Smart Innovation, Systems and Technologies 178

Carmelina Bevilacqua
Francesco Calabrò
Lucia Della Spina *Editors*

New Metropolitan Perspectives

Knowledge Dynamics and Innovation-driven Policies Towards Urban and Regional Transition Volume 2

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Carmelina Bevilacqua · Francesco Calabrò ·
Lucia Della Spina
Editors

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Editors
Carmelina Bevilacqua
Mediterranea University of Reggio Calabria
Reggio Calabria, Reggio Calabria, Italy

Francesco Calabrò
Mediterranea University of Reggio Calabria
Reggio Calabria, Reggio Calabria, Italy

Lucia Della Spina
Mediterranea University of Reggio Calabria
Reggio Calabria, Reggio Calabria, Italy

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Preface

This volume contains the proceedings for the Fourth International "*NEW METROPOLITAN PERSPECTIVES. Knowledge Dynamics and Innovation-driven Policies Towards Urban and Regional Transition"*, scheduled from 26 to 28 May 2020, in Reggio Calabria, Italy.

The Symposium was jointly promoted by LaborEst (Evaluation and Economic Appraisal Lab) and CLUDs (Commercial Local Urban Districts Lab), laboratories of the PAU Department, *Mediterranea* University of Reggio Calabria, Italy, in partnership with a qualified international network of academic institution and scientific societies.

The fourth edition of "*NEW METROPOLITAN PERSPECTIVES*", like the previous ones, aimed to deepen those factors which contribute to increase cities and territories' attractiveness, with both theoretical studies and tangible applications.

When the call for papers of New Metropolitan Perspectives was launched in September 2019, no one could imagine that in a few months we would find ourselves suddenly catapulted into a totally unknown future. And the papers sent in January 2020, of course, could not in any way reflect the dynamics caused by the spread of COVID-19, the outlines of which will all be discovered and deepened in the coming years: it is still too early to fully understand the extent of these changes.

Today, we are still dealing with what appears to be a cataclysm of planetary proportions; it will take time to "historicise" events and interpret their profound meaning and long-term impact, through the multi-level observation—through the interpretation of macro-data and the in-depth investigation of the different realities involved—that the scientific community will be able to develop when the health emergency is over. At that point, the scenarios can begin to be configured with scientific rigour, which are beginning to be intuitively delineated in constant events. It will be possible to appreciate the permanent (real and perceived) effects on the daily life of communities, on the organisation of work and logistics chains and in the system of social relations.

At present, we can only hypothesise scenarios, more or less well founded.

The common thread that linked the different themes from the Symposium in its original conception was technology, in particular the effects produced on the settlement systems by the relationship between man and technology, in two different aspects: the progressive replacement of man with machines in practically all production processes and the spread of ICT.

The pandemic and the policies and practices put in place to contain the infection have brought this issue to the fore with arrogance. The replacement of physical interactions with "virtual" contacts has used consolidated technologies but has accentuated their pervasiveness, generating impacts of a different nature. The next few months will tell us how much of this acceleration will persist in our daily lives and how much it will be a transitory phenomenon.

Permanent changes are conceivable, for example, in the organisation of work, with the adoption of smart working as an ordinary way of carrying out the various tasks, also in areas where until a few months ago it seemed a distant future, such as in teaching.

And these changes will probably also affect other areas, just think of the use of culture, in a broad sense, as the many virtual opening initiatives of museums and sites of cultural interest have shown us in this period.

As well as central issues for democratic systems will be those related to the use of big data and their impact on individual freedoms: the ongoing debate on tracking movements and personal preferences is extremely topical.

However, the data that seems to emerge with greater force from the phase we are experiencing is the progressive loss of relevance of the location factor: the pandemic has made even more evident the fall of many barriers to the global dimension of relationships and exchanges. This change brings with it, as a consequence, a change also on the plane of centre–periphery dualism: what is centre and what is periphery, when the two terms no longer refer to accessibility to physical places but, for example, accessibility to goods and services and, ultimately, to knowledge? And how do you measure accessibility if you can no longer measure in metres or hours?

The other phenomenon on which it will be increasingly necessary to reflect in future is the speed of changes. As already underlined on the occasion of the past edition of the Symposium, while society evolves with accelerations impressed by endogenous and exogenous factors (such as the pandemic COVID-19), the physical dimension of space adapts with extended times.

At the dawn of the studies on the impacts of ICT on the city, the "wired city" studied by the research group of Corrado Beguinot was divided into a system of three cities: stone, relationships and experience. To harmonise the development times of the physical city with the "liquid" city of human relations is, after thirty years, still a priority.

So how will our cities and, more generally, the settlement systems on a planetary level record these changes? Will the trend towards population concentration persist in hyper-equipped and congested metropolitan areas or will we see reflux? New perspectives open up towards what are now considered peripheral areas (such as the inner areas so dear to our Master Edoardo Mollica), in which perhaps some

organisational processes are more easily managed and there are still values that could be appreciated by future generations?

The ethics of research, in the disciplinary sectors that the Symposium crosses, invites us to feed, with scientific rigour, policies and practices that make the territory more resilient and able to react effectively to events such as the pandemic that we are suffering in recent months: we hope to know the outcomes of these courses in the next editions of the New Metropolitan Perspectives Symposium.

For this edition, meanwhile, approximately 230 papers published allowed us to develop 6 macro-topics, about *"Knowledge Dynamics and Innovation-driven Policies Towards Urban and Regional Transition"* as follows:

1 - Inner and marginalised areas' local development to re-balance territorial inequalities
2 - Knowledge and innovation ecosystem for urban regeneration and resilience
3 - Metropolitan cities and territorial dynamics. Rules, governance, economy, society
4 - Green buildings, post-carbon city and ecosystem services
5 - Infrastructures and spatial information systems
6 - Cultural heritage: conservation, enhancement and management

And a special section, *Rhegion United Nations 2020–2030*, chaired by our colleague Stefano Aragona.

We are pleased that the International Symposium NMP, thanks to its interdisciplinary character, stimulated growing interests and approvals from the scientific community, at the national and international levels.

We would like to take this opportunity, together with Carmelina Bevilacqua and the CLUDs Lab team, to thank all who have contributed to the success of the Third International Symposium "NEW METROPOLITAN PERSPECTIVES. *Knowledge Dynamics and Innovation-driven Policies Towards Urban and Regional Transition*": authors, keynote speakers, session chairs, referees, the scientific committee and the scientific partners, participants, student volunteers and those ones that with different roles have contributed to the dissemination and the success of the Symposium; a special thank goes to the "Associazione ASTRI", particularly to Giuseppina Cassalia and Angela Viglianisi, together with Immacolata Lorè, Tiziana Meduri and Alessandro Rugolo, for technical and organisational support activities: without them, the Symposium could not have place; obviously, we would like to thank the academic representatives of the Mediterranea University of Reggio Calabria too: Rector Prof. Marcello Zimbone; responsible of internationalisation Prof. Francesco Morabito; and Chief of PAU Department Prof. Tommaso Manfredi.

Thank you very much for your support.

Last but not least, we would like to thank Springer for the support in the conference proceedings publication.

Francesco Calabrò
Lucia Della Spina

Cities and Regions Towards Transition

The fourth edition of the New Metropolitan Perspective Symposium took place in a period of global uncertainty that is calling into question the essence of the economic prosperity pursued in the last decades. It is recognised that what is urgently required is a policy shift from a primary push towards ever-increasing productivity and competitiveness goals to one that pursues a "renewed" concept of competitiveness —socially just and environmentally responsible—employing a reformed pan-economic approach. The continuing and progressive changes due to the systemic impact of shocks and stresses at the global level need a convergence of efforts by all countries. This is critical to balance the need to maintain economic prosperity generated by globalisation and to mitigate global crisis like climate change and the ongoing COVID-19 pandemic. The scenario that is emerging these days is similar to a post-war reconstruction economy, alongside climate change and the risks associated with it, the emergency of the pandemic has seriously questioned social stability at the urban level and the confluence of institutions in multi-level governance processes. Concurrently, the main question to be addressed can no longer be confined to how cities and regions can compete in a global context, but rather how they can survive in a world that must face the effects of continuous shocks by ensuring socially acceptable living conditions for everyone.

At European level, this need has been stimulating the debate for the revision of policies designed to build a better Europe for its citizens and a "restructuring process" of EU institutions in the light of anti-European, populist and sovereign political movements. These movements together with far-reaching global crises and shocks are threatening the future of EU and the Cohesion Policy grounded on the virtuous principle to reduce disparities by promoting social, economic and territorial cohesion. In response, the European Commission has recently introduced the European Green Deal, a set of policy initiatives to strive for a green transition based on solidarity and fairness. This marks a novel growth strategy that is comprehensive, ambitious and bold, integrating climate, environmental and social protection goals with economic ones. Such a transformative pathway helps set the stage for policy actions in the upcoming post-2020 programming period of the Cohesion

Policy. Arguably, these days the perspective of the EU mission will be redesigned, through new priorities and new tools launched for Shaping the Conference on the Future of Europe.

In this context, the debate on how to prepare EU territories and cities to address challenges of regional and global implications cannot be more relevant. The current development approaches need to be adjusted to formulate a new development pattern. Such a pattern is characterised by a more flexible approach in allocating investment, a more integrated approach to reach the goal of transition development and a more tailored, place-sensitive approach to regional development. It should facilitate a sustainable transition process towards transforming regional and urban socio-economic and technological systems. This process will be driven with an evolutionary approach in which knowledge and innovation dynamics can break path dependency and promote an effective regional diversification. This pattern should be underpinned by an integrated, multi-scalar and multidimensional approach aimed to enhance the resilience capacity of territories to respond to the various crises and shocks they are exposed to.

To substantiate these arguments, the Symposium was also part of the TREnD (Transition with Resilience for Evolutionary Economic Development) research project funded by the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska Curie Actions – RISE 2018. Considering the above-mentioned unparalleled yet controversial complexity while responding to the European call for the green transition, TREnD proposes a new approach in the design process of place-sensitive, innovation-oriented development policies that can facilitate the regional and urban transition to sustainability while reinforcing resilience to shocks induced by transition economies (e.g. post-carbon economy). TREnD's approach is focused on how to strengthen the regional capabilities to trigger, implement and manage transition strategies towards driving "resilience-building" processes. The scope is to combine Transition with Resilience for Evolutionary Development in different territorial contexts towards a reforming process of Cohesion Policy for the next programming period 2021–2027. The TREnD, therefore, seeks to: 1) identify and examine the factors enabling or hindering the transition strategies at a governance standpoint; 2) assess the territorial characteristics critical to enable a resilience-building process; and 3) unveil the unexploited potentials for "reshaping trajectories" disclosed through the windows of local opportunities due to the external shocks cities and regions are continuously exposed to.

TREnD highlights regional diversification seen more as a process of co-creation of solutions and concepts to solve development problems through the enhancement of the resilience capacity of regions, which can be achieved by implementing tailored placed-based innovation policies with a transitional approach. Stemming from the current debates on regional diversification together with the emerging role of the city in pursuing local innovation ecosystem, the aim is to explore new development policy configuration within the evolutionary framework to help different territories effectively respond to continuous shocks. It is expected to gain a sound understanding of the triggering mechanisms conducive to frame a more

inclusive S3 process for the post-2020 Cohesion Policy. This new framework, thanks to resilience-based process and transition management, will help define tailored S3 processes more sensitive to different regional contexts and needs. In so doing, it will reinforce innovation diffusion, facilitate diversification and tighten the linkages between advanced and peripheral areas (at regional and sub-regional levels) through more inclusive approaches.

Considering this vision, the Symposium tried to offer possible solutions to sustainable development as defined by the UN Agenda 2030, focusing on the complex and dynamic relationships between human society and technological development, and the latter's socio-economic, political, institutional and environmental impacts on territorial and urban systems. Indeed, investigating the nexus between the ever-changing societal needs and rapid technological development represents a valuable opportunity to achieve this ambitious goal. The desired shift towards a more sustainable knowledge-based economy and society since the beginning of the 2000s, especially in developed countries, is impeded by several challenges. In Europe, the Smart Specialisation Strategy (S3) represents the strong push to boost economic development through knowledge, research and innovation. The current academic and policymakers' debate is questioning its capacity to break down path dependencies and facilitate economic diversification. The difficulties in implementing and doubts about the effectiveness of this ambitious innovation-oriented policy—especially at regional level—suggest the need to revise the post-2020 Cohesion Policy and the approach beyond Regional Smart Specialisation Strategy (RIS3). Among the rising concerns, the controversial effect of innovation concentration on peripheral areas due to the new geography of knowledge is coming to the fore. The surging discontent shows how policymakers are struggling with continuous mutating scenarios characterised by more complex territorial dynamics. The pillar on which the current policy action seems to rest is represented by the potentials underlying knowledge complexity and innovation in reversing negative trends. However, recent studies have pointed out how such complexity is giving rise to inequalities in both core and lagging regions, making peripheral areas a common issue to tackle. More efforts are needed to address different aspects of inequalities connected with the new geography of knowledge. Therefore, a more inclusive and integrated approach is desirable to advance technological innovation while addressing social issues of health, environment, education and social exclusion.

Accordingly, the Symposium stimulated multidisciplinary discussions on the key elements of the debate on a shift in policy design and implementation, including transition management, resilience, diversification and quality of governance to leverage the potentials of peripheral areas and reshape the trajectory of economic growth for more equitable development. It aims to identify a new and balanced developed pattern, casting light on the multi-scalar and multidimensional analysis of different perspectives, strategies, tools, objectives and impacts of local economic development and innovation processes. Such a pattern needs to be framed within the United Nations 2030 Agenda (TS25) and to reach the Sustainable Development Goals (SDGs).

The sessions have been organised around key elements affecting vertically (multi-level) and horizontally (cross-sectoral and multidisciplinary) the social, economic, institutional, organisational and physical/environmental dimensions of local economic development. The themes of sessions followed the key elements of the debate on a shift in policy design and implementation to drive transition-oriented structural change of regions. This echoes the EU's desirable smart transition that requires an economically prosperous and socially inclusive transition process to promote regional convergence. Sessions TS04T1, TS04T2, TS04T3 and TS04T4 altogether build up the overall theoretical framework of a sustainable transitional development, offering insight into knowledge complexity, transition management, resilience, diversification and quality of governance to leverage the potentials of peripheral areas and reshape the trajectory of economic growth for more equitable development.

To achieve a smart transition, it is critical to reinforce the resilience of regions at different territorial scales, especially those expected to be more affected, to respond to the shocks that green and digital transitions are likely to trigger. In this regard, the Symposium undertook a multifaceted and multidimensional conceptualisation of resilience, for which sessions TS01, TS25 and TS26 investigated territorial system resilience, urban resilience and sustainability. Session TS07 looked into smart and resilient infrastructures, and sessions TS09 and TS23 investigated urban and built environment with sustainability and resilience. Sessions TS02, TS06, TS10 and TS21 pay close attention to territorial and urban regeneration. Urban and territorial regeneration is considered as a useful tool to facilitate territorial and urban resilience-building processes by promoting positive physical transformations and thereby increasing cities' preparedness and response capacity to crises and shocks. Sustainable urban and territorial regeneration needs to define new economic and territorial strategies within a period of financial constraints. Therefore, session TS21 casts light on the issue of circular regeneration, while session TS03 conducts a critical review of territorial dynamics and urban growth models.

The value-adding of local assets from the urban–rural perspective offers a chance to define alternative development patterns. In this respect, cultural heritage, as potential local assets, needs to be properly leveraged to drive sustainable local development. The Symposium, therefore, highlighted innovative approaches to heritage management. Session TS19 casted light on the enhancement of cultural heritage in fragile areas; session TS20 presents new management strategies for the value-adding of heritage in inner areas; session TS22 relates heritage management to climate change, exploring integrated conservation strategies based on traditional and innovative technologies able to help mitigate the negative effects of climate change. The Symposium equally gives insight into the urban transition towards a post-carbon society, a key element useful for the discussions on the new objectives of the post-2020 Cohesion Policy and new strategies and tools. Accordingly, session TS23 investigated an ecosystem services approach to the evaluation of settlement transformations; session TS12 was focused on green building related to post-carbon transition, and session TS30 furthers session TS12 and proposed eco-design-based strategies and approaches.

As in the past editions, this year's Symposium has received generous support from and will see the participation of a high-quality international network of higher academic institutions and scientific societies. Therefore, it will undoubtedly serve as an important occasion for exchanging and disseminating research findings and stimulating a fruitful debate on global challenges among academics and policy-makers. All in all, the Symposium and the contributions to its different sessions contributed to deepening the discussions on a transition-oriented approach—on which the TREnD project is grounded—while offering insights into how to fill the existing gaps.

Carmelina Bevilacqua

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Environmental Health Valuation Through Real Estate Prices

Francesca Salvo[1], Pierluigi Morano[2], Manuela De Ruggiero[1(✉)], and Francesco Tajani[3]

[1] Department of Environmental Engineering, University of Calabria, Rende, CS, Italy
francesca.salvo@unical.it,
manueladeruggiero@gmail.com
[2] Department of Civil Engineering Science and Architecture, Polytechnic University of Bari, Bari, Italy
pierluigi.morano@poliba.it
[3] Department of Architecture and Design, Sapienza University of Rome, Rome, Italy
francesco.tajani@uniromal.it

Abstract. Environmental health studies are a really central topic in the debate about territorial development.

Territorial transformation was sometimes characterized by interesting phenomena of enhancement and requalification, sometimes by speculative tensions inattentive to the quality of life systems and to the sustainability of processes by territory itself.

This kind of attitude has often caused an environmental health decay and a significant decrease in human quality life.

The main obstacle to the possibility of orienting the transformation initiatives of the territory in the perspective of sustainability is to be found in the scarce ability to understand the intrinsic economic value that these operations incorporate. We are now used to thinking exclusively in terms of market and income, so territorial interventions are almost guided exclusively by economic evaluations of and speculative ones.

In a transdisciplinary perspective, the appraisal analysis can provide an important interpretation key in the analysis of territorial dynamics, intended to guide urban development policies in the logic of sustainability.

This paper intends to study some environmental feedbacks in coastal areas and to demonstrate how real estate prices can be used as a marker of environmental health, examining relationships between real estate prices and environmental variables through the use of the Hedonic Model.

The hypothesis has been validated by the application of the proposed methodology to a case study in Fuscaldo, in the south of Italy.

The results show a correlation between environmental health and real estate prices, proving that an excessive urbanization and a poor attention to environmental issues lead to a decrease in human quality life.

Keywords: Quality of life · Quantity of life · Real estate prices

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1 Introduction

The territorial development and its transformation were sometimes characterized by interesting phenomena of valorization and requalification, sometimes by speculative tensions inattentive to the quality of life systems and the sustainability of processes by territory itself. This is testified by the great attention paid to the issue of soil consumption, which despite the slowdown in recent years, continues to grow, causing the decline of ecological and environmental potential [1].

The direct consequence is the loss of resources, functions and ecosystem services. And this both in urban areas and in more peripheral and natural ones, including those intended for tourist use.

The main obstacle to the possibility to orientate the transformation initiatives towards the perspective of sustainability is to be found in the scarce ability to understand the intrinsic economic value that these operations embody. We are now used to think exclusively in terms of market and income, therefore territorial interventions are almost guided exclusively by economic.

In order to let the *Anthropocene homo* acquire full awareness regarding the importance of the environmental and ecological functions of tangible and intangible assets, it is essential to provide him with quantitative tools and indicators regarding the economic value of environmental resources. It therefore seems essential to quantitatively prove that including environmental valuation in the decision-making produces important benefits, also economic ones; the assessment of the so-called intangible resources can guarantee the community a saving if not an overall gain, which is a real economic savings, quantifiable in monetary terms.

The aim of this paper is to demonstrate how an appraisal analysis of the real estate prices and of the related variables can help monitoring environmental health and quality of life, offering tools able to help territorial governance in managing territorial interventions.

2 Background Research

We well know that the development of the territory, which involves the production of goods and services to satisfy people's desires and needs, must be intended to improve the quality of human life, intended as a state of well-being in a condition of environmental health.

When defining the concept of human quality life, the importance of the environmental context is recalled. It's central the idea that human well-being has to be intended not only by a social, economic and educational point of view [2, 3], but also according to relationship between men and their everyday urban environment in terms of air and water quality, housing quality, crowding level, urban congestion, population density, etc. [4]. This means that in planning territorial interventions it should always be kept in mind that the environmental system should be able to support, but above all to endure, all human activities related to social and economic development, without its delicate balance being troubled [5].

An essential condition for this to happen is that the production of goods and services must not exceed what Nijcamp defines as critical levels [6]. Sometimes it's used to talk about "carrying capacity", such as that impassable limit beyond which the further production of goods and services, rather than causing a further increase in well-being, produces a reversal of trend and therefore a decline in human quality life [7–10].

The proper planning of landscape territory, which we could define as progress, should therefore be achieved as an effective sum of goods and services (which we could define as Quantity of Life) and well-being (which we could define as Quality of Life).

However, this sum of contributions has not always been effective, because the rapid and often disorganized transformation of the landscape, which has often been characterized by an indiscriminate use of land for building purposes, albeit intended for the production of goods and services, has exceeded the critical limits of environmental sustainability.

While Quantity of Life increases linearly with the production of goods and services, such as construction of buildings, efficient communication routes, availability of support services, etc. The Quality of Life has a different trend so that, after an initial increase, it begins to decrease when the re-called critical levels are crossed.

Qualitative plotting the trend of the progress components, i.e. Quantity of Life Q_NL and Quality of Life Q_LL_D, we could note that while the first one could be represented by a growing straight line, the second one would be represented by a bell-shaped line, differing from the desirable trend Q_LL [11] (Fig. 1).

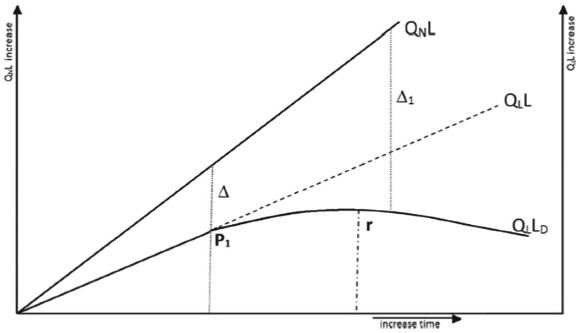

Fig. 1. Human Quality Life evolution in urbanized area [11]

The delta differential between Q_NL and Q_LL_D increases over time, until the growth of Q_LL_D is no longer proportional to time, and then it begins to decrease. Point P_1 represents the excess of environmental use, when negative territorial feedbacks begin to show up. Finally, the inversion point r indicates the threshold for exceeding environmental resilience, so that the quality of life, in correspondence with a further increase in the production of goods and services, rather than increasing further, begins to decrease.

A study aimed at assessing the quality of life, and in particular at analyzing environmental variables, recalls for the need to find suitable methods for assessing

intangible resources, attributable to services and ecosystem functions. Ecosystem function is the ability of natural processes and components to provide goods and services that meet, directly or indirectly, human needs and guarantee the life of all species [12].

As recalled by the Millennium Ecosystem Service (2005), the importance of ecosystem functions in supporting, regulating, provisioning and cultural consulting activities cannot be neglected in the management and territorial planning decisions, in order to create an effective and healthy environment at the same time.

Ecosystem services, and more generally environmental components, therefore have a value, which is a real economic value. The appraisal of environmental assets is controversial and subject to not always explicit evaluations.

The evaluation of eco-systemic services refers to ecological and cultural values [13, 14] and, more generally, is based on the assessment of the total economic value [15], defined as the sum of the value of all the fluxes of the services that the natural capital generates, suitably updated. There are many values that need to be considered in the economic assessment of the eco-systemic services: use value, related to the utility provided by consumers; option value, related to the will to assure a service in future; existence value, related to the possibility of preserving a service from its destruction; legacy value, that refers to the possibility of using a certain service for future generations.

A general analysis of copious literature reveals that over time there have been numerous proposals for assessing quality. In principle, the evaluation of the qualitative values of a resource, be it historical, monumental, artistic, environmental or religious, can be carried out according to two fundamental approaches: the economic approach and the extra-economic approach [16].

The economic approach expresses the value of resources in terms of willingness to pay and market price and takes place in a context that considers real demand and supply.

The economic approach for the evaluation of the qualitative values of the architectural-environmental and cultural resources is essentially based on three quantitative procedures aimed at estimating the willingness to pay and the market price. This approach carries out monetary measures of qualitative values

These procedures for evaluating environmental resources are: the hedonic price method (HPM), the travel cost method (TVM), the contingent valuation method (CVM). The first two procedures analyze the revealed preferences with the consumption of private goods complementary to the use of the qualitative resource [17, 18], the third procedure instead examines the preferences expressed (stated preferences) in a specially built virtual market [19, 20].

The extra-economic approach is independent of this real context and expresses the value through the analysis of the individual attributes. This approach finds its starting point in the theory of multi-attribute utility. This theory, which is the basis of multi-criteria analyzes, is closely connected to the processes of choice and starts from the general idea that in decisions what tends to maximize is not only economic utility but also a set of other elements or criteria. This approach developed for the first time by Lancaster [21] and then by Zeleny [22], Keeney and Raiffa [23], approaches the real way of reasoning and evaluating, when make choices by each individual. In the

selection processes, the multicriteria analysis relates in particular to the evaluation aimed at planning. The assessment procedures based on multi-criteria analysis are able to simultaneously take into account several objectives and consequently several judgment criteria, without necessarily providing for monetary quantification.

3 Methodology

As we know, improvement or worsening of environmental health conditions can determine increasing or reduction in the real estate values [24].

The hypothesis of this work is that environmental health trend monitoring is possible thanks to a transdisciplinary analysis, and in particular by making an appraisal analysis based on the application of the Hedonic Model [25–27]. Hedonic Model identifies price factors according to the premise that price is determined both by internal characteristics of the asset being sold and external factors affecting it. A hedonic pricing model is often used to estimate quantitative values for environmental or ecosystem services that directly affect market prices for homes, isolating with multivariate regression techniques the contribution that the interest attribute makes to the observed price. These traits can also be the so-called intangible resources, such as ecosystem resources and services.

The model is able to quantitatively evaluate the differentials of value, positive or negative ones, related to the conditions of improvement or worsening of the environmental conditions.

Many studies have been drawn in order to test the Hedonic Model in environmental analysis. Garrod and Willies have used the hedonic price model to appraise the incidence of environmental attributes [28], while Powe *et al*. have analyzed the value of urban amenities [29]. Other studies have been conducted to valuate the contribution of green spaces [24, 30, 31] and air quality [32].

The idea is that the property price is a quantitative indicator of environmental health, and that, although it isn't itself corresponding to the quality of life, it can still represent its progress. In fact, price is the result of the way sector operators evaluate the conditions of quality and well-being attributable to the use of the property.

In more technical terms, the hypothesis is plausible because property price depends on a multiplicity of conditions and characteristics, the so-called real estate characteristics, among which the most significant is the location – territorial - environmental component, understood as the set of boundary conditions within which the property falls (in terms of services, accessibility, pollution, etc.).

The hedonic method, as we said, is based on the use of multiple regression techniques, i.e. techniques used to analyze a series of data consisting of a dependent variable and one or more independent variables. The aim is to estimate a possible functional relationship existing between the dependent variable and the independent ones.

In this analysis, the dependent variable is the price, the independent variables are the real estate characteristics and the relationship coefficients are the hedonic prices, which represent the positive and negative value differentials attributable to the presence/absence/amount of characteristics and conditions:

$$p = b_0 + \sum_{i=1}^{n} p_i \cdot x_i, \tag{1}$$

where b_0 means the location factor, x_i are the amounts of the considered variables and p_i the correspondent hedonic prices.

More interesting and more useful here to see the application of the model to the case study.

4 Case Study

The methodology has been tested on a case study, Fuscaldo municipality, in the Province of Cosenza (Italy).

Fuscaldo is a tourist town on the sea, located on the Tyrrhenian coast of Calabria, quite next to the province municipality of Cosenza.

It is a very popular tourist town. Since the 70s, it has seen a great urban expansion, characterized by the spread of tourist resorts and properties intended for residential tourism. The strong expansion has led Fuscaldo to become practically contiguous to the municipality of Paola, an important urban area for its central location in the national railway system, modifying its own connotation and becoming also a residential suburb.

The working method was set in two distinct phases, the first intended to collect data, and then to acquire the observations, the second concretely oriented towards the application of the hedonic regression model and the interpretation of the results.

We have acquired 65 sales data belonging to the residential property market segment, for a period between 1973 and 2014 (Source: Database of Observatory of Real Estate Market - Department of Environmental Engineering - University of Calabria).

For each data, the following real estate characteristics were noted:

- Sale date (DAT), measured in years;
- Number of restrooms (SER), measured in n°;
- Floor level (LIV), measured in n°;
- Distance from the sea (DIS), measured in meters;
- Urbanization level (URB), measured by score;
- Shoreline variation (SHORE), measured by score;
- Protection systems (PROT), measured by score.

Urbanization level (URB), shoreline variation (SHORE), protection systems (PROT), are measured by a score assigned through a quantitative judgment based on objectively detectable conditions and their corresponding scale level, as reported in Table 1.

On the basis of the considered variables, the regression equation may be written as:

$$\begin{aligned} p = & b_0 + p_{DAT} \cdot x_{DAT} + p_{SER} \cdot x_{SER} + p_{LIV} \cdot x_{LIV} + p_{DIS} \cdot x_{DIS} + p_{URB} \cdot x_{URB} \\ & + p_{SHORE} \cdot x_{SHORE} + p_{PROT} \cdot x_{PROT} \end{aligned} \tag{2}$$

Sample statistics are shown in Table 2.

Table 1. Nomenclators table

URB (score)	Percentage change	SHORE (score)	Nourishment/Erosion	PROT (score)	Presence/absence
0	<10%	−1	Erosion	0	None
1	10% ÷ 25%	1	Nourishment	1	Punctual interventions
2	25% ÷ 50%			2	Widspread interventions
3	>50%				

Table 2. Sample statistics

Price and Characteristics	Min	Max	Average	Frequency	Std. Dev.
Total Price [€]	12,000.00	80,000.00	46,777.78	–	27,761.38
Average price [€/sqm]	101.69	775.19	594.33	–	272.99
Surface [sqm]	97.40	118	102.24	–	6.57
Restrooms [n°, 1-2-3]	1	2	–	38-24-3	–
Floor Level [n°, 1,2,3]	1	3	–	31-29-5	–
Sea Distance [mt]	5.00	870.00	365.00	–	215.31
Urbanization level [0-1-2-3]	1	3	–	0-16-28-21	–
Shoreline variation [−1, 1]	−1	1	–	43-22	–
Protection system [0,1,2]	0	2	–	39-24-12	–

Data about urbanization, evolution of the coast line and existence of coastal protection systems have been acquired by carrying out a diachronic mapping of the case study area with appropriate cartography, using topographical maps such as those of the IGM institute, and uploading them into geographic information systems to evaluate their evolution and changes over time.

The application of the hedonic model allows us to build the appraisal function, and therefore to link the unit price to the real estate characteristics.

Regression coefficients are shown in Table 3.

Table 3. Regression coefficients

b $(\frac{€}{sqm})$	**DAT** $(\frac{€}{sqm \cdot year})$	**SER** $(\frac{€}{sqm \cdot n°})$	**LIV** $(\frac{€}{sqm \cdot n°})$	**DIS** $(\frac{€}{sqm \cdot mt})$	**URB** $(\frac{€}{sqm \cdot score})$	**SHORE** $(\frac{€}{sqm \cdot score})$	**PROT** $(\frac{€}{sqm \cdot score})$
615.23	–7.43	123.76	2.41	–1.65	–2.7	7.17	6.81

In particular, the intercept equal to 615.23 (€/sqm) represents the average unitary price in 2014; the other coefficients represent the hedonic prices of the other characteristics. The correlation coefficients R^2 shows an appreciable ability to reproduce original data, being equal to 0.89.

The change in the amount of features determines a change in the price, so that it is possible to reconnect the value of the properties to the surrounding conditions, but also to monitor, thanks to the presence of the time variable, the trend of prices over time, also attributing it to externalities, through the price index numbers.

5 Results

Analyzing regression coefficients lead us to note that coastal erosion and urbanization level can be considered as negative feedbacks while the presence of shoreline protection can be interpreted as a positive one.

The negative condition of the environmental health state seems to affect the evolution of real estate prices, producing a decrease.

The result obtained by the application of the appraisal function enables to build the value of the average unitary price for each year and to reconstruct the corresponding index numbers, as reported in Fig. 2.

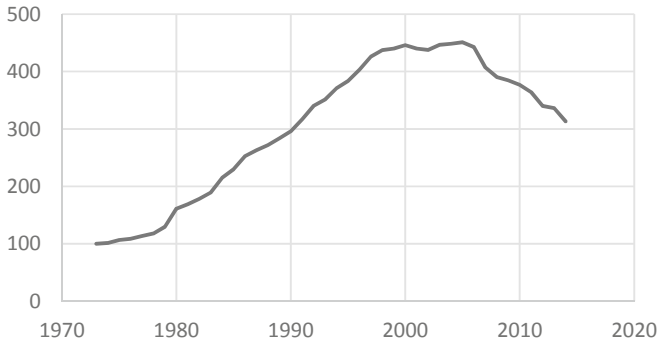

Fig. 2. Trend of index numbers

Once the historical series of market price has been built, it is possible to graphically display its trend, characterized by an almost bell-shaped line.

We can note an upward gradient until 2000, with a revaluation of about 345%. In the following years, from 2001 to 2005, market values appear fluctuating, while it follows an important decrease in real estate prices. The decrease in the real estate values is relatable to urban expansion, which against show a progressive increase.

Comparing Fig. 1 and Fig. 2, we could notice the correspondence between the trend of the index numbers and that of the quality of life, and between urbanization and the quantity of life.

This condition led us to prove that, almost for this case study, real estate prices could be used for a quantitative assessment of environmental health state and, at the same time, for a valuation of the human wellbeing.

6 Conclusion

The main obstacle to the possibility to orientate urban development towards protection of environmental health can be detected in the lack of comprehension of the intrinsic economic value that ecosistemic functions and services have. Nowadays, we are used to think exclusively in terms of market and real estate income, therefore urban transformations are guided only by economic assessments that fulfil these aspects.

This study has intended to show how an inconsistent landscape urbanization and a poor attention to environmental issues can produce significant damage, also in economic terms.

The multidisciplinary study has enabled to reconstruct the evolutionary trend of property prices and environmental variables and to detect the relationships between the respective changes over time.

Data analysis has enabled to recognize an inversely proportional behavior between the growing urban development of the examined coastal area and the morphological evolution of its coastline and the direct proportionality between property prices and protection system.

Data show also an inverse proportionality between real estate prices and environmental health when the carrying capacity of the territory is exceeded and that a little care for the environmental urban development policy negatively conditions quality of life.

We have to highlight that a multidisciplinary study regarding the morphological evolution of the territory, the urban development and the property appraisal can allow the temporal reconstruction of the environmental health state.

It should be specified that the real estate analysis is quite limited in time, in comparison to natural and antropic events observed, but the obtained results are, however, meaningful. At the same time, the territorial feedback analysis, able to establish the environmental health state, could be greater than those regarded in this present work, orienting future research to consider other environmental variables that might affect Human Quality Life.

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