Drones and Geographical Information Technologies in Agroecology and Organic Farming

Contributions to Technological Sovereignty

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Preface

The United Nations decade of ecosystem restoration (2021-2030), the Glashow Climate Pact (November 2021) reaffirms the role of Nature Based Solutions in the fight against climate change and in building shared adaptation solutions. The Glashow Climate Pact highlights the importance of ensuring the integrity of all ecosystems, the protection of biodiversity "recognized by some cultures as Mother Earth, the importance for some of the concept of 'climate justice', when taking action to address climate change".

In April 2020 Boaventura de Souza Santos published the "Cruel Pedagogy of Virus" focusing on how the COVID pandemic/syndemic has arrived at the end of six decades of uneven development and highlights the global predatory capitalism and patriarchy embodied in many development discourses, consolidating social exclusion, resource extraction, human and nature domination, environmental injustice, and accumulation by dispossession.

Deconstructing development, sustainable development, sustainable growth asks for recognizing practices of critical development, alternative development, alternatives to development, post-development to embrace what Max-Neef called "the development at human scale".

Change starts from new practices, challenging the menu of globalizing universalizing development theories and initiatives to inhabit pluriverses of words and worlds.

Agroecology, as young science that is about to turn a century, can contribute in various ways to the current challenges of facing environmental and climate emergency, halting biodiversity loss, pursuing just food systems.

The indigenous, peasant, and environmental movements of active citizenship, inspired by agroecology, promote food sovereignty, just food systems, the collaboration between food producers and consumers, the renewed alliance between natural, agricultural and urban ecosystems, technological sovereignty, innovation attentive to human rights.

This book explores the challenges posed by the new geographic information technologies in agroecology and organic farming. It discusses the differences among technology-laden conventional farming systems and the role of technologies in strengthening the potential of agroecology and organic farming. In conventional thinking, the use of new technologies is an almost exclusive domain

of precision agriculture. Traditions and links with the past are typical western urban images of agroecology compared with modern industrial agriculture, based on mechanization and evolving technology use. The many agriculture 4.0 and sustainable agricultures are still adopting a productive paradigm rooted in yield and profit of farm (as firm), innovation is something universally coming from specialized centers, local knowledge is negligible.

There is a profound connection between social and technological innovation and the multiscale dimension of innovation, especially in the place-specific agroecosystem. Farmers and citizens are themselves innovators; they should have the agency to govern technologies and to develop appropriate place-based institutional-technological innovation.

Technology can not be a commodity, it is common. Traditional agricultural systems are not statics: 9000 years of agriculture in Mexico or several thousand years of Amazon polyculture have required knowledge and ability to care for complex territories (agroecosystems) granting the reproduction of human societies and the evolution of ecosystems.

In the perspective of "technologies for all" there is a basket of promising open applications consolidating agroecology and its plural dimensions of innovation based on knowledge-intensive approaches, knowledge sharing, co-creation of knowledge, common goods and heritages of humanity at different scales.

We want to recall the Kamunguishi Declaration issued by Zapara nationality, a disappearing Amazon population having their oral heritage and cultural manifestation recognized by UNESCO in the list of intangible heritage. Kamunguishi is *the house of the forest for continuous rebirth*:

the world is ony one (*Nukaki)*
the world is forest (*Naku)*
we are forest!

Massimo De Marchi
Alberto Diantini
Salvatore Eugenio Pappalardo

Contents

CHAPTER
2

Participatory Geographic Information Science: Disclosing the Power of Geographical Tools and Knowledge in Agroecological Transition

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2.1. Introduction

Can we use the map to change the world? And how the act of mapping can promote awareness and empowerment? This chapter explores the reflections within geography and cartography sciences with a consolidated epistemological and empirical habit about the key role of maps in changing the world, starting from the pre-digital era. With the consolidation of Geographic Information Systems and the emergence of GIScience in the 1990, participatory GIS and critical GIS reinterpreted the 'mapping for change' in the light of inclusive liberation technologies in the empowerment of the weak and marginalized authors in cities and rural contexts. The chapter offers a theoretical compass to orient among the different practices: from 'material' cartography to 'immaterial' participatory GIS, Volunteered Geography, critical geodesign and neogeography. Geographical technologies are a sort of two-faced Janus as they not only unfold a world of possibilities and freedom, but also are part of a world of injustice. Despite the

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low interactions, mostly informal, in the last decades among the science of geographical information and agroecology, there are many areas of common interests and mutual interaction and co-operation for technological sovereignty.

2.2. Agroecosystem: Place, Territory, Scale

Place matters (De Blji, 2009); the placed-based approach of agroecology is identifiable in the concept of agroecosystems with the key formalization of Conway (1987). Agroecosystems are ecological systems modified by societies to produce food, fibers and other agricultural products. The structural and dynamic complexity of agroecosystems arises mainly from the complexity of the interactions among socio-economic and ecological processes. Agroecosystems are the form of territories in many contexts where societies co-evolve with ecosystems, basing social reproduction on farming, forestry, and animal husbandry or fishing. Territories (agroecosystems) are bi-modular systems (society-ecosystem) in co-evolution (Nir, 1990; Vallega, 1995). Every system represents the environment of the other and the relations between the two systems are not pure instructions, but interactions (Maturana and Varela, 1987): each of the two systems falls within the fields of possibilities of the other. Systems lie in the quantitative dimension of the parts (and the relationships between them), in the quality of the same, but also in the eye and mind of the observer. Therefore, complexity is not necessarily a property of reality, but can be a characteristic of description: different generations of system thinking generated different views on the agroecosystems (Vallega, 1995; Checkland, 1984). The agroecosystem can be analyzed by focusing on four components: space, time, flows, and decisions (Conway, 1987). The unicity of place and the specificity of time make the difference in observations and actions, either in the seasonal changes or in the short or long time changes. Place and time influence and are influenced by relations (flows of materials, energy, and the immateriality of decisions), creating the complexity of agroecosystem boundaries, more influenced by socio-economic relations than by the physical limits of ecosystems (Conway, 1987). If the physical limits of a rice pond can be easily determined in terms of spatial occupation or water flows, the social and economic relations are more undefined: Where is rice sold? Where are inputs acquired? How is extra agriculture working time invested? Agroecosystems are complex territorial systems, livelihood systems, combining farming and other types of activities, with flexible boundaries and many scales combined by a multiplicity of interacting levels. The co-evolution of agroecosystems is based on some properties (Conway, 1987; Lopez-Ridaura *et al*., 2002), like productivity, stability, sustainability, equity, and self-reliance. Productivity in agroecology goes beyond the yield – it is the output related to the applied inputs (working time, energy, products). Outputs can be work opportunities, cash, food security, aesthetic values, and a complex combination of personal, collective, social, psychological, economic, and spiritual well-being. For Conway (1987, p. 101-103), stability is the ability of the agroecosystem to grant productivity despite the short time

disturbances of the socio-ecological context and then sustainability deals with the ability of the systems to maintain long-time productivity, adapting to important changes. Considering social and ecological interaction in the agroecosystem, the other two properties make the difference in agroecological approach to agroecosystems. Equity is about the distribution of costs and benefits of systems among the different actors; there are no externalities as in conventional farming. Equity is about the distribution of products and ecosystem services not just at field or farm level, but at village, landscape, nation, and world scales. Self-reliance or self-empowerment (Lopez-Ridaura *et al*., 2002) deals with the ability to govern changes, maintaining identities and values of the system and finding appropriate local alternatives to control and answer to external and global pressures.

An agroecosystem is the point of interactions of different scales (Dalgaard, 2003): on one side the scale of natural systems: cell, organism, population, community, ecosystem, and landscape; on the other, the combination of scales of the farming systems (soil, field, farm, region, nation, and world) and, at the same time, the biological scale of plants or animals managed in the system (cell, body, species, population of animal or plants, etc.). The management of agroecosystems asks for the complex management of nested hierarchies of scales in specific places. This unicity of a place (Francis *et al*., 2003) and the nested multi-scale contextual approach of agroecology, based on sophisticated local knowledge, have to face the scale gap of standardized technical solutions driven by agricultural policies based on other scales and system approaches (Sinclair, 2019). Scaling up of agroecology needs a reversal approach: breaking the ceiling of the universalizing policies and allowing the local to emerge and consolidate. This is not just an approach to study agroecosystems but to evaluate and design agroecological transition.

2.2.1. Mapping for Change: Critical Cartography, Counter-mapping and Beyond

The challenges for sustainable food systems require the humanization of agricultural extension (Cook *et al*., 2021) to render in a different way the local logic of relations among place, power, and people and the transformative contribution of agroecology. The collection of the journal, *PLA Participatory Learning and Actions*, offers a vibrant report of the paradigm shift in rural development to overcome the Green Revolution and implement sustainable and inclusive local-based initiatives. IIED (International Institute for Environment and Development) and IDS (Institute of Development Studies, University of Sussex) published 66 issues of the journal between 1988 and 2013. Started as *RRA Notes* in 1988, the journal from No. 22 (1995) was named *PLA Notes*, adopting the name *Participatory Learning and Action* in 2004 (number 50) till the last number 66, of 2013. These steps marked the evolutionary vitality of local practices of rural change outside the universalizing paradigm of technology transfer.

At the turn of 1980 and 1990, PRA (Participatory rural Appraisal) emerged as ‘family of approaches and methods to enable local rural people to share,

enhance and analyze their knowledge of life and conditions, to plan and to act' (Chambers, 1994a, p. 953). PRA originated in five streams: participatory research and community development (the reference is to the work of Paulo Freire, 1984), agroecosystem analysis, applied anthropology, field research on farming systems, and RRA (Rapid Rural Appraisal).

South-South routes facilitated the spread of PRA, creating a meeting point among local actors, NGOs, and place-based governmental organizations in the context of decentralization. PRA diffused a different approach to development, based on local expertise, participatory behaviors to support empowering processes, consolidating local actions and sustainable local institutions. PRA promotes changes through some key reversal dimensions: from extraction to empowerment (reversal of dominance), and reversal of methods from closed to open, from individual to community, from verbal to visual, and from counting to comparing (Chambers, 1994a, 1994b, 1994c).

In the reversal methodologies, one of the key elements is the transit from verbal to visual, which is very interesting for the connection with visualization in mapping. Chambers (1994b) highlights, how in participatory processes, insiders working with visual tools (maps, diagrams, sequences, etc.) can be presenters and analysts, keeping them far from suppliers of data and information to outsiders and playing the role of researchers or experts. Visual approaches avoid the probing trap of collecting true or false answers, and information is owned and shared by insiders co-creating and circulating knowledge.

The enthusiastic approach to vizuality of PLA/PRA literature and practices can be integrated with the critical cartography point-of-view. Not so much the visual material, *in se*, is the driver of empowerment: the appropriation of visual production by marginalized actors opens the door for change of power relations. In other words, it is counter-mapping to process the opportunity of empowerment. Insiders experience the appropriation of the representation of the space, the enhancement of own knowledge, and the self-reliance in taking decisions on their lives, communities, and places.

There is an enormous value in using participatory mapping and counter-mapping practices with citizens and peasants to collectively shape the existing context and propose changes in a participatory way (Dalton and Mason-Deese, 2012; Monmonnier, 2007; Peluso, 1995).

The special issue of PLA 54, *Mapping for Change: Practice, Technologies and Communication* marked an important moment of interaction among critical cartography, counter-mapping, and alternative rural participatory development approaches (Corbett *et al*., 2006).

Before exercising an action of manipulation of the territory (physical or mental), humans need a representation of the place that can be a text or an image. The territories are rich in ready-made representations to be used – speeches produced by politicians, companies, the communication market, common sense, and also maps produced by actors who have a more sophisticated technical capacity. Speeches, maps, photos, videos and infographics are different ways of producing

territorial images. It is important to understand who are the producers of territorial images and for what reasons do they produce certain types of representations. If the physical and geometric space is univocal and can be represented by a set of co-ordinates, territories existing on the same physical space can be many, because many actors have different projects on the same geometric space (Vallega, 1995). Agroecology, for example, challenges the universalizing approach of industrial conventional farming with place-based specific alternatives. All these conflicts happen somewhere in a place and place matter with different meanings, either for global agribusiness (as commanded place by globalized interests) or for local agroecological practices, as unicity.

The different territorial representations have their own combinations of forces, authorities, influences, and persistence. Among the images, cartography has a unique peculiarity to combine strength, authority, influence, and persistence. The map has extraordinary power to become a theoretical or doctrinal tool (Boulding, 1956). It can be a proposal for discussion, the search for a shared representation of territorial complexity, or the projection on to the ground of an individual project of a strong actor, with a more or less explicit power. People have a universal attitude in locating themselves and representing the territory with mental maps or drawings of personal places in sand or on cloth of a bar, but the maps hung on the walls and which we learned to look at primary schools are constructed with government functions, by the State or strong territorial actors to communicate a territorial project through a specific form of representation. Whoever produces maps knows what is the social effect and the common perception about this sophisticated product. Maps are accepted within a conception of scientism and neutral technicality. It is a graphic instrument capable of displaying a real and non-debatable representation of the territory.

'Maps have an extraordinary authority' (Boulding, 1956, p. 65), which is not found in other images; it is a greater authority 'than the sacred books of all religions' (Boulding, 1956, p. 70. Harley, 1987, p. 2) added how the authority of the map 'can also resist the errors of the map itself' (Bracket, 1987, p. 2).

The map is not the neutral mirror of the world; it is an embedded representation of the culture, social relations, and power of a specific territorial context (MacEachren, 1995; Dorling and Fairbairn, 1997). For these reasons, the map cannot be separated from the cultural environment that makes up the territory (Harley, 1987, 2001). This extraordinary power of maps can be used in different ways to know and reveal that part of the power of the strong actors of the territory which is guaranteed by the ability to produce this sophisticated type of territorial representation. This is the starting point of critical cartography and social-mapping approaches. De-constructing the communication system of the maps and understanding how it works means the ability to use maps also as a tool for citizen geographies, which is an alternative to consolidated geographies. The map is a text that uses a particular form of visual narration (Wood, 1992), combining three basic elements: projection, scale, and symbolization (Monmonier, 2005). The map usually produces the conviction that it is a photograph of the existing

reality. However, photos are not selective, except through the resolution. Maps are graphic representations of territories, which by their nature are selective and symbolic, that is, generalized. The maps do not show all the available information: displaying information that is not relevant to the subject would obscure the message; the symbols replace the images of the objects (Tyner, 2010, p. 9).

Different from a picture, the cartographer preparing maps 'lie with maps' (Monmonier, 2005), visualizing and concealing elements through processes of cartographic generalization based on symbolization, simplification, omission, combination, enhancement, and displacement (Tyner, 2010). If a map behaves like a text (Wood, 1992, 2002; Wood *et al*., 2010), counter-mapping can visualize alternative narrations of the agroecosystems, selecting what element to give priority and handling different power relations to promote social justice (Krupar, 2015; Ascselrad, 2010).

Maps can act and actors can act with maps: 'maps are active: they actively construct knowledge, they exercise power, and they can be a powerful means of promoting social change' (Crampton and Krygier, 2006, p. 15). The agency of mapping (Corner, 1999, p. 213) can challenge the 'authoritarian, simplistic, erroneous, and coercive acts of mapping with reductive effects upon both individuals and environments. I focus . . . upon more optimistic revisions of mapping practices . . . situating mapping as a collective enabling enterprise – a project that both reveals and realizes hidden potential'. Mapping can become a creative practice, remaking territories going beyond tracing and 'participate in future unfoldings', challenging the imposed scheme of territorial representation and planning; mapping precedes maps (Corner, 1999).

Adopting the processual approach to mapping, going beyond the absolutism of map object, the critical cartography opens arenas of shifting power and emancipatory inclusive practices – 'maps are of the moment, brought into being through practices (embodied, social, technical), always remade every time they are engaged with; mapping is a process of constant reterritorialization' (Kitchin and Dodge, 2007, p. 335). Critical cartography challenges the practices of mapmaking, revealing the actions behind the object – from craft to performance, from securization to challenge (Kent and Vijakovic, 2018).

One interesting area of mapping is done by indigenous people defending their land rights: these counter-mapping practices offer concrete actions for change and at the same time challenge the embedded colonial vision in mapping, territorial management, participation, and knowledge sharing. Maps used to implement colonial rules can be weaponized by indigenous nations (Bryan and Wood, 2015) not just in the transformation of the map into a weapon, but appropriating the mapping process as highlighted by post-representational cartography (Rossetto, 2019).

Counter-mapping can act as militant research, creating co-operation among researchers and local actors to handle real problems (Dalton and Mason Deese, 2012); at the same time, it offers a theoretical framework to manage grassroots data

science in emancipatory processes (Dalton and Stallman, 2017), challenging the ongoing data accumulation for profit or securization (McCalla and Michael, 2011).

2.3. PGIS, Critical GIScience and Voluntary Geography

Star and Estes (1990) define GIS as a 'map of higher order'; this inspiring definition traces a sort of long-lasting connection among pre-digital and digital maps and mapmaking, which is very useful to 'map' continuities and discontinuities between critical cartography and critical GIS.

GIS as geographic information system in six decades witnessed the crossing of five generations and an important paradigm shift. The first generation of GIS started at the beginning of 1960 with the implementation of the geographic information system of land use in Canada by Roger Tomlinson. This first reflection on the use of computers in the electronic processing of geographic information is called the 'generation of pioneers' (Yuan, 2015). In the decade of 1970, GIS entered the second generation driven by the State (the emblematic case is the contribution of United States Census Bureau) and in 1980, with the third generation, GIS spread, driven by software houses diffusing the new GIS packages in firms, public administrations, and universities. The turning point arrived in the decade of 1990 with the fourth generation, 'the GIS of users', facilitating on one hand the diffusion of the personal computers (Yuan, 2015) and on the other, the role of universities implementing research, education, and also the dialogue with civil society.

In October 1993, in Friday Harbor, GIS practitioners and critical human geographers convened the meeting, 'GIS and Society' on the social implications of geographic information systems. John Pickles (1995) with 'ground truth' collected the debate started in 1993 on the emergence of a critical GIS, deconstructing the narrative of neutral technology of GIS and focusing on positionality and value-laden GIS products. Liverman *et al*. (1998) with 'people and pixels' consolidated the connection between geographical information and social sciences, especially regarding the use of satellite imageries.

Two special issues of *Cartography and Geographic Information Systems'* (*GIS and Society* in 1995 and *Public Participation GIS* in 1998) continued the important research area of *GIS and Society*, both as a theoretical reflection on GIS and social implications, and as an applied science in process of territorial changes. Some key research topics of the 1990 agenda are still relevant: epistemologies, technologies and indigenous views, ethical issues, rights and responsibilities, empowerment and marginalization favored by GIS, barriers to effective inclusion, role of GIS in resistance, and advocacy (Goodchild, 2015; Yuan, 2021; Brown and Kyttä, 2018).

In 1996, the NCGIA (National Centre for Geographic Information and Analysis) organized two workshops to reflect on the role of PPGIS (Public

Participation GIS) to facilitate wider public involvement in planning and decision-making processes, considering the increasing applications and the potentiality in PPGIS in urban planning, nature conservation, and rural development (Goodchild, 2015). In this period the debate arises between PPGIS and PGIS (participatory GIS) – the first related to participatory processes using GIS by a public authority to implement top-down decisions, the latter as appropriation of GIS tools by marginalized groups to challenge the status quo.

Michael Goodchild in 1992 with the article 'Geographic Information Science' triggered the second big change of GIS during the fourth generation: the paradigm shift from system to science. The acronym GIS used for 30 years to summarize Geographic Information System was reloaded in different declinations: 'Geospatial Information Science', 'Geospatial Information Studies', 'Geospatial Information Services' consolidating the new research paradigm, and label of 'Geographic Information Science' as the science behind the system. The reflections of Goodchild started from recognizing, as in other sciences, the new tools opening paradigmatic leaps: for example, the microscope in biology or the telescope in astronomy. The availability of the geographic information system (the new tool or paradigmatic artefact) opens new fundamental questions and areas of research for the GIScience, like theories of geographical representations, continuity and discontinuity with the pre-digital cartography, and how to use GIScience in the contested and uncertain representations of the world. The use of GIS tools facilitates visual thinking in exploring the earth and the world and creates different paths on defining fundamental research questions on the tools, the way of knowing, the topic to explore, the approach to scientific research, and the social and ethical implications.

From 2000, with the diffusion of personal portable devices (smartphones), the web and the social network, GIS entered the fifth generation of *produsers*, the portable and the web generation of GIS, driven by the neogeographers. The panorama of geographical data flow, until then characterized by public or private centralized data supply, is transformed by the big amount of data supplied by people (the new geographers) doing different activities, ranging from sharing GPS tracks after trekking, to mapping impacts of pollutants into rivers, to expressing preference on shops.

Crowd-sourced geographic information is the umbrella definition of a large variety of behaviors and processes of data circulation, sharing or accumulation (See *et al*., 2016; Capineri *et al*., 2016). To orient in this multifaceted context, it is important to analyze how people contribute to geographic information by looking at how people are involved: from active participation in data collecting, sharing, and analyzing to the passive supply of data to private or public storages. Presented below is a summary of the principal label used to describe different approaches in crowd-sourced geographic information.

VGI (Volunteered Geographic Information) is the name of citizen science in the context of geography and cartography. For Goodchild (2007, p. 2) VGI is 'the harnessing of tools to create, assemble, and disseminate geographic data provided

voluntarily by individuals'; Elwood *et al*. (2012, p. 572) define VGI as 'spatial information voluntarily made available, with the aim to provide information about the world'.

Citizen science, according to the white paper on Citizen Science for Europe (*Socientize*, 2014) is 'the involvement of citizens in scientific research activities to which they actively contribute with their intellectual commitment, through widespread knowledge or with their own tools and resources' (*Socientize*, p. 8). However, citizen science and VGI are big containers with different levels of participation. Haklay (2013a) distinguishes four levels of citizen participation and engagement in citizen science projects: level one is the crowdsourcing in which citizens are sensors supplying data and eventually volunteering computing data; at level two, there is the emergence of 'distributed intelligence' when citizens become basic interpreters and apply volunteered thinking; the 'participatory science' arrives at level three, where citizens can participate in problem definition and data collection. Level four of 'extreme citizen science' implements true collaborative science, where citizens define problems, collect, and analyze data.

On the other hand, we can find iVGI (inVoluntary Geographic Information) when 'georeferenced data are not provided voluntarily by individuals for use for many purposes including mapping, but especially for commercial applications, such as geodemographic profiling' (See *et al*., 2016). 'Contributed geographic information' is defined in opposed to the VGI as 'geographic information collected without the awareness and explicit consent of a user of mobile devices that record the position' (See *et al*., 2016).

2.4. Technological Sovereignty: Disclosing the Power of Transformative GIScience

As presented in the previous paragraphs, the 1990s marked a turning point (or the meeting point) for GIS and critical approaches. After decades of conventional GIS based on automated cartographic production, data storage management, quantitative computing, definition, and standardization of geoprocessing, in the 1990s, with the encountering among GIS practitioners and critical cartographers, new paths were opened. Participatory, feminist, qualitative, postcolonial, and indigenous GIS (Sui, 2015; Yuan, 2021) and many other GIS themes dealing with inclusion, empowerment, new epistemologies, critical and transformative approaches emerged in the interaction among GIScience and society (Corbett *et al*., 2016; Schlosseberg and Shuford, 2005; Sieber, 2006).

Sui (2015) names all these emerging practices with the umbrella term of alternative GIS (alt.gis) asking a key question: Is GIS becoming a liberation technology? The interesting question brings the author, through an analysis of the way of thinking behind doing GIS and critical GIS, to the discovery that liberation technology relies upon a different mind. Sui (2015) during the period 1960-1990, sees the first stream of more technical and positivist GIS consolidated

expression of the left side of the human brain: slow, sequential, literal, textual, analytical and logical. Meanwhile, the second stream of GIS (since the 1990s) is more narrative, qualitative, systematic, and oriented to empowerment and social justice. This stream would be associated with the right side of the human brain: fast, simultaneous, contextual, metaphorical, aesthetic, and affective. Adopting Pink's framework (2006) on the 'whole new mind' for the contextual age of the 21st century, Sui (2015) explores the relations among the six senses of the new mind (design, story, symphony, empathy, play, and meaning) and the emerging GIS themes. The first sense, design, could be connected with the emergence of geodesign as a participatory way of changing places by leaving the descriptive perspective (what is) to adopt the prescriptive one (what could/should be). Story, the second sense of the new mind, would be connected with the discovering of geographic lore (interesting is the affinity with the reflections on PRA/PLA, Chambers 1994a, b, c) and the roles of geonarratives, story maps, and qualitative GIS. Symphony (new mind) and synthesis (emergent theme in GIS) would be linked (Sui, 2015) in a new framework of consilience in the combination of analysis and synthesis facilitated by VGI of neogeographers. Critical GIS dealing with disenfranchised and powerless actors is still a disruptive and emerging GIS theme considering the challenges of political ecologies, environmental conflicts, climate justice, exclusion, and neo-authoritarian powers. So, critical GIS could be associated with the fourth sense of the new mind – empathy in the struggle, proximity and partnership, not only efficiency and aims. Sui (2015) associates play (fifth sense of the new mind) with the emergence of gaming as the overcoming of geoinformatics. Behind the issue of play, there is an interesting deconstruction of the way of thinking (or applying visual thinking) in GIS – from the God-eye, the vertical top-down view of the world for domination, to a visual stroll of places to enjoy the pleasure of curiosity. Kingsbury and Jones (2009) speak on Dionysian adventures on Google Earth. Meaning, the sixth sense of the new mind would be connected with the emergent GIS theme of place, the paradigm shift from space to place, and the need to deal with emotional and affective relations among people and places.

GIS, to become a liberation technology, should be deconstructed as in critical GIS to highlight the enframing nature of geospatial technology. A first enframing dimension is related to the technical issue – the need to adopt the open GIS paradigm outside the fences of proprietary software, proprietary data, patented technologies, embracing a fully open-source philosophy. Then another line of liberation is related to the theoretical dimension to adopt an alternative way of knowing beyond the Cartesian paradigm and the interactions with indigenous practices and knowledge being fundamental. The third dimension of liberation technology is to increase and diffuse the practices of GIS on human rights and environmental justice e, challenging the monopoly of technology by the military-industrial complex (Sui, 2015). Geographical technologies are a sort of two-faced Janus as they do not only unfold a world of possibilities and freedom but also are a part of a world of accumulation by dispossession, starting from data grabbing.

Klikemberg, in a vibrant article of 2007, reflects on geographies of hope and fear as open possibilities, which are not a future already done, but a future that humanity can shape (Freire, 1994). So, the creation of dangerous agglomerations of power are not the defined destiny; critical GIS and citizens handling new technologies can create points of resistance to power, decentralized global networks and multicultural co-operation to frame collective decisions (Poster, 2004).

The term 'neogeography' describes a way of producing and using geographical information, mainly online mapping through webGIS, by non-professional geographers facilitated by the availability of new technologies. It expresses a process of democratization of geographic data and the production of maps online, including new actors in a sector dominated until a few years ago by the military, companies, administrations, and research centres. It is an ongoing open process, not closed, where it is possible to experience delusions (Haklay, 2013b) and possibilities for 'another politics' (Elwood and Mitchell, 2013).

Politics of neogeography deals with two dimensions – one is the site of citizen's engagement for a change playing the dialectic of conforming the spaces of participation offered by institutions (politics from within) or in alternative transforming the context implementing politics from below or outside adopting geo-visual tactics (Elwood and Mitchell, 2013). The second deals with implementing neogeography politics to learn how to do; so neogeography is framed as a site of personal or community political formation.

This double-site political awareness starts from the deconstruction of the narrative of technological neutrality, recognizing how technology is value-laden and human-controlled, and especially how modern forms of social control are based on technology (Haklay, 2013b). Critical GIS becomes a tool of social transformation, constructing geographies of care and hope and space of critical pedagogy on politics of GIS technologies (Pavlovskaya, 2018) and recognizing technology as a result of political negotiation (Haklay, 2016).

2.5. Redesign in Agroecology: Critical Geodesign in Planning and Evaluation

The transition from efficiency/substitution-based agriculture toward socio-ecological diversity-based agroecology requires integrated management of four domains (Duru *et al*., 2014): the farming system, the socio-ecological systems, the socio-technical system, and the actor systems. Actors involved in transition should be able to manage different categories of resources – natural resources, the farms, technological complexities of food systems, and knowledge. A participatory design methodology is required to reach a territorial biodiversity-based agriculture (another name for agroecology).

Geodesign, especially critical geodesign, can offer valid support to this inclusive process, having in mind scenarios of change, design processes, pathway definition, and the management of power relations in participatory and inclusive decision making.

Geodesign, defined as a method to change the geography by design (Goodchild, 2010; Steinitz, 2012), is based on the interactions among people living in a place, planners, experts on geographic information facilitating inclusive iterative processes of creating scenarios, making simulations (what if), sharing feedbacks in real time to reach holistic planning and intelligent decisions (Foster, 2016). Geodesign, considered either as a verb and a substantive (Steinitz, 2012, pp. 19-21), is a contextual approach where geography matters: people and place are linked to a specific territorial system; scale matters: it is important to define the scale of transition, from the farm to global food system; the size matters: change on ecological networks can be smaller inside a farm or larger involving bioregion. For assessment of the place and the intervention, geodesign defines a framework to manage data, to integrate the dialogue of knowledge, and to share common values.

Geodesign, as many other participatory GIS approaches, lives the ambiguity of being captured as depoliticizing tool operating inside the structures and generating inequalities (Radil and Anderson, 2018). The challenge of a critical geodesign (Wilson, 2015) is to be engaged in real transformative actions by fusing 'progressive geographic imaginations with concrete and tangible maps' (Pavlovskaya, 2018, p. 40).

The context is not easy; on one hand, we should live in trouble with Anthropocene dealing with the three main treats: climate change, biodiversity loss, and food security; on the other, we face a post-political world (Radil and Anderson, 2018) with a shift to weak democracy or authoritarian populism.

Beyond the reflections on the technology of geographical information, the other key issue on agroecology transition is the management of geographical data. Louikissas (2019) highlights how 'all data are local' and on the need to move from 'data sets to data setting' because data are not neutral things, but result from social located work, giving meaning to data and operating a selection on relevance. Data are stored not only somewhere in the cloud, but are embeded at a higher level of human work to clean, process, standardize, and check the quality to transform local data grabbing (voluntary or involuntary) in the central commodity of datafication economy. So critical thinking is needed to deconstruct the data-driven society and to move to the co-creation of knowledge. Louikissas goes beyond deconstruction, tracing six principles for wide technological sovereignty. The first principle, declared also in the title of the book, is that 'all data are local as produced within human interpretative acts' (Louikissas, 2019, p. 17) in specific places and into a specific local knowledge system. The dialectic between local to global is central to understanding the commodification of data driven by networks granting the flow, aggregation, concentration, and circulation. 'Data have complex attachments to place, which invisibly structure their form', is the second principle. Attachment and invisibility can be directly managed by local actors, giving meaning to data, while the operations of 'detaching' and 'making visible' have to be investigated to understand who is gaining and losing. The third principle of Loukissas (2015, p. 30) is 'data are collected from heterogeneous

sources'' and heterogeneity transformed into homogeneity needs human work, but also is influenced by the vision and cultural contexts. The fourth principle is 'data and algorithms are entangled'. Algorithms to process data are the results of choice of the data analyst; algorithms allow data to reveal or conceal something, but at the same time data and algorithms conceal human work and human decisions. Data do not 'speaks by themselves' but 'platform recontextualize data' (fifth principle). Data visualization is an important process of giving meaning to data. Geovisualization can be either a process of visual thinking in the private realm of experts and scientists or a public performance of visual communication (Di Biase, 1990), sharing knowledge in a debate driven by experts synthetizing and presenting 'results' or the appropriation by local actors challenging common interpretations. Geographic information and technology deal with three variables: the continuity (or discontinuity) among private and public interaction among actors and data, the level of interaction between people and maps (or digital platforms), and the polarities of presenting the well-known world or discovering and unveil the unknowns (MacEachren, 1995). Finally, in the last principle, which is 'data are indexes of local knowledge' (Loukissas, 2015), there is a sort of circle closure. Data interpretation is again locally, culturally, and historically determined; data can speak, but some cultures are not able to listen. Can culture of yield and conventional farming read the knowledge of territorial biodiversity agroecology? And in the case of reading, what is the result?

The ecosystem of geographic information, from cartography to the new tools and data, the combination of geoinformation and geomedia, desktop GIS, GNSS, Digital Darth, Virtual Geographic Environment and Infrastructures Information Systems, webGIS and geographical CMS, portable GIS on smartphone, drones, wearable, Internet of Things, big data (especially Big Earth data), can be observed in the framework of critical GIS, critical geodesign, to avoid superficial enthusiastic positivism for a transformative technological sovereignty.

About technology of geographic information, we are applying different actions to unveil official soporific speeches, thus opening conversations for possibilities.

Whether it is used as pre-digital tool (paper maps), or as new technology (drones, geographic information systems), there is a critical use of cartography, which is an empowerment of technology, an appropriation of codes for description and transformation becoming practices of citizenship, daily production of new territories of food, and technological sovereignty (Willow, 2013) into a horizon of change (Santos, 2000).

The agroecological transition needs the geovisualization of the present and the future through an empowerment of critical cartography tools. There is data and information available, accessible technologies, engaged farmers, prepared citizens, committed researcher, but we need more awareness to get out of the consumption from the screens to embrace the production of spatial knowledge to act transformative changes.

The challenge of scaling up of agroecology requires (Lopez-Garcia *et al*., 2021) a different approach in planning: inclusive, participative, flexible, multi-scale, and based on nature matrix beyond the paradigms of land sharing/land sparing.

Vision and inclusive design processes can be positively supported by data, technology, critical geodesign; however, the context to implement the new land planning systems is not only technological driven. In a seminal work of 2001, Jankowsky and Nyerges reflected on criteria to plan and evaluate inclusive participatory GIS processes. They developed a framework called EAST 2 (Enhanced Adaptive Structuration Theory) having as starting point the Antony Giddens' theory of structuration (1984), according to which individuals and society act in dynamics of mutual constitution, detectable in the analysis of structures, continuously produced and reproduced through situated practices (Jones and Karsten, 2008). Among the elements of structuration, Jankowsky and Nyerges added the role of technology (De Sanctis and Poole, 1994) in structuring social processes in mutual interaction. So, the framework of Jankowsky and Nyerges is based on a network of eight constructs, grouped into the three areas well known in the processes of participatory planning: convocation, process, and results (Sclavi and Susskind, 2011). The three constructs of the convocation of EAST 2 are: the social-institutional influences; the influence of each participant; and the influence of participatory GIS. So, the technological dimension in starting a participatory process using technologies of geographic information (PGIS, geodesing) cannot be separated from the context created by institutions and the role of actors engaged in change. From the beginning, we can decide if we really want the transformation or if we are opting for conformation to existing unequal structures. The authors highlight how 'neither technological nor social constructs predominate: they work together to structure and rebuild each other: adaptive structuring' (Jankowski and Nyerges, 2001, p. 352).

After convocation, on entering the step of the process we find three constructs: appropriation, group processes, and emergent influence. The 'appropriation' deals not only with the appropriation of GIS technology, but with the appropriation of the topic at stake (for example, the green infrastructures, the food systems, the regional land-use planning) and the feeling to be part of a group able to decide. The second construct concerns the dynamics within the group of actors in terms of activities, co-operative relationships, conflict management embodied in a creative combination of the working climate, and the task to be carried out. The third construct of the process examines the emergence of information structuration during group processes from the combination of three elements: GIS technology, group of participants, and social-institutional set-up. For the constructs of the result, EAST 2 recalls, as in the tradition of the consensus building, how results have two dimensions: one related to the task (to prepare the regional participatory land-use plan for agroecology) and to the social and institutional context (consolidating trust and creating just and inclusive institutions). Jankowski (2011, p. 358) points out that 'participatory GIS requires reliable, inexpensive, scalable, easy to apply

and maintain communication and geographic information technologies, in order to be adopted by planners, local governments, agencies, groups of citizens in local and regional decision-making processes'. The author also emphasizes how use of participatory GIS is not just a question of technologies and settings, but 'requires the activation of a social process in which participants interact with each other and with technology' (Jankowski, 2011, p. 358).

There is enormous value in using participatory mapping and counter-mapping practices with citizens and peasants to draw the existing world and to propose changes in a participatory way (Dalton and Mason-Deese, 2012; Monmonnier, 2007; Peluso, 1995; Verplanke *et al*., 2016). For decades, counter-mapping, critical cartography, participatory GIS, voluntary geography, crowd-sourcing of geographic information have represented different declinations in the use of geographic information by actors who, in various corners of the earth, challenge the extractivist logic of accumulation by dispossession.

Accumulation by dispossession runs from the Amazon river, crossing the Arctic Shield, looking for minerals and oil and gas, but crossing the human body by looking for patenting genome or by citizens as sensors, to grab data and local knowledge.

The cartographic extra-activism (Kidd, 2019) follows several routes between militant research and the social protagonizm of citizenship based on the issues that geographic information is a common good and that geographic information technology and cartographic representations should be appropriate and shared in their active and emancipatory dimensions (Dalton and Mason-Dees, 2012; Monmonier, 2007; Peluso, 1995). It is not only about theories to be debated in academic contexts, but about inclusive social practices that have been built in the counter-mapping of indigenous lands, the challenges of urban socio-spatial justice, the multiplication of representations of nature and natural resources in the perspectives of eco-citizenship and agro-ecological transition.

These cartographic practices are plurally occurring in different situations, animated by people and resources that act out the extra-activism of possibilities. Visions of change, professional and volunteer time, knowledge and technical capacities are confronted with the official cartographies produced by the institutions of the State, the business intelligence market and the offices of trans-national corporations.

2.6. Participating in the Agroecological Transition

Basso Isonzo is a neighborhood of Padova (the city of our 800 year-old university). Despite the high concentration of buildings and inhabitants, it maintains an important agricultural area with debates and proposals for an urban agro-landscape park. Two farms, were started in 2015 in proximity agroecological production (Terre del Fiume and Terre Prossime) and they have lived, directly in their skin, the challenge of transforming conventionally-farmed land into high diversified agroecosystems. They have dug closed ditches, planted trees and

living fences, reclaimed wetlands, and maintained a small forest. But this process has not only occurred as peasant consciousness; it has also promoted a social interaction involving citizens of the city's neighborhoods in participating in the creation of the territorial biodiverse agroecosystem. 'Plant the fence and stop the concrete' (7 May, 2017) and 'A forest is born' (27 March, 2018) are just a couple of initiatives supporting the creation of forests and living fences in the two farms with the collaboration of citizens of all ages.

This is a small example among the thousands existing in different parts of the world, between urban peripheries and agroecological systems in tropical forests, where the agroecological transition of levels three, four and five occurs, accompanied by the creation of an inclusive and participated nature matrix.

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