Organisation CoLAB +ATLANTIC

D11.8 NAUTILOS Socio-Economic Impact Assessment

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NAUTILOS - New Approach to Underwater Technologies for Innovative, Low-cost Ocean observation is an H2020 project funded under the Future of Seas and Oceans Flagship Initiative, coordinated by the National Research Council of Italy (CNR, Consiglio Nazionale delle Ricerche). It brings together a group of 21 entities from 11 European countries with multidisciplinary expertise ranging from ocean instrumentation development and integration, ocean sensing and sampling instrumentation, data processing, modelling and control, operational oceanography and biology and ecosystems and biogeochemistry such, water and climate change science, technological marine applications and research infrastructures.

NAUTILOS will fill-in marine observation and modelling gaps for chemical, biological and deep ocean physics variables through the development of a new generation of cost-effective sensors and samplers, the integration of the aforementioned technologies within observing platforms and their deployment in large-scale demonstrations in European seas. The fundamental aim of the project will be to complement and expand current European observation tools and services, to obtain a collection of data at a much higher spatial resolution, temporal regularity and length than currently available at the European scale, and to further enable and democratise the monitoring of the marine environment to both traditional and non-traditional data users.

NAUTILOS is one of two projects included in the EU´s efforts to support of the European Strategy for Plastics in a Circular Economy by supporting the demonstration of new and innovative technologies to measure the Essential Ocean Variables (EOV).

More information on the project can be found at:https://www.nautilos-h2020.eu/.

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EXECUTIVE SUMMARY

This deliverable is the first version of the NAUTILOS' Socio-Economic Impact Assessment, produced in M24 of the project, and includes state-of-the-art regarding socio-economic impact assessment approaches and existing economic models, a description of the methodology to be applied and preliminary conclusions.

The NAUTILOS' Socio-Economic Impact Study is ongoing and will be reported upon in full towards the end of project, building upon the activities achieved and the information on direct, indirect and induced impacts of NAUTILOS' results that will be collected throughout the project from each partner.

The NAUTILOS' Socio-Economic Impact Assessment aims to understand and enhance the socio-economic role of the project, ensure support of various stakeholder groups and their take up of project results.

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
AUV	Autonomous Underwater Vehicle
ASV	Autonomous Surface Vehicles
CGE	Computable General Equilibrium Modelling
CTD	Conductivity, Temperature and Depth
ESA	European System of Accounts
Eurostat	European Statistical Office
GDP	Gross Domestic Product
I-O	Input-Output
NAUTILOS	NAUTILOS New Approach to Underwater Technologies for Innovative, Low-cost
OECD	Organisation for Economic Co-operation and Development
PPPs	Purchasing Power Parities
RPC	Regional Purchase Coefficients
SEIA	Socio-Economic Impact Assessment
TRL	Technology Readiness Level
UAV	Unmanned Aerial Vehicle

I. SOCIO-ECONOMIC IMPACT ASSESSMENT

1. INTRODUCTION

NAUTILOS is the project constructed by the consortium led by CNR that was successful in response to the Call for Proposals: H2020-BG-2020-1 under the BG-07-2019-2020 – The Future of Seas and Oceans Flagship Initiative: Part [C] 2020 – Technologies for observations.

NAUTILOS is one of two projects selected out of 11 candidate proposals, where the other winning project, TechOceanS, is led by the National Oceanography Centre, and in the spirit of EU collaboration can be a source of synergies and experience sharing.

Its objective is to fill in existing marine observation and modelling gaps through the development of a new generation of cost-effective sensors and samplers for physical (salinity, temperature), chemical (inorganic carbon, nutrients, oxygen), and biological (phytoplankton, zooplankton, marine mammals) essential ocean variables, in addition to micro-/nano-plastics, to improve our understanding of environmental change and anthropogenic impacts related to aquaculture, fisheries, and marine litter. Newly developed marine technologies will be integrated with different observing platforms and deployed through the use of novel approaches in a broad range of key environmental settings (e.g. from shore to deep-sea deployments) and EU policy-relevant applications:

- Fisheries & Aquaculture Observing Systems,
- Platforms of Opportunity demonstrations,
- Augmented Observing Systems demonstration,
- Demonstrations on ARGO Platform,
- Animal-borne Instruments.

The fundamental aim of the project will be to complement and expand current European observation tools and services, to obtain a collection of data at a much higher spatial resolution and temporal regularity and length than currently available at the European scale, and to further enable and democratize the monitoring of the marine environment to both traditional and non-traditional data users.

The Socio-Economic Impact Assessment of NAUTILOS's results will take place under Work Package 11 for the Exploitation and Impact, which aims to determine and manage the impact of the project and ensure the full exploitation of the instrumentation developed, integrated, tested, validated and demonstrated within NAUTILOS. The Socio-Economic Impact Assessment has the main objective of developing a tool that can be used during the later stages of the project and throughout its exploitation (even post-project) to build stakeholder support for the project results. By developing this assessment, the consortium will be able to understand the role of NAUTILOS in the blue economy value chain for specific regions and how its results can impact the sector in economic terms. This can help support the creation of future business cases and inform decision makers. On the other hand, the deliverable D2.1. "A review and prospectus of the mandate for marine environmental monitoring systems: technology challenges and opportunities", analyses stakeholders and initiatives at the European level which can constitute possible links to NAUTILOS' results and to build stakeholder support. Therefore, the present report is, in a sense, complementary to D2.1. An integral aspect of the socio-economic evaluation will be an analysis of how NAUTILOS' sensors and results contribute to cost savings which will aim to establish both the cost savings to be incurred via the implementation of NAUTILOS' activities as well as the monetized benefits as a result of the implemented interventions.

2. CHARACTERIZATION OF BENEFICIARIES

Before starting the socio-economic impact assessment of NAUTILOS results, it is important to do a characterization of the individual beneficiaries of the project in order to help to adjust strategies according to their nature as well as their specific activities in the project.

Table 1 was adapted from the table initially reported in deliverable D11.1 NAUTILOS exploitation strategy, from CEiiA, indicating the composition of the consortium and is included here for convenience and reference. This is important to report in the present deliverable since the type of entities in the consortium may influence the socio-economic impacts of the project, e.g.: a higher number of enterprises may lead to a higher probability of commercialization, more institutional relationships and consequently a higher probability to influence the regulations and policies in the way that the adoption of sensors is recommended.

Table 1 – List of NAUTILOS consortium members.

No.	Name	Short name	Country	Type (proposal designation)
1	CONSIGLIO NAZIONALE DELLE RICERCHE	01 - CNR	Italy	Public research body
2	HELLENIC CENTRE FOR MARINE RESEARCH	02 - HCMR	Greece	Public research body
3	NORSK INSTITUTT FOR VANNFORSKNING	03 - NIVA	Norway	Private non-profit research foundation
4	SUOMEN YMPARISTOKESKUS	04 - SYKE	Finland	Public research body
5	INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER	05 - IFREMER	France	Public research body
6	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	06 - CNRS	France	Public research body
7	ETT SPA	07 - ETT	Italy	SME
8	EDGELAB SRL	08 - EDGELAB	Italy	SME
9	UNIVERSIDADE DO ALGARVE	09 - UALG	Portugal	Public HEI
10	NKE INSTRUMENTATION SARL	10 - NKE	France	SME
11	AQUATEC GROUP LIMITED	11 - AQUATEC	United Kingdom	SME
12	SUBCTECH GMBH	12 - SCT	Germany	SME
13	CEIIA - CENTRO DE ENGENHARIA E DESENVOLVIMENTO (ASSOCIACAO)	13 - CEIIA	Portugal	Non-profit private research body
13a	CoLAB +ATLANTIC	13a CoLAB	Portugal	Non-profit private research body
14	HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE	14 - HES-SO	Switzerland	Public research body and HEI
15	CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT	15 - CSEM	Switzerland	Non-profit private research body
16	UNIVERZA V LJUBLJANI	16 - UL-FE	Slovenia	Public research body and HEI

17	FUNDACAO EUROCEAN	17 - EUROCEAN	Portugal	Non-profit private foundation
18	DEUTSCHES FORSCHUNGSZENTRUM FUR KUNSTLICHE INTELLIGENZ GMBH	18 - DFKI	Germany	Non-profit private research body
19	UNIVERSITA DELLA CALABRIA	19 - DIAM	Italy	Public HEI
20	IMAR - INSTITUTO DO MAR	20 - IMAR	Portugal	Non-profit private research body
21	EVROPROJECT OOD	21 - EP	Bulgaria	SME

Note: due to Linked third Party the total number of entities is 22.

To better understand the breakdown and distribution of the different entities of the consortium the following table, also reported in deliverable D11.1., which groups the entities by country and type of entity, gives a clearer view of the consortium.

Table 2 - List of NAUTILOS members by country and type.

		Public (9 entities)			**Private (13 entities)**			
No.	**Country**	**HEI**	**Research Body**	**Research body and HEI**	**Non-profit foundation**	**Non-profit research body**	**SME**	**TOTAL**
1	Italy	19- DIAM	1 - CNR				7- ETT 8- EDGE LAB	4
2	Greece		2- HCMR					1
3	Norway				3 - NIVA			1
4	Finland		4- SYKE					1
5	France		5- IFREMER 6- CNRS				10- NKE	3
6	Portugal	9- UALG			17- EUR OCEAN	13- CEiiA 13a COLAB 20- IMAR		5
7	United Kingdom						11- AQUA TEC	1
8	Germany					18- DFKI	12- SCT	2
9	Switzerland			14- HES-SO		15- CSEM		2
10	Slovenia			16- UL-FE				1
11	Bulgaria						21- EP	1
	TOTAL	2	5	2	2	5	6	22

The consortium includes a total of 11 countries and no more than 4 members of the consortium per country (CoLAB +ATLANTIC is a Third Party to CEiiA). Also, there is a complementary distribution in terms of the types of entities involved, private or public sector, which can help ensure a diverse and effective dissemination and exploitation of results. A total of 9 public entities and 13 private entities (including 6 SME) are part of the NAUTILOS' consortium.

3. List of prototypes to be developed

The prototypes that will be developed in NAUTILOS and the respective responsible entity include the following:

1. Fluorometric Sensors/dissolved oxygen (HESSO)
2. Dissolved Oxygen and Fluorescence Sensors (NKE)
3. Downward looking multi/hyperspectral and laser induced fluorescence sensors and cameras (NIVA)
4. Passive broadband acoustic recording sensor for noise monitoring (Aquatec)
5. Passive acoustic event recorder (porpoise & dolphin clicks for abundance estimation) (Aquatec)
6. Active Acoustic Profiling Sensor (Aquatec)
7. Sampler for phytoplankton and other suspended matter (NIVA)
8. Animal-borne instruments
9. Carbonate system/ocean acidification sensors (NIVA)
10. Silicate Electrochemical Sensor (NKE)
11. Sampler for Nanoplastics and Microplastics (SCT)
12. Microplastic sensors (NIVA + CSEM)
13. Deep ocean CTD (UL-FE)
14. Deep ocean low-level radioactivity sensor (HCMR)

4. Exploitation of results

The strategy for the exploitation of NAUTILOS' sensors and samplers is currently being defined in liaison with WP11 leader and remaining partners. The exploitation strategy involves decisions for the exploitation of the project results after the project is completed. Such decisions will be taken based on the answers to such questions as:

- Which results require further research, development or validation work to increase their technological maturity;
- How many additional resources are required by relevant sensors to reach TRL9. By resources we mean effort, funding, and time;
- How each partner intends to take advantage, leverage and exploit its own results and those jointly owned – e.g. by further developing the sensors, by externalizing the results (licensing or selling the designs) or other possibilities;
- For those sensors close to TRL9, which steps are required for the industrialization of the sensor and whether this is the desired route;

- Which products can be generated through the project, who are their target customers and markets, which key partnerships are required, how they are to be commercialized (e.g. selling of the sensor, renting of the sensor, subscription of the data generated or any other possibility) and who will be the partners responsible for said commercialization.
- Which actions should be undertaken to facilitate, promote or mandate the adoption of project results and whether these can be implemented by project partners, how and under which timeline;
- For those results which are close to product level how they should be commercialized, e.g. individually, in bundles, as a service or as part of an integrated offer.

Different scenarios have been discussed so far. The results of this discussion are relevant for the work reported in this document as socio-economic impacts may be different depending on the exploitation choices made. It is not reasonable to assume that all scenarios will be analysed with respect to their socio-economic impact. As such, several scenarios for the development of the socio-economic impact analysis have also been discussed. The first scenario consists in measuring the socio-economic impact of the individual sales of the individual sensors developed by partners in each of their geographic areas. In this scenario, we would carry out a replication of the socio-economic analysis for all the partners developing sensors.
The second scenario aims to measure the socio-economic impact of the individual sale of the individual sensors to a specific observatory/platform within the project. For this analysis, we would also consider the geographic area of the partners developing sensors.
Finally, the third scenario consists in measuring the socio-economic impact of the integration of the sensors of each observatory/platform. In this case, the geographic area to be studied is of the partners integrating the sensors in each observatory/platform.
These are some of the possible scenarios. However, later in the project an exploitation scenario will be defined, and this will form the baseline for our analysis.

5. State-of-the-Art

5.1. Socio Economic Impact Assessment

Socio-economic impact assessment (SEIA) is a tool that aids in understanding a potential range of impacts by the introduction of a certain change. The knowledge obtained through this assessment can contribute to the preparation of strategies to minimise the negative and maximise the positive impacts of certain activities[1].

It is important to determine not only the full range of impacts, such as changes to levels of income and employment, access to services, quality of life, but also the implications of each particular change. Impacts of a certain proposal or policy are also distinct from, though influenced by, other activities which may be occurring. It is important therefore to identify the key source of impact and to separately identify impacts arising from other sources[2].

[1] Hajdinjak, M. (2019). A Practical Guide: Assessment of Socio-Economic Impacts of Research Infrastructures. 0b698b634cc4cc3df75dd303bdc3917f5ed6e2af.pdf (interreg-danube.eu)

[2] Bureau of Rural Sciences, 2005. Socio-economic Impact Assessment Toolkit: A guide to assessing the socio-economic impacts of Marine Protected Areas in Australia. https://parksaustralia.gov.au/marine/pub/scientific-publications/archive/nrsmpa-seia.pdf

5.1.1. Challenges and Limitations

Several attempts have been made to propose a comprehensive and unified framework for assessing the socio-economic impacts but most likely it will never be possible to come up with a 'one-size-fits-all' solution for mapping all socio-economic impacts[3].

Assessment of socio-economic impacts is a complex exercise that involves numerous challenges and hides several pitfalls. Socio-economic impacts are also heavily influenced by a large variety of external factors. Certain types of impacts are more relevant for some activities and less for others[4].

Having this in mind, it is important for each SEIA to select the appropriate impacts, assessment methods and indicators based on its own specific goals, while also taking into consideration the strategic visions and heterogeneous objectives of its stakeholders.

Other type of challenge is to have poor data or no available data, to only get aggregate data or estimations and due to this have to manage expectations regarding the quality of the resulting socio-economic model.

5.1.2. Process

The first step of this assessment is scoping the change: region, stakeholders, industries, communities, and then list the data needed.

The following step is to profile the baseline or to understand the current state of the activity being examined before the change and to identify the groups and communities associated and who will be impacted.

At this point, we are capable to list the direct impacts of the change introduced. Although to measure the indirect impacts (production) and induced impacts (consumption), some quantitative methods like economic models will be used.

5.1.3. Economic Models

At a basic level, economic impact analysis examines the economic effects that a business, project, governmental policy, or economic event have on the economy of a certain geographic area. At a more detailed level, economic impact models work by modelling two economies: one economy where the economic event being examined occurred and a separate economy where the economic event did not occur. By comparing the two modelled economies, it is possible to generate estimates of the total impact the project, businesses, or policy had on an area's economic output, earnings, and employment.

In many projects the social component is added, and the assessment of socio-economic impacts is usually preferred and consists in the quantification of positive and negative impacts of the project's results on society. The results arising from this type of analysis are typically used to objectively demonstrate the socio-economic importance of a certain project/product/action to decision makers and key stakeholders, including government authorities, community stakeholders and the public in general.

[3] See footnote 1.
[4] See footnote 1.

Economic development is accompanied by changes in consumption patterns (demand), changes in production structure (supply), changes in linkages and interdependencies among sectors and changes in labour availability and consumption[5]. Standard measures of economic activity are used to measure economic effects, such as Gross domestic product (GDP), jobs, wages, and tax revenues[6].

The indirect impacts can be quantified by deriving multipliers – which identify interindustry relationships and show how the shock ripples through the rest of the regional economy. Indirect impacts will vary across regions given the nature of the local economy – e.g. the level of industrial/economic diversification, existence of downstream activities, linkages to the national or international economy. Three more complex methods for assessing economic impact are:

- regional input-output (I-O) Model
- integrated modelling
- computable general equilibrium modelling (CGE).

Table 3 – Economic Models description and limitations[7]

	Description	Limitations
I-O Model	Based on a set of tables that quantify the linkages and transactions between different sectors of the regional economy and used to prepare multipliers for measures of impact including both indirect and induced effects	It is a static analysis that does not create price responses to changes in quantity. There is an assumed homogeneous input structure for each defined industry, with constant returns to scale and fixed input proportions. There are no external economies or diseconomies, changes in technology, or supply-side constraints such as labour shortages. Therefore, I-O analysis only predicts impacts in terms of the existing situation in the region – it does not account for potential changes in behaviour by economic agents.
Integrated Model	Combines input-output and econometric techniques and has been particularly used to analyse activities such as tourism and the environment. These models retain the detailed sectoral disaggregation of the input-output system and are closed using a system of endogenous non-linear econometric relationships. This closure captures the response through time as the economy is subjected to shocks.	Construction of an integrated model requires substantial data, resources and Expertise, which significantly exceed those of input-output modelling.

[5] An Introduction to Economic Impact Assessment Microsoft PowerPoint - Input-Output Modeling URP (iastate.edu)
[6] Plumstead, J. (2012). Economic Impact Analysis, Americas School of Mines. Microsoft PowerPoint - 2012 SOM PowerPoint Economic Impact Analysis (pwc.com)
[7] See footnote 2

computable general equilibrium model	These are models of the entire economy of a nation or region, taking into account all sectors. They can model a broader range of economic variables than I-O analysis and incorporate dynamic responses such as factor substitution and changes in relative prices. CGE models are incredibly complex, data-intensive and require substantial resources and expertise – not only for their development but also for analysis.	It has been suggested that, due to the relative openness of regional economies, it is less likely that the conditions of (local) general equilibrium will hold. Whilst not currently likely to be the best model for understanding the economic impacts, future developments in regional CGE models may increase usefulness.

The I-O Model is the most commonly used technique for estimating economic impact since it considers direct, indirect and induced impacts. This is the main reason why the I-O Model will be the chosen one in this Socio-Economic Impact Assessment and will be detailed in the following section.

5.1.4. I-O Model

The Input-Output Model (I-O Model) was developed by Wassily Leontief and therefore is also known as Leontief model. This model is designed to examine all the industries in a local economy and estimate all the ways that spending in one sector influences each of the other sectors in the area's economy.

An Input-output model is an inter-industry model because it focuses on the interdependence of industries allowing to identify the structure and the existing linkages in the regional economy[8]. This, in turn, allows to understand the overall importance of a group of industries in the region or the likely economic consequences in terms of production, earnings, or employment in these firms. In particular, I-O Model is useful for estimating how an increase in demand for a product of one industry could impact other industries and the economy as a whole.

The input-output model uses a matrix representation of a region's economy to predict the effect of changes in one industry on other industries, consumers, government and foreign suppliers to the economy. In this matrix will be represented inputs like the Total Economic Effect, the Value-added and other additional inputs, such as workforce and other various capital requirements.

To estimate the total economic effect, three types of impacts must be considered: direct, indirect and induced[9] [10] [11].

- **Direct impacts** - refer to the operational characteristics of the companies or institutions that we are studying directly, e.g., a change in demand for the output of an industry or a change in an industry's employment.
- **Indirect impacts** - measure the value of additional economic demands that the direct companies or institutions place on supplying industries in the region of interest, i.e., indirect impact results from the supplying industries purchasing goods, services, and workers from suppliers in the area to meet demand.

[8] Swenson, D. (2002). An Introduction to Economic Impact Assessment. Microsoft Word - Inservice-economicimpact.doc (iastate.edu)
[9] See footnote 8
[10] Measuring Socioeconomic Impacts of Earth Observations, Applied Sciences Program NASA Earth Science. SocioeconomicImpactsPrimer.pdf (nasa.gov)
[11] NASA and Moon to Mars Program (2020). Economic Impact Study. nasa_economic_impact_study.pdf

- **Induced impacts or household effects** - result from the employees in the direct and indirect industries purchasing goods and services at a household level.

The ***total economic effects*** measure how the new spending influences the local economy. This is simply the sum of direct, indirect and induced impacts. They are all the transactions attributable, either directly or indirectly, to the activities that are being measured.

At its most basic, an I-O Model is an accounting of transactions among industries, governments, households, and imports and exports[12]. A portion of the output (i.e. sales) of one industry will appear as the input (i.e. purchase) of other industries and they form linkages. The strength or importance between these linkages, and industrial structure understanding will permit the assessment of the overall importance of a set of industries in a region or the likely economic consequences: if there is some change in production, earnings, or employment, locally or regionally.

The ***Value-added*** is a combination of payment to workers and returns to capital[13]. It includes employment compensation, incomes to sole proprietors, property incomes (dividends, interests, and rents), and indirect tax payments (primarily excise, use, and sales taxes paid by individuals to businesses)[14].

Other key metric is the ***Total industrial output***, which for most industries is simply gross sales. For public or quasi-public institutions, include all public outlays, to include the value of government sales and other subsidies received[15].

Jobs, the last measure, represent the number of positions in the economy, not the number of employed persons. The distinction is important. Many industries produce full-time jobs, primarily. Manufacturing firms, for example, tend only to hire full-time, full-year positions. Many other industries, like recreational services, retail sales, and dining and drinking establishments may hire a preponderance of part time or seasonal workers[16].

Effects are calculated based on the availability of inputs, cost of input providers and output consumers. These calculated effects are called regional purchase coefficients (RPC) and represent the proportion of regional demand for inputs fulfilled from regional production. In other words, a region containing a large, diverse economy with many suppliers will typically have high industry RPCs. As a result, when production in an export-oriented industry increases, the demand for regional input supply will go up, creating additional economic benefits within the region as euros filter through supply chains – i.e. the multiplier effect.

As applied to a local community, a multiplier is a measure of how dollars interjected into a community are re-spent, thereby leading to additional economic activity. Or, for one euro of economic activity, the output multiplier measures the combined effect of a €1 change in its sales on the output of all local industries[17]. In this regard, we need to think of the community as a closed economy system, with dollars and resources flowing between entities in the community and between those same entities and the outside world. Summing up, the multipliers represent the level of ripple effects (or spillover)

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[12] See footnote 8

[13] Hughes, D.W. (2018). A primer in economic multipliers and impact analysis using input-out models, Real Life Solutions.

[14] See footnote 8

[15] See footnote 8

[16] See footnote 8

[17] Hughes, D.W. (2003). Policy Uses of Economic Multiplier and Impact Analysis. Choices, 18(2), 25-30.

the industry's operation has in a given economy and are designed to quantify the direct, indirect and induced impacts.

Typical multiplier effects are categorized into three groups: sales, jobs and earnings.

- Sales multipliers: show how "deeply-rooted" an industry is in your region—for example, a highly-developed cluster will have a high sales multiplier because every dollar fed into the cluster from the outside has a high ripple effect, propagating through the regional economy for some time before it leaks out.
- Jobs multipliers: A jobs multiplier indicates how important an industry is in regional job creation. These multipliers are primarily tied to the type of industries in the scenario—industries with a high sales-to-labour ratio typically have a high jobs multiplier, and vice versa.
- Earnings multipliers: An earnings multiplier of 1.5 means that for every euro of earnings generated by a new scenario, a total of €1.5 is paid out in wages, salaries, and other compensation throughout your economy. This is important for understanding how a given scenario will affect quality of jobs within an area. A scenario whose ripple effect--indirect and induced effects--bring two dozen lawyers and accountants into your region would have a much higher earnings multiplier than a scenario brings two dozen food service workers.

6. The economic model implementation process

6.1. Methodology

The Socio-Economic Impact Assessment of NAUTILOS results will consist in the implementation of several steps, which include:

Figure 1 - Steps of Socio-Economic Impact Assessment

- The **scenario** description is the first step of the assessment process and is the description of what the scenario will look like socially and economically speaking, in the region/area where the activity will take place. Regarding the target regions for the analysis, according to the target demonstration areas (identified for example in Table 4 of the Annex I to the GA (part B)), Norway and Greece are some of the areas that can be considered . The scenario to be used as the baseline of our analysis is currently being defined in liaison with WP11 leader and remaining partners.
- The next step is to collect **data** and getting the numbers about the companies in the assessment, employees, salaries, production, demographics, etc. Regarding the data sources to be used, we plan to use mostly national statistics, OECD data, secondary data and industry aggregation, including data on socio-economic variables such as incomes, employment compensation, industrial output, jobs, etc. In case there is the lack of some types of data, e.g. in case there is no specific data for certain years or periods, it might be necessary to

extrapolate (e.g. depending on the variables of interest linear extrapolations or other methods will be considered). Some examples of socio-economic indicators and respective sources, that will be consulted throughout the process, are represented in Table 4 and Table 5. These will be complemented, when relevant, with data from other national and or regional or supranational bodies. This will be especially relevant for variables which are not detailed enough in the OECD and Eurostat body of statistics and indicators. As such, the tables presented below will be complemented with additional tables summarizing all data sources in the final version of the deliverable.

- Next, there is the need to get a good handle on the primary **region** of analysis. Though an industrial change is usually localized in a particular city or county, the economic effects are usually better measured if a multiple country model is specified to consider inter-country cross-hauling of goods and services and in-and out-commuting among workers.
- Finally, the I-O model, accounting of transactions among stakeholders, will be developed and direct, indirect and induced economic effects will be identified, analysed and estimated. The I-O model and its application to the study scenarios and **interpretation** will constitute the main results, to be included in the final report for NAUTILOS Socio-Economic Impact Assessment (D11.8).

Table 4 - Examples of socio-economic indicators from OECD database. OECD Data

OECD data				
Topic	Indicator Group	Indicator	Description	Reference
Economy	GDP and spending	Gross Domestic Product (GDP)	Gross domestic product (GDP) is the standard measure of the value added created through the production of goods and services in a country during a certain period. As such, it also measures the income earned from that production, or the total amount spent on final goods and services (less imports). This indicator is based on nominal GDP (also called GDP at current prices or GDP in value) and is available in different measures: US dollars and US dollars per capita (current purchasing power parities, PPPs). Data are available on a yearly basis since 1960.	OECD (2022), Gross domestic product (GDP) (indicator). doi: 10.1787/dc2f7aec-en (Accessed on 21 July 2022)
		Quarterly GDP	This indicator is based on real GDP (also called GDP at constant prices or GDP in volume), i.e. the developments over time are adjusted for price	OECD (2022), Quarterly GDP (indicator). doi: 10.1787/b86d1fc8-

			changes. The numbers are also adjusted for seasonal influences. The indicator is available in different measures: percentage change from the previous quarter, percentage change from the same quarter of the previous year and volume index (2015=100). Data are available on a quarterly basis since 1947.	en (Accessed on 21 July 2022)
Jobs	Earnings and wages	Average wages	Average wages are obtained by dividing the national-accounts-based total wage bill by the average number of employees in the total economy, which is then multiplied by the ratio of the average usual weekly hours per full-time employee to the average usually weekly hours for all employees. This indicator is measured in USD constant prices using 2016 base year and Purchasing Power Parities (PPPs) for private consumption of the same year. Data are available on a yearly basis since 1990.	OECD (2022), Average wages (indicator). doi: 10.1787/cc3e1387-en (Accessed on 21 July 2022)
		Employee compensation by activity	Compensation of employees has two components: gross wages and salaries payable in cash or in kind, and the value of social contributions payable by employers. This indicator is measured as a percentage of gross value added, and broken down by agriculture (including forestry and fishing), industry, and services. Data are available on a yearly basis since 1970.	OECD (2022), Employee compensation by activity (indicator). doi: 10.1787/7af78603-en (Accessed on 21 July 2022)
		Wage levels	Wage levels are divided by low pay and high pay. The incidence of low pay refers to the share of workers earning less than two-thirds of median earnings. The incidence of high pay refers to the share of workers earning more than one-and-a-half time median earnings. Data refer to full-time employees. This indicator is measured in	OECD (2022), Wage levels (indicator). doi: 10.1787/0a1c27bc-en (Accessed on 21 July 2022)

			percentages. Data are available on a yearly basis since 1970.	
	Employment	Employment by activity	Employment by industry is broken down by agriculture, construction, industry including construction, manufacturing and services activities. This indicator is seasonally adjusted and it is measured in thousands of people.	OECD (2022), Employment by activity (indicator). doi: 10.1787/a258bb52-en (Accessed on 21 July 2022)

Table 5 - Examples of socio-economic indicators from Eurostat database. [Statistics | Eurostat (europa.eu)]

Eurostat data				
Theme	Group of statistics	Accounts	Indicators	Description
Economy and finance	National accounts	Annual national accounts	Gross Domestic Product (GDP) and main components (output, expenditure and income)	GDP at market prices is the final result of the production activity of resident producer units.
			Population and employment	Population consists of all persons, nationals or foreigners, who are permanently settled in the economic territory of the country, even if they are temporarily absent from it, on a given date. A person staying or intending to stay at least one year is considered to be settled on the territory. By convention, the total population excludes foreign students and members of foreign armed forces stationed in a country. Employment covers all persons engaged in some productive activity (within the production boundary of the national accounts). Employed persons are either employees (working by agreement for another resident unit and receiving remuneration) or self-employed (owners of unincorporated enterprises).

		Annual sector accounts	Household saving rate	The gross saving rate of households (including Non-Profit Institutions Serving Households) is defined as gross saving (ESA 2010 code: B8G) divided by gross disposable income (B6G), with the latter being adjusted for the change in the net equity of households in pension funds reserves (D8net). Gross saving is the part of the gross disposable income which is not spent as final consumption expenditure.
			Household investment rate	The gross investment rate of households (including Non-Profit Institutions Serving Households) is defined as gross fixed capital formation (ESA 2010 code: P51G) divided by gross disposable income (B6G), with the latter being adjusted for the net change in pension entitlements (D8net). Household investment mainly consists of the purchase and renovation of dwellings.

6.2. Economic Model Matrix

As said before, the I-O Model is known as an inter-industry model because it focuses on interdependence of industries. The output of industry X is used as input for industry Y. In turn, output of Y is used as input for X. On one side there is the supply chain and on the other side there are the end-users. In between is the value chain. At this stage, some direct and indirect markets were identified for the products derived from NAUTILOS project, such as aquaculture, marine biotechnology, coastal tourism, oceanic observatories, and ports. For a better understanding of these flows, the next figure shows a simplified representation of a supply chain and value chain of NAUTILOS products.

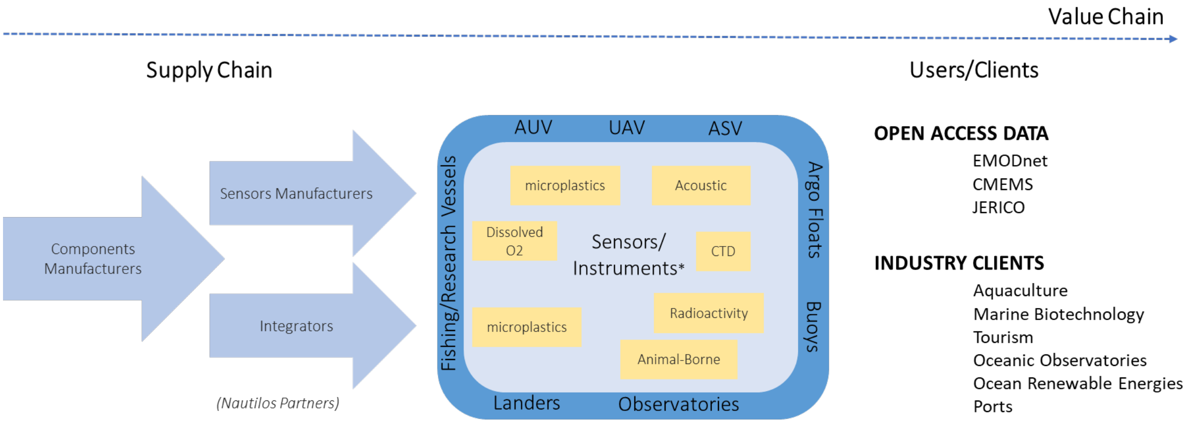

Figure 2 – Supply chain/value Chain for the scenario NAUTILOS

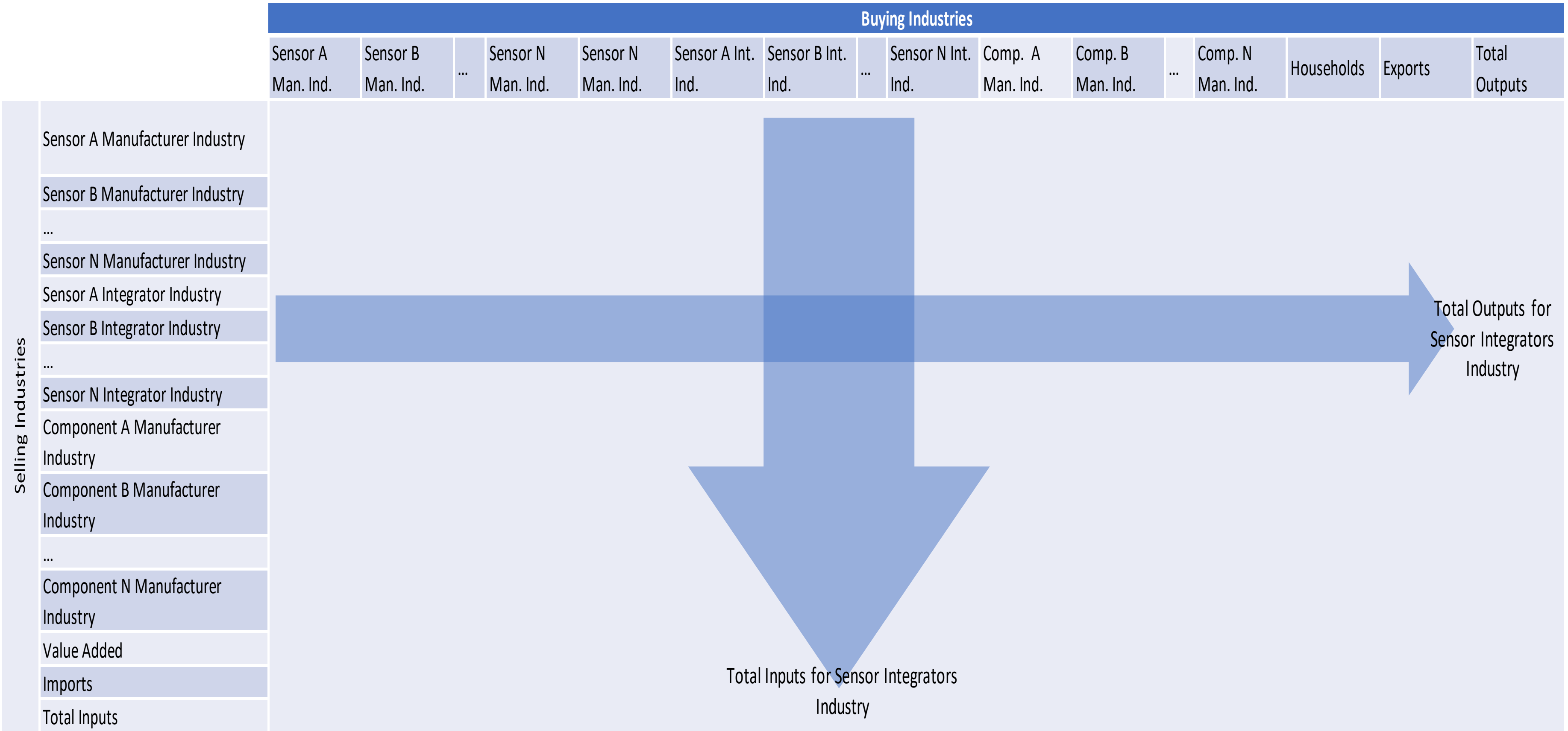

Figure 3 – Representation of the I-O model to NAUTILOS scenario case.

From this starting point, we can build the matrix representation of the country's economy to predict the effect of changes in one industry on other industries, consumers, government and foreign suppliers to the economy. In this matrix there will be represented the total inputs from selling industries and the total outputs from the buying industries, as shown in figure 3.

6.3. Data collection

A template has been prepared in order to collect information from partners regarding the results achieved throughout the project, including the development of sensors, components of a sensor, other devices such as cameras, and data produced, and focusing also on scenarios for the aftermath of the project. It is important to note that the raw materials for the construction of the model and the analysis correspond to the data that the sensor developers and manufacturers of the consortium will make available. These are extremely relevant and vary from partner to partner (they alone know what the competitive advantages of their sensor are, their target selling price, their estimated cost for engineering, development and manufacturing and their geographical target regions). The template was sent on 16th of March 2022 via e-mail to all contact points of NAUTILOS' consortium.

The information included is listed below:

- Possible to be integrated with other NAUTILOS products
- Target region (s) (region of interest) in which data is going to be disseminated
- Target region (s) (region of interest) in which the product is going to be disseminated
- Target unitary selling price of the sensor/component
- Target annual volume of sensors to be sold annually
- Market competitors
- Competitors' Technologies
- Cost saving associated with the product

Full-time jobs created:

- Direct
- Indirect
- Induced
- Annual average gross wage of direct jobs

Part-time jobs created:

- Direct
- Indirect
- Induced
- Annual average gross wage of direct jobs

At the time of writing, some of the information requested has already been received. Partners are making great efforts to estimate and answer the questions posed – note that some of the answers can only be rough or best estimates as the true answers will only materialize once, and if, project results evolve to manufacturing and commercialization. The data compilation process is ongoing, and the consortium expects to complete this in the coming months to enable the continuation of the analysis and the creation of results within the planned timeframe.

II. Conclusions

This document focuses on the methodology to be applied for assessing the socio-economic impact of NAUTILOS project.

The exploitation of NAUTILOS results was discussed since socio-economic impacts may be different depending on the exploitation choices made. Later in the project an exploitation scenario will be defined in liaison with WP1 leader and remaining partners, and this will form the baseline for our analysis.

Various methods for assessing economic impact were identified, including the regional input-output (I-O) Modelling, the integrated modelling and the computable general equilibrium modelling (CGE). The I-O Model is the most commonly used technique for estimating economic impact since it considers direct, indirect and induced impacts, which is the main reason why the I-O Model will be the chosen one in this Socio-Economic Impact Assessment. Although it presents some limitations, such as the fact that it is a static analysis that does not create price responses to changes in quantity, and that it only predicts impacts in terms of the existing situation in the region – it does not account for potential changes in behaviour by economic agents.

The several steps for the Socio-Economic Impact Assessment of NAUTILOS results were also identified, which include scenario description, data collection, definition of the target regions and interpretation of data.

As mentioned earlier, we are currently collecting information regarding the results achieved throughout the project, with some of it already received. However, it is important to highlight that the Socio-Economic impact Assessment of the project highly depends on the content and quality of the information that is being transmitted by the component and sensor developers. It is equally important to note that all the partners are making great efforts to estimate and answer the questions posed.

The consortium expects to complete the data compilation process in the coming months to enable the continuation of the analysis and the creation of results within the planned timeframe.

Appendix 1: References and Related Documents

ID	Reference or Related Document	Source or Link/Location
1	NAUTILOS Grant Agreement	NAUTILOS ownCloud
2	NAUTILOS Annex I to the Grant Agreement Part B	NAUTILOS ownCloud
3	D11.1. NAUTILOS Exploitation Strategy	10.5281/zenodo.7211802