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Supporting Cities towards Carbon Neutral Transition through Territorial Acupuncture

Federica Leone [1,*], Ala Hasan [2], Francesco Reda [2], Hassam ur Rehman [2], Fausto Carmelo Nigrelli [1], Francesco Nocera [1] and Vincenzo Costanzo [1]

[1] Department of Civil Engineering and Architecture, University of Catania, 95100 Catania, Italy
[2] VTT Technical Research Centre of Finland Ltd., P.O. Box 1000, FI-02044 Espoo, Finland
* Correspondence: federica.leone@phd.unict.it; Tel.: +39-3922275652

Abstract: Since a solution towards carbon neutrality in already highly populated territories that does not profoundly alter the territories has not yet been found, territorial acupuncture, a new methodology presented in this paper, proposes a solution to this challenge and simultaneously helps to counter the dysfunctional dichotomy between large urban centres and small towns. The aim of this study is therefore to present this new concept and its operation. Hence, a phased study was carried out. Territorial acupuncture is the result of merging different theories and practices, such as Biourbanism, urban acupuncture, and energy community design. For Territorial Acupuncture, the territory is conceived as a single organism and, just like acupuncture in traditional Chinese medicine, punctual interventions (in this case, interconnected energy communities) would benefit the entire territory organism. To make the theory work properly, it will be necessary to carry out multi-scalar and multi-disciplinary analyses over the entire territory to identify the intervention points and then proceed to the design and interconnection of the individual district. Thus, Territorial Acupuncture provides a new approach to the resilience of densely populated territories, which, through punctual interventions on a district scale, benefits the entire territory by modifying energy, socio-economic, and environmental dynamics.

Keywords: territorial acupuncture; energy community; positive energy district; biourbanism; territorial resilience; urban resilience; towards carbon neutrality; micro-invasive spatial planning; micro-invasive urban planning; resilience

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1. Introduction

The development of a new methodology such as the one presented in this paper requires an in-depth analysis of the previous topics related to it. In this way, it is possible to frame the state of the art, the limitations, and the potential of the topics related to the methodology to be presented. By outlining the general picture and identifying the present gap connecting the various topics, the reasons why a new theory/methodology is needed will be highlighted. At this point, it will be possible to present the concept and functioning of the new theory/methodology. This article carries this same organisation forward. At first, it presents the state of the art of topics related to territorial acupuncture. This information is necessary to understand the reasons why territorial acupuncture was developed. Among the main topics are those related to the climate crisis, with the resulting solutions already identified and policies developed, and those related to the problems and functioning of urban centres in the area. Subsequently, the methodology with which the article and the study were carried out was presented, as well as the urban planning theory behind it. Finally, the theory itself was presented with the concept, functioning, and variations from the theories behind it. Thus, the general framework within which the theory is ascribed, its functioning, and potential is presented.

Wanting to simultaneously contribute to the transition to carbon neutrality in already highly populated territories without wanting to have a profoundly altered territory as a response and simultaneously helping to counter the dysfunctional dichotomy between large urban centres and small towns, this study analysed two main strands of topics: climate change and urban issues. This choice made it possible to obtain an overview of the policies and solutions identified to counter the climate crisis. At the same time, it was possible to analyse how the territories in which people live create such discomfort that it is necessary to think about formulating a different model from the urban pole system hitherto familiar to everyone. Since the management of cities and territories is the main cause of the climate crisis, and since they are also the main actors suffering the consequences of it, it was a must to relate these two topics in order to understand how and insofar these two issues influence each other. Moreover, not only does their correlation identify the gap for which territorial acupuncture is needed, but it also helps to understand the reasons why the whole current of Biourbanism (from which territorial acupuncture takes its cue) has developed.

1.1. The Climate Crisis—Adaptation and Mitigation Policies

In the coming decades, our territories will have to face unprecedented consequences related to pollution and climate crisis [1]. These consequences have already started to show themselves with the emergence of new epidemics/pandemics, food crises, energy crises, and extreme weather conditions [2–6].

In order to contrast the onset of these crises, which will have serious consequences even on a humanitarian level, international organisations such as the United Nations (UN) [7–10] and the Organisation for Economic Co-operation and Development (OECD) [11] have founded agencies whose aim is to protect the world's population and the earth's resources: United Nations Framework Convention on Climate Change (UNFCCC) [12–14], World Meteorological Organisation (WMO) [15,16], United Nations Environmental Programme (UNEP) [17–19], International Atomic Energy Agency (IAEA) [20], International Energy Agency (IEA) [21–25], and Nuclear Energy Agency (NEA) [26,27]. Common goals identified by treaties such as the Global Green New Deal or the agreements drawn up during COP 1–26 are to promote the efficient use of resources by moving towards a clean and circular economy, restore biodiversity and reduce pollution [28–33]. In the most recent phase, the main goals are the decarbonisation of the energy and transport sector and increased energy efficiency in buildings [34–37].

According to the objectives set, cities are the pivotal element in this process of change and adaptation, leading to a process of transition and innovation [38–40]. The urban areas have become technical playgrounds where testing new solutions, While an Asian world, with greater availability of unbuilt land and a growing population, is experimenting with the planning of newly founded urban centres, creating realities such as sponge cities and forest cities [41–46]. Already highly urbanised territories with almost no population growth, such as Europe, are posing the problem of how to adapt existing urban centres without excessively altering the existing urban fabric, thus protecting all those areas subject to historical and cultural constraints [47]. Adaptation/retrofitting solutions were proposed at the building scale up to the most recent adaptive form on a district scale.

The search for solutions that can be applied in both new and existing cities is compounded by the current limits of urban planning. Current urban planning methods, developed in the 19th century and targeting smaller, less globalised cities, are inefficient for the design and management of interconnected megalopolises [48–51]. The climate crisis has made it clear that previous urban planning methods are almost totally ineffective for today's needs for rapid change and adaptation of cities, and furthermore, hardly ever consider the whole range of dynamics (social, economic, and energy) that spill over onto the entire territory, not only in urban areas but also in marginalised areas (inland area) [52–57].

Up to the knowledge of the authors, there is currently no methodology yet to renovate the existing urban centres and to change territorial dynamics in their entirety (energetic, settlement, social, and economical dynamics). Since no study exists on this subject, the aim of this study is to deal with this mismatch by proposing a new methodology that takes it into account.

1.2. Urban System

In our world, the centralised, urban pole system is the most widespread settlement system [58,59]. Following millennia of development and a century of globalisation and industrial growth, this settlement method has shown its limitations and problems. In fact, although this system was the best and most effective in a loosely connected reality in which each centre had a sufficient number of inhabitants necessary for the sustenance and defense of the individual urban reality (model of the ancient and medieval fortress city), with the process of industrialisation and urbanization more and more people flocked to urban centres, as cities became attractive hubs [58–60]. As this trend has continued for more than a century, the limits of this type of settlement have begun to become evident from both a spatial planning and a social point of view, increasing the gap between large megacities and small towns [61,62]. The main problems interconnected with this settlement system are:

- In the large urban centres (with variation in scale in both the eastern and western worlds), the cost of living close to the city centre and services centre has risen dramatically, so that either people can afford to spend a lot of money on the few remaining dwellings/accommodations (the city centre usually also becomes the financial centre with a majority of office buildings), or compromises have to be made on the distance to the city centre, on the cubage, on the quality of housing, on neighbourhoods, or the quality of life in general [61,63–68].
- Suburban and small rural centres are depopulating, with the loss of value of buildings, and consequent lack of investment for maintenance, to ensure territorial continuity through transport, to guarantee changes for the prevention of natural disasters, or the simple right to health and work. This phenomenon is also known as the problem of 'inland areas' [55–57,69,70].

This settlement system has thus created a dualism of problems both in the main urban centres and in the internal and secondary areas. Despite all this, however, urban centres have continued to be attractive poles for the population, for the increased labour supply, and have exacerbated the inherent problems of this settlement pattern by creating widespread pockets of poverty and crime in degraded urban areas [71–73]. Currently, when the system reaches threshold stress points, the solution is to shift the focus to a new attractive pole, gradually abandoning the previous one [74]. An example of this phenomenon is the social and urban dynamics currently taking place between California and Texas [75].

To combat this failed urban prototype while maintaining the current demands of an interconnected and globalised world, it would be necessary to change the dynamics between large urban centres and inland areas. In addition, various currents have sprung up proposing alternative development models to the current one, such as bio-urbanism or social urbanism, which call into question the central system of the urban pole and emphasise the need to put people and nature at the centre of urban and spatial planning [76–80].

While it is, therefore, necessary to rethink urban settings, it is also necessary to implement the Urban Design and Spatial Planning System to make them effective and efficient for the needs of the climate crisis [81–84]. At the basis of these two disciplines are the multiscalar principle of planning (considering different scales of intervention and detail at the same time) and the multidisciplinary principle (different thematic areas that must be interconnected) [85–90]. If these disciplines were born to develop a harmonised asset of the city and the territory, the vastness of the themes taken into consideration would have led to an extreme sectorialisation [91]. This has often meant that the overall framework does not take shape, thus breaking the multi-scalar and multi-disciplinary principle inherent in these types of planning and creating dysfunctional short circuits on various levels in the city plan.

1.3. Energy Infrastructure

To ensure the proper functioning of a settlement and basic services for the population, in urban planning, it is necessary to think first and foremost about energy supply (electricity and heat) and thus develop an energy distribution network (already long established in developed countries) throughout the entire territory [92–97]. A distribution network is defined as an infrastructure system of pipelines that enables the transport of energy from the primary source to the consumer; the most widely used are the electricity infrastructure (which will serve indoor and outdoor lighting and the proper functioning of electronic equipment) and for heat either the gas infrastructure or the District Heating Networks (which will provide indoor heating, hot water, and for cooking) [98–104].

As far as the electricity infrastructure is concerned, once it is produced in power plants, exploiting the chosen energy source (fossil fuel or renewable energy sources) and supplied through power lines at high voltage, being able to travel even great distances through the use of auto-transmitters it switches to medium and low voltage (the form in which it is supplied to users) as the network branches out over the territory thanks to the intervention of energy supply companies [105–119].

The gas infrastructure (normally methane) normally consists of high-pressure import pipelines that transport the gas from the supplying countries (United States, Russia, etc.) to the user countries. This is followed by a primary state transport network, in which high pressure is maintained, and then secondary and local networks, which, through a progressive decrease in pressure, make it possible to arrive at the end user at very low pressure, thus guaranteeing the user's safety [112,120–126].

A form of heating supply infrastructure is the District Heating Network, a centralised heat distribution system (and/or a cooling system in the case of a District Heating and Cooling Network). This type of infrastructure utilises heat generated either from the combustion of fossil fuels (using electricity in the process) or from the use of renewable energy sources such as biomass or geothermal energy, then, through a network of thermally insulated pipes, distributes it to the different urban areas [104,127–131]. District Heating Networks can often integrate heat pumps into their heat distribution system [132]. This technology is increasingly preferred and implemented as a heat infrastructure, as it is safer, less polluting (in the case of using renewable energy sources), and produced locally (so there is no need to deploy interstate/intercontinental infrastructure) [104,130,131,133–135].

The development of the energy distribution network in the territory is mainly influenced by climate and geographical conditions, politics, national security reasons, and the availability of resources [136–138]. Furthermore, it is closely linked in a system of co-influence with both the type of urban installation and the distribution of the population over the territory (urban areas with high population density and small towns with low population density) [139,140]. While from the point of view of electricity distribution, the situation remains almost the same (the territories have similar electricity needs), and only the electricity source varies; the development of the heating infrastructure network varies as the climate varies [136,141,142].

In northern Europe, district heating networks (centralised heat distribution system for residential or commercial areas with an insulated pipe system), Combined Heat and Power (CHP), and Heat Pumps (HP) are mainly developed for heat in urban centres, while in low-populated areas (inland areas) heat pumps and pellets are normally used for heat production [133,143–157]. In central Europe, there is normally a centralised DHN system, with gas networks, heat pumps, and pellets alternating in varying proportions [133,143–157]. In southern Europe, instead, gas networks are normally used in urban areas, and heat pumps or pellet heating for inland areas [133,143–157].

1.4. Transports

Another aspect necessary for the proper functioning of cities and territories is mobility. Mobility refers to all movements of people and commodities between territories, and the term 'systemic mobility' refers to systematic displacements, while 'erratic mobility' refers to occasional displacements [158]. There are different types of mobility: maritime mobility, air mobility, and surface mobility (which includes both road vehicles—cars, buses, and trucks—and railways) [158].

While mobility originally used (and in many cases still uses) fossil fuels (mainly coal and oil) as an energy source, with the climate crisis and the awareness of the impact of non-renewable fuels on the environment, the concept of sustainable mobility began to develop [159,160].

Sustainable mobility refers to both the set of infrastructures and vehicles that enable the transport of people and goods in accordance with the principles of sustainable development (use of renewable energy sources and low environmental impact) and the set of solutions aimed at reducing the number of vehicles present (car-sharing, bike-sharing, etc.) [158].

Focusing on the development of infrastructure and vehicles in line with the principles of sustainability, the main solutions identified to date were the development of hybrid (in which part of the vehicle's power supply is petrol and part electric) and electric or hydrogen vehicles [160–162].

Currently, electric vehicles are the favoured solution for the development of sustainable mobility, as hybrid vehicles are regarded as a necessary transitional solution for the development of purely electric vehicles and, in any case, produce pollution [159,160,163]. While hydrogen vehicles are not widely used as production costs are very high, and it is not a technology that is developed on a large scale, it is still an underused solution [164].

The development of these technologies involves not only the implementation of the vehicles necessary for mobility but also the entire infrastructure system capable of ensuring the proper functioning of the vehicles.

If, before 2022, electric vehicles seemed to be the best solution for sustainable mobility, the war in Ukraine and the subsequent changes in global political dynamics have exacerbated an energy crisis that was not foreseen in previous scenarios. The introduction of this variable brought some uncertainty regarding the cost of mobility fuels and could be an opportunity to give hydrogen mobility new development possibilities.

It is the opinion of the authors of this paper that this new variable could open up two different scenarios:

- In the first case, the energy situation could return to the previous one, or a different balance could be found that would guarantee energy stability such that the pre-2022 energy outlook and fuel cost stability could be returned. In this case, the development outlook would favour the previous forecasts with a clear preference for electric vehicles.
- In the second case, the costs of electricity would continue to rise or fluctuate over a long period. In this scenario, the development of electric vehicles might not be the most favourable solution. Therefore, while this prospect would be a setback to the development of sustainable mobility, it could also serve as an incentive for research and development of alternative solutions using hydrogen and other sustainable fuels not yet thought of.

1.5. Advancement in Energy Solution—Toward Carbon Neutrality

With the aim of counteracting the climate crisis without altering the urban fabric of highly populated areas, various types of energy efficiency solutions have been implemented in recent decades, especially in Europe, first at the building scale and then shifting to the district scale [6,81,83,165]. The main solutions developed at the building scale are net Zero Energy Building (nZEB), Zero Energy Building (ZEB), Near Zero Energy Building (NZEB), Retrofit Energy Building (REB), and Positive Energy Building (PEB), while at the district scale, they are Net Zero Energy District (NZED), Zero Energy District (ZED), Smart Energy District (SED), Retrofit Energy District (RED) and Positive Energy District (PED) [166–170]. The district energy solutions were developed from the nZEB concept, and among those, PED is the most up-to-date and innovative in energy efficiency at the district level [168–171].

Positive Energy Districts are portions of territory with defined boundaries that meet their energy needs entirely through the production of energy from renewable energy sources (solar, wind, hydroelectric, biomass, geothermal, and Hydrogen) [172,173].

In the design of PED, to satisfy energy needs, it will be necessary to choose technologies that produce electricity and/or heat from renewable energy sources, allow it to be stored, and possibly promote the integration of E-Mobility [172–175]. To meet these needs, it is possible to integrate certain technologies into buildings, develop them on a district scale, or even relocate their production and (in the case of electricity) their storage outside the district boundaries [172,174–177].

Different levels of import-export with external energy networks and different choices of technologies to be implemented generate different typologies of Positive Energy District; the most common operating prototypes are three: Self-Sufficient PED, Dynamics PED, and Virtual PED [172,174,175,177,178].

Self-Sufficient PED (or Autonomous PED) is defined as a portion of territory with defined borders whose energy production from renewable sources fully meets domestic demand; the energy surplus can be exported and fed into the grid, but no form of energy import is allowed [172,177].

Dynamic PEDs are defined as a portion of territory with defined boundaries whose energy production from renewable sources fully meets domestic demand; energy import and export with energy infrastructure and other PEDs are allowed [172,177].

Virtual PED is defined as a portion of territory with defined boundaries whose energy production from renewable sources fully satisfies domestic demand; energy production and storage can be either internal to the district or external to it (produced virtually) [172,177].

The model of PED to be designed is normally influenced by the energy-infrastructure typology already present in the area, the objectives set, the urban fabric on which it is going to intervene, any historical-landscape constraints, the final function of the district (residential, commercial, mixed or other), geographic and climatic characteristics, availability of different renewable energy sources, political choices, and socio-economic fabric [172,174–177].

Although the use of different types of Positive Energy Districts in different areas of the city (onion model) was already theorized, neither a plan for the integration of PEDs (or other types of energy solutions) at an urban level nor a high level of integration (territorial/state) has come to the knowledge of the authors of this study so far [172,177]. This gap in planning is the setting for the formulation of the new theory proposed in this study under the name of territorial acupuncture.

1.6. New Urban Planning Approaches—Biourbanism

Given the set of world crises that humanity faces today and the demands that our ever-changing society imposes, human beings are faced with unprecedented challenges. For this reason, a collective awareness has opened up a season of great experimentation, the birth of new branches of research, new disciplines, and stylistic currents.

The birth and development of the discipline of Biourbanism are set in this context. Biourbanism is a term coined in 2010 by the newly founded 'International Society of Biourbanism' [76–78]. This urban planning discipline conceives the urban system (understood as a set of infrastructures, services, buildings, population, etc.) as a single organism [76,78]. In this discipline, the city is identified as the life-giving focus of social development. The urban organism, therefore, is a hyper-complex and interconnected system whose internal dynamics and those of its surroundings (territory) influence each other in a non-linear manner (meaning it cannot be predicted by analysing the individual parts) [76–78]. Therefore, it is necessary to carry out multidisciplinary and interconnected studies and/or analyses using a patecipatio-maieutical methodology [179]. This means through an intersubjective verification of the communication of well-being by the population and an objective one through experimental measurements of different types of indices [179].

The goals of Biourbanism include environmental improvement with respect to the human and ecosystem's natural needs, the management of the transition from an economy based on fossil energy to one based on a new organisational model of the city, and an organic organisation of physical and cultural factors in the urban reality [76–78,179]. This is why Biourbanism identifies cities as the core of the problem but also the answer to climate change. According to this discipline, action in cities and the resulting social alteration would lead to a radical improvement for both the population and the environment [76,78,179].

Among the solutions attributable to Biourbanism is urban acupuncture [180]. This concept takes the Eastern Chinese medicine practice of acupuncture and applies it to the urban scale. According to traditional Chinese medicine, through the stimulation of certain anatomical locations (acupuncture points or acupoints), with metal needles that can be manipulated manually or by means of electrical stimulation, imbalances in the energy flow (qi) through energy channels known as 'meridians' can be corrected and the individual's overall well-being improved [181].

Creating a parallelism with acupuncture, this practice proposes the insertion of art or architectural installations (acupuncture needles) in certain points of the city, such as streets or squares (acupoints), unlocking, in this way, various social and artistic dynamics and producing a participatory city pathway aimed at improving the real and perceived well-being of a given neighbourhood [180,182,183].

Hence, imperfect parallelism is established, whose principle remains but whose scale, aims, ambitions, and application methods change. Thus, this biourban theory combines sociology, urban design, and Eastern medical traditions, translating them into a design methodology that, by its nature, is flexible and organic and relieves stress and tension in the urban environment, redirecting the city to rediscover contact with nature. This will produce minor changes in the urban fabric but extensive ones on the social level [180,182,183].

2. Materials and Methods

The study and analyses required for the development of this new methodology are so complex that it is necessary to make an initial distinction between the organisation of the paper and that of the research itself. With regard to the paper, in the "Introduction" section, the entire literature review analysis is presented. In "Materials and Methods", is presented the organisation of the work, while in "Results", the analysis and formulation of the solutions identified are presented so as to highlight the interconnections between the various topics and to present the methodology of territorial acupuncture in detail. So, this study attempts to connect topics which, although related, are quite dissimilar. Therefore, due to the vastness of the individual topics covered, it was necessary to organise the work in phases and sub-phases. Thus, three main phases were identified, following those presented in the organisation of the paper: one of literature review, one of analysis, and one of formulation of the identified solutions. These phases, in turn, contain intermediate steps which allow the individual topics to be explored in greater depth.

The literature review step was the in-depth research and study of the issues addressed. As a multidisciplinary nature of this study, different topics were already addressed in the literature review phases. For this reason, the literature review was divided into main topics, which were then analysed separately. Specifically, three main topics were identified to be tackled: an overview of the problems of spatial and environmental management, an overview of Energy Communities, and one on the urban movement of Biourbanism in general and urban acupuncture in particular. These three strands of research serve to deepen the themes and analyse the strengths and weaknesses of the individual topics. In addition, it would be possible to understand how they are interconnected or how to interrelate them, to find possible gaps and eventually some solution.

The next step takes into account that the objective of this study is to change the energy, social, economic, and environmental dynamics of the territories in which we live and to contribute to the transition towards carbon neutrality. Therefore, the analysis phase was designed to elaborate on all the information obtained in the previous step. Through charts, lists, and catalogues, it was possible to frame the research, identify possible misalignments and think of potential solutions. Thus, it was possible to identify which were the limits of today's urban and territorial systems, which aspects should be implemented in energy communities, and which were the limits of urban acupuncture. Having identified the problem, it was possible to develop a suitable solution.

This identification and formulation step of the solution detected consists of two sub-steps. A first in which the solution identified in the study is theorised (the methodology of territorial acupuncture) and a second in which the needs are analysed, the functioning of the methodology is formulated, and the steps necessary for its operation are defined. This step represents the zenith of the research. In fact, it leads to the formulation of a new theory that connects different disciplines and allows, in the short term, the implementation of punctual district-scale change interventions with macro-consequences at the territorial scale. Figure 1 schematically shows the work phases implemented in the progress of the research presented in this study.

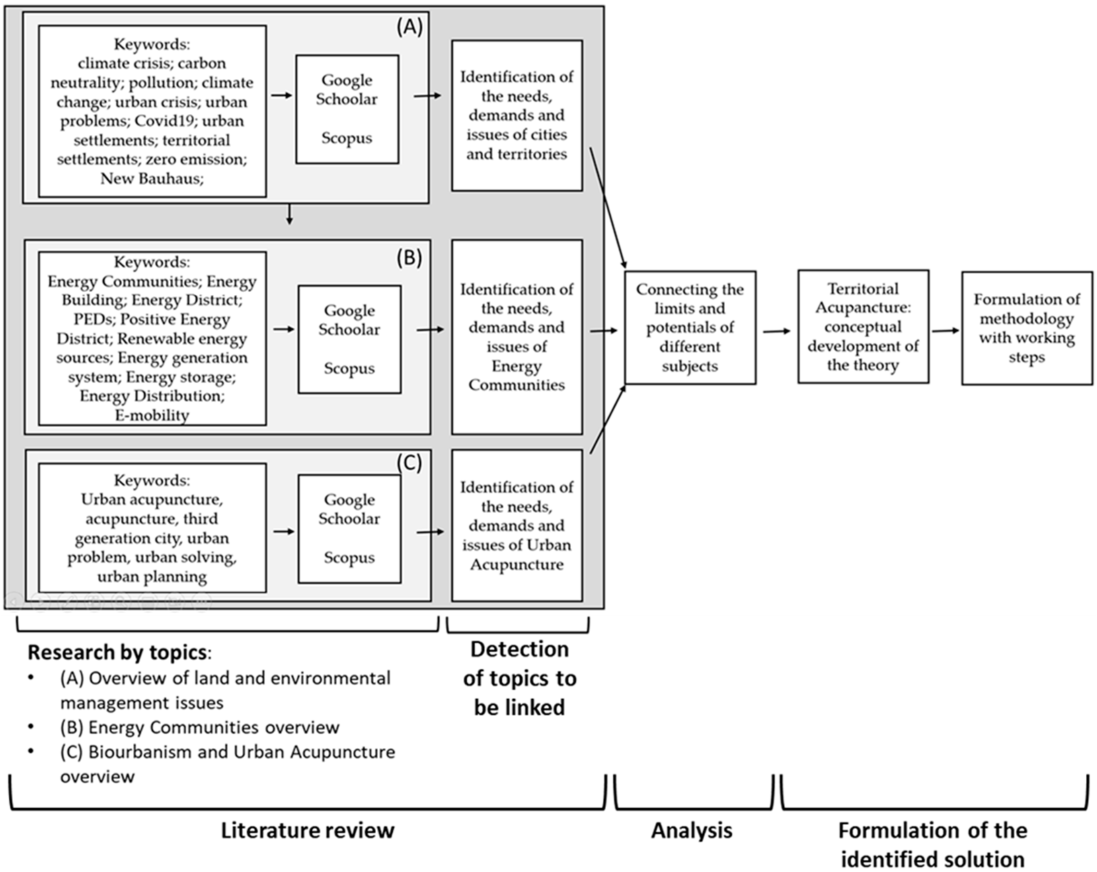

Figure 1. Methodology with which the study was carried out.

2.1. Literature Review Analysis

Given the extensive and diverse range of topics to be analysed for the proper analysis process of this study, it was necessary to carry out a literature review process involving different subjects. Due to the multidisciplinary nature of the study, sources dealing with even diametrically different topics were considered. For this reason, the literature sources are analysed in this section. In this way, it is possible to see how deeply each topic was investigated and influenced the research.

At first, an analysis was made of the macro-topics analysed. Then, a more detailed analysis was made of the different topics. Therefore, the bibliography was first divided into three macro topics: policies and environmental manner, energy, and urban and territorial planning. Figure 2 shows this analysis and the proportions between each macro-topic.

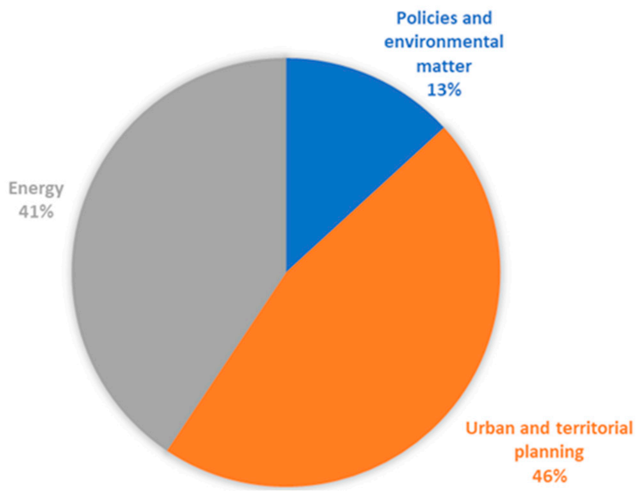

Figure 2. Literature review by macro-topics.

Then, the macro-areas of the investigation were divided into more detail. Specifically, the macro-area 'policies and environmental matter' was divided into the research topics 'national and supra-national policies' and 'environmental matter'. 'Urban and territorial planning' contains within it the following topics: spatial issues discovered in cities as a result of the SARS-CoV-2 pandemic and city planning issues based on the 'urban pole' system. Finally, the macro-topic 'energy' contains within it the following topics: the energy infrastructure system, energy communities, and electric mobility. Figure 3 shows the different topics investigated and the proportion between the various topics investigated.

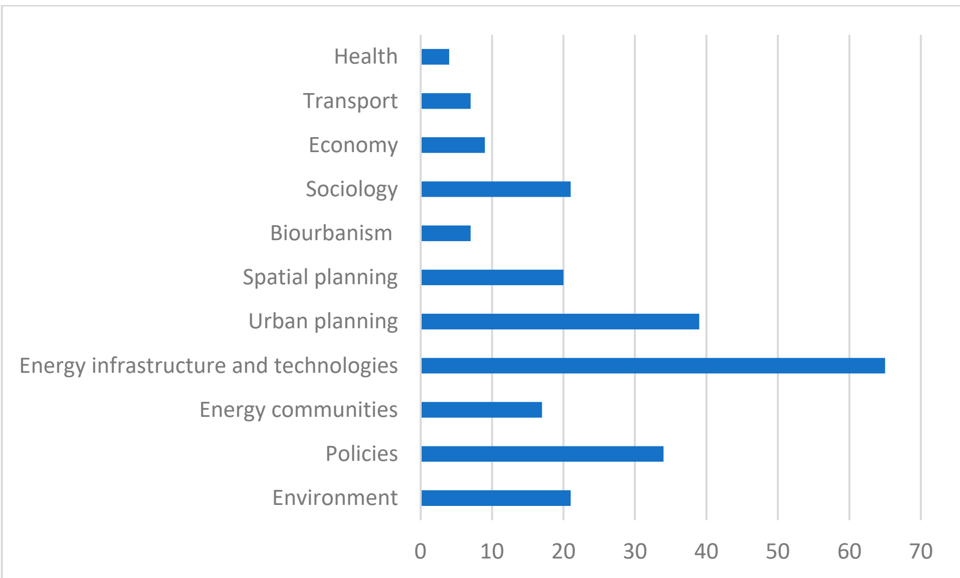

Figure 3. Proportion of the topics analysed to address the analysis required for this study.

Thus, through this paper, it was possible to explore issues such as the energy crisis, the climate crisis, and the crisis of the traditional urban layout (epidemiological issues, crisis of space modulation, inland area issues, and social city-related issues).

2.2. Analysis of Limits

As mentioned in the previous paragraphs, one of the fundamental steps in the definition and development of Territorial Acupuncture was the analysis of the issues investigated and the identification of the technological, implantation, and planning limitations in the various fields. Once the topics were identified, these were put into communication in order to identify the planning vacuum to which our study proposes a possible solution. The identification of these limits itself required an in-depth study in its own right. Firstly, the entire literature study was collected into three main macro-fields: climate crisis, urban/territorial planning, and energy. As shown in Figure 4, for each macro-category, the history and development, functioning, or causal factors were analysed. Subsequently, issues concerning the population and the environment were identified for each topic, and then the state of the art of technologies and planning methods were analysed. If state-of-the-art technology or planning met and/or correctly addressed the identified social and environmental needs, the explanation was inserted, and the research branch closed. When this was not the case, the topic was marked 'to be implemented'. Once this process was completed, the topics to be implemented were interconnected, and discussions began on how to do this. The solution identified was territorial acupuncture.

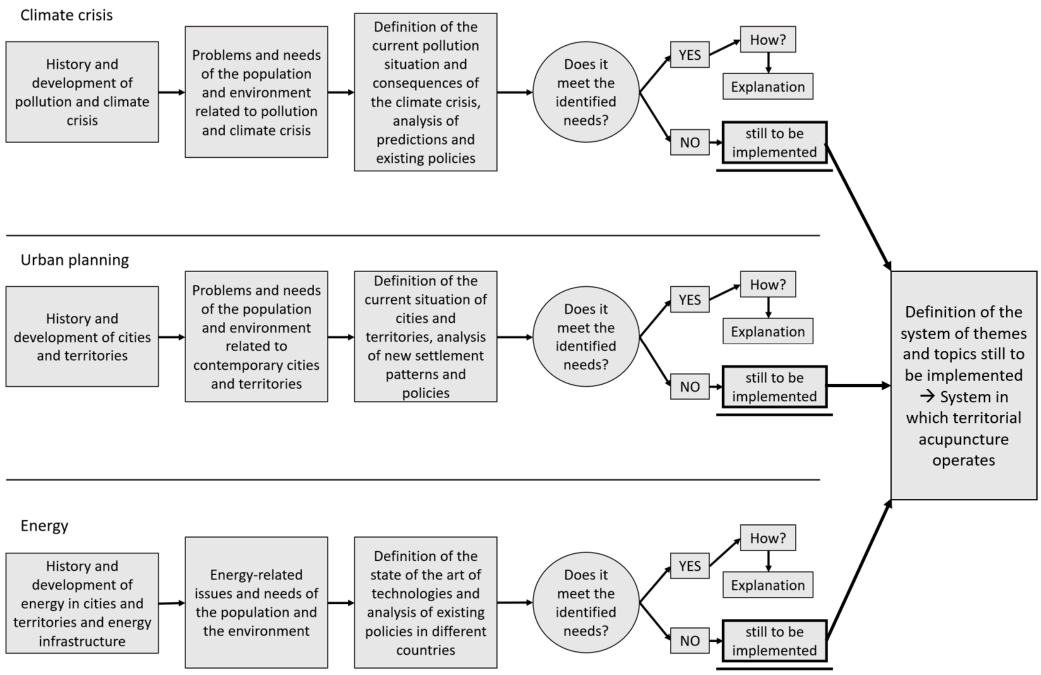

Figure 4. Outline of the study carried out to define the limits in the different macro-areas.

2.3. Formalising the Methodology

Another important aspect of this study was the process of developing and formalising the methodology. After defining the context to act within, it was necessary to specifically define the objective to be pursued. The objective identified was to propose a solution towards carbon neutrality in already highly populated territories that does not profoundly alter the territories and simultaneously helps to counter the dysfunctional dichotomy between large urban centres and small towns. For the definition of the concept, two diametrically different themes were used as a starting point: urban acupuncture and the design of energy districts. These themes were taken up, reworked, and put into communication to serve the new methodology to be developed. Having to define the functioning of this new methodology, the need was mutated from traditional urban and spatial planning practices to create a methodology based on the principles of multi-scalarity. To make the process more fluid and applicable, it was divided into phases. The result of this process was the new methodology of spatial acupuncture. Figure 5 shows the process by which territorial acupuncture was developed.

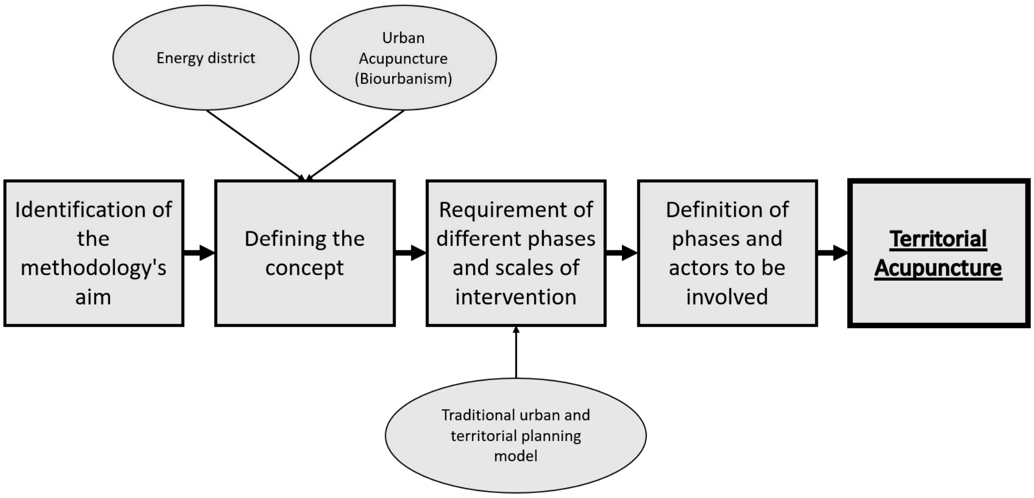

Figure 5. Process through which territorial acupuncture developed.

3. Results

Once all the information needed to carry out the study was gathered, the analysis of the data obtained was carried out. As a first step, a general analysis of the issues faced by humanity was conducted in order to see interconnections and interrelationships between the different themes.

For this reason, two major issues were identified: the climate crisis and the crisis of the urban-centric pole. These issues, although totally different, feed off each other. In addition, they cascade into a series of issues that arose or festered as a consequence of one or both of them. These crises that emerged in a subordinate manner to the first two are the energy crisis, the food crisis, the epidemiological crisis, social issues, and the space modulation crisis. Figure 6 shows the interconnection of the various issues.

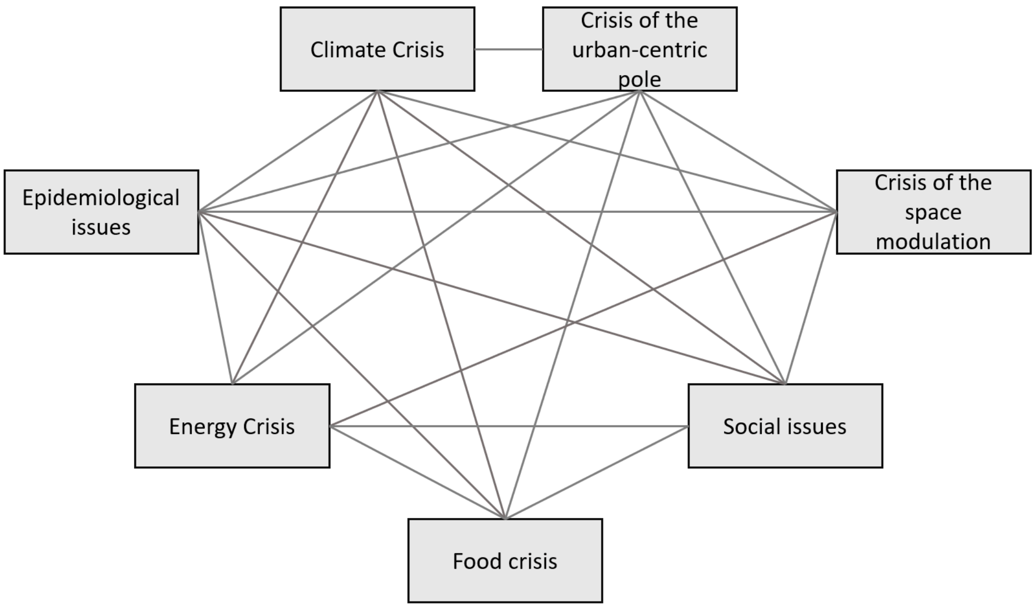

Figure 6. Interconnections of the challenges of our time.

Once the interrelationships between the various topics were analysed, the focus shifted to those issues that influence and are influenced by spatial and urban planning.

Indeed, as well as representing the place where to live and carry out everyday activities, it also represents one of the first sources that feed the vicious circle of problems we are experiencing.

3.1. Urban Analysis Results

Contemporary cities are characterised by the development of the settlement form of the metropolitan area. This type of urban structure provides for supra-municipal management of urban layout. It is characterised by progressive zoning with the development of multiple residential areas and centralisation of services. The development of these conurbation areas also has negative repercussions on the small urban centres, which gradually undergo a process of abandonment and depopulation (the problem of inland areas). Moreover, in environmental terms, too, this urban/territorial structure is unsustainable as they produce a significant amount of pollution.

In order to better understand how the urban structure influences not only the urban scale but also the territorial scale, an analysis was first carried out to compare the problems involving densely populated areas, such as metropolitan areas, and inland areas with low population density, such as urban archipelagos. Social aspects were taken into account and linked with related economic issues. In this way, it was possible to see how the traditional urban structure that favours large urban centres as attractive poles at the expense of smaller ones is a problem not only for subordinate areas but also for metropolitan areas. Table 1 shows precisely these relationships put together.

Table 1. Comparison of interrelationships between social and economic problems in metropolitan and inland areas.

Urban area		
Social Issues	Related economic issues	Ref.
Social decay	Small dwellings/apartments Compromises on housing choice for living close to the centre Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand Insufficient cubage per inhabitant Gentrification	[48,184–195]
Social injustice	Speculation in the real estate market High housing costs per square metre/in close proximity to the city centre and the service centre cost per square metre high Compromises on housing choice for living close to the centre Increased travel costs Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand Insufficient cubage per inhabitant Gentrification Health Issues	[48,159,160,162,184–188,192–205]
Micro-criminality	Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand	[192–195,200,206–208]

Table 1. *Cont.*

Micro-criminality	Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand	[192–195,200,206–208]
Organised crime	Poverty à too much offer compared to demand	[192–195,200,206–208]
Homelessness issue	Speculation in the real estate market Poverty à too much offer compared to demand	[192,194,195,197,209–212]
Zoning	Speculation in the real estate market High housing costs per square metre/in close proximity to the city centre and the service centre cost per square metre high Small dwellings/apartments Compromises on housing choice for living close to the centre Increased travel costs Need for a good public mobility service Insufficient cubage per inhabitant Gentrification	[48,159,160,162,184–188,192,193,195–197,201,205,213–217]
Loss of contact with nature	Insufficient cubage per inhabitant Health issues Population displacement in greenest areas	[218–222]
Poor quality of life	High housing costs per square metre/in close proximity to the city centre and the service centre cost per square metre high Small dwellings/apartments Compromises on housing choice for living close to the centre Increased travel costs Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand Insufficient cubage per inhabitant	[159,160,162,184,192–197,199,205,208,209]
Social differences	Compromises on housing choice for living close to the centre Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand Gentrification	[192–199,202,209,219]
Education disparity	Poverty à too much offer compared to demand	[223–225]
Marginalised areas in urban/sub-urban area	Speculation in the real estate market Small dwellings/apartments Increased travel costs Need for a good public mobility service Degraded neighbourhoods with little or no redevelopment investment Poverty à too much offer compared to demand Insufficient cubage per inhabitant Gentrification	[49,159,160,162,185,186,192,194–197,199,204,205,207,208,219,223,224]
 Inland/marginalised area		
Social Issues	Related Economic Issues	Ref.
The right to health is not ensured	Lack of funds for maintenance à deterioration of facilities and infrastructure Lack of funds for natural disaster prevention Lack of funds for healthcare	[56,57,69,161,226–239]

Table 1. *Cont.*

The right to territorial continuity is not ensured	Decreased transport services Lack of funds for maintenance à deterioration of facilities and infrastructure Lack of funds for natural disaster prevention	[56,57,69,161,226–238,240]
The right to work is not ensured	Decreased transport services Loss of building value Poverty à no demand	[56,57,69,161,226–238]
Abandonment of the territory	Decreased transport services Loss of building value Lack of funds for maintenance à deterioration of facilities and infrastructure Lack of funds for natural disaster prevention Lack of funds for healthcare Education funding cut Poverty à no demand	[56,57,69,161,226–238,241,242]
Ageing population	Education funding cut Health issues	[56,57,69,161,226–238]

Once it was understood how the urban structure typical of our century also affects both social and economic aspects on a territorial scale, an analysis was made of which solutions were the most frequently used.

Several solutions were proposed in the search for new solutions to modify the urban asset. The concept of smart cities (a proposal that closely links cities to new technologies) is among the best-known and most developed solutions. Closely related to smart cities, the development of digital twins, energy communities, and smart mobility emerge among the concepts. Therefore, energy communities (and consequently e-mobility) are part of this relationship with new, more efficient, and less polluting technologies.

At the same time, solutions with a social focus were developed, with attention to the services offered, the relationship with nature, and the psychophysical well-being of the population. To this current can be ascribed the theorisation of the 15-minute city, that of the eco-neighbourhoods, and the current of Biourbanism (with all its related theories).

In general, a progressive attempt is being made to propose solutions that integrate as many aspects as possible. However, the complexity of our time and the vastness of variables to be taken into account impose an ever-increasing sectorialisation. Additionally, as the complexity of the proposed solutions increases, so do the implementation times and the possibility of obtaining completely different territories. Above all, this last aspect is very problematic for cities or areas that cannot be altered due to their historical, artistic, or landscape relevance (for example, historical centres or areas subject to restrictions).

For this reason, a methodology that, through minimal and punctual interventions, would begin a rapid process of adaptation by favouring the integration of these changes for the population would be needed.

A structural and dynamic modification without excessive alteration of the infrastructure and layout of cities and territories. A modification of cities and territories with almost zero use of new land and with attention to the previous urban layout.

This solution, from our point of view, is territorial acupuncture.

3.2. Territorial Acupuncture

The territorial acupuncture methodology stems from the desire to propose a method for integrating energy district planning at an urban scale and at a high level of planning, thus bridging the gap identified in the previous paragraph. With the aim of contributing to the transition to carbon neutrality in already densely built-up areas, territorial acupuncture would like to change the existing dichotomy between urban centres and inland areas through the creation of networks of energy communities and eco-district on a territorial scale. This new methodology proposes a micro-invasive method to carry out punctual interventions at the district scale that succeed in modifying energy, socio-economic and environmental dynamics at the territorial scale. Thus, a methodology that, while acting locally, changes the territorial set for the better. A reorganisation, therefore, of the entire territory enhances areas that are little used or in a progressive state of abandonment, transforming them into attractors of cultural, energy, and social wealth.

Therefore, no major infrastructural changes are envisaged that would irreparably alter the appearance and urban and territorial layout of the application area. Combining the concepts of acupuncture and urban acupuncture with the design of district energy solutions, territorial acupuncture conceives of the entire territory (metropolitan areas, inland areas, natural areas, infrastructures, and population) as a single organism whose internal dynamics are so interconnected that by applying punctual interventions, acupoints, to specific areas, the entire organism-territory will benefit. Figure 7 shows where the concept of territorial acupuncture originated.

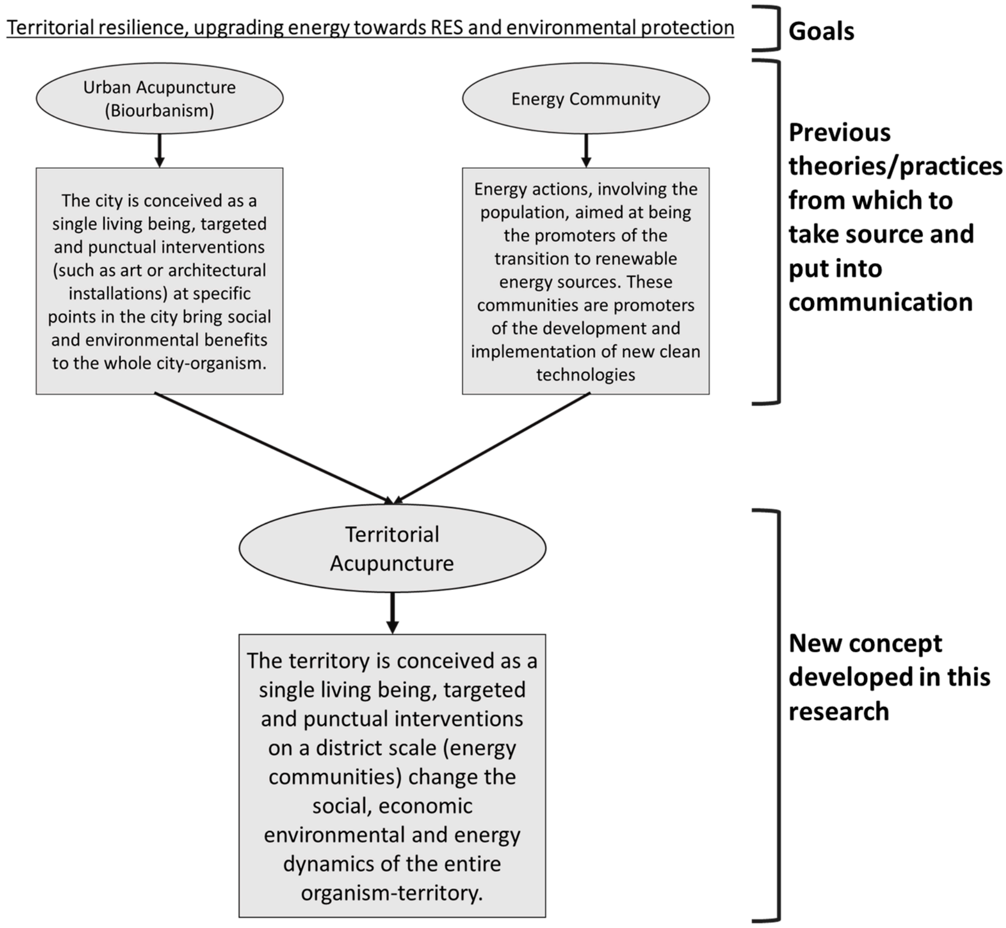

Figure 7. Presentation of the concept of territorial acupuncture and the previous theories and practices that are incorporated within the new methodology.

This methodology reshapes the holistic concepts of biourbanism with the scientific approach required for the design of energy districts solutions [76–78]. As urban acupuncture works by adopting the principles of traditional Chinese acupuncture medicine and applying and translating them into a new key by developing an urban theory proper to bio-urbanism, so territorial acupuncture takes the basic concepts of urban acupuncture and applies and declines them on a different scale and in a different way. The organism upon which to intervene (the scale of intervention) is no longer the city but the territory, and consequently, both the areas of intervention (acupoint) and the interventions themselves (acupoint needles) are now at a greater scale than that of the district. The ambitions also change, so while the common goal is to bring well-being to the city/territory organism, in urban acupuncture, the ambitions are strictly social and artistic; in territorial acupuncture, they are social-energy and environmental. Table 2 shows the three types of acupuncture in relation.

Table 2. Definition and differences in application of the three types of acupuncture.

	Definitions	**Scale**	**Application**	**Purpose**
Acupuncture	Eastern medical science, which conceives the human body not as a collection of blood vessels, organs, bone, and connective tissue but as one interdependent organism. It is theorized that the insertion of needles into specific points on the human body restore the circulation of QI (life force or energy) and its proper flow along the body's meridians, thus ensuring the health of the entire organism [181].			
Urban Acupuncture	Environmental urbanism theory, inspired by acupuncture, which conceives of the city not as a collection of streets, buildings, and equipment but as a single living organism. It is theorised that the punctual placement of artistic and architectural interventions would revitalise the entire organism city [180,183].			
Territorial Acupuncture	Spatial planning theory, inspired by urban acupuncture, which conceives the territory not as a collection of metropolitan areas, cities, inland areas, and infrastructure but as a single living organism. It is theorised that the punctual introduction of energy and eco-district interventions would revitalise the entire organism land.			

From a technical point of view, territorial acupuncture is a top-down approach that makes it possible to obtain a territorial map of the districts on which insert (as acupuncture needles) either energy communities or energy ground plants serving other districts. The choice between one solution or the other varies according to the area of intervention at the district scale (acupoint) on which it is operated. If, for example, in the intervention grid, an unbuilt area far from inhabited centres and in a state of abandonment is identified as an acupoint, it is more probable that the intervention solution in that specific point will be the implementation of an energy ground plant. If, instead, the acupoint under consideration is an already built-up and densely populated area, it is more plausible that the best intervention for that specific district will be an energy community. As far as these energy communities are concerned, all different district-scale solutions will be recommended, depending on the needs of the individual areas. However, the (state-of-the-art of energy community) Positive Energy District solution would seem to be the most effective and efficient of those currently available.

Hence, the aim of territorial acupuncture is to modify the socio-economic, energy, and environmental dynamics of an entire territory. The application of territorial acupuncture would thus make it possible to plan a transition from an energy and social system based on the attractive system of the urban pole powered by fossil fuels to a system of recoding and interaction of the different areas of the territory on a renewable energy basis. With the use of territorial acupuncture, it would not only be possible to plan the development of a network of energy districts in the territory over time, but it would also make it possible to plan a managed decrease in the energy voltage of the original power grid over time. Figure 8 shows some fields in which territorial acupuncture might bring advantages.

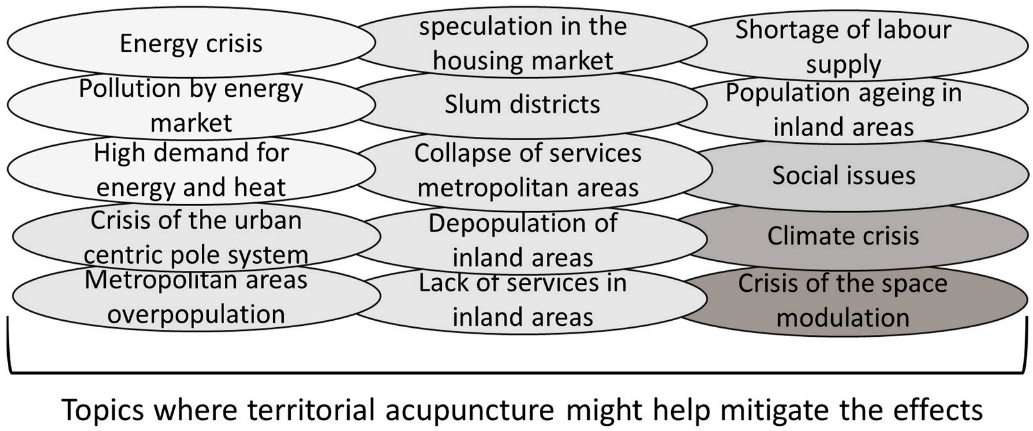

Figure 8. Summary of the benefits that a correct application of territorial acupuncture could bring.

3.3. Functioning of Territorial Acupuncture

In developing this methodology, it was decided not to take the industry into account. Indeed, the industry is a dynamic sector in itself. If, at a given historical and political moment, the interests of industry and cities (in the figures of the decision-makers) could meet and create partnerships for the production and distribution of residential energy, with even slight changes in these fragile balances (such as rising raw material costs or a generally unfavourable market) the interests could become misaligned. Thus, the energy supply system of cities would collapse. Under such conditions, alternative solutions for residential energy production would have to be found quickly, or entire territories would be left unprotected. These are the reasons why it is decided not to take this sector into account.

Territorial acupuncture is designed to allow a smooth transition towards a new concept of city and territory of the future. Indeed, profound change in urban and spatial planning is needed to succeed in ensuring a good quality of life for the population without distorting the previous asset.

This methodology brings together topics that would otherwise be difficult to communicate with each other in order to provide an overview of the entire territory. Its application requires taking into account the urban fabric, the population density of the different areas, the development history of the cities in the territory under consideration, the green plot, the blue plot, the energy infrastructure system, the availability of renewable energy sources, climate crisis adaptation policies, the distribution of services in the territory, the transport system, the demographic distribution of the population and the propensity of the inhabitants of a given territory for a change.

For this reason, the multi-scalar and multi-disciplinary methodology of territorial acupuncture is developed. This methodology works in stages that will allow, through different kinds of analyses, to identify the Acupoints (districts) on which to intervene and then interconnect them. Figure 9 shows the general functioning of the phases in the territorial acupuncture methodology.

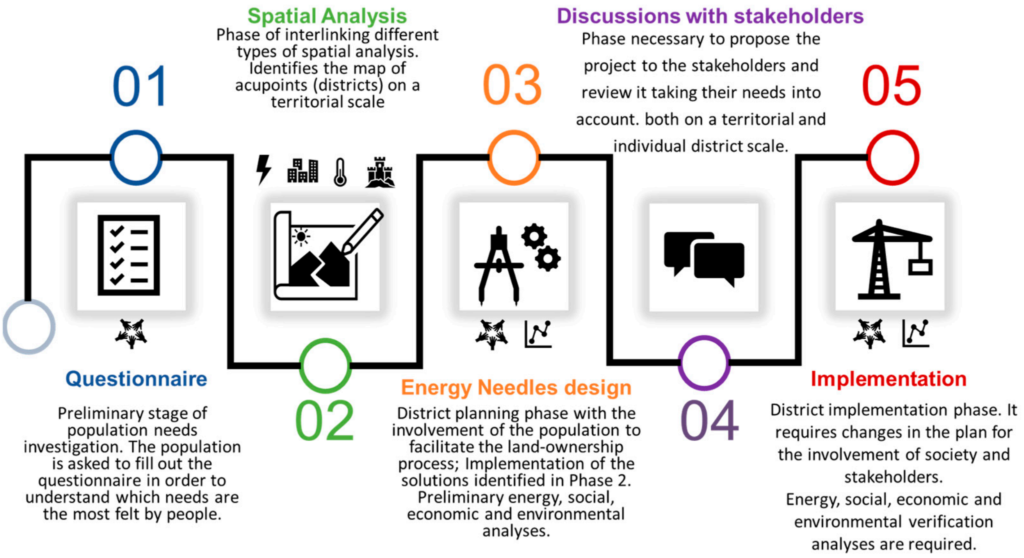

Figure 9. Functioning of the phases in territorial acupuncture.

It will therefore be necessary to carry out territorial, urban, economic, social, and energy analyses. Work will be carried out mainly at two scales, initially at the territorial and then at the district level. At various stages of implementation, it will be necessary to ensure the involvement of the population to enable a process of territorial appropriation by citizens [243].

Territorial acupuncture consists of a total of five stages. The first stage consists of a preliminary consultation of the population involved through the administration of a questionnaire to citizens. This phase is necessary in order to understand the main needs of the citizens and thus be able to integrate them into the subsequent project phases. The second phase involves multidisciplinary territorial analyses. This phase of the methodology's application is the one that makes it possible to have a map of the interventions on a territorial scale, to organise the work of modification and adaptation of the districts and, consequently, in the long term, of the entire territories. This type of analysis must take into account various aspects such as infrastructural, environmental, landscape, urban, and many others. In fact, the following analyses must be carried out:

- Energy analysis;
- Compound analyses;
- Infrastructure analysis;
- Study of isochrones (all settlements within a 45-min drive of the main attraction);
- Presence of historical and/or landscape constraints;
- Land value analysis;
- Analysis of equipment distribution in the territory;
- Analysis of the distribution of brownfield sites and ruins on the territory.

In this phase, these separate analyses are carried out and then put into communication either through the consultation of different experts or by superimposing the results obtained. This approach allows obtaining a map of the different application points (districts) on which to intervene. Consequently, both the specifications on the types of intervention to be applied in the individual district and the creation of a timetable for the work to be carried out can be defined.

The third phase is acupuncture needle design, and the focus shifts from the territorial to the district scale. As mentioned earlier, these districts can be either energy communities (preferably Positive Energy Districts) or areas serving energy communities (such as solar/wind ground plants). It is very important at this stage to concert the design of the areas with the needs of the population in order to develop a sense of belonging in the citizens and, above all, to avoid their subsequent abandonment of the areas. Another important aspect at this stage is the preliminary analyses and simulations to be carried out to calculate the district's energy needs, the amount of energy produced by the chosen technologies, and the general effectiveness of the choices made.

The fourth phase is dialogue with stakeholders, and it is necessary to agree on the actions to be taken at both the district and territorial scales. This phase, of verification of the choices and concertation of the plan, envisages slight modifications to the plan.

The fifth phase is the implementation and verification of the PED. In this phase, all the plants and facilities will be implemented. At the same time, verification analyses will be carried out to prove the effectiveness and efficiency of the solutions adopted. Finally, the PEDs will be connected in the time and manner planned during the spatial analysis phases (Step 1).

This leads to a multi-phase methodology with a hierarchical scale and top-down approach (with a small incursion of a bottom-up approach in the initial consultation phase). This methodology, modelled on the regulatory plans, includes a spatial management phase (phase 2) that manages the entire territory and subsequent phases giving the guidelines to be followed. In this phase, the map, the types of intervention, and the timetable for implementation are defined. The subsequent phases, on the other hand, are those that focus on individual districts. In these phases, it is possible to work in detail. Thus, while following the guidelines outlined in advance, it will be possible to go on to define the technological choices, and participatory processes, manage the implementation and site management phases, as well as plan the chrono-programmes to ensure proper maintenance of the sites. Figure 10 shows the hierarchical scale in the proposed methodology.

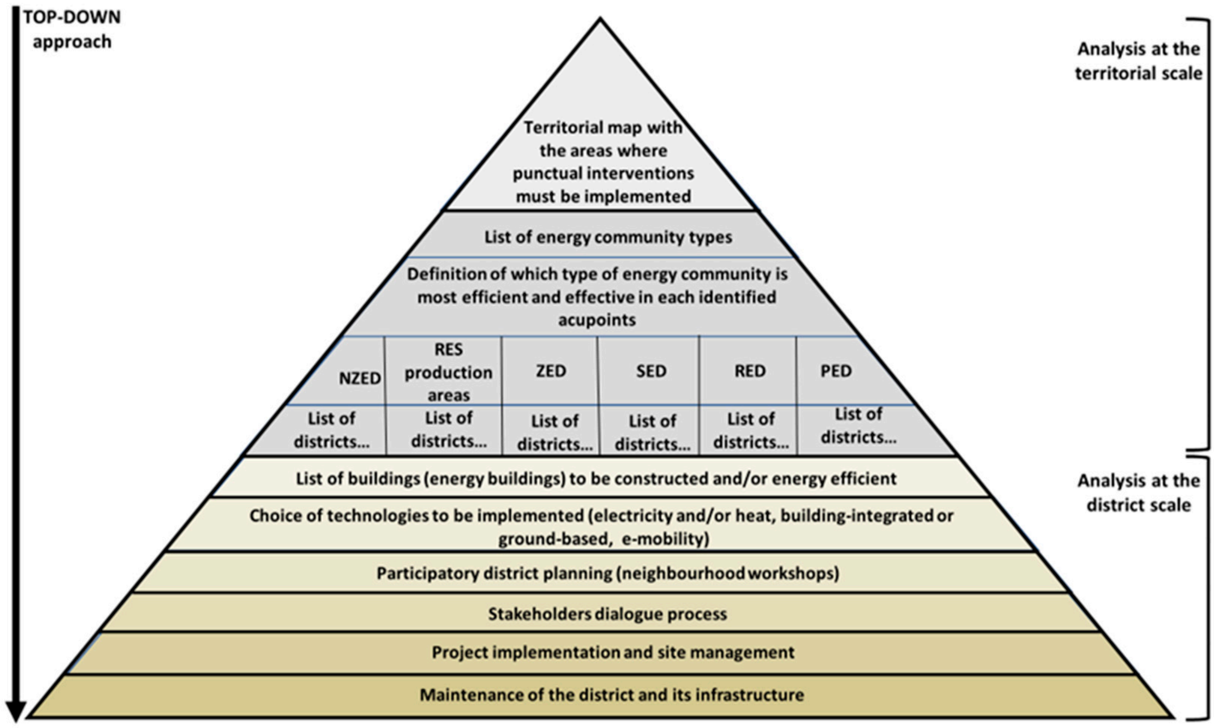

Figure 10. Hierarchical organisation of territorial acupuncture methodology.

4. Discussion

The crises affecting our world are interrelated. Action on a single effect, however necessary and useful, hardly takes into account the effects produced in other areas. This is true both when it comes to negative and beneficial aspects. However, given their close correlation, it would be necessary to devise targeted interventions that take into account all aspects that are to be influenced. Thus, starting from the correlations identified, it is possible to state that a single problem cannot be addressed without acting on the complex whole. In fact, taking care of one problem individually produces a domino effect that indirectly involves all the other problems as well. Therefore, instead of acting in a sectoral manner, creating unexpected and unmanaged consequences on other aspects, it is necessary to concert the entire complex whole through macro-scale system analysis.

This assertion is valid on a global scale in reference to all anthropicised fields; therefore, it is valid in reference to the territorial asset and urban layout system that characterises our time: the urban pole system. The spread of small urban centres was a valid solution for previous centuries, but with the advent of industrialisation and the consequent progressive globalisation, this system has shown its criticalities and limitations with reference to the needs of contemporary society. In fact, the progressive pouring of the population into these large centres of attraction has created an unsustainable dichotomy in the long run between large urban centres (metropolitan areas/megalopolises) and the small and medium-sized centres subordinate to the former, often referred to as inland areas. The definition of inland areas does not derive from a geographical location but from a distance from the services that large urban centres can offer. This type of problem today involves many countries and societies, especially in the West. Examples are the problems present in countries such as Italy, Spain, France, and Portugal.

The SARS-CoV-2 pandemic crisis (present since late 2019) has exacerbated these issues. The presence of a spatial crisis (at all scales) and a crisis of urban layout was evident. Thus, with this new awareness, which also reawakened previous ones, the process of researching and modifying urban and spatial layouts accelerated. If, on the one hand, new urban layout solutions were sought, reopening the debate on the utopian conformation of the city of the future, on the other hand, it was clear that adaptation solutions had to be found for existing centres in order to make them resilient to the challenges of contemporaneity.

Therefore, starting from the concept of retrofitting cities by making them resilient and the assumption that urban assets, energy, and infrastructure must be taken into account in a city, solutions were studied at both the territorial and urban scales. Among the most useful and innovative in this study were identified solutions related to energy communities and the theorisations related to Biourbanism (in particular urban acupuncture).

These highly valid theories, however, place the focus on specific topics that are limiting to the overall view. In fact, the solutions identified for energy communities have developed from the building scale and then evolved to the current scale: that of the district. This progressive increase in scale has meant that efficient solutions for the entire city or territory are not yet fully developed. Moreover, as the name suggests, the main focus is on energy. Therefore, all aspects that would be affected by the inclusion of these energy communities are often not explored.

Biourbanism, on the other hand, while taking a holistic view, often focuses on the social aspect and is less enthusiastic about more practical aspects such as infrastructure (mobility and energy). An example is urban acupuncture. This focuses on the social aspect (which was long left behind in urban planning) and furthermore encourages a process of re-appropriation of spaces by the population. However, while it unlocks social (and consequently economic) dynamics, it does not pay much attention to the infrastructural changes that social modifications and urban re-appropriation might require.

The authors of this study have therefore identified a gap between large-scale management of territories and solutions aimed at modifying cities from various points of view (social, energy, economic, etc.).

In order to be able to cope with the territorial modifications necessary to deal with all the new variables present in our contemporary world and to make territories resilient, it would be necessary to develop a solution that would give the maximum adaptation result with a minimal and rapidly implemented modification. For the authors of this study, the solution to this problem would be found in territorial acupuncture.

4.1. Reflections on Territorial Acupuncture

Territorial acupuncture is designed to contribute to the structural changes necessary to achieve Carbon Neutrality and, consequently, the mitigation of the climate, energy, and urban and territorial layout crisis.

Its application would provide a possible solution to enable a smooth transition to new territories and new modes of energy production.

In fact, this methodology is not conceived as the end point for finding energy and plant solutions but as one of the possible intermediate steps to be pursued to achieve the goals set by the UN and OECD bodies.

This theory, born and developed within this study, would make it possible to implement punctual interventions at the district scale, interconnect them and have in response changes in social, economic, energy, and environmental dynamics at the territorial scale.

Through the application of territorial acupuncture, it would be possible to create a territorial mapping of the punctual interventions, obtain a chronopogram of the interventions to be implemented, and customise the best solutions both for the individual district and for the entire functioning of the territory. Thus, in a densely populated area that is difficult to modify (such as a historic centre), solutions such as Virtual PEDs could be adopted. While in disused areas, energy production zones could be created to serve the entire territory. Another possibility, in urban archipelagos (inland areas), energy communities could be created that also serve as a service hub for neighbouring communities. Thus, this theory allows different solutions to be identified and customised for different realities while maintaining the validity of the process.

In our opinion, the highest priority in this historical period is to propose an efficient and effective solution for land modification so as to make them resilient without, however, increasing land use, which is why this theory is being developed.

Territorial acupuncture, in fact, does not intend to develop a different infrastructure system or expand pre-existing facilities but to adapt solutions to the local realities. The development of smart grids is not envisaged in the initial implementation phase of the methodology. Only in the event that territorial acupuncture is developed and applied on a large scale and implemented in different territories would it be possible to think about the development of a new phase for the creation of a smart grid. To give an example, at present, in the inland areas of southern Europe (areas where there is hardly any infrastructure for the production and distribution of heat), technologies will be installed at the district or building scale for the production and storage of heat.

On the other hand, in densely populated areas, the issue might be different. This means reorganising the electricity grid voltage of an entire area. In fact, energy production is currently calibrated to the current electricity demand of urban centres. The inclusion of energy communities within urbanised areas would create zones where the energy produced by the energy grid is no longer needed. Hence, the voltage of the entire grid would have to be rethought and recalibrated. It is the authors' opinion that this problem would be solved through phase 1 of the application of territorial acupuncture, that of spatial analysis and planning. In fact, this phase would result in an intervention plan to be implemented with the specifications of the types of intervention and the timetable for change. If well concerted, this phase would also make it possible to plan a gradual change in the voltage of the traditional electricity grid.

In conclusion, after studying the correlations between the various problems, the need for multi-scalar and multi-disciplinary coordination, and the study of the solutions proposed to date, the theory of territorial acupuncture represents, in our opinion, a valid proposal for a transition to the territories of the future. Indeed, it is the authors' opinion that it can ensure a rapid, orderly transition that takes into account all aspects affecting territories so as to predict what the effects will be in the various fields of action in both the short and long term. Territorial acupuncture, therefore, could be a new and valid proposal to facilitate the transition to carbon neutrality.

4.2. Future Perspectives of Territorial Acupuncture

A challenge that might be encountered during the application of territorial acupuncture is the lack (in the current state) of guidelines for design quality from the point of view of aesthetics and relationship to the environment. For this reason, in the planning and design phases of the district, we suggest that the objectives pursued in the design of eco-neighbourhoods should also be pursued [244]. These objectives and principles not only do not conflict with energy communities but, on the contrary, extend and complement them by providing a broader vision (which also takes into account the relationship between nature and art).

Furthermore, the way territorial acupuncture is currently conceived is referred to as being applied on a territorial scale, where territory refers to a system of regions, a region, or a portion thereof. Moreover, in the meantime, it has not yet been applied in any territory, thus maintaining a merely theoretical aspect. It would be desirable, therefore, if, in the future, this methodology were to break out of this academic-theoretical sphere and be applied in different territories and contexts (climatic, geographic, social, and urban layout). In this way, it would be possible to analyse different applications in various scenarios so as to understand which choices are always recurring and which are typical of specific settings. In this way, it would be possible to outline archetypal models of different contexts and suggest more efficiently and effectively the areas in which acupoints should be inserted, thus helping in the application through technological, settlement, or acupoint insertion suggestions.

5. Conclusions

In conclusion, our territories are facing an epochal crisis in the conception of traditional territorial and urban planning that is combined with climatic, environmental, food, energy, and space modulation crisis and social and epidemiological issues. This implies a rethinking of the territorial and urban structure that deeply undermines the foundations of the current vision of urban planning in order to allow cities and territories, and consequently the population, to adapt to the changes demanded by our century and the current contingencies. In an attempt to respond tout the court to a transition towards carbon neutrality that respects the principles of the new European Bauhaus, this study proposes a methodology that is not the end point but proposes a methodology for a smooth adaptation phase to develop a new concept of territory applicable to different realities. This solution is, according to this study, territorial acupuncture.

Thus, in this study, it was possible to:

- To delve into various topics related to the climatic-environmental and urban-planning crises and to create an overview that connects them. By revealing these dynamics and interconnections, it became even more evident how necessary it is to expand the processes of interdisciplinary concertation by increasing the holistic approach.
- Highlight that, at the moment, mitigation solutions proceed in parallel following two different and opposite approaches. While mitigation policies, by their very nature, proceed on a very large scale (supranational, national, and/or regional), practical and technological solutions have the opposite approach. In fact, in this case, the development of punctual solutions (such as individual mobility vehicles or energy efficiency in individual buildings) is followed by scaling up as progress is made. There is, therefore, a divergence of approaches that would take several years to converge.
- Develop the concept of a methodology that could be one of the possible solutions to help with the problems identified in the previous points: Territorial acupuncture. In fact, this methodology, with its network of punctual but diffuse interventions on a territorial scale, could guarantee a smooth but rapid transition towards carbon neutrality. Starting from the concepts of Biourbanism and urban acupuncture, territorial acupuncture envisages that the programmatic insertion of energy communities and service poles can change the environmental, social, economic, and energy dynamics of entire territories.

- Designing work steps useful for the correct functioning of the theory by progressing from the territorial to the district scale.

Hence, territorial acupuncture is designed to contribute to the structural changes necessary to achieve Carbon Neutrality and, consequently, the mitigation of the climate, energy, and urban and territorial layout crisis.

Nevertheless, this methodology is not conceived as the end point for finding energy and plant solutions but as one of the possible intermediate steps to be pursued to achieve the goals set by the UN and OECD bodies.

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