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A Research Agenda for Smart, Sustainable Uplands: Socio-Digital Innovations for the Uplands Twin Transition

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Table of Contents

A Research Agenda for Smart, Sustainable Uplands: Socio-Digital Innovations for the Uplands Twin Transition

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Abstract

Digitalisation and sustainable development are key trends in the uplands: the world's higher-altitude regions of hills, plateaus and mountains. The two trends have been rather disconnected to date but there is an increasing logic for recognising their intersection in pursuit of the creation of smart, sustainable uplands. Some argue that incremental change will be insufficient to address the anthropogenic challenges faced by the uplands. From this emerges the concept of a more-fundamental "uplands twin transition" that integrates digital transformation with a sustainability transition. This paper reviews some of the arguments for, and features of, an uplands twin transition, and lays out a future research agenda on this new concept.

A. Introduction: The Digital—Sustainability Intersection

Recent years have been marked by a number of approaches to the intersection between digital technologies and sustainability (Hilty & Hercheui 2010). There have been concerns about the carbon and wider ecological footprint of ICTs leading to a "green ICT" agenda that seeks to address this (Fuchs 2006, Heeks et al 2015). There have been more positive hopes in relation to "smart ICT", seeing the potential of digital technologies to reduce carbon emissions across a range of sectors: smart transport, smart buildings, etc (Raj & Raman 2015). The two were intersected more broadly with the recognised importance of ICTs in delivering the UN Sustainable Development Goals (Tjoa & Tjoa 2016). At around the same time emerged the notion of the "smart, sustainable city" in which the understanding of sustainability was less broad than the SDGs but extended beyond energy and pollution. It often drew on the earlier Brundtland Commission definition to argue that a smart sustainable location is one that "meets the needs of its present inhabitants without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and where this is supported by ICT" (Hojer & Wangel 2015:347).

Most-recently has emerged the notion of the "twin transition". In simple terms, this is "a simultaneous transition toward sustainability and digitalization" (Muller et al 2024) but behind that are a number of different conceptualisations:

- In relation to the "transition" element, both the speed but also the extent of change vary: some definitions are more gradualist and see transition as the incremental adoption of digital technologies and of a sustainability agenda, while others are more radical and see transition as the metamorphic transformation of digital and socio-economic systems into a completely new form (Dolata 2011, Muller et 2024).
- In relation to the "twin" element, the digital component tends to be a relative constant, but the other element can be understood at three different scopes, as summarised in Figure 1. Green transition focuses on energy, carbon emissions and other pollutants; ecological transition focuses on green plus the health of natural ecosystems; sustainability transition focuses on ecological plus socio-economic sustainability including issues of inequality (Brunori 2022, Muller et al 2024, Narayan 2024).

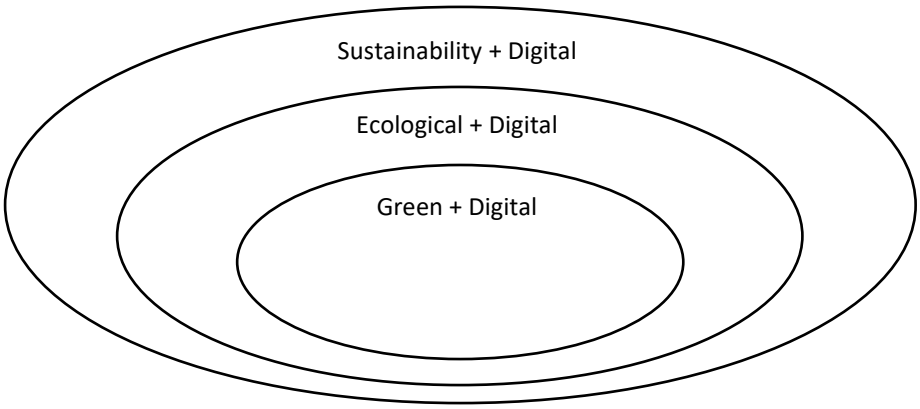

Figure 1: Different Scopes of Twin Transition

The concept of twin transition has arisen for two reasons that can be teased out from its two elements. Transitions are seen as needed when current socio-technical systems are regarded as unsustainable or in other ways causing significant problems; most-obviously "persistent and worsening environmental problems (such as climate change, biodiversity loss, resource depletion)" (Geels 2019). A specifically-twin transition is seen as needed because the agendas of green / ecological / sustainability transition and digital transformation are argued to have been too siloed to date, and to require combinative planning because of the extent of their intersection (Santaniello et al 2022, Brink 2023). Latterly, the concept has been given a significant boost: implicitly with the adoption by the UN-inspired Coalition for Digital Environmental Sustainability of its Action Plan for a Sustainable Planet in the Digital Age (CODES 2022), and more explicitly with the EU's adoption of its European Green Deal and its Europe's Digital Decade policies which are seen to represent separate transitions but also to have potential to combine as a European twin transition (EC 2022, Leterme 2024).

B. Uplands Twin Transition

Place-based analysis of the twin transition has started to emerge (Collini & Hausemer 2023, Bianchi et al 2024) but – as in the instance of these sources cited above – it is the global North which is the main focus. Yet, the argument is made that it is the global South that should be the greater focus as "the need of twin transition is even more profound in developing and emerging economies where development of digital infrastructure and the implementation of climate-sensitive and resilient transformation are still in their early stages" (GIZ 2022:5). A very similar asymmetry can be seen along the urban—rural axis. It is cities that have been more the focus for twin transition than rural areas despite the evident value of rural twin transition (Furst et al 2021, Brunori 2022, SCDI 2024). Yet that prioritisation risks exacerbating urban—rural inequalities (Cattani et al 2023), repeating a pattern seen with both the "smart" and the "smart sustainable" agendas where the emphasis to date has been almost exclusively urban (Thapa & Thapa 2022, Jakobsen et al 2023).

This same argument will apply with even greater force if we consider the twin transition in uplands[1]: those higher-altitude regions of hills, plateaus and mountains. These are the most-remote regions of the world, least-connected and least-digitalised, yet at the same time facing major threats to their economic, social and ecological sustainability (Glass et al 2013, TMI 2020). Hence, for example, the relevance of the twin transition to Europe's upland regions has been recognised in the EU Strategy for the Alpine Region (EUSALP 2023). Beyond that one source, however, there is as yet no literature – research-based or otherwise – on uplands twin transition or near-equivalents such as creation of smart, sustainable mountain regions.

The separate elements have been researched. Non-digital socio-technical innovations for uplands sustainability address areas including agriculture e.g. adoption of powered mini-

[1] We prefer the terms "uplands" to "mountain" because the former is more inclusive of non-mountain regions such as those characterised by hills and plateaus which nonetheless share key features of mountain regions in that they are subject to "marginalization, vulnerability, and material scarcity" (Balsinger et al 2024).

tillers to address loss of labour through outmigration (Devkota et al 2020), forestry e.g. adoption of communal forest ownership to address deforestation (He et al 2014) and tourism e.g. creation of mountain bike trails to ensure more sustainable visitor income (Gajdosikova et al 2018). Digital innovations can likewise be found addressing upland agriculture e.g. use of e-commerce to facilitate sales of upland produce (Liu et al 2019), upland employment e.g. creation of digital co-working spaces (Burgin & Mayer 2020) and upland tourism e.g. new apps for hotel and restaurant bookings (Sgroi & Modica 2024).

If we consider the intersection of digital and sustainability, a number of uplands digital innovations could be related to sustainability: the three illustrations just given could be argued to help maintain the sustainability of uplands livelihoods and incomes, for example. More directly, a few authors make at least some connection between upland smart villages and sustainability goals (Stojanova et al 2021, Chaudhary 2023). However, overall, it was not possible to find research specifically investigating innovations for the twin transition in uplands or for the combined goals of smart, sustainable uplands. This is not surprising given the lack of literature generally on uplands twin transition, on smart, sustainable uplands or on synonymous equivalents relating to hills and mountains and alpine regions.

C. Features of the Uplands Twin Transition

Despite this absence, we can extract some key features of the uplands twin transition.

It might best be conceived in the broad sense of twin transition as discussed above. Uplands regions are on the frontline of, and "affected disproportionately" by, global environmental change including climate change (Chakraborty 2021). However, they not the sources of, for instance, carbon emissions or other pollutants and it is thus other regions that need to undergo a proactive green transition. At most, uplands need reactive change to this. Equally high up the agenda for sustainable uplands development are preservation of biodiversity, response to outmigration and poverty, and creation of sustainable forms of resource exploitation and tourism (Shucksmith & Ronningen 2011, Glass et al 2013, Kreutzmann 2024). This therefore fits best with the "sustainability + digital" twin view.

The uplands twin transition might best be conceived in the accretive sense of twin transition as discussed above. Any reactive change to wider anthropogenic impacts will likely be incremental given those impacts have themselves been incremental (Vij et al 2021). Likewise the pace of any other transitional changes e.g. to new models of sustainable agriculture, sustainable tourism or other sustainable economic models is likely to be gradual not least because of "the physical challenges of mountain terrain, low adaptive capacities, limited knowledge and high uncertainty about future risks" (Rasul et al 2020). Given the anticipated slow pace of transition it may need to be seen as the longer-term goal, with formation of "smart, sustainable uplands" a more interim measure.

The deficit model of uplands – reflected in earlier quotes around "low adaptive capacities" (Rasul et al 2020) and "marginalization, vulnerability, and material scarcity" (Balsinger et al 2024) – is quite dominant. There is a reality here that must be recognised: one, for example, that both imposes serious constraints on innovation and change while simultaneously meaning uplands are most in need of innovation and change given the

problems they face. But it is also a narrative that needs to be challenged because of its potential implications: a failure to recognise the indigenous innovations that arise from within uplands regions, and a tendency to then legitimise the need for externally-sourced innovations that may hamper rather than support sustainability (Balsinger et al 2024).

Uplands are often cast as places disconnected from the outside world and its external socio-economic circuits (del Marmol 2020, Bal 2022): think of the traditional Chinese saying, "The mountains are high, and the emperor is far away". Yet, as already alluded, the narrative of disconnection is clearly inappropriate – anthropogenic forces originating in the lowlands impact the uplands, ecosystem services from uplands serve lowland populations, external innovations from the lowlands penetrate uplands, and so on. Any consideration of uplands twin transition therefore does need to consider the uplands—lowlands link; after all, smart, sustainable uplands will be more not less connected to lowlands (Garcia Fernandez & Peek 2023).

Inequality between lowlands and uplands and, to some degree, within uplands themselves is a cause for concern (De Bruin 2011, Price et al 2022, Chakraborty et al 2023). It suggests that the focus should not simply be the twin transition but – drawing on the idea of "just transition" (Heffron 2021) – should be a <u>just</u> twin transition: which we can define as the integrated pursuit of a smart, sustainable transition that is inclusive and equitable. Linked to this will be an important role for social innovations for the uplands: innovations which are participatory in origin, which aim to create social value rather than profit, and which amend local social practices (Nijnik et al 2023). This might alternately be characterised as a need for inclusive innovation: "the means by which new goods and services are developed for and/or by those who have been excluded from the development mainstream" (Heeks et al 2013), with those living in the uplands epitomising those exclusions.

D. The Uplands Twin Transition Research Agenda

In many ways, the features just outlined are more hypothesised than known, which leads us finally to the research agenda for the uplands twin transition. We should first ask whether the absence of research – indeed of much of an agenda – on a twin transition to create smart, sustainable uplands is actually a problem? We would argue that it is. In a general sense, there have already been calls for "overarching prioritization of future research that promotes transformation in mountain regions" (Price et al 2022; see also Gleeson et al 2016).

Research on uplands sustainability has had a long tradition stretching back to at least the 1980s (Carpenter & Harper 1989) and given a particular impetus by the 1992 Rio Environment and Development Conference statement on sustainable mountain development (UNCED 1992). In recent years, this has included calls to prioritise research on transformation for sustainability in upland regions (Adler et al 2020, Payne et al 2020). Research on digital uplands is much more recent and more limited yet, despite the ample presence of non-digital uplands innovations, digital is an increasing component of uplands change. It is both a facilitator of sustainability actions and also itself a catalyst for change – including potential harms to sustainability – as it moves from connectivity underlay to individual applications to the mesh of digital platforms that increasingly mediate economic,

social and political life in uplands regions (Martinez-Gil 2022, Dixit 2023). In recent years, this has led to calls to prioritise research on digital transformation in upland regions (IAS 2021).

As a result, digital and sustainability are of growing importance to the present and future of uplands regions, which brings us to the first element of an uplands twin transition research agenda, summarised overall in Figure 2 in relation to strategy. Mapping the existing digital—sustainability intersection in uplands would help to understand the current state-of-play. This could, for example, categorise the type of digital systems and type of sustainability goals that intersecting initiatives involve.

The arguments behind the concept of twin transition were made above and are assumed to apply equally in uplands. The twin element argues for more integrated thinking about the future of digital and sustainability given the downsides of separating the two. How does or how could this strategic integration manifest itself in uplands? And what are the implications of the intersection: does each impetus complement the other or are there tensions between them? The transition element has been described above in theory but what future transition is being sought – or imposed – in uplands? What is the scope of change, from more incremental to more transformative? And what is the speed of change, from gradual to disruptive?

Transition requires innovation and change, with discussion of just transition and social or inclusive innovation in part surfacing the importance of process. What are the processes by which smart, sustainable innovations for the uplands are conceived, designed, developed, implemented, adopted and used? And who is, and is not, involved in each of these processes? In particular, inclusion and justice incorporate a requirement for processes of engagement and involvement of upland stakeholders when innovations are designed and developed; an issue identified for future study in papers identifying uplands research priorities (Price et al 2022, Nijnik et al 2023).

Looking beyond these processes, twin transition impact must be researched. Digital may be just a means to an end but sustainability is an end in itself, and can form the basis for evaluation, both of the smart, sustainable innovations emerging and also of the processes by which they emerge. More broadly, impact assessment can judge what type of twin transition – if any – is taking place, and who are the winners and losers from this change.

Finally, we can consider imperatives for the design of uplands twin transition research. Two potential priorities emerge from recent papers on future uplands research. In terms of research process, then research should involve the participation of local uplands stakeholders (Singh & Thadani 2015, Nijnik et al 2023). And in terms of research location, upland regions in the global South have so far been under-represented in scholarship and this needs to be redressed (Gleeson et al 2016, Price et al 2022), not least because of the priority argued above for the twin transition in the global South (GIZ 2022).

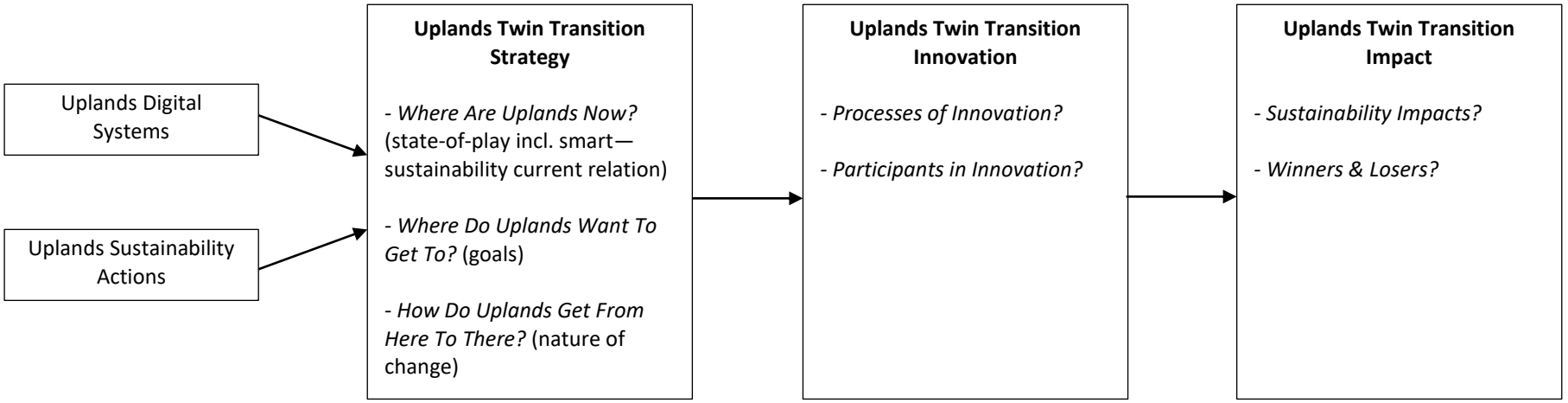

Figure 2: Uplands Twin Transition Research Agenda

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