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| **Indicator** | 14.1.1a Index of Coastal Eutrophication |
| Target | By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution. |
| Custodian | United Nations Environment Programme (UNEP)  | Tier | II |
| Current approach and challenges | **Approach:**SDG Indicator 14.1.1a aims to measure the contribution to coastal eutrophication from countries and the state of coastal eutrophication. The methodology for SDG Target 14.1.1a Agenda 2030 is a country-led and country-owned process. The methodology encourages the use of globally available environmental data to enhance country-derived data, filling data gaps and enabling countries to more rapidly make progress towards achieving SDG targets. SDG 14.1.1a has a progressive monitoring approach which brings together globally modelled data and national data. This same approach has been adopted for other SDG indicator methodologies.This progressive monitoring approach means that countries can utilize both globally- and nationally- derived data to report on Indicator 14.1.1a. Where countries have the data and capacity to do so, they should aim to report on all aspects of Indicator 14.1.1a. While it is beneficial to capture data on all aspects of the indicator, it is recognised that not all countries may have all required data available to achieve this. Therefore, the progressive monitoring approach presented here encourages different levels of ambition, depending on a country’s capacity.The progressive monitoring approach uses 3 Levels. Level 1 data utilizes data which is already globally available and for which UNEP will produce data products. This allows to establish a foundation which can be strengthened by countries as they develop capacity and ability to report on Level 2 data and Level 3 data. Level 2 data is recommended for national data collection in all countries. Level 3 data is a list of supplementary information which is suggested that countries consider monitoring. The Level 1 data utilizes global satellite data. Since this global data is derived from global algorithms, some countries may choose to provide their own data derived from regionally tuned algorithms as part of the Level 2 data. **Challenges:**Many countries lack the in-situ data needed to track eutrophication (nitrogen, phosphorous, chlorophyll, etc.). Global satellite products provide a course assessment but regionally tuned, higher resolution products are lacking in many regions for Level 2 data due to a lack of validation data and regional capacity. **Consideration of EO:** Satellite-derived indicators provide a proxy for eutrophication. To validate the eutrophic state, in situ data are required.  |
| **Opportunities for Earth Observation** |
| Opportunities for EO | Satellite data provides synoptic views of areas that are not available with sparse in situ data. In the future, adding in additional satellite information such as land-use change, agriculture distribution, run-off and stream flow, information about potential sources of eutrophication can be identified and monitored.  |
| EO Data availability | Focus on the primary CEOS satellite data that applies to SDG 14.1.1. You might also want to summarize other derived tools and services that apply to this SDG.**Primary Tools and Data Services*** [EsriOceans Chlorophyll Hub](https://chlorophyll-esrioceans.hub.arcgis.com/)
* [ESA Ocean Color CCI](https://climate.esa.int/en/projects/ocean-colour/)
* [NOAA CoastWatch VIIRS single-sensor S-NPP and NOAA-20 Anomaly products](https://coastwatch.noaa.gov/cw/satellite-data-products/ocean-color/anomaly.html)
* [NOAA’s Ocean Color Viewer](https://www.star.nesdis.noaa.gov/socd/mecb/color/ocview/ocview.html#date=20220831/zoom=2/lat=0/lon=0/tc=true/l2=false/sens=VIIRS/proj=4326/algo=noaa_msl12_nrt/prod=chl/ave=daily/cbar=false/gran=false/coast=true/grid=false)
* [NOWPAP Environmental Watch](https://ocean.nowpap3.go.jp)
* [NOWPAP Google Earth Engine Viewer](https://eutrophicationwatch.users.earthengine.app/view/global-eutrophication-watch)
* [Marine Regions](https://www.marineregions.org/sources.php#longhurst)
* [NASA Ocean Biology Processing Group](https://oceancolor.gsfc.nasa.gov)
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| International Initiatives | **Support is being provided by GEO Blue Planet and CEOS.** |
| **Proposed Methodology** |
| Step-by-Step guide for EO integration into SDG indicator framework | **Level 1 Data:** The Chlorophyll-a Deviation Modeling ToolThe ESA Ocean Colour CCI (OC-CCI) project, led by Plymouth Marine Laboratory (PML), has produced a consistent, merged chlorophyll-a product from SeaWiFS, MODIS, MERIS and VIIRS, spanning the years 1997 to 2019 (Sathyendranath et al., 2018). The merged multi-sensor product will be updated in both time and with data from additional sensors (e.g., OLCI) as part of the Copernicus Climate Change Service (C3S) and the Copernicus Marine Service (CMEMS) that will continue the time series on an operational basis. Future OC-CCI releases will also include algorithmic improvements developed under the CCI+ initiative.Chlorophyll-a concentrations for this indicator are obtained from the global ocean, 4 km spatial resolution per pixel monthly mean product of the OC-CCI project product for each pixel within a country’s EEZ. For purposes of this sub-indicator, reporting year values are compared to a baseline of years 2000 to 2004. The baseline climatology was calculated as the mean of the 5 years of each month by pixel (e.g., mean of 5 years of January) resulting in a 5 year mean of each calendar month over the period 2000 to 2004.The Intra-annual EEZ Chlorophyll-a Anomalies Tool The Intra-annual EEZ Chlorophyll-a anomalies tool was developed to evaluate the intra-annual changes in chlorophyll-a concentration anomalies in each Exclusive Economic Zone (EEZ). It utilizes the NOAA VIIRS chlorophyll-a ratio anomaly product produced daily for the globe at 2 km spatial resolution. The daily global VIIRS chlorophyll-a concentrations are produced from the NOAA Multi-Sensor Level 1 to Level 2 (MSL12) processing of the VIIRS sensor on the Suomi SNPP satellite. (Wang et al., 2017; Wang et al., 2014) This anomaly product is defined as the daily chlorophyll-a concentration subtracted from a rolling 61-day mean baseline with a 15 day lag (based on Stumpf et al., 2003), then normalized to the rolling 61 day mean to create the proportional difference anomaly.**Level 2 Data:** To date, two regions, the Northwest Pacific Region (NOWPAP) and Europe, have produced methodologies for using regionally tuned satellite data for the Level 2 data. NOWPAP Level 2: Potential eutrophic zones (Chlorophyll-a concentration)This sub-indicator is based on eutrophication based on regionally defined values of chlorophyll-a limits and interannual trend. The indicator data will be derived using regionally tuned algorithms for satellite-derived chlorophyll-a. For additional information, see de Raús Maúre et al., 2021. European Level 2In this method, potential eutrophicaton and potential oligitrophocation maps are produced using CMEMS Ocean Colour regional products. The analysis is based on Padro et al., 2021. The full methodology (Brando et al., in press) will be published shortly in the Journal of Operational Oceanography.  |
| **Recommendations for implementation** |
| Activities | The GEO Blue Planet Initiative is currently working with member countries to validate the effectiveness of the Level 1 satellite indicators. Data and visualizations will be continually updated in collaboration with Esri. Moving forward, CEOS will be working with GEO Blue Planet to support the development Level 2 satellite products in additional regions. If you are interested in working with GEO Blue Planet on the use of the use or development of satellite derived eutrophication, please contact Emily Smail at emily.smail@noaa.gov. |
| Timeframe | Activities on going.  |
| **References** | Brando, V.E., S. Pardo, S. Sathyendranath, B. Howey, P. Land, T. Jackson, R. Santoleri, M. Sammartino, S. Colella, K. von Schuckmann, D.Ghafari, E. Smail, K.VanGraafeiland, S. Ramachandran, V.P. Lance, and M. Wang (in press). Potential eutrophication of European waters using satellite derived chlorophyll following the UN Sustainable Development Goal 14 framework. Journal of Operational Oceanography (accepted). Elígio de Raús Maúre 1✉, Genki Terauchi1, Joji Ishizaka 2, Nicholas Clinton3 & Michael DeWitt3. 2021. Globally consistent assessment of coastal eutrophication. Nature Communications, 12, Article number: 6142. https://doi.org/10.1038/s41467-021-26391-9.Pardo, S. Sathyendranath, S., Platt, T. (2021) 2.4 Eutrophic and oligotrophic indicators for the North Atlantic Ocean. Journal of Operational Oceanography, 14, No. S1,1, 1-185. https://doi.org/10.1080/1755876X.2021.194624.United Nations Environment Programme (2021). Understanding the State of the Ocean: A Global Manual on Measuring SDG 14.1.1, SDG 14.2.1 and SDG 14.5.1. Nairobi. Wang, M., X. Liu, L. Jiang and S. Son (2017), The VIIRS Ocean Color Product Algorithm Theoretical Basis Document, National Oceanic and Atmospheric Administration, National Environmental Satellite and Data Information Service, 68 pp. Wang, M., X. Liu, L. Jiang, S. Son, J. Sun, W. Shi, L. Tan, P. Naik, K. Mikelsons, X. Wang and V. Lance (2014), Evaluation of VIIRS Ocean Color Products, Proc. SPIE 9261, 92610E. https://10.1117/12.2069251. |