International Cartographic Association
Association Cartographique Internationale

Mapping for Sustainable Development: Comparing different mapping techniques for monitoring mangroves to reach SDG 15 and 6

Britta Ricker [a,*], Maarten Eppinga [b], Sharona Jurgens [c], Eric Mijts [c]

[a] *Utrecht University, b.a.ricker@uu.nl*
[b] *University of Zurich, maarten.eppinga@geo.uzh.ch*
[c] *University of Aruba, sharona.jurgens@ua.aw, eric.mijts@ua.aw*

* Corresponding author

Keywords: Sustainable Development, mangroves, small islands, remote sensing

Abstract:

Mapping the United Nations (UN) Sustainable Development Goals (SDG) is necessary to identify where to place localized interventions to meet these goals. The UN Statistics Agency is responsible for establishing and curating SDG indicator data to measure how close or far each country is to achieving the goals. Each UN member state may voluntarily share their SDG indicator data as a form of data sovereignty. While the value of mapping the SDGs is clear, governments are not urged to collect or share spatial data for mapping the SDGs. Many countries with the most missing SDG data are islands, some of the most vulnerable countries (Gosling-Goldsmith et al., 2020). SDG indicators related to the environment can be challenging to collect and require localized data collection strategies, otherwise valuable and vulnerable ecosystems may risk being missed from data collection efforts (Hák et al., 2016; Kulonen et al., 2019).

One valuable and endangered ecosystem found in many (sub-)tropical islands are mangroves. Mangroves are well known to provide valuable ecosystem services such as coastal erosion prevention, habitat for biodiversity including fisheries, carbon sequestration and nutrient cycling and flood control (Chow, 2018; Maurya et al., 2021). Mangroves are dense, salt-tolerant plants that inhabit tropical and subtropical intertidal zones, and act as a buffer between shorelines and the ocean (Maurya et al., 2021). Small Islands, with their relatively small land surface area, high vulnerability, and unique ecosystems could benefit from mangrove monitoring by using drone data for mapping. Several specific SDG indicators include mangroves in their calculations. Mangroves are mentioned in at least three specific indicators related to three targets and two different goals, for example SDG 15. “Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss” and SDG 6” Ensure availability and sustainable management of water and sanitation for all. For each SDG indicator, each country is expected to share a single number, not the actual spatial extent of the forests, or where changes in forests occur”.

The UN offers standardized methodologies, which the UN calls metadata, to capture indicator data, however, these are rough guidelines open to interpretation lacking detailed step-by-step instructions to guide data collection. It is painfully clear that to protect mangroves to achieve goal 15, far more than a single number reporting the proportion of land that is forest (SDG 15.1.1 – see figure 1a) or degraded land (15.3.1) is needed to reach this goal. To protect and restore water-related ecosystems such as mangroves, spatial data and maps are needed. For example, in Aruba, only mangroves are counted as forests and the mangrove areas in Aruba are very small, only 1.15 % of the total area of the island are considered forests, see figure 1 b. (Aruba, 2021). While not an official SDG indicator, it is possible to monitor the health of the mangrove ecosystem, leaf area index, and stress conditions, ecosystem functioning, species identification, canopy height, carbon sequestration of specific areas through the use of remote sensing (Maurya et al 2021). Monitoring the health of the mangroves over time could be useful for the preservation, to identify protection measures, to meet the SDGs.

Mangrove areas are difficult to access due to their dense vegetation and water. However, monitoring health remotely is possible and being done using satellite data which are too coarse to monitor these sensitive ecosystems in detail in a place like Aruba. The use of drones is increasingly feasible since they are dropping in cost, are easy to fly, and can be flown at time intervals relevant to the stakeholders. The United Nations is encouraging countries to work together and use new and alternative data sources specifically for mapping the SDGs (Arnold et al., 2016; UN-GGIM, 2022). With true color images of mangroves, is possible to quickly see where dead mangroves are located inside the dense forests (see figure 1c). In multispectral images, it is possible to recognize vegetation health with different vegetation indices and classification techniques (Hakimdavar et al., 2020; Quang et al., 2022; Tran et al., 2022). With LiDAR there are even more possibilities for monitoring mangroves from calculating above ground biomass, carbon sequestration, calculate biomass, height and much more (Niwa et al., 2023; Salum et al., 2021). It is useful for governments and researchers to

https://doi.org/10.5194/ica-abs-7-137-2024

have a plan in place, in terms of what they would like to measure explicitly and to have the software and who to hire with the technical know-how.

Remote sensing data coupled with efficient cartography could be used to make maps that address questions like: Where are mangrove health struggling the most? What is the cause? What methods could or should be used to classify the mangrove health? What are the communication goals for the mangrove map? What visual variables are most useful to meet the communication aim?

Here we will show visualizations and analysis possibilities for policymakers, land use planners, environmental agencies, and the general public, to help identify what data processing and visualizations are useful to meet their localized mangrove monitoring needs to achieve SDG 15 and 6. We offer an overview of options and considerations for environmental monitoring with drones with different payloads and cartographic possibilities. Finally, we articulate how the existing SDG indicators need to be expanded to include spatial data and to request countries also share their methodology in addition to the values they share. By mapping the SDGs we are steps closer to achieving them.

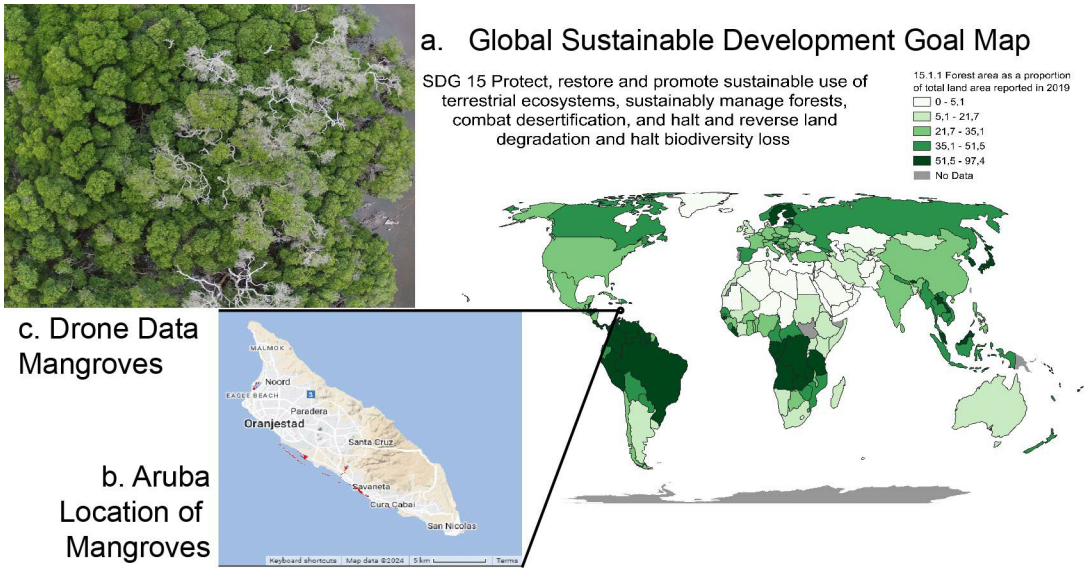

Figure 1. a. Global SDG Map of SDG indicator 15.1.1 from 2019 data.b. inset of Aruba with red showing the locations of mangroves c. is a drone image of dead mangroves in a small patch in Aruba.

References

Arnold, S., Chen, J., & Eggers, O. (2016). *Global and Complementary (Non-authoritative) Geospatial Data for SDGs: Role and Utilisation*. https://ggim.un.org/documents/Report_Global_and_Complementary_Geospatial_Data_for_SDGs.pdf

Aruba, G. of. (2021). *Aruba Sustainable Development Goals Indicators 2021: A report on new baselines and time serives analysis*. https://www.deaci.aw/wp-content/uploads/2021/12/FINAL_SDG-IWG-INDICATORS-2021_REPORT.pdf

Chow, J. (2018). Mangrove management for climate change adaptation and sustainable development in coastal zones. *Journal of Sustainable Forestry*, *37*(2), 139–156. https://doi.org/10.1080/10549811.2017.1339615

Gosling-Goldsmith, J., Ricker, B., & Jan Kraak, M. (2020). Topographic and thematic (in)visibility of Small Island Developing States in a world map. *Journal of Maps*, *16*(1), 50–56. https://doi.org/10.1080/17445647.2020.1736194

Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators*, *60*, 565–573. https://doi.org/10.1016/j.ecolind.2015.08.003

Hakimdavar, R., Hubbard, A., Policelli, F., Pickens, A., Hansen, M., Fatoyinbo, T., Lagomasino, D., Pahlevan, N., Unninayar, S., Kavvada, A., Carroll, M., Smith, B., Hurwitz, M., Wood, D., & Uz, S. S. (2020). Monitoring Water-Related Ecosystems with Earth Observation Data in Support of Sustainable Development Goal (SDG) 6 Reporting. *Remote Sensing 2020, Vol. 12, Page 1634*, *12*(10), 1634. https://doi.org/10.3390/RS12101634

Kulonen, A., Adler, C., Bracher, C., & Dach, S. W. Von. (2019). Spatial context matters in monitoring and reporting on Sustainable Development Goals. *GAIA - Ecological Perspectives for Science and Society*, *28*(2), 90–94. https://doi.org/https://doi.org/10.14512/gaia.28.2.5

Maurya, K., Mahajan, S., & Chaube, N. (2021). Remote sensing techniques: mapping and monitoring of mangrove ecosystem-a review. *Complex & Intelligent Systems*, *7*, 2797–2818. https://doi.org/10.1007/s40747-021-00457-z

Niwa, H., Ise, H., & Kamada, M. (2023). Suitable LiDAR Platform for Measuring the 3D Structure of Mangrove Forests. *Remote Sensing*, *15*(4), 1–11. https://doi.org/10.3390/rs15041033

Quang, N. H., Quinn, C. H., Carrie, R., Stringer, L. C., Hue, L. T. Van, Hackney, C. R., & Tan, D. Van. (2022). Comparisons of regression and machine learning methods for estimating mangrove above-ground biomass using multiple remote sensing data in the red River Estuaries of Vietnam. *Remote Sensing Applications: Society and Environment*, *26*, 100725. https://doi.org/10.1016/J.RSASE.2022.100725

Salum, R. B., Robinson, S. A., & Rogers, K. (2021). A validated and accurate method for quantifying and extrapolating mangrove above-ground biomass using lidar data. *Remote Sensing*, *13*(14). https://doi.org/10.3390/rs13142763

Tran, T. V, Reef, R., & Zhu, X. (2022). *A Review of Spectral Indices for A Review of Spectral Indices for Mangrove Remote Sensing*. https://doi.org/10.3390/rs14194868

UN-GGIM. (2022). *The SDGs Geospatial Roadmap:Data and indicators for the 2030 Agenda for Sustainable Development* (session 53). https://unstats.un.org/unsd/statcom/53rd-session/documents/BG-3a-SDGs-Geospatial-Roadmap-E.pdf