

# Building impact pathways for digitalization in agriculture and rural areas: the case of hydrogeological risk management in North of Tuscany

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## **Extended Abstract**

International institutions and policies are promoting digitalization as a key element to the redesign of efficient and sustainable food production systems (1,2) and to the achievement of the UN Sustainable Development Goals (SDGs) in rural areas (3,4). The Sustainable Development Goals (SDGs) 2030 Targets, adopted by the United Nations General Assembly, consist of 17 goals and 169 target to be achieved by the 2030, however progress is perilously slow and it is important for each country adopting them to demonstrate the progress towards their achievement. Building impact pathways for digitalization across SDGs targets can then be relevant to link local use of digital tools with global-level SDGs impacts.

Digitalization is also one of the European Union's strategic priorities for the post-2020 period present in several EU policies (CAP, European Green Deal, EU Circular Economy Action Plan, EU Digital Strategy etc.) (5). However, this positive picture, which looks at digital technologies as an opportunity to enable sustainable futures in agriculture and rural areas (6) risks to underestimate the possible undesirable effects due to the social complexity of digital technologies identified in the literature (7,8,9). In particular, Salemin et al. (8) highlight how contextual specificities should be taken into consideration in the promotion of digitalization in rural contexts.

Digitalization is the process of digital tools defining a new sociotechnical context in which human activities are performed (6,10,11). This process is currently developing also in agriculture and rural areas, increasing the flows of information from the field to the decision-making level and vice versa in different ways and with various aims. Some of them are related to improving the performance of the sociotechnical systems and promote the involvement of citizens in public service delivery through experiences of e-governance (15). Some other aims are addressing policy monitoring and performance evaluation with a specific focus on the environmental aspects. Public investments are requested in order to reach social utility through the use of data. Policies and institutional structures represent important factors to address the adoption of digital technologies in agriculture and rural areas, especially if such diffusion should contribute to broader sustainability goals. Looking at impacts of digitalization in agriculture and rural areas should help clarify the trade-off between SDGs in different contexts. The aim is to consider if addressing a specific SDG, for example the more environmental ones, we are not making worse other, more "social" SDGs.

The objective of the present research is to include the context specific dimension in the development of impact pathways for digitalization in agriculture and rural areas. In particular the research wants to explore the connections between digital solutions and impacts in a specific application scenario, namely *hydrogeological risk management*, in the specific context of remote mountain areas of Northern Tuscany, thus explicitly considering its contextual specificity.

The specific context will be presented through the intricate relationships among different entities involved in the digitalization process and described in the definition of the *socio-cyber-physical system* (SCPS).

The concept of SCPS has been introduced in the H2020 DESIRA project ([www.desira2020.eu](http://www.desira2020.eu)) as an extension of the *cyber-physical system* (CPS) paradigm used in the ICT domain. A SCPS can be defined as a system constituted by the social world (people), the digital world (digital tools and data), and the physical world (things), putting emphasis on the social aspect and the interlinkages between the three aspects. A CPS focuses on two aspects only, i.e., the digital and the physical world, and represents a technological solution aimed at achieving a given goal in a given context (i.e., the application scenario) by means of ICT tools. In the case under consideration, the remote mountains areas of Northern Tuscany and the actors therein constitute

the SCPS. Among all the relationships in this SCPS, this research focus on the *hydrogeological risk management* and in which conditions the use of digital tools can play a *game changing* role, both from the negative and from the positive standpoint. The research has been carried on in the framework of activities in a Living Lab, namely “Toscana Nord”. Engaging relevant stakeholders in a participatory process anticipating future impact pathways trajectories is the method applied in DESIRA Living Labs in order to contribute to the reflection on digital transformation in agriculture and rural areas (12,13).

The Living Lab Toscana Nord has been organized around the activity of land and water management carried on by the local public authority “Consorzio Toscana Nord” with the aim of looking at how digital technologies can improve the farmers participation in the adjustment of the drainage network as an efficient solution to reduce the risk for floods and landslides with ordinary land management. In the specific context, farmers and forest owners located in mountain areas have been already involved in the process (14) and the public institution is willing to apply an e-governance approach (15).

Qualitative in-deep interviews with experts and stakeholders have been carried out in order to define the SCPS and the functional use of each technology mentioned by local actors. A deep analysis of the interviews and workshop discussion allowed the researchers to connect each specific function of a technology in the application scenario with a specific impact. In addition to that, impact have been also collected from the taxonomy proposed by Rolandi et al. (16). Identified impacts have been then clustered and connected to the SDGs. Positive impacts are the better control of the hydro-geological risk, thanks to the improved communication quality guaranteed by instant messaging apps, and the reduced need for on-site inspections by the central authority, which can rely on geo-references pictures sent by inhabitants, Negative impacts are the information overload of some stakeholders, who end up being always connected, and the exclusion of the part of the population that is not connected, due to the limited network coverage that penalises large areas of the mountain territory. Besides that, the reduction of the problem-solving ability of technical workers, who tend to delegate decisions to their manager thanks to the quicker communication, is also regarded as a detrimental aspect.

The connection with the U.N. Sustainable Development Goals was made by highlighting how each of the impacts observed can influence their achievement. The assessment was made through direct attribution, starting from the objectives explicitly stated in the 2030 Agenda document (17). The results obtained were further analysed based on the framework proposed by Rijswijk et al. (18) that relates SCPS to the impact drivers of digital transformation. Once the SDGs involved were defined, it was possible to highlight how the whole process affects the three dimensions of Sustainability (social, economic and environmental), following the subdivision elaborated by Vinuesa et al. (19) based on (20) and (21). Starting from the social dimension, the improved efficiency of ordinary land management, facilitated by digitalization, means reduced vulnerability of local communities to extreme climate events [1.5], protection of water-related ecosystems [6.6], reduction of deaths and economic losses caused by natural disasters [11.5], increasing the number of human settlements implementing disaster resilience-oriented plans and promoting holistic disaster risk management [11.b], increasing the effectiveness of institutions [16.6] and implementing participatory decision-making at all levels [16.7] that also involves local communities in improving water management [6b]. In the economic dimension, promotion of a safe working environment [8.8], and access to information and communication technologies [9.c]. Finally, in the environmental dimension, strengthening the capacity to adapt to climate-related risks and natural disasters at the local level [13.1] and combating land degradation including flooding [15.3]. The achievement of these objectives is closely linked to how these technologies are designed. Consider that a well-designed reporting platform interface can facilitate the exchange of information and the achievement of the (all SDGs) goals. This can improve, among other things, the participation of local communities and foster the involvement of citizens and farmers [16.7 and 6.b] and the transparency of P.A. [16.6 and 16.7]. Accessibility (e.g. digital divide or connection issues) can also have a considerable impact, especially on the quality of work in terms of process efficiency (all SDGs), the safety of

the workplace [8.8], and negatively affect the involvement of stakeholders leading to their exclusion [6.b]. Finally, the complexity of the system can have a relevant impact on the entities belonging to the system, e.g. by reducing the number of deaths following a flood [11.5] and on all SDGs that have been identified.

One of the goals of carrying on this impact analysis is to define future scenario for the development of digitalization in the specific context and to support public investments in a specific direction.

In order to facilitate the achievement of the positive impacts, there is a need to involve the local community in the identification of future scenarios of digital technologies use. The direct involvement of the local community in the specific application scenario allows to better identify context specific impacts in the use of digital technologies.

Existing studies have in general a focus on specific technologies, sectors and dimensions instead of on the application scenario, defined as the way users interact with digital systems in each context (16). We are including the context specific dimension to it. This work aims to contribute in the achievement of the overall goal of DESIRA to analyze the ongoing digitalization process in rural areas and agriculture to strengthen the capacity of society and political bodies in responding to digital challenges.

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