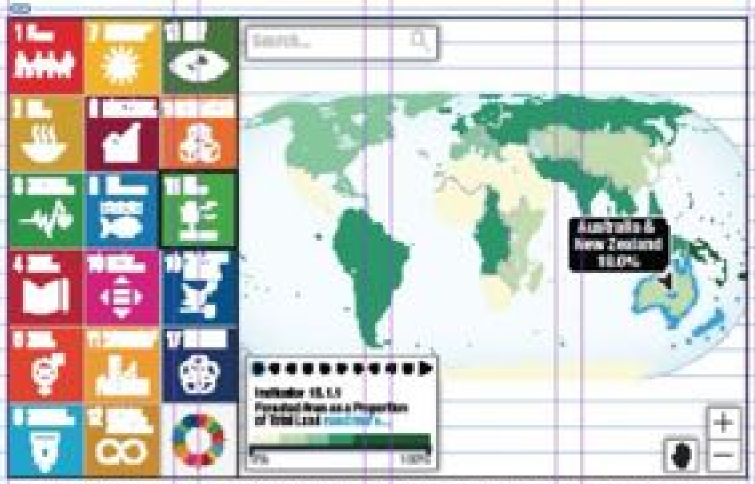


Figure 4.11-2: Interactive atlas. Like a traditional atlas, an interactive atlas organizes datasets and maps by themes, such as individual SDG indicators. The audience first selects an SDG (here, SDG 15, Life on Land) and then scrolls through a slideshow sequence of maps (here, the indicators that constitute SDG 15). Users can activate additional information about a specific indicator based on their interest. Because the atlas is interactive, users also can search for specific indicators or places as well as pan, zoom, retrieve details, and possibly perform additional operators.

Digital atlases can take a number of alternative forms, such as a series of unique web pages hyperlinked from a table of contents or a set of map layers toggled onto the same central basemap. Digital atlases typically include interactivity, particularly the overlay, search, and sequence operators in addition to the more common pan, zoom, and retrieve operators (see Section 4.4). Digital atlases also can serve as the spatial catalogue to a rich array of multimedia about mapped topics, including text, photographs, animations, and videos.

The order of the atlas pages shapes the overall atlas narrative (see Section 4.7). A paper atlas has a fixed narrative, although users often browse pages out of this order. A digital atlas provides more opportunity for breaking from a pre-defined narrative path based on audience backgrounds and interests (see Section 4.1).

An interactive atlas of the SDGs is increasingly possible as more SDGs indicators attain Tier 1 status (**Figure 4.11-2**). The World Bank published an initial compendium on the SDGs using their world development indicators as proxies to the indicators. Creation of an atlas of the SDG indicators has many challenges, such as global distribution, multilingual translation, and regular updates. However, it could be a centerpiece for supporting local and national decision-making as well as public education and advocacy.

2.8 Dimensionality

Dimensionality describes the minimum number of coordinates needed to specify an object's location. In a vector data model, geospatial data can be specified as points (conceptually "zero" dimensions, one X,Y coordinate), lines (1D, minimum two coordinates to connect the arc), polygons (2D, minimum three coordinates to enclose area), or volumes (3D, with a minimum of four coordinates to enclose the volume) (see Section 1.3). Maps often contain a mixture of features at multiple dimensions (Figure 2.8-1).

In the map shown in the bottom-right of Figure 2.8-1, the buildings are resized based on a height classification, an individual level attribute of the building. Such statistical use of the third dimension sometimes is described as "2.5D" because it only depicts the top surface of the volume in a static map rather than complete 3D information within the volume. The third dimension also can be used to express temporal data (see Section 3.9).

Consideration of dimensionality is important during generalization, as the same map features may be represented at different dimensionalities to reduce visual complexity when moving from larger to smaller cartographic scales (see Figure 2.7-1). ***Collapse*** describes a decrease of dimensionality, such as replacement with a city boundary with a single point at smaller scales. ***Aggregate*** describes an increase in dimensionality, such as enumeration of individual people into a single administrative polygon. Finally, ***merge*** describes a combination of many features into one feature while maintaining dimensionality, such as merging individual countries into larger M49 regions.

Dimensionality is important to thematic mapping (see Section 3.1), as humans perceive lines, polygons, and volumes differently when encoding attribute or temporal information (Figure 2.8-2). Lines symbols (1D), such as proportional bars, require visual estimation in a single direction and are largely reliable when used to encode numerical data. However, areal proportional symbols (2D) require estimation in two directions, producing a systematic underestimation as polygon sizes grow larger that can be mitigated through perceptual scaling (see Section 3.4). Underestimation of volumes (3D) is even more severe, and 3D representations usually require interactivity (see Section 4.3).

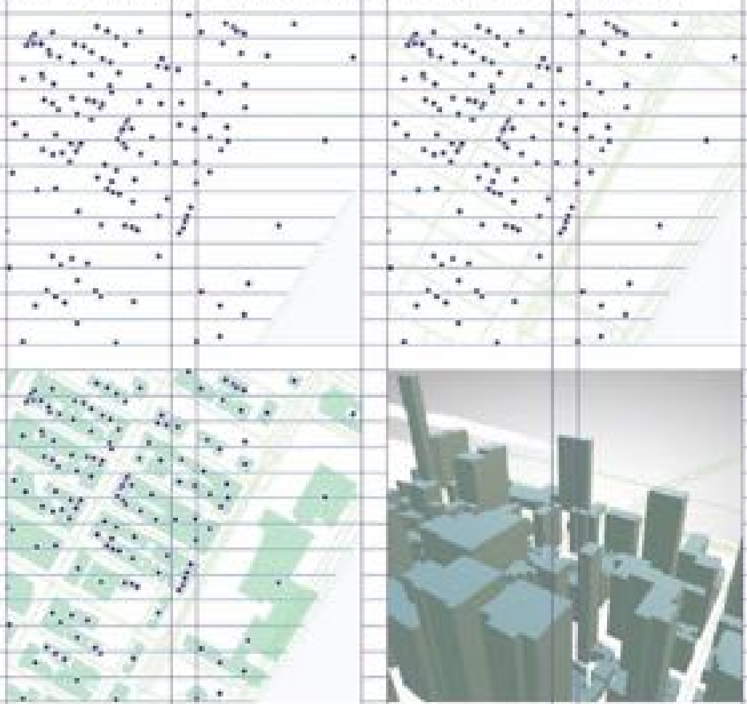


Figure 2.8-1: Symbol dimensionality. The series of figures builds up the Figure 1.2-2 reference map showing the United Nations headquarters. **Top-left:** Address location points (0D). **Top-right:** Street centre lines (1D). **Bottom-left:** Building footprints polygons (2D). **Bottom-right:** Change to an oblique perspective to depict building heights (2.5D).

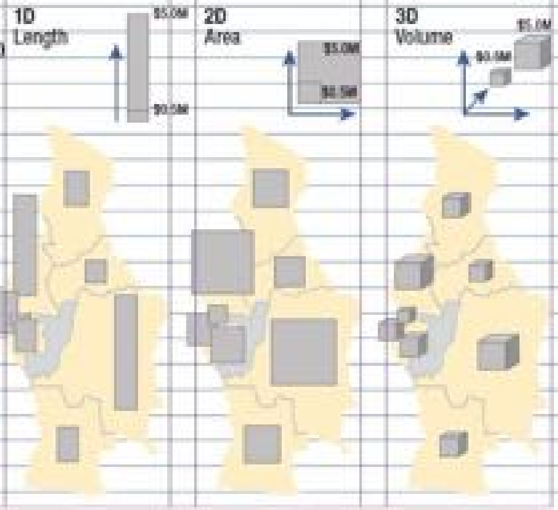


Figure 2.8-2: Perceptual effects on symbol dimensionality. Indicator 4.b.1 (2009) on total official flows for scholarships in Middle Africa is represented as proportional symbol maps by three dimensions. The maps depict the same data, but areas and volumes are perceptually scaled to account for underestimation.

3.7 Bivariate Maps

A ***bivariate map*** (bi=two, variate=variables) depicts two data attributes in a single thematic map. Bivariate maps can be powerful for visual interpretation of spatial patterns, particularly for comparing the spatial distribution of two potentially related SDG indicators as well as for identifying outlier locations that do not conform to an expected relationship between SDG indicators. However, bivariate maps can be confusing and even misleading because they exhibit increased information complexity and are found less frequently in popular media.

In practice, it is useful to consider three kinds of bivariate maps based on combinations of the visual variables: separable (e.g., thematic map combinations, shaded cartograms, shaded proportional symbols), integral (e.g., bivariate choropleth maps), and configural (e.g., split symbol maps). Bivariate map legends should be plotted with X- and Y-axes to show all possible symbol combinations (Figure 3.7-1) and, thus, inform how each symbol combination should be read in the resulting map.

A ***separable*** bivariate map preserves reading of both original X and Y indicators in the map, with a separable map functionally serving like two different maps on a single page (Figure 3.7-2). Use separable maps for independent indicators with different attribute units, such as comparing an absolute frequency to a relative percentage or an unnormalized indicator to a normalized variant.

An ***integral*** bivariate map restricts reading of the original X and Y indicators but promotes reading of the + relationship between indicators, making it easier to infer correlations and identify places that do not conform to the expected relationship (Figure 3.7-3). Use integral maps for dependent indicators in the same attribute units for visual correlation. Avoid integral maps when there is no known correlation as they can be misleading and infer a causal relationship.

A ***configural*** bivariate map maintains reading of the original X and Y attributes while including a visual hint about the + relationship that can be used for visual correlation (Figure 3.7-4). Use configural maps for independent indicators in the same attribute units. These are useful for comparing temporal changes, such as before versus after, or subsets within

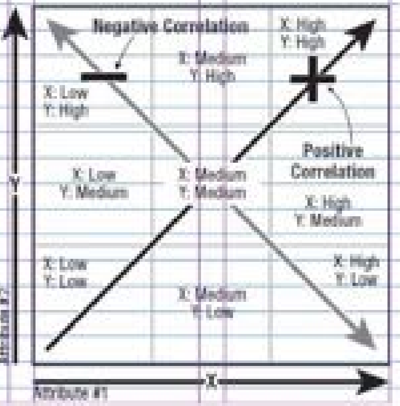


Figure 3.7-1: Reading bivariate maps. Bivariate map legends should be arranged in two dimensions to show example symbol combinations. Different bivariate map types then vary by how the X- and Y-axes and positive (+) correlation are preserved.

Figure 3.7-2: Separable bivariate map. Indicator 4.3.1 (2016) on the percent of women in formal and non-formal education and training is mapped as a choropleth and Indicator 5.5.2 (2016) on the percent of women in managerial positions is mapped with proportional symbols. Separable maps preserve X and Y but do not have an emergent positive (+) dimension.

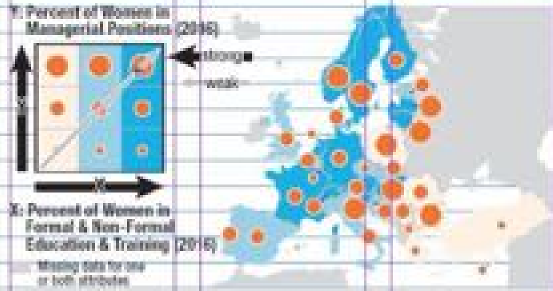


Figure 3.7-3: Integral bivariate map. Indicator 4.3.1 (2016) and 5.5.2 (2016) are remapped using a bivariate choropleth, which has an emergent positive (+) dimension. Because both indicators have the same attribute unit (percentages), the bivariate choropleth map is a better solution than the thematic map combination in Figure 3.7-2.

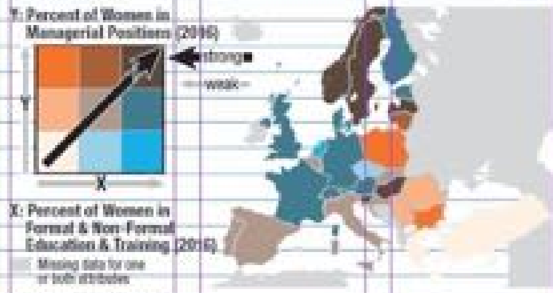
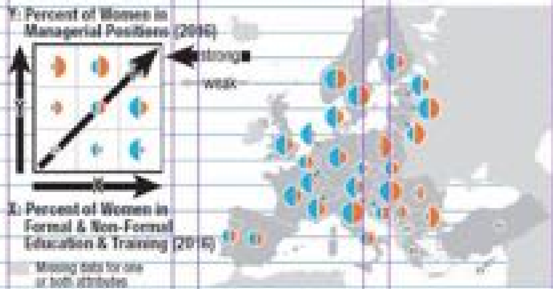


Figure 3.7-4: Configural bivariate map. Indicator 4.3.1 (2016) and 5.5.2 (2016) are remapped as a split proportional symbol map. Configural solutions preserve X and Y but also have an emergent + dimension. The split proportional symbol map is more appropriate than the Figure 3.7-3 bivariate choropleth if independence between attributes is assumed.



an indicator, such as rural versus urban.

Integral and configural bivariate maps usually are classified into just 2x2 or 3x3 classes to reduce complexity (e.g., 3x3 results in nine unique bivariate symbols). Separable bivariate maps can include 4x4, 5x5, or even 7x7 classes much like univariate maps since it is possible to attend to the X and Y attributes separately (see Section 1.9).

Style sheet

STROKES & CORNERS

- country boundary (30K, 0.4 stroke width)
- figure arrowheads (100K, arrow 2, scale 80%, rounded cap)
- figure rounded rectangles (3pt corner radius)
- figure rounded rectangels outline (30K, 0.4 stroke width)

EXPORTS

Place .AI files rather than image exports into layout

"print" setting

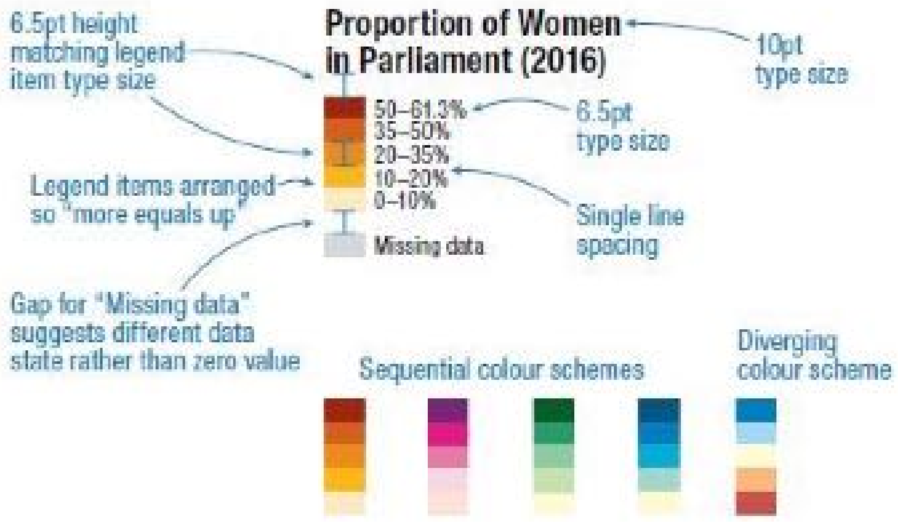
BACKGROUND

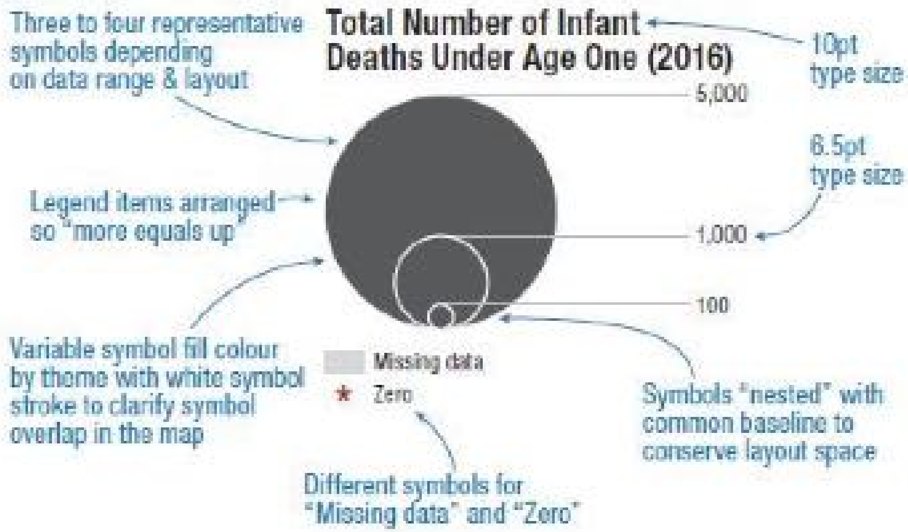
Land:
White polygon, exported to photoshop
Outer Glow:
Color 50/10/15/0
Multiply
Opacity 51
Noise 0
Spread 16
Size 9
Color Overlay:
Color 50/10/15/0
Multiply 71

0 500 1000km

Water:
White polygon, exported to photoshop
Inner Glow:
Color 18/0/3/0
Multiply
Opacity 46
Size 250
Color Overlay:
Color 30/0/6/0
Multiply 11

REGION
Country





3.6 Map Legends

A ***legend*** or ***key*** provides a description of each kind of symbol included in the map. The legend clarifies the primarily visual map symbols with text, which might include qualitative category names or quantitative numbers. Not all maps require legends, and proper use of the visual variables enable audiences to see immediately the broader map patterns without first referencing specific symbol values (see Section 2.9).

Effective legend design is important for maps made for general audiences that may have little background knowledge in the mapped phenomena, such as SDG maps designed for awareness and outreach. The legend provides an opportunity to introduce and explain the broader SDG as well as frame the narrative by marking critical values such as the current average or future desired level (see Section 4.7). In this way, the legend is an exercise in education, providing instructions in how to interpret and, therefore, make use of the map itself. To this end, the legend title for SDG maps should restate the full location, attribute, and temporal context (see Section 1.2) rather than or in addition to listing a specific indicator number to prevent look-up. Effective legend design and legend titles are particularly important for SDG maps distributed across diverse audiences, as specific symbols and phrasings may have variable cross-cultural meanings requiring translations (see Section 4.1).

General guidance suggests that all point, line, and polygon symbols included in the map should be included in the legend. However, it is common to exclude symbols at the lowest level of the visual hierarchy (see Section 2.13), serving more as basemap reference (e.g., political borders, water versus land).

Thematic map legends often include just the symbols that encode the thematic layer (see Section 3.1). For thematic maps, every symbol in a classed scheme should be included in the legend, but only three to five representative symbols need to be included for an unclassed scheme (see Section 1.9). Nominal thematic maps depicting qualitative data should include gaps between legend items to evoke a metaphor of discrete categories, while choropleth, proportional symbol, etc., maps depicting quantitative values should not include gaps to evoke a metaphor of a continuous number line, even when classed. Quantitative thematic maps also should evoke a "more equals higher" metaphor by placing the lowest value on the bottom when legend items are stacked vertically. Figures 3.6-1, 3.6-2, and 3.6-3 display the legend specifications used for this book for nominal maps (see Section 3.2), choropleth maps (see Section 3.3), and proportional symbol maps (see Section 3.4) respectively.

Finally, nearly all legend designs can be improved by combining the design with a diagram (see Section 3.10), such as a histogram showing the distribution of map features in each class (see Figure 1.9-1). Legends also can be reinforced or completely replaced with interaction (see Section 4.3), bringing the legend or exact data value into the map as the user probes or selects a specific feature.

Figure 3.6-1: Nominal map legend. The nominal legend specifications for this book use a qualitative colour scheme adapted from the SDG icon colours. There is a gap between legend items to suggest discrete categories. Each legend item is the same height as the legend label type size, with 1.5 line spacing to create the discrete gaps. Nominal legend items are arranged alphabetically in this book.

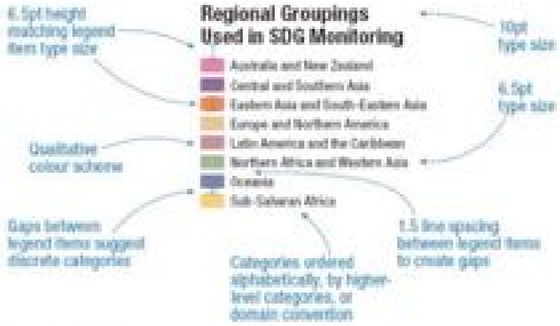


Figure 3.6-2: Choropleth map legend. The choropleth map legend specifications for this book rotate among five sequential and diverging colour schemes. No gap is included between legend items to suggest a continuous number line. The "Missing data" category is offset with a gap to suggest a different data state rather than a zero value. Legend items are arranged so that "more equals up".

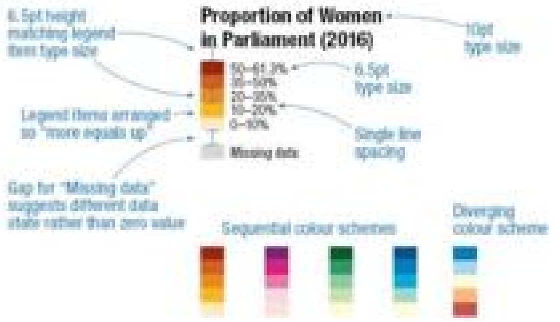
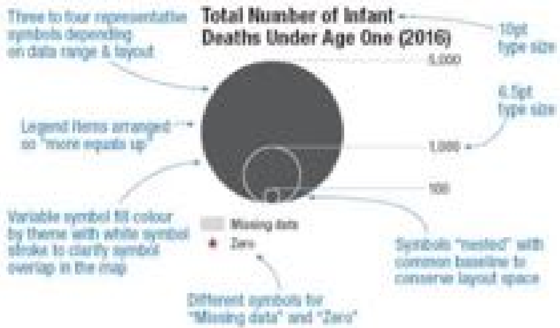


Figure 3.6-3: Proportional symbol map legend. The proportional map legend specification for this book includes three to four representative symbols depending on the data range and layout. Symbols are arranged so that "more equals up" and "nested" with a common baseline to conserve layout space. Separate symbols are provided to clarify "Missing data" and "Zero", when relevant to the mapped dataset.



Glossary

The following glossary presents terms as they are defined and used in this book:

2030 Agenda for Sustainable Development: see **Sustainable Development Goals (SDGs)** (Section 1.1, pp. 2–3)

Absolute attribute: see **Attribute** (Section 1.4, pp. 8–9)

Absolute location: see **Location** (Section 1.3, pp. 6–7)

Absolute time: see **Time** (Section 1.5, pp. 10–11)

Accessibility: the ability to obtain and benefit from a map, with the goal of supporting the widest possible range of audiences (Section 4.2, pp. 92–93)

Accuracy: the correctness of the data (Section 2.15, pp. 52–53); see also **Uncertainty**

Adjacent maps: the representation of multiple attributes, data with its uncertainty, or a time series on separate maps (Section 2.15, pp. 52–53); also called **Small multiples**

Aggregate: an increase in dimensionality (Section 2.8, pp. 38–39); see also **Generalization operator**

Analysis: the confirmation of hypotheses generated during exploration (Section 4.10, pp. 108–109); see also **Cartography Cube**

Analytical dashboard: see **Dashboard** (Section 4.9, pp. 106–107)

Animation: the use of digital system time to update the map display (Section 4.8, pp. 104–105)
- ***non-temporal animation:*** an animation with frames ordered to facilitate understanding of the map
- ***temporal animation:*** an animation with display time representing real-world time

Arithmetic classification scheme: see **Classification scheme** (Section 1.9, pp. 18–19)

Arrange: an interactive change to the layout of maps and diagrams (Section 4.4, pp. 96–97); see also **Interaction operator**

Arrangement: the layout of graphic marks in the symbol (Section 2.9, pp. 40–41); see also **Visual variable**

Aspect: orientation of the map surface to the globe (Section 2.5, pp. 32–33)
- ***normal aspect:*** orientation of the map surface to the Earth's axis of rotation, resulting in standard parallels
- ***oblique aspect:*** all aspects that are not normal or transverse
- ***transverse aspect:*** orientation of the map surface 90° from the axis of rotation, resulting in standard meridians

Aspect ratio: horizontal versus vertical dimensions of the layout (e.g., portrait versus landscape) (Section 2.13, pp. 48–49)

Atlas: an intentional sequence of maps, text, and other graphic elements depicting different dimensions of geographic phenomena and processes (Section 4.11, pp. 110–111)

Attribute: the *what* or *who* of data (Section 1.4, pp. 8–9); see also **Geospatial data**
- ***absolute attribute:*** an attribute measured or counted and reported without consideration of other attributes

- ***enumerated attribute:*** an individual-level attribute that is aggregated or counted within a predefined space, or enumeration unit
- ***individual-level attribute:*** unique conditions or qualities of a specific place
- ***relative attribute:*** an attribute that is normalized based on one, two, or multiple other values

Attribute change: see **Change** (Section 1.5, pp. 10–11)

Audience: the intended users of the map (Section 2.1, pp. 24–25; Section 4.1, pp. 90–91)

Azimuthal projection: see **Projection** (Section 2.4, pp. 30–31)

Bar chart: a univariate diagram using rectangular bars to depict the distribution of an attribute across different nominal categories (Section 3.11, pp. 78–79)

Binary map: a thematic map showing two categories such as presence/absence or yes/no (Section 3.2, pp. 60–61)

Bivariate map: a thematic map depicting two data attributes (Section 3.7, pp. 70–71)
- ***configural bivariate map:*** a bivariate map that maintains reading of the original X and Y attributes while including a visual hint about the + relationship that can be used for visual correlation
- ***integral bivariate map:*** a bivariate map that restricts reading of the original X and Y indicators but promotes reading of the + relationship between indicators
- ***separable bivariate map:*** a bivariate map that preserves reading of both original X and Y indicators in the map

Bubble chart: a variant of a scatterplot that depicts a third attribute by resizing the point symbol (Section 3.13, pp. 82–83)

Calculate: an interactive derivation of new information from the map (Section 4.4, pp. 96–97); see also **Interaction operator**

Cartogram: a thematic map that scales the area of each enumeration unit by its attribute value (Section 3.8, pp. 72–73)
- ***contiguous cartogram:*** a cartogram that maintains topology between enumeration units while compromising on shape
- ***non-contiguous cartogram:*** a cartogram that maintains shape completely by scaling each enumeration unit within its boundary

Cartography: the art, science, and technology of making and using maps (Introduction, pp. v)

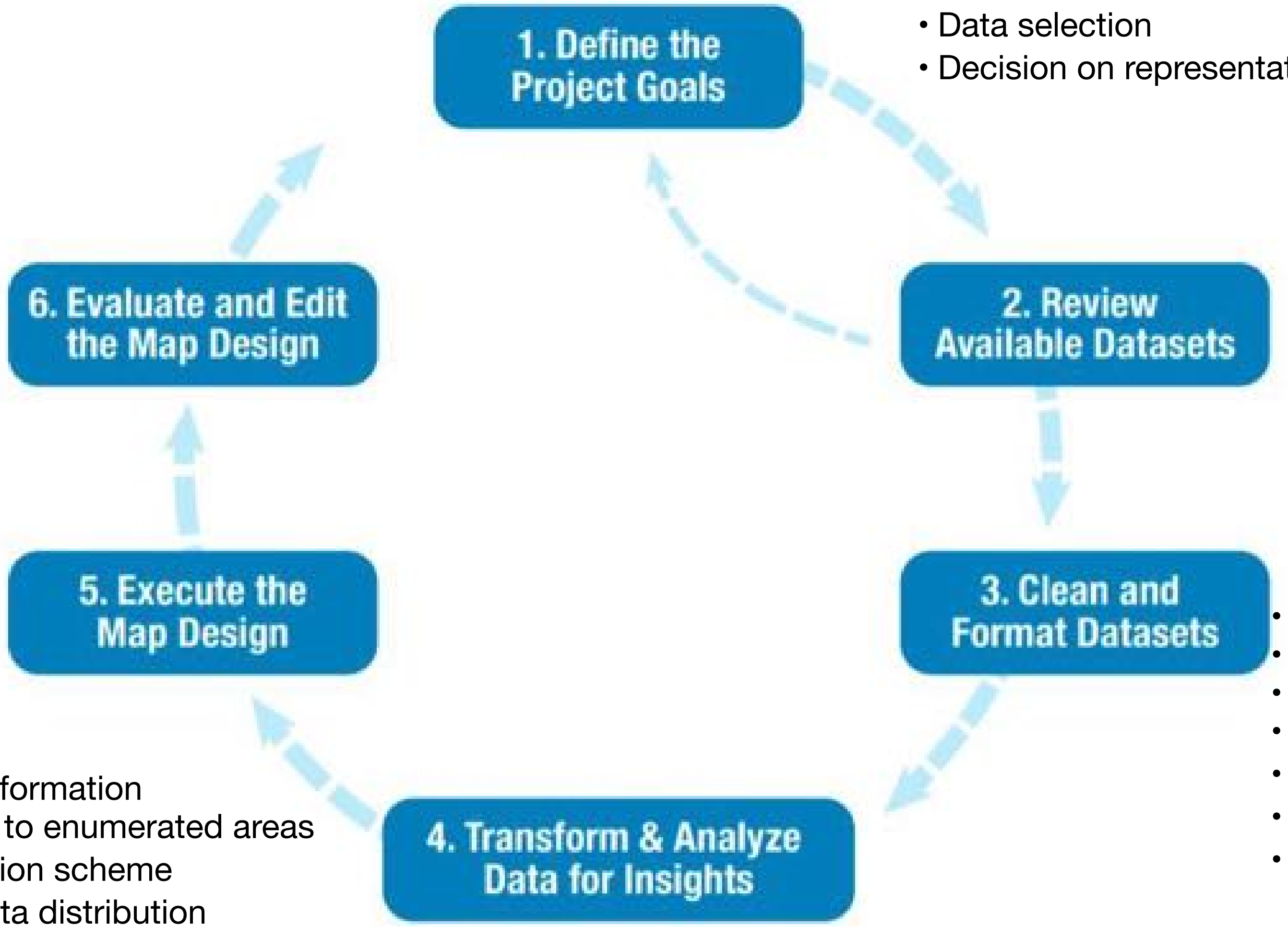
Cartography Cube: a framework that organizes broad map use cases according to three axes: map users, map use tasks, and map interactivity (Section 4.1, pp. 90–91)

Cartographic scale: the ratio between a distance represented on a map and the corresponding distance in the real world (Section 2.6, pp. 34–35)
- ***large cartographic scale:*** a representative fraction that computes to a relatively larger decimal number, resulting in a map depicting small geographic scale phenomenon
- ***small cartographic scale:*** a representative fraction that computes to a small decimal number, resulting in a map depicting large geographic scale phenomenon

Cascading Style Sheets (CSS): an open web standard used to style contents of a web document (Section 4.5, pp. 98–99)

Central meridian: see **Meridian** (Section 2.5, pp. 32–33); see also **Projection**

Cartographic planning and design



1. Define the Project Goals
- Subject/Goal
- Audience
- Environment
- Data selection
- Decision on representation

2. Review Available Datasets
- Review available datasets
- Collect official SDG indicator data

3. Clean and Format Datasets
- Choose software
- Clean and Reformat
- Choose Enumeration areas
- Align attributes
- Assess completeness
- Manage missing data
- Join temporal data

4. Transform & Analyze Data for Insights
- Data transformation
- Normalize to enumerated areas
- Classification scheme
- Review data distribution
- Check anomalies or patterns

5. Execute the Map Design
- Projection
- Symbolization
- Scale & extent
- Thematic map type
- Visual variable
- Symbol/shape
- Annotation/Typography

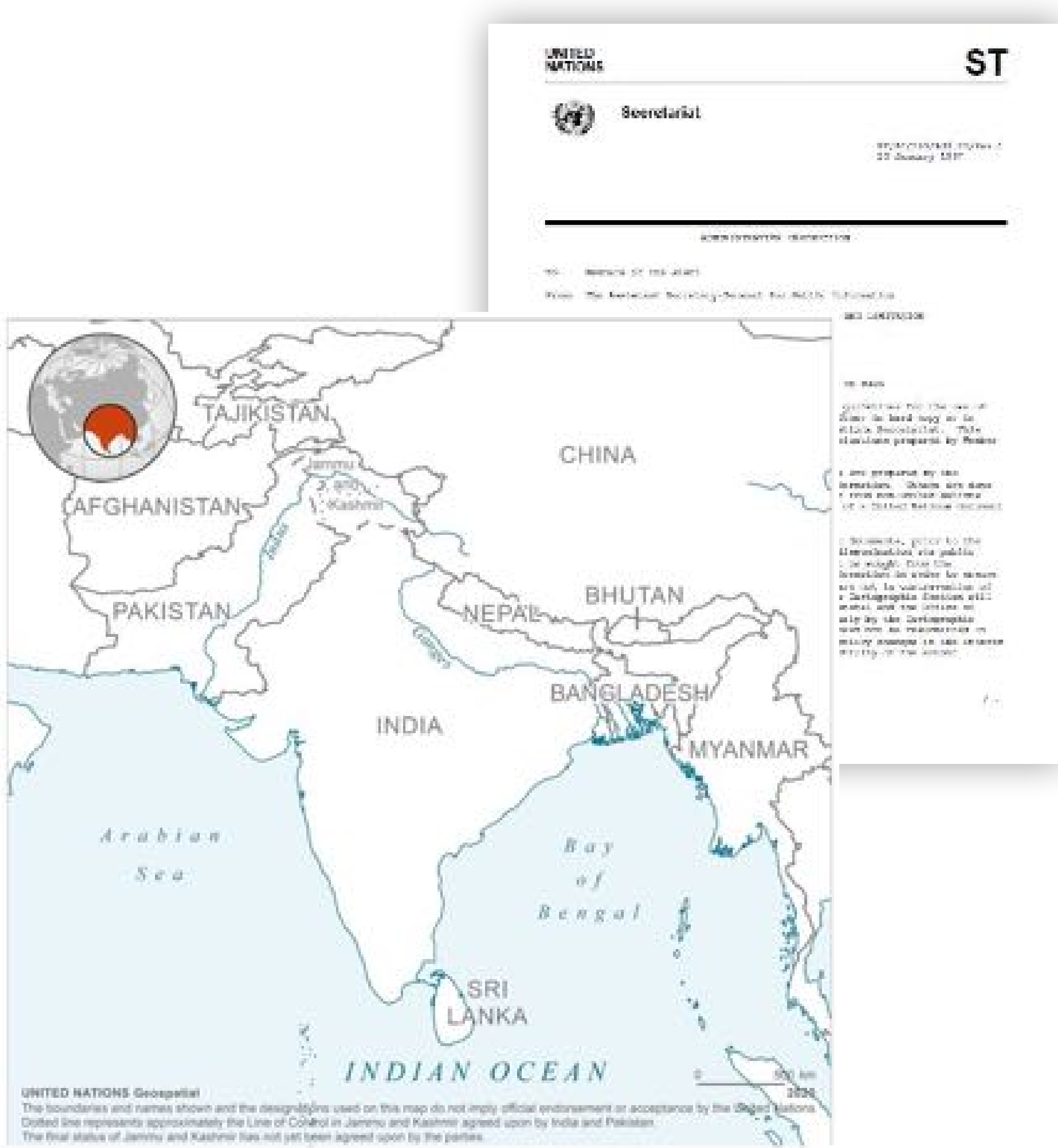
6. Evaluate and Edit the Map Design
- Complete a self-edit
- Consultation/feedback
- Revise and finalization

1 **Mapping for the Goals**
Publication
General public (policies)

Guidelines for the Publication of Maps

Administrative Instruction ST/AI189/Add25/Rev1

"In view of the sensitive nature of cartographic documents, prior to the issuance of any map at any duty station, including dissemination via […] Internet, clearance must be sought […] to ensure that maps meet publication standards and that they are not in contravention of existing United Nations policies.."



2

Statistical - SDG indicators

Geospatial - UN Geodata

SDG indicators

United Nations Global SDG Database

https://unstats.un.org/sdgs/indicators/database/

SDG indicator data

Goal	Target	Indicator	SeriesCode	SeriesDescription	GeoAre	GeoAreaName	Nature	Reporting Type	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	2	Africa	G	G	PERCENT			47			43			41		39	38
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	8	Albania	G	G	PERCENT			2			1			0			
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	12	Algeria	G	G	PERCENT												1
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	19	Americas	G	G	PERCENT			8			7			5		4	4
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	24	Angola	G	G	PERCENT	32								30			
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	32	Argentina	G	G	PERCENT	6	9	14	7	5	4	3	3	3	3	2	1
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	51	Armenia	G	G	PERCENT		19	15	11	8	5	3	3	1	2	2	2
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	142	Asia	G	G	PERCENT			30			23			19		15	12
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	36	Australia	G	G	PERCENT		1		1	1				0		0	
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	53	Australia and New Z	G	G	PERCENT			1			1			0		0	0
1	1.1	1.1.1	SI_POV_DAY1	Proportion of population	40	Austria	G	G	PERCENT	0			0	0	0	0	0	1	1	1	0

2

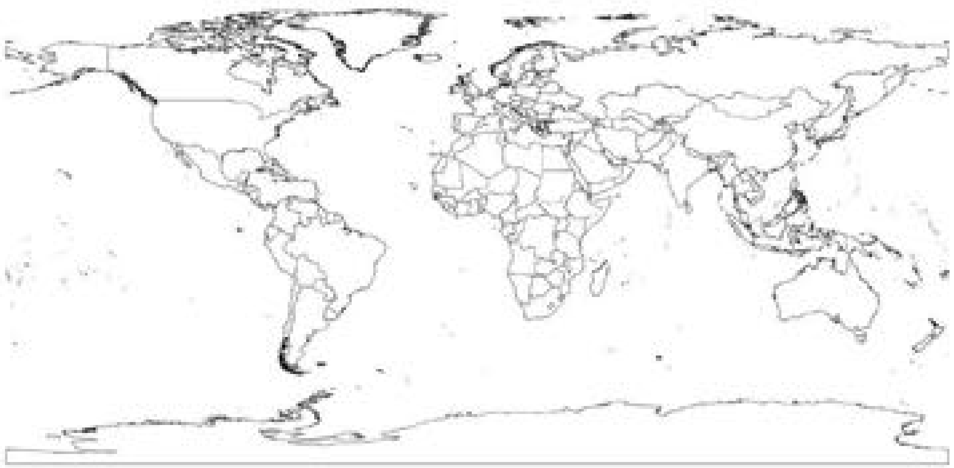
Statistical - SDG indicators
Geospatial - UN Geodata

Global geodata: general country-based data

Geographic objects
249 rows

Estimated scale
N/A

Projection Robinson
World Geodetic System 1984



Geographic objects
270 rows

Estimated scale
25M

No projection
World Geodetic System 1984

3 Enumeration areas

Countries

SDG groupings

Sub-regions

Intermediary regions

4

Transform & Analyze

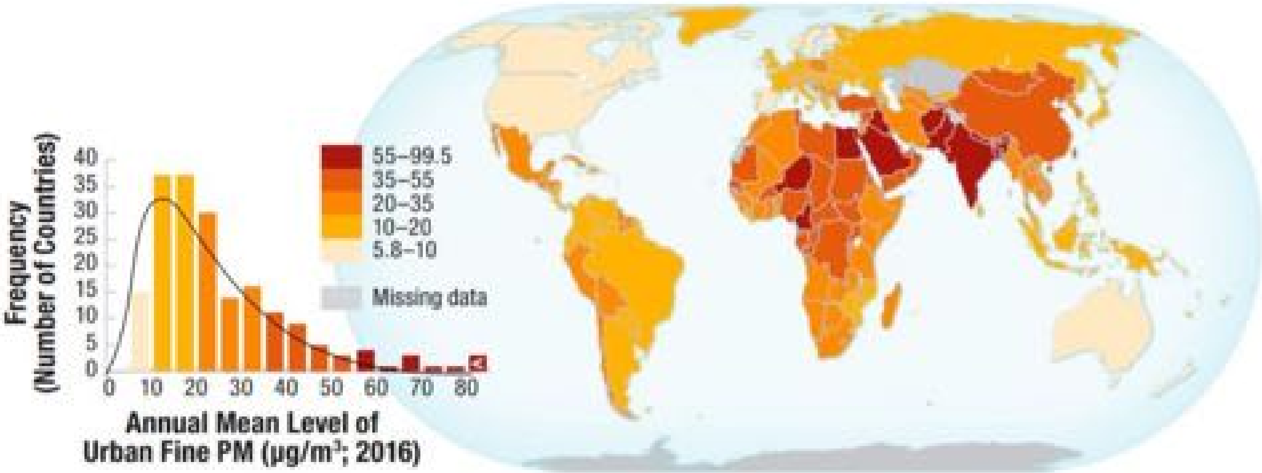


Figure 1.9-1: Data distributions and classification. **Left:** The histogram depicts the left-skewed attribute distribution for Indicator 11.6.2 (2016) on the annual mean levels of urban fine particulate matter. **Right:** The resulting arithmetic scheme increases distances between class breaks in a regular progression, here expanding each class width by 5 μg/m3 to provide more detail for features in the clustered side of the distribution rather than emphasizing outliers.

Statistical distribution analysis and classification

Geographic transformation

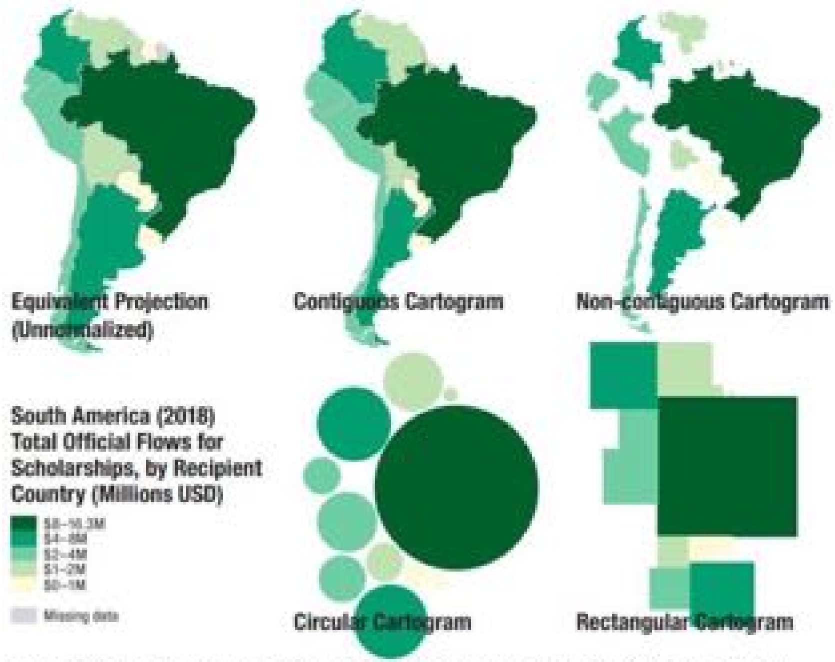


Figure 3-8.2: Types of cartograms. Indicator 4.b.1 (2018) on the total official flows for scholarships, by recipient country (Millions USD) is mapped for South American countries as a choropleth atop four different population-based cartograms. **Top-centre:** Contiguous. **Top-right:** Non-contiguous. **Bottom-left:** Circular. **Bottom-right:** Rectangular.

5

Execute map design

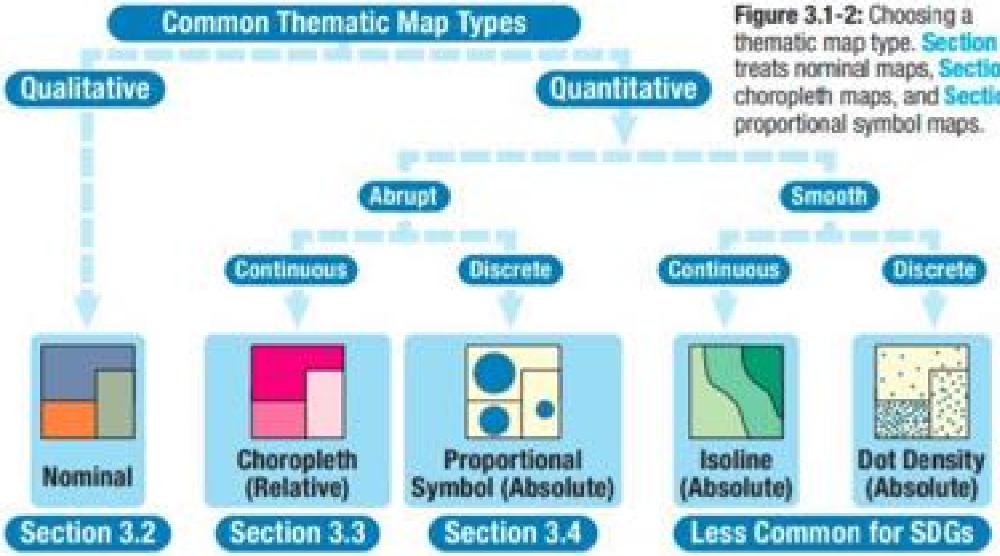


Figure 3.1-2: Choosing a thematic map type. Section 3.2 treats nominal maps, Section 3.3 choropleth maps, and Section 3.4 proportional symbol maps.

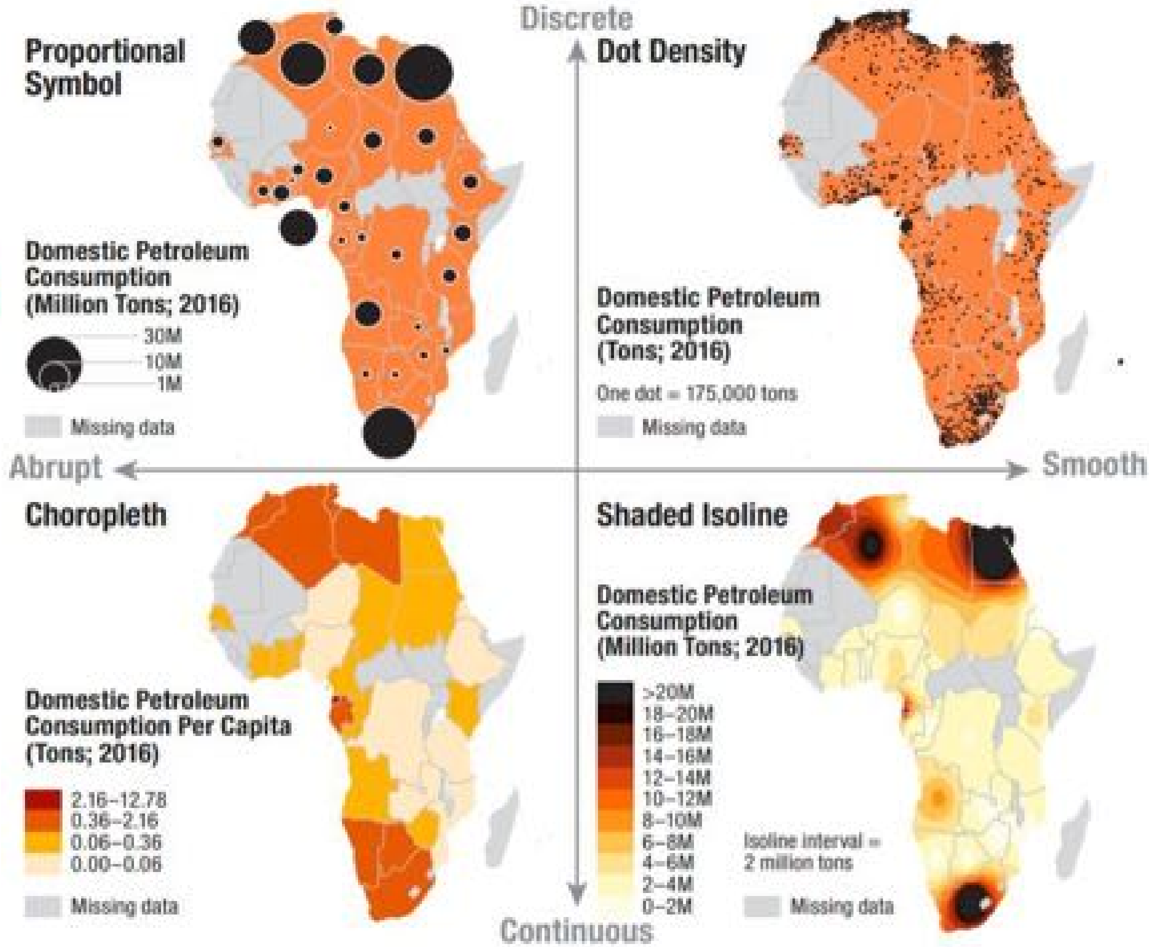
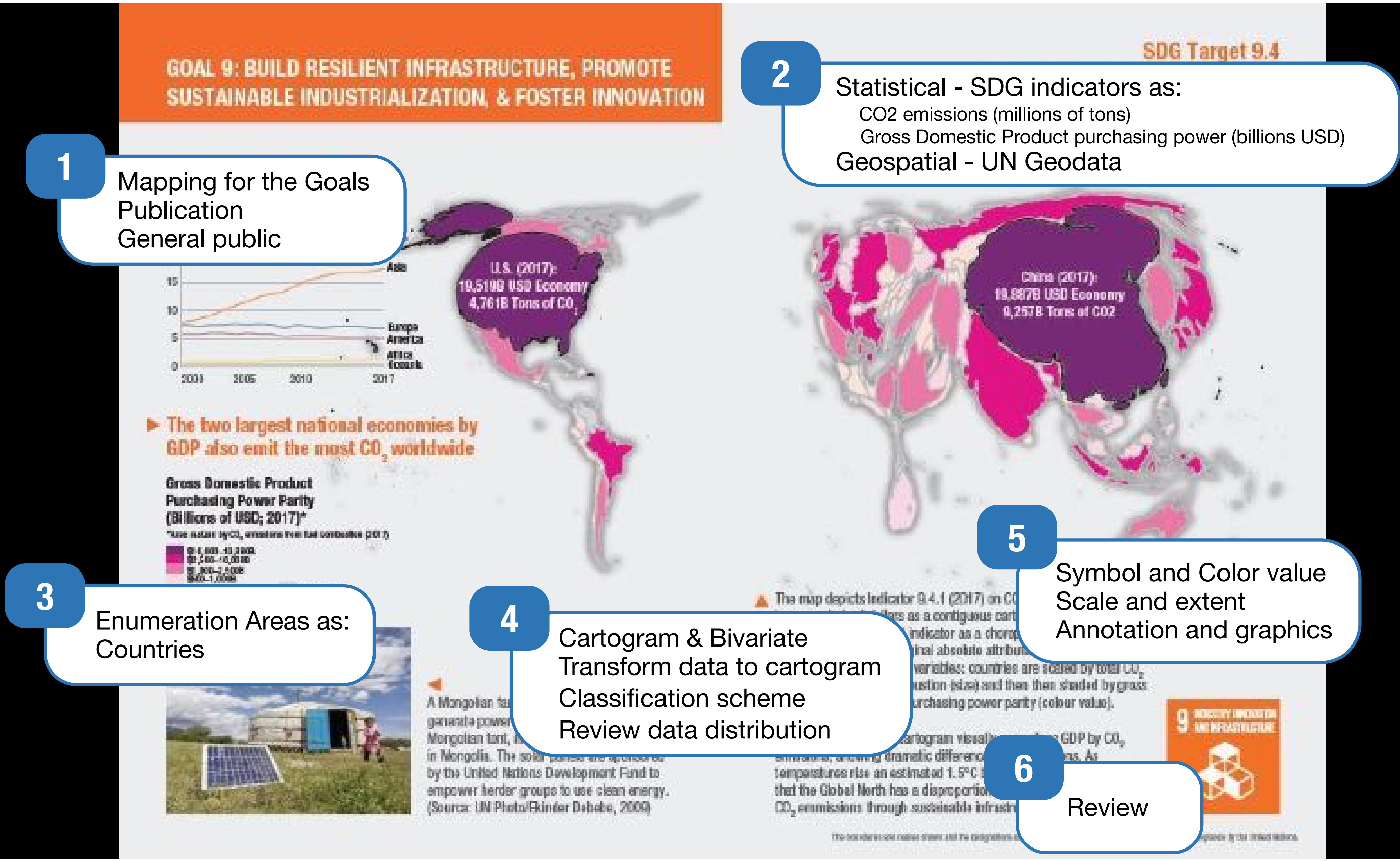
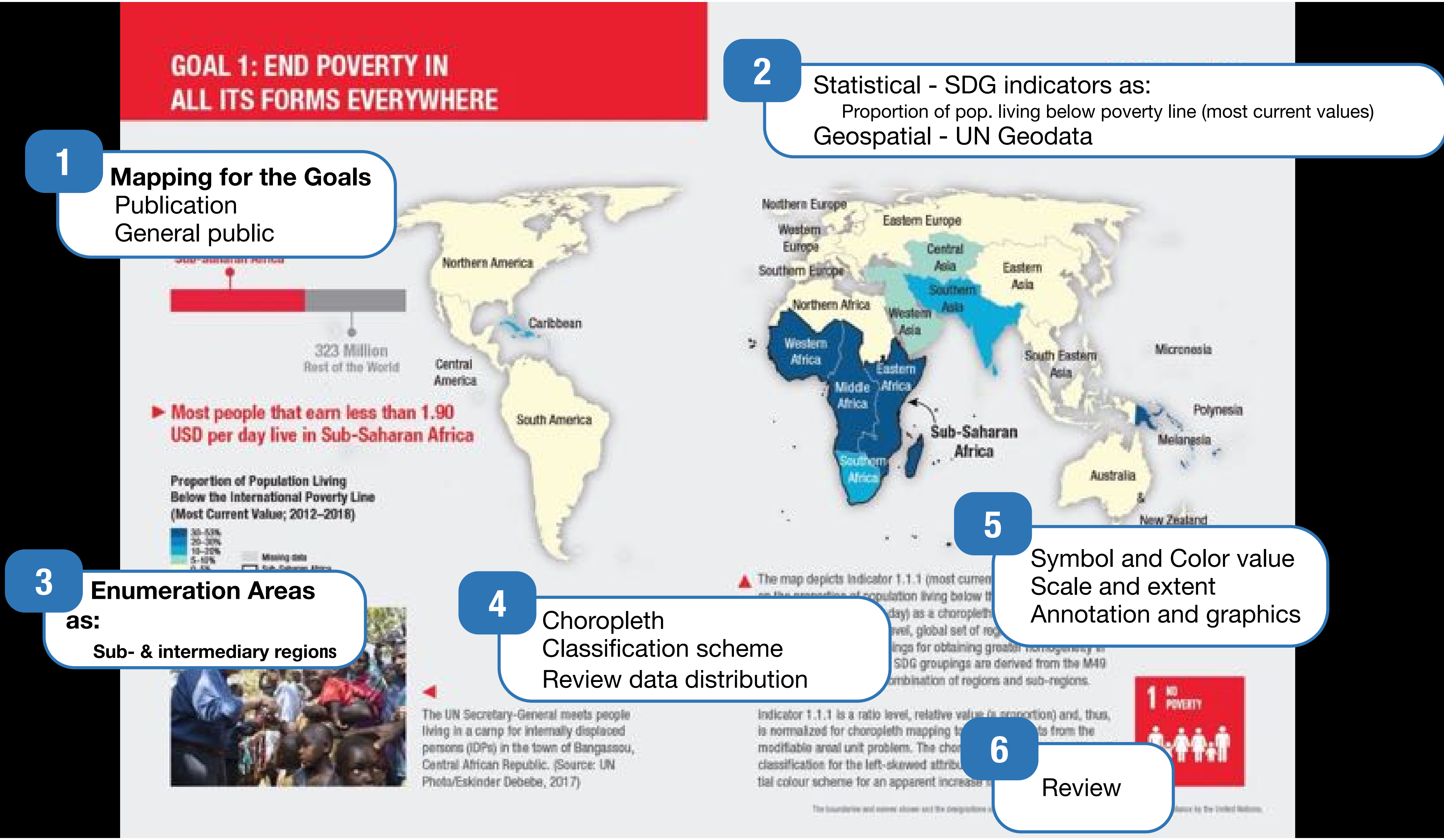
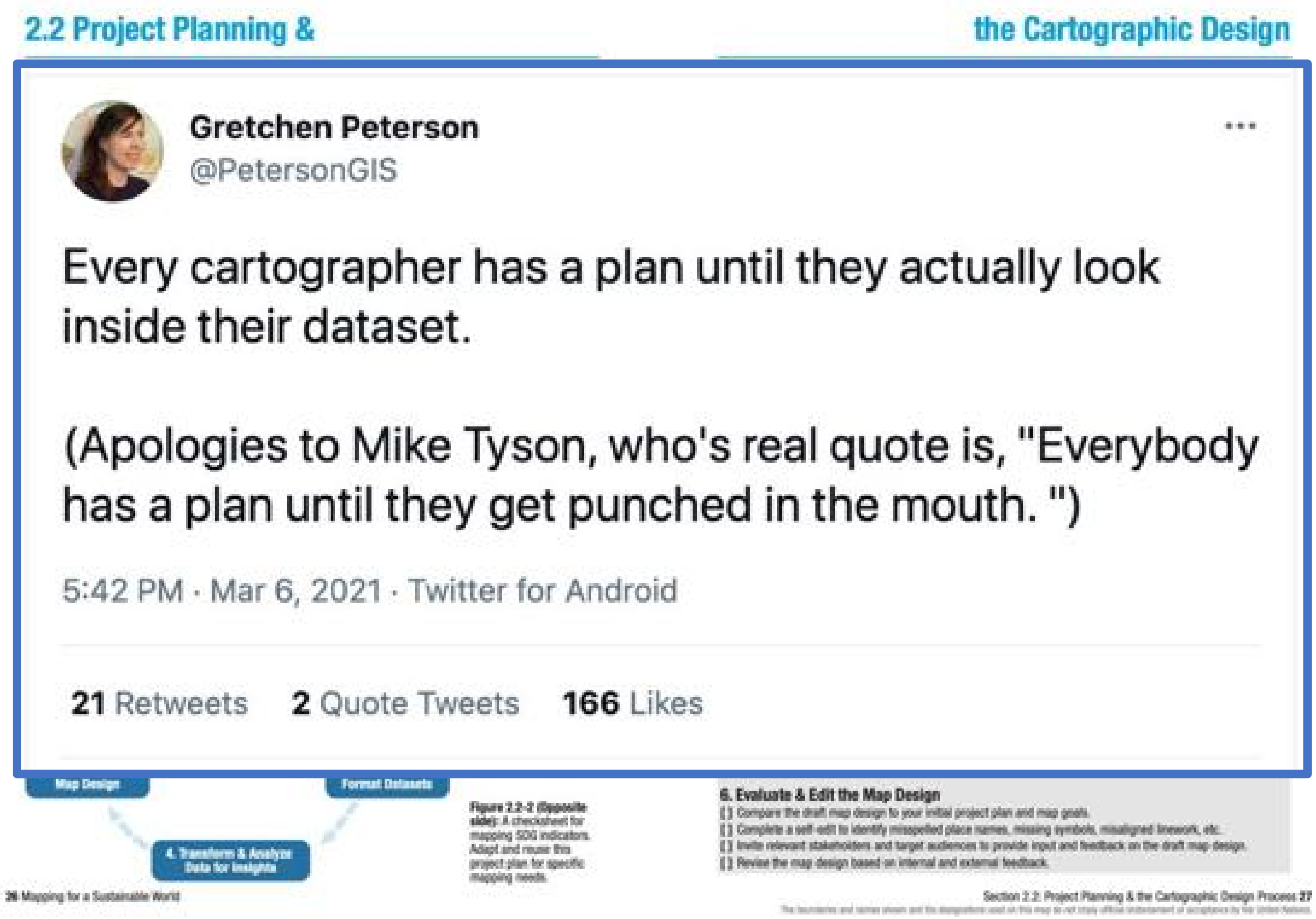


Figure 3.1-1: Thematic map types. The four maps depict Indicator 12.2.2 (2016) on domestic petroleum consumption. **Top-left:** Proportional Symbol. **Top-right:** Dot density. **Bottom-left:** Choropleth. **Bottom-right:** Shaded isoline.


GOAL 9: BUILD RESILIENT INFRASTRUCTURE, PROMOTE SUSTAINABLE INDUSTRIALIZATION, & FOSTER INNOVATION
SDG Target 9.4
1
Mapping for the Goals
Publication
General public
2
Statistical - SDG indicators as:
CO2 emissions (millions of tons)
Gross Domestic Product purchasing power (billions USD)
Geospatial - UN Geodata
U.S. (2017):
19,519B USD Economy
4,761B Tons of CO2
China (2017):
19,887B USD Economy
9,257B Tons of CO2
Asia
Europe
America
Africa
Oceania
The two largest national economies by GDP also emit the most CO2 worldwide
Gross Domestic Product
Purchasing Power Parity
(Billions of USD; 2017)*
3
Enumeration Areas as:
Countries
4
Cartogram & Bivariate
Transform data to cartogram
Classification scheme
Review data distribution
5
Symbol and Color value
Scale and extent
Annotation and graphics
6
Review


GOAL 1: END POVERTY IN ALL ITS FORMS EVERYWHERE
1
Mapping for the Goals
Publication
General public
2
Statistical - SDG indicators as:
Proportion of pop. living below poverty line (most current values)
Geospatial - UN Geodata
3
Enumeration Areas as:
Sub- & intermediary regions
4
Choropleth
Classification scheme
Review data distribution
5
Symbol and Color value
Scale and extent
Annotation and graphics
6
Review
323 Million
Rest of the World
Most people that earn less than 1.90 USD per day live in Sub-Saharan Africa
Proportion of Population Living Below the International Poverty Line (Most Current Value; 2012–2018)
Missing data
Northern America
Caribbean
Central America
South America
Northern Europe
Western Europe
Southern Europe
Eastern Europe
Central Asia
Eastern Asia
Southern Asia
Western Asia
Northern Africa
Western Africa
Middle Africa
Eastern Africa
Southern Africa
Sub-Saharan Africa
South Eastern Asia
Micronesia
Polynesia
Melanesia
Australia & New Zealand
The map depicts Indicator 1.1.1 (most curren
SDG groupings are derived from the M49
Indicator 1.1.1 is a ratio level, relative value
The UN Secretary-General meets people living in a camp for internally displaced persons (IDPs) in the town of Bangassou, Central African Republic. (Source: UN Photo/Eskinder Debebe, 2017)
1 NO POVERTY

Planning



2.2 Project Planning &
the Cartographic Design
Gretchen Peterson
@PetersonGIS
Every cartographer has a plan until they actually look inside their dataset.
(Apologies to Mike Tyson, who's real quote is, "Everybody has a plan until they get punched in the mouth. ")
5:42 PM · Mar 6, 2021 · Twitter for Android
21 Retweets
2 Quote Tweets
166 Likes
Map Design
Format Datasets
4. Transform & Analyze Data for Insights
6. Evaluate & Edit the Map Design

Which map type? Dasymmetric map

Figure 3.5-1: Original choropleth map. Indicator 2.1.1 (2017) on the number of undernourished people per km² is mapped for four countries in Sub-Saharan Africa.

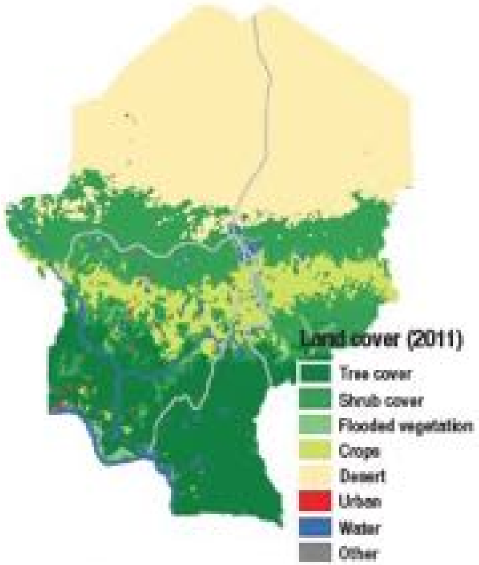


Figure 3.5-2: Exclusionary data. Classified land cover (2011) processed from satellite imagery is used to identify areas where people do not live: desert and water.

Figure 3.5-3: Vector math. Vector math is applied to remove the desert and water classes from the enumeration unit. Large areas in the north are removed due to the location of the Sahara Desert as well as smaller water bodies such as Lake Chad and the Niger River.

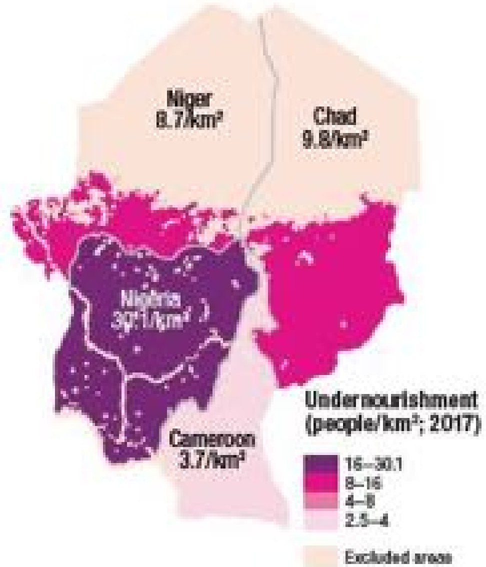


Figure 3.5-4: Resulting dasymetric map. Indicator 2.1.1 (2017) on the number of undernourished people per km² is remapped with a new area denominator. As a result, Niger and Chad have a much greater density, pushing them into higher choropleth classes.

The next steps

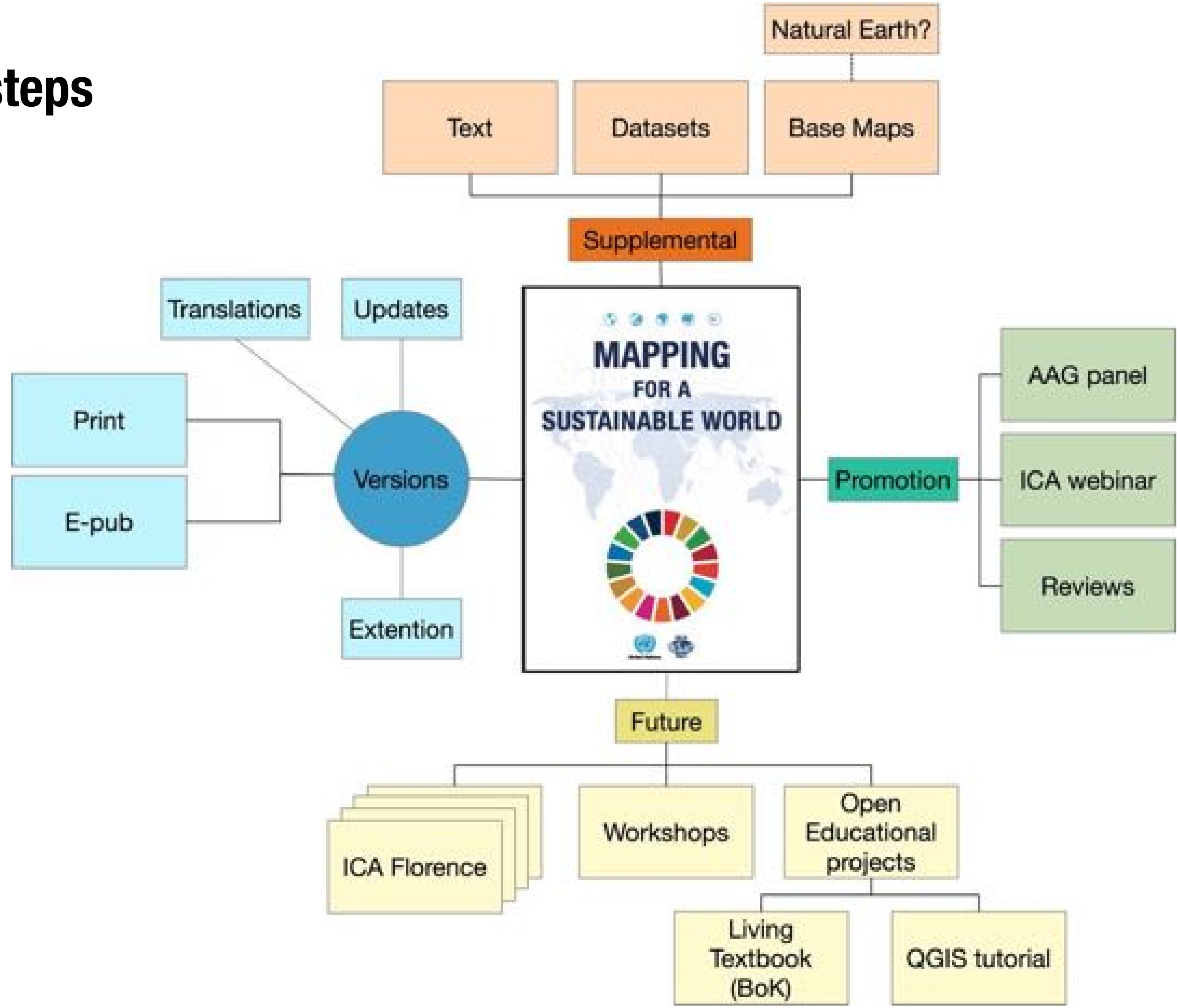


Figure Data & Design Archive

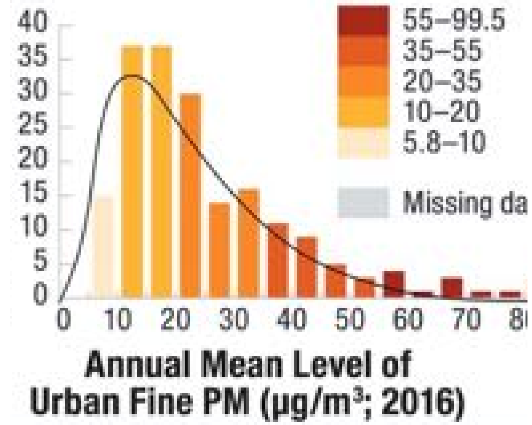
This repo archives UW Cart Lab data and design materials for the book as part of the open educational resource. Data were downloaded from the United Nations SDG Indicators Database, which is continuously updated and maintained. Archived datasets reflect the version used for figures in *Mapping for a Sustainable World* to enable their exact replication from the book.

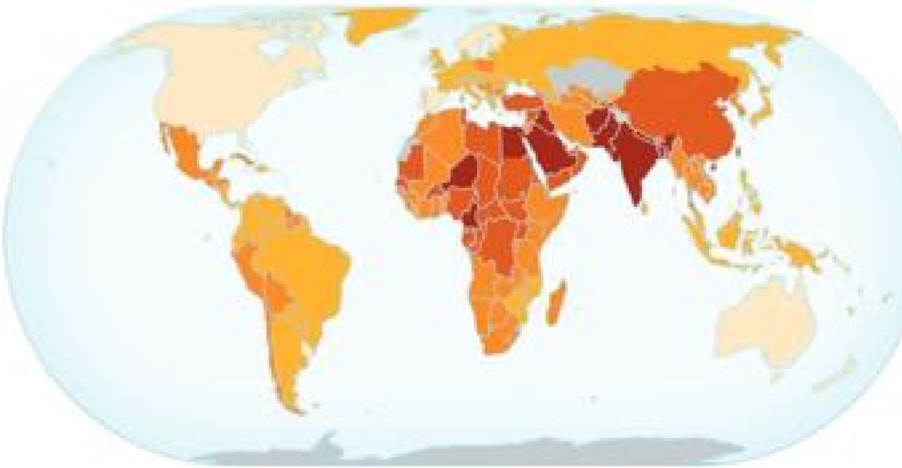
The UW Cart Lab also provides the *Mapping for a Sustainable World: QGIS Technical Supplement* to walkthrough how to recreate these figures using the QGIS open source mapping software. All archived materials, including the QGIS Supplement and contents of the Mapping for a Sustainable World cartography book, are available for classroom or workshop use following a CC BY-NC license.

Summary of All Archived Datasets (Excel download)

Section 1: SDGs & Geospatial Data

- **Figure 1.1-1:** The SDGs
- **Figure 1.2-1:** Components of geospatial data
- **Figure 1.2-2:** Attributes
    - **Left:** A qualitative attribute
    - **Right:** A quantitative attribute
- **Figure 1.2-3:** Time
    - **Left:** The area around the United Nations Headquarters in 1836
    - **Right:** The same area today
- **Figure 1.2-4:** Example data from the Global SDGs Indicators Database
- **Figure 1.3-1:** M49 regions and subregions
- **Figure 1.3-2:** M49 intermediate regions
- **Figure 1.3-3:** SDG regional groupings
- **Figure 1.4-1:** Attribute levels of measurement and associated example symbolization
- **Figure 1.4-2:** SDG indicators and their level of measurement
- **Figure 1.5-1:** Time in geospatial data
- **Figure 1.5-2:** Change in geospatial data
- **Figure 1.6-1:** Indicator Tiers and Tier I mappable values





Mapping for a Sustainable World: QGIS technical supplement

Cite/Attribute as: Houtman L, and R.E. Roth. 2021. *Mapping for a Sustainabl*
University of Wisconsin Cartography Lab.

About

These tutorials pair with the open-source book *Mapping for a Sustain*
cartography through the United Nations' 17 Sustainable Development
developed as a collaboration between the United Nations and the Inte
University of Wisconsin Cartography Lab supporting creation of the b
National Science Foundation CAREER Grant #1555267.

All tutorials demonstrate map design using the open access mapping
tutorials is to enhance the cartographic design thinking described in M
map software training, putting concepts into practice.

Tutorial 2 - Proportional Symbol Map

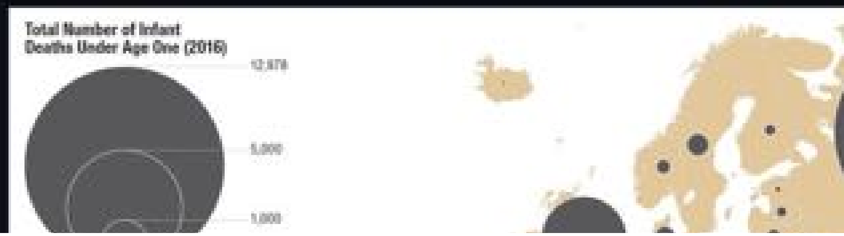
Tutorial 2.1: Overview and Setup

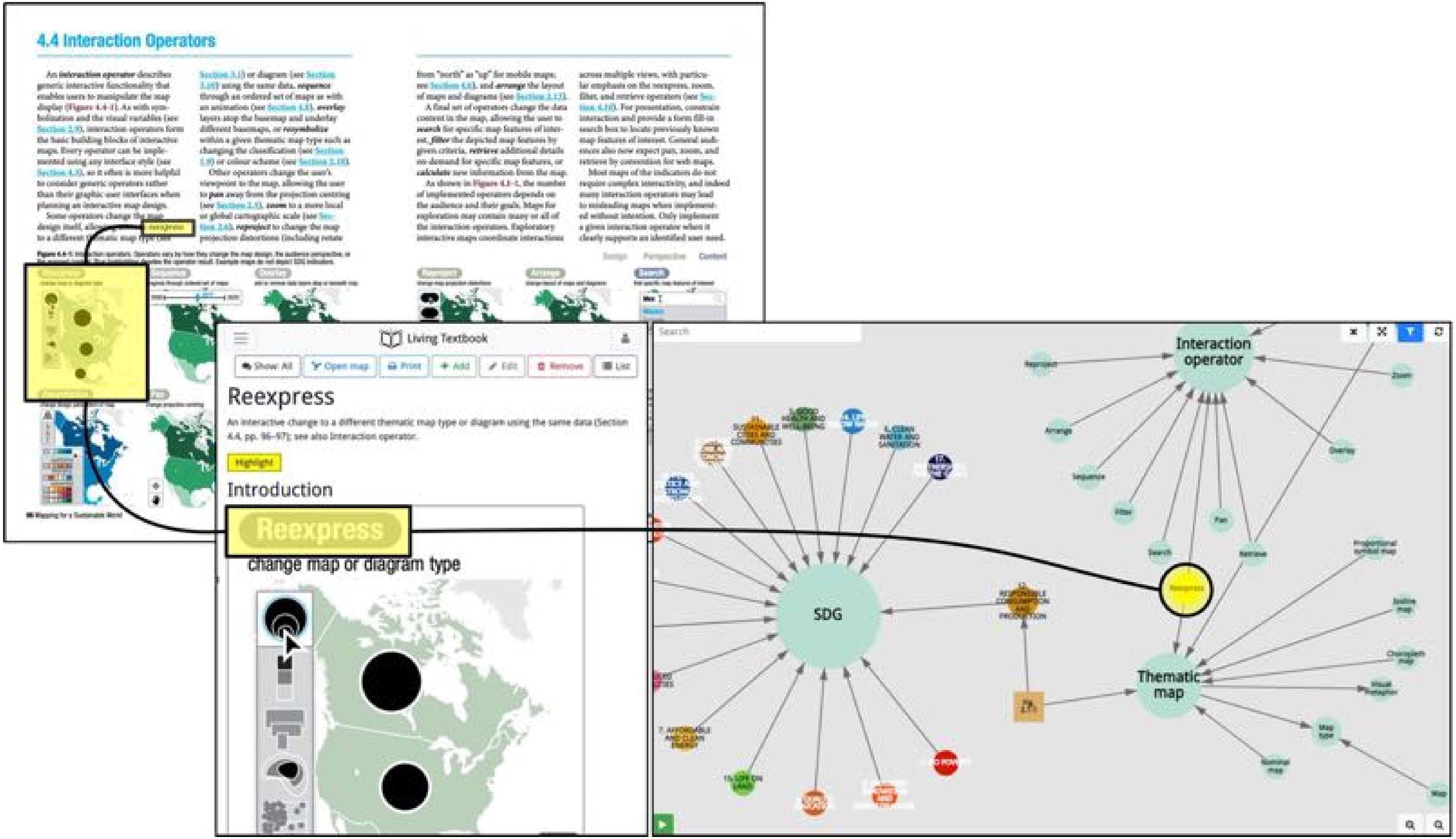
Summary

Tutorial 2.1 demonstrates how to make the *proportional symbol map* on page 65, which displays SDG Target 3.
preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal
as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births" (Figure 2.1-1).

This is the second in a set of tutorials paired with *Mapping for a Sustainable World*. The first tutorial teaches you
map. Completion of the previous tutorial is not required to complete the proportional symbol map tutorial. Howe
is a specific, step-by-step tutorial. The proportional symbol map tutorial is less specific and asks you to refer to
"how to", rather than describing each step in absolute detail.

> *Proportional symbol map*: a thematic map that uses the visual variable size to scale point symbols by their a
> Section 3.4)



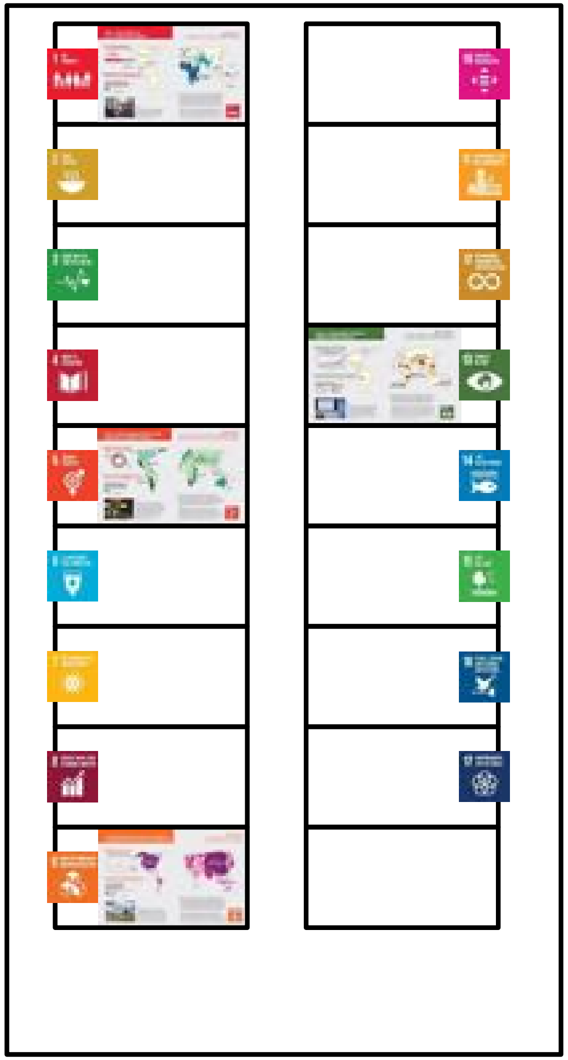

4.4 Interaction Operators
Living Textbook
Show: All
Open map
Print
Add
Edit
Remove
List
Reexpress
An interactive change to a different thematic map type or diagram using the same data (Section 4.4, pp. 96–97); see also Interaction operator.
Highlight
Introduction
Reexpress
change map or diagram type
Search
Interaction operator
Reproject
Zoom
Arrange
Overlay
Sequence
Filter
Pan
Search
Retrieve
Reexpress
SDG
Thematic map
Map type
Nominal map
Map

POSTER CONCEPT

SDG01
Choropleth & aggregation by region

SDG05
Generalization & Cloropleth

SDG09
Cartogram



SDG13
Proportional symbol & classes

Map Types
See ICA – UN co-publication
Section 3

- 3.1 Thematic maps
- 3.2 Nominal maps
- 3.3 Choropleth
- 3.4 Proportional symbol
- 3.5 Dasymetric
- 3.7 Bivariate
- 3.8 Cartograms
- 3.9 Maps &Time

UN-GGIM Geospatial Societies

side event 10-08-2021