Supplementary Information to

Does the European Union Achieve Comprehensive Blue Growth? Progress of EU Coastal States in the Baltic and North Sea, and the Atlantic Ocean against Sustainable Development Goal 14

The Supplementary Information includes a detailed description of the indicator selection and transformation (SI.A) and as separate .zip file the original and transformed data and the mathematica file to carry out the aggregation at the SDG level with a Monte-Carlo Simulation (SI.B).

A Indicator Selection and Transformation

Below we discuss for the ten targets associated with SDG 14 our indicator selection and transformation.

Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

Progress against target 14.1 is supposed to be measured by two indicators: Index of Coastal Eutrophication (ICEP) and Floating Plastic Debris Density (summarized as Indicator 14.1.1). Since the methodology for both indicators is not fully developed, and data is missing, Indicator 14.1.1 is ranked Tier 3. The ICEP is supposed to be measured by the nutrient input (nitrogen, phosphorus and silica) of rivers. As there is consensus that ICEP will not be operational for several years, Chlorophyll-a concentration as an indicator of phytoplankton biomass is proposed as a provisional indicator that can be derived from satellite-based optical sensors (IAEG-SDGs, 2017b). Data on the Chlorophyll-a concentration will be collected from 2018 to 2020 until ICEP takes over in 2021. Neither the data itself nor information about the frequency of data collection is determined yet (United Nations Statistics Division, 2017a). Floating Plastic Debris Density refers to modelled macro- (>4.7mm) and micro- (<4.7mm) plastics distribution over the world oceans. The modelling is supposed to be based on surface water circulation and proxies like shipping density, coastal population density, and area of impermeable catchment like urban areas with rapid run-off. As interim solution, beach litter has been proposed to be an alternative indicator for marine litter (IAEG-SDGs, 2017a)). While the methodology on beach litter is supposed to be developed by 2017, the final indicator of floating plastic debris density will be developed in 2021 and data will be updated biannually (United Nations Statistical Comission, 2017). While the two indicators, Index of Coastal Eutrophication (ICEP) and Floating Plastic Debris Density will, once available, describe the state of the marine pollution, they miss tracking and assessing individual country’s contribution to marine pollution. Accordingly, in line with Rickels et al. (2016), we use the indicators #1 Gross Nitrogen Balance to measure coastal eutrophication and the indicators #2a Plastic Waste Generation per Capita and #2b Recovery Rate of Plastic Packaging to measure plastic pollution. Information for these indicators is obtained from Eurostat (2018c, 2018d). Gross Nitrogen Balance provides information on the relationship of total nitrogen inputs minus total nitrogen outputs to the soil, the surplus presenting an important agricultural source for eutrophication. The gross nitrogen balance per ha is derived by dividing the total gross nitrogen balance by the reference area. To obtain the score for Gross Nitrogen Balance we apply a Max-Min Transformation where the max-value is the maximum value in the period 2012-2014 and the minimum is set to zero. To obtain the score for Plastic Waste Generation per Capita we apply a Max-Min Transformation where the max-value and min-values are the maximum and minimum in the period 2012-2014, respectively. We use Recovery Rate of Plastic Packaging without further transformation as score as it is provided dimensionless.
**Target 14.2:** By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans. Progress against target 14.2 is supposed to be measured by indicator *Proportion of national exclusive economic zones managed using ecosystem-based approaches* (Indicator 14.2.1). Indicator 14.2.1 is assessed through markers on ecosystem-based management (EBM) frameworks on existing national plans. In a second step, changes in national/regional adoption and implementation of defined principles of the ecosystem approach are assessed with a spatially derived tracking system. While pilot countries start a testing phase in 2018, complete data is supposed to be collected from 2021 onwards in a 3-5 year cycle (United Nations Statistics Division, 2017b). Hence, indicator 14.2.1 is ranked Tier 3, through incomplete methodology and data scarcity (IAEG-SDGs, 2017b). (Rickels et al., 2016) neglect target 14.2 because a comparison across the EU is problematic since the EU Maritime Spatial Planning directive came into force in 2014 and aims to be implemented by all countries in 2021 (European Commission, 2015). Thus, a spatial comparison within the EU is not expected to yield great differences and we neglect Target 14.2.

**Target 14.3:** Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. Progress against target 14.3 is supposed to be measured by indicator *Average marine acidity (pH) measured at agreed suite of representative sampling stations* (Indicator 14.3.1). Due to missing data coverage and the methodology not being tested, this indicator is ranked Tier 3. In open consultation it is demanded to develop an additional indicator that measures the impact of acidification (on coral reefs or phytoplankton etc.) and compliments the short term chemical indicator pH by 2020 (IAEG-SDGs, 2017a, 2017b). First tests in pilot countries started 2017. From 2020 on, data on this state-indicator should be collected biannually (United Nations Statistics Division, 2017b). Like with Target 14.1, the indicator does not allow to track individual country’s progress against this target (i.e., reducing CO₂ emissions). Here, in line with Rickels et al. (2016) we use indicators related to carbon emissions and select *Compliance in Effort Sharing Decision (ESD) Sectors* and *Carbon Emissions (per capita)*. Information on *Compliance in ESD Sectors* and *Carbon Emissions (per capita)* is obtained from Eurostat (2018a, 2018b). The former is assessed against the EU target level, the latter is transformed by applying a Max-Min Transformation where the max-value and min-value are the maximum and minimum in the assessment period (2012-2016).

**Target 14.4:** By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics. Progress against target 14.4 is supposed to be measured by indicator “*Proportion of fish stocks within biologically sustainable levels*” (Indicator 14.4.1). The IAEG-SDGs defines biologically sustainable levels as an abundance of a fish stock that can produce the MSY. Data is supposed to be collected and released biannually. The derivation of this indicator is technically demanding as it needs stock assessment (using fish catch statistics, fishing effort data and biological information that needs to fit to a population dynamics model). Thus, despite being classified as Tier 1, data for this indicator is provided as world data and not yet at the country level (IAEG-SDGs, 2017a; 2017b), preventing therefore cross-country assessment. Here, we obtained information on 79 fish stocks in the Baltic and North Sea and the Atlantic (and Arctic Ocean) and information on country’s catches on these fish stocks from ICES (2018). We use as indicators catch-weighted *FMSY/F* and catch-weighted *B/BMSY*. If fishing mortality, including fishing mortality from bycatch, exceeds the growth rate of the stock, a decline of the fish stock will be the consequence. The growth rate of a fish stock depends on
its biomass $B$, and reaches its maximum at $B_{MSY}$. Thus, $F_{MSY}$ equals the growth rate at $B_{MSY}$ for a sustainable management of a certain fish stock (Swasey, 2014). The indicator is calculated as catch-weighted average of the ratio $F_{MSY}/F$ (if this ratio is greater or equal to 1, a value of 1 is assigned) and multiplied with 100. Likewise, $B/B_{MSY}$ is calculated as the catch-weighted average relation of the biomass stock to the biomass reference point. Fisheries where the biomass stock exceeds the reference point are assigned 1. Accordingly, if a country would restrict its fishing activities to fisheries where the biomass is above the reference point, it would score 100. The former indicator has in the context of Target 14.4 the interpretation of a pressure indicator, the latter the interpretation of state indicator. Both indicators are calculated to be ratio-scale full comparable.

**Target 14.5:** By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

Progress against target 14.5 is supposed to be measured by indicator *Coverage of protected areas in relation to marine areas* (Indicator 14.5.1). The indicator is ranked Tier 1 and shows the mean percentage coverage by designated protected areas for each site that is important for biodiversity. The status “designated” is achieved if a country officially designates the protection of an area for the purpose of biodiversity (and not any other activity, e.g. military; even though it is argued, that this areas might be managed in a way that is consistent with the persistence of biodiversity (Jonas et al., 2014). The information for this indicator is obtained from Global Indicator database which is so far restricted to the year 2016 preventing therefore to measure any progress achieved in this dimension of sustainable development (ICES, 2017; United Nations Statistical Division, 2018). To obtain the score for *Coverage of protected areas in relation to marine areas* we apply a Distance to Reference Transformation where the max-value is set instead of 10 percent to 30 percent (following (Brandi, 2015) and the minimum value is zero percent. However, the benefits of a marine protected area (MPA) might not only be derived from the cumulative area of MPAs in the coastal and marine area. Edgar et al. (2014) show “that the conservation benefits of 87 MPAs investigated worldwide increase exponentially with the accumulation of five key features: no take, well enforced, old (>10 years), large (>100km2), and isolated by deep water or sand (p. 216).” We consider *Coverage of protected areas in relation to marine areas* as an important instrument to sustain marine biodiversity (Brandi 2015) which we believe is the fundamental aim of this target and acknowledge that there are further instruments and factors relevant for making progress against the fundamental target. Accordingly, we include information on the state of marine biodiversity and *Biodiversity (OHI)* as additional indicator. The information is obtained from the OHI (2018b). *Biodiversity (OHI)* measures the status of marine species and habitats. We use only the status information from the OHI goal *Biodiversity* and use the indicator without further transformation as score as it is provided dimensionless.

**Target 14.6:** By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation

Progress against target 14.6 is supposed to be measured by indicator *Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated (iuu) fishing* (Indicator 14.6.1). Indicator 14.6.1 summarizes three indicators: 1: Development and implementation of a national plan of action to combat IUU fishing, 2: Ratification and implementation of the 2009 FAO Agreement on Port State Measures, and 3: Ratification and implementation of the 1993 FAO Compliance Agreement. The first and second indicators are each weighted 40 percent while the third is weighted 20 percent in a simple arithmetic mean. Data is supposed to be collected biannually by sending questionnaires to the countries (United Nations
Statistical Commission, 2017). Indicator 14.6.1 was recently reclassified Tier 2 (IAEG-SDGs, 2017b) (i.e. not yet available). Following Rickels et al. (2016) we use information from the OECD on the Fishery Support Estimate (OECD, 2018). The Fishery Support Estimate provides disaggregated data on various aspects of subsidies and payment to fishermen, from which we select and summarize i) transfers to individual fishers (including market prize support and fuel tax concessions) and ii) general service support transfers (excluding transfers for the management of resources, education and training, and research and development.) We set the sum in relation to the country-specific value of landings and apply a Max-Min Transformation where the max-value and min-value are the maximum and minimum in the assessment period (2012-2016) and label the indicator Fishing Subsidies. In addition, to measure the existence and enforcement of legal frameworks to comply with the total allowed catch (TAC), we select in line with (Rickels et al., 2016) (catch-weighted) TAC/Catch as a second indicator for target 14.6. The indicator is calculated as the catch-weighted average relation of landings relative to TAC and the data was obtained from ICES (2018). Fisheries in which landings are below TAC are assigned 1. Accordingly, if a country complies on all fish stocks with TAC, it would score 100.

**Target 14.7:** By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

Progress against target 14.7 is supposed to be measured by indicator Sustainable fisheries as a percentage of GDP in SIDS, LDC and all countries (14.7.1). Indicator 14.7.1 is the least developed indicator in the indicator set for SDG14 and not even fully defined in the metadata. Thus, indicator 14.7.1 is ranked Tier 3 (IAEG-SDGs, 2017b). Clearly, the target is not designed with respect to developed countries (which we address in our study). However, in combination with the environmental and social dimension, the economic dimension (i.e. economic benefits) is an important pillar for sustainable development. Furthermore, in particular against the question whether EU coastal states achieve comprehensive blue growth it is important to also account for the economic dimension which should include, but not be restricted to benefits from fisheries, aquaculture, and tourism. In line with Rickels et al. (2016) we select Coastal Livelihoods & Economics (OHI) and Tourism (OHI) as indicators for assessment. Coastal Livelihoods & Economics (OHI) contains two subgoals, Livelihoods and Economies. The Livelihoods status is calculated in the OHI as the number of direct and indirect jobs in marine sectors (not considered in other goals) and the per capita wages in these sectors relative to reference values. The reference value for the number of jobs is determined by a moving average so that the status assessment partly reflects the extent to which the jobs in the marine sectors have been sustained. The Economics status is calculated in the OHI as direct and indirect revenues from shipping, boat building, ports, and harbors relative to a reference value. Again, the reference value is obtained using a moving average. The Tourism status is calculated as the number of jobs sustainably employed in the tourism sector relative to the total coastal labor force. The OHI assessment obtains information on the sustainability of the jobs (and the coastal tourism sector) from the Tourism Competitiveness Index (TTCI), which is calculated by the World Economic Forum (WEF (World Economic Forum), 2015). Data for both indicators is obtained (OHI, 2018a) and we apply both indicators without any further transformation.

**Target 14.a:** Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

Progress against target 14.a is supposed to be measured by indicator Proportion of total research budget allocated to research in the field of marine technology (Indicator 14.a.1). The indicator was
recently reclassified as Tier 2 (IAEG-SDGs, 2017b). The testing phase in pilot countries was finished in 2017 and data collection starts in 2018. The data is supposed to be collected by questionnaires every five years and an initial data set is already available in the Global SDG Indicators Database (United Nations Statistical Division, 2018). The coverage of countries is still rather low (only for 4 out of 15 countries in our assessment indicator information are provided) but as we favor using official data were possible, we include the indicator Marine Research (measured by the Proportion of total research budget allocated to research in the field of marine technology) in our assessment (United Nations Statistical Division, 2018). We apply a Max-Min transformation where the max-value and min-value are the maximum and minimum in the assessment period (2009-2013) of all European countries (not restricted to our selected 4 countries). Here, we used for all countries without data the average score of the countries with data. In addition, we select as indicator (catch-weighted) SAD/TAC as a proxy for the implementation of scientific recommendations in policies. The indicator is calculated as the catch-weighted average relation of TAC relative to Scientific Advice and the data is obtained from ICES (2018). Fisheries in which TAC is below scientific advice are assigned 1. Accordingly, if a country fishes only on fish stocks where assignment of TAC follows scientific advice, it would score 100.

**Target 14.b:** Provide access for small-scale artisanal fishers to marine resources and markets

Progress against Target 14.b is supposed to be measured by indicator Progress by countries in the degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small scale fisheries (Indicator 14.b.1). The composite indicator consists of a weighted arithmetic mean of three variables: 1) Existence of instruments that specifically target or address the small-scale fisheries sector (weight 40 percent), 2) Ongoing specific initiatives to implement the SSF Guidelines (i.e. the International Guidelines on Securing Sustainable Small Scale Fisheries as defined by the (FAO, 2018))(weight 30 percent), and 3) Existence of mechanisms enabling small-scale fishers and fish workers to contribute to decision-making processes (with a weight of 30 percent). The three variables take the value 1 or 0, depending on whether the instruments, initiatives, and mechanism exist or not, respectively. Data is supposed to be collected biannually by questionnaire (United Nations Statistics Division, 2017b) and the Indicator 14.b.1 was recently reclassified as Tier 2 (IAEG-SDGs, 2017b), however, is not yet provided by the Global SDG Indicators Database. Obviously, improving small-scale artisanal fishing appears more relevant for developing countries than for EU coastal states. Still, we consider elements related to Target 14.b relevant for a comprehensive investigation of sustainable development and include two indicators, Artisanal Fishing Opportunities (OHI) and Percentage of Fish Species Threatened. The former appears relevant because it measures pressures by including information about chemical and nutrient pollution, alien species, habitat destructing commercial fishing, bycatch, destructive fishing, and changes in sea temperature and resilience by including information about ecological integrity in coastal areas and institutional efforts concerning habitat and fishing resilience (OHI, 2018b). Furthermore, we decide to use the “full” information provided by Artisanal Fishing Opportunities (OHI) and not restrict our selection to the sub-indicator, measuring fisher access, but also include the information about access relative to demand. Including the full information, including the information about access relative to demand, better aligns the indicator with other SDG targets. The indicator is used without further transformation. The latter appears relevant because it measures in contrast to indicators assigned to Target 14.4 non-catch weighted and non-commercial state of fish stocks which could be relevant for small-scale and recreational fisher. Information on Percentage of Fish Species Threatened was obtained from the (World Bank, 2018) which is based on the data of Froese and Pauly (2018). The number of fish species threatened summarizes those species which are classified by the IUCN as “Critically Endangered”, “Endangered” or “Vulnerable” (IUCN, 2016). It has to be mentioned that the extinction risk is evaluated for only 5% of all species. Even though for some
groups the extinction risk can be calculated, the number of threatened species remains uncertain. We use *Percentage of Fish Species Threatened* without further transformation.

**Target 14.c:** Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of *The Future We Want.*

Progress against Target 14.c is supposed to be measured by indicator *Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United UNCLOS, for the conservation and sustainable use of the oceans and their resource* (Indicator 14.c.1). As no clear methodology exists, and the metadata states, that the key characteristics of this indicator have not been negotiated yet, this indicator is ranked Tier 3 (IAEG-SDGs, 2017b; United Nations Statistics Division, 2017b). We select two indicators to cover the governance dimension related to sustainable (ocean) development: Participation in agreements of the International Marine Organization (*IMO Participation Rate*) and *Measures under the Marine Strategy Framework Directive*. The former is calculated as the participation rate in international sea protocols of the IMO (2018), the latter is calculated as the rate of appropriateness measures taken by member states against pressures as defined under the Marine Strategy Framework Directive (European Commission, 2018). Both indicators are used without any further transformation. Unfortunately, for both indicators only most recent information is available, preventing an intertemporal comparison.

**References**


European Commission: The maritime spatial planning directive: For the sustainable growth of Europe's blue economy, [Publications Office], [Luxembourg], 1 online resource (1 leaflet.), 2015.


FAO: International Guidelines on Securing Sustainable Small-Scale Fisheries:
IAEG-SDGs: Fifth Meeting of the Inter-Agency and Expert Group on the Sustainable Development
IAEG-SDGs: Tier Classification for Global SDG Indicators, 33 pp., 2017b.
IMO: Status of Conventions:
   http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/Default.aspx, last access:
   1 August 2018.
IUCN: A Global Standard for the Identification of Key Biodiversity Areas, Version 1.0, Gland,
   Switzerland, 46 pp., 2016.
   Protected Areas to Consider Other Effective Area-Based Conservation Measures, Parks, 20, 111–
OHI: Ocean Health Index:Science: http://ohi-science.org/data/, last access: 1 June 2018.
Rickels, W., Dovern, J., Hoffmann, J., Quaas, M. F., Schmidt, J. O., and Visbeck, M.: Indicators for
   monitoring sustainable development goals: An application to oceanic development in the European
United Nations Statistical Comission: Global indicator framework for the Sustainable Development
United Nations Statistical Division: SDG Indicators Global Database:
United Nations Statistics Division: The Sustainable Development Goal indicators website:
World Bank: Metadata on Number of Fish Species Threatened:
   D.NO.