

Disorder and Complexity in contemporary Ecosystems Man/Society/Environment

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ABSTRACT ¹

The interesting and compelling themes of the IMCI 2024 Conference can be found in the Action-Research we have been practicing as human ecologists within many Man/Society/Environment (M/S/E), complex and disordered eco-systems in which Nature, Science, Philosophy, Arts, Economies and Technologies interact with People, Societies, Cultures and Public Institutions in relation to the living environments of their influence.

All this has led us to consider the disordered complex systems - usually the domain of different/separate disciplines- as components of a “common home” in which they interact to build *knowledge* and stimulate wider scientific and human *community dynamics*, towards a new epistemology.

This text aims to contribute to these arguments by developing into four parts:

1. *The complex disordered systems, from science to experience and vice versa*
2. *Human Ecology, an approach to complex disordered systems in contemporary realities*
3. *Toward a common epistemology*
4. *Action-Research in Ternary Ecosystems in their becoming*

1. THE COMPLEX DISORDERED SYSTEMS, FROM SCIENCE TO EXPERIENCE AND VICE VERSA

In a wide range of systems, (from physic to human systems) complexity and disorder have been recognized as prerogatives that characterize their *transition phases* (changes of state and/or configurations) whatever their size and the mixing of

¹ We acknowledge the Peer- Editor of the final version of this paper prof. Filippo Gravagno

their diverse components. In them interact heterogeneous variables that give place to original behavioral dynamics that, for the physic systems, are interpretable and describable by means suitable (specific) physic and mathematic tools, whatever their different micro and macro dimensions. The most recent achievements in physics have *thrown the doors wide open* to the world of disordered systems, (G.Parisi) [1]. In them fluctuations and interactions among their components lead these systems to be simultaneously in different states of equilibrium which, for physical systems, are related to the *minimum energy* condition (steady states).

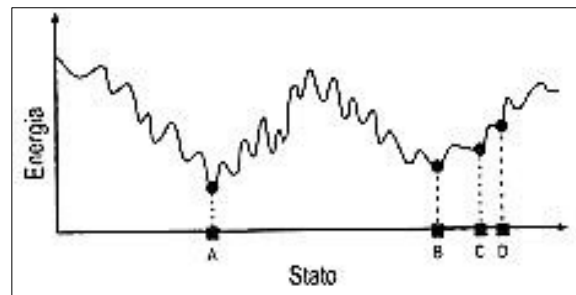


Fig. 1 G. Parisi, cit. pg.87”at low temperatures the system moves in the direction in which energy decreases and can be in any one of a number of states” represented by the line (A,B,C,D)

1.1 Prerogatives and structures of complex and disordered systems in physics research

Complexity and disorder, are the basic prerogatives that enable Systems to ensure at the same time *multiple steady states*, *multiple new transition phases* and the perpetuation over time of *multiple changes*. In disordered systems these transitions occur in homologous ways and depend on the behavior of *microscopic agents that constitute the systems and that we cannot observe individually*. [1].

Beginning in the 1930s-40s of last century, the study of transitions phase became fundamental to understanding the mechanism by which they occur

and to interpreting them with the tools of physics. The physics of the 1950s-60s, highlighted the general idea of *energy minimization* toward a *stable equilibrium point* at which the system can remain even indefinitely in the absence of external intervention to stimulate it to find a new configuration, that for the complex systems, is potentially still disordered, but also stable.

As Prof. Giorgio Parisi teaches, in physical systems, transition phases lead to *changes of state* and are characterized by the variation of a parameter (called the *order parameter*) that changes during the transition, assuming numerical values whose physical meaning is easily understood. The transition phases of disordered complex systems do not lead to mere changes of state but to *new configurations*, whose *order parameters* cannot be a simple number but functions. *“one point was not sufficient to characterize their transition [which, instead] needed a function composed of infinite numbers [...] whose physical meaning was difficult to understand [since]. the physical meaning of these results [functions composed of infinite numbers] common to all of disordered systems was unexpected and corresponded to a very large number of different stationary equilibrium [steady states, that] have different energy levels [that allow the system] to evolve, when stimulated by the variation of an external condition [e.g. temperature, density] that modifies its energy levels [heat] leading it to assume different configurations, [obviously compatible] with its nature and evolutionary history”*². The “strange procedure”³ developed to describe this situation mathematically *“turned out to be a powerful mathematical and conceptual tool that can be summarized in models designed to describe the behavior of disordered physical systems synthesized in models, proves valid for solving a wide range of seemingly disconnected problems: the problems of disordered systems' of the real world. [in which] many situations can be described by a large number of interacting elementary agents, [such as] spins, atoms or molecules, neurons, cells in general, but also websites, stock market agents, stocks and bonds,*

² Two modes distinguish the transition phase in which the system goes from a more ordered to a disordered state, which in turn depends on the way the energy changes and the energy received by the system (e.g. latent heat), whether it accumulates without slow and gradual transitions or whether it produces abrupt transitions.

³ the strange mathematics devised by Parisi the application of mathematical techniques used only for integer numbers (combinatorial calculus) was extended to non-integer numbers and made it possible to describe the multiple outcomes of the transition phases of complex disordered systems.

*people, animals, components of ecosystems, and so on.”*⁴

2. HUMAN ECOLOGY, AN APPROACH TO COMPLEX DISORDERED SYSTEMS IN CONTEMPORARY REALITIES

Human Ecology is an approach to the realities of the contemporary world that corresponds to the need to live in accordance with the complexity of the social and environmental contexts of which people are part and to which they recognize that they belong.

In each of these realities we can find or reconstitute as many Ecosystems that can be recognized as such when relationships and dynamics of transformation and/or evolution are established through the interactions among their human, social and environmental components that lead these ecosystems to assume multiple and ever-changing configurations.

Ecosystems of this nature (Ternary M/S/E ecosystems)⁵ are multiple and variable, but all of them structure, transform, die out or renew themselves in ways homologous to those of all the disordered and complex systems found in nature, and that are recognizable, interpretable, describable precisely because of their capacities to transform (and/or) evolve with qualitatively and quantitatively differentiated outcomes at the same time. (biodiversity in nature, anthropological diversity in human societies).

For Ternary Man/Society/Environment Ecosystems, the Relationships and Interactions between their components are configured in turn as *continuously variable dynamic networks* in inextricable entanglements that can never be ascribed to rigid patterns or linear dynamics but perpetuate themselves, following increasingly entangled cyclical trends, keeping away the systems from equilibrium, toward increasingly complex configurations.

To these ternary systems, neither the binary logics nor the oppositions of Games, the games with rules, in which you win or lose and in which all other alternatives are ruled out, can be applied. In this case, we can say that in such Ecosystems the Relationships and Interactions take on the dynamics proper to the *Play*, the game whose rules are not predetermined but

⁴ All citation in italics are referred to *In a Flight of Starlings*, pp.65-73, G.Parisi, 2021

⁵ The Ternary M/S/E Ecosystems include all living systems in which relationships are established and enduring between individuals, their societies, and the living environments to which they belong.

are established differently in an open process in which no one wins and no one loses but all participants continue their interactions toward new levels of disorder and complexity.

The *Caucus Race* (typical of electoral competitions) changes, like the Play described by L. Carroll in *Alice in Wonderland* [2]: no one wins, no one loses but everyone receives a prize when the race is over and everyone can start playing again, and this situation could correspond to different simultaneous equilibrium states in the transition phases of physical systems.⁶



Fig..2 L. Carrol Alice in Wonderland
The participants in the Caucus Race

2.1 The intrinsic dynamics of the complex disordered systems of living matter

It is appropriate here to renew interest in research that from complex disordered systems turns to the evolution of living matter. In this sense, the researches of B. Mc Clintock⁷, in the late 1940s, and the

⁶ L. Carrol, [2] Alice in Wonderland, Milan 1982, p.32 Alice's *Caucus Race* showed that the behaviors assumed by the participants during a spontaneous game may not be determined by pre-established Rules but may give varied outcomes from which new games may be born... and so on. Alice's Caucus Race anticipates *Play* by a century, in which rules are progressively constructed in the course of a spontaneous game. the correspondence between the human behaviors described and the behaviors of complex disordered systems appears evident.

⁷ The epistemological value of B. Mc Clintock's research would require further study, which we cannot present here. We recall here what She wrote in 1973: "Over the years I have found that it is difficult if not impossible to bring to consciousness of another person the nature of his tacit assumptions when, by some special experiences, I have been made aware of them. This became painfully evident to me in my attempts during the 1950s to convince geneticists that the action of genes had to be and was controlled. It is now equally painful to recognize the fixity of assumptions that

discovery of *transposons*, also known as *jumping genes*, which revolutionized genetics and radically altered our understanding of cell differentiation. Her researches have not only an extraordinary universal scientific value but also an epistemological significance linked to all the philosophical elaborations that lead to the recognition in living matter of the secrets of its capacity for continuous self-creation that accompany its evolution.

The research in various scientific fields and the "evolutionary explorations" carried out by Philosophers of Nature and Knowledge in the 20th century thus find a common epistemological reference, a new "Sacred Unity" for dealing with the contemporary world.

2.2 The official acknowledge of ternary Ecosystems

Since the '60s UNESCO has recognized Ternary Ecosystems as structural components of the dynamics of our Biosphere. On this recognition developed the new *Man And Biosphere Project* approaches (known as MAB projects, UNESCO, 1973) intended as concrete experiences of *putting into practice* the principles and criteria that characterize Human Ecology and its multiple M/S/E Ternary Ecosystems. In those same years, the Ecology of Nature, hitherto conceived of as separate from man, considered alien and often the enemy, in G. Bateson's *Sacred Unity* became a foundational part of Human Ecology, in which all transformations/evolutions of living environments and human cultures and civilizations are co-participants.

Over the past century, complex disordered systems far from equilibrium have attracted the attention of scientists, and their transformation dynamics (transitions phases), thought to be indescribable by the tools of classical science until a century ago, have been revealed and described in their quintessence, as the crossroads and junction from which the transformation dynamics of the complex disordered systems of the living world have developed and branched out.

3. TOWARD A COMMON EPISTEMOLOGY

Today we can rediscover the relationships and correspondences that can lead back to a common epistemology of the world's evolutionary phenomena, through transdisciplinary paths that overcome

many persons hold on the nature of controlling elements in maize and the manners of their operation. One must await the right time for conceptual change" -Barbara Mc Clintock, Wikipedia, 2023

traditional rigid stratifications to consider the qualitative and quantitative differences present in complex disordered systems as activators of their transformations. In this sense, Human Ecology can become the *connecting field* of transdisciplinary exchanges, interactive relationships and research, as well as community learning and knowledge, related to the societies and living environments of the contemporary world.

In this *new field* interact the multiple and diverse complex and disordered ecosystems that we have assumed as M/S/E ecosystems to whose becoming all People, Communities and Living Environments in which they relate, can contribute, according to principles and criteria proper to G. Bateson's *Ecology of Mind and Nature*. [3].

In ecological terms, we still need to clarify how the dynamics of the transformations of living systems, termed by many philosophers as *virtual-actual//tension-factual* dynamics, in turn expresses the variable interaction between the two states that characterize the transitional phases that are characteristic of every living system: *homeostasis* and *homeoeresis*, which succeed each other in the course of its lifetime.

The combined dynamics of the two pairs *virtual-actual//tension-fact* guarantees the natural intrinsic sustainability (perpetuation and evolution) of living systems.

For these systems the term homeostasis corresponds to a steady state in which potential dynamics for further changes remain, that correspond to the first term of the pairs (*virtual- tension*).

The term homeoeresis, on the other hand, refers to state changes (production of new changes), which correspond to the second terms of the two pairs (*actual/factual*).

Dynamics of this nature are common to behavior in the course of their everyday life experiences, when people find themselves making choices or realizing their desires autonomously without being conditioned by imposed Rules.

These topics have been addressed by distinguished philosophers and scientists throughout history up to this century.

The Italian free Philosopher Margherita Pascucci [4] highlighted the concatenation of their elaborations that become fundamental for an epistemology of complex systems.

In these dynamics we could recognize the principle of *causa sui* (autonomous, independent and spontaneous capability of transformations, intrinsic to all living systems) as the core of auto-poiesis, the evolution mover of all Ternary Ecosystems, Humans included.

All the phenomena of becoming correspond to Relationships that are spontaneously created, stabilized and propagated between the different components of each system. It is now known that all the *relational dynamics* originated from the *primary resonance's dynamics*, are common to all the *disordered complex systems* of our planet.

Everywhere, from the resonances and from their *perpetuation in time* (not mechanical replication!) new Configurations are produced, new Forms and new Relationships, while the transformations originate and develop.

Evolutionary phenomena are usually identified as producers of bio-diversity over time, or phenomena that occur with non- linear, cyclical and discontinuous tendencies, sometimes perceived as “contradictory involutions”. This is because in these cases there can also be violent alterations or destruction of previously established Relationships within the systems, risky to their component parts (human and natural in particular).

Until the contemporary age, the *transformations* (even occurred after dramatic catastrophes of species extinctions, geo-climatic changes, nuclear explosions) have never completely annihilated or totally compromised the perpetuation of the transitional processes both of the *aboriginal disordered complex systems* (spin glass) and of the *hyper disordered complex living systems* (Ternary Ecosystems).

However, unexpected living contexts can be created, often dangerous for nature -if they cause or devastate natural ecosystems- or can sometimes be perceived by Humans as catastrophes for human survival on the planet.

For these reasons we have then related these *transformations* to the common *epistemological conceptual criteria*, synthesized above, that harbors and hold together all the *disordered complex systems of our world*, from spin glasses to ternary ecosystems. In other words these criteria allow us to recognize the fundamental prerogatives that remain *ab origine* of all *transitions phase's phenomena* from which originate the *evolutionary phenomena* of the world.

Within this epistemological womb the dynamics of the transition phases intrinsic to the physics systems - highlighted by G. Parisi- and the dynamics of self-preservation and creativity intrinsic to living entities -

acknowledged by Philosophers as outcomes of *virtual/actual/tension-fact dynamics (causa sui)*- are welcomed and recognized.

All this brought us to acknowledge in them the *quintessence of all phenomena* originated, rooted and unfolded in an *evolutionary crescendo* of disorder, complexity and beautifulness that constitute the reality we live in.

All these evolutionary processes became progressively perceivable, interpretable and describable throughout conceptual/technical tools belonging to Mathematics, Physics, Biology, Cognitive Science, and Artificial Intelligence, according to integrated combined procedures of conceptual/multidimensional mappings⁸.

The co-existence of these conceptual /technical tools leads us to understand that the *physics systems dynamics* (referable to algorithmic structures) and the *living systems dynamics* (structured on resonances/relationships) whose natures are clearly distinguishable, are part of wider, universal, still unknown dynamics.

On this basis, it has been possible to follow, accompany and stimulate from within their evolutionary processes using integrated conceptual/experiential mapping procedures that have led these ecosystems to reach new levels of knowledge and responsibility.

3.1 Contradictions and contrasts between conceptual and technical procedures

Among the conceptual/technical procedures, Artificial Intelligence has pervaded every field of research, also heavily influencing Action Researches and experiential practices that are specific to Ternary Systems. All of this is provoking a transformation of the present natural/technological realities in a *digital reality*. This kind of reality is interpretable as a sort of *paradoxical algorithmic evolution* of the complex disordered systems, that could turn out a potent insidious trap to capture and dominate all the human and natural dynamics of life, from which itself has been originated.

In this hypothesis the transitions would no longer originate from the living world, while only the digital

⁸ Fuzzy logic and Mathematics of Relations turned out an useful tools to interpret and describe the social perception of life environments within experiential learning processes carried out with groups of scholars and academic researchers (1990). We thank our friend and colleague Prof. Wyllis Bandler,(1917-1995) who supported and took part in our early research (1980-90) on the social perception of living environments used in human ecology [5].

transformations could be produced and propagated without limits, so that the *relational quintessence* of evolutionary processes could be totally captured by digital mechanisms, capable of altering even the *original intrinsic characters* of *evolutionary dynamics*.

These dynamics are based -as G. Bateson taught us- on *herb syllogism*” The herb is mortal, the men are mortal, the men are herb” a paradoxical anti-logical statement to which the living phenomena are totally referred.

For Nature and for Human Societies the danger is that the current coexistence between natural/artificial worlds becomes a competitive *Game* in which the winner could be the artificial world. If this were to happen, the *external digital control* could dominate the whole living world, influencing human societies in the illusion of reaching new equal participation, even going towards a new *digital false democracy*.

Faced with this impending degenerative phenomenon, neither denial nor frontal opposition make sense. It is instead necessary to prevent digital reality from dominating the creativity of living systems by appropriating their prerogatives and artificially transforming them to the point of altering the processes of perception, learning and awareness (Cognitonics procedures).⁹

Really many contemporary living environments have already been transformed into unexpected *transition environments* in which natural and digital realities coexist, mutually and strongly intertwined. The two types of transformation, *respectively influenced by nature and digital networks, still coexist within them*. Within these unexpected environments arise and branch out various types of relationships and connections that influence technologies, agriculture, art, science, behaviors, perception and that, at their turn, stimulate new environmental, human and social configurations.¹⁰

⁹ The ”Cognitonics procedures” have been devised by Vladimir.A Fomichof and Olga.S. Fomichova in the course of the biennial Conference on Cognitonics – the Science about the Human Being in the Digital World (Slovenia, Ljubljana) where these themes have been developed and discussed according to procedures devised by V. Fomichof and O.S. Fomichova, experimented with and discussed within interdisciplinary groups.[6]

¹⁰ Keeping in mind the *Molecular Revolution* as formulated by F. Guattari [7] and G. Deleuze [8]

4. ACTION-RESEARCH IN TERNARY ECOSYSTEMS IN THEIR BECOMING

For human societies adequate strategies based on relational dynamics are necessary to trigger Communitarian Action/Research Processes tailored on the needs, desires, competences of the social contexts towards their ambits of life. For this it is therefore necessary to approach every favorable condition in which the Action-Research can be practiced to encourage the environmental/social relationships, the interpersonal resonances, and the social perception of Life Environment that can suitably trigger ternary ecological processes, able to give breath and elasticity to the stiffened fabric of contemporary contexts, reopening spontaneous dynamics among participants. What has been expressed above became the *structural framework* of our experiential researches within different Ternary Ecosystems, where suitable Laboratories for Action- Research could be activated and structured on the following cores:

- *recognition and formation of communitarian life contexts*, encouragement of sympathetic resonances self-produced among people
- *development of ecological ternary contexts* in which dynamics of natural and human co-creation can be re- opened
- *support of every experiential activity* capable of overcoming the difficulties and obstacles present in transformed life environments or in their process of change

On this base various processes of *perception, learning and adequate knowledge*¹¹ can be activated within the *human/society/environment* ternary systems, in place or potentially practicable, like the *Landscape Contract*, as the one we are about to summarize below, just as a significant sample among a large group of homologous cases that we have been experienced since the end of last century.

4.1 The case of Landscape Contract on Panaro River

This experience has been developed on Panaro River - Landscape valley in Emilia-Romagna Region North Italy (2009) and at the present still alive in progress as an *Action Research Process* promoted by Emilia Region, Province of Modena, and the three local river Municipalities (Vignola, Savignano, Spilamberto) following an exasperate insolvable contrast between

¹¹ We would like to remind that this term was defined by B. Spinoza, XVII Century, as highlighted by M. Pascucci [4]



Fig.3 A Panoramic view of Panaro River

local inhabitants, who claimed the quality of their river environment against its dangerous devastations, and their own local governments, to whom they were requesting concrete responses. In this context since the remotest to contemporary ages -from Pliocene, to 20th Century age- many interesting natural, scientific, cultural evidences have been stratified on this part of the river valley. At that moment strong alterations (quarry excavations, industrial activities, pollution, and so on) were menacing this river area provoking a strong civic reaction.

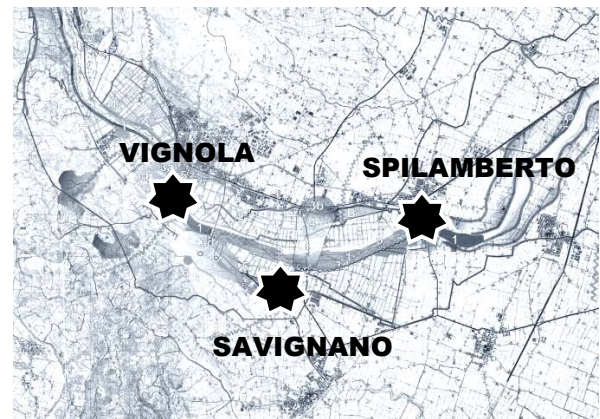


Fig.4 This map shows the definition of the fluvial ambits belonging to the first group of Municipalities where the River Contract originated. The fluvial ambits indicated on the spots are the territorial Relational Framework of the Action Researches of the Contract

On this base the regional and local governments supported and encouraged the participative experience of *Landscape Action* (European Landscape Convention)¹² where the single persons, social groups -with their desires, competences, and concrete capability of participating in a new *Action - Research Process*, together an interdisciplinary staff contributed in the creation of an Human Ecology's Laboratory where the local groups, associations, public

¹² Landscaping Action, as stated by European Landscape Convention, Firenze, 2000 [14]

bodies (politicians and technicians) schools, local museums and local entrepreneurs (tourism, culture, agriculture) could interact, working together.

In such new context a *Landscaping Action Research* has been developed as a concrete proposal of *River Landscape Contract*, subsequently accepted and ratified both by Public Bodies and participative Group (2009).

The *Action Research* in the form of *landscape participative activities* had been developed throughout the following *five phases*:

- *Social perception* of Life Environment – friendly learning approach among local groups, experts and staff - Informal colloquies, survey promenades, thematic syntheses-
- *Self-reflection* on the local River Landscape – shared valuations, constitution of a common stock of information and aesthetic landscape appreciations
- *Social potentialities* and actions -ecological, cultural, scientific, educational, economical- have been recognized in their mutual relationship with specific fluvial areas and connected as a dynamic interactive network (represented in the form of a *Creative Hive*)
- *Location of the network* on the fluvial landscape valley through a specific representation of projects, actions and programs conceived as a *Relational Field*
- *The proposal of the Contract* as a new pact between society and river sites, an agreement between Groups of citizens and official Bodies (Region, Province, Municipalities, Local Groups, Technicians, Public Managers) for a new way to manage the natural -social common heritage in evolutionary terms according to Human Ecology

This Contract intrinsically involves all of its signatories in an *open and continuous experiential agreement*.

In this agreement different projects, actions, managements and any other appropriate initiative concerning the river area are harmonized in a sort of scientific/creative coordination, finally shaped as a specific Civic Laboratory dedicated to the *Genesis and evolution of the River Landscape*.

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Fig.5 The group is discussing the first achievement, the so-called *Beehive*. Everyone is aware and proud of their work of mutual and friendly learning and expressing their abilities



Fig.6 Perceptual explorations of riverine landscapes and reflections on outdoor group work were repeated cyclically, arriving at the definition of the *Contract areas* and the modalities of their ecological management, protection and promotion with the production of the *Contract's Drawings and Statute*

In this Laboratory, where proposals, programs, projects and management of the local resources (environmental, cultural, social, economic, etc.) suitably structured in the Contract – converge, are discussed and verified, to be involved in new interrelate processes of protection, promotion and management of selected fluvial ambits. A *Landscape Contract Council* set by all participants equally involved in the non-hierarchical Action-Research guarantees the correct management of the Contract.

New experience are in progress and they will be suitable to propagate this ethic style of research, encouraging new Relational Conditions and Landscaping Actions Researches.

The experience of the *Landscape Contract* leads us to new explorations on different contemporary conditions and can demonstrate the concrete practicability of these itineraries.

The experiential process above described evidence that

- among the social groups, local institutions and individuals it is possible to turn exasperated protests into creative interactions and new opportunities, concretely practicable in renewed living environments.

and that

- the exasperated contrapositions between *Connections/Relationships; Mechanisms/Organisms; Mutations/Evolutions; Competition/Balanced Coexistences*, could be reversed avoiding the degenerative submission of the world of nature to the digital one by including the digital world in a wider and complex Human Ecology's life environment
- Here *unexpected interactive dynamics* could be established by using the digital opportunities to improve and propagate the experiences yet matured within the living context. The digital instruments and technological devices, correctly included in the participative processes can be helpful to improve their trend
- In this way, diversified processes have been stimulated and implemented, while ecosystem's complexity and human and informational dynamics interact to achieve new evolutionary balances and new environmental, social, urban, cultural behavioral configurations.

Moreover these activities started up specific exchanges of relational interactions towards wider homologous realities achieved throughout networks and digital instruments self- created and autonomously managed.

5. CONCLUSIONS

For these reasons, we believe that the themes addressed above can be developed on the basis of new conceptual criteria, finding acceptance in an epistemology where disorder and complexity, once again, become protagonists of evolution, and at the same time we believe it is fundamental to practice Human Ecology in the terms of *molecular revolutions*, as defined by G. Deleuze at the end of the last century. We would like to assert that the epistemological unity to which we have referred, able to embrace all the complex disordered Systems of the world could become a potent structure to enhance and improve the coexistence for a life environment referred to Nature, and Human, able to incorporate the artificial and digital world in wider and wider Relational Dynamics.

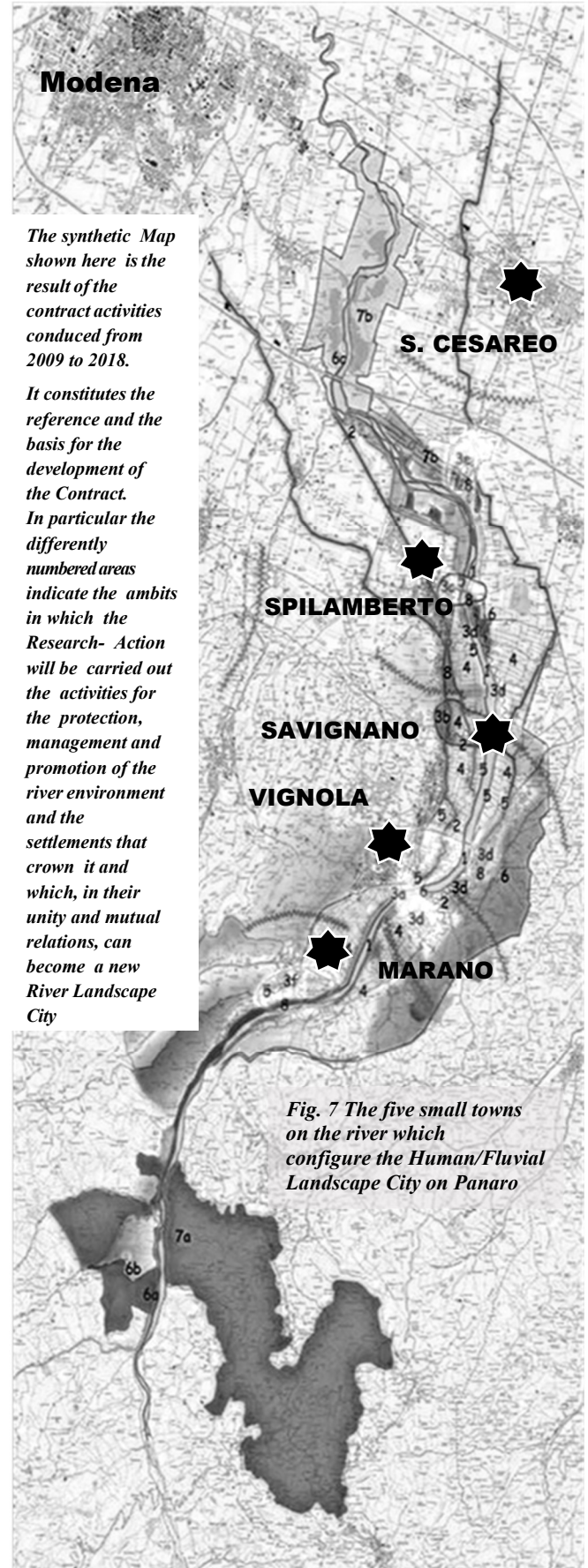


Fig. 7 The five small towns on the river which configure the Human/Fluvial Landscape City on Panaro



Fig. 7 Experts and middle school students observe the river and prepare to become members of the River Landscape Presidium

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