Emerging technologies in agriculture – an Environmental and Social LCA

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Introduction

The Horizon XGain project focuses on fostering sustainable, balanced, and inclusive development across rural, coastal, and urban areas by facilitating access to advanced connectivity and edge computing technologies.

Objectives

The project aims to evaluate the socio-environmental impacts of technologies using environmental and social Life Cycle Assessments (LCA), supported by the **K**nowledge **F**acilitation **T**ool (KFT), to inform business models and decision-making for selecting the most suitable connectivity and edge-processing options.

Methodology

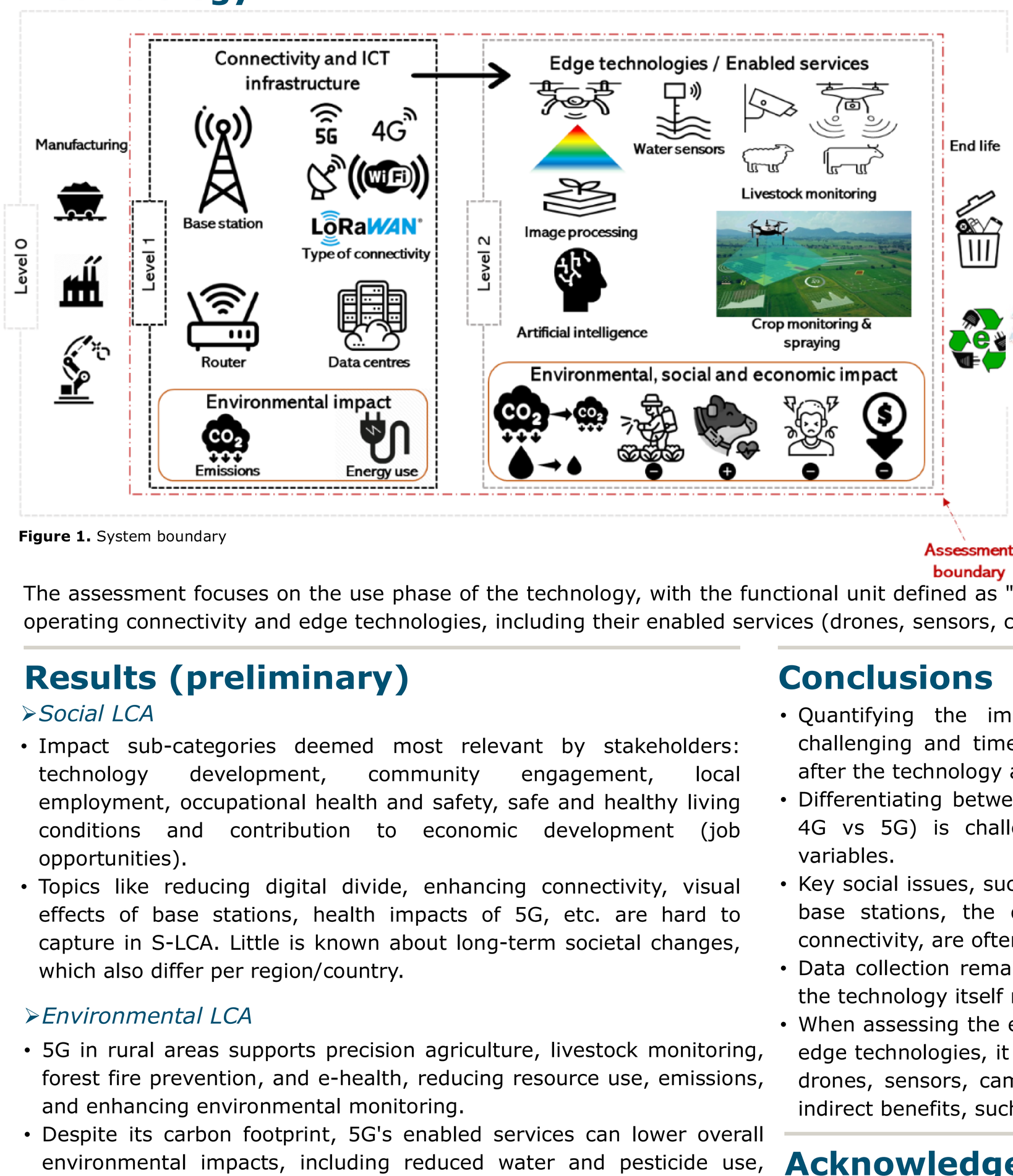

Figure 1. System boundary

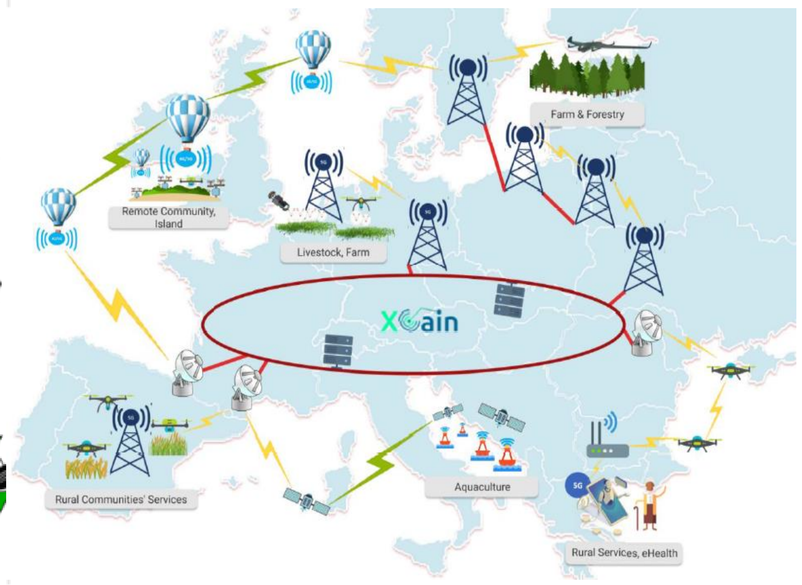

Figure 2. Use cases in Europe.

The assessment focuses on the use phase of the technology, with the functional unit defined as "one hour of use." This unit captures the impacts of operating connectivity and edge technologies, including their enabled services (drones, sensors, cameras), for one hour.

Results (preliminary)

➢*Social LCA*

- Impact sub-categories deemed most relevant by stakeholders: technology development, community engagement, local employment, occupational health and safety, safe and healthy living conditions and contribution to economic development (job opportunities).
- Topics like reducing digital divide, enhancing connectivity, visual effects of base stations, health impacts of 5G, etc. are hard to capture in S-LCA. Little is known about long-term societal changes, which also differ per region/country.

➢*Environmental LCA*

- 5G in rural areas supports precision agriculture, livestock monitoring, forest fire prevention, and e-health, reducing resource use, emissions, and enhancing environmental monitoring.
- Despite its carbon footprint, 5G's enabled services can lower overall environmental impacts, including reduced water and pesticide use, leading to a net positive effect.
- Studies show that UAVs and sensor technologies in agriculture achieve water savings of 22% to 93%, fertilizer reductions of 19% to 25%, and up to 50% less pesticide use, highlighting substantial environmental benefits.
- In remote areas, choosing the right connectivity option based on service needs and location specifics is important. Tools like KFT can help reduce environmental and social impacts.

Conclusions

- Quantifying the impacts of adopting technologies like 4G/5G is challenging and time-consuming, requiring an assessment before and after the technology adoption.
- Differentiating between the social impacts of various technologies (like 4G vs 5G) is challenging due to overlapping effects and complex variables.
- Key social issues, such as health impacts, infrastructure/visual effects of base stations, the digital divide, urbanization, migration, and rural connectivity, are often excluded from S-LCA.
- Data collection remains a challenge, as the main focus tends to be on the technology itself rather than its broader societal impacts.
- When assessing the environmental impact of connectivity (e.g., 5G) and edge technologies, it is important to consider the enabled services (e.g., drones, sensors, cameras, robots) to fully understand both direct and indirect benefits, such as reduced resource use and improved efficiency.

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