The quality of life conditioning with reference to the local environmental management: A pattern in Bivona country (Calabria, Southern Italy)

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1. Introduction

This paper comes out from the knowledge that territorial development, through goods and services production to meet the wants and the needs of people, must involve an improving in Human Quality Life intended as a pattern of wellbeing in compliance with a state of environmental health. So, the environmental system should be able to support all human activities related to social and economic development plans without being stressed in its balance (Howe, 1979). On the contrary, a strong human pressure could affect the environmental state and, in the long run, reduce its quality (Nijkamp, 1993). The essential requirement, for a proper territorial development, is a goods and services production within the environmental limits so to avoid its deterioration. These limits are expressed as “critical levels” (Nijkamp, 1993) or as “carrying capacities” (Stankey, 1984; Pearce and Kirk, 1986; Romeril, 1990; Canestrelli and Costa, 1991; Moriani, 1991; Butler, 1996) and their exceeding affect the environmental health of an area and its economic activities (Girard, 1993). However, in this paper, the concept of “carrying capacities” means a fundamental limit for a proper territorial development able to create an increase of wellbeing and, then, of Human Quality Life. Whereas this, the proper planning of landscape development (D) should be realized as an effective summation of goods, services (here expressed as “Quantity Life” QNL) and wellbeing chances (here expressed as “Quality Life” QLL) within the environmental limits or in other terms: 

\[ D = Q_{NL} + Q_{LL} \]

In these last years, the fast landscape transformation, due to the increasing soil exploitation for building purposes, has determined a remarkable progress in goods production (QNL) for the improvement of Human Quality Life (QLL). The fast and unorganized development of human activities has often produced an overload of the environmental sustainability limits (Nijkamp, 1993). These human actions have caused conditions of environmental deterioration triggering negative territorial feedbacks against built...
goods and resident populations. In this background, it appears a reduction in human wellbeing and then in Quality Life, appraisable through those factors estimable in economic values, as for instance the analysis of real estate prices. The temporal evolution of economic values in the real estate and, also, the relative factors could be appreciated through the application of the Hedonic model (Lancaster, 1966; Rosen, 1974, 1978; Dreze and Hagen, 1978; Bartik, 1987; Garrod and Willis, 1992; Powe et al., 1995; Adair et al., 1996; Sheppard, 1999; Pagourtzi et al., 2003). This kind of approach, able to supply useful informations about the gained or the reduced values of building industry, is caused by the improvement or by the worsening of environmental health conditions (Howe, 1993). In this respect, the used methodologies are referred to regression models but also to estimation methods such as the Market Comparison Approach (Simonotti, 2006; Appraisal Institute, 2008) and others mentioned in the International Valuation Standard (IVSC, 2007).

An application of these concepts has been conducted for Bivona country, in Vibo Valentia Province, along the Calabrian Tyrrhenian coasts (Southern Italy). This kind of urbanization has been performed through a raving development without any appropriate town planning scheme or often modified by human needs. Therefore, the high and unorganized production of human goods (QNL), which would have to produce an increased amount of human wellbeing (QLL), has triggered, contrary to expectations, a lot of negative territorial feedbacks. Amongst these, the coastal erosion and the increasing hydrogeological vulnerability represent, today, the main hazards for the extant heritage, both natural and building goods. So, territorial feedbacks are a clear expression of a Quality Life reduction (QLL) measured through the application of the Hedonic model.

The present study aims to show how a wrong urbanization, pursued through an excessive increase of Quantity Life (QNL), could affect also the geomorphological delicate equilibrium, producing a reduction in Human Quality Life (QLL) estimated by analyzing real estate prices. In this work, we also suggest a new graphical representation, applicable in any human-dominated environment, in which is shown the Human Quality Life trend in function of a man-made development.

2. Study area

Bivona country (Fig. 1), close to Vibo Marina town, spreads out along the southern edge of Lamezia Terme Gulf on the Calabrian Tyrrhenian coasts (Southern Italy). Its town planning expansion, along a littoral stretch of about 3 km, has remarkably increased from 1970 through the implementation of touristic resorts and residential buildings at holiday vocation. The intense urbanization of coastal stretch, occurred in the following years, particularly from 1980 to 2000, has almost joined, in the same urban conglomerate, Bivona country with Vibo Marina town, producing a slow and steady transformation of land use from tourist to residential neighborhood.

The geomorphological pattern of the studied area is marked by sandy beaches extending at the base of a hilly strip with top elevations of about 500 m a.s.l. The lithological outcropping is constituted by a crystalline metamorphic bedrock (gneiss rock) from Paleozoic age, belonging to the Polia-Copanello Unit (Cortese, 1895; Novarese, 1931; Nicotera, 1959; Amodio-Morelli et al., 1976; Ghisetti, 1980; Tortorici et al., 2003). This outcrop is overlaid, in transgression, by Tortonian marine sediments (Nicotera, 1959), constituted by silico-clastic layers little cemented. Continental detritic-eluvial layers and vegetal soils, of variable thickness, overlay the Tortonian sediments or are directly in contact with a crystalline basement. The lithological sequence is characterized by a weak mechanical resistance to erosion, not only for genetic factors, due to the feeble or negligible cementation in sedimentary deposits (Ietto et al., 2013), but also for some acquired features, as tectonic deformation and weathering processes in crystalline...
3. Methodology of the study

3.1. Layering mapping

It has been conducted a cartographic study about the morphological evolution of coastline and the urban sprawl of Bivona littoral for the period 1870–2006. The results, coming out by this urban development study, are used to value the increasing over time of “Quantity Life” (Q.L.), while the morphological evolution of coastline has been intended as one of the possible expressions of the “environmental health” of coastal system. On this purpose, some topographic maps and orthographic photos, respectively supplied by the Military Geographic Italian Institute (I.G.M.) and by the Calabria Region, have been used, as are:

- Topographic map I.G.M. (scale: 1:50,000), dated on 1870;
- Topographic map I.G.M. (scale: 1:25,000), dated on 1960;
- Topographic map I.G.M (scale 1:25,000), dated on 1993;
- Orthographic photos (Calabria Region), dated on 2006.

The cartographic materials, referred to the same coordinate system, have been geo-referenced using the Geographic Information System “Quantum GIS 1.7.0” and, then, a digital comparison has been performed through overlapping all the elements previously computerized. This process has enabled to value the area of urban sprawl in the following temporal steps: 1870–1960; 1960–1993; 1993–2006. The same process has been used to reconstruct the evolutionary trend of the coastline, enabling to estimate the areas in erosion and/or in accretion and the implementation, on time, of breakwaters for coastal protection. For this purpose, some ground control points were chosen to ensure acceptable data, providing a maximum error in shoreline position of ≤5 m.

3.2. Price analysis in real estate sales

The value of Human Quality Life, intended as wellbeing production respecting conditions of environmental health, has been estimated through the method of “Hedonic Price” (Lancaster, 1966; Rosen, 1974, 1978; Dreze and Hagen, 1978; Hoevangel, 1994; Saderion et al., 1994; Garrod and Willis, 1999). This method lets assign the economic values of real estate on the basis of the usefulness attributed to each feature that make it up. In this regard, there are a lot of variables contributing to fix the price of a real estate and these data are differentiated in relation to the various kind of property market. Thus, it is impossible to establish the economical values of a market price beforehand. Therefore, it is necessary, not only, to analyze the real estate prices but, also, to examine the different features affecting their values to establish a statistical forecasting survey of the market values.

In this paper, amongst the different methods generally used for the estimation of Hedonic Prices, it has been adopted a multiple linear regression analysis that enables to point out the variations in estate values (depending fluctuations) according to its features (independent fluctuations). The multiple regression analysis is a statistic tool, widely spread, applied to economic estimating appraisals (Bruce and Sundell, 1977). This data processing allows to establish: a) correlation between the real estate market price and all the features affecting this value; b) mutual relations between the different features valued and the quantitative effect exerted by each feature on price; c) estimate of price according to the basic principles of data processing realized by a function that, better than others, approaches to the same data.

In regression appraisal analysis, the unknown quantities are represented by the estimated values of real estate prices and by the variable rates depicting specific Hedonic prices. These last ones show the real estate market price variations in according to the increased or decreased value of each feature regarded. Therefore, these prices are considered “implicit” because concealed in the estate market and related to some indivisible features, often connected with each other, of the real estate. The definition “implicit prices” indicate, as known, only the final price because it is unknown the real connection of the invisible features with the final price of the real estate. Through the estimation of Hedonic prices, it is possible to value the monetary contribution of each variable to the final market price of the real estate valued (Dunford et al., 1985).
In the case study of Bivona’s built-up area, in Vibo Valentia Province, 90 purchase prices of flats have been detected in the period 1973—2010. It was impossible to increase the period of the survey because historical purchase prices are unavailable. In fact, before 1973, the practice to create a real estate data set was uncommon. The real estate sample regarded is made up by condominium apartments located along the coastline and placed in the same area, so exceeding locational factors. The data collection was realized using specific tabs that have enabled, for each apartment, the census of the following features:

1) locational: concerning the position of the apartment in the urban context (facilities, services, etc…);
2) positional: concerning the position of the apartment in the condominium (floor level, exposition, etc…);
3) typological: concerning the features of the apartment (surfaces, maintenance conditions, plants, etc…);
4) economical: concerning the conditions and the restrictions in estate use (free or leased, constraints, etc…);
5) financial: concerning the forms of financing for costumers;
6) institutional: concerning the law framework (taxations, benefits, etc…).

For each sampled apartment it has been, also, detected its real price in the transaction (total price) and its main estate features, as reported below:

- transaction date (DAT);
- commercial surface in square meters (SUR);
- restrooms number (RES);
- floor level (FLO);
- distance to sea in meters (DIS).

Among the real estate features, used for the appraisal, have been valued only the characteristics affecting the market price. In this specific case, these ones are the only features different in the final amount, while the other characteristics, locational, positional and economic are equal in the amount and, therefore, unaffectioning the market price formation of the property. Obviously, between the considered individual real estate features, none is able to represent, directly, the conditions of the Human Quality Life. Therefore, this latter is not considered as an independent variable in the multiple regression method, but comes out from the set of many variables that make up the total economic value of the property which, represents how the buyers evaluate the quality conditions and the wellness deal of the property. Knowing the real estate prices function and their evolution in time is, therefore, useful to have more informations about the change of environmental quality conditions (Howe, 1993) and so of the Human Quality Life. In Table 1, the main sample statistics are reported.

The set of census data has been analyzed by multiple regression method and by price’s equation theoretically expressed by a linear progression, as in the following expression:

\[ y_j = b_0 + b_1 \cdot x_{j1} + b_2 \cdot x_{j2} + \ldots + b_n \cdot x_{jn} \]

where:

- \( y_j \) = dependent variable (sale price of generic real estate \( j \));
- \( x_{ji} \) (with \( i = 1,2, \ldots n \)) = features considered significant;
- \( b_i \) = Hedonic prices of the valued features.

This equation has enabled to obtain, year by year, the average unit prices, through which it has been possible to value the indexes numbers of the real estate prices (\( k_t \)), considering the year 1973 as the reference base. Therefore, the indexes numbers have been calculated on the base of the arithmetic mean of total prices, for each year, and on the base of the arithmetic mean of the corresponding areas. In particular, the indexes numbers (\( k_t \)) have been estimated traditionally by the following formula:

\[ I_t = \frac{PRCA_t}{PRCA_0} \]

where:

- \( PRCA_t \) is the estimated value of unit price at time \( t \);
- \( PRCA_0 \) is the estimated value of unit price at the reference time.

The indexes numbers of estate price (\( k_t \)), calculated in this way, represent the numerical indicators useful to the comprehension of real estate returns. These numbers enable to represent their rates as a result of the continuous and systematic revaluation/devaluation of market prices from 1973 to 2010. Therefore, indexes numbers could be considered transaction based (Case and Quigley, 1991).

4. Results

4.1. Layering mapping

The cartographic comparison, for the periods: 1870—1960, 1960—1993, 1993—2006, has enabled to reconstruct shoreline evolution and to assess areas in erosion or in accretion along the coastal stretch of Bivona country. It has also been measured, in the same periods, the growth of urbanized areas and the extension of littoral areas protected by breakwaters.

The results of cartographic comparison are illustrated in histogram of Fig. 2 and are summarized in specific data reported in Table 2. The data show that, in time range 1870–1960, the urbanized surface, missing in 1870, has increased by about 17,370 m². In same range time, the study of shoreline evolution has revealed a sharp preponderance in accretion processes. In particular, along a coastline of about 3 km, the variation in surface of coastal area showed an erosion of −57,400 m² and a progradation of +76,350 m². The positive sediment balance in coastal area, with small stretches in deficit, highlights the presence of a coastal system still flexible and well nourished by fluvial sedimentary transport. In the subsequent period investigated 1960–1993, the littoral area has been affected by a high increase in urbanization, for a total of 22,850 m² and by a considerable erosion of beach areas equal to −155,540 m² and with some coastal stretches in accretion equal to +24,000 m². In this time lag, the comparison between littoral areas in erosion and in accretion shows a clear reversal trend of sedimentary budget, with strongly negative values, confirming a

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### Table 1

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Media</th>
<th>Frequency</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total price (€)</td>
<td>12,000.00</td>
<td>80,000.00</td>
<td>46,777.78</td>
<td>–</td>
<td>27,761.38</td>
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<tr>
<td>Average price</td>
<td>101.69</td>
<td>775.19</td>
<td>462.33</td>
<td>–</td>
<td>272.99</td>
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<tr>
<td>PRCA (€/sqm)</td>
<td>97.4</td>
<td>118</td>
<td>102.24</td>
<td>–</td>
<td>6.57</td>
</tr>
<tr>
<td>Commercial surface (SUR) (sqm)</td>
<td>1</td>
<td>2</td>
<td>102.24</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Restrooms (RES)</td>
<td>1</td>
<td>2</td>
<td>8–1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Floor level (FLO)</td>
<td>1</td>
<td>3</td>
<td>3–4-2</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Distance to sea (DIS) (m)</td>
<td>5</td>
<td>870</td>
<td>365</td>
<td>–</td>
<td>320.36</td>
</tr>
</tbody>
</table>

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poor sedimentary nourishing of coastal system. In the same period, the first breakwaters against coastal erosion have been realized protecting 500 m of sandy beaches. In the period 1993–2006, the urbanized surface covered an area of 382,240 m² while the breakwaters, for coastal protection, extended for a length of 1760 m, as 57% of the Bivona’s littoral. Therefore, this coastal protection system has produced an artificial stabilization of the coastline, as highlighted by the following data: +37,700 m² littoral area in accretion and −24,380 m² littoral area in erosion.

4.2. Market values of real estates

For better achieving the function of the real estate price, have been applied linear regression, not linear and logarithmic models. Among these, linear patterns were the best of all the tested models and more than others matched with the criteria of multiple regression model. In this regard, the linear regression analysis, applied to real estate prices of ninety flats in the period 1973–2010, has enabled to formulate an estimate function related to the average unitary prices (PRCA) and to the Hedonic prices of estate features.

In the linear model the depreciations and the allowances of estate features (DAT, RES, FLO, DIS) show directly the Hedonic prices. Therefore, the estimate function of the average unitary price (PRCA) has been expressed by the following formula:

\[
PRCA = 635.15 \frac{€}{m^2} - 8.20 \frac{€}{m^2} \cdot DAT \\
+ 146.80 \frac{€}{m^2} \cdot RES + 2.35 \frac{€}{m^2} \cdot FLO \\
+ (-1.31 \frac{€}{m^2} \cdot DIS)
\]

In particular, the intercept equal to 653.15 (€/m²) represents the average unitary price in 2010 year; the Hedonic price of DAT feature (transaction date) points out that the real estate is revalued annually for 8.20 (€/m²); the Hedonic price of RES feature (restrooms number) points out that the real estate is revalued of 146.80 (€/m²) for every bathroom included in flat; the Hedonic price of FLO feature (floor level) points out that the real estate is revalued of 2.35 (€/m²) by increasing level floor; the Hedonic price of DIS feature (distance to sea in meters) points out that the real estate value increases of 1.31 (€/m²) by decreasing its distance from the sea.

The estimate function adopted is representative of the analyzed case as gets through the following check tests: $s^2$, $R^2$, $t$ and $F$ (Brown, 1974), where:

1) the standard error $s^2$ shows the difference between observed data and interpolated data by the model and it represents a measure of narrowness in the relationship between variables;
2) the correlation coefficient $R^2$ estimates the model ability to reproduce the original data;
3) the test $t$ shows the statistical importance of each variables, by which this coefficient can be tested against the null hypothesis of randomness;
4) the test $F$ rises from the corresponding variance analysis and allows to establish whether the variance, calculated by the regression method, is statistically significant or could be assigned randomly.

The results obtained by application of estimate function has enabled to reconstruct, for each year, the values of the average unitary price (PRCA) and the corresponding index number ($I_t$), as reported in Table 3.

Once reconstructed the historical series of market prices, it has been possible to highlight the trend of interest market segments. Particularly, the numerical index analysis, based on the values of media unitary prices, shows a conflicting trend of the market estate, with an upward gradient until 2000 and a slight decrease until 2010. Indeed, from 1973 to 2000, it has been detected a constant
increase in the economic values of real estate with a revaluation of about +370%. In the following years, from 2000 to 2010, the analysis of market values appears fluctuating and it is marked by slight increases and decreases in real estate prices. However, the overall trend of real market indicates a fall in prices and a reversal of its trend respect to 2000 with a depreciation of −11%. For instance, a specific devaluation of real estate economic value, of about −7%, has been observed only in the period 2006–2010. In Fig. 3, it has been reported through a diagram showing the economic trend of estate values in the survey period 1973–2010.

5. Discussion

The data analysis aims to prove as an unorganized urbanization in the coastal area, can modify its unsteady geomorphological equilibrium triggering, sometimes, new and/or extreme phenomena to reach new balance conditions. These territorial feedbacks to an improper urbanization are expression of a worsening in the environmental state, able to produce unforeseen issues or high hazard conditions to environmental and built goods. The final result is a reduction in Human Quality Life estimable, also, through the appraisal of real estates.

The study on urban development of Bivona’s hamlet highlights that, from 1870 to 2006, it was built on area of 382,240 m² (Fig. 4), with a heavy increase of buildings in the decade 1970–80. This trend is in accordance with the coastal urban development occurred in Calabria during the period 1970–1990 in which there was a sharp increase in housing (about +61.6%) along the Tyrrenhian coast within 200 m from the sea (Greco et al., 1995).

The urban development of Bivona’s built-up area, occurred without any appropriate urban planning, has produced a confused overbuilding of landscape, highlighting a high local vulnerability to landslides and flood events (Ietto et al., 2009). Particularly, many tourist and residential resorts have been built in riverside areas or within fluvial beds, which have been buried in undersized water piping. Further implementations of road and railway networks, running parallel and close to coastline, have produced several bottlenecks along the river pathways, obstructing the normal flow of waters. Besides, in order to protect built-up areas, the watercourses have been strictly bound by hydraulic works as: artificial riverbanks, bridges and, sometimes, cementation of riverbeds, especially in river mouths more densely populated. These works have produced, year by year, a gradual reduction until an almost total loss of river solid transport to the sea, with a consequent poor nourishment of coastal system. The building of residential resorts, until upper limit of backshore, has produced the total destruction of dune system and the interruption of the natural shoreline dynamic equilibrium. The direct consequence has been the progressive deterioration of the unsteady coastal morphological balance and, accordingly, a reversal in shoreline trend evolution: in accretion until 1960 and in clear erosion from 1993. In the following years, until 2006, urbanization of coastal area has further increased while morphological evolution of shoreline has been rather stable following the construction of a coastal defence system along a strip of 1760 m, corresponding to about 57% of littoral fringe. These works, even if useful to reduce coastal erosion, have produced negative impacts on landscape and into backshore ecosystem. Indeed, our recent studies on backshore sands, protected by artificial breakwaters, have demonstrated the prevalent presence of typical continental arthropods taxa instead of coastal ones, due to the absence of washing action on sands by waves (Ietto et al., 2009). This data reveal a high deterioration state into the backshore ecosystem.

Another detected effect, resulting from a confused urbanization, has been the increase of hydraulic vulnerability by flooding events in an area subjected to heavy rainfalls. Indeed, a specific contribution to the increasing of hydraulic hazard has been the presence of unsuitable buildings that have produced bottlenecks,
obstructions and burials of fluvial networks, blocking the normal flow of waters and increasing the flooding likelihood in densely populated areas (Ietto et al., 2009).

Evidence of such phenomena was the rainfall event occurred on July 2006, which has affected Bivona’s built-up area, producing widespread landslides with a high supply of sediment into river-beds and making inadequate the drainage network principally in urbanized coastal areas. As a direct consequence, there was the flooding of inhabited areas causing heavy damages, for a total amount of 17 million Euros and the death of four persons.

Coastal erosion, deterioration of backshore ecosystem and increase in hydraulic hazard into Bivona’s coastal area, could be considered as negative feedbacks due to an incorrect urban development and, therefore, expression of a general environmental decay. In this context, it is evident the wrong environmental management lacking of any “holistic approach”, that could be able, instead, to connect the right management of natural processes with a growing social and economic development (Kelleher and Kenchington, 1990).

The bad conditions of the environmental health state have directly affected the evolution of real market estate, as stated by the estimative analysis of selling prices properties surveyed. Indeed, data analysis, reported in Fig. 3, shows that in the period 1973–2000 there was a revaluation of estate values of about +370%. In the following years, until 2010, the estate prices are aligned on a decreasing trend, showing an overall devaluation of about –11% reflecting the negative effects of local environmental decay. Noteworthy, is the marked depreciation of estate values in the period 2006–2010 in reply to the flood event occurred on July 2006.

The data analysis shows how the trend of market estate is heavily influenced by the local conditions of environmental health, as suggested by some Authors (Howe, 1993; Girard, 1993; Geoghegan, 2002; Bengochea-Moranco, 2003; Jim and Chen, 2006 and many others). Therefore, the values, obtained through an estimative analysis of the real estate prices, could be used for a quantitative assessment of environmental health state and, at the
same time, for an assessment of the human wellbeing (Quality Life), as it is dependent by the same environmental conditions.

It should be noted that, in the present paper, we have considered only the most evident territorial features capable to influence the Human Quality Life conditions. This choice aims to highlight how wrong urbanization may trigger negative geomorphological feedbacks able to influence the wellbeing of a place and then the Human Quality Life. Therefore, it is not excluded that other features might affect Human Quality Life, as for example: pollution, urban congestion, overcrowding, etc…

5.1. Graphic representation of Human Quality Life related to human activities

Urban green spaces, water bodies and principally good environments provide amenities and services that contribute fundamentally to improving the Human Quality Life in urban sites (Shafer et al., 2000; Hidano, 2002; Van Herzele and Wiedemann, 2003; Chiesura, 2004). Their importance to the wellbeing of cities and citizens is, often, neglected in mainstream urban planning and policy making related to development (More et al., 1988; Luttik, 2000; Tyrväinen and Miettinnen, 2000; Tajima, 2003; McConnell and Walls, 2005). Due to their unpriced nature and largely intangible benefits, their contribution or lack thereof is usually difficult to assess and quantify. In this regard there is a substantial literature that examines the relationships between economy and environmental health. This literature has shown that estimates of environmental and human health can be inferred from a wide variety of market situations. Various approaches have been proposed and tested, amongst which the Hedonic pricing method (Rosen, 1974) has been widely applied to estimate the value of quality environmental amenities and services production. The term QLL refers to Human Quality Life, intended as wellbeing creation within environmental limits and detectable by one or more factors estimated in market prices. The broken line QLL represents, in a correct development policy, the potential growth of Human Quality Life (QLL) obtainable by the production of goods and services (QL) within environmental limits. On the contrary, in a context of high production of QNL, beyond the environmental limit of sustainability, negative territorial feedbacks might cause a reduction over time of environmental quality and, accordingly, of Human Quality Life. In the diagram of Fig. 5 it is possible to observe that the difference Δ, between QNL and QLL terms, increases over time, until becoming inversely proportional (Δ₁) when excessive growth in QNL occurs. In this condition, it is possible to observe an increase of QNL and a decrease of QLL, as represented by the bell-shaped curve QLLD. The beginning of the parabolic curve QLLD is the point P₁. This point represents an exceeding of the environmental use, beyond threshold values, when the negative territorial feedbacks begin to appear. The inflection point in QLLD curve, represented by point r, could indicate the threshold limiting value of environmental resilience; namely the point in which the human-dominated environment is still able to recover itself once stopped anthropic activity. Then, exceeding of point r represents a critical condition where the negative territorial feedbacks cannot recede by itself, producing a steady decrease in environmental quality and, so, in Human Quality Life.

6. Conclusions

The multidisciplinary study on morphological evolution of coastline, on hydraulic hazard, on urban growth and on estimative

![Diagram](image-url)
analysis of the real estate values in coastal area of Bivona country, has enabled to reconstruct their evolutionary trend and to detect the relationships between the respective changes over time. Indeed, data analysis has enabled to recognize an inversely proportional behavior between the growing urban development of this coastal area and the morphological evolution of its coastline. In this regard, the use of artificial breakwaters in order to control coastal erosion, though it has been partially effective, has produced a negative impact on the littoral landscape and the deterioration of backshore ecosystem. Another effect of urban growth is represented by the increase of hydraulic hazard in inhabited coastal areas, as confirmed by the last flood event in 2006. Therefore, coastal erosion, deterioration of backshore ecosystem and increase of local hydraulic hazard, represent clear examples of territorial negative feedbacks due to an incorrect urbanization, highlighting a decrease in the state of environmental health. So, the worsening of environmental health becomes the main cause of Human Quality Life reduction. The quantitative evaluation of “Quality Life” conditions has been assessed through the Hedonic Analysis of estate values, which highlights the decreasing values of market to the occurrence of environmental decay phenomena. It should be specified that, even though the real estate estimation analysis is quite limited in time, in comparison to natural events observed, 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.

Furthermore, the quantitative data, surveyed for Bivona’s built-up area, seem to confirm the reliability of diagram suggested in Fig. 5. In particular, the Quantity Life expression, represented by QL curve, has been reconstructed through the data of urban growth in the period 1870–2006 (Fig. 4). The trend of Quality Life over time, represented by QL curve in Fig. 5, has been assessed through the analysis of economic values of the real estate (Fig. 3), reconstructed only for the period 1973–2010 owing to the lack of historical data. The comparison between these two curves highlights that, opposite of prevailing growth in Quantity Life up to 2006, occurs over time a decrease of Quality Life (in growth from 1973 to 2000), with negative values of about –11%, during the period 2000–2010 (QLo). This fall corresponds to the occurrence of negative environmental feedback caused by an improper urbanization, as reported in dot P1 (Fig. 5). Therefore, this multidisciplinary study highlights the functionality of the suggested diagram by quantitative data how an incorrect policy of urban development affects the environmental health and the Quality Life of a country.

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