



Beyond global versus local: illuminating a cosmological framework for convivial technology development

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Abstract

A reconceptualisation of technology, as a vital component of modern society cutting across all its other aspects, is required to achieve social and environmental sustainability. This paper presents a convivial technology development framework using the concept of “cosmological” production. The latter captures the dynamic of dispersed technology initiatives, which exhibit conceptualisations of living, working and making around the commons. It is a structural framework for organising production by prioritising socio-ecological well-being over corporate profits, over-production and excess consumption. From the vantage point of Tzoumakers, a cosmological initiative in which the authors participate, this paper offers an empirical account of its conception and evolution. We further examine its relation and cooperation with various similar interconnected places in urban and rural settings.

Keywords Political ecology · Degrowth · Environmental justice · Ecological economics

Introduction

The mountainous Epirus region in Greece, home to several Natura 2000 areas, is a place of captivating beauty. It has also been part of a baffling nationwide search for oil deposits across multiple aquatic and forest ecosystems. As the Greek minister of Energy and Environment stated in late 2022, “the oil reserves...[of the area]...can address Greece’s energy demands for the following decade” (Skrekas 2022). Moreover, Epirus has been witnessing a trending rush to install massive wind farms with little regard for environmental and efficiency reports that dispute their need (Kati et al. 2021). The shady proceedings have outraged the local population,

who see their livelihoods threatened (Aggeli 2021; CrisisWatch 2018). At the same time, local community-driven initiatives have provided creative outlets for the pent-up frustration and the sense of helplessness that has been building up over the years of the Greek economic crisis. They aim to introduce alternative conceptualisations of living, working and making sustainably together, enabled by a dialectic synthesis of low-tech and high-tech tools.

This paper draws insight from these initiatives to explore a technologically mediated socio-spatial production configuration geared towards degrowth. For Kallis et al. (2018), degrowth is a process of political and social transformation that reduces a society’s throughput (of material and energy) while improving the quality of life. As one of the most articulated post-capitalist imaginaries, degrowth positions itself against the dominant socio-technological narratives (D’Alisa et al. 2014; Demaria et al. 2013; Pansera and Fressoli 2021). From the standpoint of Tzoumerka, a cluster of villages in Epirus, this paper discusses a framework of convivial technology development through the paradigmatic case study of “Tzoumakers”. From an institutional and spatial perspective, we demonstrate a framework of convivial technology development. Tzoumakers is a small-scale factory (a “makerspace” as we explain later) in mountainous Epirus and a community, which collaboratively identifies local needs and produces solutions using knowledge from

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several commons-based initiatives. The project also draws the attention of disenfranchised city-dwellers seeking a way out of their socio-economic surroundings and an alternative vision for creative and convivial living.

Borrowing from the traditions of organisation, science and technology, political economy and geography studies, this paper presents a novel socio-technical configuration, which we shall call “cosmolocalism”. We explore the potential of cosmologicalism to formulate strategies of organisation and production processes. Ultimately, we trace its capacity to inform a policy agenda towards a degrowth society. The rest of the article is structured as follows. “[Technology for a degrowth framework](#)” introduces the theoretical foundations of the paper and the subsequent section describes its methodological approach. Next, “[Case study](#)” presents Tzoumakis and illuminates the framework of convivial technology development through practical examples. “[Discussion](#)” discusses some of the challenges and opportunities to formulate cross-spatial strategies to empower commoning. “[Conclusions](#)” provides some concluding remarks regarding cosmological production and degrowth and paths for future research and action.

Technology for a degrowth framework

The degrowth literature highlights the unsustainability of current production practices and economic structures and promotes local and sectoral projects as inspirational alternatives (Krähmer 2022; Lübker et al. 2021). Still, this focus on localism may neglect to account for larger geographical spaces and relevant structures, and so far, few studies have attempted to take on the spatial perspective (Demaria et al. 2019; Krähmer 2022). This is a complex dimension because it functions on multiple scales and cuts through various disciplines. However, if degrowth is to contribute to global social/economic/political/ecological transformation, it must move past localism and dry critiques of socio-economic metabolisms on more and wider scales, such as the regional and the global (Olsen et al. 2018; Rutting et al. 2022).

We may broadly trace two currents affecting wider social change, prioritising either the global or the local respectively. On one hand, according to Swyngedouw (1997, p. 160), although the contemporary politics of resistance recognise the paramount importance of scale, “its protagonists have failed to transcend the confines of a militant particularism”. A “global ambition” (Harvey 1997) shared by existing and emerging social movements could and should be articulated by transcending such confines. Alliances should be built and collaboration should be organised over space (Swyngedouw 1997). Similarly, theorists like Hardt and Negri (2000, p. 411) see a globally organised counter-power

as the only way to challenge neoliberal globalisation: “the only event that we are still awaiting is the construction, or rather the insurgence, of a powerful organization”.

On the other hand, Gibson-Graham (2002, p. 53) recognise globalisation as a call for just one of many forms of politics, i.e. “mobilization and resistance on the global scale”. However, they pinpoint other ways of practising transformative politics by “involving an opening to the local as a place of political creativity and innovation”. In this setting, novel practices and techniques are involved to cultivate the capacities of local subjects as agents for this transformation. Gibson-Graham’s vision relies on a plurality of emancipatory and egalitarian ideals. They regard the narrative of competing massive forces for domination as a masculine objectivist idea. This plurality forms an economic ecosystem with the potential to match the universality of capitalism. The “global power” of this ecosystem is channelled through different forms of exchange and enterprises, as well as livelihoods. It is, however, a type of power that is not concentrated and consolidated into a uniform whole but remains diverse and partial (Gibson-Graham 2002).

As this paper illustrates below, technology is a connective tissue that may bridge the two perspectives into one unified framework for social change aligned with degrowth. While several degrowth scholars engage with the role of technology in our society (see only Kerschner et al. 2018; March 2018; Pansera and Owen 2018; Vetter 2018), there is no common perspective on technology within the degrowth community (Grunwald 2018). Instead, technology has brought up divergent views between enthusiasts and sceptics (Vetter 2018). A core theme among these debates is the concept of conviviality, dating back to Illich (1973). Conviviality emphasises the importance of autonomy in the construction of technology in a social manner (Priavolou and Niaros 2019). Conviviality is thus an intrinsically ethical value that is the “opposite of industrial productivity” and designates the individual freedom realised in personal interdependence (Illich 1973, p. 17).

Technology is not developed only in labs as it is often imagined. On the contrary, technology shapes our environment and, in reverse, it is shaped by the socio-economic system and its power geometries, while reflecting them (Bijker et al. 1987; Feenberg 2002). Recognising technology as a powerful element in the broader discussions around sociopolitical change, we propose “cosmolocalism” as a framework to examine a type of technology that may provide the tools and structures for cross-spatial organising for change.

The concept of cosmologicalism has emerged along with the proliferation of digital communication networks (Schismenos et al. 2020). It describes the methods to bridge local communities in networks of shared resources and products (Manzini 2015). Cosmolocalism redefines the communal in terms of place via resilient

infrastructures for sharing knowledge, techniques and practices over open communication channels (Escobar 2018). Practically, cosmologicalism offers the framework for localising collaborative forms of production whilst sharing resources in the form of digital commons globally. Several technology initiatives exemplify cosmological practices, e.g. RepRap (3D printers), Wind Empowerment (wind-turbines), WikiHouse (buildings) and OpenBionics (robotic and prosthetic devices). Such initiatives utilise a global pool of knowledge to produce tools locally and enrich it with their own contributions (in the form of design files, good practices and know-how). Thus, cosmologicalism allows local communities to tentatively reduce their dependence on global value chains. Cosmologicalism qualitatively differs from capitalist globalisation, by relying on the values of reciprocity and self-organisation that prioritise local autonomy and cultural diversity but also a sense of global common benefit (Schismenos et al. 2020).

The technological processes associated with cosmologicalism have previously been identified as compatible with the principles of degrowth (Kostakis et al. 2018). Specifically, design-embedded sustainability, i.e. products designed to last for as long as possible; on-demand manufacturing, i.e. materials tend to travel less; and optimisation of infrastructures, i.e. digital and physical productive infrastructures are shared, separate cosmologicalism from the conventional industrial production model and link to degrowth (Kostakis et al. 2018). Such principles may assist the enhancement of the degrowth potential identified in key spatial areas for sustainability and democratisation, like the deployment of renewable energy technologies and community-based infrastructure (Wächter 2013).

In this paper, by highlighting the division between approaches that prioritise the global and local in enacting social change, we put forward cosmologicalism as a framework for a degrowth agenda in terms of production and consumption practices. We consider this as a practical foundation for expanding the vision of a society towards less resource use and more democratic foundations while challenging incumbent structures in society (Wächter 2013; Xue 2022). We also view the technology-centric framework proposed here as an important tool for planners to design alternatives for current policies and practices with dire future consequences (Xue 2022). This vision of cosmologicalism should be distinguished by other proposals for localised production enabled by novel desktop manufacturing technologies (see Anderson 2014; Arvidsson 2019). These alternatives adopt a maximalist approach to production with market mechanisms enabling wider distribution of production capacities in society with little regard for the material and political concerns associated with degrowth.

Methodological approach

To achieve the goals of this paper, we examine the relation and cooperation of Tzoumakers with a variety of similar interconnected places based in urban and rural settings, nationally and internationally. The case of Tzoumakers highlights more general characteristics of cosmological structures in one of the most essential economic activities in society. Agriculture, being at the base of the primary sector, presents the opportunity to explore the foundations for a commons-based alternative to the interdependent and vastly complex techno-economic system. Moving beyond the primary sector, the case of Tzoumakers engages with the secondary one through the development of agricultural tools, as well as the tertiary sector with the delivery of services such as the sharing of open-source designs and skills development. This inclusivity allows for a more integrated approach to the investigation of cosmologicalism.

Tzoumakers is an initiative originally conceived within the Epirus-based P2P Lab. The P2P Lab is a collective of researchers and activists researching the intersection of open-source technologies, degrowth and the commons. The authors of this article are core members of the P2P Lab as well as members of the Tzoumakers community and their official role within it is that of action researchers. As such, we initiate actions related to the cosmologicalism framework, examine how they influence the community and generate insights from that interaction.

It should be clarified that the P2P Lab members introduced the concepts of cosmologicalism and degrowth to the Tzoumakers community. Although some of the non-researcher participants of Tzoumakers have explicitly referred to alternatives to capitalism, both degrowth and cosmologicalism have been mostly an implicit part of the action project in Tzoumakers. For instance, the Tzoumakers community has been exploring alternative ways of production and consumption, focussing on local needs and resource efficiency. Still, the success of the participants' endeavours is linked to values seen in degrowth and cosmologicalism, such as inclusivity, sustainability and conviviality. As academics, we have the luxury to grapple with concepts like degrowth through experimentation in the field and enrich our understanding by interacting with other scholars globally. Our financial viability is not dependent on market growth mechanisms, so it is our duty to assist those whose livelihood is impacted in developing the conditions for securing sustainable alternatives.

This paper adopts an interpretivist perspective (Miller 2004; Schwartz-Shea and Yanow 2013) while providing a bird-eye-view of our action research project. We aim to further theorise the cosmologicalism framework within the spatial aspects of the degrowth field through our subjective

interactions and experiences within the project (Myers 2008). Evidence has been gathered from multiple focus groups, questionnaires and unstructured interviews, with varying participants ranging from ten to thirty persons. Further, several workshops have been organised to design collaboratively, act, observe, document and reflect on the cosmological processes (McIntyre 2008; McTaggart 2001). Thus, this article is developed subjectively mainly through personal observations and interpretations, informal discussions, interviews and artefact analysis and reflexive arguments.

Specifically, the participants provided pertinent information for the initial documentation of local needs around agricultural production; from technical issues (e.g. new tools for farming) to more organisational ones (e.g. ways of collaborating). These open gatherings were attended by people of varying backgrounds (e.g. farmers, artisans, activists, academics) and motives (e.g. personal benefits, solidarity).

There may be some incongruence between our efforts to provide a normative description of a framework of convivial technology development according to our understandings and our goal to amplify knowledge produced within similar initiatives and broader social movements. We are aware of our relative power and privileged positions as members of the initiatives we tackle here amidst the various cultural and professional identities we embody. We thus try to be mindful of these tensions throughout this article.

Last, the narrative of the case study is organised in chronological order. “Places are processes”, Massey (1994) postulates. The chronological narration, thus, allows for conceptualisation in terms of the social processes that are tied together in the spatial reality of our case study. This chronology shows the evolution of human interactions concerning the changing needs, goals, opportunities and environmental and economic materialities.

Case study

Gathering the seeds

Tzoumakers is the culmination of five smaller action research projects aiming to explore how local autonomy, sustainability and know-how exchange may be achieved by tapping into a global pool of knowledge commons. Such projects provided valuable insight into the various research disciplines of the P2P Lab members, from science and technology studies to economics and sustainability studies. They also provided the blueprint for the production configuration dubbed “design global, manufacture local” (Kostakis et al. 2015, 2018) or cosmologicalism (Schismenos et al. 2020). Experience indicated the potential of freely accessible diverse knowledge to be adapted and

adopted into addressing local needs and ultimately shared globally again in a virtuous cycle.

To test this configuration, the Tzoumakers project was conceived by P2P Lab members as a pilot application in a small-scale, regenerative agriculture context. The rationale behind this decision was manifold. In a broader context, agriculture is a sector that, despite the rise of agribusiness and industrial farming, still relies mainly on the tacit knowledge and ingenuity of farmers rather than building on organisational and technical innovation introduced by social groups in advanced sectors (Giotitsas 2019). As the base sector of productive activities, it also offers a clearer landscape to explore potential alternatives in the highly interdependent and complex techno-socioeconomic system (Giotitsas 2019). In terms of the local conditions, small-scale agriculture is a prevalent activity in the Epirus region, with a particular increase in interest following the economic recession of 2008 (Region of Epirus 2014).

The project’s goal was to establish a community of primarily farmers, engineers, designers, makers and other artisanal workers who would collaborate to address local needs. It also involved the creation of a physical space, inspired by high-tech makerspaces across the globe but adapted to the local needs and conditions as expressed by the community. Makerspaces are used as an umbrella term for small-scale manufacturing facilities, which are often used by local communities as a physical platform to share resources and access to critical manufacturing equipment (Niaros et al. 2017; van Holm 2017). Makerspaces could also be seen as spaces for the co-production of convivial tools that “foster conviviality to the extent to which they can be easily used, by anybody, as often or as seldom as desired, for the accomplishment of a purpose chosen by the user” (Illich 1973, p. 22).

Inspiration for the Tzoumakers initiative was relevant communities across the globe. Specifically, the Farm Hack network in the United States and the L’Atelier Paysan organisation in France provided not only examples to follow but collaborative channels were also formulated. P2P Lab members visited Farm Hack and L’Atelier and participated in their workshops before and during the birth of Tzoumakers (Pantazis and Meyer 2020). Such initiatives share an open-source ethos and hold the commons as the connecting element for establishing global connections with like-minded groups and individuals.

Before establishing the makerspace, the P2P Lab aggregated resources from various projects it undertook and promoted partnerships with other local organisations to maximise the potential impact. The following section will elaborate on how this initiative came to be and its mode of operations to provide glimpses of the spatial dynamics that formulate around the technological development activities.

Fig. 1 Glimpses from gatherings in four different areas (two villages, the city centre and a semi-urban area), which preceded the establishment of Tzoumakers



The birth and modus operandi of Tzoumakers

The Tzoumakers makerspace is located in a small mountainous village in North-Western Greece called Kalentzi. Kalentzi, one of the most central villages of the Tzoumerka cluster, is rich in natural and cultural wealth yet scarce in the economic means of welfare. The local population mostly depends on small-scale and low-intensity activities combining market gardening, beekeeping and animal husbandry. Thus, Kalentzi was seen by the P2P Lab members as fertile ground for the realisation of a cosmological initiative, which would test and demonstrate its dynamics for conviviality. In addition, two P2P Lab members hail from the village; hence, a more personal connection to the area and its people existed.

The idea for establishing a makerspace in Kalentzi was gestating within the P2P Lab for several months. The initiative was triggered once funds became available through EU research programmes. The first aim of P2P Lab was to plant the seeds for creating a local community around the initiative before the makerspace was established and the project officially launched.

To do so, multiple focus groups were organised across the regional unit of Ioannina, the capital city of Epirus, targeting people from both urban and rural areas (Fig. 1). This process cultivated a favourable environment to share, reflect and ideate on common challenges and aspirations. Yet, there was a common belief that such an initiative could form an aggregation nexus for regional collaboration.

The primary outcome of these gatherings was creating a core group of fourteen individuals willing to actively participate in establishing the makerspace under the

coordination of the P2P Lab members. The locals were also involved in designing and constructing the makerspace (see Fig. 2). As a consortium member of an EU grant led by the P2P Lab, the local municipality assisted by providing the building and covering fixed costs (e.g. electricity, water and Internet connectivity supply) for the space to be housed. The two-floor building that hosts the Tzoumakers used to be the Cultural Centre of Kalentzi. The idea of transforming the place into a makerspace for agricultural production appeared attractive to the board members of the Cultural Centre; hence they provided the space.

The challenge for the P2P Lab was to design, along with the locals, the working areas that would be needed for its purposes (such as the wood workshop and the metal workshop) and construct the relevant infrastructure. The manufacturing equipment that would outfit the space was also determined. Although “off-the-shelf” lists of equipment are readily available (e.g. the online open-access Fab Foundation list), P2P Lab’s approach was mainly driven by local input. Local farmers and makers are well-versed in using low-tech tools and producing solutions for their daily activities (as in improvising around their animal and farming infrastructure to suit their needs better and reduce costs). At the same time, the P2P Lab team introduced tools related to digital fabrication and microcontrollers (e.g. 3D printers, Arduino) through its involvement with international makers.

Once the community began taking shape and more tangible outcomes were available, further engagement became possible. To that end, existing members of the Tzoumakers community communicated the initiative to the surrounding villages to create a wide network with the makerspace serving as a central node. The need for community organisation became evident as the number

Fig. 2 The building and some of the rooms of the Cultural Centre of Kalentzi where the Tzoumakers makerspace is hosted



of participants rose. The coordinator of Tzoumakers, who is also a P2P Lab member, became responsible for compiling a code of conduct, which the Tzoumakers would revise and confirm after a public deliberation. This code of conduct was necessary to secure the proper and safe use of the space while allowing for more inclusivity in the decision-making processes. The first version of this code of conduct was collectively articulated and approved by the Tzoumakers community in a public event in the summer of 2021.

The activities at Tzoumakers are proposed by community members and are usually geared towards developing a particular technological artefact. This takes place through a process of expressing a specific need to the rest of the community. Should there be a critical mass of interest, the resources are gathered to develop the solution, usually in an impromptu fashion. Moreover, small-scale daily activities, such as repairing a tool, take on demand without prior scheduling.

Nevertheless, the main operation to strengthen the community and test research ideas has been through the realisation of workshops financially supported by the received EU grants. The technological solutions produced in each workshop have been led by makers from within the local community or internationally. In both cases, the local and global network of Tzoumakers is activated through knowledge transfer (e.g. designs, blueprints) and/or the participation of external experts in the workshops (e.g. skills and know-how sharing). Ultimately, connections between the participants were established, thus triggering a continuous exchange of ideas across different communities worldwide, even after the completion of the workshops.

Networking through technology development

The P2P Lab's technical and agricultural knowledge has been limited regarding technology. Members of the P2P Lab previously visited and researched network initiatives like the aforementioned L'Atelier Paysan and Farm Hack. However, these visits were mostly focussed on those initiatives' organisational/operational side. P2P Lab members lack the technical capacity for tool development. Still, P2P Lab members have been operating as links for experience and knowledge transfer from similar initiatives within their network through collaboratively organised physical workshops or digital knowledge transfers across various spatial levels.

The Epirus region features initiatives like The High Mountains, a social cooperative aiming at reviving mountainous communities and repopulating the isolated villages of Epirus; Boulouki, an interdisciplinary NGO that explores traditional construction techniques and preserves cultural heritage; the Pokari Project, a social cooperative that preserves and collaboratively develops traditional weaving technology; the Fab Lab Ioannina, which is an urban makerspace in Ioannina, and Habibi Works, an intercultural makerspace that empowers refugees and promotes education and links with the local population. These indicative initiatives form a local network of support, knowledge and resource exchange with Tzoumakers (Fig. 3). Specifically, co-organised workshops have taken place with the participation of members of the respective communities. Further, this network has been used to share tools and good practices in terms of organisation and communication adapted to the local setting.

On the national level, Tzoumakers have collaborated closely with Melitakes, a social cooperative cultivating

Fig. 3 The growing network of Tzoumakers. Small and local-oriented but globally connected initiatives create a cosmological ecosystem of value creation

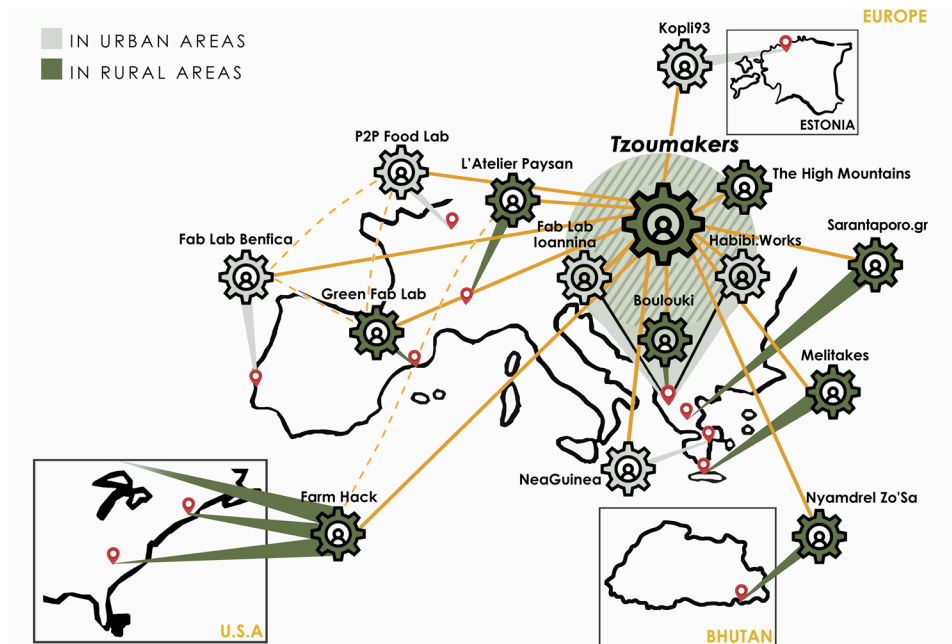


Fig. 4 Kopli93 is hosted in the previously abandoned cultural centre of Tallinn, Estonia (up). Glimpse from the production of a small-scale wind turbine supported by a Wind Empowerment Association member (up right). The Nyamdrel Zo'Sa makerspace (bottom) is often used to repair and re-appropriate low-tech tools (bottom right)



seeds of local traditional varieties, using agroecology methods. In an attempt to address a common need, members of Tzoumakers visited Melitakes to document a small-scale harvesting machine and share the designs with similar initiatives. Moreover, Tzoumakers have been connected with Sarantaporo.gr, a community wireless network in an isolated rural area of Thessaly. As a side activity within Tzoumakers, members of the Sarantaporo.gr community visited Kalentzi to help establish a local wireless network and guide locals on how to maintain it. In addition, Tzoumakers have collaborated with the Athens-based NGO NeaGuinea, a member of the Wind Empowerment Association. The collaboration spans a wide array of activities (from collaborative research to event co-organisation and funding support). For example, in 2022, a summer

school on the political economy of energy was collaboratively organised. This included the local manufacturing of a small-scale wind turbine.

Further, Tzoumakers has been inspired and greatly informed by its international collaborators. Over time more meaningful connections developed as actual know-how flowed from such communities towards Tzoumakers and future projects began to be developed collaboratively, mainly through EU research grants. The latter have facilitated the expansion of our network with other makerspaces that work on agroecology and/or technology. These spaces are either hosted by universities (i.e. the Fab Lab Benfica in Portugal; the Green Fab Lab in Spain; and the New Dexterity research group in New Zealand) or informal citizen-driven projects (i.e. the P2P Food Lab in France).

Fig. 5 The traditional weaving machine (left) was built in the Tzoumakers makerspace with the support of the Ioannina-based Pokari Project (photo by Pokari Project). Glimpse from the traditional pine tar production, during a Tzoumakers-organised summer school, facilitated by the Tzoumerka-based Boulouki (right—photo by Ioanna Ntoutsis)



Tzoumakers is also in close contact with Kopli93 (Fig. 4), a community-based makerspace situated in the formerly industrial peninsula of Tallinn, Estonia. The instigators of Kopli93 were Estonia-based activists/researchers, inspired by Tzoumakers. With the support of the P2P Lab, seed funding was secured from the EU and the municipality of Tallinn to kick off the initiative. In the 2 years of the pandemic, Kopli93 managed to create a strong and diverse community. Kopli93 is in an urban area and its activities may differ from those of Tzoumakers. Although a sister project of Tzoumakers, Kopli93 has its modus operandi and governance mechanisms that resonate with the values and culture of its local community members.

The network of Tzoumakers expands mainly in what is typically referred to as the Global North (i.e. more affluent countries in the globe). To explore the potential of cosmological initiatives in different contexts, the P2P Lab decided to test it beyond the context of high-income countries. After some preparatory work in Bhutan, the birthplace of the Gross National Happiness philosophy (Verma 2017), P2P Lab recruited a local individual to join the team and, eventually, coordinate the respective activities in the region. The pilot has been developing in the Chirtshosa village in South-Eastern Bhutan. This particular area was selected due to its commonalities with Kalentzi in terms of the challenges faced, i.e. a village with varying terrain concerning other villages in the gewog (block) administration and people with limited access to technology for agricultural production. The local makerspace, called Nyamdrel Zo’Sa (Fig. 4), has drawn lessons from experience in Tzoumakers and freely adjusted to the local culture and needs. Initial steps included the creation of a community of farmers, carpenters and tech-enthusiasts around the initiative; the identification of local needs; and several dissemination activities. Although the pandemic had several times stalled progress, Nyamdrel Zo’Sa is in the process of taking an official status.

Technology is the link that binds the initiatives mentioned above. For instance, Boulouki collaborated with Tzoumakers to produce an organic insulation material called “katrami” through a traditional technique of pine tar processing (Fig. 5). In a participatory workshop facilitated by the Pokari Project, a traditional weaving machine was built (Fig. 5). Other tools, instigated by international collaborators and developed at Tzoumakers, are a nursery with an automated irrigation system, a waterjet for the monitoring of wetlands and a harvester for small vegetables (Fig. 6). In addition, along with the refugees participating in Habibi Works, Tzoumakers created tools like a solar dryer for fruits and a mobile chicken coop (Fig. 7). Last, several tools were initiated by the community, such as a hand tiller, a grinder for aromatic plants and a mechanical press (Fig. 7).

Given the open-source nature of these artefacts and many other constructions that take place, inspiration and know-how are drawn through the work of different initiatives. For instance, multiple versions of the chicken coop have been shared digitally across the globe and adapted to specific settings. While dispersed and not always in touch with each other, all these initiatives draw inspiration and embed themselves in social movements, like the organic or open-source or peasant movement, which provide the foundation for a global network.

The values of these converging spaces are embedded within the technology developed, creating a divergent technological development trajectory away from the dominant profit-driven paradigm of the last couple of centuries. For instance, tools are designed with longevity in mind, instead of a business model built on planned obsolescence. In the same vein, repair and reuse are prioritised with recycled materials and shared infrastructure to reduce costs and, consequently, the environmental footprint. Furthermore, there is a push for the use of local materials. However, some materials are impossible to obtain locally in some instances and

Fig. 6 The seeds' nursery (up left) was built with the support of the Fab Lab Benfica. The waterjet (bottom left) was built with the support of the New Dexterity Lab, which also empowers the OpenBionics Initiative. The harvester for small vegetables (right) was built with the support of the P2P Food Lab from France

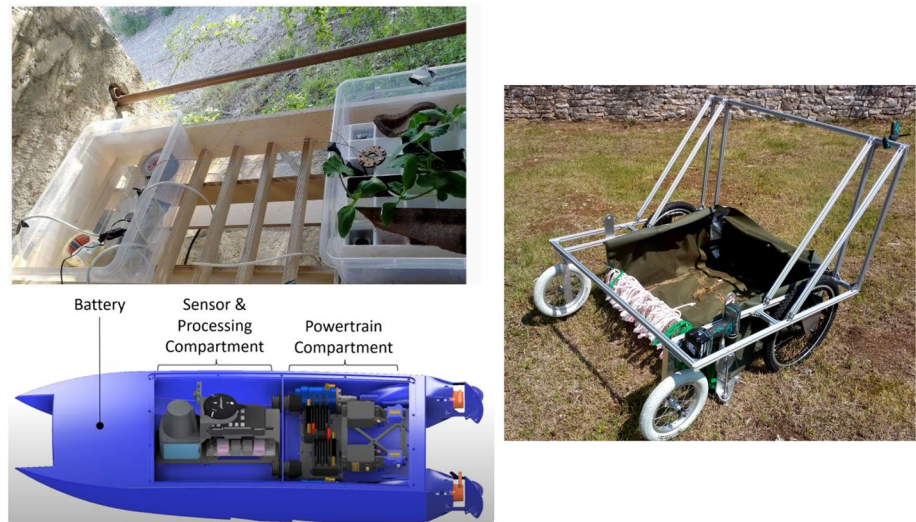


Fig. 7 The chicken coop (bottom left) and the solar dryer (bottom right) were built in the Ioannina-based intercultural makerspace Habibi.works. The hand tiller (up left), the beehive framing tool (up middle), the grinder for aromatic plants (bottom middle) and the mechanical press (up right) were initiated by the Tzoumakers community



global supply chains, along with scale industries make them an inefficient option in others.

In addition to the spaces involved in producing technological solutions, new initiatives have been sparked through interaction with Tzoumakers. For instance, as we mentioned above, Epirus has been a place of intensive search for oil deposits and efforts to install massive wind farms. Therefore, some members of Tzoumakers' community decided to look into more democratic alternatives to energy production. This led to the establishment of an energy cooperative, named Commonen, to self-produce electricity and decommodify energy. Some of the Tzoumakers members coalesced with other local commons-based entities and individuals to create the first collective self-consumption solar project in mainland Greece. They also aim to promote open-source, locally

manufactured technologies as an alternative to proposed fossil oil extraction and massive, poorly planned renewable energy projects.

Moreover, as a reaction to the plan of the Governor of Epirus to create a Silicon Valley-inspired high-tech and science park, some Tzoumakers members instigated the creation of a citizen initiative for an open-tech and science park. An ongoing public deliberation has been taking place that, so far, has resulted in eight proposals for a commons-oriented technology and business development that would focus on the local economy, society and environment. The citizen initiative managed to persuade the Governor to integrate most of their proposals into the final plan submitted to the central government in May 2022. According to the plan, one of the six buildings of the park would be named "Centre for Open Technology and Social Innovation". This

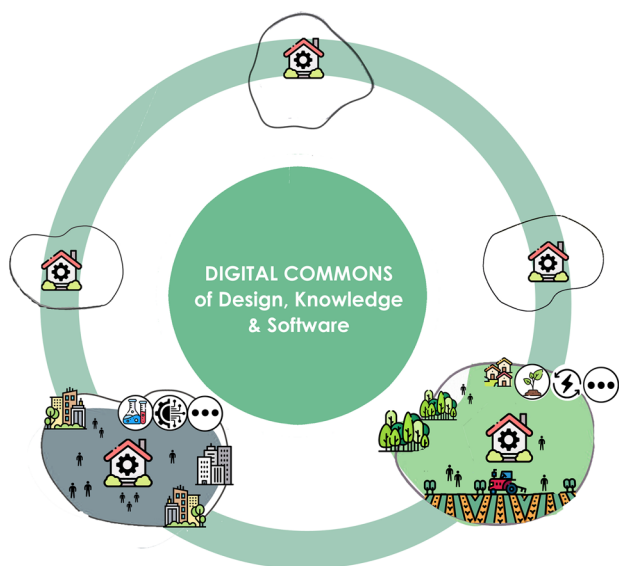


Fig. 8 An overview of the cosmological structural framework with its functions (e.g. knowledge transfer), spatial dimensions (e.g. urban, rural), and main fields of activity (e.g. agriculture, digital technologies)

citizen initiative is ongoing and all key developments are documented in a bilingual online logbook.

Last, Epirus' first Association of Social and Solidarity Economy initiatives was formed in early 2022. The Association consists of thirteen social cooperatives (at the time of this writing) and other affiliated members, with the President of the Association being a key member of Tzoumakers. In the context of these developments, Tzoumakers have inspired locals to unite under the umbrella of commoning and generate impact in different localities.

Ultimately, it is essential to highlight that Tzoumakers does not provide blueprints for solutions to be simply copy-pasted elsewhere. The same applies to the projects that have been its inspiration which cannot convey one unified cosmopolitan vision for the agricultural sector or any sector of activity. In the next section, we frame our experience within the discussion around a new politics of scale.

Discussion

Having provided an overview of convivial technology development inspired by cosmologicalism, we focus on a potentially new politics of scale that challenges the power of the global/local binary. This politics of scale emerges from practical examples, which combine place-based creative resistance with championing globally digitally networked activities (Fig. 8). Such technology-related initiatives involve diverse ideologies and practices or, in Gibson-Graham's terms (2002, p. 52), processes "constructing communities

of difference". So, this "powerful organization", which Hardt and Negri (2000) await, may consist of small-scale and locally-oriented communities that cultivate the communal capacities of individuals and groups and contribute to the global digital commons. Commons or commoning can become a universal language "without being universalist" (Gibson-Graham 2002, p. 53). These communities may arguably unite through commoning; therefore, they may articulate a "global ambition" through networked and commons-driven organisation(s).

Developments within cosmological production exemplify struggles to formulate such cross-spatial strategies. They are far from perfect and we do not claim that they are the right or the only way to move forward. We, however, believe that they can offer inspiration and lessons for future action. We thus focus on an effort in which Tzoumakers and other "open-source agriculture" initiatives participate. Emerging from the aggregation of various initiatives, such as those discussed here and technology- and product-oriented movements, open-source agriculture may be considered another technology-oriented social movement (Giotitsas 2019). Such social movements challenge existing technological systems by creating and promoting alternative technological artefacts and/or practices (Hess 2005). Cases of technology- and product-oriented movements can be found in various historical periods and fields.

From nineteenth century Britain when the Luddite movement rebelled against technologies that prioritised profits over other human values; to the 70s appropriate technology movement promoting human-centred technology that is small-scale, affordable, environmentally sound and locally autonomous; to the organic food movement encompassing alternative agricultural methods; to the open-source software and hardware movement that oppose proprietary software and hardware production. The open-source agriculture movement builds on their legacy (Giotitsas 2019). It exhibits a cosmological framework of convivial technology development. Cosmologicalism describes the agglomeration of commons-based technology- and product-oriented movements that have both a local and global orientation (Schismenos et al. 2020).

Tzoumakers is a node of various interrelated networks that exercise this cosmological production. Figure 3 provided a bird-eye-view of the networks that Tzoumakers belong to. From the vantage point of Tzoumakers, the core network includes initiatives that form the open-source agriculture movement and/or are related to makerspaces. The open-source agriculture initiatives produce, use, share and adapt designs, bill of materials, manuals and software of tools for small-scale agriculture produced as a commons. However, these initiatives also use and sometimes improve commons that initiatives from other movements have produced. For example, Tzoumakers, L'Atelier Paysan and the Farm Hack

network use software produced by the free and open-source software movement (e.g. Drupal,¹ Wiki,² Wordpress,³ Apache Web Server⁴); licences produced as a commons by the free culture movement (the Creative Commons⁵ initiative); hardware that has been produced by the open hardware (e.g. Arduino,⁶ Raspberry pi⁷) and the appropriate technology movement (e.g. Hexayurt⁸). Hence, much wider networks of initiatives engage in direct, indirect, synchronous and asynchronous collaboration and coordination through the commons:

For instance, Tzoumakers do not need to sign an agreement with a free and open-source software or hardware project to use its digital products, as long as Tzoumakers follow the conditions of the licence that the respective productive community has chosen. These conditions may require the final digital product to become available under the same commons-oriented licence (e.g. in the case of a General Public Licence) or that only worker-owned institutions can profit from it (e.g. Peer Production Licence). Similarly, Tzoumakers' counterparts from Bhutan, or any place of the world or sector of the economy, can use any of the digital commons that Tzoumakers community has developed or contributed to fit their local needs and setting. So, by lowering the transaction costs (Benkler 2006), time and energy are saved, enabling local communities to experiment and focus on adapting global commons to their needs without reinventing the wheel.

Based on our research with the Tzoumakers project, we have identified at least two significant challenges in our effort to empower commoning and reap the benefits of such a cosmological organisational production configuration. The first challenge concerns the digital design commons. Even an expert would find it difficult to explore and manage the vast, scattered and often poorly documented digital commons, which may be useful for agriculture. One of the main reasons is that designers, farmers and makers either do not know how to document and share their products or follow their different ways of documenting and sharing. So, there is no standardised way of documenting and sharing a solution as a commons. Moreover, understanding the open-source

product's blueprints can be difficult for the non-expert or those who cannot read English, or the local manufacturing can be problematic (e.g. producing dysfunctional objects and waste). Further, licencing the hardware is complicated (Open Source Hardware Association 2021), and there is no standardised way to do it.

The second challenge concerns the makerspaces, the physical spaces where local manufacturing occurs. In addition to producing useful artefacts, the manufacturing workshops are also crucial for community-building and the financial sustainability of the makerspaces (Niaros et al. 2017). Makerspaces often operate in a “grey area” regarding labour and legal security. There are no standardised protocols for makerspaces regarding organising safe and effective manufacturing workshops that focus on materialising a needs-based design approach. Moreover, the makerspaces organise workshops under questionable conditions concerning the participants' security and their legal involvement in non-profit or for-profit initiatives, since their participation may not be foreseen in the official activities of the legal entity. It is thus essential to address the legal issues and challenges of a community makerspace and propose a formally recognised, distinct legal entity framework for makerspaces whose characteristics may not be covered by existing legal representation.

There are at least two tensions in creating institutions to support commoning through standardisation and its goals for justice and functionality/effectiveness. The first tension relates to standardisation. The documentation standards introduce a certain set of rules and a method that would serve the needs of those who participate in the network. In that way, commoning within this specific network may be empowered. However, standardisation may act as a funnel to limit people to a minimal set of documenting and sharing choices. On the one hand, openness may have become a foundational value for cosmological production. On the other hand, open standards may also depend on hierarchical forms of control (Russell 2014). Drawing from the history of the Internet, processes for setting industry standards have often embodied competing values (Russell 2014). Therefore, it is essential to question who sets the standards and be aware of this issue. However, despite its contradictions, standardisation may also act as a starting point and a prism to generate a rainbow of possible options customised to other individuals or communities.

The second tension relates to functionality and effectiveness. As Costanza-Chock (2020, p. 218) highlights, “a design project may be wonderfully inclusive, provide all participants with a sense of ownership and reward people equitably for their work, but fail to produce a design product that is useful to the community”. We fully subscribe to this position. The tension between inclusiveness and justice versus functionality and effectiveness is difficult to resolve.

¹ A free and open-source web content management system.

² A database for creating, browsing and searching through information that could be either open to the public or limited to use within an organisation.

³ One of the most popular website builders.

⁴ A free and open-source cross-platform web server software.

⁵ One of several public copyright licences that enable the free distribution of an otherwise copyrighted work.

⁶ A microcontroller kit for building digital devices.

⁷ A small single-board computer.

⁸ Primarily an emergency structure which is self-contained and easily packed for transportation.

It may take more time and effort to find a fine balance; to design both inclusive and functional technology. But, in a degrowth spirit, “going slower is worth it to build a better, more just and sustainable world” (Costanza-Chock 2020, p. 219).

Of course, any further social change shall take place under the dominant market forces that set the “rules of the game” (Swyngedouw 2005, p. 1991). Open-source technologies enable infrastructures for commoning, but they also serve capitalism, “which siphons off the collaboration, the creativity and the free labour of millions” (Kioupiolis 2021). In addition to the configurations the above-discussed initiatives are struggling with, more conscious political choices away from neoliberal politics are needed (Kioupiolis 2020, 2021). For the draining link with capitalism to be severed, all facets of political identity and organisation building should embrace the commons as the guiding force and vision.

Through the case of Tzoumakers, cosmopolitanism exemplified how the commons may take form, multiply and expand. Such a technology development framework allowed Tzoumakers to create favourable conditions for the multiplication and expansion of the commons, not only within the same field (i.e. agricultural production) but also beyond it (i.e. energy production, citizens initiatives, social solidarity economy). Significantly, the initiation of new commons-oriented ventures in other fields demonstrates how a commons’ ecology may infiltrate systems of power (Varvarousis 2020). In other words, the diverse initiatives under the cosmopolitan framework may form a unified political front under the commons umbrella to demand institutional/structural change based on their sprawling transformative vision (D’Alisa and Kallis 2020; Pazaitis and Drechsler 2021). Thus amplifying the effect of the alternative technological and economic activity trajectories they promote.

Conclusions

A degrowth-oriented reconceptualisation of technology, as a vital component of modern society cutting across all its other aspects, is arguably required. We thus presented a convivial technology development framework using the concept of cosmopolitanism. Drawing insights from an action research project, we discussed a potential structural framework for organising technology development with non-negligible positive potentialities for degrowth. Such a framework could enhance key principles and values of degrowth: first, conviviality by increasing local control over technology development; second, design-embedded sustainability by unleashing human creative capacities to produce and maintain useful artefacts; third, localisation by reversing the trend towards long-distance bulk transportation; and, fourth, a sense of

belonging by building alliances and a new politics of scale through commoning, considering the unique cultural and environmental contexts.

Through the case of Tzoumakers and its network, this paper illustrated that a framework of convivial technology development may create different spatial dynamics. Technology that emerges from values of equity, diversity, sustainability and, ultimately, degrowth may provide the ground for a recontextualisation of theory outside the dualities of global–local, urban–rural and developed–developing. The differences in culture, environmental conditions and local needs/resources in combination with hyper-connectivity can become a source of sustainability rather than contention.

Moulaert et al. (2005) call for more interdisciplinary case studies, which practically examine the complex interactions among the state, civil society and grassroots movements. Our pilot took their request on and our cosmopolitan framework attempted to complement their insights on cross-territorial organising with our insight into production processes. This paper argues that cosmopolitanism offers a set of experimental practices and policies that could inform a policy agenda towards a degrowth society. To do so, the process of connection, collaboration and reflection between local communities has to be followed in each context, whether rich or poor, populous or sparse, in abundance or scarcity. Yet the combination of human creativity, craftsmanship, meaningful work and sharing provides the foundation for the deep connection across different localities. Thus, new socialites and new production configurations can be generated in a more collaborative way.

Of course, cosmopolitan production is not without tensions and contradictions. First, there are tensions between inclusiveness, standardisation and functionality. Second, although cosmopolitan production may put less pressure on natural resources and the relevant local populations (e.g. minerals from African countries), it is still using energy- and material-intensive infrastructures, such as the Internet. Third, cross-spatial strategies, such as those discussed in the context of our action research project, need to be coupled with a broader realisation and more unambiguous articulation of a *senso comune*, a reinvigorated common(s) sense. We, however, believe that the framework we trace here can form a catalyst to bridge the multitude of local initiatives and unify their radical narratives while preserving their diversity. As our species currently faces an unprecedented existential threat, it is time for such bold experimentations to be brought to the fore and inspire much-needed steps towards genuine change.

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Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

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