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Executive Summary

This report provides an overview of political, economic, social, technological, legal, and environmental factors that impact companies and public actors dealing with Big Data technologies in the bioeconomy sector. The report presents identified issues within each factor and presents examples of impact.

Big Data is still a new concept with many challenges remaining to be solved. The balance between privacy protection on the one hand and the need to access and use data for new Big Data services on the other, remains a challenge despite recent EU legislation. This has implications on companies' operational preconditions in a global market. Missing standardisation and common platforms cause technical challenges and drive development costs. Social acceptance of Big Data technologies is critical for both political decision-making and public funding of research into Big Data technologies and for developing new services. The availability of skilled IT workers may turn out as limiting factor. Transparency, equal access and evidence of the benefits of Big Data solutions are key to public attitudes and subsequent policy and legislation.

Partners of the DataBio project may use the results of this report when they define and develop various pilot implementations for agriculture, forestry and fisheries. The report can also be used as background information for strategy work in other Big Data companies in the bioeconomy sector. The analysis should then be further refined and targeted to specific companies or market niche. Due to the volatility of the sector, the results should be regularly updated to reflect recent developments.

Deliverable Leader:	Göran Granholm, VTT
Contributors:	Katarina Stanoevska, USTG Vera Lenz-Kesekamp, USTG Roberto Russo, CIAOT Irene Matzakou, INTRASOFT
Reviewers:	Fabiana Fournier, IBM Matthias Krieger, CSEM Jaroslav Smejkal, ZETOR Tomas Mildorf, UWB Katarina Stanoevska-Slabeva, UStG
Approved by:	Athanasios Poulakidas, INTRASOFT

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Definitions, Acronyms and Abbreviations

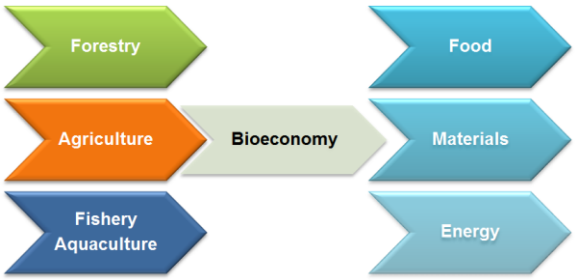
Acronym/ Abbreviation	Title
CAGR	Compound annual growth rate
CAP	Common Agriculture Policy
EMFF	European Maritime and Fisheries Fund
EVD	Economic Value of Data
GDPR	General Data Protection Regulation
IoT	Internet of Things
PA	Precision agriculture

Term	Definition
PESTLE Analysis	Analysis of Political, Economic, Social, Technological, Legal, and Environmental factors, which the company cannot control but have an impact on business.
Chilling effect	In a legal context, a chilling effect is the inhibition or discouragement of the legitimate exercise of natural and legal rights by the threat of legal sanction.
FTE	Full-time equivalent (FTE) or whole-time equivalent (WTE) is a unit that indicates the workload of an employed person
SWOT analysis	A structured planning method that evaluates an organisation's strengths, weaknesses, opportunities, and threats

1 Introduction

1.1 Project Summary

The data intensive target sector selected for the DataBio project is the **Data-Driven Bioeconomy**. DataBio focuses on utilizing Big Data to contribute to the production of the best possible raw materials from agriculture, forestry and fishery/aquaculture for the bioeconomy industry, in order to output food, energy and biomaterials, also taking into account various responsibility and sustainability issues.



DataBio will deploy state-of-the-art Big Data technologies and existing partners' infrastructure and solutions, linked together through the **DataBio Platform**. These will aggregate Big Data from the three identified sectors (**agriculture, forestry and fishery**), intelligently process them and allow the three sectors to selectively utilize numerous platform components, according to their requirements. The execution will be through continuous cooperation of end user and technology provider companies, bioeconomy and technology research institutes, and stakeholders from the Big Data value PPP programme.

DataBio is driven by the development, use and evaluation of a large number of **pilots** in the 3 identified sectors, where also associated partners and additional stakeholders are involved. The selected pilot concepts will be transformed to pilot implementations utilizing co-innovative methods and tools. The pilots select and utilize the best suitable market ready or almost market ready ICT, Big Data and Earth Observation methods, technologies, tools and services to be integrated to the common DataBio Platform.

Based on the pilot results and the new DataBio Platform, new solutions and new business opportunities are expected to emerge. DataBio will organize a series of trainings and hackathons to support its take-up and to enable developers outside the consortium to design and develop new tools, services and applications based on and for the DataBio Platform.

The DataBio consortium is listed in Table 1. For more information about the project see www.databio.eu.

Table 1: The DataBio consortium partners

Number	Name	Short name	Country
1 (CO)	INTRASOFT INTERNATIONAL SA	**INTRASOFT**	Belgium
2	LESPROJEKT SLUZBY SRO	**LESPRO**	Czech Republic
3	ZAPADOCESKA UNIVERZITA V PLZNI	**UWB**	Czech Republic

4	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.	**Fraunhofer**	Germany
5	ATOS SPAIN SA	**ATOS**	Spain
6	STIFTELSEN SINTEF	**SINTEF ICT**	Norway
7	SPACEBEL SA	**SPACEBEL**	Belgium
8	VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.	**VITO**	Belgium
9	INSTYTUT CHEMII BIOORGANICZNEJ POLSKIEJ AKADEMII NAUK	**PSNC**	Poland
10	CIAOTECH Srl	**CiaoT**	Italy
11	EMPRESA DE TRANSFORMACION AGRARIA SA	**TRAGSA**	Spain
12	INSTITUT FUR ANGEWANDTE INFORMATIK (INFAI) EV	**INFAI**	Germany
13	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION	**NP**	Greece
14	Ústav pro hospodářskou úpravu lesů Brandýs nad Labem	**UHUL FMI**	Czech Republic
15	INNOVATION ENGINEERING SRL	**InnoE**	Italy
16	Teknologian tutkimuskeskus VTT Oy	**VTT**	Finland
17	SINTEF FISKERI OG HAVBRUK AS	**SINTEF Fishery**	Norway
18	SUOMEN METSAKESKUS-FINLANDS SKOGSCENTRAL	**METSAK**	Finland
19	IBM ISRAEL - SCIENCE AND TECHNOLOGY LTD	**IBM**	Israel
20	MHG SYSTEMS OY - MHGS	**MHGS**	Finland
21	NB ADVIES BV	**NB Advies**	Netherlands
22	CONSIGLIO PER LA RICERCA IN AGRICOLTURA E L'ANALISI DELL'ECONOMIA AGRARIA	**CREA**	Italy
23	FUNDACION AZTI - AZTI FUNDAZIOA	**AZTI**	Spain
24	KINGS BAY AS	**KingsBay**	Norway
25	EROS AS	**Eros**	Norway
26	ERVIK & SAEVIK AS	**ESAS**	Norway
27	LIEGRUPPEN FISKERI AS	**LiegFi**	Norway
28	E-GEOS SPA	**e-geos**	Italy

29	DANMARKS TEKNISKE UNIVERSITET	**DTU**	Denmark
30	FEDERUNACOMA SRL UNIPERSONALE	**Federu**	Italy
31	CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT	**CSEM**	Switzerland
32	UNIVERSITAET ST. GALLEN	**UStG**	Switzerland
33	NORGES SILDESALGSLAG SA	**Sildes**	Norway
34	EXUS SOFTWARE LTD	**EXUS**	United Kingdom
35	CYBERNETICA AS	**CYBER**	Estonia
36	GAIA EPICHEIREIN ANONYMI ETAIREIA PSIFIAKON YPIRESION	**GAIA**	Greece
37	SOFTEAM	**Softeam**	France
38	FUNDACION CITOLIVA, CENTRO DE INNOVACION Y TECNOLOGIA DEL OLIVAR Y DEL ACEITE	**CITOLIVA**	Spain
39	TERRASIGNA SRL	**TerraS**	Romania
40	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	**CERTH**	Greece
41	METEOROLOGICAL AND ENVIRONMENTAL EARTH OBSERVATION SRL	**MEEO**	Italy
42	ECHEBASTAR FLEET SOCIEDAD LIMITADA	**ECHEBF**	Spain
43	NOVAMONT SPA	**Novam**	Italy
44	SENOP OY	**Senop**	Finland
45	UNIVERSIDAD DEL PAIS VASCO/ EUSKAL HERRIKO UNIBERTSITATEA	**EHU/UPV**	Spain
46	OPEN GEOSPATIAL CONSORTIUM (EUROPE) LIMITED LBG	**OGCE**	United Kingdom
47	ZETOR TRACTORS AS	**ZETOR**	Czech Republic
48	COOPERATIVA AGRICOLA CESENATE SOCIETA COOPERATIVA AGRICOLA	**CAC**	Italy

1.2 Document Scope

This report provides an overview of political, economic, social, technological, legal, environmental factors related to increasing utilization of Big Data in the bioeconomy sector,

with special focus on efficient and sustainable production of raw materials in agriculture, forestry and fishery businesses.

The **objective of this report** is to give an overview of some of the most significant political, economic, social, technological, environmental and legal factors that may have an impact on the application of Big Data sources and related technologies in the bioeconomy industry. The report is intended to provide an example of how the PESTLE analysis can be used to identify and evaluate these factors in three sectors of bioeconomy: agriculture, forestry and fisheries. Because of broad coverage and the diversity of actors, the results of this study can only be seen as an initial exercise highlighting some general trends and drivers. Thus, the application of the methodology in individual companies would require a much more detailed and specific analysis, taking into account the particular product/service portfolio, business environment and strategies in order to separate out the most important factors in each case. Hopefully, the results of this general analysis can serve as inspiration and starting point for further elaboration within companies and public actors to produce important insights to support strategic planning and decision making.

1.3 Document Structure

This document is comprised of the following chapters:

Chapter 1 presents an introduction to the project and the document, including the objective of this report.

Chapter 2 provides a brief overview of the PESTLE analysis and how to apply the results in combination with other business analysis tools.

Chapter 3 summarizes the relevant background.

Chapters 4 to 9 analyse political, economic, social, technological, legal and ecological factors related to the use of Big Data technologies. Each of these chapters includes: a description of the PESTLE factor; definition and identification of significant issues; examples of issues and their impact on DataBio sectors; and a summary.

Chapter 10 provides conclusions.

Chapter 11 lists sources referenced in the text.

2 About PESTLE analysis

PESTLE is a strategic analysis tool that considers important elements of the operating environment that have an impact on the organisation and its operation [REF-01].

2.1 Purpose

The PESTLE Analysis supports companies' strategic planning by providing insight about external environment in which the companies operate. By analysing political, economic, social, technological, legal, and environmental aspects of the environment, companies get a comprehensive picture of the status and trends of important factors that are beyond their control but have an impact on their businesses.

2.2 Limitations

The PESTLE Analysis only aims to identify external factors. It does not provide solutions or strategies to deal with the individual factors.

In particular, this report focuses on a narrow subset of the external environment, namely factors that are directly related to the use of **Big Data** within the **bioeconomy** sector. As part of a comprehensive strategic planning companies need also to analyse the PESTLE factors from other viewpoints.

2.3 Use of the results

PESTLE analysis helps companies develop scenarios for strategic planning. Depending on the business, the importance of the different factors will vary. Companies may rank the factors based on their likelihood and expected impact in order to align their business strategies according to the most relevant elements of their operating environment. As the PESTLE analysis only considers external factors, the results should be used in combination with the analysis of internal factors and other tools to support strategy. Identified PESTLE factors may for example feed in to the threats and opportunities sections of a SWOT analysis.

3 Background

Big Data technology has been characterised as "A data revolution where information from virtually every aspect of life in the modern world [...] is being converted into machine-readable data that we can analyse algorithmically to discover new insights and make faster, more accurate decisions. The outcome is a vast new array of opportunities to spur economic and social progress".

A technology with such wide applicability and profound impact will inevitably be linked with major political, economic, social, technological, environmental, and legal questions in society. The development of these factors forms a continuously evolving landscape in which companies dealing with Big Data technologies have to operate, face challenges and find solutions leading to new business opportunities. It is therefore of crucial importance for companies to understand the impact and potential changes of these key factors, in order to find robust business strategies.

The following general trends may serve as background to the current analysis:

Data-driven innovation in Europe will require access to three things: **reusable data**, including personally identifiable information; **IT capital**; and a **skilled workforce**. Big Data and digital platforms require a clear and supportive **regulatory environment**. A shift in the EU regulatory environment is needed [REF-02].

Slow productivity growth: Over the last 20 years, Europe's productivity has grown slower than prior periods and slower than the United States [REF-03].

Growing interest among countries: Germany has formulated an "Industry 4.0" initiative to transform its manufacturing sector by leveraging data and connected devices, UK is leading the open data evolution, and the Netherlands have one of the most advanced smart city projects in the world (European Parliament, 2016). The Internet of Things (IoT) and advances in sensor technologies produce increasing amounts of data at lower cost from all kinds of devices at higher speed and accuracy regardless of physical distance. New technological frameworks and platforms are needed to manage this data. The World Health Organisation (WHO) has formed an ecosystem within and between countries to gather health data via sensors, wearables, and monitors. They work together with the Health **Ethics** and **Policy** Lab at the University of Zurich to focus on policy challenges in personalised medicine and digital health.

In relation to the three sectors in DataBio, Europe is lagging behind the US in data-driven **agriculture** development and investments. However, there is a growing interest and support for Big Data technologies in agriculture and more projects are receiving funding from the European Commission, Also, in the Climate Change for Agriculture and Food Security (CCAFS), researchers use Big Data analytics to show how weather and climate variation impacts crop yields [REF-04], [REF-05].

According to the World Bank, **fisheries** are an underperforming asset whose production could be increased by 50bn/ year. There is growing interest in the fisheries industry for the use of Big Data combined with sensor technology to monitor and control the location and amount of fishing activity. Big Data projects will also help monitor (over-)fishing [REF-06].

In **forestry**, new technologies are being developed which gather more accurate information about trees from a host of sensors. Global Forest Watch [REF-07] is an online platform, which uses satellite images to provide real time data on forests and enable companies to track deforestation and to better manage forests. Currently 70% of Finnish forestry estates have laser scanned forest management plans available online free of charge [REF-08]. The coverage will be 100 per cent by 2020.

In the following chapters, each of the PESTLE factors and their potential impact on the application of Big Data technology in bioeconomy are analysed.

4 Political factors

4.1 Description and overview of political factors

Bioeconomy deals with exploitation of natural resources for economic gain. The efficient and sustainable use of these resources is a societal interest and, therefore, an important subject for political discussion and decision-making.

In the EU, the goal of an increasing political and economic integration is supported by common policies and activities. While the extent of European integration is the subject of continuous political debate between and within the member states, many common measures concerning a sector or activity eventually lead to a ''common'' or ''Union'' policy. Changes in public sentiment and the political development in countries participation in defining common agendas may be significant indicators to follow.

This section analyses political actions and changes that may affect Big Data actors in the field of bioeconomy.

4.2 Definition and identification of relevant political factors

Political factors include regulations at national, European and global level as well as political stability and predictability issues that may have an impact on business decisions and RTD investments.

The following viewpoints may be considered when identifying political factors:

- Current legislation
- Future legislation
- International legislation
- Tax policy
- Regulatory bodies and processes
- Government policies
- Lobbying and pressure groups
- Political conflicts and stability

Political concerns relating to Big Data and actions taken to relieve these concerns are listed in Table 2. Examples of political issues and their impact on DataBio sectors are presented in section 4.3.

Table 2. Political Concerns

Big Data Concerns	Big Data Facilitation
Use and Misuse of Data: The question is about who retains ownership of information from devices and apps helping farmers to make on-farm decisions i.e. manage and identify weeds (Bronson, 2016).	**Better Transparency:** Issues of inadequate transparency and a lack of understanding among users are being addressed with new EU wide (Digital Single Market) reforms.
Political Instability: Top EU agriculture producers are Spain and Italy. Both countries rank moderately high in political instability (Eurostat, 2015).	**Building Trust:** The EU data protection reform will better protect user information and foster trust. In 2016, EC has launched a Public-Private Partnership on cybersecurity to build cybersecurity solutions for various sectors.
Better Access to Data Needed: Individual Fishermen do not have the time or skill to sift through large quantities of data, therefore regulations need to be put in place so that firstly information is available and understandable.	**Limit Illegal Fishing:** EU Regulation to prevent, deter and eliminate illegal, unreported and unregulated fishing (IUU) has been introduced and facilitated via the use of Big Data.
	Availability of Funds: EU funds several Fisheries projects e.g. datACRON, which is a project that uses Big Data to sense abnormal activity in large fleets (Ship Technology, 2017).
Lack of Forest Regulation Consistency: EU forest laws are EU country specific. Although an EU Forest Strategy was introduced in 2013, there are no clear regulations involving Big Data in this sector (Council of The European Union, 2014).	**Interest in Big Data:** The EU adopted a communication on the EU Forest Strategy in 2013, which highlights resource efficiency and optimisation. Big Data will be an important facilitator (Eurostat, 2017).

4.3 Examples of political issues and their impact on DataBio sectors

This section summarises identified political factors and their impact on three bioeconomy sectors agriculture, forestry and fisheries.

4.3.1 Data ownership and use

Issue	Impact
There is increasing concern about the **use and misuse of data** collection. Difficulties arise when this is not clearly defined. For example, who retains ownership of data and information from apps helping farmers to manage and identify weeds, there may be privacy implications since data is gathered directly from farmer's land. Questions arise about the data used for profit maximising purposes such as innovations of new chemical products.	Issues of inadequate transparency and a lack of understanding among users are being addressed with new EU wide (Digital Single Market) reforms. http://journals.sagepub.com/doi/pdf/10.1177/2053951716648174

4.3.2 Reforms and Regulations

Issue	Impact
EU Data Protection reform will require companies to publish transparent and accessible data protection policies.	This is positive for users since it **stimulates trust** from a better understanding of data protection policies.

4.3.3 Overall sentiment and situation

Issue	Impact
Farmers are **limited from accessing** and interpreting data generated from various technologies, and are thus at a disadvantage compared to large corporations.	Policy must ensure the **fair distribution of data** to users. It would also be beneficial to involve farmers in determining which data should be collected and in which way since this can insure that Big Data is and stays relevant for farmers. http://journals.sagepub.com/doi/pdf/10.1177/2053951716648174
Consumers are **increasingly concerned about privacy**, which puts pressure on states to protect data.	**This creates barriers** for data sharing and data use. In fact, the EU has the highest data protection standards in the world. http://ec.europa.eu/justice/data-protection/files/data-protection-big-data_factsheet_web_en.pdf

4.3.4 Digital Single Market

Issue	Impact
Aim: to enable **fewer barriers** and **more opportunities** which will enable businesses to trade and innovate freely. This includes the free movement of goods, persons, services, capital and data. In 2016 EC has launched a **Public-Private Partnership on cybersecurity** to build cybersecurity solutions for various sectors such as energy, health, transport, finance.	**Fewer barriers** will help to facilitate the faster and easier sharing and use of data. European wide cybersecurity solutions will help tackle privacy concerns as well as foster a better understanding of security in Europe overall. http://ec.europa.eu/justice/data-protection/reform/index_en.htm
All companies operating in the EU must follow the same **data protection** and data sharing regulations, regardless of whether they are based in Europe or not.	This makes it a lot easier to control **data sharing and handling** activities. It also ensures greater transparency for consumers. http://europa.eu/rapid/press-release_MEMO-17-1441_de.htm
The **EU-US privacy shield agreement** allows data from the EU to be transferred to the US, provided that the data processing in the US complies with regulations approved by the European Commission.	The EU-US agreement enables the sharing of information more globally while maintaining consistency in transparency of data use. http://ec.europa.eu/justice/data-protection/international-transfers/eu-us-privacy-shield/index_en.htm

The EU data protection reform is to ensure that the personal data of victims, witnesses, and suspects of crime are duly protected and will facilitate cross-border cooperation in the fight against crime and terrorism. More than 90% of Europeans say they want the **same data protection rights across EU**. In December 2016, an agreement was reached in which personal data is protected from processing and the free movement of such data. A further directive states that personal data can be processed by competent authorities for investigation, prevention of offences etc.	This further strengthens the **'right to be forgotten',** which in turn fosters people's trust in online services and the digital economy in general. http://ec.europa.eu/justice/data-protection/reform/index_en.htm http://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=52404

4.3.5 Political stability

Issue	Impact
BREXIT led to financial market instability. EU - UK partnerships will need to be reformulated. It can also lead to a spill over effect causing local political instability in countries with Eurosceptic parties i.e. Spain. Spain and Italy ranked moderate-high in political instability in 2015 (The Global Economy).	**Lack of focus** or common agreement of issues regarding Big Data. Higher politically instable countries such as Greece, Spain and Italy, where the agricultural industry is a large part of the economy, may also negatively affect public sentiment about collecting and sharing more information online due to increased insecurity and mistrust. http://www.reuters.com/article/us-britain-eu-ecb-idUSKCN0Z60G1
Political instability in countries that are large producers of agricultural products such as Italy and Spain may make Big Data collection processes more complex.	**Companies may not trust country policies** and may be against the collection of sensitive information. On the other hand, EU wide standardized and more transparent policies such as the EU data protection reform may facilitate user trust. https://ec.europa.eu/agriculture/sites/agriculture/files/statistics/factsheets/pdf/eu_en.pdf
The largest fishery producers in Europe are: Spain, UK, Denmark, and France. Apart from Spain, the three countries mentioned have low political instability.	Generally, the risk is low due to moderate to high political stability. This means that there is trust in these countries, which aids the evolution of Big Data. http://ec.europa.eu/eurostat/documents/3217494/7777899/KS-FK-16-001-EN-N.pdf/cae3c56f-53e2-404a-9e9e-fb5f57ab49e3
Germany, France and the Czech Republic have the **largest forestry output** in Europe. The political instability of these countries is moderately low.	This means that forestry-producing countries do not pose a political threat in terms of instability. This is good news for Big Data since consumers and providers do not need to worry about overcoming this potential threat. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=for_eco_cp&lang=en

4.4 Summary of political factors

Political factors include political stability, government policies, and activities of regulatory bodies and lobbying groups that may affect business through legislation, fiscal policies, rules and regulations. Political factors are closely tied to legal factors but are more focused on the underlying drivers and the political process eventually leading to binding legislation.

The main political concerns relating to Big Data has to do with **transparency**, **access** and **use** of data resources, especially data containing personal information. The balance between private and corporate interests is a political issue affecting companies and citizens everywhere. Different approaches to the accessibility and use of data in different parts of the world drive costs and put companies in different positions based on where they operate.

The EU constantly works towards unifying legislation across Europe as part of its common policy goal. Protection of privacy and controlling the collection and storage of personal data are high priorities. The General Data Protection Regulation (GDPR), which enters into force in 2018, is a significant step in this regard and has a strong impact on data collection and management practices on many levels. This has clear implications on the Big Data industry.

5 Economic factors

5.1 Description and overview of economic factors

With products and services based on existing Big Data technologies, developed to meet identified needs, companies need to align their strategies within the constraints of external economic realities in order to gain competitive advantages and sustainable success. In addition to purely market driven factors also government priorities may affect economic conditions trough public spending or fiscal measures.

In the agriculture sector, the EU has implemented a Common Agriculture Policy (CAP), which includes income support, market measures and rural development measures to improve productivity of the European agriculture. Agriculture is supported almost exclusively at the European level, unlike most other sectors of the economy for which the responsibility lies with national governments. In 2016, the common agricultural policy budget was €61 billion or about 40% of the EU budget [REF-09].

Precision agriculture (PA), or precision farming, is a modern farming management concept using digital techniques to monitor and optimise agricultural production processes. PA methods promise to increase the quantity and quality of agricultural output while using less input (water, energy, fertilisers, pesticides…). The aim is to save costs, reduce environmental impact and produce more and better food. The methods of PA rely mainly upon a combination of new sensor technologies, satellite navigation and positioning technology, and the Internet of Things.

With regards to the forestry sector, the EU currently contains 5 % of the world's forests and EU forests have continuously expanded for over 60 years, although recently at a lower rate. EU Forests and Other Wooded Land now cover 155 million ha and 21 million ha, respectively, together more than 42 % of EU land area [REF-10]. In 2010, 60.3 % of the EU-28's forests were privately owned. Rural development funds can support the implementation of sustainable forest management by the Member States. Co-financing of forestry measures under the Rural Development Regulation represents the main means of EU-level funding for forests [REF-11]. Effective utilization of available forest resources can be facilitated by easy access to up-to-date information on forests enhancing the utilization of available forest resources. Better data enables more efficient and higher quality planning and operations in the entire wood supply chain.

With regards to the fishery sector, in the European Union, both marine fishing and aquaculture are heavily regulated sectors. A considerable amount of data is collected about the species caught or produced, employment, income generated and other sector-specific indicators. The sector employed around 109 000 FTE and generated income of €7.0 billion in 2014 [REF-12]. The reform of the EU's common fisheries policy that took effect in 2014 aims to secure fishermen's livelihoods, while stopping overfishing and the consequent depletion of stocks. The European Maritime and Fisheries Fund (EMFF) is one of the five European

Structural and Investment (ESI) Funds, which complement each other and seek to promote a growth and job based recovery in Europe [REF-13].

5.2 Definition and identification of economic factors

Economic factors include long-term trends of global economy as well as fast market fluctuations, costs and competition, as well as economic implications of political decisions, taxation and legislation.

Questions to consider:

- Economic growth
- Interest rates
- Inflation rates
- General taxation issues
- Taxation specific to product or service
- Technology costs
- Competition
- Producer cost and prices levels
- Customer/end-user drivers
- Market routes and distribution
- Specific market factors

The situation for Europe is more urgent than for other parts of the world. Over the last 20 years, Europe's productivity has grown slower than prior periods and slower than the United States. Europe needs to improve productivity to grow.

Table 3. Economic Concerns

Economic Concerns	Big Data Facilitation
Big Data are an excellent source of **potential value**, but this value is of limited **economic** value in its **raw** form, a fact that make organizations discover that one does **not monetize** Big Data by directly selling them.	(Raw) Big Data are refined with **analytics** that have more potential value in the form of **customer**, **product** and **operational** insights. Therefore, organizations actually monetize the Insights buried in the data (i.e., customer purchase behaviours, product performance tendencies, new market demands, cyber security prevention) to uncover unmet customer and market needs that are the basis for new products, services, channels and markets.
Economic value of Big Data: Big Data do not have an innate fixed value, especially as compared to traditional assets. This fact makes determining the **economic value** of data very difficult, and maybe even irrelevant, using traditional accounting techniques. However, the economic value of data can have a multiplier effect, being used simultaneously across multiple business use	Big Data **Value Creation Framework**: Big Data have three **Intellectual Capital** (IC) dimensions: • Data • analytics and • use cases.

cases, increasing its financial and economic value to the organization [REF-14].	These three entities create the three "dimensions" of a so-called Big Data IC Rubik's Cube [REF-15]. The alignment of those IC dimensions is critical for the organization's ability to optimize key business processes, uncover new monetization opportunities and create a more compelling user engagement. Identifying, prioritizing and quantifying the business use cases are key activities to effectively align and coordinate the organization's data and analytic assets, as well as the corresponding financial and human **investments**. If not aligned to the organization's key business use cases, the organizations may end up with missing or misaligned data and ineffective or orphaned analytics that yield suboptimal (or even the wrong) business outcomes.
Using traditional accounting practices to calculate the **Economic Value of Data** (EvD) one cannot accurately capture the financial and economic potential of the data asset.	We need to transition the EVD conversation away from the accounting retrospective of what we paid to acquire the data, to a data science predictive of how the data is going to be used to deliver "value in use".
Scarcity of data: organisations may have insufficient resources, goods or capabilities to achieve their objectives that may vary from a **limited** pool of data to limited analytics resources.	Additional **analytical capabilities**, **tools** and methodologies are being developed to serve the high demands in data (higher than the data supply itself). Good **consultancy** services are also necessary.
Profit potential: Cost-effectiveness for businesses of all sizes: Value is always at the forefront of decisions around Big Data use. A **barrier** for companies using Big Data is finding a **balance between cost and access**. Moreover, given the personnel hours absorbed by data cleaning, management, and analysis, these are not insignificant considerations when weighing costs of expanding datasets.	A **cost-benefit** analysis and a clear **profit model** are essential and should be applied to all elements of a Big Data strategy. Businesses should take into account potential future uses of any data that might be collected, especially if a traditional "purely myopic" cost-benefit analysis does not look favourable [REF-16].
Collecting and **storing** (Big) Data is becoming much cheaper, but **it is not free**. However, **sophisticated data analysis** operations require equally sophisticated hardware and software infrastructure, and therefore, a range of companies have emerged with the capability to supply this "physical" infrastructure.	Data collection and storage **becomes cheaper**, analysis faster, and tools progressively streamline reporting and analysis, technological advancements increasingly drive strategic decisions. However, strong leadership towards an awareness of the limitations of large datasets is needed, especially regarding **maintenance** and **usability**, and how this is integrated into a **profit** model, so as to maximise lucrative engagement with the data. Therefore, the expanding technologies around the generation, management, processing, and storage of Big Data, although they provide a lot of business opportunities, they still must be **balanced** against benefit and value.
The **monetary cost** of **mining** Big Data in the **cloud** can still be unexpectedly high. Mining Big Data often requires tremendous computational resources.	It is often more preferable to achieve a sufficient accuracy, e.g., 99%, at a much lower cost, e.g., 10%, than the cost of achieving the 100% accuracy [REF-17].

The vast number of online prices displayed on the web are a source of Big Data which seems to have potential in various **macro and international economic indicators' nowcasting and forecasting** (e.g. GDP, CPI inflation, etc.) and this is something which has not been extensively studied up to now	**Big Data** have the potential to improve statistics and **empirical research** in economics, by combining both empirical and online data, providing the economists with greater opportunities to stop treating the data as "given" and get directly involved with data collection. An example of how this can be achieved by using Big Data is described by the work carried out in the **Billion Prices Project at MIT** [REF-18], emphasizing key lessons that can be used for both inflation measurement and some fundamental research questions in macro and international economics. In particular, this example shows how online prices can be used to **construct daily price indexes in multiple countries** and to avoid measurement biases that distort evidence of price stickiness and international relative prices. In a relevant research study, 43% of participants believe that the use of Big Data in financial analysis will affect the industry significantly and 42% think the low or negative interest rate environment will drive major changes in the industry [REF-19].
There is a real **diversity of Big Data business models** representing an interdependent data ecosystem of businesses and other stakeholder organisations. These are often **dependent** upon each other's products and services so the vitality of the sector, as a whole, is crucial REF-20.	Data must be **central to the business** model, integrated into the core of business, not as an add-on or afterthought, driving real-time decisions. Big Data businesses can essentially be categorised as **data users, data suppliers, and data facilitators.** These are not mutually exclusive and many firms engage in a range of activities. This categorization facilitates business modelling, giving directions on the use and exploitation of Big Data value.
The **flow of vessels and seafood products** in and out of ports provides a wealth of information about the global fishing industry. However, the **economics of the seafood industry** are not reflected in their full extent as illegal fishing is still entering the market. The production of seafood is a **growing industry** depended upon by billions, both for food and livelihood. **Illegal, Unreported and Unregulated (IUU) Fishing activity** has the potential to topple food and **economic security** by undermining the ability to appropriately **manage this resource**. It's hard to quantify the impacts of the illegal activity without knowing its full extent, but one worldwide analysis put the value of illegal fishing losses between 10 and 23.5 billion annually [REF-21].	FAO Port State Measures Agreement (PSMA) [REF-22] is an EU Regulation to prevent, deter and eliminate IUU that has been introduced and facilitated via the use of Big Data. Designed to combat illegal fish product from entering markets, the PSMA is an international treaty that sets minimum standards for nations to abide by when fishing vessels or carrier vessels come into port [REF-23]. This treaty, **combined with the acquisition of data** on vessel activity out at the sea, resource managers, scientists and conservationists will have a better understanding of how much marine life is removed from the ocean every year and how much effort is going into fishing, as well as the economics that underpin the seafood industry [REF-24].
In Fishery official capture production figures and stock assessment are **uncertain** in some countries as there is **poor quality of catch data and/or low data availability**. It is well known that data collection systems for inland water catches in several countries are **unreliable or non-existent**. Recent findings by FAO have shown that official	Efforts to improve data availability and statistics in support of **blue growth** and advice on best practice, such as the Guidelines to Enhance Fisheries and strengthen fishery data collection systems should be fostered. Improvements to national data collection

statistics were based on target levels rather than on real data collection.	systems usually produce **increased registered catches** due to better system and improved coverage. Aquaculture Statistics through a Census Framework [REF-25], should improve reporting by encouraging countries to enhance reporting on small-scale operations through census and survey questionnaires. Greater focus on the **socio-economic** contributions of even occasional engagement rather than on purely **economic** contributions should help encapsulate more of the people who engage in the sector. FAO is now in contact with Departments of Fisheries, both to run pilot projects to improve data collection in regions (with a view to extending this to the whole country), but also to revise together the **official capture production figures** for the last 10–15 years. Global coverage of aquaculture production statistics has improved at an extent, with a record 200 countries and new territories now included in the FAO database.
Low volume and/or low data quality, lack of regulation, conservation and sustainable management practises prevented the **fishery sector** from constituting a **sustainable** economic sector. The overall **value generated** by fisheries services is not yet fully available, as usually they are recorded together with services related to other activities.	The concept of a "**blue economy**" came out of the 2012 Rio+20 Conference. It emphasizes conservation and sustainable management, based on the premise that healthy aquatic ecosystems are more productive and a must for **sustainable economies** [REF-26]**.**
In view of the growing data volume, there is a need to ensure that data acquisition and data analysis is as **cost-effective** as possible.	A combination of methods in data collection, such as Airborne Laser Scanning (ALS) and Terrestrial Laser Scanning (TLS), can be combined so as to measure and correlate numerous tree and agriculture attributes, gaining proper and more **accurate and precise insight** Also, the offset of those high costs should be shifted to commercial agents who are contracted for this initial data collection stage. In order to acquire consistent and transparent data gathering and dispensation, the inventory data standards are set and the commercial agents are observed [REF-27].
Foresters need **more and better data** to make better decisions. Up to now, there are not sufficient levels of the suitable forest-related data available to make the right data-based decisions for sustainable forestry.	This need is covered by the constantly evolving technologies of Big Data, Cloud Data and the Internet of Things, which deliver new levels of data and information. Dramatic increases in computing power, improved networking and data analytics are leading to greatly improved business performance [REF-28].
Time and cost constraints and a rising need to do more with less resources, even in the case of high availability of (Big) Data coming massively from foresters on the ground, harvest machines, drones, satellite etc., create	An **integrated forest information system** (platform) that would be able to connect with similar existing systems and manage the massive and constantly growing number of Big Data coming from (various sources as mentioned before) will enable easier and

the need for an overall data analysis solution, so as to enable efficient prediction and decision making.	quicker monitoring, management and decision making, offering a profound impact forest sustainability, increasing profits, reducing costs whilst delivering improved customer service [REF-29].
Differences in national data protection regulations, in turn, together with differences in data standards, also pose a challenge, in the form of our *global* ability to collect, aggregate, disseminate and share data. In today's interconnected world, a global approach to data collection is a prerequisite for developing a coherent view of the global economy and financial system, and for identifying vulnerabilities. But many legal hurdles to cross-border data sharing remain to be overcome, and implementation gaps to be filled, if the intended benefits of the data harmonisation reforms in the financial field are to be fully achieved [REF-30], [REF-31].	Within the EU, measures towards a **single market** limit the national barriers. At a global scale, **international agreements,** e.g. under the World Trade Organizations, allow more uniform data protection. Overcoming national barriers allow **new business** and higher **productivity**. For example, new fintech firms will be able to use Big Data to design new tailor-made products and to allow real-time access to financial services anywhere and at any time. This can be expected to foster productivity. At the same time, regulators need to be mindful of the potential financial **stability implications**, in particular, if incumbents fail to rise to the challenge, and fintech firms thus, start to crowd banks out of a large range of financial services. Granting access to Big Data therefore, has the potential to shift economic structures [REF-31], [REF-32].
The **cost of collecting** or acquiring **forest data** has also been a problem for the industry and decisions without proper data cannot be relied upon to improve profitability and sustainability [REF-33].	An increasing level of innovation in the abovementioned technologies (Big Data, Cloud Data and IoT) is delivering to foresters cutting-edge technology imaging laser scanners, along with drones with higher levels of centimeter resolution imagery and all those at a low cost base. Combining both the laser and drone data is giving new insight into the contents of the forest and we are moving ever closer to a total census of the forest. The usage of IoT technologies to serve forestry needs is expected to create a new era and new type of technology, the so-called "Internet of Trees".
Regarding **Big Data revenue**, there is a challenge to make Big Data solutions **affordable** for farmers, especially for those in developing countries.	If there will be more users of Big Data applications it will lead in its turn to more valuable data, often referred to as the reciprocal value of Big Data [REF-34]. This is a very important feature that needs to be carefully implemented in companies' strategies.
Regarding Big Data **costs** in agriculture, the challenge is to automate data acquisition in such a way that there are **virtually no costs**. Because on-farm data will generally remain in the hands of individual companies, **investments** are needed in a common pool infrastructure to transfer and integrate data and finally make applications out of it. Like in many other scientific domains, forestry researchers traditionally rely on their own peers and scientific networks when collecting the data required for their work. Only recently, the forestry	Such a common pool infrastructure has been proposed to be the **Agricultural Business Collaboration and Data Exchange Facilities** (ABCDEFs) [REF-35]. An important question concerning these ABCDEFs is if these will be closed, proprietary systems such as currently Monsanto's FieldScripts or if these will be more open as proposed by e.g. the OpenATK or the FIspace platform.

research community has started to **harmonize and share their data**, especially in the area of genetics. However, a lot of relevant data is still stored in silos, sometimes even in local or private repositories. Moreover, datasets often are **not documented with appropriate metadata**. In many cases, researchers do not see the benefits of documenting data, or data is consciously kept private for example because associated research results are still to be published or because of fear for Misuse.	Interdisciplinary approaches are needed to be applied, like integrated modelling [REF-36], to better sync and align the work and activities in the domain.
From a business perspective, farmers are seeking ways to **improve profitability and efficiency** by looking for ways to **reduce their costs and obtain better prices** for their product. There is an increasing need for information and knowledge that is generated on-farm in its local-specific context instead of advisory services that were based on general knowledge that once was derived from research experiments.	It is expected that Big Data technologies will help to achieve these goals in a better way [REF-37], [REF-38]. A specific circumstance for farming is the influence of the weather and especially its volatility. Local-specific weather and climate data can help decision-making a lot [REF-39]. A general driver can be the relief of paper work because of all kind of regulations in agri-food production [REF-40].
A "handshake deal" between farmers is not enough to settle the **data ownership out of a farmland**. Agriculture is changing and the (Big) Data generated on farmland is becoming more and more **valuable**. As the industry grows, more complex farm data information will be produced, having value to both landlords and tenants, especially when it comes to **negotiate farm rental rates**. Landlords and tenants will both have an idea of what the farm is producing, and the level of inputs required, giving both parties a good idea of what the farm is capable of producing. For example, there might come a point in the future when landlords without access to this data could be forced to take lower rental rates than those with access.	**Farm data is valuable information** (yield data, the amount of inputs utilized, soil mapping, nutrient levels, etc.). When farmers understand the soil's properties and growth potential, then they are able to take into account the total costs and total return [REF-41]. Therefore, data ownership must be clearly defined in farm leases, in terms of - Defining what the data is; - Defining early who owns this data; and - Specifying how data is shared or not shared between landlord and tenant and that data is transferred to the landlord at the end of the lease [REF-42].
Behind Expectations: Online marketplaces are still mainly domestic in terms of online services and only 7% of small and medium sized businesses in the EU sell cross border.	**Digital Single Market:** The aim is to reduce barriers to enable the free movement of goods, persons, services, capital and data. All companies operating in the EU have to follow the same data protection and data sharing regulations, regardless of whether they are based in Europe or not.
The financial crisis reduced the income of the farmers, lowering the price of their products, while the price of the inputs remains practically the same. The crisis also limits the farmers' ability to receive credit from banks.	This has a great impact in terms of **Big Data enabled solutions acceptance**. The farmers, especially the small farmers who are the vast majority of farmers in countries like Greece, can afford only very inexpensive services and only if they offer real value to them. On the other hand, it increases the value of such solutions, as they can help solve the farmers' problems.

Input costs are very high (fertilisers, pesticides).	This is a threat for Big Data enabled solutions, because it limits the resources available to farmers to buy these solutions. Most importantly, it is a major opportunity since they have an increasing need to minimise the use of inputs, using tools like the ones offered by the DataBio partner Neuropublic.
Competitiveness of EU farming.	Farm holdings will apply **Precision Agriculture** technologies to produce 'more with less', increasing the competitiveness of farm holdings and agri-food chains. Large farms will benefit the most [REF-43].
Fuel consumption in fishery. Fuel consumption is a challenge for most fisheries, as it represents 60-70% of total annual cost of a vessel activity.	Reduced energy consumption and emissions through **efficient fishery planning** and operation with better information services.
Catch optimisation in fishery. A key challenge for the fishermen and shipping companies is to locate the fish as efficient as possible to reduce the time and energy needed to fill the quota at a time when prices are good.	There is great potential for leveraging Big Data technology, and especially **descriptive and predictive analytics**, to optimize the catch process both in terms of where the fish is, but also what the expected market value will be.
Forest monitoring. Forests occupy large land areas that are difficult to access. Getting a comprehensive assessment of the forests health and available wood resources is slow and expensive.	**Hyperspectral imaging** from small, unmanned aerial vehicles (UAV) offers agile type of remote sensing. Satellite data can be locally magnified by UAV hyperspectral data to get information about individual trees, including their specie and health status via more accurate radiometric image and accurate heights via more precise canopy height model.

5.3 Examples of economic issues and their impact on DataBio sectors

5.3.1 Funding and grants

Issue	Impact
The EMFF is the fund for the EU's maritime and fisheries policies for 2014-2020. Its aim is to support the growth in the fisheries industry. FARNET - the European Fisheries Areas Network is a space created for members of the community to come together to discuss and tackle challenges in the fisheries market. The datACRON is a project, which uses Big Data to sense abnormal activity in large fleets.	With this funding and better access to Big Data, fishermen can improve their productivity and reduce costs. Farmers can also use these partnerships to have a voice in which information they would find useful and thus have the opportunity to influence Big Data evolution in their industry. This gives greater transparency and insight, which may be used to more productively plan the activities of fisheries. https://ec.europa.eu/fisheries/cfp/emff_en http://cordis.europa.eu/project/rcn/199835_en.html

5.3.2 Resource efficiency

Issue	Impact
The EU adopted a communication on the EU Forest Strategy in 2013, which highlights resource efficiency and optimising the contribution of forests to rural development.	This creates an incentive to use Big Data to improve efficiency within the forestry sector motivating users to be receptive to Big Data usage opportunities. http://ec.europa.eu/eurostat/web/forestry/overview/policies

5.3.3 Barriers

Issue	Impact
EU General Data Protection Regulation threatens to expose companies to substantial new penalties for any compliance violations.	This means that organizations are increasingly reluctant to implement data-driven strategies that carry a large measure of legal, and therefore, financial and reputational risk.
A barrier for companies using Big Data is finding a **balance between cost and access.** **Hardware and software costs** to acquire, store and maintain Big Data can be quite high. Although cost is constantly decreasing and technological solutions are becoming more and more efficient, the overall cost is still considerable. Also, the personnel hours absorbed by data cleaning, management and analysis, are significant considerations when weighing costs of expanding datasets.	A **cost-benefit analysis** and a **clear profit model** are essential and should be applied to all elements of a Big Data strategy. Businesses should take into account potential future uses of any data that might be collected. https://www.oii.ox.ac.uk/archive/downloads/publications/nemode_business_models_for_bigdata_2014_oxford.pdf

Previously small companies from an EU country had to pay legal fees in order to comply with another EU country's data protection regulations. Now the standards are the same throughout EU.	Costs will be reduced via the standardised regulation, which will reduce barriers for businesses operating across EU. http://europa.eu/rapid/press-release_MEMO-17-1441_de.htm

5.3.4 Economic value

Issue	Impact
Big Data is an excellent source for potential value, but this value is of limited economic value in its raw form. Big Data is **not a commodity** and pieces of data are **not indistinguishable** from any other piece of data.	Big Data is refined with (**data**) **analytics** that have more potential value in the form of **customer**, **product** and operational **insights**. However, the economic value of Big Data is realized when the relevant analytics are "put into motion", so as to optimize key business processes, uncover new monetization opportunities and create a more compelling customer engagement. https://blog.dellemc.com/uploads/2017/03/USF-The-Economics-of-Data-and-Analytics-Final2.pdf
The economic value of Big Data can have a **multiplier effect**, being used simultaneously across multiple business use cases, increasing its financial and economic value. Big Data do not have an innate fixed value, especially as compared to traditional assets, as already explained above. Thus, their economic value is not constrained by transactional limitations. To the contrary, **data gain more value with usage**, as the more the organization uses them across more use cases, the more valuable, complete and accurate they become. These same characteristics apply to **analytics**, where analytics is basically "data" that has been refined or "curated" into customer, product or operational insights.	Big Data have **three Intellectual Capital (IC) dimensions**: **data, analytics and use cases**. These three entities create the three "dimensions" of a so-called **Big Data IC Rubik's Cube**. The alignment of those IC dimensions is critical for the organization's ability to optimize key business processes, uncover new monetization opportunities and create a more compelling user engagement. Identifying, prioritizing and quantifying the business use cases are key to effectively aligning and coordinating the organization's data and analytic assets and corresponding financial and human investments. If not aligned to the organization's key business use cases, the organizations may end up with missing or misaligned data and ineffective or orphaned analytics that yield suboptimal (or even the wrong) business outcomes. https://infocus.emc.com/william_schmarzo/the-big-data-intellectual-capital-rubiks-cube/ https://blog.dellemc.com/uploads/2017/03/USF-The-Economics-of-Data-and-Analytics-Final2.pdf
We cannot use accounting techniques to calculate the **Economic Value of (Big) Data (EVD).** Traditional retrospective (accounting) methods of determining EvD won't work because the intrinsic value of Big Data is not what one paid to acquire them, but the value is in how that data **will be used** to create monetization opportunities ("data in use").	To exploit the economic value of data, organizations need to transition the conversation from an accounting perspective (of what has happened) **to a data science perspective** (on what is likely to happen) on their data assets. That way, the calculation of the **Economic value of Data (EvD)** becomes more manageable, more understandable and ultimately more actionable.

	https://infocus.emc.com/william_schmarzo/economic-value-data-challenges/
Europe's fisheries are an important contributor to economic wealth, generating EUR 550bn annually. There is growing interest in the fisheries industry for the use of Big Data combined with sensor technology to monitor and control the location and amount of fishing activity.	Several uses for Big Data within the Fisheries industry have already been identified and put into action. Overall, the benefits of using Big Data in the fisheries industry are understood, and seem to outweigh the risks. http://www.sciencemag.org/news/2015/06/overfishing-could-push-european-fish-species-extinction
Online marketplaces are still mainly domestic in terms of online services and only 7% of small and medium sized businesses in the EU sell cross border. It is currently difficult for businesses to move large amounts of company data from one cloud service provider to another.	The Digital Single market aims to make it easier for businesses to share large quantities of data in a secure and transparent way. http://ec.europa.eu/justice/data-protection/reform/index_en.htm
Fishery is **not yet a sustainable** economic sector. The overall **value generated** by fisheries services is not yet fully available. Low volume and/or low data quality, lack of regulation, conservation and sustainable management practices.	The concept of a "**blue economy**" came out of the 2012 Rio+20 Conference. It emphasizes conservation and sustainable management, based on the premise that healthy aquatic ecosystems are more productive and a must for **sustainable economies.** http://www.fao.org/zhc/detail-events/en/c/233765/ http://www.fao.org/zhc/detail-events/en/c/233765/

5.3.5 Business models

Issue	Impact
There might be a difficulty in defining a **Big Data business model.** There is a real **diversity of Big Data business models** representing an interdependent data ecosystem of businesses and other stakeholder organisations. Notably, these are often **dependent** upon each other's products and services.	Data must be **central to the business** model, integrated into the **core of business**, not as an add-on or afterthought, driving real-time decisions. Big Data businesses can essentially be categorised as **data users, data suppliers, and data facilitators.** These are not mutually exclusive and many firms engage in a range of activities. This categorization facilitates business modelling, giving directions on the use and exploitation of Big Data value. https://www.oii.ox.ac.uk/archive/downloads/publications/nemode_business_models_for_bigdata_2014_oxford.pdf

5.4 Summary of economic factors

Big Data technology is playing an increasingly important role in driving the world's economic growth. It is expected that Big Data technology will grow global GDP by an over 2% year-on-year increase by 2020 [REF-44].

Large volumes of data are currently available, requiring careful analysis to gain the proper insights. In order to extract actual knowledge, of real economic value, an efficient combination of data and their analytics applying into certain use cases are necessary.

Data as well as analytics do not suffer from transactional limitations and do not depreciate with usage. Notably, they appreciate with usage as the data and the analytics become more and more complete and accurate. Big Data and analytics are assets that need to be accounted for as part of an organization's financial health and assets. As organizations seek to leverage data and analytics to power their business models and improve operational and strategic decision-making, organizations need to manage and account for data and analytics as corporate assets. Data and analytics will become the primary economic driver in many organizations that seek to optimize key business process, reduce security and compliance risks, uncover new monetization opportunities, and create a more compelling user experience.

Therefore,

Big Data, combined with their analytics, are powerful assets in which to invest.

Big Data sources (raw, organic data) represent a huge opportunity for profit making, as long as we understand the weaknesses of data. We will not overcome the "outsourcing" of the data acquisition and analysis. Blending raw data sources and filling in missing observations with data that can be measured otherwise, is the most efficient way to the future.

Across sectors, data are drawn from multiple sources. While sectors may rely on transactional data more heavily others, they share a dependence on diverse datasets from a mix of open and proprietary sources. Also, the consensus of novel Big Data economic datasets are that the various types of data (along with the statistical ones of the past) should be viewed as complementary as they continue evolving. It is certainly exciting to see new and interesting ways official government statistics and Big Data will complement each other going forward in the realm of economics.

Policy makers must focus on the need for Big Data from all sources as imperative and urgent requirement for positive impact on macroeconomic statistics [REF-45].

Big Data can help policymakers overcome some of the shortcomings of traditional macroeconomics providing plenty of opportunities to deepen our understanding of behavioural economics, and how psychology can drive macroeconomic developments [REF-46].

6 Social factors

6.1 Description and overview of social factors

Social factors refer to the economic and social conditions of individuals or groups of the society. These are reflected in attitudes, preferences and trends that can influence market behaviour and political decisions and eventually legislation. It is therefore important to understand how social factors may influence market demand, funding possibilities and legislation on order to determine how they may affect future business environment.

The relevant social factors and the society of interest will depend from case to case. It is also good to note that the social factors may change quickly, for example, as employment or economic conditions change. For the purpose of the DataBio project, we will look at the European market as a whole and on regional social differences that may have an influence on the acceptance of Big Data technologies in different parts of Europe.

Together with physical capital and technology, human capital is a key factor describing a society's overall development [REF-47]. Figure 1 shows a general framework describing how social factors relate and interact with other factors of development.

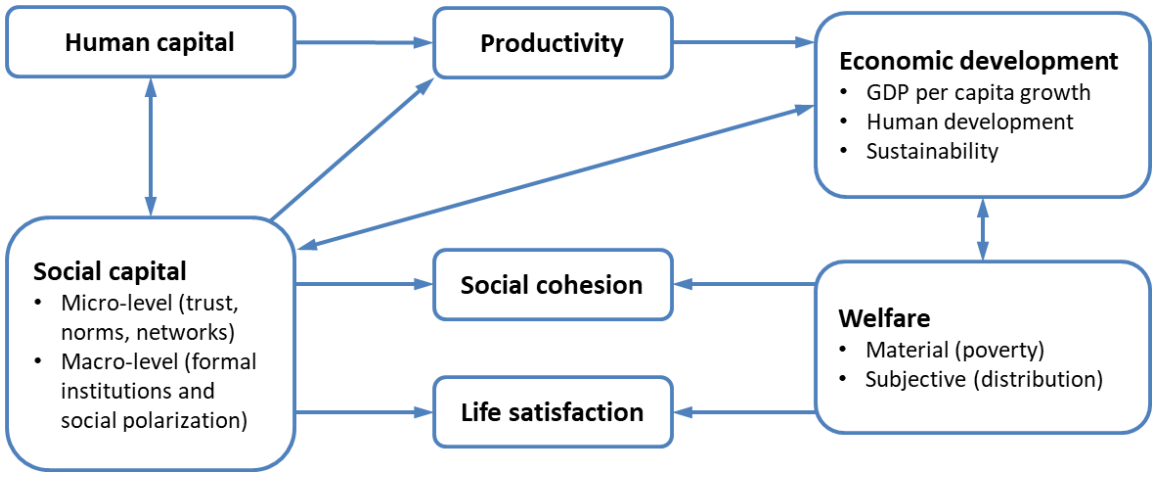


Figure 1. Social aspects and factors of economic development [REF-47]

Social welfare comprises both material welfare, such as wealth or disposable income, and subjective welfare reflecting the distribution of resources in society.

Improving working conditions, living standards and gender equality has always been a key priority in Europe. New jobs have been created since the economic crises, but there are still 1.4 million fewer jobs in the EU in 2015 compared with 2007 [REF-48]. Skilled labour is needed: there is more demand for Big Data jobs than there are available workers with the necessary skills. 32% of Europe's workforce has insufficient digital skills [REF-02]. At the same time, 17% of the 15-29 year olds are disconnected from both employment and education.

This will have an impact on the availability of skilled workers in high-tech industries and advanced end users capable of taking advantage of high tech solutions.

6.2 Definition and identification of social factors

Public opinion and societal needs are reflected in political decisions, legislation and public funding. Thus, the attitudes and priorities of individual citizens as well as social structures of society will have an impact on Big Data industry. Social factors that may be considered include:

- Health consciousness
- Population growth rate
- Age distribution
- Career attitudes
- Emphasis on safety
- Attitudes towards work
- Lifestyles
- Attitudes towards ecological products
- Disposable income

Issues relating to these factors are discussed next.

Table 4. Social concerns.

Big Data Concerns	Big Data Acceptance
Lack of Transparency: Less than 24% of Europeans know what happens with their data (Vodafone Institute, 2016).	**Willingness to Share With Value:** German users are more willing to share data when they see a clear advantage (Ecommerce, 2017).
Scepticism About Data Protection: Europeans are most sceptical about data protection methods and feel that they are no longer in control of their data (European Commission, 2015).	**Need for Transparency:** People value transparency about data collection and use. SATW (Swiss Academy for Technical Sciences) outlines the importance of ethical actions in Big Data collection and usage to earn people's trust.
Lack of Perceived Advantages: Only 32% of Europeans see more advantages in Big Data than disadvantages (Vodafone Institute, 2016).	**High Interest:** Many companies have embraced the importance of Big Data and are working on applications (City University of London, 2017).
Personal Security: In Germany and the Czech Republic, people are most concerned with not giving out their real name and data for personal security purposes. (Vodafone Institute, 2016)	**Ireland is Positive:** In Ireland however, people are more positively responsive to Big Data use and see more advantages than disadvantages (Vodafone Institute, 2016).

Selective use of Big Data: Data is being used for solely profit maximizing purposes and is not 'agriculture externalities and vulnerabilities' i.e. impact of pesticides and other chemicals on crops (Carbonell, 2016).	**High Interest:** Even small-scale farmers are gathering information from large datasets to make on-farm decisions (Bronson, 2016).
Big Data Divide: There is an unequal availability and access of information between farmers vs. large organisations (Carbonell, 2016).	**Wide Applications:** Stakeholders throughout the agri-food system are more widely affected by the applications of Big Data. Large corporations are acquiring smaller players with Big Data capability (Wolfert, 2017).
Need for Greater Accessibility: Information is not yet widely accessible for the smaller players in this market i.e. fishermen. Big Data needs to be put packaged into an easy to understand format and be available more widely (Wilkinson, 2015).	**Growing Interest:** There is growing interest in the fisheries industry for the use of Big Data combined with sensor technology to monitor and control the location and amount of fishing activity. Big Data projects will also help monitor (over-)fishing (Wilkinson, 2015).
	Better Access and Availability: Fishing Big Data is becoming increasingly accessible and available for the wider society. Global Fishing Watch, for example, is releasing a product this year that will let anyone view and interact with data on fishing from across the global oceans for free (Global Fishing Watch, 2017).
Dispersed Information: Information is currently widely dispersed and inaccessible to individual owners and smaller companies (Kitikidou, 2015).	**Growing Interest:** More attention is being given to Big Data in the Forestry sector. A study has been conducted on the impact of Biodiversity on productivity in forests using Big Data to sample over 770k forest areas from 44 countries (ForstPraxis, 2016).
Organic produce. Health consciousness, food safety concerns and ethical self-identity are driving a growing interest for organic produce among consumers.	This has a great impact in terms of Big Data enabled **solutions acceptance**. The farmers, especially the small farmers can afford only very inexpensive services and only if they offer real value to them. On the other hand, it increases the value of such solutions, as they can help solve the farmers' problems.

6.3 Examples of social issues and their impact on Databio sectors

6.3.1 Privacy Concerns

Issue	Impact
A study by Vodafone (2015) on consumer acceptance of Big Data states that people in Europe are most sceptical about the data protection methods and feel that they are no longer in control of their data. Europeans are concerned about the misuse of their data; however, the younger population segment tends to see the sharing of their information as a price for using free online services and thus view data sharing in a more pragmatic way. 64% of participants state that transparency helps build their trust. In Germany and the Czech Republic people are	Consumer acceptance of Big Data is a crucial concern that needs to be addressed and the way will impact the adoption of Big Data in Europe. http://www.vodafone-institut.de/wp-content/uploads/2016/01/VodafoneInstitute-Survey-BigData-Highlights-de.pdf

most concerned with not giving out their real name and data for personal security purposes.	

6.3.2 Knowledge and skills

Issue	Impact
Europe will face a shortfall of 900,000 IT workers by 2020. Currently the European Commission estimates that 32 percent of Europe's workforce has insufficient digital skills. To obtain knowledge, people with a higher education level search the internet more than people with a lower education level. The study also states that people share their data daily; however, they have little knowledge about what happens to this data. Less than 24% of Europeans know what happens with their data.	A concerning number of people do not have a clear overview of which data is collected and what it is used for. Lack of transparency may hinder people from trusting and using sites that collect Big Data. http://www.vodafone-institut.de/wp-content/uploads/2016/01/VodafoneInstitute-Survey-BigData-Highlights-de.pdf http://ec.europa.eu/justice/newsroom/data-protection/news/240615_en.htm

6.3.3 Benefits

Issue	Impact
Only 32% of Europeans see more advantages in Big Data than disadvantages. In Ireland, however, people are more positively responsive to Big Data use and see more advantages than disadvantages.	It is important for the Big Data industry to improve trust and its overall image so that it can expand its reach and generate valuable insights. https://bigdatablog.de/2016/01/21/mangelnde-akzeptanz-von-big-data/ http://www.vodafone-institut.de/wp-content/uploads/2016/01/VodafoneInstitute-Survey-BigData-Highlights-de.pdf

6.3.4 Transparency

Issue	Impact
A study by SATW (Swiss Academy for Technical Sciences) outlines the importance of ethical actions to earn people's trust. Furthermore, people value transparency about data collection and use.	Transparency is very important for people to be willing to share personal and other data. http://www.google.ch/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwjppKSh7NjVAhVIOxoKHXyXA7gQFgg7MAI&url=http%3A%2F%2Fwww.satw.ch%2Ffileadmin%2Fuser_upload%2Fdocuments%2F04_Footer%2F03_Medien%2F01_Medienmitteilungen%2FSATW_MM_BigData_DE_170222.pdf&usg=AFQjCNGErmGlJZUKSHwvLHruDKWmKn-VfQ

6.3.5 Stakeholder data

Issue	Impact
Big Data has implications not just for farmers but also for stakeholders throughout the agri-food system. For example, food processors are monitoring social media data in an effort to predict consumer sentiment and secure social approval. Large companies such as Monsanto acquired start-ups with technical capability to collect data. They can then combine large quantities of previously proprietary information and gain useful insights. German users are more willing to share data when they see a clear advantage. For example, 82% of car users state that information sharing between cars to inform them about accidents and traffic is very useful.	Implications for the use of Big Data within agriculture are widespread across society ranging from farmers, chemical producers, larger agricultural organisations, to consumers. The needs and interests of these stakeholder groups need to be considered. http://journals.sagepub.com/doi/full/10.1177/2053951716648174 http://www.sciencedirect.com/science/article/pii/S0308521X16303754 It is interesting to see the difference between German people's mentality when considering personal data. They shy away from any opportunity that requires them to share personal data; however, when an opportunity of value arises their concern for privacy is minimized. http://www.e-commerce-magazin.de/studie-big-data-wird-gegen-sicherheit-und-geld-eingetauscht

6.3.6 Selective use of data

Issue	Impact
Selective use of Big Data: To date Big Data has been used for efficiencies and profit maximization. Data on inputs and production has been collected. There is a lack of data collection on 'agriculture externalities and vulnerabilities', for example the impact of certain pesticides or other chemicals on crop growth. Big Data could also be useful for non-industrial farming practices.	With more transparency and better access to information, society is demanding more sustainable uses of Big Data collection. http://journals.sagepub.com/doi/full/10.1177/2053951716648174

6.3.7 Equal access

Issue	Impact
Even small-scale farmers are gathering information passively collected by precision agricultural equipment, and many farmers are using information from large datasets and precision analytics to make on-farm decisions. **Big Data Access**: At present, there is an unequal relationship between the information that is available to farmers vs. large organisations. For example, John Deere, an American Big Data provider installs sensors on tractors to gather information on soil and crop	For Big Data to be further expanded in the agriculture industry, information needs to be shared fairly, otherwise there is the risk of creating an unfair playing field especially for smaller players. Also, there is evident interest in using Big Data within the industry. http://journals.sagepub.com/doi/full/10.1177/2053951716648174

conditions. The data is not openly accessible to farmers, who need to subscribe to this data. In forestry, Information is currently widely dispersed and inaccessible to individual owners and smaller companies. This makes it difficult for the forestry sector to make most effective use of Big Data to improve productivity and growth. Fishing Big Data is becoming increasingly accessible and available for the wider society. Global Fishing Watch, for example, is releasing a product this year that will let anyone view and interact with data on fishing from across the global oceans for free. Farmers have limited access to information gathered by complex technologies belonging to larger corporations. Usually the information is only available for a price (Bronson, 2016).	https://policyreview.info/articles/analysis/ethics-big-data-big-agriculture Big Data applications within the forestry sector are still at the primary phase. Trust will need to be built in this industry and new implications explored. http://scialert.net/fulltext/?doi=rjf.2015.1.5 With more accessible information and better transparency, the fisheries industry can strongly benefit from new Big Data applications. http://www.sciencemag.org/news/2015/06/overfishing-could-push-european-fish-species-extinction http://globalfishingwatch.org/

6.4 Summary of social factors

Social factors affect companies' current and future operating environment through economic and political instruments. A positive development in employment and wealth distribution contribute to stability and confidence in society.

Big Data will increasingly touch people's lives in the coming years. However, it is still a complex and relatively new concept for the majority of citizens. Public opinion will have an impact on decision makers and markets. Only 32% of Europeans see more advantages in Big Data than disadvantages. Attitudes towards Big Data is determined largely by knowledge and understanding of the technologies and perceived benefits. Transparency regarding collected data and equal access to Big Data resources is crucial.

The availability of skilled workforce is critical. Europe will face a shortfall of 900,000 IT workers by 2020. Currently the European Commission estimates that 32 percent of Europe's workforce has insufficient digital skills.

7 Technological factors

7.1 Description and overview of technological factors

Technologies keep developing at accelerating pace. Digitalisation of almost all sectors of society has been the dominant trend for quite some time and will continue to challenge conventional solutions by offering increased capacity and lower costs. Digitalisation is also the main driver behind the growth of Big Data, both in the form of data generation and as technologies to manage and analyse massive data sets. The Internet of Things (IoT) promises to change fundamentally the industrial landscape by providing ubiquitous connectivity and accessibility of information. At the same time, technologies develop within the bio economy sector itself, for example in the form of more efficient and environmentally friendly production or logistics solutions. In many cases, benefits are sought through a combination of new technologies, digitalisation and data, paving the way for new products and services.

Global smart agriculture market is expected to grow from US$ 11.30 billion in 2016 to US$ 30.01 billion by 2025 at a CAGR of 11.5% between 2017 and 2025 [REF-49].

The forest sector is expected to become an integral component of the emerging bioeconomy, exploiting “Big Data” for unparalleled access to digital information that represents unprecedented opportunities for advancing science and supporting forest management through data-intensive approaches.

The global forest sector economy is valued at approximately US$468 billion, or 1% of global gross value added to global, and makes a constant contribution to international trade, national economies, employment, and household incomes.
Finally, the fishery sector is growing worldwide with a value today of around € 100 billion, 29 billion€ in Europe (the main market worldwide).

Figure 2 shows the word’s main trade flows and aquaculture products in 2016.

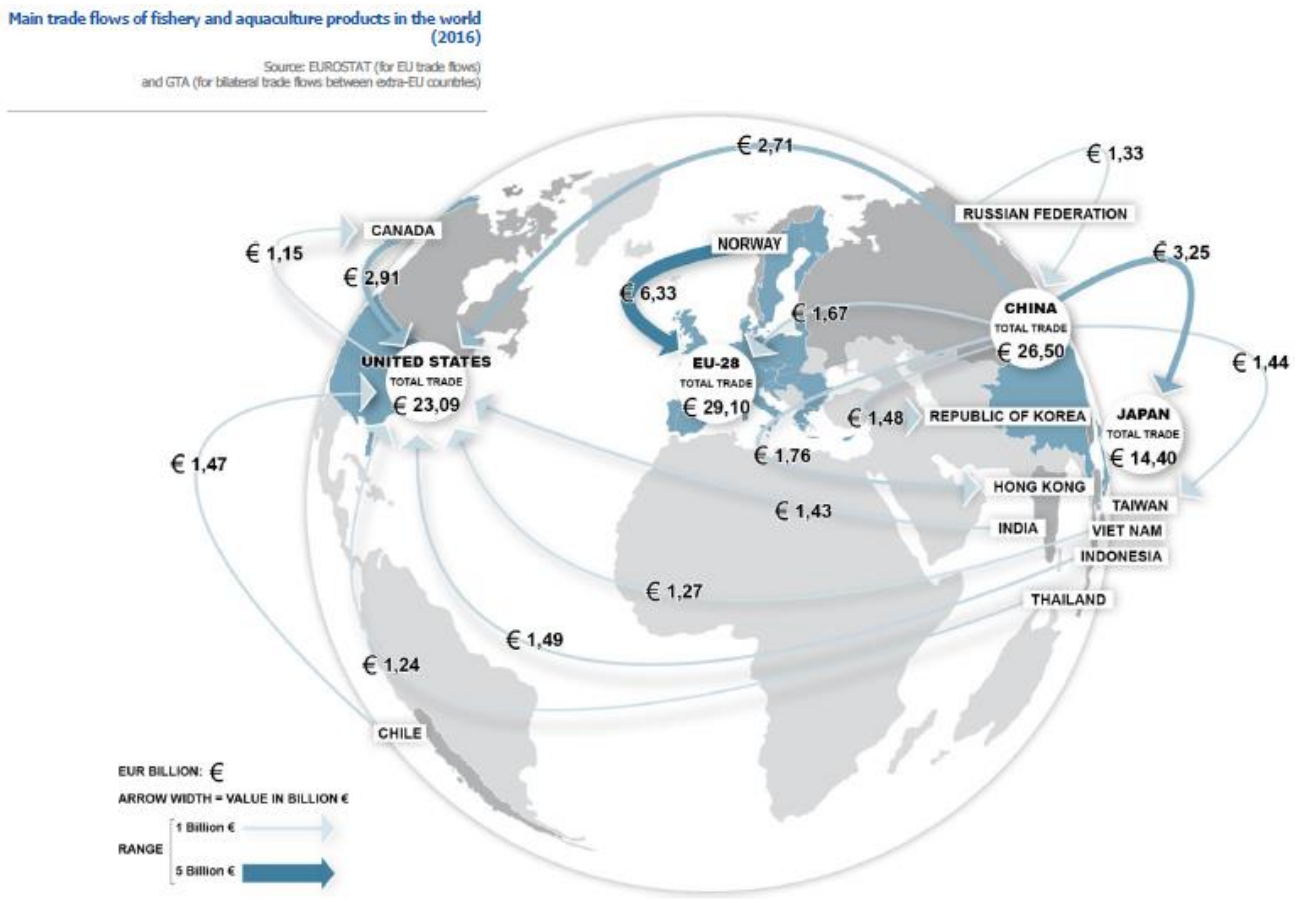


Figure 2. Fishery market worldwide [REF-50]

The main technologic needs related to smart Agriculture, Fishery and Forest are: i) Precision Farming; ii) Livestock and fish monitoring; iii) Yield monitoring; iv) Soil health monitoring; v) Irrigation system management; vi) Asset management; and vii smart greenhouse [REF-49], [REF-51], [REF-52].

All three sectors are stimulating the research and production of many different innovative solutions, mainly categorised as follows: Variable Rate Technology (VRT); Sensor Based Monitoring System; Smart Detection System; GPS Enabled Ranging System; Drones; Software; Climate Information; Supply Chain Management [REF-49], [REF-53], [REF-54], [REF-55].

Over last few decades, computing research has unleashed game-changing capabilities in smart agriculture, fishery and forestry, preserving natural resources, and contending with impending weather events. Computing components such as global positioning systems, sensors, computerized map visualization to understand inter- and intra-field variability, spatial and temporal databases to collect and query data, spatial statistical analysis to delineate management zones, spatial decision support systems, and drones. These components and capabilities enable service-based operations and decision making at multiple levels, namely, descriptive, prescriptive, predictive and proactive levels:

- Descriptive: data collection aims to characterize spatial and temporal variability in crop, fish and terrains and weather characteristics and identify stressors and traits that need better management.
- Prescriptive: Using collected data and associated maps of individual characteristics or traits, a prescriptive analysis is conducted to determine necessary management interventions.
- Predictive: Similarly, a predictive analysis that uses historic data as well as integrated models may forecast crop yield, fishes' routes and forestry growth at the end of the season.
- Proactive: Proactive involves observations of developments and stress on multiple factors over large regions and time scales. Data from these observations are pooled and mined to obtain relationships between site characteristics and performance under a range of management conditions. These relationships can be used to customize management practices and proactive reaction to changing conditions.

In general, policies related to privacy, security, intellectual property, and even liability will need to be addressed in relation to technologies and data collection. Organizations need not only to put the right talent and technology in place but also structure workflows and incentives to optimize the use of Big Data.

This chapter lists some of the technological factors that may affect various actors in the bioeconomy sector.

7.2 Definition and identification of technological factors

Big Data services build on technologies and innovations that facilitate the collection, transfer, storage and analysis of huge amounts of data. The continuous development of these enablers give rise to new service innovation and business opportunities but also pose new challenges as technologies and standards continue to evolve. Things to consider may include:

- Basic infrastructures
- R&D activity, innovation
- technological developments
- competing technologies
- related/dependent technologies
- technological maturity
- manufacturing capacity
- technology access, IPR, licensing, patents

The following section lists technological factors, which may affect the use of Big Data solutions in bioeconomy.

Table 5. Technological Concerns

Big Data Concerns	Impact
Lack of Connecting Services Connections remain a key hurdle, as connecting services have not yet reached the technical maturity level seen in other verticals, such as retail and automotive.	**Expansion of Smartphone and Internet Penetration** People are increasingly reliant on smartphones and other intelligent mediums to keep up-to-date about the latest development in their own sector. They depend upon broadband and other wireless networks to stay updated and participate in specific industry directed knowledge sharing initiatives. Collection and sharing of data is becoming more and more accessible.
Data Management for Decision Making Data aggregation and data management is a troubling obstacle. One considerable barrier in the efficient use of data is the lack of industrial standards for data management applications. The difficulty is rooted in the requirement to standardize the data management system throughout the industry to ensure the widespread uniformity of operations.	**Increasing Adoption of Technologies** Connected technologies such as low power wide area (LPWA), Zigbee, WiFi, and additional wireless sensor technologies enable to efficiently plan and execute various operations, such as purchasing, inventory control, planting, and harvesting.
High Capital Investment Requirement Farmers must lend significant initial investment to establish and revolutionize the existing field infrastructure set-up to deploy a capable and sustainable IoT ecosystem. The high cost of adopting such smart solutions is a serious challenge for farmers in developing countries such as China, Brazil, and India.	Telecom operators can support **IoT deployment at multiple levels**. Beyond connectivity, they can provide provisioning, authentication, security, billing, device management, location-based services, application enablement, and analytic services. In a number of cases, mobile operators are likely to provide these capabilities to LPWA users as cloud services that can be easily accessed via application programming interfaces (APIs).
Climate change toward Big Data technologies Climate change will significantly impact agricultural production. In order to avoid significant losses in terms of yields and efficiency, it is necessary to improve the managements of the crop production.	**IoT and Smart Services.** By exploiting Big Data and IoT-based solutions in agriculture, it will be possible to hugely increase yields and crop production efficiency.
Need for water conservation technologies Agriculture consumes nearly 70% of fresh water. Since water scarcity is becoming an increasingly significant problem across the globe, the efficient utilization of water for agricultural activities requires more attention.	Proper **Big Data technologies** can help reduce water consumption by 10%. Applications such as smart irrigation systems will help to save water in agricultural applications. Leveraging IoT for water conservation will be a major trend in the future of agriculture.
Big Data technologies for **Enhancing Efficiency** **Costs**, resources and efforts associated to agricultural activities are growing rapidly. Farmers need to address these factors in order to remain competitive in the market.	**Smart agriculture** enables farmers to minimize these factors, and optimize various agricultural resources such as seeds, fertilizers, and pesticides along with human labour. Advanced technologies enable reduced energy consumption and fuel usage too. Smart agriculture enhances productivity by guiding farmers to expertly invest both time and resources in the appropriate combination to achieve the perfect balance for optimized production.

Algorithms for **spotting and predicting fish stocks and trends.** No other group of animals is as difficult to monitor as fish. Humans are not capable of looking into the ocean and counting the fish they see. Instead, they must try to estimate the size of fish stocks as accurately as possible. The Food and Agriculture Organization of the United Nations (FAO) uses various sources to estimate global fish stocks and trends as accurately as possible.	Big Data technologies, **mainly sonars, radars and prediction algorithms**, will be very effective in optimising the process of spotting and predicting fishes' stocks and trends, leading to a consistent reduction of costs and inefficiency during fishing activities.
Reducing costs through Big Data tools. Forest machines are expensive and having them stand idle is even more costly. It is difficult to predict the conditions of forest work, because they are affected by the weather, season, soil properties, elevation differences and the developmental phases of tree species. If forest work is done at the wrong time, it causes unfortunate environmental damage. Heavy machines can easily sink into clay soil.	Big Data and new ways of creating **prediction models** based on Big Data are helpful.

7.3 Examples of technological issues and their impact on DataBio sectors

7.3.1 Technology requirements from regulations

Issue	Impact
EU regulation is requiring countries to use techniques like anonymisation, pseudonymisation, and encryption protocols.	http://ec.europa.eu/justice/data-protection/files/data-protection-big-data_factsheet_web_en.pdf

7.3.2 AI for data veracity

Issue	Impact
City University in London are working with Google to develop an app that **combines Big Data and artificial intelligence** to help journalists verify information quickly.	This is a positive user case of combining Big Data with easy to use applications and so making Big Data more accessible for society.

7.3.3 Data Management, Storage and Analyses technologies

Issue	Impact
In order to be effective Big Data tools and services need to be easily usable by all end users. To this end, it is fundamental to develop tools and systems for storage of data, easy access to them and finally providing outputs easily readable by end users.	**In the DataBio project,** different solutions will be developed and integrated in an interoperable easy to use cloud platform. The platform will storage the data and make them easily accessible to each end user according to their access rights.

7.3.4 Need for advanced data collection technologies in Agriculture

Issue	Impact
In order to exploit the potential of Big Data, it is important to develop advanced methods and tools for **data collection**. Currently three different technologies are needed: remote sensing, in situ sensors and tools for data collection from end users.	**In-situ.** During the DataBio project, different technologies for in-situ data collection (drones, sensors, UAVs, and RPAs) will be optimised and tested according to pilots. These technologies will primarily address the following data: Soil pH, salinity, and composition in key elements (multi-depth); ambient temperature; humidity; solar radiation; leaf wetness; rainfall volume; wind speed and direction; barometric pressure; Information on crop growth and development; soil nutritional status testing; optical, thermal, multispectral data; field boundaries; topography; restrictions (nitrate directive protected areas, water bodies buffers, soil erosion protected zones, etc.).
	Remote Sensing. During DataBio project different technologies for remote data collection (Landsat, Sentinel 1, 2, drones, sensors, UAVs, and RPAs) will be optimised and tested according to pilots. **T**hese technologies will primarily address the following data: Tractor utilization information; fuel information; tractor localisation; crop, soil and environmental properties; telemetry IoT for crop monitoring and yield/seed maturity estimation; IoT data: Atmospheric and soil data; HR Optical Data (Sentinel-2); Satellite imagery; Aerial imagery.
	Farm data collection: During DATABIO project different technologies for farm data collection (IoT systems, data collection software and apps) will be optimised and tested according to pilots. **T**hese technologies will primarily address the following data: Farm logs and farm profiles; crop data; yield maps and records; technical practices at farm level; irrigation information; Phenomics, metabolomics and genomics datasets.

7.3.5 DataBio technologies value proposition in Agriculture

Issue	Impact
Big Data applied to **Agriculture** have the potential to boost the sector and increase competitiveness of all actors inside the value chain. Actually, novel value chains will emerge in order to maximise the impact of Big Data in Agriculture	During the project, 13 pilots will be realised in Agriculture sector, aiming at optimising and delivering in the market innovative technologies able to exploit the huge Big Data potential toward Smart Agriculture sector. In particular, they will have impact on: Cost reduction, Agriculture efficiency, fuel and energy reduction, crop variety improvements, insurance risks reduction, water use reduction, quality and soil health improvement.

7.3.6 Need for advanced data collection technologies in Forestry

Issue	Impact
In order to exploit the potential of Big Data, it is important to develop advanced methods and tools	**Quality control tools.** During DataBio project different technologies for quality control (laser scanning, field

for data collection. Currently two different technologies are needed: remote sensing and quality control tools.	measurement, growth modelling or notification) will be optimised and tested according to pilots. These technologies will primarily address the following data: Forest damages such as storms, snow, pests and diseases; type of the forest work, sample plot locations, measured data per sample plot, measurement averages per compartment, measurement date and user information.
	Remote Sensing. During DataBio project, different technologies for remote data collection (Landsat, Sentinel 1, 2, drones, sensors and UAVs) will be optimised and tested according to pilots. **T**hese technologies will primarily address the following data: Forest damages such as storms, snow, pests and diseases; Type of the forest work, sample plot locations, measured data per sample plot, measurement averages per compartment, measurement date and user information.

7.3.7 DataBio technologies value proposition in Forestry

Issue	Impact
Big Data applied to Forestry have the potential to boost the sector and increase competitiveness of all actors inside the value chain. Actually, novel value chains will emerge in order to maximise the impact of Big Data on Forestry.	During the project, seven pilots will be realised in Forestry sector, aiming at optimising and delivering in the market innovative technologies able to exploit the huge Big Data potential toward Smart Forestry sector. In particular, they will have impact on: Cost reduction for forest operators; growth of forests in Europe; improved handling of forest damages (fires, snow, etc.); improved turnover of the Forestry industry.

7.3.8 Need for advanced data collection technologies in Fishery

Issue	Impact
In order to exploit the potential of Big Data, it is important to develop advanced methods and tools for data collection. Currently three different technologies are needed: Local measurement tools, remote sensing, and modelling tools.	**Local measurements tools.** During DATABIO project different technologies for local measurements (data centres, IoT platforms, sensors, hydro-acoustic sonars) will be optimised and tested according to Pilots. These technologies will primarily address the following real-time data: destination, engines, propulsion, route and speed of the vessel; hydro-acoustic/sonar data from vessels.
	Remote Sensing. During DATABIO project different technologies for remote sensing (Landsat, Sentinel 1, 2, UAVs, and meteorological stations) will be optimised and tested according to pilots. **T**hese technologies will primarily address the following data: sea surface currents and other oceanographic parameters; and fish routes and patterns.
	Modelling tools: During DATABIO project different technologies for modelling (e.g., meteorological models, prediction models) will be optimised and tested according to pilots. **T**hese technologies will primarily address the

	following data: hindcast and forecast of meteorological and oceanographic data; fish movements; tides alterations and more.

7.3.9 DataBio technologies value proposition in Fishery

Issue	Impact
Novel value chains will emerge in order to maximise the impact of Big Data on Fishery.	During the project, six pilots will be realised in the Fishery sector, aiming at optimising and delivering in the market innovative technologies able to exploit the huge Big Data potential toward Smart Fishery sector. In particular, they will have impact on: Cost reduction, boats fuel consumption reduction, sea species preservation, sustainable fishing, and increased turnover of the overall Fishery industry.

7.4 Summary of technological factors

As a result of continuing technological development, the capacity to produce, transfer, store and analyse diverse data will steadily increase. At the same time, technologies develop within the bio economy sector itself, for example in the form of more efficient and environmentally friendly production or logistics solutions. In many cases, benefits are sought through a combination of new technologies, digitalisation and data, paving the way for new products and services. This creates new business opportunities for suppliers of Big Data solutions but also requires cooperation across domains to create shared digital platforms and common approaches.

8 Legal factors

8.1 Description and overview of legal factors

Effective legislation constitutes a binding set of rules and regulations that define the legal framework within which both companies and public actors and individuals have to operate. Knowledge of existing legislation is a prerequisite for successful operation but also the impact of new and foreseen regulations must be analysed to be able to define future strategies. Legislation follows political decisions. For a longer look-ahead, companies need to follow politics and social sentiments that eventually may be implemented as law.

Big Data may comprise both personal information and technical data. From a legal perspective, the main risks relate to discrimination, privacy violations and chilling effects [REF-56], and in the case of technical date to data ownership and copyright.

Big Data is global. Therefore, applications and technologies that make us of data sources, stores or generate new data or companies need to comply with a multitude of different rules and regulations. Because Big Data technology is relatively new phenomenon, legislation is still lagging behind and varies from country to country.

For instance, in the US there is no single, comprehensive federal law regulating the collection and use of personal data, but a multitude of federal state laws and regulations that sometimes overlap or contradict each other [REF-57].

In the EU, much of the legislation follows union policies that reflect common needs, goals and interest and established as common legislation through legal instruments, such as regulations, directives and decisions. The Commission oversees departments and various agencies that execute or enforce EU law.

The EU General Data Protection Regulation (GDPR) replaces the Data Protection Directive and enters into force 25 May 2018. After that, organizations in non-compliance will face heavy fines [REF-58]. The GDPR is designed to harmonize data privacy laws across Europe, to protect and empower all EU citizens' data privacy and to reshape the way organizations across the region approach data privacy.

This chapter lists factors relating to current or upcoming laws and regulations that will have an impact on the adaptation of Big Data technologies in bioeconomy.

8.2 Definition and identification of legal factors

Legal factors pertain to both national and international law stipulation the rights and responsibilities for companies, individuals and public actors.

Things to consider include:

- Trade restrictions
- Data Protection
- Copyright, patents / Intellectual property law
- Consumer protection and e-commerce
- Health and safety law

Table 6. Legal Concerns

Big Data Concerns	Big Data Facilitation
Competition Law Violation: The concern is that the use of Big Data by internet companies may result in a few large companies controlling data collection and processing, as well as the access conditions for smaller companies.	**EU-US Privacy Shield, 2016**: The agreement allows data from the EU to be transferred to the US, provided that the data processing in the US complies with regulations approved by the European Commission.
Personal Data: Personal data protection will become more difficult when information is multiplied and shared more widely around the world.	**Personal Data Protection:** EU regulation is requiring countries to use techniques like anonymisation, pseudonymisation, and encryption protocols. In 2016, a data protection reform was reached where personal data is protected from processing and the free movement, except for the processing by competent authorities for investigation, prevention of offences.
Consumer Sentiment: Consumers are increasingly concerned about maintaining their privacy, which puts pressure on states to protect data.	**Standardisation:** 28 national legislations will also be replaced by 1 legal framework outlining the rules and conditions for companies in the Big Data market. A standardisation of data use across the EU has also been introduced; EU consumers are now able to use data at their home country rate throughout the EU.

8.3 Examples of legal issues their impact on DataBio sectors

8.3.1 Big Data legal framework

Issue	Impact
With the EU Data Protection Reform, effective in 2018, 28 national legislations will be replaced by **1 legal framework** outlining the rules and conditions for companies in the Big Data market.	For the Big Data industry, the impacts are twofold. A **standardized playing field** means that companies will need to comply with EU-wide standards that may limit their flexibility. However, at the same time, it will be easier to share and interpret data between EU member states. Also, bureaucracy and costs for EU companies and startups will be reduced, perhaps stimulating a growth in the number of providers in the Big Data market. For users a clearer and more easy-to-understand system means less insecurity about how data is collected and how this data is used. This may cause the number of Big Data users to grow. http://ec.europa.eu/justice/data-protection/files/data-protection-big-data_factsheet_web_en.pdf

8.3.2 Data protection

Issue	Impact
Personal data protection will become more difficult when information is multiplied and shared more widely around the world with Big Data collection platforms and mechanisms. EU regulation is requiring countries to use techniques like anonymisation, pseudonymisation, and encryption protocols.	This requires **skills for Big Data management** and specific IT knowledge to encrypt and decrypt large amounts of data. Companies will need to invest in employee training to develop specific IT skills. http://ec.europa.eu/justice/data-protection/files/data-protection-big-data_factsheet_web_en.pdf

8.3.3 Competition law

Issue	Impact
There is a concern that the use of Big Data by internet companies violates competition law since collecting Big Data may make it more difficult for small companies to compete when larger internet companies have more capability and resources for ecommerce and marketing. There is also a lack of clear legislation for the protection of data during mergers. "If just a few companies control the data you need to satisfy customers and cut costs, then you can give them the power to just drive rivals out of the market".	An important point for legislation is that companies are given a fair chance to use Big Data for their development and expansion of their offering. https://venturebeat.com/2016/02/06/german-watchdog-wants-user-data-considered-before-approving-internet-mergers/

8.3.4 Missing legislation

Issue	Impact
Lack of Forest Regulation Consistency: EU forest laws are EU country specific. Although an EU Forest Strategy was introduced in 2013. There are also no clear regulations involving Big Data in this sector.	It is difficult for Big Data Projects to be facilitated when there is no clear structure available. http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/agricult/142685.pdf

8.4 Summary of legal factors

Big Data technology will affect many sectors of the economy, industry and society at large, and touches peoples' personal life. A covering and harmonized legislation is required to ensure equal rights and responsibility across Europe and when dealing with other countries.

The EU General Data Protection Regulation (GDPR) is designed to harmonize data privacy laws across Europe, to protect and empower all EU citizens' data privacy and to reshape the way organizations across the region approach data privacy. The regulation requires countries to use techniques like anonymisation, pseudonymisation, and encryption protocols. This will bring consistency across Europe but may be seen as a disadvantage in global competition.

On the other hand, country specific legislation may complicate international Big Data projects.

9 Environmental factors

9.1 Description and overview of environmental factors

Bioeconomy in this context comprises the parts of the economy that use renewable biological resources from land and sea to produce food materials and energy. These activities will have an impact on the environment. As environmental factors are a major public concern, sustainability, eco-friendly products and services, and corporate responsibility become important issues for strategic analyses.

Climate change could have an effect on both agriculture and forestry, changing the conditions for crop and plant growth and, in turn food supply, increasing the pressure on soil and water availability as well as farming methods with a reliance on fertilisers or other chemical products. The effect of climate change on forests over different European bioclimatic regions are expected to be multiple and complex, but rising CO2 concentration, higher temperatures, changes in precipitation, flooding, drought duration and frequency will all have significant effects on tree growth [REF-59], [REF-60].

Forests currently contribute about one-sixth of global carbon emissions when cleared, overused or degraded; they react sensitively to a changing climate; when managed sustainably, they produce wood fuels as a benign alternative to fossil fuels; and finally, they have the potential to absorb about one-tenth of global carbon emissions.

Soil erosion from farmland threatens the productivity of agricultural fields and causes a number of problems elsewhere in the environment. The consequences for long-term crop yields have not been adequately quantified. The amount of erosion varies considerably from one field to another, depending on soil type, slope of the field, drainage patterns, and crop management practices; and the effects of the erosion vary as well. Areas with deep organic loams are better able to sustain erosion without loss of productivity than are areas where top soils are shallower.

Erosion affects productivity because it removes the surface soils, containing most of the organic matter, plant nutrients, and fine soil particles, which help to retain water and nutrients in the root zone where they are available to plants. The subsoils that remain tend to be less fertile, less absorbent, and less able to retain pesticides, fertilizers, and other plant nutrients [REF-61].

Finally, commercial fisheries can do tremendous damage to the marine ecosystem if they are not managed properly. Commercial fishing impacts on the availability of fish, overfishing, fisheries, and fisheries management. There is a growing gap between the supply of fish and demand, due in part to world population growth [REF-62].

This section includes an analysis of external environmental factors that will have an impact on DataBio objectives.

9.2 Definition and identification of environmental factors

Environmental factors include external environmental influence on the operating conditions of the business as well as the influence of common opinion and activist groups with the power to affect the business.

- Weather
- Climate change
- Laws regulating environment pollution
- Air and water pollution
- Recycling
- Waste management
- Attitudes toward environmental issues and ecological diversity
- Endangered species

Table 7. Environmental Concerns

Environmental Concerns	Big Data Facilitation
Climate Change/Weather A gradual temperature rising as well as increasing fluctuations and weather extremes all have an impact on bioeconomy through changing growing conditions and distribution of spices.	Exploiting the Big Data, **Smart Forestry** can really impact on climate change. In fact, forest resource projections with alternative management and policy assumptions indicate that forest carbon storage in EU forests could continue to increase from 2010 to 2030 by around 20%, providing additional sequestration of up to 170 Mt CO2/y by 2050. http://www.efi.int/files/attachments/publications/efi_fstp_2_2015.pdf
Water Consumption Globally, the agricultural sector consumes about 70% of the planet's accessible freshwater – more than twice that of industry (23%), and dwarfing municipal use (8%). The main causes of wasteful and unsustainable water use are: • leaky irrigation systems • wasteful field application method • cultivation of thirsty crops not suited to the environment. The problem is made worse by misdirected subsidies, low public and political awareness of the crisis, and weak environmental legislation.	**Big Data applied to precision Farming.** Precision Farming can hugely affect water consumption, monitoring on one hand the leakages and correct functioning of systems, while providing precise indication on the amount of water to use and location where to irrigate. Considering the extreme usage of water and wasteful current usage of it, Big Data can bring to a huge environmental impact. http://wwf.panda.org/what_we_do/footprint/agriculture/impacts/water_use/
Fishes endangerment Big Data can help limit illegal fishing by tracking fishing activity. EU Regulation to prevent, deter and eliminate illegal, unreported and unregulated fishing (IUU) has been introduced and facilitated via the use of Big Data.	This may motivate more fishermen to stay in the market and to also themselves use Big Data tools to more productively track fishing activity.

	http://www.ship-technology.com/features/featureusing-big-data-to-combat-illegal-fishing-5688984/ https://ec.europa.eu/fisheries/cfp/illegal_fishing_en
Soil degradation When natural vegetation is cleared and when farmland is ploughed, the exposed topsoil is often blown away by wind or washed away by rain. Soil carried off in rain or irrigation water can lead to sedimentation of rivers, lakes and coastal areas. **Sedimentation** causes serious damage to freshwater and marine habitats, as well as the local communities that depend on these habitats. For example, people living in Xingu Indigenous Park in Brazil report declines in fish numbers. Furthermore, pesticides and fertilizers carried in rainwater and irrigation runoff can pollute waterways and harm wildlife. **Land degradation** stretches to about 30 % of the total global land area. But the problem is that because agricultural land is often degraded and almost useless, producers keep on moving to more productive land. Globally, the land used and abandoned in the last 50 years may be equal to the amount of land used today.	**Smart Agriculture impact.** Big Data applied to agriculture can help inverting this trend, enabling farmers to reduce land exploitation while increasing productivity and variety of crops. In fact, smart agriculture and precision farming can help decide the right crop to yield, variation of crops, reduce use of fertilizers and pesticide and improve land fertility. http://wwf.panda.org/what_we_do/footprint/agriculture/impacts/soil_erosion/
Sustainability Overfishing has contributed to the extinction of 90 species of marine fishes in Europe's waters. Big Data projects will help monitor (over-)fishing. Currently 70 per cent of Finnish forestry estates have laser scanned forest management plans available online free of charge. The coverage will be 100 per cent by 2020. The platform is called Metsään.fi	This is an exciting application for Big Data and there is already a current project that explores it. http://www.sciencemag.org/news/2015/06/overfishing-could-push-european-fish-species-extinction Global Forest Watch is an online platform which uses satellite images to provide real time data on forests and enable companies to track deforestation and better manage forests.
Biodiversity A study has been conducted on the impact of Biodiversity on productivity in forests using Big Data to sample over 770k forest areas from 44 countries. WWF Finland will launch a campaign targeted at private forest owners (622 000 in Finland) to collect data from high nature value sites and other important flora and fauna, that forest owners want to preserve in coming care work activities and harvesting operations.	This shows **increased interest and trust** within society to apply Big Data to the forestry industry. https://www.forstpraxis.de/big-data-publikation-in-science-belegt-diversitaet-in-waeldern-als-schluesselfaktor-fuer-waldertraege/

9.3 Examples of environmental issues and impact on DataBio Sectors

9.3.1 Climate Change/Weather

Issue	Impact
Agriculture is extremely vulnerable to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. In developing countries, climate change will cause yield declines for the most important crops. Climate change will have varying effects on irrigated yields across regions. Similarly, Climate change impacts **Fisheries**, leading to increased competition for - and within - essential and limited habitats, predation, diseases, or parasitism, all of which have the potential to affect abundance, distribution and genetic integrity of native fishes. Finally, **Forestry** is affected by Climate change too, in particular in terms of new pathogens capable of attacking and damaging trees and forest health.	In DataBio project, novel solutions and services will be tested and validated in 26 Pilots, aiming to monitor, **environmental impacts of Climate Change on Agriculture, Forestry and Fishery**. Mitigation activities, to reduce impact of Climate change and to mitigate Climate change itself, will be implemented and validated during the project lifetime. http://www.saiplatform.org/uploads/Library/IFPRIONCC.pdf http://www.dfo-mpo.gc.ca/science/publications/article/2014/10-23-14-eng.html https://phys.org/news/2017-05-climate-impact-forest-pathogens-trees.html

9.3.2 Water Consumption

Issue	Impact
Agriculture consumes more than 70% of the total water used on earth. A large part of this water is wasted thus contributing to reduce a non-inexhaustible element. Furthermore, in many regions water is scarce thus representing a huge hindrance to agriculture and forestry development.	In DataBio, all Pilots located in Greece and some in Italy, will analyse water consumption and will propose advance solutions for precision farming, in order to reduce to minimum waste of water. The objective of the pilot is to validate how to reduce the impact of Water consumption on Agriculture and Forestry, while improving quality and resilience of crops and trees. http://wwf.panda.org/what_we_do/footprint/agriculture/impacts/water_use/

9.3.3 Fishes endangerment

Issue	Impact
Overfishing is one way to disrupt ocean ecosystems. Allied causes are trawl nets and other fishing gear, which destroy marine habitat and catch large quantities of juvenile and non-targeted fish species. In addition, processing plants and fishing vessels release greenhouse gasses and other pollutants into the environment. Fish and shellfish populations are renewable, but they are not inexhaustible. A sustainable fishery harvests fish without depleting the population or jeopardizing the ecosystem, which includes marine life and habitat. Overfishing was	In DataBio, 6 Pilots will be realised in Fishery sector. The scope of the pilots will be to monitor fishing patterns and optimise fishing activities both in terms of reduced fuel consumption and of preservation of fish populations. http://www.heritage.nf.ca/articles/economy/environment-fisheries.php

largely to blame for the commercial extinction of northern cod in the 1990s and has caused the depletion of many other fish stocks, including herring and tuna populations in the Atlantic and Pacific oceans.	

9.3.4 Soil degradation

Issue	Impact
Soil is the earth's fragile skin that anchors all life on Earth. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually increase soil erosion beyond the soil's ability to maintain itself. The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species.	Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation, erosion and the loss of valuable land to desertification. In DataBio project, it will be monitored land usage, in order to optimise soil protection while improving crops production. https://www.worldwildlife.org/threats/soil-erosion-and-degradation

9.3.5 Sustainability

Issue	Impact
Agriculture, forestry and fisheries play a central role in the concept of sustainable development, because unlike other sectors of the economy, those three areas have close relations to all three dimensions of sustainable development. Agriculture and forestry, for example, require a great proportion of the fertile land area of the earth and thus affect environmental parameters in a global scale. With respect to the concept of sustainable development, some aspects of agricultural production require special attention, because they have long-term effects with consequences for all three dimensions. Important is the development of soil fertility, the effect of pesticide application and plant protection as well as the productivity of agriculture, forestry and fisheries.	In DataBio, the sustainability will play a central role, and all pilots will analyse this parameter. In particular, rotation of fields, variation of crops, management of forests for woodcutting, water usage, and other sustainable practices will be assessed and validated, exploiting innovative technologies based on Big Data. http://www.eolss.net/Sample-Chapters/C10/E5-22-05.pdf http://www.fao.org/about/what-we-do/so2/en/
Big Data can help **limit illegal fishing** by tracking fishing activity. EU Regulation to prevent, deter and eliminate illegal, unreported and unregulated fishing (IUU) has been introduced and facilitated via the use of Big Data.	This may motivate more fishermen to stay in the market and to also themselves use Big Data tools to more productively track fishing activity. http://www.ship-technology.com/features/featureusing-big-data-to-combat-illegal-fishing-5688984/ https://ec.europa.eu/fisheries/cfp/illegal_fishing_en

Uncertain official capture production figures and stock assessment. **Poor quality of catch data and/or low data availability** due to **unreliable or non-existent** data collection systems for inland water catches in several countries.	Efforts to improve data availability and statistics in support of **blue growth** and advice on best practice, such as the Guidelines to Enhance Fisheries and strengthen fishery data collection systems should be fostered. Aquaculture Statistics through a Census Framework, should improve reporting by encouraging countries to enhance reporting on small-scale operations through census and surveys. http://gsars.org/wp-content/uploads/2015/06/Guidelines-to-Enhance-Fisheries-and-Aquaculture-Statistics-through-a-Census-Framework-WEB.pdf
The **economics of the seafood industry** are not reflected in their full extent. **Illegal, Unreported and Unregulated (IUU) Fishing activity** is still entering the market, having the potential to topple food and **economic security** by undermining the ability to appropriately **manage this resource**. It is hard to quantify the impacts of the illegal activity without knowing its full extent, but one worldwide analysis put the value of illegal fishing losses between 10 and 23.5 billion annually.	FAO Port State Measures Agreement (PSMA) is an EU Regulation to prevent, deter and eliminate IUU that has been introduced and facilitated via the use of Big Data. Designed to combat illegal fish product from entering markets, the PSMA is an international treaty that sets minimum standards for nations to abide by when fishing vessels or carrier vessels come into port. This treaty, **combined with the acquisition of data** on vessel activity out at the sea, resource managers, scientists and conservationists will have a better understanding of how much marine life is removed from the ocean every year and how much effort is going into fishing, as well as the **economics** that underpin the seafood industry. http://blog.globalfishingwatch.org/2017/09/illegal-fishing-a-threat-to-national-economic-and-food-security-worldwide/ http://www.fao.org/fishery/psm/agreement/en http://blog.globalfishingwatch.org/2016/09/what-ports-can-tell-us/

9.3.6 Biodiversity

Issue	Impact
A large number of the world's poor rely directly on biodiversity and ecosystem services, and their livelihoods would be affected first and foremost by biodiversity loss. Agriculture needs a number of ecosystem services to produce goods. These are "regulating services" and serve to maintain the quality of air and soil, providing flood and disease control, and pollinating crops, to name a few. Agriculture can contribute to Biodiversity in terms of: • Forest restoration, for example, contributes to air and water purification, carbon sequestration and storage.	Biodiversity is a key element for sustainability and long-term improvement of Agriculture, Forestry and Fishery sectors. DataBio will include biodiversity concepts and KPIs into the 26 Pilots. Reduction of pesticides towards natural predators, differentiations of crops, and preservation of fish populations represent some of the parameters relevant and monitored in DataBio Project http://www.fao.org/biodiversity/en/ https://www.cbd.int/doc/nbsap/agriculture/BrazilCubaMexico.pdf

• Well maintained agricultural and forest lands reduce risks and damage from floods, storms, tsunamis, avalanches, landslides and droughts. • Vegetation cover prevents soil erosion and ensures soil fertility through natural biological processes such as nitrogen fixation. • Well-managed fisheries contribute to sustained ecosystem services from both freshwater and marine systems, with trophic webs and provisioning and regulating services extending well beyond the scope of the target stocks. • Natural enemies (predators, parasites and pathogens) of crop pests provide a regulating service called biological control that can drastically minimize the use of agrochemicals, thereby reducing adverse effects on the environment, such as contamination of natural resources, and on human health.	http://www.fao.org/3/a-i6602e.pdf

9.4 Summary of environmental factors

Climate change could have an effect on both agriculture and forestry, changing the conditions for crop and plant growth and, in turn food supply, increasing the pressure on soil and water.

The increasing demand for food, energy and materials from natural resources has in many areas met or exceeded sustainability limits. Over fishing, excessive water consumption and deforestation must be controlled.

Water consumption and soil degradation can be important factors in agriculture.

Biodiversity is not only an ecological value in itself. The livelihoods of a large number of the world's poor would be affected first and foremost by biodiversity loss.

Big Data collection and analysis can be used to monitor effects and to ensure that activities stay within sustainable limits.

10 Conclusions

Big Data solutions are quickly expanding to the bioeconomy sector. The business environment in which Big Data companies operate is complex and rapidly changing. PESTLE analysis is a strategic tool by which companies can identify and analyse political, economic, social, technological, legal, and environmental factors that will contribute to the change. The findings can be used for further analysis to support strategic decisions.

Bioeconomy is a significant contributor to the European economy through the value of products produced and the number of jobs created. Efficiency improvements can be achieved by management of data throughout the production chain. This includes reducing production costs by avoiding unnecessary use of fertilisers and pesticides in agriculture and forestry, and by reducing fuel costs and maximising catch/effort ratio in fisheries. Further benefits come from better market predictions based on Big Data.

As a result of continuing technological development, the capacity to produce, transfer, store and analyse diverse data will steadily increase. At the same time, technologies develop within the bioeconomy sector itself, for example in the form of more efficient and environmentally friendly production or logistics solutions. In many cases, benefits are sought through a combination of new technologies, digitalisation and data, paving the way for new products, and services. This creates new business opportunities for suppliers of Big Data solutions but also requires cooperation across domains to create shared digital platforms and common approaches.

Big Data technology affects many sectors of the economy, industry and society at large, touching peoples' personal life.

Social factors affect companies' current and future operating environment through economic and political instruments. A positive development in employment and wealth distribution contribute to stability and confidence in society. Transparency regarding collected data and equal access to Big Data resources is crucial in order to maintain social acceptability. A covering and harmonized legislation is required to ensure equal rights and responsibility across Europe and when dealing with other countries.

The EU constantly works towards unifying legislation across Europe as part of its common policy goal. Protection of privacy and controlling the collection and storage of personal data are high priorities. The General Data Protection Regulation (GDPR) is designed to harmonize data privacy laws across Europe, to protect and empower all EU citizens' data privacy and to reshape the way organizations across the region approach data privacy.

The increasing demand for food, energy and materials from natural resources has in many areas met or exceeded sustainability limits. Climate change could have an effect on both agriculture and forestry, changing the conditions for crop and plant growth and, in turn food supply, increasing the pressure on soil and water. Over fishing, excessive water consumption and deforestation must be controlled. Big Data collection and analysis can be used to monitor effects and to ensure that activities stay within sustainable limits.

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