INTRODUCTION

Digitalisation can have both positive and negative impacts, depending on the conditions of access to information and communications technologies (ICTs), the design and application of these technologies, and the complexity of the systems in which they are used. The socio-economic assessment within the DESIRA project aims to measure the impact of digitalisation on sustainable development. In order to do so, DESIRA is developing a set of indicators to measure different aspects of sustainability, based on a methodology called the Integrative Concept of Sustainable Development (ICoS). With these sustainability indicators it is possible to evaluate the social, economic, and environmental impacts of digitalisation. This involves collecting stakeholder perspectives on the impacts of digitalisation on the fulfillment of sustainability targets within the three DESIRA domains (agriculture, forestry and rural areas). This is explained further in Section 3.

Overall, the purpose of impact assessment with sustainability indicators is to inform and guide the political decision-making process. The assessment will suggest how to improve sustainable development and simplify communication by reducing complexity. Sustainability indicators can be used to assess different development areas for a number of purposes, such as monitoring progress towards goals and targets based on development conditions over time and space; aiding public participation and awareness; promoting decision making, and political and behavioural change; comparing places and situations; and improving communication on debates over sustainability (Moreno-Pires 2014).

1. SOCIO-ECONOMIC SUSTAINABILITY INDICATORS (SESI)

The development of a set of indicators and related targets to assess the socio-economic impacts of digitalisation in rural areas is one of the main intended results of the DESIRA project. These indicators are known as Socio-Economic Sustainability Indicators (SESI) and are relevant for at least one, if not all, of the three domains covered by DESIRA Living Labs (LL): agriculture, forestry and rural areas.

The selection of the first set of SESI was done using a multistep and interdisciplinary process. The list is based on the comprehensive Integrative Concept of Sustainable Development (ICoS), which defines three general goals and preconditions for sustainable development. These goals are:

1. Securing human existence: includes the basic needs and capability of people to shape their own lives;
2. Maintaining society’s productive potential: this potential consists of natural, man-made, human and knowledge capital;
3. Preserving society’s options for development and action: this addresses immaterial needs, such as integration in cultural and social contexts, as well as material needs.
Additionally, ICoS includes a set of instrumental rules, known as Conditions to achieve substantial sustainability, which address the economic, political and institutional framework conditions required to fulfil the rules within the three goals. The substantial sustainability rules describe the minimum requirements of sustainable development for all people in present and future generations (See Table 1).

The DESIRA partnership’s selection of scientifically sound, politically or societally discussed, and practically applicable indicators started with a literature review. In this first step, scientific, political, administrative and public documents; monitoring systems; and databases at different scales were comprehensively assessed. The research included the revision of a broad range of sources at international and national level, including the United Nation’s Sustainable Development Goals (SDGs), the UCL INEQ-CITIES Atlas, the OECD main economic indicator set, and the European Environment Agency indicators, among others.

DESIRA has not only selected socio-economic sustainability indicators, but also environmental indicators to assess sustainability. Digitalisation is expected to provide benefits for the environment and these should be checked in the DESIRA Living Labs.

DESIRA partners and LL coordinators contributed to refine the first set of indicators through personal communications and project meetings. Through an iterative process, indicators were selected and defined taking into account the perspective, needs and expectations of local players.

The preliminary list of indicators that resulted from this process is presented in Table 1. This list will be assessed by external stakeholders through a series of exchanges with the Rural Digitalisation Forum, local partners from the Living Labs, and workshops of the application scenarios. The final aim is to obtain a comprehensive list of SESI that can be applied to agriculture, forestry and rural areas.

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**2. HOW ARE THE LIVING LABS USING THE SESI TO ASSESS THE SOCIO-ECONOMIC IMPACTS OF DIGITALISATION?**

In order to assess the impact of digitalisation on the socio-economic sustainability of a Living Lab (LL) focal question, the coordinators of the LLs will use the preliminary indicator list for their domain to select 10 of the most relevant indicators to the topic and region. Together with other research questions relevant to the DESIRA project, these indicators are part of an online survey for distribution and completion among the stakeholders in the LLs. In this survey, the LL stakeholders are asked to assess the 10 selected indicators by considering the impact that digitalisation could have on the fulfilment of given targets. Each indicator has been assigned a DESIRA sustainability target, which is essentially the sustainable form of the indicator. For instance, the indicator ‘Pollution of air and water’ has the sustainability target of ‘reduced pollution of air and water’. The targets are not assigned with a specific timeframe or region - this is left for interpretation by the respondent in regards to their particular LL focal question and region. The target clarifies the sustainability ambition to be achieved, and therefore makes it possible to assess the perspectives of stakeholders on the impact of digitalisation towards achieving the objective.

Stakeholders can select their answer via a Likert scale (strongly decrease likelihood of reaching target – strongly increase likelihood of reaching target). Secondly, the LL stakeholders are asked to select the five targets that they find most important to the impact of digitalisation on their focal question. This selection and ranking works to improve and fortify the SESI set towards a final, useable SESI tool for the Living Labs.

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**Figure 1: The use of SESI in the Living Labs**

Source: DESIRA, 2020
3. How will the results of the assessment and selection of SESI be used?

With the information collected from the stakeholders’ assessment of selected SESIs, the LL coordinators will have many perspectives from stakeholders on how they believe digitalisation will impact the socio-economic sustainability issues of their region.

Additionally, the DESIRA partners will have a large overview on the perceived impacts over all 20 LLs from across Europe. This will allow for in-depth analysis at LL level, as well as a comparative analysis between LLs and within agriculture, forestry and rural areas. The perceptions collected are vital pieces of information on the acceptance, barriers, perceived advantages and disadvantages of digitalised tools in agriculture, forestry, and rural areas.

The SESI assessment provides critical information for decisions made by policymakers, technology developers, and the general public. By collecting and understanding the expected impacts of digital tools, the development and marketing of these tools can be improved. Policies at EU and Member-State levels can be improved to support the transition towards digitalisation in agriculture, forestry, and rural areas. These results create opportunities for co-design between the users and producers of digital tools. Additionally, assessments with the indicators over time can measure societal change in the shift towards digital agriculture, forestry and rural areas.

4. Preliminary set of SESI

Table 1 presents the preliminary set of SESI that have been selected to assess the impact of digitalisation on sustainable socio-economic development in DESIRA’s Living Labs.

<table>
<thead>
<tr>
<th>ICoS Rule Group</th>
<th>ICoS Rule</th>
<th>Indicator</th>
<th>Indicator source</th>
<th>SDG</th>
<th>Applies to Domain</th>
<th>DESIRA sustainability target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securing Human Existence</td>
<td>Protection of human health</td>
<td>Share of manual workers in workforce</td>
<td>UCL INEQCITIES atlas</td>
<td>3, 8, 10</td>
<td>all</td>
<td>increased share of manual workers in the workforce</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health risks to farmers by work-related accidents</td>
<td>DESIRA</td>
<td>3, 6</td>
<td>AG</td>
<td>reduced risk to farmers by work related accidents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health risks to farmers by dust and pesticides</td>
<td>DESIRA</td>
<td>3, 6</td>
<td>AG</td>
<td>reduced risk to farmers by dust and pesticides</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health risks to the public by dust and pesticides</td>
<td>DESIRA</td>
<td>3, 6</td>
<td>AG</td>
<td>reduced risk to public by dust and pesticides</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pollution of air and water</td>
<td>DESIRA</td>
<td>3, 13</td>
<td>all</td>
<td>reduced pollution of air and water</td>
</tr>
<tr>
<td></td>
<td>Satisfaction of basic needs</td>
<td>Volume of production per labour unit</td>
<td>DESIRA (from SDG 2.3.1)</td>
<td>2, 10, 8</td>
<td>all</td>
<td>increased volume of production per labour unit by classes of farming/pastoral/forestry enterprise size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Value added to end-product via digitalisation</td>
<td>Kruse et al. 2009</td>
<td>8, 9</td>
<td>all</td>
<td>added value to end-product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of small-scale industries in total industrial value added</td>
<td>SDG 9.3.1</td>
<td>8, 9, 10</td>
<td>all</td>
<td>increased proportion of small-scale industries in total industrial value added</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unit labour cost</td>
<td>OECD 31</td>
<td>8</td>
<td>all</td>
<td>reduced unit labour cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total employment</td>
<td>OECD 33</td>
<td>8</td>
<td>all</td>
<td>increased total employment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dependence on seasonal migrant workers</td>
<td>DESIRA</td>
<td>8</td>
<td>AG</td>
<td>decreased dependence on seasonal migrant workers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Employment of women in agriculture and forestry</td>
<td>DESIRA</td>
<td>5, 8</td>
<td>AG, FO</td>
<td>increased employment of women in agriculture and forestry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average income of small-scale food producers, by sex and indigenous status</td>
<td>SDG 2.3.2</td>
<td>2, 5, 8</td>
<td>AG</td>
<td>increased average income of small-scale food producers, by sex and indigenous status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contribution to income (of new technology)</td>
<td>adapted from Kruse et al 2009</td>
<td>8, 9</td>
<td>all</td>
<td>positive contribution to income</td>
</tr>
<tr>
<td>ICoS Rule Group</td>
<td>ICoS Rule</td>
<td>Indicator</td>
<td>Indicator source</td>
<td>SDG</td>
<td>Applies to Domain</td>
<td>DESIRA sustainability target</td>
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</tr>
<tr>
<td><strong>Securing Human Existence</strong></td>
<td></td>
<td>Ownership and disclosure of collected data</td>
<td>DESIRA</td>
<td>10, 12</td>
<td>all</td>
<td>protected ownership and disclosure of collected data</td>
</tr>
<tr>
<td>Just distribution of opportunities to use natural resources</td>
<td></td>
<td>Accessibility of public data with business-related interfaces (farmers)</td>
<td>DESIRA</td>
<td>10, 12</td>
<td>AG</td>
<td>increased accessibility to public data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of women among owners or right-bearers of agricultural land (by type of tenure)</td>
<td>SDG 5.a.1</td>
<td>5</td>
<td>all</td>
<td>increased proportion of women among owners or right-bearers of agricultural land (by type of tenure)</td>
</tr>
<tr>
<td><strong>Maintaining Society’s Productive Potential</strong></td>
<td></td>
<td>Freshwater use efficiency</td>
<td>DESIRA</td>
<td>6, 13, 14</td>
<td>all</td>
<td>improved freshwater use efficiency</td>
</tr>
<tr>
<td><strong>Sustainable use of renewable resources</strong></td>
<td></td>
<td>Agricultural input efficiency (pesticides, fungicides, insecticides, fertilizer, etc.)</td>
<td>DESIRA</td>
<td>2, 12, 13, 14, 15</td>
<td>AG</td>
<td>improved agricultural input efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land use efficiency</td>
<td>DESIRA</td>
<td>13, 15</td>
<td>all</td>
<td>increased land use efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy use efficiency</td>
<td>DESIRA</td>
<td>7, 13</td>
<td>AG</td>
<td>increased energy use efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Area under organic farming</td>
<td>Eurostat_sdg_02_40</td>
<td>2, 13, 15</td>
<td>AG</td>
<td>increased area under organic farming</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agriculture: area under management practices potentially supporting biodiversity</td>
<td>EEA_SEBI020</td>
<td>2, 13, 15</td>
<td>AG</td>
<td>increased area under biodiversity practices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Progress towards sustainable forest management</td>
<td>SDG 15.2.1</td>
<td>15</td>
<td>FO</td>
<td>increased progress towards sustainable forest management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forest: growing stock, increment and fellings</td>
<td>EEA_SEBI017</td>
<td>15</td>
<td>FO</td>
<td>increased growing stock...</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Forest fires</td>
<td>EEA_CLIM035</td>
<td>15</td>
<td>FO</td>
<td>reduced number of forest fires</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Livestock genetic diversity</td>
<td>EEA_SEBI006</td>
<td>15</td>
<td>AG</td>
<td>increased livestock genetic diversity</td>
</tr>
<tr>
<td><strong>Sustainable use of non-renewable resources</strong></td>
<td></td>
<td>Fossil fuel use efficiency</td>
<td>DESIRA</td>
<td>7, 12, 13, 14, 15</td>
<td>all</td>
<td>improved efficiency of fossil fuel use efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greenhouse gas emissions total</td>
<td>DESIRA</td>
<td>7, 12, 13, 14, 15</td>
<td>all</td>
<td>reduced greenhouse gas emissions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO2 emissions per unit of value added (infrastructure and industries)</td>
<td>SDG 9.4.1</td>
<td>9, 13</td>
<td>all</td>
<td>reduced CO2 emissions per unit of value added (infrastructure and industries)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electric machines/vehicles as a proportion of the total fleet in agriculture/forestry</td>
<td>based on EEA_TERM034</td>
<td>7, 13</td>
<td>all</td>
<td>increased electric machines/vehicles as a proportion of the total fleet in agriculture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final energy consumption by agriculture/forestry per hectare of utilised agricultural area (renewable and fossil energy)</td>
<td>Eurostat_tai04</td>
<td>7, 13, 15</td>
<td>AG, FO</td>
<td>reduced final energy consumption by agriculture/forestry per hectare of utilised agricultural area (renewable and fossil energy)</td>
</tr>
<tr>
<td>ICoS Rule Group</td>
<td>ICoS Rule</td>
<td>Indicator</td>
<td>Indicator source</td>
<td>SDG</td>
<td>Applies to Domain</td>
<td>DESIRA sustainability target</td>
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</tr>
<tr>
<td>Preserving Society’s Options for Development and Action</td>
<td>Equal access for all to information, education and training</td>
<td>Gender pay gap</td>
<td>DESIRA</td>
<td>5, 8, 10</td>
<td>all</td>
<td>decreased gender pay gap</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average hourly earnings of female and male employees by occupation, age, and persons with disabilities</td>
<td>SDG 8.5.1</td>
<td>5, 8</td>
<td>all</td>
<td>increased hourly earnings, equal hourly earnings across all genders and abilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Person hours of production</td>
<td>Kruse et al. 2009</td>
<td>5, 10</td>
<td>all</td>
<td>reduced person hours of production</td>
</tr>
<tr>
<td></td>
<td>Participation in societal decision making processes</td>
<td>Public awareness of a subject</td>
<td>EEA</td>
<td>4, 10, 16</td>
<td>all</td>
<td>increased public awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public image of a subject or product</td>
<td>DESIRA</td>
<td>4, 10, 16</td>
<td>all</td>
<td>improved image of a subject or product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marketing of a product</td>
<td>DESIRA</td>
<td>4, 10, 16</td>
<td>all</td>
<td>improved marketing of a product</td>
</tr>
<tr>
<td>Conditions to achieve the substantial sustainability</td>
<td>Gross Domestic Product (GDP) - Outlook from the Organisation for Economic Co-operation and Development (OECD)</td>
<td>Gross Domestic Product (GDP)</td>
<td>EEA, Outlook041</td>
<td>8, 11</td>
<td>all</td>
<td>increased GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gross value added of the forestry industry, at basic prices</td>
<td>Eurostat, tag00058</td>
<td>8, 9, 15</td>
<td>FO</td>
<td>increased gross value added to industry</td>
</tr>
<tr>
<td></td>
<td>Balance of power between societal actors</td>
<td>Application of digital technology in small and medium sized enterprises</td>
<td>DESIRA</td>
<td>8, 9, 10</td>
<td>all</td>
<td>increased application of digital technology in small and medium sized enterprises</td>
</tr>
</tbody>
</table>

*This list includes all indicators selected from the literature, existing sets, and the extra indicators indicated in the DESIRA discussions. Further fine-tuning will be made to this based on stakeholder consultations.*
References


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