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Potential applications of natural capital accounting in marine policies for the North Sea and North East Atlantic

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Executive summary

Marine ecosystems are essential for human well-being due to their ability to provide economic, environmental and social benefits to society. These benefits provided through ecosystem services directly and indirectly translate to social and economic value. Since the health of ecosystems and their ability to provide ecosystem services are closely linked, the degradation of the health of marine environments causes the benefits in terms of ecosystem services to decrease as well. Therefore, the protection of marine ecosystems and the services they provide for society should be a priority.

The marine environment provides important biotic and abiotic resources for society. **Currently, indicators for measuring human progress such as Gross Domestic Product (GDP) do not not (fully) include environmental aspects**. However, these recourses are essential for human well-being and support future human development. Therefore, policymakers should to look **beyond GDP** and require an integrated information stream that accounts for both economic and environmental development.

Natural capital accounting (NCA) is a method that uses integrated accounting frameworks to provide measurements and reports on the stocks and flows of the natural capital and ecosystem services. **Natural capital accounting provides a standardized framework for measurement for the benefits that ecosystems provide for society** and provide relevance for sustainable management of ecosystems and natural capital.

The System of Environmental-Economic Accounting Ecosystem Accounting (SEEA-EA) provides an organized and integrated framework to value ecosystem services and track the extent and changes in the ecosystem assets. This framework was adopted by the UN statistical commission in 2021 and is currently being tested in over 90 countries. The SEEA Ecosystem Accounting framework can be used to provide information on the state of ecosystems, but also to provide support for decision-making, review and analysis.

The SEEA-EA framework **consists of 5 main accounts**:

- **Ecosystem extent account:** Which records the size of the ecosystems
- **Ecosystem condition account:** Describes the condition of selected attributes of an ecosystem at specified points in time. The condition account can indicate information on the changes in the health of an ecosystem, if reported over time.
- **Ecosystem services flow accounts** (physical and monetary): Presents the ecosystem services that are supplied by ecosystem assets and used by various economic sectors in society .
- **Ecosystem asset account:** records information on stocks and changes in stocks (additions and reductions) of ecosystem assets. This includes accounting for ecosystem degradation and enhancement.

Ocean accounting is another form of NCA that is compatible with other accounting frameworks such as the System of National accounts (SNA) and the SEEA Ecosystem Accounting framework. While NCA mainly focusses on environmental economic accounting, **Ocean Accounts include social aspects and governance factors that affect the ocean ecosystems.** This allows more dimensions to be integrated into ocean management and can improve the sustainability of ocean decision-making. However, it also requires more extensive data investments which might have limitations depending on the country.

NCA can be implemented and used in all stages of the policy cycle such as problem identification, policy response, implementation, monitoring and policy review throughout the policy cycle. The main **added value** of NCA is the **integrated approach to economic and environmental systems** and the relations between them, which allows for a coherent analysis. The possibilities of using NCA increases with the quality, spatial resolution and the possibility of time-series analysis of the accounts. Furthermore, the comprehensive integrated information can serve as a basis for cost-benefit analysis and scenario analysis that takes into account the impacts of policy-decisions on the value of natural capital and its condition.

The large amount of information provided by natural capital accounts can be used by a variety of stakeholders depending on the policy question and properties of the accounts. While (key) indicators allow for more broad policy application such as monitoring the environment, the accounts also allow for more in depth policy analysis:

- ***The key indicators:*** are a small subset of indicators that can be used to raise awareness, provide information and support communication. This is the least detailed information from the accounts and can be used by the general public, (high-level) policy makers, lawmakers and journalists.
- ***The indicators:*** are a large set of indicators provided by the accounts and can support policy-making and coherence. This information can be used by policy analysts, government officials, managers and other stakeholders.
- ***The accounts:*** provide a detailed and extensive (statistical) overview of information that can serve numerous purposes. This information can support in depth policy analysis for researchers, statisticians and policy analysts.

Natural capital accounting is currently being applied worldwide with a variety of projects, partnerships and initiatives such as the Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES), the Mapping and Assessment for Integrated ecosystem Accounting (MAIA) project and the Global Ocean Accounts Partnership (GOAP). Based on a comprehensive analysis of case studies by various countries, institutions and academic literature this report has identified the following **potential policy applications for the marine environment**:

- **Issue identification and monitoring the state of the marine environment:** Natural capital accounts can provide quantitative information that can identify problems in a spatial setting. Furthermore, it can provide important indicators to monitor the state of the marine environment.

- **Establish insights on trade-offs and interactions between marine ecosystems and economy and provide quantitative spatial information for maritime spatial planning***:* The information provided by the accounts can inform environmental policy makers for maritime spatial planning. For example, where to examine locations for ecosystem restoration or establishing marine protected areas taking into account the potential economic consequences.

- **Provide a communication tool for policy makers to raise awareness with respect to the importance of the marine environment and blue economy:** Information from natural capital accounts can incorporate ecosystem values into measures of economic progress and therefore provide further relevance for protecting and conserving the marine environment. Furthermore, it can provide insights in the size and (social) importance of the blue economy.

- **Serve as a data input or baseline for other types of analysis:** Natural capital accounts can be combined with methods such as scenario analysis and cost benefit analysis to provide an economic-environmental integrated insight to assess (future) policy decisions.

- **Support multidisciplinary communication and cooperation between stakeholders:** The integrated nature of natural capital accounts supports and stimulates stakeholders with different backgrounds to communicate with each other across disciplines, which can increase the coherence of marine policy.

- **Measure the development of the marine environment and look beyond GDP*:*** Natural capital is often not been accounted when measuring the progress of the economy. Therefore, the value of ecosystems is often not fully represented in national accounts. Natural capital accounting can establish the economic importance of ecosystems and serve as data input for looking beyond Gross Domestic Product (GDP).

- **Transparency in natural capital extractions**: Natural capital accounts can provide transparency for resource extractions from ecosystems. This information can be used as basis for taxes on the use of natural capital. Since information on extraction value is often lacking, NCA can be a valuable tool for decision-makers.

- **Reducing transaction costs in the long term:** The integrated NCA framework can reduce time and transaction costs when communicating and sharing information across different institutions from various disciplines. However, this requires initial start-up costs for producing the accounts.

However, there are some **limitations and challenges related to natural capital accounting:**

- **Hard to incorporate non-economic values:** Biodiversity can be hard to express in monetary terms, even though it plays an essential role in ecosystems and the services they provide. NCA does not incorporate the intrinsic value of nature and might give the impression that policymakers are trying to put a price on nature.

- **Interactions should not be interpreted as causality:** Even though NCA can point to relationships and pressures between ecosystems and the economy, this does not mean that there is causality. These insights need to be used for further research and not be communicated as a causal relationship.

- **Data constraints and spatial resolution:** One of the main issues of natural capital accounting are data constraints in producing (useful) accounts. Due to the extensive data required from various stakeholders and biophysical models accounts are often incomplete, especially for developing countries. Valuing ecosystem services that do not have an inherent market value also remains rather difficult. Additionally, the marine environment poses an additional challenge of incorporation the 3-dimensional character of the marine environment into the accounts

Potential applications of natural capital accounting in marine policies for the Dutch part of the North Sea and the North East Atlantic

The case studies, interviews and the discussion during the OSPAR workshop were used to establish (potential) policy applications for the Dutch part of the North Sea and the OSPAR area.

Some possible policy applications of NCA for the Dutch part of the North Sea:
The European Marine Strategy Framework Directive (MSFD) was implemented in 2008 in order to protect, restore and preserve the marine environment of the European seas. The Dutch MSFD consists of 3 parts:

- A description of the current state of the environment of the North Sea (Part 1)
- Monitoring program (Part 2)
- The Program of Measures to ensure the sustainable use of the North Sea (Part 3)

Since the Dutch natural capital accounts make use of the data from the first 2 parts of the MSFD there is no inherit benefit for monitoring purposes while transferring this data into a different framework. However, **NCA can support the program of measures by providing a more comprehensive economic insight into the assessment of measures.** It can support the MSFD by evaluating future policy decisions to establish insights into the costs and benefits of achieving Good Environmental Status (GES) for various scenarios based upon the impact on ecosystems and their services in the Dutch part of the North Sea.

Increased clarity in the potential use of NCA for the MSFD and other policies can be supported by local case studies and examples to test the use of NCA. Even though the Netherlands has a relatively developed marine natural

capital accounts, it is currently lacking practical examples for the marine environment**. Pilot studies can identify knowledge gaps, potential applications and support the upscaling of natural capital accounting in the future.**

In 2015, the 2030 Agenda for Sustainable Development accompanied by 17 Sustainable Development Goals (SDGs) were adopted by all United Nations Member States including the Netherlands. Achieving the SDGs requires integrated economic, social and environmental policy with understanding for different interactions between nature and the economy. **The SEEA-EA framework provides integrated environmental-economic information that can be used to monitor and communicate on the progress on various SDGs.** In case of the North Sea, the SEEA-EA framework can provide information and indicators on SDG 14 "Life below water" which includes the sustainable use of oceans and marine recourses. Achieving SDG goal 14 can provide synergies with various other SDGS's.

Natural capital accounts can provide various indicators for sustainability of the marine environment and support monitoring on the development of sustainability of the European Blue Economy. Furthermore, protection of Europe's natural capital is emphasized in the Green Deal and also specifically mentioned to integrate into economic decision-making in the *"new approach for a sustainable blue economy in the EU."*

This North Sea Programme 2022-2027 emphasizes the extensive national and international policy context of the North Sea and its stakeholders. **The quantitative economic-environmental information provided by marine natural capital accounts can improve insights in the trade-offs** for various stakeholders and **support Maritime Spatial Planning**. The spatial approach can inform decision-makers on the economic value of ecosystem services and their condition. However, the type of analysis is dependent on the policy question, the spatial resolution and data availability for the specific area. Additionally, **the information from the Dutch natural capital accounts can be used to support a better description of ecosystem services for the North Sea Programme 2022-2027.**

There is an increasing need to look beyond GDP to measure the state of human well-being. Therefore, the Netherlands monitors "The Well-Being Economy" to look beyond GDP. Rijkswaterstaat, the executive agency of the Dutch Ministry of Infrastructure and Water management, is currently analysing how it can contribute to the Well-Being economy when managing the North Sea. The well-being economy consist of 3 main categories:

- The well-being economy 'here and now': This measures the current well-being and quality of living for inhabitants of the Netherlands.
- The well-being economy 'later': the use of resources has impacts on future generations of the Netherlands. This recognizes that this requires that the next generations at least have the same availability of capital as the current one. Capital is divided into four categories: economic, natural, human and social capital.
- The well-being economy 'elsewhere': measures the impact of Dutch choices on income, resources and the environment in other (especially developing) countries.

Environmental data from natural capital accounts can be used to monitor the size and state of natural capital values for the Well-Being Economy. Even though NCA does not contain any future estimates, **NCA can provide information that allows policy-makers to monitor the level of natural capital. Therefore, it can inform policy makers on ensuring that the amount of natural capital stays at least at the same level for future generations.** The SEEA-Ecosystem accounting framework used in the Netherlands currently does not incorporate social data and cannot be used for assessing the social or human capital dimension of the Well-Being Economy.

Ocean Accounting can contain information regarding social and governance indicators such as health, income distribution, poverty and social inclusion. **Therefore, a suggestion might be to add a social dimension to the current NCA and make them real ocean accounts so they can be better used to monitor the Well-being economy for the North Sea.** This also provides for an even more comprehensive socio-economic analysis that could provide more sustainable policy due to incorporating a social perspective.

An accompanying suggestion is that the Netherlands could become a member of the Global Ocean Accounts Partnership (GOAP). **Through participation the Netherlands can use the knowledge of GOAP and its extensive community to establish an ocean account and incorporate a social dimension to the current framework.** Furthermore, it allows the Netherlands access a large global network of experts and interested organizations in Ocean Accounting. **This provides members with a large pool of resources to help, advise and advance work on ocean accounts and natural capital accounting**, but also other types of analyses of the marine environment more broadly.

Some possible policy applications of NCA for OSPAR:

In addition to the fact that many of the above potential applications may also be relevant to OSPAR, the following applies specifically to OSPAR:

OSPAR is facing challenges in multiple areas such as biodiversity loss, pollution, and climate change. **Natural capital accounting can support monitoring and decision making in those areas by providing relevant and robust information in a consistent way.** One of the assessment tools for the state of the marine environment used by OSPAR is the Drivers-Activities-Pressures-State Impacts-Response (DAPSIR) framework. **The focus on synergies between the Natural Capital Accounting framework and the DAPSIR framework can promote a common approach for stakeholders and improve communication, data collection and usage.** This can support decision-making by further integrating social, economic and environmental information.

The spatial approach of natural capital accounts can offer insights on locations that offer strong economic contribution to society. For example, NCA can be used for spatial investment decisions such as establishing nature-based solutions or marine protected areas. **However, this requires a significant investment in building natural capital accounts at OSPAR level**. The preliminary version of the natural capital accounts comprised of a limited amount of data. which limits current policy applications. Currently, natural capital accounts emphasize the importance of the

blue economy, identify knowledge gaps and allow for stakeholder communication and corporation. **The value of natural capital accounts can increase with improved data and regular updates of the accounts would enable time-series analyses.**

Samenvatting

Mariene ecosystemen zijn fundamenteel voor het welzijn van de samenleving door de economische, ecologische en sociale voordelen die ze kunnen bieden. Deze voordelen die via ecosysteemdiensten worden aangeboden, vertalen zich direct en indirect in sociale en economische waarde. Aangezien de gezondheid van ecosystemen en hun vermogen om ecosysteemdiensten te leveren nauw met elkaar verbonden zijn, zorgt de achteruitgang van de gezondheid van mariene milieus ervoor dat de voordelen van marine ecosysteemdiensten afnemen. **Daarom is de bescherming van mariene ecosystemen en de hun diensten die zij leveren aan de samenleving een prioriteit in marien beleid.**

Het mariene milieu levert belangrijke biotische en abiotische hulpbronnen voor de samenleving. **Momenteel houden indicatoren voor het meten van menselijke vooruitgang, zoals het bruto binnenlands product (bbp), niet (volledig) rekening met milieuaspecten.** Deze zijn echter essentieel voor het menselijk welzijn en de toekomstige ontwikkeling van de samenleving. Daarom moeten beleidsmakers verder kijken dan het bbp en bestaat er behoefte aan geïntegreerde informatie over zowel de economische als de ecologische ontwikkeling.

Natuurlijk Kapitaalrekeningen zijn een methode die gebruikmaakt van geïntegreerde boekhoudkundige kaders om te rapporteren over de voorraden en stromen van het natuurlijk kapitaal en ecosysteemdiensten. **Natuurlijk Kapitaalrekeningen (NKR) bieden een gestandaardiseerde methode aan voor het meten van de voordelen die ecosystemen leveren aan de samenleving en verschaffen relevante informatie ten behoeve van duurzaam beheer van (mariene) ecosystemen en natuurlijk kapitaal.**

Het 'System of Environmental-Economic Accounting Ecosystem Accounting' (SEEA-EA) is een integraal raamwerk waarin ecosysteemdiensten worden gewaardeerd en de omvang en veranderingen in de activa van ecosystemen kunnen worden gevolgd. Deze methode is in 2021 door de statistische commissie van de VN aangenomen en wordt momenteel getest in meer dan 90 landen. SEEA-EA kan worden gebruikt om informatie te verstrekken over de toestand van ecosystemen, maar ook om ondersteuning te bieden bij besluitvorming, beoordeling en analyse.

Het SEEA-EA raamwerk **bestaat uit 5 rekeningen:**

- **Ecosystem extent account:** waarin de omvang van de verschillende ecosystemen wordt vastgelegd
- **Ecosystem condition account:** beschrijft de toestand van een ecosysteem. Deze rekening kan informatie geven over de veranderingen in de gezondheid van een ecosysteem.
- **Ecosystem services flow accounts** (fysiek en monetair): hier worden de ecosysteemdiensten geregistreerd die worden geleverd door ecosystemen en door de verschillende sectoren in de samenleving worden gebruikt. Het aanbod en gebruik van deze ecosysteemdiensten wordt vastgelegd in fysieke en monetaire eenheden.
- **Ecosystem asset account:** registreert de voorraad en veranderingen in voorraden (toevoegingen en verminderingen) van ecosysteemactiva.

Ocean accounting is een andere vorm van NKR die compatibel is met andere boekhoudkundige kaders zoals het systeem van nationale rekeningen (SNA) en de SEEA-EA. Waar natuurlijk kapitaalrekeningen zich voornamelijk richten op milieu-economische boekhouding, **omvatten Ocean Accounts ook sociale aspecten gerelateerd aan de ecosystemen van de oceaan.** Hierdoor kunnen meer dimensies worden geïntegreerd en kan de duurzaamheid van besluitvorming ten behoeve van marien beleid worden verbeterd. Het vereist echter ook uitgebreidere data-investeringen die de mogelijkheid voor het creëren van een Ocean Account kunnen beperken.

Natuurlijk kapitaalrekeningen kunnen worden gebruikt in verscheidene stadia van de beleidscyclus, zoals probleemidentificatie, analyses en implementatie van maatregelen, monitoring en evaluatie. De belangrijkste toegevoegde waarde van NKR is de geïntegreerde benadering van economische en milieusystemen en de relaties daartussen, die een coherente analyse mogelijk maakt.

De grote hoeveelheid informatie die natuurlijk kapitaalrekeningen opleveren, kan door verschillende belanghebbenden worden gebruikt, afhankelijk van de beleidsvraag en de kenmerken van de rekeningen. Waar (kern)indicatoren een bredere beleidstoepassing mogelijk maken, zoals monitoring van het milieu, maken de rekeningen zelf een meer diepgaande beleidsanalyse mogelijk:

- **Kern indicatoren:** Een kleine selectie van indicatoren die kunnen worden gebruikt om maatschappelijke relevantie aan te kaarten, informatie te verstrekken en communicatie te ondersteunen. Dit is de minst gedetailleerde informatie uit de rekeningen en kan worden gebruikt door een breder publiek, beleidsmakers, wetgevers en journalisten.
- **Indicatoren:** Een grote reeks indicatoren die door de rekeningen worden verstrekt en die beleidsvorming en coherentie kunnen ondersteunen. Deze informatie kan worden gebruikt door beleidsanalisten, overheidsfunctionarissen, managers en andere belanghebbenden.
- **Rekeningen**: Een gedetailleerd en uitgebreid (statistisch) overzicht van informatie die tal van doelen kan dienen. Deze informatie kan diepgaande beleidsanalyses door onderzoekers, statistici en beleidsanalisten ondersteunen.

Natuurlijke Kapitaalrekeningen worden momenteel wereldwijd toegepast in verschillende projecten, samenwerkingsverbanden en initiatieven. In dit rapport zijn op basis van een uitgebreide analyse van casestudies door verschillende landen, instellingen en academische literatuur de volgende mogelijke beleidstoepassingen voor het mariene milieu geïdentificeerd:

- **Het identificeren van knelpunten en monitoren van de toestand van het mariene milieu:** NKR kunnen kwantitatieve informatie verschaffen en knelpunten in ruimtelijk verband identificeren. Daarnaast kan NKR belangrijke indicatoren verschaffen om de toestand van het mariene milieu te monitoren.

- **Inzicht verkrijgen in relaties en interacties tussen mariene ecosystemen en economie en verstrekken van kwantitatieve ruimtelijke informatie:** de informatie die door de rekeningen wordt verstrekt kan worden gebruikt ten behoeve van maritieme ruimtelijke ordening. Bijvoorbeeld, met betrekking tot mogelijke locaties voor herstel van ecosystemen of het instellen van beschermde gebieden op zee, waarbij tevens rekening wordt gehouden met de mogelijke economische consequenties.

- **Dienen als communicatie-instrument voor beleidsmakers om het bewustzijn te vergroten van het belang van het mariene milieu en de blauwe economie:** informatie uit natuurlijk kapitaalrekeningen kan worden gebruikt ten behoeve van de communicatie over het economisch belang van het mariene milieu en kan dienen als motivatie voor de bescherming van het mariene milieu. Bovendien kan het inzicht geven in de omvang en het (maatschappelijke) belang van de blauwe economie.

- **Gebruiken als basis voor andere soorten (economische) analyses:** Natuurlijk kapitaalrekeningen kunnen worden gecombineerd met andere methoden zoals scenarioanalyse en kosten-batenanalyse om een integraal milieu-economisch inzicht te verschaffen en (toekomstige) beleidsbeslissingen te beoordelen.

- **Ondersteuning van multidisciplinaire communicatie en samenwerking:** Door het geïntegreerde karakter van natuurlijk kapitaalrekeningen worden belanghebbenden met verschillende achtergronden gestimuleerd en ondersteund om met elkaar te communiceren over disciplines heen, wat de samenhang van het mariene beleid kan versterken.

- **Het meten van de ontwikkelingen van het mariene milieu en verder kijken dan het bbp:** De mogelijke consequenties van economische activiteiten op het natuurlijk kapitaal wordt vaak niet meegerekend bij het meten van de voortgang van de economie. Daardoor wordt de waarde van ecosystemen vaak niet volledig weergegeven in nationale rekeningen. NKR kunnen het economische belang van ecosystemen vaststellen en zo helpen om verder te kijken dan het bruto binnenlands product (bbp).

- **Transactiekosten op de lange termijn verlagen:** Natuurlijk Kapitaalrekeningen kunnen tijd en transactiekosten besparen bij het communiceren en delen van informatie tussen verschillende instellingen uit verschillende disciplines. Dit vereist echter initiële opstartkosten voor het maken van de rekeningen.

Er zijn echter ook enkele beperkingen en uitdagingen bij het gebruik van natuurlijke kapitaalrekeningen:

- **Het registreren van niet-economische waarden:** Biodiversiteit kan moeilijk in geld worden uitgedrukt, ook al speelt het een essentiële rol in ecosystemen en de diensten die ze leveren. NKR houdt geen rekening met de intrinsieke waarde van natuur en kan de indruk wekken dat beleidsmakers proberen een prijs op de natuur te zetten.

- **Interacties mogen niet worden geïnterpreteerd als causaal verband:** Hoewel NKR relaties en interacties tussen ecosystemen en de economie kan aanduiden, betekent dit niet dat er sprake is van oorzakelijk verband. Deze

inzichten in mogelijke relaties moeten worden gebruikt voor verder onderzoek en niet worden gecommuniceerd als een causaal verband.

Mogelijke toepassingen van natuurlijk kapitaalrekeningen in het mariene beleid voor het Nederlands deel van de Noordzee en de Noordoost Atlantische Oceaan

De casestudy's, interviews en de discussie tijdens de OSPAR-workshop zijn gebruikt om (potentiële) beleidstoepassingen voor het Nederlandse deel van de Noordzee en OSPAR vast te stellen.

Mogelijke toepassingen voor het Nederlands deel van de Noordzee

De Europese Kaderrichtlijn Mariene Strategie (KRM) is in 2008 geïmplementeerd met als doel om de ecologische kwaliteit van het mariene milieu van de Europese zeeën te beschermen, herstellen en te behouden. De Nederlandse KRM bestaat uit 3 delen:

- *Een beschrijving van de huidige toestand van het mariene milieu, de goede milieutoestand met bijbehorende doelen en indicatoren (Deel 1)*
- *KRM-Monitoringprogramma (Deel 2)*
- *Het programma van maatregelen voor een duurzaam gebruik van de Noordzee en het behalen van een goede milieutoestand (Deel 3)*

Aangezien de Nederlandse natuurlijk kapitaalrekeningen gebruik maken van de gegevens uit de eerste 2 delen van de KRM is er momenteel geen duidelijk gebruik voor monitoringdoeleinden. Echter natuurlijk kapitaalrekeningen kunnen worden gebruikt om het maatregelenprogramma ondersteunen door toekomstige beleidsbeslissingen te evalueren en inzicht te geven in de kosten en baten van het bereiken van een Goede Milieutoestand. Het gebruik van NKR voor beleidsdoeleinden zoals de Kaderrichtlijn Mariene Strategie en andere **beleidstoepassingen kunnen worden ondersteund door voorbeelden in de vorm van (regionale) pilotprojecten om het gebruik van NKR te testen.** Hoewel Nederland een ontwikkelde mariene natuurlijk kapitaalrekening heeft, ontbreken op dit moment praktijkvoorbeelden voor het mariene milieu. **Pilotprojecten kunnen mogelijke beleidstoepassingen identificeren, helpen in het vaststellen van ontbrekende kennis en data, en om de opschaling van het gebruik van NKR in de toekomst te ondersteunen.**

In 2015 is de "2030 Agenda for Sustainable Development" met 17 bijbehorende Sustainable Development Goals (SDG's) aangenomen door alle lidstaten van de Verenigde Naties, waaronder Nederland. Het behalen van de SDG's vereist een geïntegreerd economisch, sociaal en milieubeleid dat rekening houdt met verschillende interacties tussen natuur en economie. **NKR kan geïntegreerde milieu-economische informatie verschaffen die kan worden gebruikt om de voortgang van verschillende SDG's te monitoren en te communiceren.** In het geval van de Noordzee kan het SEEA-EA raamwerk informatie en indicatoren verschaffen met betrekking tot SDG 14 "Life below water", waaronder het duurzaam gebruik van oceanen en mariene ecosystemen.

Het Noordzeeprogramma 2022-2027 benadrukt de omvangrijke nationale en internationale beleidscontext van de Noordzee en haar stakeholders. **De kwantitatieve milieu-economische informatie die wordt verschaft door mariene natuurlijk kapitaalrekeningen kan het inzicht in de afwegingen**

voor verschillende belanghebbenden verbeteren en maritieme ruimtelijke ordening ondersteunen. De ruimtelijke benadering kan beleidsmakers informeren over de economische waarde van ecosysteemdiensten, hun locatie en hun toestand. Het type analyse is echter afhankelijk van de beleidsvraag, de ruimtelijke resolutie en de beschikbaarheid van gegevens voor het specifieke gebied. **Daarnaast kan de informatie uit de Nederlandse natuurlijk kapitaalrekeningen worden gebruikt ter ondersteuning van een betere beschrijving van de ecosysteemdiensten in het Noordzeeprogramma 2022-2027.**

Er bestaat een toenemende behoefte om de vooruitgang van het welzijn in Nederland te meten en om verder te kijken dan het BBP. Mede om die reden publiceert het CBS jaarlijks de "Monitor Brede Welvaart". Rijkswaterstaat analyseert momenteel hoe het kan bijdragen aan de Brede Welvaart van de Noordzee. De Brede Welvaart bestaat uit 3 hoofdcategorieën:

- *Hier en nu*: meet het huidige welzijn en de kwaliteit van leven van inwoners van Nederland.
- *Toekomst*: het gebruik van hulpbronnen heeft gevolgen voor toekomstige generaties in Nederland. Dit erkent dat dit vereist dat de volgende generaties minstens dezelfde beschikbaarheid van kapitaal hebben als de huidige. Kapitaal is onderverdeeld in vier categorieën: economisch, natuurlijk, menselijk en sociaal kapitaal.
- *Elders*: meet de impact van Nederlandse keuzes op inkomen, hulpbronnen en milieu in andere (ontwikkelende)landen.

NKR kunnen worden gebruikt om de omvang en toestand van het natuurlijk kapitaal voor de brede welvaart te monitoren. Ook al bevat de NKR geen toekomstige schattingen, het kan informatie verschaffen waarmee beleidsmakers het niveau van natuurlijk kapitaal kunnen monitoren en zien of de hoeveelheid natuurlijk kapitaal voor toekomstige generaties op zijn minst op hetzelfde niveau blijft. Het SEEA-Ecosystem Accounting raamwerk dat in Nederland wordt gebruikt, bevat momenteel geen sociale gegevens en kan niet worden gebruikt voor het beoordelen van de sociale of menselijke kapitaaldimensie van de Brede Welvaart.

Ocean Accounting kan informatie bevatten over sociale en bestuurlijke indicatoren zoals gezondheid, inkomensverdeling, armoede en sociale inclusie. Een suggestie zou daarom kunnen zijn om een sociale dimensie toe te voegen aan de huidige NKR en er echte "Ocean Accounts" van te maken, zodat ze beter kunnen worden gebruikt om Brede Welvaart voor de Noordzee te monitoren. Dit zorgt ook voor een mogelijkheid tot het uitvoeren van sociaaleconomische analyses die door het inbrengen van een sociaal perspectief kan zorgen voor een duurzamer beleid.

Een aanvullende suggestie is dat Nederland lid zou kunnen worden van het Global Ocean Accounts Partnership (GOAP). **Door deelname kan Nederland de kennis van GOAP en zijn gemeenschap gebruiken om een Ocean Account op te zetten en een sociale dimensie aan het huidige kader toe te voegen.** Bovendien biedt het Nederland toegang tot een wereldwijd netwerk van experts en geïnteresseerde organisaties in Ocean Accounting en stimuleert het de kennisuitwisseling op het gebied van oceaanrekeningen en natuurlijk kapitaalrekeningen, maar ook andere soorten analyses van het mariene milieu.

Mogelijke toepassingen voor de Noordoost Atlantische Oceaan

Naast het feit dat veel van de bovenstaande mogelijke toepassingen ook relevant kunnen zijn voor OSPAR, geldt voor OSPAR specifiek het volgende:

OSPAR wordt geconfronteerd met uitdagingen op meerdere gebieden, zoals verlies van biodiversiteit, vervuiling en klimaatverandering. **Natuurlijk kapitaalrekeningen kunnen de monitoring en besluitvorming ondersteunen door op een consistente manier relevante en robuuste informatie te verstrekken.** Een van de beoordelingsinstrumenten voor de toestand van het mariene milieu die door OSPAR wordt gebruikt, is het (DAPSIR)-raamwerk. **De focus op synergiën tussen NKR en de DAPSIR-methode kan een gemeenschappelijke aanpak voor belanghebbenden bevorderen en communicatie, gegevensverzameling en gebruik verbeteren.** Dit kan de besluitvorming ondersteunen door sociale, economische en milieu-informatie verder te integreren.

De ruimtelijke benadering van natuurlijk kapitaalrekeningen kan inzicht bieden in locaties die een sterke economische bijdrage leveren aan de samenleving. Bijvoorbeeld, NKR kunnen worden gebruikt voor ruimtelijke investeringsbeslissingen, zoals het vaststellen van gebieden waar 'nature based solutions' (kosten)effectief en efficiënt zouden kunnen worden geïmplementeerd, of beschermde gebieden het best zouden kunnen worden aangewezen. **Dit vereist echter een aanzienlijke investering in het opbouwen van natuurlijk kapitaalrekeningen op OSPAR-niveau.** De eerste versie van de natuurlijk kapitaalrekeningen voor de Noordoost Atlantische Oceaan bestaat uit een beperkte hoeveelheid gegevens wat echter ook de huidige mogelijkheden voor beleidstoepassingen beperkt. Momenteel benadrukken natuurlijk kapitaalrekeningen het belang van de blauwe economie en bevorderen ze de communicatie en het bewustzijn voor het maatschappelijk belang van de Noordoost Atlantische oceaan. **De waarde van NKR kunnen toenemen door verbeterde gegevens en het regelmatig bijwerken van de rekeningen, waardoor tijdreeksanalyses mogelijk worden.**

List of abbreviations

BCR	-	Benefit to cost ratio
CBA	-	Cost-Benefit analysis
CLAMS	-	The Coordinated Local Aquaculture Management System
CICES	-	The Common International Classification of Ecosystem Services
DAPSIR	-	Drivers-Activities-Pressures-State Impacts-Response
EMFF	-	European Maritime and Fisheries Fund
GDP	-	Gross Domestic Product
GOAP	-	The Global Ocean Accounts Partnership
IDEEA group	-	The Institute for Development of Environmental-Economic Accounting
INCA	-	Integrated system of Natural Capital and ecosystem services Accounting
INCASE	-	The Irish Natural Capital for Sustainable Environments
ISPONDRE	-	The Institute of Strategy and Policy on Natural Resources and Environment
MEA	-	Millennium Ecosystem Assessment
MMAF	-	Ministry of Marine Affairs and Fisheries
MSFD	-	Marine Strategy Framework Directive
MSP	-	Maritime
MPA	-	Marine Protected Area
NEAES2030	-	North East Atlantic Environmental Strategy 2030
NCA	-	Natural capital accounting
NCAVES	-	Natural Capital Accounting and Valuation of Ecosystem Services
NPV	-	Net present value
OECD	-	The Organization for Economic Co-operation and Development

OSPAR	-	Oslo and Paris convention
QSR	-	Quality Status Report
SEEA-CF	-	The System of Environmental-Accounting Central Framework
SEEA-EA	-	The System of Environmental-Economic Accounting Ecosystem accounting
UNCEEA	-	The United Nations Committee of Experts on Environmental-Economic Accounting
UN-ESCAP	-	The United Nations Economic and Social Commission for Asia and the Pacific

1 Introduction

The state of the marine environment has been declining in the past decades due to anthropogenic pressures such as climate change, overfishing and pollution. The condition of ecosystems such as coral reefs, sea grass and mangroves have been facing degradation that can even result in ecosystem collapse (Bland et al., 2018). Additionally, biodiversity has been under threat due to the destruction of habitats and overexploitation (Luypaert et al., 2020)

Marine ecosystems are essential for human well-being due to their ability to provide economic, environmental and social benefits to society (Gonzalez et al., 2015). These benefits provided through ecosystem services directly and indirectly translate to social and economic value (Remoundou et al., 2009). Examples of these are climate change mitigation by sequestering carbon, supporting fish population and providing the environment for recreational activities. Since the health of ecosystems and their ability to provide ecosystem services are closely linked, the degradation of the health of marine environments causes the benefits ecosystem services to decrease as well. Therefore, the protection of marine ecosystems and the services they provide for society should be a priority.

However, the natural capital from the marine environment that provide both biotic and abiotic resources for society are often not included in measures of economic progress such as Gross Domestic Product (GDP). Natural capital accounting (NCA) are methods using integrated accounting frameworks to provide measurements and reports on the stocks and flows of the natural capital of ecosystems. NCA recognizes that natural capital provided by the environment benefits society and is therefore important to manage in a sustainable way.

The System of Environmental-Economic Accounting Ecosystem Accounting (SEEA-EA) is a form of NCA and provides an organized and integrated framework to value ecosystem services and track the extent and changes in the ecosystem assets. The system was adopted by the UN statistical commission in 2021 (United Nations Statistical Commission, 2021) and is currently being tested in over 90 countries. The framework provides a better insight into the impact and trade-offs between the economy and the environment in a spatial setting. Various ecosystem services such as coastal protection, carbon sequestration or cultural services are currently ignored in national accounts. However, these services do provide strong benefits for society and are included in the SEEA-EA framework. The SEEA Ecosystem Accounting framework can be used to provide information on the state of ecosystems, but also to provide support for policy-making, review and analysis (UN et al., 2017). Furthermore, the framework can look beyond GDP when measuring human wealth (Hein et al., 2020).

As previously stated, the health of the marine environment is under threat. Unfortunately, this is also the case for the marine environment of the North Sea and the North East Atlantic (OSPAR, 2021). Climate change, eutrophication, pollution, overfishing and seabed distortion form a major threat to the functioning of the marine ecosystem. These environmental problems threaten the ability of the North East Atlantic to provide ecosystem services in the future.

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) aims to protect and restore the marine environment from human activities. Their North East Atlantic Environmental Strategy 2030 (NEAES) consists of various objectives to tackle challenges of the marine environment. Under strategic objective 7, to achieve productive and sustainable seas, OSPAR has indicated its interest to account for ecosystem services and natural capital. It is specified as follows (OSPAR, 2021):

S7.O3 By 2025 OSPAR will start accounting for ecosystem services and natural capital by making maximum use of existing frameworks in order to recognise, assess and consistently account for human activities and their consequences in the implementation of ecosystem-based management.

OSPAR specifically states its aim to make maximum use of existing frameworks which is where natural capital accounting could play a role. Additionally, it is important to assess how to use a framework such as NCA to support the implementation of ecosystem-based management.

1.1 Aim of the report

Even though a large number of countries are organizing NCA according to the SEEA-EA framework, the use NCA for policy making remains complicated (Ruijs et al., 2019). With increasing pressures on the ecosystems of the marine environment it is imperative to gain a better understanding of how we can use NCA for marine policy-making.

The goal of this report is to assess how we can use natural capital accounts for marine policy of the Dutch part of the North Sea and North East Atlantic Ocean. It will build further upon the marine natural capital accounting analysis for the North Sea and the North East Atlantic (Blazquez, 2021; Schenau, 2019).

This analysis will provide an overview of strengths, limitations and challenges of NCA based upon case study review, interviews and the discussions during the OSPAR working group on the 13th and 14th of December. Afterwards, this knowledge will be used to discuss the potential use of NCA for the Marine Strategy Framework Directive (MSFD), Maritime Spatial Planning, the European Green Deal and the North East Atlantic Environmental Strategy 2030 of OSPAR.

1.2 Outline

First, in chapter 2 establishes the importance of natural capital for human well-being and environmental policy. Additionally, the various categories of ecosystem services are discussed. Then, the methodology of the SEEA-EA framework and Ocean Accounting will be examined.

The theoretical frameworks that give insight in how NCA can be used for policy support will be analysed in chapter 3; thus, answering the question, in which stages of the policy cycle can NCA be used and what type of information is relevant for which stakeholder. Additionally, various strategies to optimize the use of NCA in decision-making are discussed.

Then, an overview of various international case studies will be used to examine the current and potential use of natural capital accounting for decision-making. This will result in a comprehensive overview of strengths, limitations and challenges of natural capital accounting in policy-making.

In chapter 4, the possible policy applications for the Dutch part of the North Sea will be examined. First, the European Marine Strategy Framework Directive (MSFD) as a tool to achieve Good Environmental Status (GES) and the potential use of NCA will be analysed. Then, the ability of NCA to identify trade-offs between economy and environment of the North Sea will be discussed. Finally, this chapter will examine possibility to use natural capital data from the accounts for the monitoring the Sustainable Development Goals and the "Wellbeing economy" of the North Sea.

Last, chapter 5 will examine policy applications and added benefit of natural capital accounting for OSPAR. As the organization being responsible for coordinated management of the North East Atlantic, OSPAR has indicated in the North East Atlantic Environmental Strategy 2030 (NEAES) to be interested in NCA. Furthermore, this chapter examines the ability of NCA to support the ecosystem approach and the Drivers-Activities-Pressures-State Impacts-Response DAPSIR framework currently used by OSPAR. Furthermore, possible synergies, challenges and next steps are discussed.

2 Natural capital accounts

Before examining how we can use natural capital accounts for policy making, it is important to understand the dynamics of the method itself. The literature on the System of Environmental-Economic Accounting Ecosystem Accounting (SEEA-EA) framework (United Nations et al., 2021), the first report on natural capital accounting for the North-East Atlantic area (Blazquez, 2021), the report on the natural capital accounts for the Dutch part of the North Sea (Schenau, 2019) and the technical guidance (GOAP, 2021) of The Global Ocean Accounts Partnership (GOAP) will provide a foundation for this chapter.

First, the relevance of natural capital will be explained. The components of natural capital, its importance for human well-being and its relation to other forms of capital will be discussed. Furthermore, the relationship between the environment, economy and society is examined. After that, more background on the SEEA Ecosystem Accounting framework will be provided, followed by a description of the method of Ocean Accounting as presented by the Global Ocean Accounts Partnership (GOAP). This description will also address questions such as how do marine ecosystem accounts differ from ocean accounts, and why is ocean accounting more difficult than terrestrial accounting and how are ocean accounts formed? Finally, an analysis will be made on how NCA can be used to support other economic analysis such as cost-benefit analysis, scenario analysis and the Drivers-Activities-Pressures-State Impacts-Response (DAPSIR) framework used by OSPAR.

2.1 Natural capital

Since the 1970s the concept of natural capital has been gaining increased attention from academics, government and society. The term natural capital was first mentioned by the Oxford economist E.F. Schumacher in 1973 in 'Small is beautiful, Economics as If People Mattered' (Schumacher, 1973). Schumacher recognized the need to include the environment into the economy and to acknowledge its contributions to society. According to Schumacher, environmental issues mainly occur due to anthropogenic inputs or extractions as a consequence of the market economy.

There is a large variety of definitions of natural capital. The Organization for Economic Co-operation and Development (OECD) Glossary of Environment Statistics uses the following definition (OECD, 2019):

"Natural capital are natural assets in their role of providing natural resource inputs and environmental services for economic production."

The concept includes nature as an asset that not only provides raw materials, but also contributes to human well-being through services that provide economic value. Natural capital consists of several components provided presented in the framework below in Figure 1 (Maes et al., 2013):

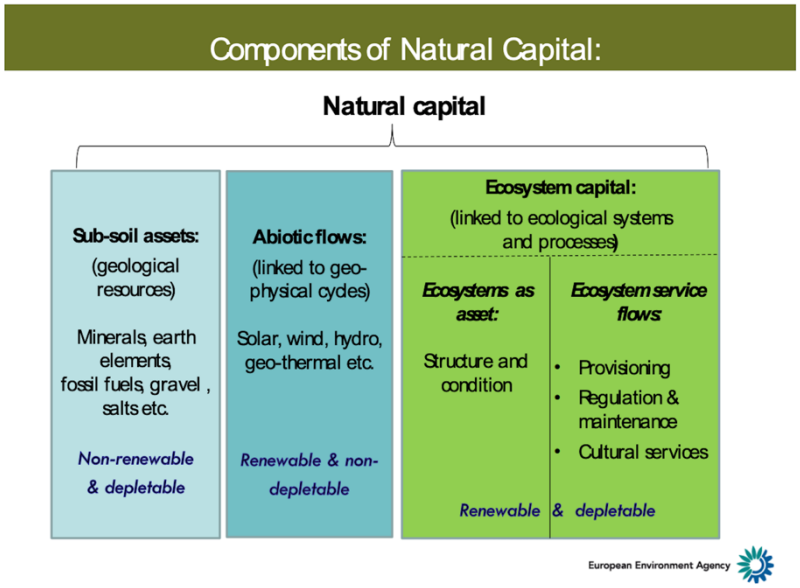

Figure 1: Components of natural capital (Maes et al., 2013)

Natural capital is divided into 3 mayor components as can be seen in figure 1:

- The non-renewable and depletable abiotic assets such as minerals and fossil fuels
- The renewable and non-depletable abiotic flows such as water flows that provide hydropower and the sun that provides solar energy
- Ecosystem capital which consists of both biotic and abiotic assets and flows that are renewable and depletable.

A more detailed description on ecosystem services is provided below.

Categories of ecosystem services

As previously mentioned, human well-being is strongly dependent upon ecosystem services. The ecosystem services and categories gained increased attention due to the Millennium Ecosystem Assessment which main objective was to establish the impact of ecosystem change on human-wealth (MEA, 2005). Even though the categories can vary slightly the ecosystem services are generally categorized in three parts (TEEB, 2010). The Common International Classification of Ecosystem Services (CICES) uses the following categories (CICES, 2018):

- *Provisioning services*: The goods provided to society by ecosystems. These include the provisioning of food, energy and raw materials.
- *Regulating and maintaining service*s: These are the benefits obtained from the ability of ecosystems to provide biological regulation. These include the ability to regulate climate, hydrological and biochemical cycles, soil retention and formation, water purification and disaster protection like disease control and flood protection.

- *Cultural services*: The mental and physical benefits provided by ecosystems that benefit human well-being that are obtained from the natural environment. These can include activities such as walking through a forest, various cultural activities or the value one obtains from protecting nature for its intrinsic value.

Different forms of capital

The framework presented in Figure 2 provides insight into the various forms of capital. Each of these forms of capital contribute the economy and human well-being (Black & Hughes, 2001). *Built capital* is capital manufactured by humans and provides economic benefits by improving production of business processes. Examples of these can be machines, building and equipment. *Human capital* are skills, knowledge and abilities that enable people to contribute to the economy and human well-being. *Social capital* consists of social connections and values that can improve working relationships and is relatively hard to measure.

At the bottom of figure 2 *natural capital* is illustrated with the various services it provides. This can be seen as the basis for all other forms of capital and brings forth fundamental living conditions for society (Lopez et al., 2020). Built capital is provided raw materials from natural capital, but can also benefit from regulating services such is the case for agriculture and pollination. Natural capital also plays a critical role in human and social capital through providing (mental) health, protection and spiritual connection from ecosystem services (Bratman et al., 2019; Stürck et al., 2014; Tengberg et al., 2012).

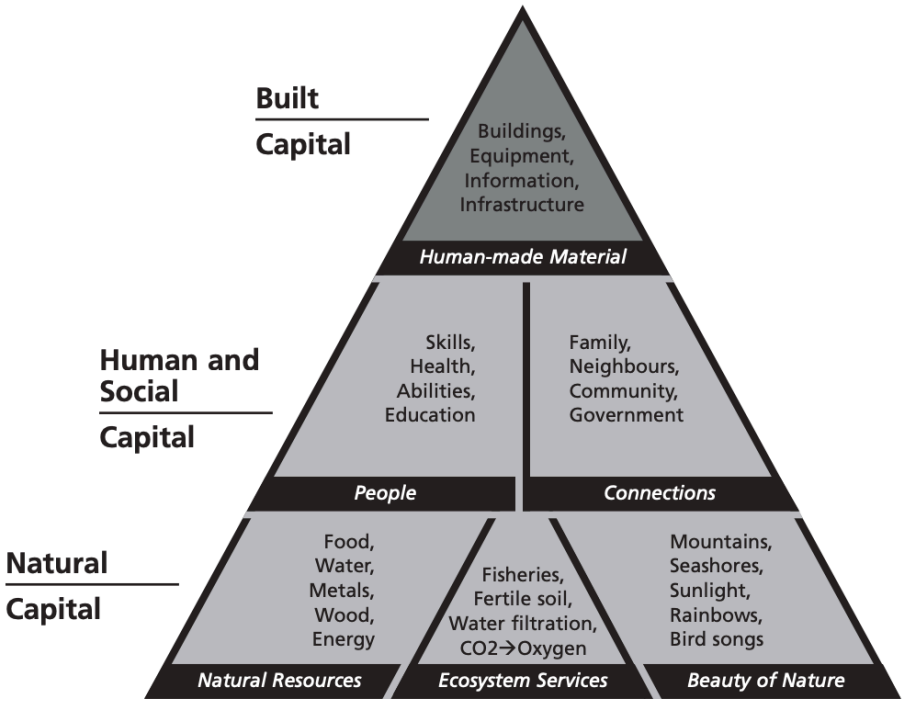

Figure 2: Different forms of capital (Black & Hughes, 2001)

2.2 SEEA Ecosystem Accounting

In this subchapter the methodology of Ecosystem accounting formed by the SEEA-EA framework will be illustrated (United Nations et al., 2021; United Nations Statistical Commission, 2021). First some background information on the development of the SEEA Central Framework (SEEA CF) and the SEEA Ecosystem Accounting will be given and their differences will be addressed. Afterwards, the 5 accounts of the SEEA-EA will be discussed and an example of a spatial approach of the SEEA-EA is provided.

In 2012 the UN Statistical commission adopted the SEEA central framework. This is the first international accounting standard that focusses on economic-environmental accounting. The SEEA CF provides a standardized approach that combines economic and environmental information for specific environmental assets such as timber, energy, water or fish.

While the SEEA CF focusses on specific assets or sectors the SEEA Ecosystem Accounting framework provides an integrated assessment of ecosystem in a spatial setting. The method was adopted by the UN Statistical Commission in March 2021 as an international accounting standard. Currently, a regulation is proposed by the European Commission in order to make it mandatory for EU member states to provide ecosystem accounts (European Commission, 2022).

Ecosystem accounting allows the assessment of interactions of environmental and economic components within a whole ecosystem. The conceptual framework of the SEEA-EA consists of 5 main accounts which are illustrated in figure 3:

- *Ecosystem extent account*: Which includes the total area recorded for a specific ecosystem accounting area such as a province, basin or protected area. The account is categorized by ecosystem and is measured over time from one accounting period to another accounting period and therefore indicates the change of the ecosystem extent.

- Ecosystem condition account: Describes the condition of selected attributes of an ecosystem at specified points in time. The condition account can indicate information on the changes in the health of an ecosystem, if reported over time.

- Ecosystem services flow accounts (physical and monetary): Presents the ecosystem assets that are supplied by ecosystem services and used by society in economic units.

- Ecosystem asset account: Accounts record information on stocks and changes in stocks (additions and reductions) of ecosystem assets. This includes accounting for ecosystem degradation and enhancement.

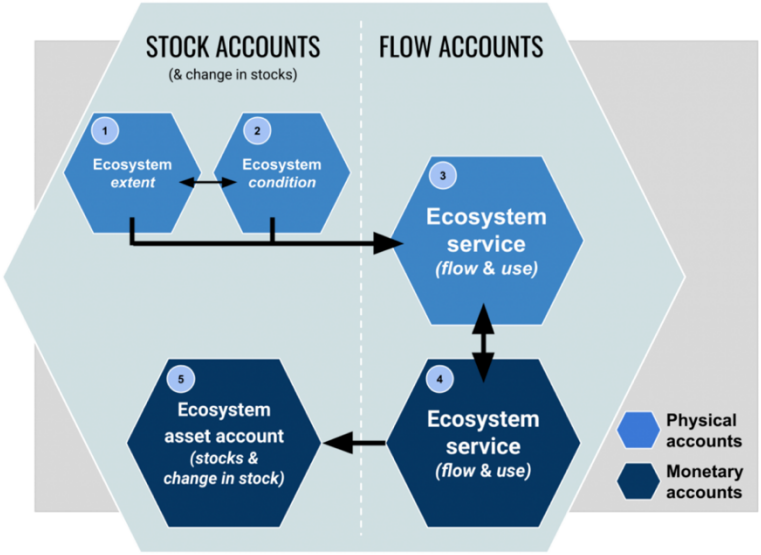

Figure 3: Ecosystem accounts SEEA-EA (United Nations Statistical Commission, 2021)

The spatial approach taken by SEEA-EA framework can aid in recognizing key ecosystems and identify certain environmental problems at specific locations. Furthermore, the SEEA-EA framework can identify the stakeholders that benefit the most from the specific ecosystem which can be important in providing sustainable policy.

An example of this spatial approach is provided in figure 4, which shows an example of the extent account using various layers. Spatial presentation can aid in answering a wide variety of policy questions, since accounts can be established on a variety of levels to meet the policy -makers demand. However, this is strongly dependent on the availability and spatial resolution of data which can hinder the development of certain accounts.

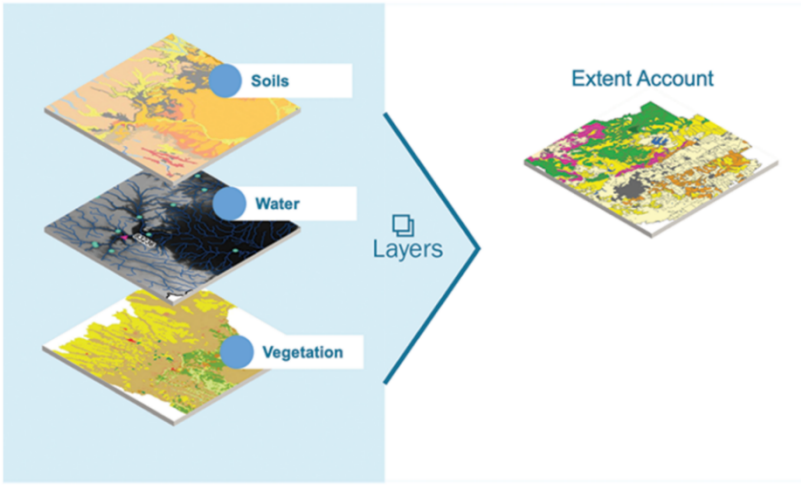

Figure 4: Example spatial approach & maps SEEA-EA (United Nations Statistical Commission, 2021)

Furthermore, the monetary values provided by the SEEA-EA framework can value nature that currently does not have a market price, support budgetary decisions and serve as input for specific cost-benefit analysis cases (United Nations Statistical Commission, 2021).

2.3 Ocean Accounting

In this subchapter, the conceptual framework for ocean accounts and the importance of marine ecosystems will be addressed. The challenges of marine accounting and its differences with terrestrial ecosystems will be discussed. Last, the need for ocean accounts in measuring change in ocean ecosystems, economic impact and improving communication between stakeholders will be examined.

The ocean covers around 70% of the surface of the Earth. Depths can go up to over ten kilometres and a large part of the ocean remains unknown (GOAP, 2021). Marine ecosystems are of great importance in supporting human well-being through ecosystem services, such as food production, clean energy and climate change mitigation (Duarte et al., 2020). Measuring marine accounts differs fundamentally from measuring terrestrial accounts and is considered very complicated. Marine boundaries are more difficult to assess than land assets and the economic owners are therefore not always clear (Hooper et al., 2019). Furthermore, it is difficult to account for different water columns and the high spatial mobility of its ecosystems.

The Global Ocean Accounts Partnership (GOAP)

The Global Ocean Accounts Partnership (GOAP) is a partnership that connects various countries[1], institutions [2]and other stakeholders and that are commited to the sustainable development of the ocean. They do this through the standardisation of ocean-data, measure ocean progress and work towards sustainable ocean management. GOAP provides a new method of "ocean accounting" that uses a standardized framework to organize social, economic and environmental ocean data. This allows for measuring ocean progress beyond GDP and measures progress towards a sustainable inclusive ocean economy. Currently, various countries are setting up ocean accounts. A few examples of these pilot projects can be found in the case studies of chapter 3.3. Ocean accounts are defined as follows:

"Ocean accounts are integrated records of regularly compiled and comparable data concerning ocean environment assets (e.g., extent/condition of mangroves), economic activity (e.g., sale of fish) and social conditions (e.g., coastal employment)."

[1] *Currently: The United Kingdom, Australia, Canada, China, India, Indonesia, Malaysia, Norway, Maldives, Thailand, Vietnam*

[2] *World Bank, UN–ESCAP, UNEP-WCMC, Australian National Centre for Ocean Resources and Security, University of New South Wales, University of Ottawa, Guangxi Academy of Oceanography, World Resource Institute – Indonesia, Cape Peninsula University of Technology*

Ocean accounts show compatibility with other accounting frameworks such as the System of National accounts (SNA) and the SEEA Ecosystem Accounting framework. While NCA mainly focusses on environmental economic accounting, the ocean accounts also include social accounting and governance factors that affect the ocean ecosystems. Ocean accounts can improve decision-making and aid in a sustainable marine management. They consist of four main components (GOAP, 2021):

- Macro-economic accounts that include economic measures such as GDP and from which legal, illegal, unreported and reported ocean activities can be derived.
- Environmental-economic accounts that provide information on the assets, and flows, taxes, wastes, subsidies and expenditures.
- Ecosystem accounts that provide a spatial framework that includes the extent, condition, biodiversity and value of ocean ecosystems.
- Structured data on ocean beneficiaries, technology, governance, and management.

The ocean account framework is illustrated in figure 5. Much like the SEEA-EA framework the ocean account framework allows policy makers the ability to monitor environmental assets and services, while monitoring residuals such as waste and emissions. However, ocean accounting can also contain information regarding social and governance indicators such as health, income distribution, poverty and social inclusion (GOAP, 2022a). This allows more dimensions to be integrated into ocean management and can improve the sustainability of ocean decision-making.

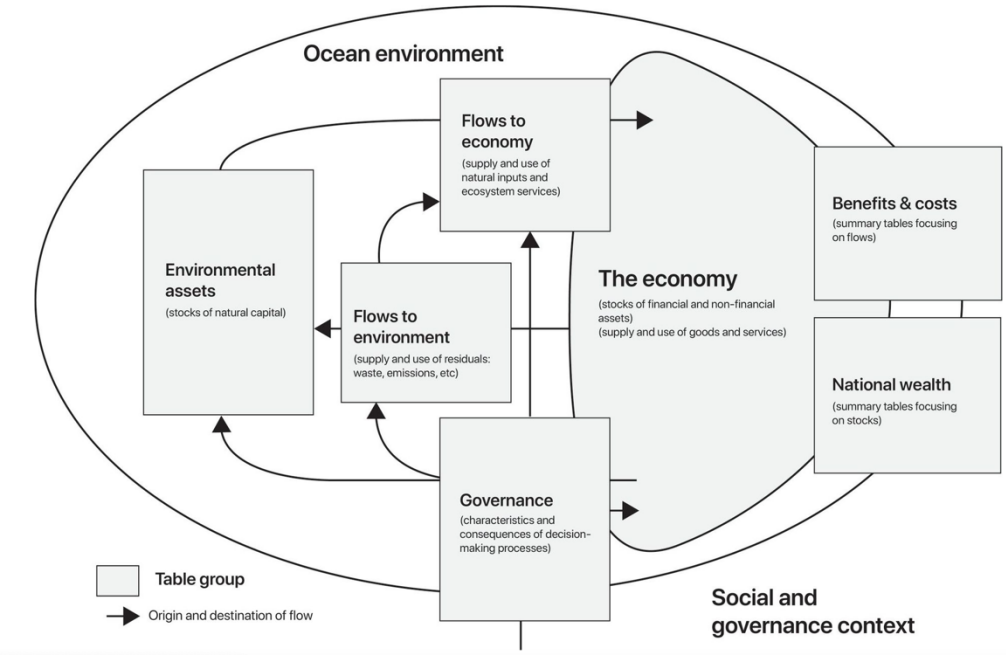

Figure 5: Overview conceptual framework ocean accounts (GOAP, 2022a)

2.4 Natural capital accounting & other methods

In this subchapter the added benefit from using natural capital accounting in combination with more traditional valuation methods such as (social) cost-benefit analyses and scenario analysis will be described. This is an important tool by governments and other stakeholders to assess various environmental policy-options and their economic consequences.

2.4.1 Cost-Benefit Analysis

The data provided by natural capital accounts can serve as an input for cost-benefit analysis of individual government projects and provide additional relevant economic-environmental data to support decision making (Bright et al., 2019). Since the value of nature is often not fully taken into account in decision-making, using NCA as basis can result in a more comprehensive cost-benefit analysis (CBA) that takes into account the value of the environment into decision-making. However, this strongly depends on the spatial resolution of the accounts and the type of question of the policy-makers, which do not always align. Decision-makers might need data on a local level while natural capital accounts are established on a more aggregated level.

The use of ecosystem accounting for cost-benefit analysis has already been used for various terrestrial pilot studies of the SEEA-EA in Indonesia and South-Africa which are elaborated in subchapter 3.3 (Turpie et al., 2021; United Nations et al., 2021). These case studies show the ability to examine the cost and benefits of different policy alternatives and incorporate the value of ecosystems. The possibility of using natural capital data from accounts will increase in the future since increased quantity and quality of data can result in more comprehensive accounts. Better spatial resolution allows data to be used for cost-benefit analysis of individual projects at a more local or regional level.

2.4.2 Scenario Analysis

Natural capital accounting can be used as a basis for scenario analysis to estimate environmental and economic consequences of policy decisions (Carnell et al., 2022; Gomersall & Dunn, 2021; Turpie et al., 2021). This can inform decision-makers of cost and benefits of policy options, establish economic relevance for nature restoration and assess various investment decisions. It is important to inform stakeholder that this type of analysis is dependent on assumptions made for scenarios and it is advised to make conservative estimates.

A more detailed of example of using natural capital accounting for scenario analysis and cost-benefit analysis can be found in chapter 3.3 for the case studies for Australia, the United Kingdom and South-Africa (Carnell et al., 2022; Gomersall & Dunn, 2021; Turpie et al., 2021).

3 Natural capital accounts & policy applications

The SEEA-Ecosystem accounting framework is currently being applied in over 90 countries where the main focus is setting up the accounts with a variety of projects and initiatives. Natural capital accounting is developing worldwide with global projects such as the Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES[3]) which was funded by the European Union, projects that focus mainly on ocean accounting such as Global Ocean Accounts Partnership (GOAP) and European projects such as Mapping and Assessment for Integrated ecosystem Accounting (MAIA[4]).

The SEEA-EA provides a policy tool for monitoring the state of the environment and policy progress. Around 40 indicators provided by the SEEA-EA are coupled to 9 of the Sustainable Development Goals (SDG's). Additionally, around 70% of the indicators from the SEEA-EA are coupled to the Aichi biodiversity goals. While the applications of natural capital accounting seem extensive, a majority of the countries is still in the development phase of setting up the accounts. Especially the marine natural capital accounts are in the development phase, since data is often more limited than terrestrial ecosystem accounting. However, the interest in using NCA for various marine policy applications is growing.

This chapter provides an overview of theoretical frameworks and case studies concerning (marine) natural capital accounting. Overall, the information of this chapter serves as a building block to see how and where we can use NCA in the policy cycle, how we can use NCA for decision-making, how we can improve communication between NCA-stakeholders, and what the future challenges and opportunities of NCA are.

First, the different types of information from NCA that can be used by policy makers are illustrated by the information pyramid of the SEEA. This pyramid links different kinds of users of the accounts to the type of information the SEEA-EA can provide. Afterwards, the potential use of NCA in the various stages of the policy cycle are discussed. Furthermore, six strategies to optimize integration of NCA for decision-making are examined. Then, a large variety of case studies of (mainly) marine natural capital accounting is analysed. This includes the main policy context of the case study, their findings and limitations. This analysis will be used to provide an overview of the potential policy applications of NCA, the limitations and the challenges to ensure success of NCA in marine decision-making.

In the following chapters 4 and 5 the theoretical frameworks and case studies will be used to establish in what areas of policy making NCA could be applied for the North Sea and the North-East Atlantic Ocean for OSPAR.

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[3] India, Brazil, China, Mexico and South Africa: Funded by EU and implemented by collaboration between UN statistical division, UNEP and secretariat of Convention of Biodiversity (CBD)

[4] 9 EU member states and Norway

3.1 Information use of the SEEA-Ecosystem accounting framework

The large amount of information provided by natural capital accounting can be used for a variety of stakeholders depending on the policy question and properties of the accounts. The information pyramid of the SEEA illustrated in figure 6 below shows the potential of different types of information of natural capital accounting that can be used by a variety of stakeholders (SEEA, 2017):

- *The key indicators:* are a small subset of indicators (or a weighted/aggregated index) that can be used to raise awareness, provide information and support communication for a larger audience. This is the least detailed information from the accounts and can be used by the general public, (high-level) policy makers, lawmakers and journalists.

- *The indicators:* are a large set of indicators provided by the accounts and can support policy-making and coherence. This information can be used by policy analysts, government officials, managers and other stakeholders. This can be used at a European level to track for example the progress on the Sustainable Development Goals, but also to monitor national policy goals that are couples to indicators.

- *The accounts:* provide a detailed and extensive (statistical) overview of information that can serve numerous purposes. This information can support in depth policy analysis for researchers, statisticians and policy analysts.

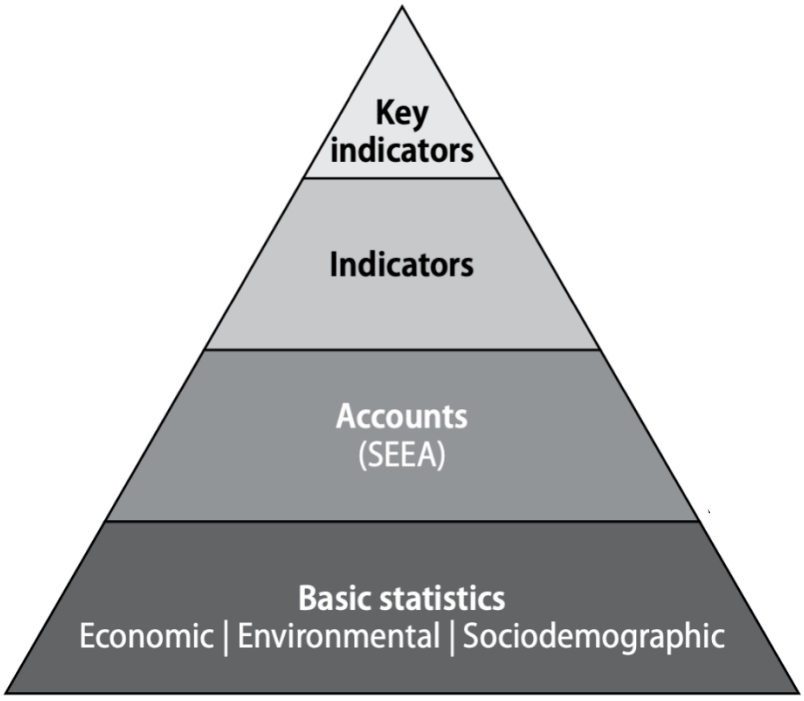

Figure 6: information pyramid (SEEA, 2017)

Even though the indicators can be provided by other sources of statistics, the SEEA-ecosystem accounting framework can improve the integration, consistency and coherency of data. Additionally, the use of information is not mutually exclusive. The approaches can complement each other to communicate a more coherent story.

It is clear that the SEEA-EA framework can provide a large variety of information for evidence-based decision-making. The information used from the accounts is dependent on the type of user, policy question and depth of the analysis. It can support policy application throughout different stages in the policy cycle. The use of NCA in various stages of the policy cycle is elaborated in the next subchapter 3.3. Furthermore, six strategies for optimizing the use of NCA throughout the policy cycle are discussed.

3.2 Policy cycles and the use of NCA

A growing number of countries are interested or currently creating natural capital accounts based upon the ecosystem accounting framework provided by the SEEA. Even though the information provides better insights into ecosystems, its economic value and its natural resources, it can be difficult to use NCA in supporting policy making (Ruijs et al., 2019). This is mainly due to data limitations of the accounts, but also because of the fact that it requires time for new methods to be incorporated into policy-making that are mainly supply driven. Especially, due to the fact that the value of NCA increases over time since time-series can be analysed and trends can be identified. The number of examples for the design of policy remain scarce. However, NCA can support decision-making in various stages of policy.

In figure 7 a conceptual policy cycle is presented, including the most important stages of policy: issue identification, policy response, implementation, and monitoring and reviewing. The cycle itself is a continuous process, and NCA can be implemented or used in any of the stages depending on the question of the decision-maker. The main added value of NCA is the integrated approach to economic and environmental systems and the relations between them, which allows for a coherent analysis. Since NCA is relatively new and many of the accounts are being set up at the moment, the use of NCA has mainly been applied in the problem identification and monitoring stages of the policy cycle. The few cases where NCA has been used for policy design were in countries that have been using NCA for a longer period of time.

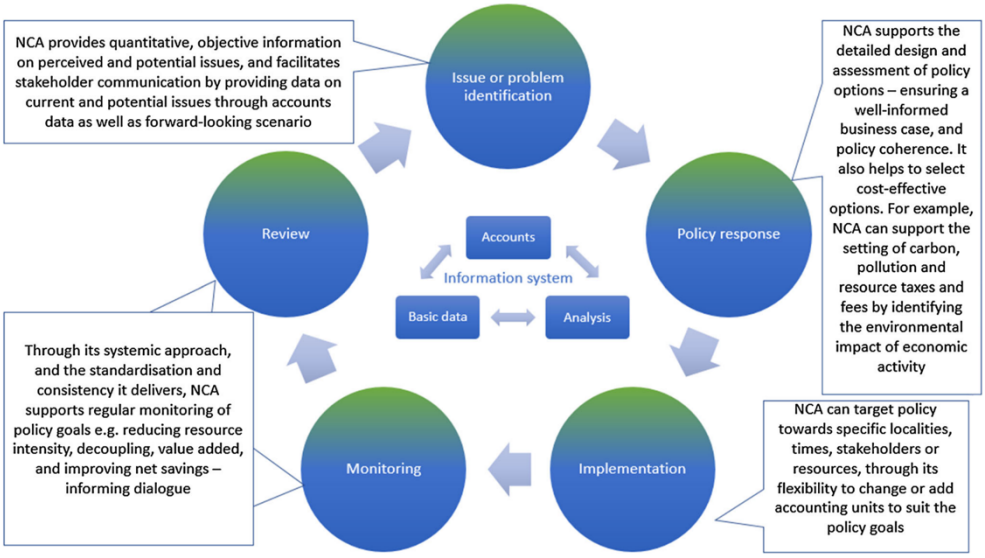

Figure 7: Framework of the policy cycle for NCA use (Ruijs et al., 2019).

The large amount of integrated environmental-economic information provided from natural capital accounts can support various policy decisions throughout the policy cycle. However, integrating NCA into policy-making can be challenging. Ruijs et al., (2019) identify how policy decisions can be improved based upon the discussions from policy forums[5], various practical examples and policy theory. This resulted in ten principles that can aid in the use of NCA for policy-making (see Appendix I). In order to apply these principles, the following six main strategies to optimize use of NCA in policy decisions were identified (Ruijs et al., 2019):

1. *Establish the credibility and trustworthiness of the NCA:* since the system is considered new for many countries and stakeholders involved, it is essential that the information provided through NCA is credible. The standardization of the SEA-EA has contributed to the trustworthiness of the data. Another measure that could contribute to the credibility of NCA is to divide the provisioning of data and the policy-making between different institutions.

2. *Match the supply and demand of NCA in order to agree upon the purpose of NCA:* the accounts provided by NCA should be created for policy relevance. Currently, many accounts are still supply based and can therefore remain unused. The scale, detail, policy options and policy questions should be considered when creating the accounts to align supply and demand.

3. *Provide high quality support:* the support of high-level government officials and cooperation with important institutions such as central ministries contribute strongly to the success of creating NCA accounts and their value.

[5] Organized by the World Bank Wealth Accounting and Valuation of Ecosystem Services program and the United Nations Statistical Division.

4. *Stimulate the cooperation between various stakeholders in order to optimize the use of NCA for policy:* a large amount of the data needed to support NCA is available. However, the data is generally dispersed between a large number of stakeholders. The countries that show success in setting up NCA experienced that multi-disciplinary cooperation is imperative. Common interests should be emphasized to promote cooperation and are key for NCA policy among different sectors.

5. *Address importance of natural capital for economy:* in order to increase the importance of sustainability and natural capital on the policy agenda, the evidence for economic relevance should be provided. This can align the social, economic and environmental objectives within different branches of governments instead of treating them as separate topics. Addressing the economic importance can therefore improve the policy application of NCA.

6. *Provide clear policy communication:* By communicating the results of NCA clearly with a focus on policy-use is essential in NCA in the policy process. The complexity of NCA should be transformed into digestible information such as indicators, maps and charts. A clear communication strategy with stakeholders can ensure the support of NCA policy application with the target audiences.

Since 2019 many countries have developed and used natural capital accounts, especially since the adoption of the SEEA-EA by the United Nations Statistical Commission in 2021. Chapter 3.3 provides an up-to-date overview of case studies regarding (marine) NCA and their implications for policy-making. The policy cycle is used to analyse in what stages NCA is used the most and what has been the progress over the last years. Additionally, limitations will be examined and possible additional strategies to ensure the use of NCA in policy making are discussed.

3.3 Natural capital accounting case studies

It is clear that natural capital accounts can provide a large amount of quantitative information for a variety of stakeholder and can support evidence-based policy-making throughout various stages of the policy cycle. Many countries are currently still (at the start) of the development phase of producing the accounts. However, natural capital accounts have been established by different organizations and projects, such as the Global Ocean Accounts Partnership (GOAP), Natural Capital Accounting and Valuation of Ecosystem Services" (NCAVES), the MARine Ecosystem Accounting project (MAREA), The Institute for Development of Environmental-Economic Accounting (IDEEA group) and Mapping and Assessment for Integrated ecosystem Accounting (MAIA). Additionally, national statistical offices and independent researchers have created accounts and analysed their possibilities. The depth of the analysis from the different case studies varies strongly per country and study. This is dependent on the development stage of the accounts, policy engagement and the quality and availability of data.

This subchapter provides an extensive overview of the development of recent (marine) natural capital accounting case studies and their policy context. The goal of this chapter is to briefly describe the policy context of the case study, the main findings, limitations, challenges and especially the coupling of the findings to specific policy goals and applications.

Even though many of the studies are a first approach to setting up (marine) natural capital accounts and do not influence policy decisions directly, the studies show the possibilities of policy applications, identify the policy context and identify knowledge gaps. Overall, the case studies are essential to show the current use and potential of NCA in policy-making.

The analysis of case studies is used to establish an overview of the strengths, limitations and challenges of marine NCA in policy-making in subchapter 3.4. Furthermore, it will serve as a building block to examine the possibilities of NCA for policy application for the Dutch part of the North Sea in chapter 4 and the North-East Atlantic Ocean for OSPAR in chapter 5.

3.3.1 Australia

Lake Illawarra

For Lake Illawarra, New South Wales (NSW), ocean accounts were composed between 2010 and 2020 based upon the Ocean Accounting framework (Gacutan, Lal, et al., 2022). The entrance of the coastal lake was permanently opened in 2007 and the dynamics between social, economic and environmental dynamics pose a strong challenge for decision-making.

Since New South Wales considers the marine environment a valuable asset, the Marine Estate Management Strategy of 2018-2028[6] of NSW was established. The vision of the government of NSW for the marine environment is as follows*: A healthy coast and sea, managed for the greatest wellbeing of the community, now and into the future* (Marine Estate Management Authority, 2018)*.* The results of this study can support the identification of economic, environmental and social benefits of the marine environment provided to the community. Furthermore, it can provide insights into interactions within the ecosystem and the economy. Due to lack of data, the ecosystem condition account was not established. Therefore, the study cannot be used to support the Monitoring Program that aims to monitor the trend of environmental assets.

The study established an extent account, ecosystem services flow account for mangroves, tidal marshes and seagrasses, fishery production and an ocean employment account. The main goal of the study was to provide integrated insight on coastal ecosystem, economy, production and employment. The ocean accounts show the following results:

- The mangroves show an increase in extent of 2 hectares(ha), the tidal marshes show an increase of 5 ha and seagrasses a decrease of 82 hectares.
- Mangrove expansion is mainly a consequence of the permanent opening of the entrance of the lake, which provides very favourable conditions for mangroves.
- The erosion and sediment deposition due to the increased velocity of the tides buried a large amount of seagrass and is expected to continue in the future.
- Carbon, nitrogen and phosphorus sequestration increased and is expected to increase in the future due to the future development of the mangroves.
- Fish catch varies strongly over the 10-year period due to the changes in coastal vegetation and are dependent on the state of seagrass and tidal marsh.
- Ocean related employment has doubled over the 10-year time period.

This study allows an integrated economic-environmental insight into the coastal economy. The use of these ocean accounts is mainly for issue identification and monitoring of trends for the ecosystem and the economy. If the accounts would be continued over time, they could be used to assess the impacts of marine policies. Examples of these can be coastal management, spatial planning and area-based protection measures (Gacutan, Lal, et al., 2022).

[6] *Initiatives in order to deliver outcomes: 1. Improving water quality and reduce litter, 2. Delivering healthy coastal habitats with sustainable use and development, 3. Planning for climate change, 4. Protecting the Aboriginal cultural values of the marine estate,5. Reducing impacts on threatened and protected species, 6. Ensuring sustainable fishing and aquaculture, 7. Enabling safe and sustainable boating, 8. Enhancing social, cultural and economic benefits, 9. Delivering effective governance*

It is important to keep in mind that selection bias could pose issues when establishing ecosystem accounts. In the case of Lake Illawarra, the mangroves are a relatively small ecosystem (0.2%), but completely counteract the loss of carbon stocks and eutrophication mitigation caused by the decrease of seagrass. If the mangrove account was not included into the study due to its size, it would have a considerable impact on its outcome. Therefore, the selection bias should be considered by policy makers when establishing natural capital accounts.

Furthermore, it is important to note that ocean accounts do not have the ability to forecast rapid changes because of the nature of tipping points in ecosystems. The growth and decrease of mangroves and seagrass are however a good demonstration of the ability of NCA to identify trade-offs by the information provided by the accounts.

Port Phillip and Western Port, Melbourne

The Institute for Development of Environmental-Economic Accounting (IDEEA) group is an organization focused on measuring the benefits that ecosystems provide and provide strategic policy advice and management tools for natural capital for both public and private organisations. The group is based in Melbourne, Australia and uses the ecosystem accounting framework of the SEEA-EA to conduct research on natural capital.

A recent study from the IDEEA group in collaboration with Deakin University and The Nature Conservancy shows the potential benefits of restoring marine ecosystems. This study established ecosystem accounts for two large metropolitan bays, Port Phillip and Western Port in Melbourne (Carnell et al., 2022). The accounts included mangroves, tidal marshes and seagrass. Next to showing development of the accounts over time, future restoration options were analysed. Various net benefits were compares based on scenarios for restoring ecosystem were examined for different sites. The restoration activities that were identified were fencing to reduce grazing in tidal marshes and mangroves, levee removal to improve tidal flow and a combination of the two measures.

The combined restoration scenario resulted in an investment ratio of 10.5 when restoring all sites due to the considerable increase in ecosystem services. The spatial approach of ecosystem accounting allows for identification of high net benefit areas of restoration (Carnell et al., 2022). This identification can support governments in prioritize their areas of interest which can be relevant when facing budget limitations. Additionally, it can aid in maximizing their return for investment for the environment.

The study shows the potential of NCA of analysing restoration scenarios, providing additional key indicators such as investment-benefit ratios and informing decision-makers on future policy applications. Additionally, it demonstrates the potential benefits of ecosystem restoration for governments and communities. This type of analysis requires a coherent data collection at a regional level with strong substantiated scenarios to establish economic relevance for investment decisions.

3.3.2 Canada

Statistics Canada (STC) and the Department of Fisheries and Oceans (DFO) have produced an Ocean Accounts pilot for the ecosystem extent, condition and services accounts (Ganter et al., 2021; Statistics Canada, 2022b). Furthermore, they also established a protected area account and marine economy account. This supports the goals of the High-Level Panel for a Sustainable Ocean Economy (Ocean Panel) that were set under Canada's G7 presidency (Ocean Panel, 2021).

A spatial register for the marine and coastal ecosystem accounts will be created in the future based upon the funding of the Census Environment program. The focus of this program is to establish essential ecosystem data in order to monitor the state of the environment and its trends (Statistics Canada, 2022a). Furthermore, it will support evidence-based decision-making for economic-environmental issues that affect Canadian wellbeing. This allows the government to create environmental policies to preserve natural capital and inform spatial planning of municipalities. However, the natural capital accounts and their policy applications are still in development.

3.3.3 Fiji

An Ocean Accounting pilot study was conducted for Fiji with a focus on mangroves by the Global Ocean Accounts Partnership (GOAP) funded through the Blue Planet Fund of the United Kingdom. The main goal was to increase knowledge on ocean ecosystem services, creating technology and assessment development tools for environmental issues, and opening policy dialogues (GOAP, 2022b). The findings of this pilot study can support various policy goals from national policies, strategies and development plans that promote sustainable marine resource management and the ocean economy[7].

The various aim of the study is aligned with policy goals[8] of the National Ocean Policy 2020-2030 (NOP) of Fiji which aims to be a benchmark for national ocean planning and management (Republic of Fiji, 2020). A more detailed description of the aims of the case study and the alignment with Fiji's NOP can be found in Appendix II. Furthermore, Fiji is a member of the Ocean Panel which includes the goal of setting up Ocean Accounts by 2025 (Ocean Panel, 2021). The information provided by the Ocean Accounts can support a variety of ambitions set by the Ocean Panel[9]. Additionally, Ocean Accounts can support international reporting for Biodiversity targets, Sustainable Development Goals and the Paris Agreement.

Even though this study only focusses on mangroves the goal is to expand this study by adding more ecosystem services, such as seagrass and coral reefs in the future. The main findings of the pilot study are as follows:

[7] *National Ocean Policy 2020-2030 (NOP), 5- and 20-year development plan, the National Action Plan for the Implementation of Agenda 2030 for Sustainable Development, Marine Economy plan, National Climate Change Policy and the Environmental act for 2005*

[8] *Goals from NOP 2020-2030: Cooperation (1), sustainability (2), security (3), people (4), development (5), knowledge (6) and Advocacy (7)*

[9] *Creating and restoring 30% of MPA's, reducing GHG's by 20%, creating jobs, increase seafood supply by 6 times in 2050, generating 12 million ocean jobs by 2030*

- The mangrove account has decreased by 0.9% from 2008 to 2016. The impact of tropical cyclones on this decrease has to be investigated further since the mangroves in northern provinces were severely impacted.
- Around 20 to 30 million USD are provided directly by the mangrove forests annually, which translated to around 0.5% of GDP.
- Mangroves related activities provide around 3500 jobs directly which is translates to around 2% of this industry in Fiji.

This pilot study is a first attempt for the development of Ocean Accounts for the mangroves of Fiji. Therefore, the implications for policy use are mainly providing information, opening policy dialogues, create a future roadmap for ocean accounting in Fiji and issue identification for mangroves specifically. The findings emphasize the need for protection of mangrove forests due to its substantial contribution to the marine economy.

In order to protect mangroves forests, policy intervention is necessary. Mangrove protection can increase other ecosystem services such as shoreline protection, fishery industry and carbon sequestration. Additionally, it can aid in reaching various policy goals of Fijis NOP and the Ocean Panel. Fiji faces the challenge of balancing the protection of the mangrove ecosystem and ensuring the industrial value for future local livelihoods. Activities that improve the ecosystem service value of mangroves, such as mangrove tourism, could support this balance.

Data limitations had significant impact on time-series, the alignment of economic and environmental data and the ecosystem accounts often do not represent the change in the state of ecosystems. Future research requires increased monitoring and on-site research to improve the ecosystem accounts through collaboration with potential partners such as universities.

Even though the project emphasizes the importance of regulating ecosystem services of mangrove forests, such as carbon sequestration, flood control and water purification, the physical quantity, condition and monetary value are not provided in this first scope, but planned in the future. Improved data collection for mangroves can provide further relevance for protecting ecosystems since benefits such as carbon sequestration can have substantially high economic values up to 74 million USD per year (Gonzalez et al., 2015). Even though the current natural capital accounts give insights into the economic importance of mangrove forests, their value is currently underestimated which results in less coherent policy.

Further expansion of the Ocean Accounts for seagrass and tidal marshes are planned for the future. The ocean accounts can provide quantitative information for monitoring and reporting on various national and international policy goals. This insight can establish importance of natural capital for the maritime economy and indicate further directions for marine decision-making.

Blue Bond

Fiji initiated their Sustainable Bond Framework during the COP27 in Egypt (UNDP, 2022). The Blue Bond is issued by the government to support the blue economy, ocean health and sustainability (Fijian Ministry of Economy, 2022). Ocean Accounts can serve as a tool to monitor the progress and effectiveness of various projects of the Blue Bond. Furthermore, the information and indicators from the Ocean Accounts can be used for reporting the state of the ecosystem, economy and society (Singh et al., 2022).

3.3.4 Finland

The MARine Ecosystem Accounting (MAREA) project was initiated to establish ecosystem accounts for the Baltic Sea and to analyse how ocean accounts can support decision-making in marine policy on multiple levels such as monitoring policy goals and support maritime (MAREA, 2022). The lead partner of the project is the Finnish Environment Instutute (Syke) and is partnered with Pellervo Economic Research, the University of Estonia and the Baltic Environmental Forum. The MAREA project focusses specifically on the Baltic Sea and tests tools such as the mapping of ecosystem services, ecosystems accounting, decision-making support tools and sustainability assessment tools. The division of various tasks can be found in Appendix III.

PlanWise4Blue (PW4B) Geoportal

The outcomes from the project are translated into a decision-making tool, Geoportal, that can support in the development of sustainable marine planning. The main pilot areas in this tool are the Gulf of Riga and the Gulf of Finland. The project is currently in development, an example of the results of the geoportal can be seen in figure 8 below.

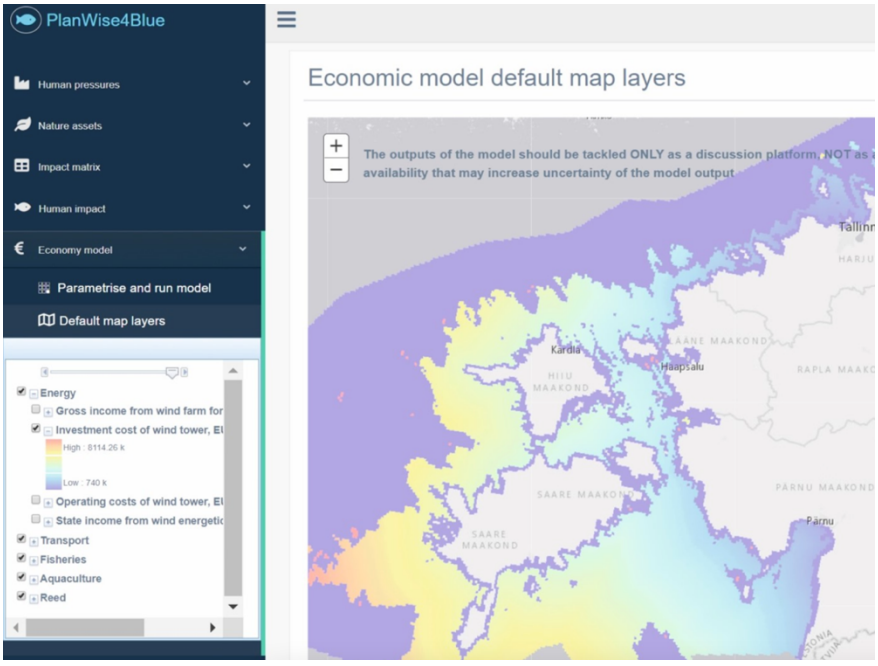

Figure 8: example of Geoportal from the MAREA project extracted from: http://marea.balticseaportal.net/activities/geoportal/

The tool can support decision-makers by providing relevant indicators, possible outcomes of scenarios, monitor national marine policy goals and the Sustainable Development Goals (Kotta et al., 2022) . Additionally, it can act as a communication tool for policy-makers and establish the importance of the blue economy and its growth. However, it is important to communicate to various stakeholders that values of the marine natural capital accounts that are incorporated in the Geoportal are based on assumptions, models and contain uncertainties.

Sustainability Compass

Next to the Geoportal, the MAREA project provides the knowledge from the marine natural accounts in the Sustainability Compass. This tool communicates the most important indicators to policy-makers organized by specific themes that are connected to the Sustainable Development Goals. The Sustainability Compass is constantly updated trough learning of stakeholders and experts that enable the knowledge of a sustainable marine environment. This allows for the assessment of sustainability of maritime or other regional projects.

3.3.5 France

A variety of French government institutions such as the French biodiversity office (OFB), French ministry for an ecological transition (MTE) and the Sustainable Development Commission (CGDD) have expressed interest in natural capital accounts (Comte et al., 2020).

The marine ecosystem accounts can support policy-making in multiple ways. The biophysical and economic accounts can provide a variety of indicators, support budgetary decisions and the spatial information can be used to support marine and coastal planning (Comte et al., 2020). Additionally, the information on marine ecosystems from the accounts can be used for reporting to integrated marine policies such as the Marine Strategy Framework Directive (MSFD). The monetary asset account can be used for the monitoring the cost of environmental degradation and the ecological debt can be used as an indicator for measuring sustainability (Comte et al., 2022).

Currently, France has established an ecosystem extent, condition and monetary asset accounts for marine ecosystems. The extent account was developed to support the identification of Good Environmental Status and environmental targets for the Marine Strategy Framework Directive for Benthic habitats.

However, data gaps remain problematic for coastal habitats and overseas territories and policy applications remain limited. The monetary asset account of marine ecosystems in France was established by the unpaid ecological cost method for the French Exclusive Economic Zone[10] (EEZ). This method is based upon the costs due to continued economic activities to the natural capital. Marine accounts currently are reliant on inconsistent data that impact the coherence of the ecosystem extent and condition account. In order to increase policy engagement, the natural accounts should be specifically designed to answer policy questions in order to demonstrate their usefulness and motivate their investment costs (Comte et al., 2022).

[10] *Sub regions of French EEZ: Greater North Sea, Celtic Seas, Bay of Biscay, Western Mediterranean*

3.3.6 Ireland

The Irish Natural Capital for Sustainable Environments (INCASE) project was initiated to combine knowledge of economists, ecologists and statisticians to account for natural capital and improve the understanding of nature and sustainable management for Ireland (Farrell & Stout, 2020). The project duration is from March 2019 to March 2023 and is funded by the Environmental Protection Agency (EPA). Establishing natural capital accounts support the targets set by the Irish National Biodiversity Action Plan 2017–2021 (DCHG, 2017):

- *Action: 1.1.10. Develop a natural capital asset register and national natural capital accounts by 2020 and integrate these accounts into economic policy and decision making.*

- *Action: 1.1.11.47 Initiate NCA through sectoral and small-scale pilot studies, including the integration of environmental and economic statistics using the framework of the UN SEEA.*

The study allows for a better insight into the condition and value of ecosystem services of Ireland. Furthermore, the accounts can improve the understanding of the economic importance of the environment and can support the economic assessment of food production policies. The INCASE project will use ecosystem account information on river catchments to create decision-making tools to support policy-makers.

Natural capital accounts can be used to monitor the progress on the EU Biodiversity Strategy of 2030 and various Sustainable Development Goals. Overall, the information provided by the natural capital accounts can support a variety of European or Irish integrated economic-environmental policies which can be found in Appendix IV (Farrell & Stout, 2020).

Natural capital accounts were established for four catchments: Caragh (peatland), Bride (agricultural), Figile (peatland) and Dargle (mix of peatland, agriculture, urban, forestry and heathland). Additionally, the IDEEA group examined case study possibilities for the Irish Seafood Development Agency, Bord Iascaigh Mhara (BIM) for the marine environment specifically (IDEEA Group, 2020). This resulted in a recent case study for the Clew Bay Area.

Clew Bay Area

The IDEEA group conducted a pilot study and produced the first marine natural capital accounts for the Clew Bay Area in Ireland. The study was funded through the Knowledge Gateway Scheme which is part the Operational Program of Ireland under the European Maritime and Fisheries Fund (EMFF). The marine natural capital accounts can support informed local decision-making for various stakeholders such as the Irish Seafood Development Agency, The Coordinated Local Aquaculture Management System (CLAMS) group, local communities and the fishery industry.

The quantitative information provided by the natural capital framework can support evidence-based decision-making for the marine environment. The information can be used to aid in the assessment of the sustainability of the Irish seafood sector, improve sustainability performance and serve as a communication tool. Furthermore, NCA can be used to report on the progress for various Sustainable Development Goals[11]. Furthermore, the accounts can support Ireland's Maritime, the National Marine Planning Framework (NMPF).

The study for the Clew Bay Area consisted of 3 main objectives (Mcleod et al., 2022):

1. Test and demonstrate the possibilities of a data collection approach that places existing scattered multidimensional data in a standardized framework using the SEEA-EA for the Irish Seafood sector.
2. Develop the knowledge on the relationship between the marine environment and Irish seafood activities.
3. Provide information for sustainable marine management of the Irish seafood sector and the marine environment.

One of the key findings of the study was the need for improved future data collection and modelling. Currently, the information provided from the natural capital accounts remain too limited for immediate use of MSP and sustainability assessment for the seafood sector. Data limitations such as low spatial resolution, lack of data and time inconsistency posed challenges for setting up the accounts, since the study only uses existing data for the Irish marine environment. Even though in the information of natural capital accounts currently might not provide new knowledge to decisionmakers in its development stage. NCA can identify (data) knowledge gaps with a spatial approach and provide support for investment decisions for future data collection.

Improved and time consistent data collection can develop the possibilities for using NCA for decision-making. The current and future data collection process is more useful if the design focusses more on integration of different data sets. Furthermore, it is important to link information supplied from the accounts to specific policies and reporting applications to improve its usefulness. Different projects, approaches or analysis require different levels of information and can be linked to the components of NCA. This requires strong stakeholder engagement to align and prioritize data collection.

[11] Next to SDG14: Life under water, indicators from the accounts can support targets from various other SDGs 6, 8, 11 and 15

Using an accounting framework such as the SEEA-EA can also significantly reduce costs related to decision making, because the integrated framework can reduce time and transaction costs when communicating and sharing information across different institutions from various disciplines. Additionally, it can reduce reduces learning costs for economists and policymakers, since they are already familiar with considering environmental information through the framework and can incorporate this into decision-making. Last, the knowledge of integrated information can possibly reduce risks of making poor policy decisions which would have resulted in some form of costs.

3.3.7 Italy

Marine Protected Areas (MPAs) are areas that are protected by law and are a way to conserve and protect biodiversity and the ecosystem service benefits they provide (Edgar et al., 2007). While the biophysical and monetary value for MPAs can be useful for policy makers, data can often be unavailable or incomplete. Therefore, environmental accounting modelling can be used to estimate values and support conservation strategies (Buonocore et al., 2020). The study of Buonocare et al., (2020) aims to estimate the value of MPAs of Gulf of Naples and Campania Region. Even though the study does not directly use a NCA framework, the results show the importance of modelling for obtaining data for natural capital. Furthermore, the outcomes can support international policies such as the Convention on Biological Diversity (CBD) and UN 2030 Agenda for Sustainable Development (Buonocore et al., 2020).

The study shows that the value of natural capital for the Gulf of Naples is estimated at around 796 million, while the value of natural capital in the Campania region was estimated at around 4323 million. Even though the Sciaphilic hard bottom (SHB) habitat only constitutes of 1-4% of the marine area it contributes to around 27% of the natural capital value. This provided further relevance for sustainable management for preserving SHB habitats trough marine protected areas.

The spatial outcomes of the study can support local decision-making and sustainability assessment for marine protected areas in Italy. The quantitative information and indicators can support the monitoring of the marine environment and serve as input for investment decisions for establishing marine protected areas. Furthermore, the visualization can aid in establishing insights into trade-offs between human activity and the conservation of the marine environment (Buonocore et al., 2020).

3.3.8 Norway

The first Ocean Accounts in Norway were produced in May 2022. Additionally, Norway recently became a member of the Global Ocean Accounts Partnership (GOAP). The results from the ocean accounts can support Norway's management plans for 3 of their sea areas: the Norwegian Sea, Barents Sea–Lofoten, the North Sea and Skagerrak. The goal of the management plans is to ensure a sustainable use of the sea that enables economic progress while maintaining marine conservation based on current scientific knowledge on ecology. The management plan includes the environmental status and its pressures, ocean-based industries and maritime. The management plan was established by the Norwegian Forum for Integrated Ocean Management directed by the Norwegian Environment Agency. This forum communicates to a steering group of ministries next to relevant institutes.

In February of 2021 the Norwegian Forum received the following goal from the steering group (Heill et al., 2022):

"*… take a closer look at how the international debate related to the development of "Ocean Accounts" or a natural capital account for the ocean ("ocean accounting") can be followed up in Norway, and especially how it can contribute to the work on the management plan for the ocean areas in 2024 when it concerns value creation and ecosystem services. We are therefore asking the Forum to start professional work on this. The work should describe the necessary knowledge needs and data base, together with opportunities and utility. The work should also address uncertainties and limitations of such an ocean accounting. If possible, should specific examples be given of how an ocean account can look in practice. […] The work will result in a document from the Forum to the steering group*".

The forum established various uses of ocean accounts based upon a seminar of ocean accounting of August 2021, a working group of May 2022 from the Norwegian Environment Agency and research the Forum conducted themselves.

- *Policy making:* Ocean accounts can aid in the assessment of developing a sustainable marine economy. The various indicators provided by ocean accounts can monitor development, ecosystem services and the condition of the environment over time.
- *Comprehensive knowledge base:* Ocean accounts provides an integrated framework that presents knowledge for multiple areas or interest. This approach can give insights into new interactions between the environment and the economy. Additionally, the accounts provide insight into the value of ecosystem services.
- *Maritime:* Due to the spatial approach of ocean accounting, ocean accounts can provide geographical knowledge of desired values and support MSP.
- *New data:* Developing the ocean accounts can provide new data and the development of valuable new knowledge.

MARine ecosystem accounting project (MAREA) for coastal planning in the Oslofjord[12]

Norway is also participating in research projects of the MAREA Project with a focus on non-market valuation of ecosystem services. The goal of the current project is to establish a regional ecosystem account for the Oslofjord and to obtain insights into conflicts of interest of users of this ecosystem. The project consists of various Norwegian research institutes[13] and started in the autumn of 2021 and will run until 2025.

Besides setting up a regional ecosystem account, the project will provide an overview of the use of monetary values and a variety of biophysical indicators for marine decision-making and maritime. Additionally, MAREA will provide insights into tradeoffs between coastal ecosystem services and behavior change in recreational fisheries. The project will demonstrate how to quantify and communicate ecosystem services and its tradeoffs for local issues of the Oslofjord such as pollution, decline in fish stock, benthic habitat loss and the increase in density of shoreline properties.

The study will be applied by hedonic pricing of housing in order to derive value of recreational areas for municipalities of the Oslofjord. Policy application will be tested with various case studies supported by a hedonic property value assessment tool that supports public purchasing guidelines and local tax recommendation.

Oceans for Development (OfD)

Norway acknowledges the important role the ocean plays in supporting a healthy environment and mitigating climate change. Therefore, the Norwegian Agency for Development Cooperation (Norad) created the Oceans for Development (OfD) program. The goal of OfD is to ensure the sustainable and inclusive use of the ocean economy for collaborating countries. The OfD also contributes to Norway's goal of Sustainable Development Goal 14: Life under water. Additionally, the program is developed to promote transnational institutional cooperation for ocean management and governance.

Part of the OfD program is the collaboration with GOAP member Indonesia. This parentship focusses on knowledge-sharing and progressing ocean accounts. The main areas of collaboration are ocean satellite accounting, visualization of ocean data, exploration of ocean accounts for supporting marine policy and ecosystem services accounts for marine protected areas (MPA's).

[12] This is not a part of the MARea Project that focusses on the Baltic Sea, but a separate program funded by the Research Council of Norway.

[13] Statistics Norway, Norwegian Institute for Water Research (NIVA), Norwegian Institute for Nature Research (NINA) and Menon Economics AS (Consultancy company)

Ocean Panel & Norwegian Ocean Economy Dashboard

In 2018 the High-Level Panel for a Sustainable Ocean Economy (Ocean panel) was established in order to move towards a sustainable ocean economy where sustainable production and marine protection coexists (Ocean Panel, 2021). The ocean panel currently consists of 17 countries[14]. The Ocean panel recognizes that creating a sustainable ocean economy can support SDG 14 and help meet all of the Sustainable development Goals, an overview of these interactions can be found in Appendix IV.

The goal is to manage 100% of the ocean area sustainably by 2025. Additionally, ocean accounts must provide insights in all benefits society obtains from the ocean. One of the key actions of the Ocean panel is to increase accessibility of ocean account information through visualization with interactive data dashboards (Ocean Panel, 2021):

> **KEY ACTIONS:** To measure the value of the ocean more accurately, national statistical offices, in partnership with other agencies, need to develop complete sets of national ocean accounts. Interactive dashboards should be created to allow users to explore the data by aggregating and disaggregating sectors and groups of people.

For this reason, Norway created an Ocean Economy dashboard. This dashboard provides the ability to organize ocean data, provide a variety of indicators, facilitate ocean information for decision-makers and allows policymakers to look beyond GDP. The of the Ocean Economy dashboard pilot is currently available online and an example can be found in Appendix V.

[14] *Australia, Canada, Chile, Fiji, France, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, Portugal, United Kingdom, United States of America*

3.3.9 South Africa

The Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) project conducted a cost-benefit study on land degradation for the Thukela Catchment located in KwaZulu-Natal in South Africa (Turpie et al., 2021). The assessment was conducted based on ecosystem account pilot data from 2005-2011. The quantitative information from the various scenarios of this pilot study can be used by policymakers such as Department of Forestry, Fisheries and the Environment's (DFFE) and the Department of Environmental Affairs & Tourism (DEAT). It can also specifically support outcome 6 of South Africa's Land Degradation National Action Plan (NAP) of 2017-2030 that is currently being updated (DEAT, 2004):

"By 2030 South Africa to ensure that degraded ecosystems are restored whilst contributing to ecosystem services delivery, climate change adaptation and mitigation"

South Africa adopted the Sustainable Development Goals (SDGs) in 2015. The outcomes of this pilot study can directly contribute to Sustainable Development Goal 15, Life on Land, and specifically target 15.3 (United Nations, 2017):

"By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world."

Furthermore, this pilot study can support informing and monitoring on the progress of various international policies such as the Convention Biodiversity (CBD), the Convention to Combat Desertification (UNCDD) and the Framework Convention on Climate Change (UNFCCC) (Turpie et al., 2021).

This study practiced a scenario-based approach that used achieving land degradation neutrality (LDN) by 2030 as a basis. Land degradation scenarios and their cost and benefits were analysed from 2015 to 2030. Additionally, this project tested the possible application of NCA for policy making. The project consists of 3 scenarios: a business as usual (BAU) scenario with no or little interventions, a Land Degradation Neutrality (LDN) scenario with a starting year of 2021, and a full restoration scenario. The cost and benefits were calculated for an upper and lower bound scenario that differed in the effectiveness of sustainable land management (SLM). In figure 9 below you can see the conceptual framework of achieving LDN for the catchment is presented.

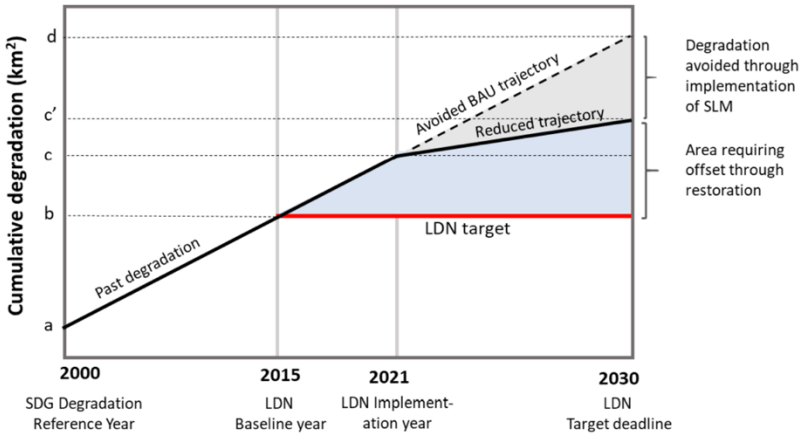

Figure 9: Conceptual framework of achieving land degradation neutrality for the Thukela catchment (Turpie et al., 2021)

The cost and benefits of the scenarios relative to the business-as-usual scenario are presented in table 1 showing the net present value (NPV) and benefit to cost ratio (BCR) of each scenario. The results show the following:

- The benefits of achieving land degradation neutrality are expected to exceed the costs for both lower and upper bound costs relative to the BAU scenario.
- Restoring land degradation that took place before 2015 (full restoration) can even result in stronger benefits.
- The results do not include all ecosystem service benefits and could be underestimated.
- Various institutional concerns should be addressed to ensure the success of sustainable land management and the outcome of these scenarios.
- Further research is needed to improve the resolution, modelling and defining the reference ecosystem condition is needed to reduce uncertainty.
- A substantial amount of funding is necessary to address land degradation. Therefore, providing an environment that enables the private sector to invest should be considered.

	Present value (R millions) base estimate		
Costs relative to BAU	**LDN Scenario**		**Full Restoration Scenario**
	Upper bound costs	Lower bound costs	
Clearing IAPs	514.4	514.4	2 355.2
Addressing Bush Encroachment	507.2	237.6	691.1
Active restoration of grasslands, erosion	2 623.6	-	-
Sustainable land management	-	1 981.02	6 093.62
Total present value of costs	**3 645.18**	**2 733.09**	**9 139.98**
Benefits relative to BAU			
Water supply	2 591.4	2 591.4	10 757.2
Sediment retention	38.9	38.9	63.1
Tourism	121.8	121.8	243.6
Carbon storage (avoided national cost)	-274.91	-274.91	597.5
Harvested resources	70.6	70.6	2 391.3
Livestock production	620.7	620.7	1 476.9
Total present value of benefits	**3 168.6**	**3 168.6**	**15 529.6**
Net Present Value	**-476.6**	**435.5**	**6 389.6**
BCR	**0.9**	**1.2**	**1.7**

Table 1: Net present value of cost and benefits of scenarios relative to business-as-usual scenario (With a discount rate of 3.66% expressed in millions of Rand) (Turpie et al., 2021)

This case study shows the possibility of combining natural capital accounts with scenario analysis in order to assess the cost and benefits of different scenarios. The outcomes can be used to inform the possibilities for policy intervention and aid in the Land Degradation National Action Plan (NAP) and measuring the progress on Sustainable Development target 15.3. Additionally, this type of analysis can support policy choices with respect to the timing of interventions: The results from this case study show that preventing degradation is a more cost-effective option and most beneficial if started as soon as possible.

Whenever a scenario analysis is done, assumptions have to be made and should be communicated clearly for increased transparency. In the case of the Thukela Catchment, benefits can be underestimated, since not all ecosystem services are included and the monetary estimates of the benefits of carbon storage are very conservative. However, the benefits of the ecosystem services are reliant on the success of sustainable land management and should therefore be prioritized. The limitations can provide policy makers with areas to focus on and reduce uncertainty. The uncertainties can also be reduced by improving high quality (time-series) data collection by field studies and modelling. This can improve ecosystem accounting as a monitoring tool and inform decision-makers on land degradation in the future.

3.3.10 United Kingdom

In 2011, the Department for Environment, Food and Rural Affairs (Defra) stated the following:

"We will put natural capital at the centre of economic thinking and at the heart of the way we measure economic progress nationally. We will include natural capital within the UK Environmental Accounts. We will establish an independent Natural Capital Committee to advise the Government on the state of natural capital in England. " (Defra, 2011)

With over 10 years of experience the United Kingdom is one of the forerunners when it comes to establishing natural accounts. Due to strong collaboration with over 67 stakeholders and 275 data sources the natural capital accounts have met all targets of previous NCA roadmaps. With the increased relevance from the Dasgupta Review of The Economic of Biodiversity the ambition to increase the quality of the accounts and to integrate them into policy has only increased (Dutton, 2022).

The extensive work of the United Kingdom on establishing (marine) natural capital accounts, their use in policy making and future developments will be examined using various sources such as the NCA roadmap (Dutton, 2022), Marine Accounts UK 2021 (Engledew, 2021) and other literature (Harris & Smith, 2019b; Her Majesty's Government, 2019; Stebbings et al., 2020).

NCA Roadmap 2022

Even though the UK has produced high quality accounts so far, the goal is to enhance their use for policy application in the future (Dutton, 2022). Especially since it is recognized that public policy often focusses on economic values. With the addition of natural capital, the environment is included in assessments which would normally often be ignored. Four main strategies were identified for the natural capital accounts for the next 5 years.

- *Macroeconomic policy*: as a reaction to the Dasgupta Review, the Office for National Statistics created new measures of *inclusive income* in May 2022. Next to human capital and households accounts the goal is to integrate natural capital accounts into these inclusive wealth accounts. Even though a part of the data for inclusive wealth accounts is currently provided by natural capital accounts, future development is necessary. Additionally, the macroeconomic decisions that could benefit from natural capital data are examined in order to support future decision-making.

- *Households*: neighbourhood based natural capital information and articles will be produced in order to engage the public into the local environment and its importance. This natural capital approach visualizes local neighbourhoods and their relation with nature in an interactive way. However, this requires future development of methods and data.

- *Local authorities, private sector and charities*: a large demand from local stakeholders for natural capital data has been recognized. However, natural capital accounts on a local level are currently unavailable. This data should be produced in the future to improve decision making at a local, private and NGO level.

- *Environmental policy and government appraisal*: natural capital accounts provide information to monitor environmental protection and can be used for public policy appraisal. However, increases and decreases in the value of natural capital and ecosystem services do not explain the reason for the change in production. Therefore, the expertise to examine and communicate the drivers of these changes to policy makers will be developed in the future. This will improve environmental policy decision making that are based upon natural capital accounts.

Policy uses of NCA in the United Kingdom

Even though the potential of natural capital for policy makers is recognized the current use for decision-making is hard to establish (Harris & Smith, 2019b):

"It is rare for there to be a clear causal connection between a particular piece of evidence and policy decisions, as the latter are influenced by a range of other factors. Often, the best that natural capital accountants (and statisticians in general) can expect is that policy decisions are 'informed' decisions. With Natural Capital Accounts in their infancy, the influence on policy will be even more intangible"

The assessment of the use of natural capital accounts in policy (in the United Kingdom) remains difficult. Nevertheless, following applications have been established:

- *Foundational*: by providing information on the interactions between ecosystems and society, policy can be developed.

- *Raising awareness*: by providing value to ecosystem services these trustworthy estimates can be used by policy makers and ministers to establish their importance. An example of this the value of natural capital in urban areas.

- *Facilitating communication*: the multidisciplinary characteristics of natural capital promotes the communication between a wide variety of stakeholders.

- *Supporting & enabling* other accounting applications*:* by integrating natural capital into the national accounts, decision-making is affected at multiple levels. The national data can aid in establishing natural capital accounts for the private sector or at a municipal level.

- *Advocacy*: the natural capital accounts are used gaining support for policy. Examples of these are Departmental bids for funding or gaining funding for green infrastructure on a municipal level.

While the accounts provide a large amount of information it can however be difficult to translate the results to policy makers and other stakeholders. Therefore, development of thematic accounts such as forests, climate change or biodiversity. This type of thematic analysis can improve the applications and understanding for decision-making. However, it can be difficult to set boundaries for a theme due to the interactive nature of ecosystems.

Natural capital accounts for marine areas in the UK

Establishing natural capital accounts for marine areas remains relativity difficult compared to terrestrial ecosystem accounting as is mentioned in chapter 2. Challenges that remain are the fact that the areas are much larger than terrestrial areas, mobile, 3-dimensional and unsusceptible for remote sensing by for example satellites. However, if the accounts are more developed into the future, they can contribute to a variety of marine policy issues (Harris & Smith, 2019a).

- *The ability of identifying and managing protected and unprotected marine areas:* due to the spatial nature of ecosystem accounting the accounts should allow the ability to inform and monitor marine areas, which offer essential services/resource provision.

- *The ability to measure and understand the interactions of the blue economy:* natural capital accounts can include non-market services provided by the marine environment that are currently not included in the blue economy. This will increase the economic and social relevance of the marine environment.

- *Improving the understanding of users and social interactions with marine ecosystem services:* by connecting social factors with marine ecosystem services a better overview of the social importance and beneficiaries can be provided (social importance is also emphasised by SDG 14: life below water).

With the possible contributions of natural capital accounts to marine understanding and policy it is imperative to improve the quality of the accounts. Using models to determine habitats extents, improving spatial resolution, linking social characteristics and expanding accounts are necessary to be able to use NCA in marine analyses and (local) policy applications. Furthermore, the ability of marine ecosystems to continue to provide services in the future is not included into the condition account. This connection should be developed in order to be able to use the condition account for decision-making.

Sandeel fisheries in the North Sea

The study on the impact of sandeel fisheries in the North Sea provides a practical example of the use of economic and environmental evidence provided by marine natural capital accounts (Gomersall & Dunn, 2021). This case study is embedded in policy-making through a variety of international conventions and treaties, national policy goals such as the UK-EU Trade and Cooperation Agreement & International Law, the 25 Year Environment Plan (YEP), the UK Fisheries Act 2020, the Seabird Conservation Strategies and the OSPAR Convention.

Since the 1960's the sandeel population has halved due to sea warming caused by climate change and the extensive fishery in the North Sea. This while the sandeel is an important part of the ecosystem that provides food for a variety of fish and (threatened) seabirds. The sandeel fishery is active in areas with threatened species. The maximum catchment levels solely depend on the sandeel population and does not account for the negative effect on other populations.

The case study used a baseline approach for the ecosystem service value of the North Sea combined with a scenario analysis approach of different fishing activities. The outcomes are based upon modeled ecological data from Ecopath and Ecosim. The sandeel population biomass is expected to increase by 40% with the full closure scenario of the fishery. This will result in an increase of 20% for biomass of fish that consume sandeel. Additionally, the biomass of marine mammals and seabirds is expected to increase by 42% in the first 10 to 15 years.

With the closing of the sandeel fishery, in 60 years the economic value of the North Sea Area IV is expected to increase by 240 million pounds compared to keeping it open mainly due to increase of higher value fish biomass that consume sandeel. Next to this, there are many benefits that increase due to the closing that are not visible in the accounts such as biodiversity, education and nature-based recreation. Therefore, it is recommended to pose restrictions on commercial sandeel fisheries in the UK EEZ or at minimum the Doggerbank zone and the Scottisch zone and develop the annual catchment limits (TAC) for sandeel according to scientific evidence.

3.3.11 Vietnam

The Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE) conducted research on ocean accounts in the Quang Ninh province. The goal of this pilot study is to examine changes in the ocean ecosystems, connecting land-based pollution sources and estimating the contribution of the marine environment to the economy (ISPONRE, 2022). The Ocean Accounts can monitor the progress of Vietnams socio-economic Development plan of 2024-2030 by improving spatial planning and natural capital allocation. Additionally, they can contribute to the national strategy of Vietnam for the sustainable development of the ocean economy of 2030 and 2045. The pilot study was conducted according to the guidelines of the GOAP and provides the following findings:

- The results show that the ocean provides around 704 million USD per year in the period of 2018 to 2020 which translates to a share of 8.4% of the GDP in the region. Which main contribution was due to fishery (38%) and industry and transportation (both around 18%).
- The economic growth is unfortunately also accompanied by pollution flows from industries such as coal mining and power generation.
- Seagrass has severely degraded, with half of the areas showing a decrease in size of around 50%. This is due to land reclamation in order to construct urban and economic regions.
- Even though mangrove forest areas are currently stable they are expected to decrease in the future since a large amount is converted to production forests for economic development.
- Coral ecosystems in the coastal areas have decreased dramatically from 30 to up to 90% compared to 1995. This is mainly due to increased turbidity and the damage from the fishing industry.

This study shows the strong contribution of the marine sector to the economy in Vietnam. Ocean accounts should be improved and expanded to support the optimization of economic planning in the future. Additionally, Vietnam should invest in protection of the seagrass and coral ecosystem that provide essential ecosystem services for fishery which contributes the most to the region’s economy (38%).

This current study mainly informs decision makers, but can have many implications for future policy. Maritime spatial planning is supported by the integrated data provided by Ocean Accounts. By providing this integrated approach it can support policy makers by balancing economic, social and environmental factors (ISPONRE, 2022). Furthermore, the data provided by the ocean accounts monitor Vietnams goals for a sustainable blue economy in 2030. The ecosystem condition account could also be used in establishing and tracking the condition of protected areas and provide information to decision makers on when to take action.

3.4 Overview of strengths and limitations of NCA in policy making

This subchapter will provide an overview of the strengths, limitations and challenges of natural capital accounting. These are important aspects to show the potential of NCA for the future, but also to show insights on challenges to ensure the success of NCA in (marine) policy making. These finding are based upon the results of case studies, interviews, suggestions from colleagues and theoretical literature. Additionally, this chapter uses the insights of the discussion of the OSPAR workshop on the 13th and 14th of December. An overview of this discussion can be found in Appendix VII.

Strengths

- *Issue identification and monitoring the state of the marine environment:* Natural capital accounts can provide quantitative information that can identify problems in a spatial setting. Furthermore, it can provide important indicators to monitor the state of the marine environment.

- *Establish insights on trade-offs and interactions between marine ecosystems and economy and provide quantitative spatial information for maritime:* The information provided by the accounts can inform environmental policy makers for maritime spatial planning. For example, where to examine locations for ecosystem restoration or establishing marine protected areas due to economic relevance.

- *Provide a communication tool for policy makers to raise awareness with respect to the importance of the marine environment and blue economy:* information from natural capital accounts can incorporate ecosystem values into measures of economic progress and therefore provide further relevance for protecting and conserving the marine environment. Furthermore, it can provide insights in the size and (social) importance of the blue economy.

- *Serve as a data input or baseline for other types of analysis:* Natural capital accounts can be combined with methods such as scenario analysis and cost benefit analysis to provide an economic-environmental integrated insight to assess (future) policy decisions.

- *Support multidisciplinary communication and cooperation between stakeholders:* Due to the integrated nature and applications of natural capital accounting, stakeholders of different backgrounds are stimulated to communicate which can increase the coherence of marine policy.

- *Measure the development of the marine environment and look beyond GDP:* Natural capital is often not been accounted when measuring the progress of the economy. Therefore, the value of ecosystems is often not fully represented in national accounts. Natural capital accounting can establish the economic importance of ecosystems and serve as data input for looking beyond Gross Domestic Product (GDP).

- *Transparency in natural capital extractions:* natural capital accounts can provide transparency for resource extractions from ecosystems. This information can be used as basis for taxation for the use of natural capital. Since information on extraction value is often lacking is can provide as a valuable tool for decision-makers.

- *Reducing transaction costs in the long term:* The integrated NCA framework can reduce time and transaction costs when communicating and sharing information across different institutions from various disciplines. However, this requires initial start-up costs for producing the accounts

Limitations

- *Complexity:* the accounts could be too complex to use for economic and environmental policy application in the near future (Brandon et al., 2021). Policymakers might only have knowledge on specific topics provided by the accounts and cannot fully use or see the potential of the large amount of economic and ecological information provided by the accounts. Furthermore, even though policymakers are mainly interested in key indicators provided from the natural capital accounts, establishing the accounts requires complex statistical choices that should not be overlooked. This should also be communicated to stakeholders in order to reduce possible conflict when it comes to decision making.

- *Tipping points:* Even though ecosystem accounts can provide insight in ecosystem conditions the ability to forecast ecosystem collapse remains limited, since currently indicators that foresee tipping points are not included into the accounts. Tipping points can be detrimental for ecosystems and can lead to irreversible states with high societal costs (Dakos et al., 2019). Furthermore, ecosystems accounts do not include the non-market value of natural capital (McGrath & Hynes, 2020).

- *Hard to incorporate non-economic values*: Biodiversity can be hard to express in monetary terms, even though it has an essential role in ecosystem and the services they provide. NCA does not incorporate the intrinsic value of nature and might give the impression that policymakers are trying to put a price on nature.

Challenges

- *Data constraints and spatial resolution:* One of the main issues of natural capital accounting are data constraints in producing (useful) accounts. Due to the extensive data required from various stakeholders and biophysical models accounts are often incomplete, especially for developing countries. Valuing ecosystem services that do not have an inherent market value, such as air filtration, also remains rather difficult. Data collection requires strong institutional cooperation which may pose a challenge. Data often have to be obtained from various institutions, they can be incompatible, which could make it difficult to integrate them. Additionally, the marine environment poses an additional challenge of incorporation the 3-dimensional character of the marine environment into the accounts

- *Costs and capacity:* Even though natural capital accounting might reduce costs in the long run, it requires high efforts, time and capacity from national statistical offices. Data has to be collected from many different stakeholders, pricing poses challenges and data can have compatibility issues. Furthermore, data can require biophysical and economic modelling. This while NCA often does not have immediate value for policy-makers.

- *Visualization:* Various countries are currently working on decision making support tools to test how to communicate the extensive information provided from natural capital accounts to policymakers. The development of visualizing the comprehensive data of natural capital accounts in a user-friendly way that supports decision-making remains a novel and challenging project.

- *Interactions should not be interpreted as causality:* Even though NCA can point to relationships and pressures between ecosystem and the economy, this does not mean that there is causality. These insights need to be used for further research and not be communicated as a causal relationship.

- *Showing regional examples of (policy) applications of NCA:* Natural capital accounting has the ability to tackle a large variety of economic-environmental policy issues. While many accounts are being developed, they are mainly supply driven. However, there is a need for decision-makers to see the concrete potential use from NCA for policy purposes at a local level. This requires projects with a clear scope of definition, stakeholder analysis, data demands and course of action with concrete steps to be taken.

4 Policy applications of NCA for the North Sea

This chapter will use the knowledge gained from theoretical frameworks, case studies and literature to examine (future) policy applications of NCA for the North Sea. Furthermore, this chapter uses the outcomes, suggestions and limitations that were gathered during the discussion of the workshop on natural capital accounting for the Dutch part of the North Sea on Tuesday the 13th of December (van der Veeren, 2022a).

In this chapter the national, European and international policy context and the use of NCA for the North Sea is examined. First, the potential use of NCA for the European Marine Strategy Framework Directive (MSFD) in achieving sustainable seas will be analysed. For what parts of the MSFD can NCA be used to benefit current policy measures? After that, the possible role of NCA in monitoring and reporting on Sustainable Development Goals for the North Sea and especially SDG Goal 14 "Life Under Water" will be examined. Then, the ability of NCA to identify trade-offs in the maritime will be discussed. Finally, the possible contribution of NCA in monitoring the Wellbeing Economy (or Brede Welvaart in Dutch) for the North Sea will be described.

4.1 European Marine Strategy Framework Directive

The European Marine Strategy Framework Directive (MSFD) was implemented in 2008 in order to protect, restore and preserve the marine environment of the European seas (European Union, 2008). It includes 11 qualitative descriptors that together describe Good Environmental Status (GES). Since the Netherlands is a European Member State, it is obligated to provide a sustainable marine policy that is aimed to protect the marine environment of the North Sea and take measures to obtain GES (Rijksoverheid, 2022).

The current Dutch Marine Strategy (2018-2024) exists of 3 parts:

- Part 1: A description of the current state of the environment, environmental objectives and indicators for the North Sea
- Part 2: Monitoring program
- Part 3: The Program of Measures to ensure the sustainable use of the North Sea

The potential of NCA for MSFD

Natural capital accounting has the possibility to support the European sectoral policies and the MSDF in various ways as described in the final report of phase II from the Integrated system of Natural Capital and ecosystem services Accounting (INCA) report of 2021 (Vysna et al., 2021):

"2: EU Sectoral policies. NCA can contribute to the better understanding, articulation, and accounting of the range of services that ecosystems provide (provisioning, regulating and cultural). These services stand alongside those typically accounted for, such as the provision of timber or food, and need to be

explicitly taken into account. Specific examples of policies to which NCA can add value to include environmental policies, agricultural and Regional polices: Provide a basis for future CAP reviews, Marine Common Fisheries Policies (MSFD, CFP): etc. "

Part 1 of the initial assessment MSFD consists of a description current status of the marine environment, the desired Good Environmental Status (GES) of the North Sea and the environmental goals to reach or conserve GES. Natural capital accounts can support the implementation of the European Marine Strategy Framework Directive by monitoring and communicating the (changes in) state of the marine environment for the North Sea. Furthermore, it can be used to identify missing monitoring indicators that emphasize relevant messages for the monitoring program of the MSFD part 2. However, currently the data from the Dutch natural capital accounts are provided by the MSFD monitoring data. Therefore, it has no inherent value to these parts of the MSFD.

The MSFD part 3 presents measures to achieve Good Environmental Status for the North Sea. Natural capital accounting can provide an integrated insights into economic and environmental pressures of the North Sea. Additionally, NCA can provide a basis for cost benefit analyses, scenario analysis, evaluate policy responses and future policy decisions while trying to achieve GES. This type of analysis can support investment incentives for the marine environment and support decision-makers by adding an economic perspective where to best implement measures.

However, it is important to note that the current producer of the natural capital accounts for the North Sea, Statistics Netherlands, is not allowed by law to do ex-ante analysis. Therefore, if NCA would be used for ex-ante analysis such as establishing business cases for nature restoration or creating marine protected areas, another institution such as the Netherlands Environmental Assessment Agency (PBL) must be responsible for this type of analysis. This requires a clear step-by-step plan and analysis of required stakeholders within and outside of the government, an overview of required outputs of the accounts, geographical scale of interest, level of detail and data demands.

Next Steps

Even though the value might not be immediate since there is already a monitoring system in place for the MSFD in the North Sea. An integrated framework such as NCA can support various parts of the MFSD by providing environmental data and monitoring the progress of policy goals. Furthermore, it can improve communication between stakeholders of the North Sea and aid in obtaining additional insights in environmental and economic pressures and impacts

However, a more in-depth analysis is essential to obtain a step-by-step plan on how to use NCA to answer specific policy questions regarding the MSFD. NCA might be more applicable to different elements of the MSFD depending on the topic, data requirements and current state of the accounts. Therefore, making natural capital accounts more demand driven it can significantly improve policy applications for the MSFD and support identifying knowledge gaps. Establishing a clear policy goal with accompanying steps, a concrete timeline with ambitions and goals could increase clarity in the practical approaches and implementation of NCA for the MSFD.

Increased clarity in the potential use of NCA for the MSFD can be supported by local case studies and examples to test the use of NCA. Even though the Netherlands has a relatively developed marine natural capital accounts, it is currently lacking practical examples for the marine environment. Pilot studies can identify knowledge gaps, potential applications and support the upscaling of natural capital accounting towards national level in the future.

When establishing guidelines or testing case studies, the type of analysis and responsible institution must be considered. For example, monitoring can be done through the accounts provided by Statistics Netherlands. However, for using NCA for ex ante analysis such as cost-benefit or scenario analysis for evaluating policy options for the MSFD part 3 a different institution must be responsible.

One of the current uses of NCA could be to incorporate the results of the natural capital accounts of the North Sea into the biannually report of ‘State of the North Sea’ and the MSFD part 1 update. This can help identifying issues and connect to monitoring, and keep policy makers engaged.

4.2 Support reporting on progress on Sustainable development goals

In 2015 the 2030 Agenda for Sustainable Development were adopted by all United Nations Member States including the Netherlands. This ambitious plan includes 17 Sustainable Development Goals (SDGs) with 169 targets with over 244 indicators to measure progress. Achieving the SDGs requires significant integrated economic, social and environmental policy decisions with understanding for different interactions between nature and the economy. Policy could be supported by a coherent integrated information stream to inform evidence-based decision-making and measure progress on the various SDGs. Since the SEEA-EA framework encourages an integrated economic-environmental information stream through NCA, it can be used to monitor the progress on various SDGs (Ruijs et al., 2018). The United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) estimated that around 40 indicators provided by the SEEA-EA can be coupled to 9 of the Sustainable Development Goals (SDG's), as illustrated in figure 10 below.

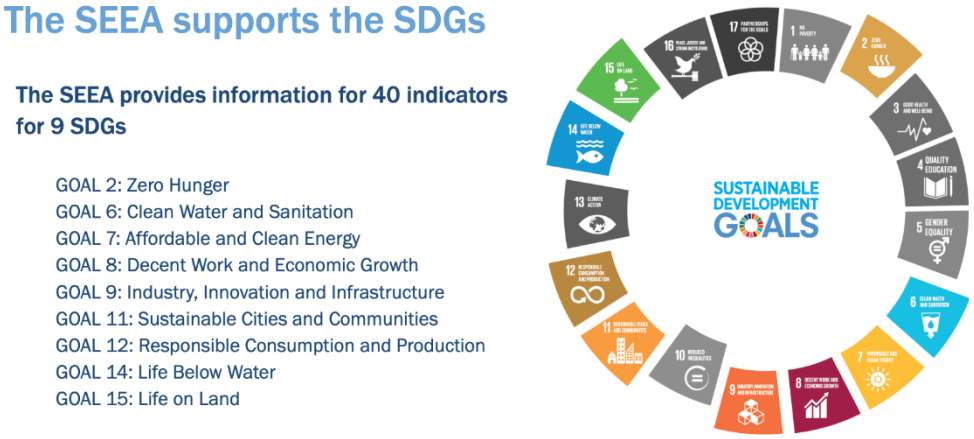

Figure 10: Illustration on how SEEA can provide information on indicators to monitor SDGs

In case of the North Sea, the SEEA-EA framework can provide information on SDG 14 "Life below water" which includes the sustainable use of oceans and marine recourses. Additionally, progression on SDG 14 and achieving a sustainable use of the ocean can produce benefits for all of the other SDGs which is illustrated in Appendix IV (Ocean Panel, 2021). The Netherlands can therefore use the information from the Ecosystem Accounts established by Statistics Netherlands (CBS) to monitor and report on progress on SDG 14. Specifically, the following indicators examined by the UNCEEA (SEEA, 2020).:

- 14.1.1: Index of coastal eutrophication and floating plastic debris density,
- 14.4.1: Proportion of fish stocks within biologically sustainable levels,
- 14.5.1: Coverage of protected areas in relation to marine areas,
- 14.6.1: Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing,
- 14.7.1: Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries,
- 14.a.1: Proportion of total research budget allocated to research in the field of marine technology

A more in-depth overview of the indicators established by the UNCEEA including the way forwards, notes on the data and custodian agency can be found in Appendix VIII.

4.3 The European Green Deal

The European Green Deal was adopted in by the European Commission in December 2019. The main goal of the Green Deal is to address climate change and reach climate neutrality by 2050 with various policy initiatives. This while focusing on creating jobs and reducing income inequality (European Commission, 2021):

"The European Green Deal calls for a transformation of our economy to become a modern, resource-efficient and competitive economy where net emissions of greenhouse gases are phased out and the EU's natural capital is protected. The Recovery Plan for Europe sets out to boost the green and digital transitions and make Europe's economy fairer, more resilient and more sustainable for future generations."

The blue economy has to take into account to both the European Green Deal and The Recovery Plan. Therefore, the European Commission has approved *"new approach for a sustainable blue economy in the EU."* (European Commission, 2021). Natural capital accounting can support the EU and its members states to reach various objectives of the Sustainable Blue Economy.

Natural capital accounts can provide various indicators for sustainability of the marine environment and support monitoring on the development of sustainability of the European Blue Economy and its member states. Furthermore, protection of Europe's natural capital is emphasized in the Green Deal and also specifically mentioned to integrate into economic decision-making in the *"new approach for a sustainable blue economy in the EU."* (European Commission, 2021):

"Release a stable methodology to integrate the concept of 'natural capital' in economic decisions. This implies assessing and quantifying both the economic value of marine ecosystem services and the socio-economic costs and benefits derived from keeping the marine environment healthy "

European Biodiversity Strategy

NCA can inform policy-makers of the North Sea on the value and state of marine ecosystem services and provide evidence-based information for decision in the marine environment. This is why in the European Biodiversity strategy natural capital accounting is explicitly mentioned to be promoted as a new initiative (European Commission, 2021). A concrete action from the Biodiversity Strategy is the recent proposal by the European Commission to make it mandatory for European member states to provide ecosystem accounts (European Commission, 2022).

4.4 Identifying trade-offs for the North Sea

Since the North Sea is subject to intensive use from a large variety of sectors, it is essential to find a sustainable societal balance in its use. For this reason, the Netherlands formed the North Sea Programme 2022-2027 which encloses part 3 of the Dutch Marine Strategy Framework Directive (MSFD) (Rijksoverheid, 2022). The program was formed to ensure growth of the North Sea in a sustainable way while balancing various policy goals including food transition, energy transition and ecosystem boundaries.

This North Sea Programme 2022-2027 emphasizes the extensive national and international policy context of the North Sea and its stakeholders. The quantitative economic-environmental information provided by marine natural capital accounts can improve insights in the trade-offs for various stakeholders and support Maritime Spatial Planning (Gacutan, Galparsoro, et al., 2022).

NCA should be used as supporting information for MSP on the ecosystem services in a specific area. The spatial approach can inform decision-makers on the economic value of ecosystem services and state of their condition. However, the type of analysis is dependent on the policy question, the spatial resolution and data of the specific area. Additionally, the information from the Dutch natural capital accounts can be used to support a better description ecosystem service for the North Sea Programme 2022-2027.

The ability of combining natural capital accounting with cost-benefit and scenario analysis can be a useful tool for decision making and spatial planning for the North Sea. NCA can monitor the state of marine areas that offer ecosystem services in a spatial matter. Furthermore, including non-market values that are currently not included in the Blue Economy can increase the economic relevance of protecting the marine environment.

Sustainable Blue Economy

The European Commission sets out to use Maritime Spatial Planning (MSP) to address policy priorities. One of their objectives is as follows (European Commission, 2021):

"Prepare guidance on an ecosystem-based approach to maritime spatial planning and promote the multi-use of marine space by combining different activities in the same location (for instance, mariculture and offshore renewable energy systems)."

Natural capital accounting can provide quantitative ecosystem-based data in a spatial setting to inform policy-makers on trade-offs between the economy and the marine environment. However, this requires high spatial resolution and quality of data on a more local level. Up until now, this data is only partly available. In order to be able to use NCA for this purpose this requires additional efforts to close this data gap.

4.5 Measuring the state of the Well-being economy (Brede Welvaart) for the North Sea

For many years growth in Gross Domestic Product (GDP) has been an important (if not the only) indicator for measuring economic progress of countries. However, GDP as an indicator was never intended to measure well-being (Costanza et al., 2009). GDP does not include factors such as sustainability, income inequality, health and safety that all strongly contribute to human wealth. When countries are too reliant on GDP as a measure of progress and use it as a main indicator for policy it can result in poor decision-making (Stiglitz et al., 2018). Therefore, there is an increasing need to look beyond GDP to measure the state of human well-being. For this reason, Statistics Netherlands (CBS) publishes a yearly report 'Monitor Well-being Economy & Sustainable Development Goals' in order to measure well-being beyond GDP for the Netherlands (CBS, 2022). The Well-Being Economy and the SDGs overlap and complement each other.

Rijkswaterstaat, the executive agency of the Dutch Ministry of Infrastructure and Water management, is currently is currently analysing how it can contribute to the Well-Being economy when managing these systems. With the North Sea being the largest nature area of the Netherlands, it is important to examine how Rijkswaterstaat can contribute to the Well-Being Economy for the North Sea.

The potential of using data provided from natural capital accounts to measure the state of the Well-being Economy is discussed in this subchapter. This will be done by elaborating the different categories of the Well-being economy, examining the possible contribution of NCA and discussing various limitations.

The Well-Being Economy & Natural capital accounting

The well-being economy considers 3 categories (CBS, 2022):

- The well-being economy 'here and now': This measures the current well-being and quality of living for inhabitants of the Netherlands. Since this is a very broad concept it is comprised of 8 main categories[15].

- The well-being economy 'later': the use of resources has impacts on future generations of the Netherlands. In order to ensure a sustainable way of life, there needs to be a sustainable number of recourses. This recognizes that this requires that the next generations at least have the same availability of capital as the current one. Capital is divided into four categories: economic, natural, human and social capital.

- The well-being economy 'elsewhere': measures the impact of Dutch choices on income, resources and the environment in other (especially developing) countries.

[15] *1: Subjective well-being, 2: Material well-being, 3: Health, 4: Labor & free Time, 5: Housing, 6: Society, 7: Safety, 8: Environment*

Here & Now

Natural capital accounts can provide quantitative information on the current state of the environment which is incorporated in category 8 of the Well-Being Economy "here and now". For the North Sea NCA can provide insights into various indicators such as biodiversity, water quality and climate change. This allows for policy-makers to look beyond GDP while examining the development of the North Sea.

Later

Environmental data from natural capital accounts can be used to monitor the size and state of natural and economic capital values. Even though NCA does not contain any future estimates, NCA can provide information that allows policy-makers to monitor the level of natural capital. Therefore, it can inform policy makers on ensuring that the amount of natural capital stays at least at the same level for future generations.

The SEEA-Ecosystem accounting framework used in the Netherlands currently does not incorporate social data and cannot be used for assessing the social or human capital dimension the Well-Being Economy. Ocean Accounting can contain information regarding social and governance indicators such as health, income distribution, poverty and social inclusion (GOAP, 2022a). Therefore, a suggestion might be to add a social dimension to the current NCA and make them real ocean accounts so they can be better used to monitor the Well-being economy for the North Sea.

Elsewhere

Using natural capital accounting to measure the impact of Dutch choices in other countries and especially developing countries is currently infeasible and remains a serious challenge for the future. This requires countries to have fully functioning ecosystem accounts that have the ability to link specific accounts to Dutch consumption.

4.6 Next Steps

Overall, the integrated information from marine natural capital accounts can support various marine policies for the North Sea. However, increased spatial resolution and incorporating more ecosystem services can provide the possibilities in the future. Furthermore, linking ecosystem services with other accounts would increase the ability to establish insights on interactions and pressures. This study provides a broad overview of the possibilities of NCA in policy making. Therefore, it is suggested to focus on specific policies with a more in-depth analysis to make the required next steps for integrating NCA in specific policies more concrete.

Furthermore, pilot studies in the North Sea can show the potential of NCA in a concrete way, improve communication to different stakeholder and can contribute to the policy engagement for NCA. The need for concrete examples was confirmed by various policy-makers in interviews and during both the OSPAR working group at the 13th and 14th of December. It is advised to incorporate policy-makers and stakeholders early in the decision-making process to ensure the success of integrating NCA into policy.

Additionally, the various case studies show that various countries are developing and testing decision-making support tools that can support visualization of NCA to support policy makers. To ensure the success of NCA it is important to examine how to present specific parts of the accounts to various stakeholders and decision-makers.

Last, since Statistics Netherlands cannot provide ex ante analysis, their main task is to produce the accounts. It is important to think about the possibilities for institutions that can perform ex ante analysis such as scenario analysis or cost-benefit analysis to assess future marine policy decisions.

The next chapter will explore the possible policy applications of NCA for OSPAR and synergies with the DAPSIR framework. OSPAR has other significant challenges due the size of the area, number of stakeholders and data availability.

5 Natural capital accounts and potential value for OSPAR

As the organization being responsible for coordinated management of the North East Atlantic, OSPAR has indicated in its North East Atlantic Environmental Strategy 2030 (NEAES) to be interested in accounting for natural capital while using existing frameworks. This is stated under strategic objective 7, to achieve productive and sustainable seas, it is specified as follows (OSPAR, 2021):

S7.O3 By 2025 OSPAR will start accounting for ecosystem services and natural capital by making maximum use of existing frameworks in order to recognise, assess and consistently account for human activities and their consequences in the implementation of ecosystem-based management.

This chapter will examine policy applications and added benefit of natural capital accounting for OSPAR. The ability of NCA to support the ecosystem approach and DAPSIR framework used by OSPAR and possible synergies will be examined. Furthermore, challenges and next steps are discussed. Furthermore, this chapter incorporates the outcomes, suggestions and limitations that were gathered during the discussion of the workshop on natural capital accounting for the North-East Atlantic on Wednesday the 14th of December (van der Veeren, 2022b). An overview of the questions and answers of the workshop can be found in Appendix VII.

5.1 Synergies between DAPSIR framework & NCA

In this subchapter the potential synergies between the natural capital accounting framework and the Ecosystem approach and the accompanying DAPSIR framework that are used by OSPAR will be discussed. The potential benefit of adding monetary values from a quantitative integrated framework to improve insights on environmental-economic pressures of the marine environment are examined based upon literature, the North East Atlantic Environmental Strategy 2030 (NEAES) and interviews (Blazquez, 2021; Cornacchia, 2022; Judd & Lonsdale, 2021; OSPAR, 2019).

5.1.1 The Ecosystem Approach

In order to understand interactions in ecosystems and connect them to human activities the OSPAR commission uses the Ecosystem Approach. This approach is used to address various issues from OSPAR strategies in an integrated matter. The ecosystem approach used by OSPAR convention is defined as follows (OSPAR, 2021):

"*The comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity*".

This holistic approach is used to understand and support the management of the complex interactions between human activities and ecosystems. For example, with respect to the management of marine protected areas.

The ecosystem approach supports an obligation for member parties of OSPAR to use the precautionary principle when the scientific evidence remains unclear. With this approach, preventive procedures should be taken if there is a reasonable assumption that human activities can pose a threat to human health, the health of the marine environment or constrain the use of the ocean. Additionally, the OSPAR Convention requires the application of polluter pays principle[16] and Best Available Techniques[17] (BAT) and Best Environmental Practice (BEP).

As mentioned before, in operational objective 7.03 OSPAR has stated its interest in using Natural Capital Accounting (OSPAR, 2021). However, how a natural capital approach can be used in assessment programs remains unclear (Judd & Lonsdale, 2021).

As a part of implementing the ecosystem approach is done by the DAPSIR framework that is currently used by OSPAR for Thematic Assessments. First the DAPSIR framework is described. Afterwards, the potential synergies between the DAPSIR framework and a natural capital approach is examine based upon Judd & Lonsdale (2021). Last, the added benefit of using NCA for OSPAR is discussed.

5.1.2 The DAPSIR Framework

One of the assessment tools for the state of the marine environment used by OSPAR is the Drivers-Activities-Pressures-State Impacts-Response (DAPSIR) framework illustrated in figure 11. The framework examines the relationship between the health of the marine environment of the North-East Atlantic and environmental, social and economic pressures. The DAPSIR framework is used for various Thematic Assessments delivered for the Quality Status Report (QSR) of 2023. As can be seen in figure 11, the DAPSIR framework provides an overview of qualitative, quantitative and semi-quantitative data related to the marine environment for OSPAR.

[16] "Costs of pollution prevention, control and reduction measures must be borne by the polluter"

[17] "Latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste". BEP is defined as "the application of the most appropriate combination of environmental control measures and strategies"

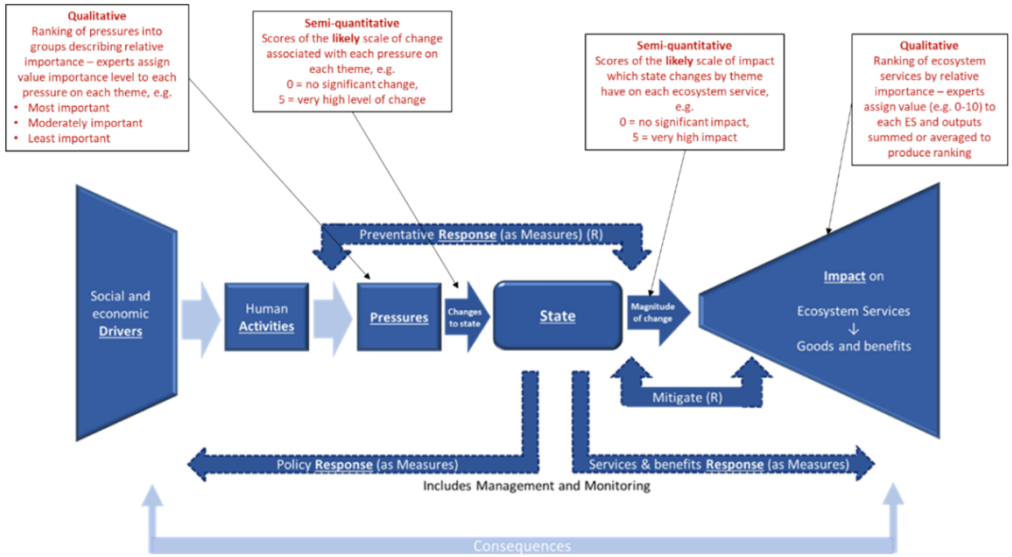

Figure 11: DAPSIR Framework used by OSPAR to support thematic assessments (OSPAR, 2019)

5.1.3 Synergies between natural capital accounting and the DAPSIR framework

Natural capital accounting can be used as an extension rather than a replacement of the current ecosystem assessments for marine policy (Judd & Lonsdale, 2021). Therefore, it is important to focus on synergies between natural capital accounting and the DAPSIR framework, rather than treating them as a mutually exclusive method.

The focus on synergies between the Natural Capital Accounting framework and the DAPSIR framework can promote a common approach for stakeholders and improve communication, data collection and usage. This can support decision-making by further integrating social, economic and environmental information. Both frameworks show large overlap in information flows. Especially, between the ecosystem extent, condition and service account from the SEEA-EA and the state and impact on ecosystem services from the DAPSIR framework. Therefore, it is important for stakeholders to share information in order to improve data quality. Furthermore, since the overlap is quite strong, terminology is important to communicate between the users of the frameworks to enhance synergies. In figure 12 a common conceptual framework is presented that merges the Natural Capital Approach and the DAPSIR framework into a single framework (Judd & Lonsdale, 2021). The state part of the DAPSIR framework provides strong synergies with the condition of natural capital provided through NCA.

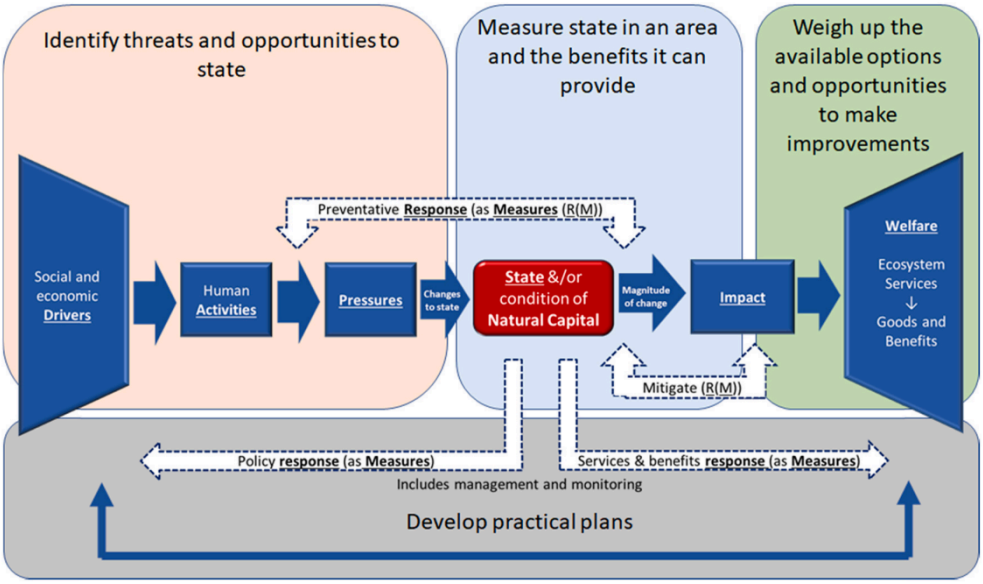

Figure 12: Conceptual framework for multidisciplinary projects (Judd & Lonsdale, 2021)

5.2 Potential added benefit of NCA

Natural capital accounting can add a quantitative overview of the state of ecosystem services in the North-East Atlantic Ocean. The ecosystem services provided by natural capital accounting can be used for analysis of the DAPSIR Framework and add a quantitative perspective to the state, impact and welfare part of figure 12. This can provide a link between ecology and social, economic and cultural pressures (Cornacchia, 2022). The spatial approach of NCA can offer insights on locations that offer strong economic contribution to society (Blazquez, 2021). Furthermore, it can be used for investment decisions such as establishing nature-based solutions or marine protected areas in a spatial matter. However, this requires a significant investment in building natural capital accounts at a OSPAR level.

The overlap of data can bring opportunities and synergies between the two frameworks. QSR provides an overview of various thematic assessments that include quantitative, semi-quantitative and qualitative reviews. While this is a summary of the various Thematic assessments, natural capital accounting provides an integrated framework that encompasses various themes. This can allow for a more integrated analysis of interactions between ecosystems and the economy. Additionally, by providing monetary values the accounts can track economic pressures.

5.3 Next steps

OSPAR is facing challenges in multiple areas such as biodiversity loss, pollution, and climate change. Natural capital accounting can support monitoring and decision making in those areas by providing relevant and robust information in a consistent way.

The preliminary version of the natural capital accounts comprised of a limited amount of data and capacity to build them also limits current policy applications. Currently, natural capital accounts emphasize the importance of the blue economy, identify knowledge gaps and allow for stakeholder communication and corporation. The value of natural capital accounts can increase with improved data and regularly updating the accounts can provide the ability for time-series analysis.

Establishing more complete accounts can aid ecosystem-based management and support marine decision-making. It is therefore important to show how natural capital accounts can help to support various policies and thus be useful for different stakeholders. Therefore, it is important for the people working on natural capital accounts for OSPAR to have close relations with the various thematic groups when preparing the next NCA. This can also make the accounts more demand driven, therefore increasing their value. However, this would require far more significant capacity than currently available.

Furthermore, NCA can support quantitative information for investment decisions such as where to implement nature-based solutions. This can establish insights into trade-offs between economic and ecological consequences. This can be more practical at a regional level than for the entire OSPAR region.

6 Discussion

There is an increased need for integrated information stream while tackling the various environmental challenges that the marine environment is currently facing. This requires a framework that has the ability to identify the relationship and interactions between ecosystems and the economy to support comprehensive sustainable policymaking for the marine environment.

This report provides an overview of the development of natural capital accounts that shows that countries recognize the need for accounting for natural capital and is therefore embedded in various policy goals. Natural capital accounting provides a standardized framework that presents economic and environmental data for ecosystems which allows for an integrated understanding between ecosystems and the economy. Additionally, the framework establishes international comparability and enables comprehensive policy applications.

The potential applications for the marine environment can vary depending on the country due to the development of the accounts. For example, in the Netherlands the natural capital accounts use data provided by the monitoring program of the MSFD. Therefore, the use of natural capital accounts for monitoring for this specific policy is still low. This while for developing countries, establishing the accounts could be the first time that they are monitoring ecosystems in this spatial comprehensive matter. Therefore, the motoring and identifying value of natural capital accounts can be higher for developing countries.

Due to the strong data availability of the Netherlands the potential for using NCA for evaluating (future) policy decisions might be closer. However, this requires pilot projects to test the potential policy application at a regional scale and to identify knowledge gaps. Additionally, the value of natural capital accounts can increase over time due to the availability of data with higher spatial resolution, linking of the accounts and the ability to use NCA for time-series analysis.

Establishing natural capital accounts at OSPAR level could have additional benefits, since ocean measures can have transboundary impacts on ecosystems. Establishing more complete accounts can aid ecosystem-based management and support marine decision-making for the North-East Atlantic. It is important to show how natural capital accounts can help to support various policies and thus be useful for different stakeholders. Therefore, it is important for the people working on natural capital accounts for OSPAR to have close relations with the various thematic groups when preparing the next version. This can also make the accounts more demand driven, therefore increasing their value for policymaking. However, this would require far more significant capacity than currently available.

Challenges

Natural capital accounting might be illustrated as a way to put a value on nature and allows for more ways to pollute. Ecosystem accounting should be handled as a tool for policy-makers rather than a solution for environmental problems. Even though the accounts can identify issues, trade-offs and interactions this does not indicate that there is causality. NCA should be used as an identification for possible issues that require more in-depth research. Decision-makers should carefully

consider the limitations and uncertainties of natural capital accounts and communicate these as such as while creating economic-environmental policy.

Natural capital and its value are an important indicator for the state of nature. It is important to keep in mind that maximizing its value is not always the objective. For example, while establishing a forest it might be attractive from a value perspective to create the fastest growing highest timber value forest, this might not necessarily improve biodiversity or other environmental issues.
However, NCA can provide quantitative integrated information for evidence-based decision-making that can serve as an important policy tool for decision-makers that face problems that cross multiple dimensions.

Next Steps

Currently, natural capital accounts are mainly supply driven which can make it hard for NCA to have a direct added benefit for policy application. There is a need for more regional practical examples to show the potential of NCA for policy-makers for both the North Sea and OSPAR. This was also emphasized in the various interviews during the writing of this report and during both days of the OSPAR workshop. These small-scale examples can improve policy-engagement for NCA while providing a bases for upscaling. This requires a clear policy goal accompanied by a step-by-step plan that clearly describes the policy context, level of detail of the accounts, data requirements and possible policy applications. Pilot studies support the identification for knowledge gaps, establish current and potential applications and support the upscaling of natural capital accounting towards national level in the future. Additionally, stakeholders need to be included early into the decision-making process to ensure the success of the project.

Another suggestion for the Dutch North Sea might be to add a social dimension to the current NCA and make them real ocean accounts so they can be better used to monitor the Well-being economy for the North Sea. This also provides for an even more comprehensive socio-economic analysis that could provide more sustainable policy due to incorporating a social perspective.

Therefore, the Netherlands could become a member of the Global Ocean Accounts Partnership (GOAP). Becoming a member of GOAP requires no financial investment other than exchanging the knowledge on the development of its natural capital accounts. The membership allows countries to join yearly meetings (at their own expense), but this is not required.

Through participation the Netherlands can use the knowledge of GOAP and its extensive community to establish an ocean account and incorporate a social dimension to the current framework. Furthermore, it allows the Netherlands access a large global network of experts and interested organizations in Ocean Accounting. This provides members with a large pool of resources to help, advise and advance work on ocean accounts and natural capital accounting, but also other types of analyses of the marine environment more broadly.

Natural capital accounting shows extensive possibilities for policy-making, but it requires more investment in testing applications and establishing comprehensive ecosystem accounts. However, it is essential to account for our natural capital and provide support for sustainable policy in the future.

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8 Appendix

Appendix I: Principles of NCA in policy making

Figure I: 10 principles of NCA policy making Ruijs et al., (2019)

Comprehensive	
Inclusive	Acknowledging the diverse stakeholders concerned with decisions affecting natural capital, responding to their information demands, respecting different notions of value, and using appropriate means of engagement
Collaborative	Linking the producers of NCAs, the users of NCAs for policy analysis and the policy-makers using the NCAs results, and building their mutual understanding, trust, and ability to work together
Holistic	Adopting a comprehensive, multi/interdisciplinary approach to the economic and environmental dimensions of natural capital and to their complex links with policy and practice
Purposeful	
Decision-centred	Providing relevant and timely information for indicator development and policy analysis to improve and implement decisions with implications for natural capital
Demand-led	Providing information actually demanded or needed by decision makers at specific levels
Trustworthy	
Transparent and open	Enabling and encouraging public access and use of NCAs, with clear communication of the results and their interpretation including limitations of the data sources, methods, and/or coverage
Credible	Compiling, assessing, and streamlining data from all available sources, and deploying objective and consistent science and methodologies
Mainstreamed	
Enduring	With adequate, predictable resourcing over time; continuous application and availability; and building increasingly rich time series of data
Continuously improving	Learning focused, networked across practitioners and users, testing new approaches, and evolving systems to better manage uncertainty, embrace innovation, and take advantage of emerging opportunities
Embedded	NCA production and use becoming part of the machinery of government and business, building capacity, improving institutional integration for sustainable development, and incorporating NCAs use in procedures and decision-support mechanisms

Appendix II: Ocean accounting pilot study GOAP Fiji alignment of aims with Fijis National Ocean Policy 2020-2030 goals[18]

Table I: Alignment of aims Fiji case study GOAP and Fiji NOP 2020-2030 (GOAP, 2022b)

Aim	Description	NOP aims
1	Strengthen Fiji's capacity to better account for its Ocean resources (mangroves and other biotic and abiotic marine resources). This supports the Government's priority to mitigate immediate threats to incomes and livelihoods of local communities due to climate change effects.	1, 2, 3, 4 & 5
2	Develop information on a range of Ocean ecosystem services (starting with those of mangrove ecosystems) to assist Ocean Accounting in Fiji.	1, 3, 4 & 5
3	Promote development and/or adoption of better technologies and assessment tools for dealing with biodiversity losses, pollution and destruction of marine ecosystems and unsustainable use of marine resources.	4 & 5
4	Assist Fiji with development of evidence-based policies, legislative mechanisms, and advanced monitoring platforms.	2, 3, 4, 5 & 6
5	Provide an outline of available or potential data sources for constructing mangroves accounts in Fiji and highlight the current limitations to creating an ocean account for mangroves in Fiji.	6
6	Provide recommendations for improving the quality of accounts and scaling nationally.	6

[18] *Goals from NOP 2020-2030: Cooperation (1), sustainability (2), security (3), people (4), development (5) and knowledge (6*

Appendix III: MAREA Project

Figure II: Overview of task division of stakeholders from the MAREA project

There are 4 main activities in the MAREA project:

Ecosystems service mapping and modelling/ led by Finnish Environment Institute. The main aim of this activity is to develop an innovative framework to integrate ecosystem structure and functioning with the benefits produced, including regulating services that sustain life.

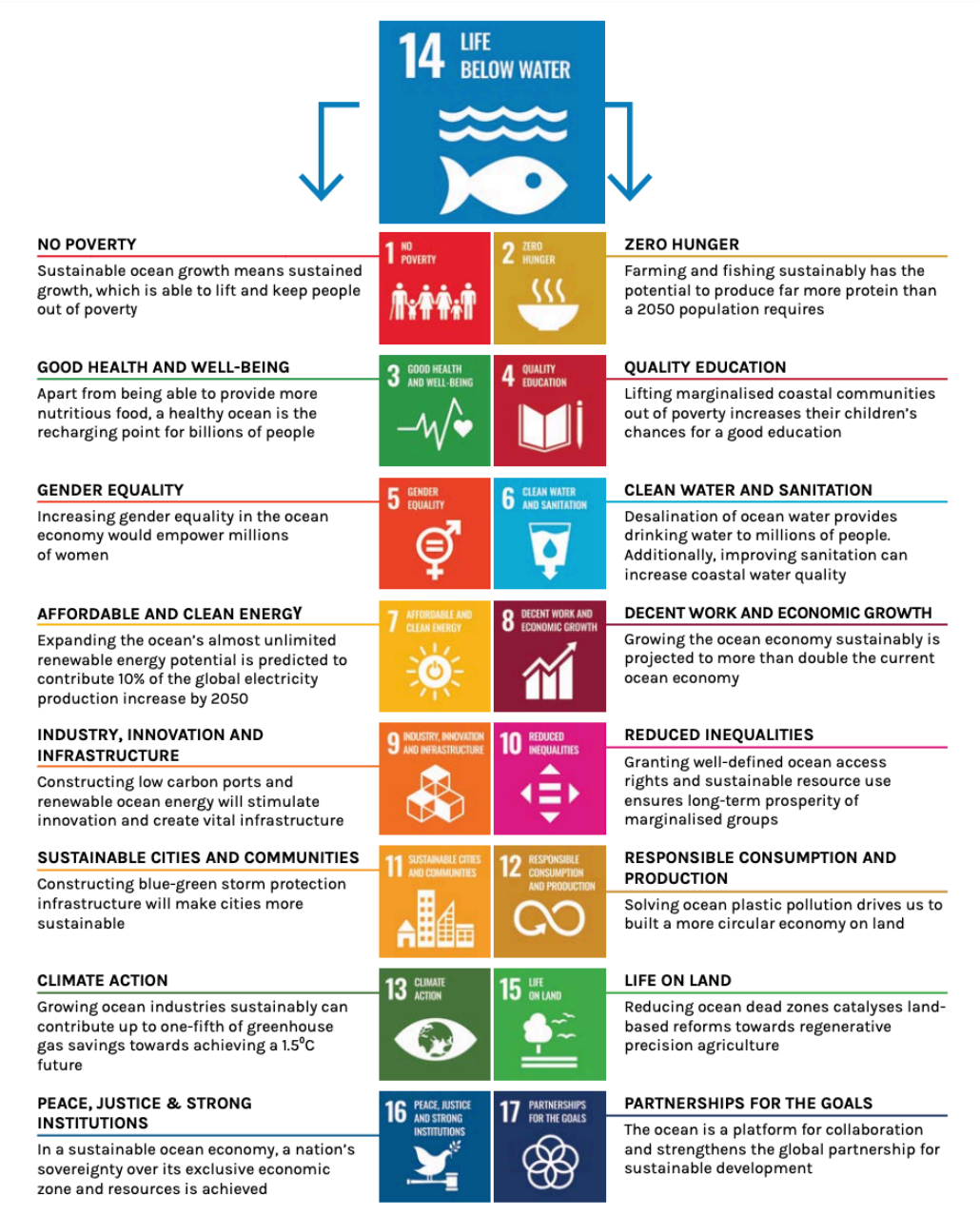
Ecosystem accounting/ led by Finnish Environment Institute. The Natural Capital Accounting concept will be developed and tested in the Baltic Sea region using high resolution datasets

Sustainability compass/ led by Pellervo Economic Research PTT. The knowledge generated by the environmental accounting system is used and communicated through the Sustainability Compass

Decision-support geoportal/ led by University of Tartu. Geoportal will dynamically link novel concepts of ecosystem services mapping, environmental accounting and sustainability compass into a geo-spatial representation tool tailored for key actors/stakeholders

Appendix IV: How Life Below Water (SDG14) can support Sustainable development goals

Figure III: An overview of how sustainable oceans can aid in meeting all Sustainable Development Goals (SGD's) (Ocean Panel, 2021):



Appendix V: Examples Norwegian Ocean Economy Dashboard

Figure IV: Example of Norwegian Ocean Economy Dashboard extracted from at 5/12/2022: https://environment.yale.edu/data-science/norwegian-ocean-economy-dashboard

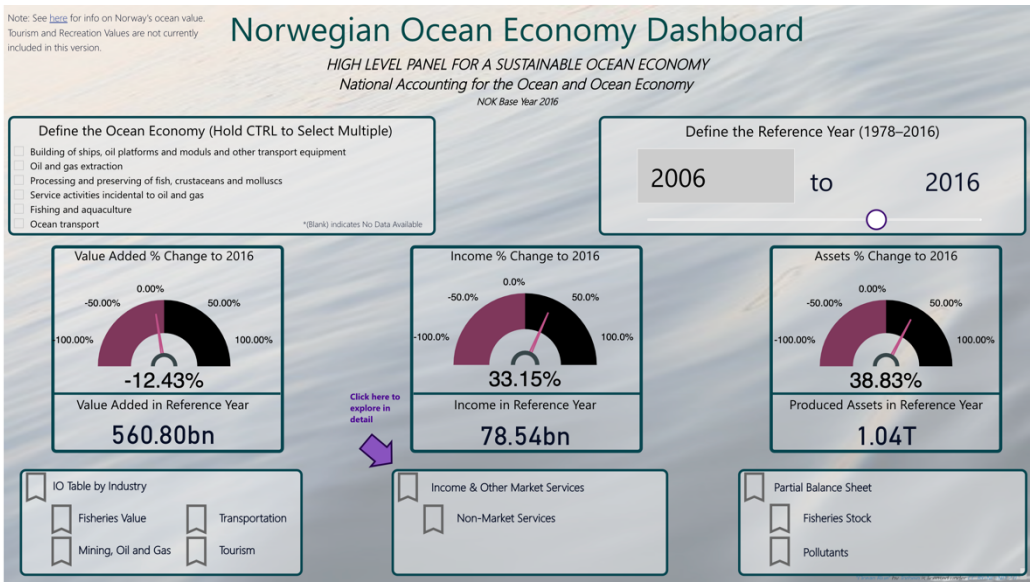
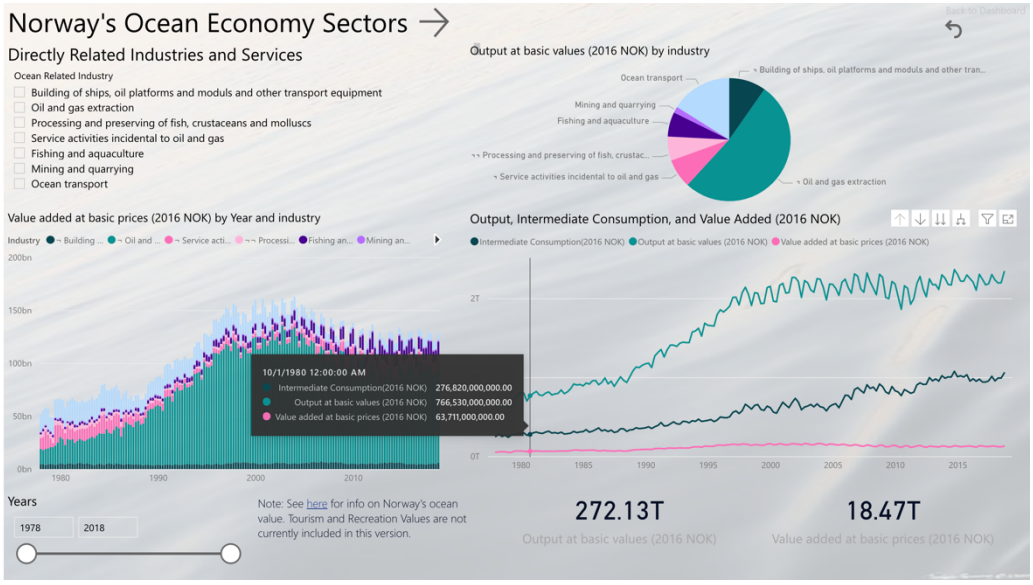


Figure V: Example of Norwegian Ocean Economy Dashboard extracted from at 5/12/2022: https://environment.yale.edu/data-science/norwegian-ocean-economy-dashboard



Appendix VI: Overview of potential future policy applications of NCA in Ireland

Table II: Overview of potential policy links of NCA applications Ireland (Farrell & Stout, 2020):

Relevant natural capital asset/service	Relevant agency/ organisation	Potential NCA application	Potential policy link
Aggregates (geosystem service)	EPA; GSI	Valuation of mineral resources; trade-offs with other land use	LULUCF and forestry
Carbon stores	DCCAE; EPA	Map high carbon stores, sinks and sources; LULUCF reporting	Climate action; CAP; forestry; peatland strategy; carbon tax
Climate regulation (creating carbon sinks)	DCCAE; EPA	Where to restore carbon sinks; offset losses	Climate action; CAP; forestry; peatland strategy
Coastal protection	Local authorities; NPWS; OPW	Reducing coastal erosion; managing coastal habitats	Natura 2000; planning and development
Energy (potential spaces for wind, solar, geothermal)	DCCAE; SEAI	Space for renewables	Climate action; energy
Flood mitigation	DHPLG; local authorities; OPW; RAs	Flood prevention; NWRMs	Floods Directive; WFD; planning and development
Groundwater	GSI; Irish Water	Protection of groundwater	Drinking water
Habitat	ENGOs; NBDC; NPWS; local authorities	Restoration planning; nature networks/conservation	Natura 2000; Birds and Habitats Directives; Wildlife Act
Landscape	Heritage Council	Conservation of cultural and natural landscape features	Landscape policy
Marine food production	BIM; DAFM; Marine Institute	Sustainable development	MSFD; CFP
Planning (space)	DHPLG; local authorities; RAs	Urban and rural planning	Planning Framework Ireland; Regional and County Development Planning
Pollination	DAFM; Teagasc	Reducing pollinator decline	Pollinator Plan; CAP
Soil	DAFM; Teagasc	Protection of soils	Soils Directive
Terrestrial food production	DAFM; Teagasc	Sustainable development	CAP; Natura 2000
Timber	Coillte; Forest Service	Sustainable development	CAP; forestry
Water	EPA; IFI; Irish Water; LAWPRO	Protection of fisheries; habitats	WFD; Natura 2000
Water (drinking)	EPA; Irish Water; LAWPRO; NFGWS	Protect and restore water sources	WFD; drinking water

Appendix VII: Overview discussion workshop natural capital accounting North Sea/North-East Atlantic

Table III: Overview of discussion of question 1 of presentation Wesley van Veggel workshop natural capital accounting North Sea/North-East Atlantic on December the 13th and 14th. Source: Authors own interpretation and notes.

1. What types of (marine) decision-making can natural capital accounting support?
NCA can provide integrated information in a consistent robust way and this information can support decision-makers from various disciplines
The ability to emphasize the importance of protecting the marine environment and underline (economic) importance of marine protected areas
Communication to EU and member states and reporting purposes (such as various Sustainable Development Goals)
NCA can improve communication with various stakeholders and policymakers from various disciplinaries due to the integrated nature of the framework and its data needs.
Green deal/biodiversity strategies: show benefits of investing in nature restoration through added (economic) value in ecosystem services such as carbon storage etc.
Monitoring state of the marine environment for various policy purposes. Increased consequent monitoring through NCA will also identify trends, interactions and trade-offs between ecosystems and the economy
NCA can be used to assess regional ecosystem management, for example: the assessment of where to use nature bases solutions
The spatial approach can show interconnectivity of issues in a crowded area with various stakeholders such as the North Sea. If the information is detailed enough, it can be used to support Maritime (MSP)
Ecosystem services values from NCA could be included to the Maritime part in North Sea Program.
Combining Natural Capital Accounting with other types of assessments tools such as cost benefit analysis and scenario analysis can aid in (future) decision making for the North Sea.
Business cases
Economic motivation for investment decisions for restoring the (marine) environment

Even though the information can currently be too little to support policy decisions. It can identify knowledge gaps and data gaps that are needed for future decision-making.
Guidance where to conserve and restore marine ecosystems Provides information for the design of payments for ecosystem services (including side-payments within e.g., international fishery agreements between signatories)

Table IV: Overview of discussion of question 2 of presentation Wesley van Veggel workshop natural capital accounting North Sea/North-East Atlantic on December the 13th and 14th. Source: Authors own interpretation and notes.

2. What are some of the main challenges to be able to use natural capital accounting for marine policy?
The spatial resolution needs to increase for NCA to be useful on a regional level
Data availability and finding good (time consistent) quality data for the marine environment can often be challenging
Due to the time it takes to process data by statistical offices it is often a few years old. While policymakers would like to most up-to-date information.
Uncertainties and complexities of marine ecosystems can be difficult to capture in NCA
Still a lot of uncertainty how to incorporate the 3-dimensional character of the sea into NCA
How do we take mobility of marine ecosystems into account? This requires more cooperation between natural capital accounts of different countries to establish better insights on interactions and pressures. This also requires more comparability of the accounts (being set up similarly)
Increased clarity in purpose and use of NCA for specific policies such as MSFD and SDGs in a detailed matter. What is the output necessary, on what spatial scale and what is the level of detail?
The outcomes of monetary accounts are very dependent on valuation methods. Sometimes it is hard to establish which one is the best and countries might choose different methods. That make comparability of the accounts more difficult.
Natural Capital Accounts/ecosystem accounting are complicated and difficult to calculate using a standardized approach.
Linking biodiversity & ecosystem services to ecosystem assets
Applying a more bottom-up approach of setting up ecosystem accounts

Currently NCA is focusses on the past, but for policy decisions it is necessary to look more into the future. How will we do this and which party will be responsible?

Table V: Overview of discussion of question 3 of presentation Wesley van Veggel workshop natural capital accounting North Sea/North-East Atlantic on December the 13th and 14th. Source: Authors own interpretation and notes.

3. What is needed to keep policy makers engaged while the accounts are being developed?
More examples, case studies to show the possibilities from NCA for (marine) policy making. Examples of these can be investment, cost benefit or scenario analysis for specific areas.
Visualized tools, portals, databases or websites that can be used by policy-makers to show the results of NCA in a relatively simple to use spatial setting
More regional (potential) policy application examples
Guideline for practical implementation summarizing the assumptions, indicators, potential data sources, challenges, etc. per step
Incorporate stakeholders and policymakers early (in an easy-to-understand way) to make the accounts more demand driven, increase understanding and increase policy engagement.

Appendix VIII: Overview indicators from SEEA that support SDG14

Table VI: overview of the indicators established by the UNCEEA including the way forwards, notes on the data and custodian agency (SEEA, 2020)

Updated broad brush analysis of SEEA-relevant SDG indicators						
Existing Indicator	**Custodian Agency**	**Tier**	**Notes/Meta-Data**	**Data Availability and Sources**	**Previous engagement/work done on Indicator**	**Way forward**
Goal 14						
14.1.1 - Index of coastal eutrophication and floating plastic debris density	UNEP; partner with IOC-UNESCO, IMO, FAO	Tier III	**N/A**	**N/A**		
14.4.1 - Proportion of fish stocks within biologically sustainable levels	FAO	Tier I	**Definition:** Proportion of fish stocks within biologically sustainable levels, where biologically sustainable is defined as a fish stock of which abundance is at or greater than the level that can produce the maximum sustainable yield (MSY) classified as biologically sustainable. The basic benchmarks for the sustainability of fisheries are set out by the UN Convention on the Law of the Sea.	There is no data at a country level at the moment. To compute the indicator, one needs to carry out a stock assessment that uses fish catch statistics, fishing effort data and biological information and fit the data to a population dynamics model. After completing the stock assessment for all stocks concerned, fish stocks that have abundance at or above the level associated with the maximum sustainable yield are counted as biologically sustainable and otherwise are considered as overfished. FAO has estimated fish stocks around the world since 1974 to 2013, representing 70% of global landings. However, these assessments have not been done at the country level.		**Proposed connection to the SEEA:** The indicator requires a stock assessment of fish stocks within a country. The SEEA asset accounts for aquatic resources can provide information on the stocks and changes in stocks of the quantity (and value) of aquatic resources within a country's coastal and inland fisheries in its exclusive economic zone. The asset accounts cover both natural and cultivated stocks and also include those on the high seas over which the country holds ownership rights.
14.5.1 - Coverage of protected areas in relation to marine areas	UNEP-WCMC, UNEP; partner with Ramsar	Tier I	**Definition:** Coverage of protected areas in relation to marine areas; the indicator's intent is to show temporal trends in the mean percentage of each important site for marine biodiversity that is covered by designated protected areas. Protected areas are defined by the International Union for Conservation of Nature (IUCN). Sites contributing significantly to the global persistence of biodiversity are identified following globally standard criteria for the identification of Key Biodiversity Areas (IUCN) applied at national levels.	Protected area data are compiled by ministries of environment and other ministries responsible for the designation/maintenance of protected areas. Protected area data is also available for sites designated under the Ramsar Convention and the UNESCO World Heritage Convention. These data are aggregated globally into the World Database on Protected Data (IUCN & UNEP-WCMC). UNEP-WCMC produces the UN List of Protected Areas every 5-10 years. Key Biodiversity Areas are identified at national scales through multi-stakeholder processes and aggregated into the World Database on Key Biodiversity Areas. The indicator is then derived from a spatial overlap between digital polygons for protected and digital polygons for marine Key Biodiversity Areas.		**Proposed connection to the SEEA:** SEEA can inform classification of marine ecosystems and protected areas via land-use classifications. Biodiversity accounts for key biodiversity areas can link drivers of and pressures contributing to biodiversity loss.
14.6.1 - Progress by countries in the degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing	FAO	Tier II	**Not yet posted**	**Not yet posted**		
14.7.1 - Sustainable fisheries as a proportion of GDP in small island developing States, least developed countries and all countries	FAO, UNEP-WCMC	Tier III	**N/A**	**N/A**		**Proposed connection to the SEEA:** The indicator requires a stock assessment of fish stocks within a country. The SEEA asset accounts for aquatic resources can provide information on the stocks and changes in stocks of the quantity (and value) of aquatic resources within a country's coastal and inland fisheries in its exclusive economic zone. The asset accounts cover both natural and cultivated stocks and also include those on the high seas over which the country holds ownership rights.
14.a.1 - Proportion of total research budget allocated to research in the field of marine technology	IOC-UNESCO; partner with UNEP	Tier II	**N/A**	**N/A**		

Appendix IX: State & Impact interactions with ecosystem services

Figure VI: State & Impact interactions with marine ecosystem services adapted form UK NEA (Judd & Lonsdale, 2021)**:**