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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

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KIEL WORKING PAPER

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



No. 2112 September 2018

Wilfried Rickels, Christian Weigand, Patricia Grasse, Jörn Schmidt, Rudi Voss

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

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Keywords: Sustainable Development Goals, Blue Growth, European Union, Fisheries

JEL classification: Q01, Q22, Q56

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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

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Abstract

The Sustainable Development Goal for the oceans and coasts (SDG 14) as part of the 2030 Agenda can be considered as an important step towards achieving more comprehensive blue growth. Here, we selected a set of 18 indicators to measure progress against SDG 14 for EU coastal states in the Baltic and the North Sea and the Atlantic Ocean since 2012. In our assessment we distinguish between a concept of weak and strong sustainability, assuming high and low substitution possibilities, respectively. Overall, we show that the majority of countries in our assessment fail to achieve comprehensive blue growth. Sweden, Spain, Ireland, and in particular Portugal experienced a considerable decline in scores since 2012. The only exemption is Estonia which managed to improve its scores over time under both concepts of sustainability. The unsustainable development at the EU level is mainly driven by deteriorations in indicators related to fisheries.

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1 Introduction

Achieving economic growth and development while maintaining the natural assets base is considered to be essential for sustaining well-being. In this regard, the term *blue growth* has recently entered the debate to highlight the importance of ocean resources and services (Eikeset et al. 2018). For example, the European Commission has launched a blue growth initiative to properly acknowledge the seas and ocean as drivers for the European economy, innovation and growth (European Commission 2017) and the Organisation for Economic Cooperation and Development (OECD) has launched a report to explore the growth, employment, and innovation prospects of the ocean economy by 2030 (OECD 2016). Despite clearly acknowledging the importance of sustaining the natural resource base, the focus of such initiatives and reports appears to be rather on economic growth and employment, raising the question how comprehensive their approach to blue growth actually is. Growth in the ocean economy has in particular arisen from improved access to, utilization of, and production efficiency from ocean resources and services (Klinger et al. 2018). However, poorly regulated open access regimes are considered a key reason for sub-optimal and non-sustainable ocean resource use (McCauley et al. 2015; Visbeck et al. 2014). Against this background, the inclusion of a specific United Nations (UN) Sustainable Development Goal for the oceans and coasts (SDG 14) as part of the 2030 Agenda can be considered as an important step towards achieving more comprehensive blue growth, encouraging the development of sustainable and resilient coastal communities.

Since the adoption of the 2030 Agenda by the United Nations General Assembly in 2015 (United Nations 2015), a few initial assessments have been published to measure the progress over and against the overall SDG goals and associated targets. However, these assessments have so far rather focused on terrestrial resources or have omitted the ocean in their assessment of trade-offs and synergies among the SDGs (Pradhan et al. 2017) because of poor data availability for indicators associated with SDG 14. One exemption is the study of Rickels et al. (2016) who select indicators to provide an initial assessment of the state of SDG 14 for EU coastal states. However, by definition sustainable development requires assessment over time. Here, we extend the analysis of Rickels et al. (2016), providing an assessment of sustainable ocean development for EU coastal states as defined by SDG 14. The comparison over time provides not only important information but does also circumvent intrinsic limitations in the results of Rickels et al. (2016) arising from transformation and aggregation. Overall, the results indicate that the majority of countries in our assessment failed to achieve comprehensive blue growth. Only Estonia managed to improve their scores since 2012.

Essential for the assessment of the 2030 Agenda is the development of the Global Indicator Framework by the Inter-agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) (United Nations 2015). Formed by the United Nations Statistical Commission (UNSC, 2015) in March 2015, the IAEG-SDGs consists of national statistical offices taking a leading role

while regional and international organizations and agencies act as observers. The first version of the proposed Global Indicator Framework consisted of 300 indicators and has been reduced to the number of 232 indicators as a result of ongoing consultation (IAEG-SDGs 2015; UNSC 2017). The set of indicators is supposed to be refined annually, complemented by indicators on a regional and national level and reviewed in 2020 and 2025 (United Nations 2017). To facilitate the implementation of the Global Indicator Framework, each indicator is classified in a tier system. The tier system consists of three tiers that depend on methodological development and the availability of data at the global level (IAEG-SDGs 2017): Tier 1: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant; Tier 2: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries; and Tier 3: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested. Since methodologies are developed and data availability increases, the classification of indicators tends to change and is reviewed bi-monthly by the IAEG-SDGs. As of May 2018, the Global Indicator Framework consists of 93 Tier 1 indicators, 72 Tier 2 indicators and 62 Tier 3 indicators.

Currently, only for two of the indicators assigned to the targets of SDG 14 official data is available for cross-country comparison (United Nations Statistical Division 2018). Accordingly, Pradhan et al. (2017) had to leave out SDG 14 in their correlation analysis between different indicators to identify synergies and trade-offs between SDGs. Rickels et al. (2016) analyze SDG14 for EU coastal states in detail, selecting indicators by themselves to approximate progress against the various targets related to SDG14. They analyze the performance against these indicators by means of composite indicators at the target and SDG level, showing that such aggregated indicators guide the assessment of sustainable development. However, there exist no unambiguous rules for selecting indicators (Böhringer and Lange 2005) and selecting different indicators would have resulted in a different ranking than that obtained by Rickels et al. (2016). Furthermore, without officially defined reference values for certain indicators, high or low scores might rather provide information about the skewness of the indicator distribution than about the actual state of Sustainable Ocean Development. Clearly, our modification and updating of the approach by Rickels et al. (2016) cannot fully overcome these structural limitations as only for two indicators official data is available. However, by focusing on the change of indicators over time, various problems related to standardization and selection are mitigated as the focus on change between two different points in time allows for a more robust assessment of sustainable development than an assessment of the state at given point in time. Another problem of the assessment by Rickels et al. (2016) is that they rely for four indicators on data from the International Council for the Exploration of the Sea (ICES). The ICES data covers the Baltic Sea, the North Sea, and the Atlantic Ocean, but not the Mediterranean Sea. Accordingly, no value for these four indicators

is assigned to Mediterranean EU coastal states, implying that the other indicators have a higher weight in the aggregated score in the assessment of Rickels et al. (2016) for Mediterranean EU coastal countries. Depending on whether these four indicators rank relatively high or low compared to the other indicators (for those countries where data is available), the inclusion of these indicators results somewhat in a bias, giving an advantage or disadvantage to ICES countries, respectively. Here, we restrict our assessment to ICES countries, reducing on the one hand our coverage of EU coastal countries but again increasing the robustness of the assessment.

The paper is structured as follows. Section 2 introduces our method to assess sustainable ocean development for (selected) EU Coastal states by comparing the most recently available information against a 2012 baseline. Section 2.1 explains the indicator selection and transformation and Section 2.2 explains the indicator aggregation. The results are presented in Section 3, discussing first the results for the ocean state (Section 3.1) and second the results for ocean development (Section 3.2). Section 4 concludes.

2 Method

SDG14 includes ten targets, 14.1 to 14.7 and 14.a to 14.c whereby the last three targets aim specifically at implementation (Means of Implementation targets). The Global Indicator Framework assigns to target 14.1 two indicators, for all others one indicator. However, for target 14.6 and 14.b the indicators are composite indicators, aggregating three indicators each. The Global SDG Indicators Database currently provides only for two indicators associated with SDG14 cross-country information (United Nations Statistical Division 2018). Accordingly, further indicators need to be selected to measure progress against SDG14. We selected for each target at least two indicators (excluding target 14.2), including the two indicators from the Global SDG Indicator Database. For target 14.1 we selected three indicators because we measure progress against marine plastic pollution by two indicators (which are then aggregated into a composite indicator). The indicators are aggregated at the target level and at the SDG level, allowing tracking changes on different levels of aggregation. We aim for assessing sustainable ocean development by comparing two points in time: the most recent ocean status against the status in 2012.

2.1 Indicator Selection and Transformation

There exist no unambiguous rules for selecting indicators (Böhringer and Patrick 2007) and selecting or neglecting indicators implicitly involves a weighting decision (Rickels et al. 2016). Our selection of indicators was guided by the Global Indicator Framework and we aimed for approximating those indicators currently not yet available with closely related indicators from official sources like Eurostat, OECD, or ICES. ICES provides various information for European fish stocks which we used to calculate in total four indicators. For the calculation we included all (ICES) fish stocks which account for at least one percent of total annual catch at the EU level. Further information is obtained from the Ocean Health Index (OHI), introduced by Halpern et al. in 2012. The OHI measures scores for ten

ocean-related societal goals and is updated annually. We provide more detailed information about the indicator selection in the *Supplementary Information A*. For those indicators not yet available as ratio-scale, fully comparable indicators, we apply either the distance-to-reference (dis-ref) transformation (for indicators with exogenous given target values) or Max-Min transformations (for the remaining indicators) (OECD 2008). The complete dataset, including the untransformed and transformed data are included in *Supplementary Information B*. The selection and transformation of indicators is summarized in Table 1.

We have not selected any indicators to measure progress against target 14.2 which is supposed to be measured by the indicator *Proportion of national exclusive economic zones managed using ecosystem-based approaches*, but is not yet available (Tier 3). Integrated ecosystem-based management (EBM) is considered to be crucial to overcome the so far largely fragmented and therefore potentially socially inefficient existing management of ocean and coastal resources (Wright 2015, Klinger et al. 2018). Yet, progress against the application of EBM approaches is expected to be achieved at the EU level. The EU Maritime Spatial Planning directive, including EBM, came into force in 2014 and aims to be implemented by all countries in 2021 (European Commission 2015). Accordingly, we could not identify any related indicator which provides information for a cross-country assessment against this target of SDG14 at the EU coastal state level.

UNSC Indicator (description)	Selected Indicator	Unit, Source, Transformation, Comparison Years
Target 14.1 Marine Pollution		
Index of coastal eutrophication and floating plastic debris density	#1 Gross Nitrogen Balance	Nitrogen in kg/ha, Eurostat, Max-Min, 2012 v. 2014
	#2a Plastic Waste	Kg per capita, Eurostat, Max-Min, 2012 v. 2014
	#2b Plastic Waste Recovery Rate	Percent, Eurostat, no trans, 2012 v. 2015
Target 14.2 Ecosystem-Based Management		
Proportion of national EEZ managed using ESB approaches	No indicator selected	
Target 14.3 Ocean Acidification		
Av. marine acidity (pH) measured at representative sampling stations	#3 CO2 Compliance	GHG emissions in ESD sectors relative to target, Eurostat, dis-ref, 2012 v.2016
	#4 CO2 per Capita	kg, Eurosat, Max-Min, 2012 v. 2016
Target 14.4 Overfishing		

Proportion of fish stocks within biologically sustainable levels	#5 Fishing Mortality	catch-weighted average of F/F_{MSY} , ICES, no trans, 2012 v. 2016
	#6 Sustainable Fishing	catch-weighted biomass stock to biomass reference point, ICES, no trans, 2012 v. 2016.
Target 14.5 Protection and Conservation		
Coverage of protected areas in relation to marine areas	#7 MPA/EEZ	Percentage, UNSD, dis-ref with target 30 percent, 2016
	#8 Biodiversity (OHI)	Score, OHI, no trans, 2012 v. 2017
Target 14.6 Fishing Subsidies		
Instruments aiming to combat illegal, unreported and un-regulated (iuu) fishing	#9 Fisheries Subsidies	Percent in relation to value of landings, OECD, Max-Min, 2012 v. 2016
	#10 Landings exceeding TAC	catch-weighted average of landings exceed TAC, ICES, no trans, 2012 v. 2016
Target 14.7 Economic Benefits		
Sustainable fisheries as a percentage of GDP	#11 Livelihoods& Economics (OHI)	Score, OHI, no trans, 2012 v. 2017
	# 12 Tourism (OHI)	Score, OHI, no trans, 2012 v. 2017
Target 14.a Marine Science		
Research budget allocated to marine technology	#13 Marine Research	Research budget share for marine research, UNSD, Max-Min, 2009 v. 2013
	#14 TAC exceeding Scientific Advise	catch-weighted average of TAC exceed scientific advice, ICES, no trans, 2012 v. 2016
Target 14.b Artisanal Fishing		
legal/regulatory/policy/institutional framework to recognize/ protect access for small scale fisheries	#15 AFO (OHI)	Score, OHI, no trans, 2012 v. 2017
	#16 Fish Species Threatened	Percentage, World Bank, no trans., 2012 v. 2017
Target 14.c Marine Governance		
Progress in ratifying, accepting and implementing ocean-related instruments that implement international law	#17 IMO Participation Rate	Rate, IMO, dis-ref with target: max number protocols, 2018.
	#18 MSDF Measures	Rate of appropriate measures, EC, no trans, 2018.

Table I: Indicator Selection and Transformation for EU Ocean Sustainable Development Assessment.

2.2 Indicator Aggregation

The different dimensions of sustainable ocean development can be captured by a nested composite indicator with different substitution possibilities at different layers. We first aggregate those indicators with better substitution possibilities, and assume less optimistic substitution elasticities at the top level of aggregation (Dovern et al. 2014; Rickels et al. 2016). We follow Rickels et al. (2016) and apply the (weighted) constant elasticity of substitution (CES) function to achieve a meaningful aggregation of the selected indicators, I_{it} , into composite indicators, CI_t :

$$CI_t(a_{it}, I_{it}, \sigma) = \left(\sum_{i=1}^N \alpha_{it} I_{it}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \text{ for } t = 2012, 2018(\text{most recent}), \quad (1)$$

with weights $\alpha_i > 0$ for the individual ratio-scale and full comparable indicators, and the parameter σ to quantify the *elasticity of substitution* between the different indicators (Solow 1956, Arrow et al. 1961, Armington 1969, Blackorby and Donaldson, 1982). High (low) values for σ imply good (poor) substitution possibilities which means that the low score in one indicator can very well (not well) compensated by a good score in another indicator. Consequently, high and low values for σ correspond to concepts of weak sustainability and strong sustainability, respectively.

The nesting structure reflects the SDG framework by having first an indicator level, second a target level, and third an SDG level. The target and SDG level are assessed by means of *CI*s and where more than one indicator is selected, we also calculate *CI*s for the indicator level. The substitution possibilities are upwardly decreasing in the nesting structure, implying that we consider a concept of weak sustainability at the indicator and target level (good substitution possibilities) and a concept of rather strong sustainability at the SDG level (poor substitution potential). Measuring development against the concept of strong sustainability requires choosing a substitution elasticity value below 1 (e.g., Gerlagh and van der Zwaan 2002, Heal 2009, Bateman et al. 2011, Traeger 2013). Accordingly, at the indicator and target level we assume that $\sigma_{Indicator,Target} = 10$ and at the SDG level that $\sigma_{SDG} \sim U(0,1)$ (Dovern et al. 2014, Rickels et al. 2014, Rickels et al. 2016). The aggregation at the SDG level is carried out by a Monte Carlo simulation (N=10,000). The calculation of aggregated scores, including the Monte-Carlo simulation has been carried out with *Mathematica 10.3*. and the corresponding file is part of *Supplementary Information B*.

Contrasting aggregation scores obtained under two concepts of sustainability provides a good measure to identify unbalanced performances across targets because the score under the concept of strong sustainability is much sensible to negative outliers. Accordingly, we also aggregate at the SDG level under a concept of weak sustainability with perfect substitution possibilities ($\sigma \rightarrow \infty$). However, aggregation under the assumption of weak sustainability results in higher scores expect for the special case where all scores at the target level are equal. Accordingly, comparing the ranking information under the two concepts of sustainability provides straightforward information about the balance of

scores across targets for the countries because a country with a balanced performance ranks higher than a country with unbalanced performance under the concept of strong sustainability.

The aggregation at the SDG level, $CI_{SDG,t}$, provides information about the state of ocean resources and services in the selected EU coastal states, i.e. *EU Ocean State*, the comparison over time, $\Delta CI_{SDG} = CI_{SDG,2018} - CI_{SDG,2012}$, provides information about the development of ocean resources and services in the selected EU coastal states, i.e. *EU Ocean Development*, allowing to assess whether the development has been sustainable ($\Delta CI_{SDG} \geq 0$).

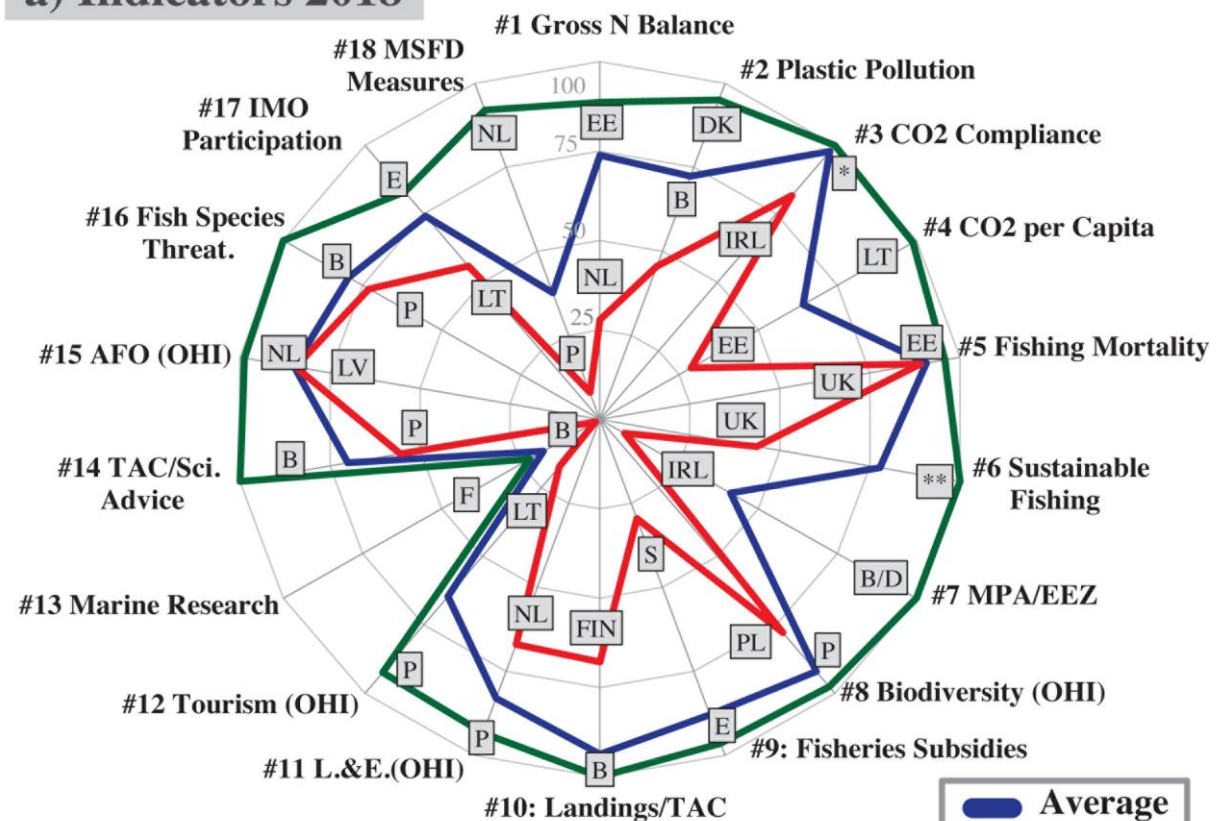
3 Results and Discussion

3.1 EU Ocean State

Interpreting the scores measuring EU Ocean Status requires some caution because for five of our indicators the max-min transformation has been applied. High or low scores might not necessarily indicate a good or poor state. However, as the determination of the maximum and minimum values of the original data not only included the countries in our assessment but all countries in the EU or even Europe (see *Supplementary Information A*), one can interpret the maximum value as kind of a best-practice reference value.

Figure 1 shows the maximum, minimum, and EEZ-weighted average scores at the indicator and target level for 2018 (upper and lower panel, respectively). Notably, are the low scores for the indicator #13 *Marine Research* and a rather large spread between maximum and minimum scores for #1 *Gross Nitrogen Balance*, #4 *CO₂ (emissions) per Capita*, #7 *MPA/EEZ*, and #18 *MSFD Measures*. For *Marine Research* the reference value in the standardization is given by Norway which spends 3.6 percent of its total expenditure for research and development for ocean science. Among the countries in our assessment, France has the highest expenditures, spending 0.8 percent for ocean science. Accordingly, the highest score in our assessment is obtained by France which still scores relative low (22 points) compared to Norway.

a) Indicators 2018



b) Targets 2018

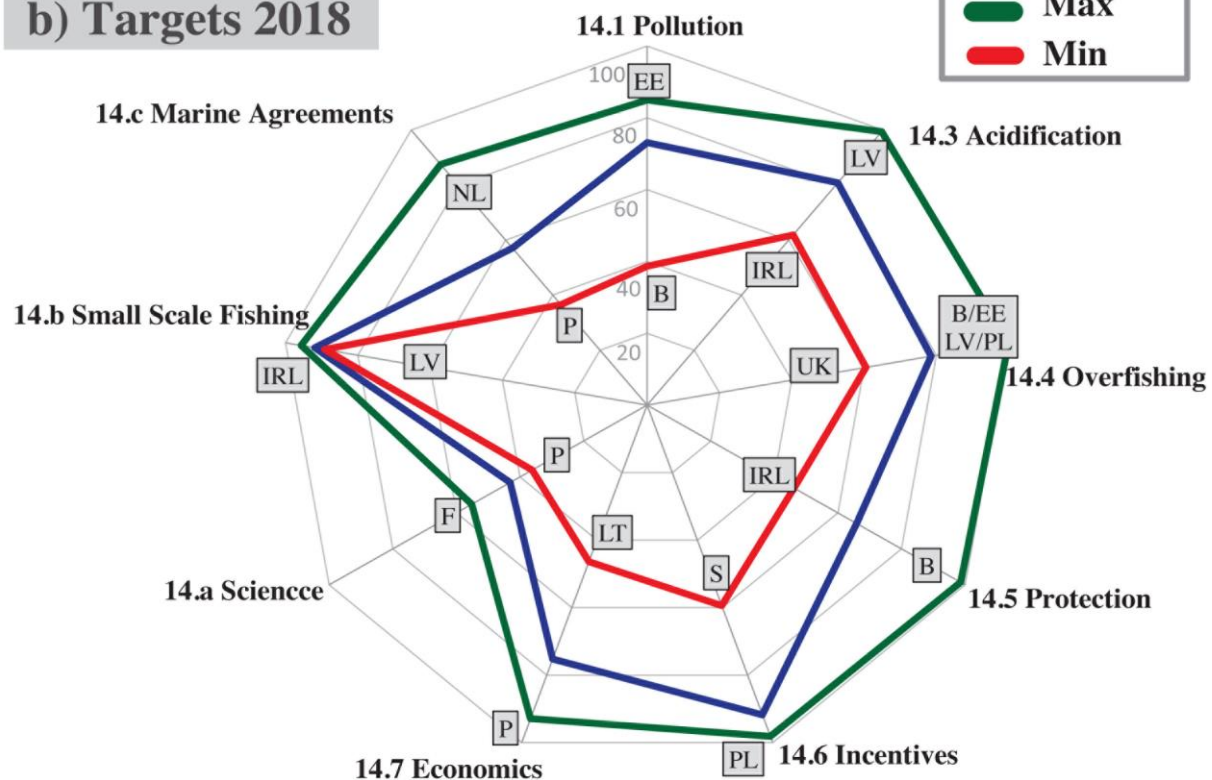


Figure 1: Ocean Status of EU Coastal States at the Indicator and Target Level. The figure shows the EEZ-weighted average, the maximum, and minimum scores for indicators (a) and targets (b) for the most recent available information. In the upper panel (a), the max score for Indicator #3 (*) is shared by EE/E/LT/LV/NL/PL/P/S/UK and for Indicator #6 (**) by B/EE/F/LT/P.

For *Gross Nitrogen Balance* one could ask whether country-specific reference values would be more appropriate, accounting for the agricultural structure in the country. However, this might be an option for a more comprehensive assessment of sustainable development where aspects like food provision are considered. Here, with focus on marine pollution we believe that the minimum and maximum values across countries in Europe provide a good reference with respect to nitrogen pollution, indicating the so far still very different performance of countries against this target. Still, the application of the max-min transformation explains the large spread like it is also the case for *CO2 (emissions) per capita*. For the indicator *Marine Protected Areas* we have chosen an even more ambitious reference value as declared in target 14.5 (30 percent compared to 10 percent, respectively) as we follow Brandt et al. (2015) who claims that a more ambitious target is more appropriate for EU coastal states. The maximum score of 100 indicates that the target is well achievable (achieved by Belgium and Germany). For the indicator *MSFD Measures* the range reflects the broad spectrum of performances of countries against this dimension of marine governance.

The indicators are aggregated under high substitution possibilities at the target level. Accordingly, if one would argue that *CO2 (emissions) per capita* does not properly account for country specific circumstances, the country can compensate a poor score in this indicator by a good score in the indicator *CO2 Compliance* which measures progress against country-specific emission targets for greenhouse gas emissions outside the European Emission Trading Scheme (EU ETS). Similar reasoning applies to other indicators discussed above and Panel b) in Figure 2 shows that there is a smaller spread in scores at the target level. Accordingly, the interpretation of ocean status at the target level allows for a more sound assessment as the influence of miss-selected or miss-specified indicators is reduced. Still, any assessment requires also analyzing the indicator level because in case of low scores not explained by miss-selection or –specification, the poor performance might be somewhat hidden at the target level.

We conclude that overall the EU coastal countries in our assessment perform rather well at the different dimensions defined by SDG14 expect for expenditures in *Marine Research*. Still, there is sufficient variation in scores across countries resulting in ranking of countries which can be compared under the two concepts of sustainability (Figure 3).

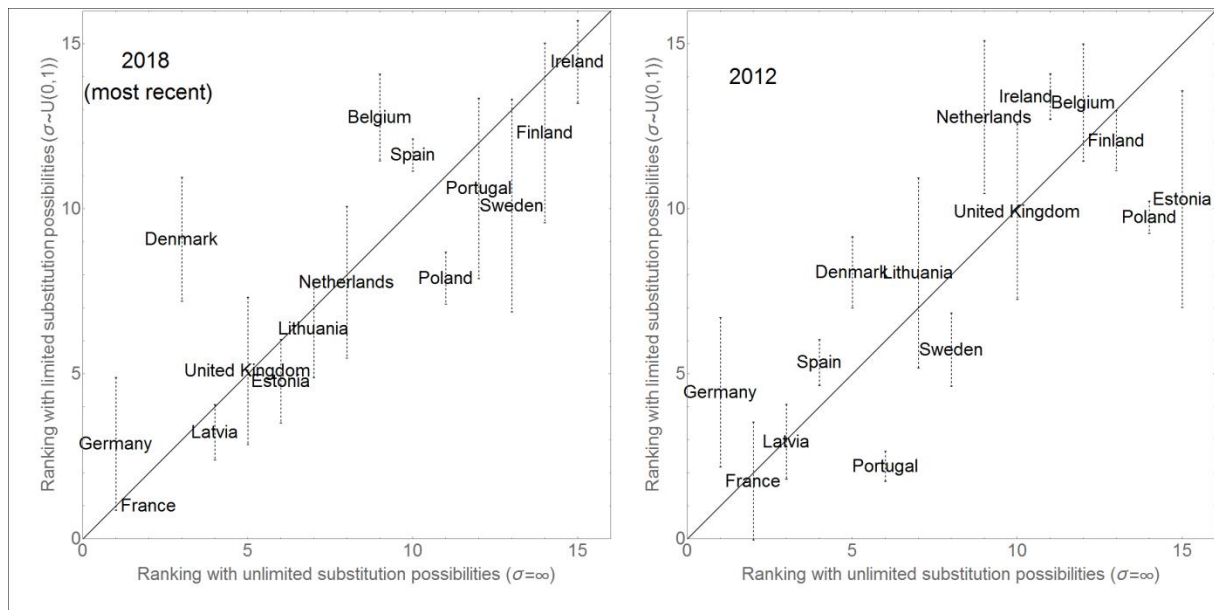


Figure 2: Ocean Status Ranking of EU Coastal States under the two Concepts of Sustainable Development. The information is provided for the two assessment dates, 2018 (most recent data) and 2012, in the left and right panel, respectively. Error bars indicate ± 1 standard deviation under the Monte-Carlo Simulation based calculation of average rank under the concept of strong sustainability.

Countries above the 45 degree line in Figure 2 rank better under a concept of weak sustainability which allows them to compensate for a poor performance in one or more targets by a good performance in other targets. Countries below the 45 degree line rank better under a concept of strong sustainability, indicating that these countries have a relative balanced performance across targets compared to other countries. Taking for example Denmark which ranks worse under a concept of strong sustainability compared to a concept of weak sustainability (in 2018). Denmark has relatively to its scores in other targets a rather low score in the target Marine Scientific Capacities (14.a) because they experience a significant decline in indicator #14 *TAC exceeding Scientific Advice*. Under a concept of weak sustainability, Denmark can compensate for the low score in this target by its good scores in targets Fishing Subsidies (14.6) and Marine Agreements (14.c). Under a concept of strong sustainability with low substitution elasticities the possibility to compensate for poor scores is limited. The complete information about scores at the SDG level and corresponding ranks for both concepts of sustainability and for both assessment points in time can be found in Table A.I in the Appendix.

Comparing our assessment for 2012 with the assessment in Rickels et al. (2016) (which relies mostly on data from 2012) reveals some important changes. For example, Portugal ranks 11th and 18th (in a ranking with 23 countries under a concept of weak and strong sustainability, respectively) in Rickels et al. (2016). Here, it ranks 6th and 2nd (in a ranking with 15 countries under a concept of weak and strong sustainability, respectively). Ireland ranks 4th and 7th (under a concept of weak and strong sustainability, respectively) in Rickels et al.(2016). Here, it and ranks 11th and 13th (under a concept of

weak and strong sustainability, respectively). These differences can be explained as follows. We have selected two indicators from the Global Indicator Framework Database which become available only recently. In particular the indicator *Coverage of protected areas in relation to marine areas* (#6 MPA/EEZ) obtained from the official database provides different information for some countries compared to Rickels et al. (2016) who calculated the indicator themselves, relying on information from Natura 2000 (European Commission 2016). We have selected other indicators than Rickels et al. (2016) for targets 14.3 and 14.c, replacing *Natural Product (OHI)* by #3 *CO2 Compliance* in measuring progress against Target 14.3 (Ocean acidification) and replacing *Participation rate in International Marine Agreements* by #17 *IMO Participation* and #18 *MSFD Measures* in measuring progress against Target 14.c. For two indicators, #5 *Fish Species Threatened* and #8 *Fishing Subsidies* the underlying calculation method and database have changed compared to Rickels et al. (2016), respectively. For other indicators, values for 2012 have been recalculated because of new data became available (e.g. Gross Nitrogen Balance) or changes in the calculation of the indicator have been applied retroactive (e.g., indicators taken from the Ocean Health Index). Finally, the number of selected fish stocks for the calculation of indicators based on ICES data has slightly changed (see for details on these changes Supplementary Information). Despite these considerable changes, the ranking information has not flipped compared to Rickels et al. (2016). In both assessments, Germany and France rank on the first places (even though they have switched places) and other countries like for example Poland, the Netherlands or Estonia rank rather similar.

Still, until all indicators for SDG14 as defined by the IAEG-SDGs are provided by Global Indicator Framework Database it appears rather unlikely that an assessment of the current ocean state or corresponding ranking information are accepted by (all) member states. At the same time the difference between the two assessment indicates the difficulties faced in the IAEG-SDG process, namely that any selection or dumping of indicators implicitly involves a weighting decision with important consequences for the assessment which in turn explains the bargaining nature of this process between country representatives. Anyhow, while these considerations clearly limit the validity of our status assessment, they do not apply to the comparison over time where unambiguous assessment of development is possible.

3.2 EU Ocean Development

Figure 3 shows the strongest improvement, the strongest decline, and the EEZ-weighted average change at the indicator and target level between 2012 and the most recent available data (upper and lower panel, respectively). Notably, all ICES based indicators decline (on average), #9 *Landings exceeding TAC* drops by 4 points, #5 *Fishing Mortality* by 12 points, #12 *TAC exceeding scientific advice* drops by 14 points, and #6 *Sustainable Fishing* even by 22 points. With respect to the latter, at least five countries managed to maintain their perfect score of 100: Belgium, Estonia, Finland, Latvia, and Poland. The EEZ-weighted strong decline in this indicator is mainly driven by the United

Kingdom (-56 points), followed by Spain and Portugal (-32 and -19 points, respectively). Improvements at the indicator level can be observed for #13 *Artisanal Fishing Opportunities (OHI)* (+7 points), #2 *Plastic Pollution* (+2 points), and #4 *CO2 emission per capita* (+2 points). Still, the magnitude of improvement is considerably smaller. We observe for the Targets 14.1 (Marine Pollution), 14.3 (Ocean acidification), 14.5 (Protection and Conservation), and 14.b (Small Scale Fishing) minor improvements while for all targets the aggregated scores decline. The decline in the ICES based indicators translates into significant declines for Target 14.4 (Overfishing), Target 14.b (Marine Science Capacities), and Target 14.6 (Incentives) (-17 points, -7 points, and -4 points, respectively). However, notably is the development of Estonia which achieved for three targets the strongest improvement (14.4, 14.6, and 14.7).

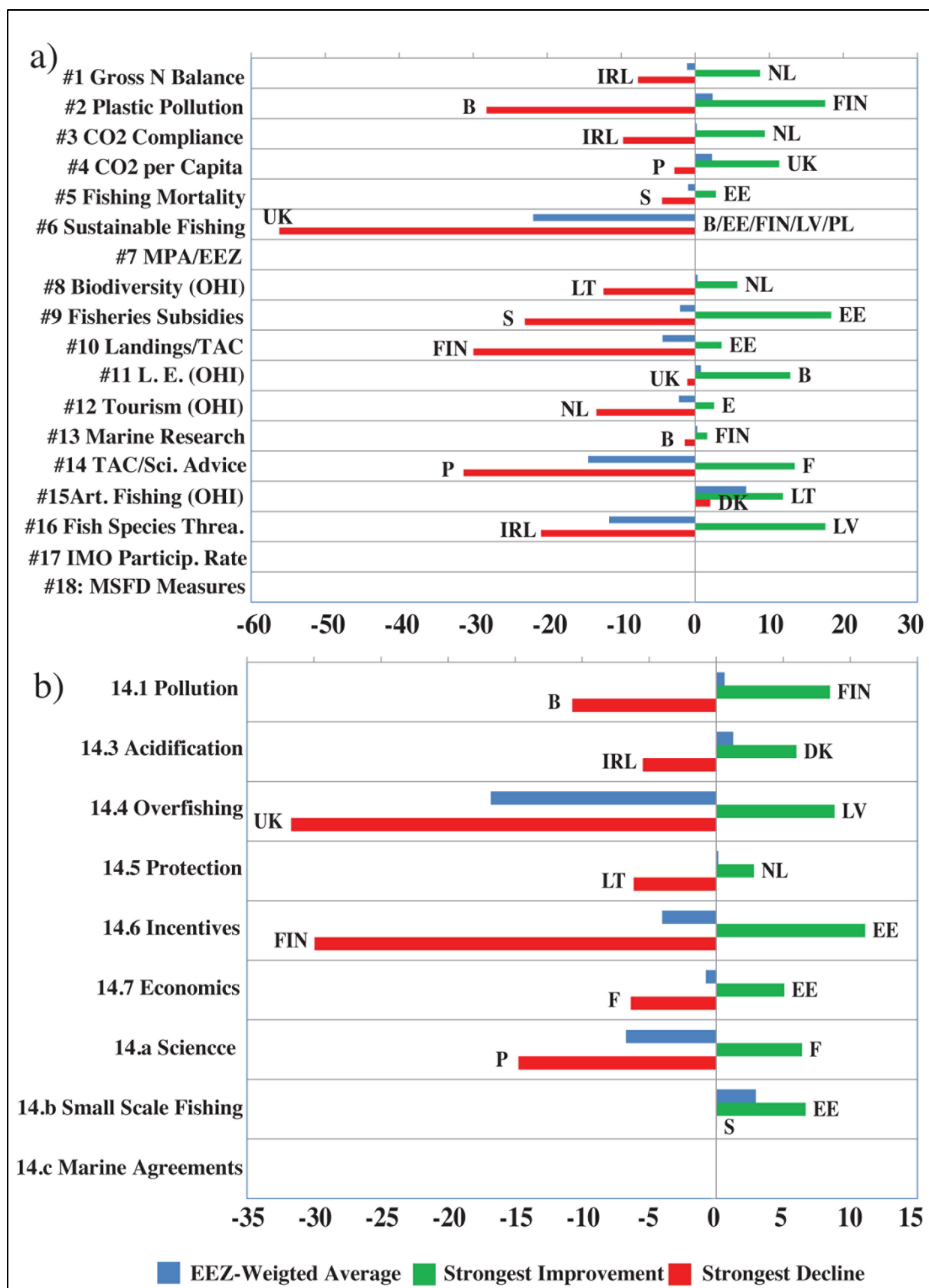


Figure 3: Ocean Development of EU Coastal States at the Indicator and Target Level. The figure shows the EEZ-weighted average change, the strongest improvement, and strongest declines across indicators (a) and targets (b) between 2012 and the most recent available information.

Accordingly, Estonia achieved sustainable ocean development under both concepts of sustainability—as only country in our assessment (Figure 4). Estonia improved in all indicators but three, *#14 TAC exceeding Scientific Advice*, *#12 Tourism (OHI)*, and *#8 Biodiversity (OHI)*. For both, tourism and biodiversity, the reduction in scores is small (-2 points), only for total allowable catch relative to scientific advice, Estonia had a reduction in score by 9 points. However, it scored rather high in this indicator before so that it compensate for this reduction overall by improving in particular in *#9 Fisheries Subsidies* (+18 points), *#16 Fish Species Threatened* (+13 points), and *#2 Plastic Pollution* (+13 points).

Figure 4 shows the actual change in scores at the SDG level between the two assessment dates for both concepts of sustainability. Quadrant I and III contains developments where under both concepts of sustainability either sustainable development is achieved or missed, respectively. Quadrant II contains developments where sustainable development is achieved under a concept of strong sustainability but missed under a concept of weak sustainability. Such a development can emerge if overall the country performance becomes more balanced which means it improves its scores in a relatively poor performing target while at the same time the score in a relatively strong performing targets declines. If the latter exceeds the improvement in the former, sustainable development under a concept of weak sustainability is missed because here the sum of scores is relevant and not its distribution across targets. The opposite mechanism is at play for Quadrant IV which contains developments where sustainable development is achieved under a concept of weak sustainability but missed under a concept of strong sustainability. Here, the aggregated sum of scores has increased but became less equally distributed across targets than before. In our assessment, three countries are situated in Quadrant II: France, the Netherlands, and the United Kingdom. On the first view the placement of the United Kingdom might surprise, given that they face a considerable decline in Target 14.4 (Overfishing). However, relatively to 2012, the United Kingdom experienced their major decline in a relative good performing targets, while increasing its scores in rather poorly performing targets (14.1, 14.3, 14.5, and 14.a). In our assessment, Quadrant IV is empty. Detailed information about changes in scores for both concepts of sustainability can be found in Table A.I in the Appendix.

The majority of countries can be founded in Quadrant III which unambiguously indicates that these countries have not achieved sustainable ocean development. While Germany, Lithuania, and Poland can be found near the origin, indicating only a small decline in scores, other countries like Sweden, Ireland, Spain, and in particular Portugal experienced considerable declines in scores. The unsustainable development of Portugal is basically explained by their poor performance in targets 14.4 (Overfishing), 14.6 (Incentives and Compliance), 14.a (Marine Scientific Capacities), and 14.b (Small Scale Fishing). Given the poor performance of the majority of countries, it does not surprised that the change in the EEZ-weighted average EU scores has also dropped under both concepts of

sustainability, indicating that the EU on the aggregated level and for the majority of its coastal states has not achieved comprehensive blue growth.

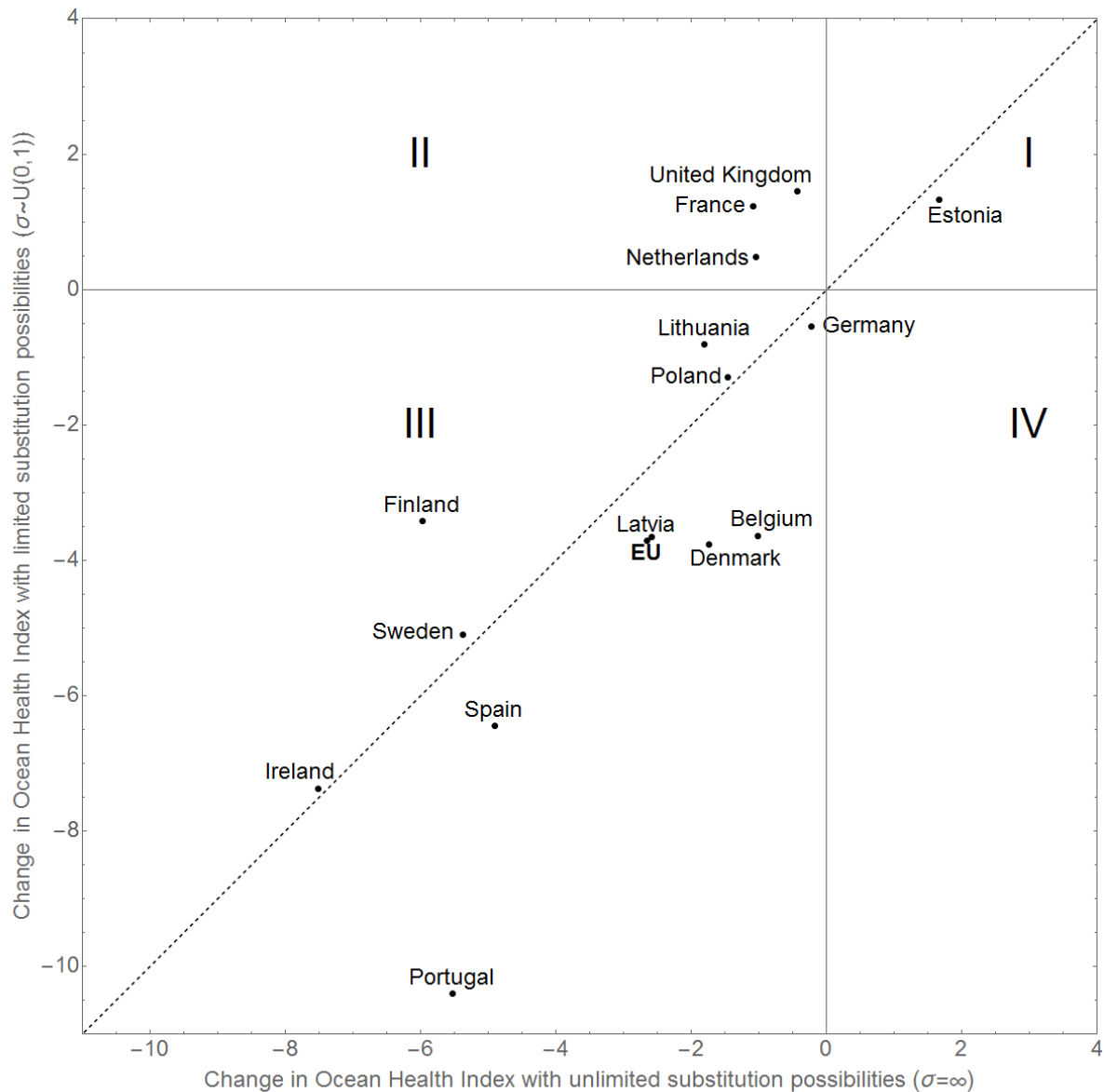


Figure 4: Ocean Development of EU Coastal States at the SDG Level under two Concepts of Sustainability. The figure displays absolute average change in scores at the SDG level between the two assessment dates, 2018 (most recent data) and 2012, for a concept of weak sustainability and strong sustainability on the x and y axis, respectively.

4 Conclusion

The European Commission (EC) established its Blue Growth strategy to coordinate the development in maritime and marine sectors, focusing on renewable energies, biotechnology, (deep-sea) mineral resources, aquaculture, and tourism (Eikeset et al. 2018). At the same time, the strategy acknowledges the importance of sustaining the marine resource base to actually achieve long-term blue growth and in turn requires harmonization with the Marine Strategy Framework Directive. Here, we extended the analysis of Rickels et al. (2016) to provide an assessment of sustainable ocean development for EU

coastal states as defined by SDG 14 (Ocean and Coast) over time to assess whether the EU coastal states have achieved comprehensive blue growth. We selected a set of 18 indicators to measure progress against SDG 14. For two of these 18 indicators the data is already provided by the official Global SDG Indicators Database. We have restricted the assessment to EU coastal states in the Baltic and North Sea and the Atlantic Ocean because only for these states information related to fisheries is provided by ICES. The indicator set allows assessment of sustainable ocean development at the indicator, target, and SDG level. The aggregation at the target and SDG level was achieved by nested composite indicators with different substitution possibilities at different levels. At the SDG level we distinguished between a concept of weak and strong sustainability, assuming high and low substitution possibilities, respectively. We compared two points in time: the most recent status against the status in 2012. By focusing on the change at the indicator, target, and SDG level over time, various problems related to standardization and selection are mitigated as the focus on change between two different points in time allows for a more robust assessment of sustainable development than an assessment of the state at given point in time.

Our results show that the majority of countries in our assessment fail to achieve comprehensive blue growth. Only Estonia managed to improve their scores over time under both concepts of sustainability. On the contrary, Sweden, Spain, Ireland, and in particular Portugal experienced a considerable decline in scores between the two assessment points in time. Accordingly, in aggregated terms the EU coastal states in our assessment did not achieve sustainable ocean development. The unsustainable development is mainly driven by deteriorations in indicators related to fisheries. Relatively to 2012, the catch on fish stocks which are below their corresponding biomass reference value has considerably increased, translating into a drop in the associated indicator by on average 22 points. This development becomes also present in other fisheries related indicators because they reveal that landings have increasingly exceed total allowable catch and that total allowable catch follows to a smaller degree scientific advice, both relative to 2012. We hope our findings encourage further research to identify the (not performed) political decisions and (insufficient) institutional framework explaining the unsustainable ocean development of EU coastal states—or in the case of Estonia the decisions taken making it possible to resist the overall unsustainable ocean development trend.

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Appendix

	Concept of Strong Sustainability ($\sigma \sim U(0,1), N = 10000$)									Concept of Weak Sustainability ($\sigma \rightarrow \infty$)				
	2018		2012			2018		2012		2018	2012		2018	2012
	Score	SD	Score	SD	Change	Rank	SD	Rank	SD	Score	Score	Change	Rank	Rank
France	75.76	5.42	74.49	7.79	1.27	1.00	0.00	1.75	1.78	78.91	80.00	-1.09	2	2
Germany	71.67	8.11	72.22	7.80	-0.54	2.88	2.00	4.47	2.25	80.31	80.53	-0.22	1	1
Latvia	69.88	6.20	73.60	5.52	-3.72	3.22	0.84	2.91	1.13	74.13	76.79	-2.66	4	3
Estonia	68.88	5.15	67.56	4.21	1.32	4.75	1.25	10.24	3.24	73.37	71.71	1.67	6	15
UK	68.82	7.61	67.34	8.87	1.48	5.10	2.23	9.96	2.66	73.41	73.85	-0.44	5	10
Lithuania	67.54	6.81	68.34	8.16	-0.80	6.41	1.49	8.12	2.87	73.25	75.06	-1.81	7	7
Netherlands	66.84	4.46	66.34	5.18	0.50	7.71	2.30	12.73	2.31	73.19	74.23	-1.04	8	9
Poland	66.51	5.48	67.80	5.96	-1.29	7.88	0.78	9.74	0.49	71.61	73.07	-1.46	11	14
Sweden	65.26	3.86	70.35	5.60	-5.09	10.03	3.20	5.69	1.11	68.87	74.24	-5.37	13	8
Denmark	65.22	7.57	69.01	5.58	-3.79	9.12	1.87	8.06	1.08	74.24	75.98	-1.74	3	5
Spain	63.92	5.94	70.37	5.67	-6.46	11.63	0.49	5.34	0.69	71.67	76.58	-4.91	10	4
Portugal	63.19	9.75	73.66	6.71	-10.47	10.71	2.71	2.20	0.46	70.19	75.73	-5.53	12	6
Finland	62.87	3.65	66.25	5.69	-3.38	12.28	2.71	12.07	0.92	67.19	73.17	-5.97	14	13
Belgium	61.88	8.31	65.55	6.25	-3.67	12.83	1.30	13.31	1.76	72.20	73.22	-1.02	9	12
Ireland	58.36	4.26	65.71	6.27	-7.35	14.45	1.25	13.41	0.69	66.21	73.73	-7.52	15	11

Table A.I Scores and Ranks for EU Coastal States in the Baltic and North Sea and the Atlantic Ocean for 2012 and the most recently available data (2018 assessment).