J Environ Sci Public Health 2020; 4 (4): 349-366 *DOI: 10.26502/jesph.96120106*

Research Article

Covid-19 Incidence and its Main Bionomics Correlations in the Landscape Units of Monza-Brianza Province, Lombardy

Vittorio Ingegnoli*, Elena Giglio

Department of Environmental Sciences, University of Milan, Italy

***Corresponding Author:** Vittorio Ingegnoli, Department of Environmental Sciences, University of Milan, Italy, E-mail: vittorio.ingegnoli@guest.unimi.it

Received: 05 November 2020; **Accepted:** 11 November 2020; **Published:** 25 November 2020

Citation: Vittorio Ingegnoli, Elena Giglio. Covid-19 Incidence and its Main Bionomics Correlations in the Landscape Units of Monza-Brianza Province, Lombardy. Journal of Environmental Science and Public Health 4 (2020): 349-366.

Abstract

Today both ecology and medicine pursue few systemic characters and few correct interrelations. After the exciting result of the relation between the bionomic functionality (BF) and the mortality rate (MR) in Monza-Brianza Province (Ingegnoli [1]), the curiosity to test the correlation of structure/function conditions of the same landscape units (LU) even Vs. Covid-19 incidence was experienced, becoming the aims of this work. The necessity to follow a new scientific paradigm, shifting from reductionism to systemic complexity, leads to the emergence of a new life concept, not centered on the organism, but on the entire "biological spectrum". So, limits to traditional ecology have emerged, e.g., the ambiguous concept of ecosystem or the lack of the hierarchical interscalar relationships, leading to the emergence of an ecological upgrading discipline, Landscape Bionomics.

Following bionomics principles, the territory of Monza-Brianza was studied in all the 55 municipalities (LU). The correlation of Covid-19 (incidence %) Vs. the bionomic functionality (BF) resulted evident: at BF = 1.0, Covid-19 = 0.90 %, while at BF = 0.45, Covid-19 = 1.20 %. Other parameters, unpredictably, have a weak correlation, as urbanization, population age, and agriculture, except the bionomic carrying capacity. A good convergence with the cited research (BF Vs. MR) results from BF Vs. Covid-19. So, biological studies may affirm that the relation between Landscape bionomic state and

human pathologies is essential, even if not limited to pollution or infection agents per se, as Etiological paths may demonstrate.

Keywords: Covid19; Monza-Brianza; Landscape Bionomics; Bionomic functionality

1. Introduction

Medicine prefers to attend *sick care* than *health care* and rarely follows a complete systemic view (Fani Marvati and Stafford [2]; Bottaccioli [3, 4]). On the other side, conventional ecology does not recognize the environment as a proper biological level of organization (Ingegnoli [5, 6]). Both Ecology and Medicine reject such systemic concepts considering them as imprecise, belonging to the superficial level of common-sense language, but that should be banned from the rigorous (reductionistic) discourse of science. As underlined by Evandro Agazzi [7], this attitude was in keeping with the scientific culture inspired by positivism still predominant in the first half of the twentieth century but, up to today, too frequently followed (Urbani-Ulivi [8]).

The new ecological discipline of *Bionomics* (Ingegnoli [9, 1]; Ingegnoli, Bocchi and Giglio [10]) profoundly upgrades the main principles of traditional ecology by being conscious that *Life on Earth is organized in a hierarchy of hyper-complex systems* (often indicates as *levels*), *each one being a Living Entity, which cannot exist without its proper environment*. In all its form, life and the related environment are the necessary components of each complex system. Life depends on exchanging matter, energy, and information between a concrete entity, like an organism or a community, and its environment. That is why the concept of life is not limited to a single organism or a group of species and, consequently, life organization can be described in hierarchic levels (i.e., the so-called "biological spectrum").

In both the first and second insurgence of Covid-19 in Italy (Feb-April and Sept-October), Lombardy has been the region with the most elevated prevalence in Italy. The main reasons proposed are: (a) the most populated territory, (b) the most urbanized one, (c) the most congested public transportation networks, (d) the most air-polluted (Coker et al.,[11]) (e) a quite old Population Age, not to mention (f) the public health organization, exceedingly depending on nonscientific suggestions. Can we add other important reasons due to environmental alteration?

This study follows the bionomic principles, so a short synthesis of the bionomic discipline is presented before the methodology. For any further information, see the volume Landscape Bionomics: Biological-Integrated Landscape Ecology (Ingegnoli [1]). The aim of the research is discovering *other* essential reasons for the Covid-19 incidence in Lombardy. The main point of the article concerns the proposal of an advanced ecological (i.e., Bionomics) parameter not considered today in correlation with the Covid-19 incidence. This factor is the Bionomic Functionality (BF), sensu Ingegnoli [1, 12]. capable of evaluating the complex metastable relationships between natural and human characters of a Landscape Unit (mainly: forest efficiency and human habitat).

2. Theory: Bionomics and Landscape Bionomics

The concept of life is not limited to a single organism or a group of species and, consequently, life organization can be described in space-time-information hierarchic levels (i.e., the so-called "biological spectrum" *sensu* Odum [13, 14]). The life organization itself, also, composes the environment around life; so, the integration reaches new levels again. As all remember, the Gaia Theory (Lovelock and Margulis [15]; Lovelock [16]) has already asserted that the Earth itself is very similar to a living entity. Consequently, limits to traditional ecology also have emerged, e.g., the ambiguous concept of the ecosystem (O'Neil et al., [17]; Allen and Hoektra [18]; Ingegnoli [1]). In add, Bionomics (Table 1) underlines the difference between the various approaches to the study of the environment (viewpoints) and *what exists: t*hey are the six scale Living Entities, each one definable through *ontological and emerging properties*. Ontological properties are common to all the levels of the biological spectrum, even if each specific biological level may express the same process in an own *way*, depending on its scale, structure, functions, amount of information and semiology. Moreover, emerging properties characterize each one of the previous levels, specifically related to that level as a complex, unique system, making each system that owns proper characters an entity.

SCALE	Viewpoints				REAL SYSTEMS5
	SPACE1 CONFIGURATION	BIOTIC2	FUNCTIONAL3	CULTURAL-ECONOMIC4	
Global	Geosphere	Biosphere	Ecosphere	Noosphere	Eco-bio-geo-noosphere
Regional	Macro-chore	Biome	Biogeographic system	Regional Human Characters	Ecoregion
Territorial	Chore	Set of communities	Set of Ecosystems	District Human Characters	Landscape
Local	Micro-chore	Community	Ecosystem	Local Human Activities	Ecocoenotope
Stationary	Habitat	Population	Population niche	Cultural/Economic	Meta-population
Singular	Living space	Organism	Organism niche	Cultural agent	Meta-organism
1= not only a topographic criterion, but also a systemic one; 2= Biological and general-ecological criterion; 3= Traditional ecological criterion; 4= Cultural intended as a synthesis of anthropic signs and elements; 5= Types of living entities really existing on the Earth as spatio-temporal-information proper levels.					

Table 1: Hierarchic levels of Biological Organization.

Advancing from Landscape Ecology (Naveh [19]; Forman and Godron [20]), Ingegnoli enhanced the importance of the scientific concept of *landscape* (nothing to do with scenery, visual perceptions or similar definitions). Thus, the landscape is an information system essential for co-evolution and group selection because the genetic characterization is linked to three scale levels: cell, population, and landscape. Moreover, Landscapes present a modality of transformation led by bionomic laws, which may change the culture and man's ethology to maintain a metastable equilibrium, inducing a buffer effect when landscapes suffer a heavy changing pressure.

2.1 Landscape bionomics: a synthetic content

While standard ecology approaches a landscape through the concept of *eco-mosaic*, the fundamental structure of a landscape is systemic: it is an *"ecological tissue"* as the weft and the warp in weaving or the cells in a histologic tissue. Therefore, the *Ecotissue* concerns a multidimensional conceptual structure representing the hierarchical intertwining, in the past, present and future, of the ecological upper and lower biological levels and their relationships in the landscape: it is constituted by an essential mosaic and a hierarchic succession of correlated structural and functional patchworks and attributes. Among them, a relevant role is played by the patchworks of the *Landscape Apparatuses*, constituted by different ecocoenotopes which carry different ecological functions (e.g., protective, productive, resilient, residential, etc).

The *Landscape Unit (LU)*, intended as a sub-landscape, is a part of a landscape, the peculiar structural or functional aspects of which characterize it as regards to the entire landscape: it is not a simple arrangement of ecotopes, even if it forms a connected patch of them, and its structure is not always immediately recognizable, needing proper studies. A (simple) LU can be defined as an interacting disposition of recurrent and "genetic" (*sensu* geomorphology) ecotopes, a configuration which assumes a particular significance (function) in its landscape. Unfortunately, it is not always possible to investigate the environment through them, due to administrative limits. In this case the simple Landscape Unit (LU) becomes an operative LU.

Thus, a *theoretical corpus* has been developed to study the natural systems (Ingegnoli [9, 1]; Ingegnoli, Bocchi and Giglio [10]), particularly concerning the central levels of Tab.1. Here a brief synthesis of the main principles proposed by Landscape Bionomics:

1. Stated that Life on Earth is subjected to time arrow, no return to the prior state (restoration) is possible: actions are irreversible and intervention must be intended in the sense of structural and functional rehabilitation;
2. Being Living Entities, the health state of a territory/landscape/region can be investigated on the field through a proper quality-quantitative clinical-diagnostic methodology: therapeutic criteria and methods of its strategic rehabilitation can be suggested and monitored;
3. Each Living Entity, from the local to the upper scales, manage *a flux of energy to reach and maintain a proper level of organization and structure through its vegetation communities,* their metabolic data, and order functions (biomass, gross primary production, respiration, B, R/GP, R/B); a systemic landscape function, named BTC (*Biological Territorial Capacity of Vegetation)* (Ingegnoli [6]), linked to metastability (based on the concept of resistance stability) gives us *a quantitative*

evaluation of this flux of energy [Mcal/m^2/year].

4. The ecological efficiency of a vegetation phytocoenosis can be evaluated. The *CBSt (Concise Bionomic State)* should be reached considering: (1) the significance of the surveyed BTC of the patch in relation to the "maturity level" (MtL) of its vegetation coenosis and (2) its bionomic quality (bQ) always resulted from a parametric survey. Therefore, this function has to be designed as CBSt = (MtL x bQ)/100) (Ingegnoli [21]);
5. Humans affect and limit the self-regulation capability of natural systems. An evaluation of this *aptitude* brings to the concept of *Human Habitat (HH) (*Ingegnoli [6]).
6. The state function strictly related to the previous concepts is the *vital space per capita* [m^2/inhab.], the set of portions of the landscape apparatuses indispensable for an organism to survive, better known as *Standard Habitat per capita (SH).*
7. The connected *Minimum Theoretical Standard Habitat* per capita (SH*) is the state function estimated in dependence of human survivance: the ratio SH/SH*, named Carrying Capacity (σ) of a LU, is the state function able to evaluate the self-sufficiency of the human habitat (HH), a basilar question for sustainability and ecological territorial planning.

2.2 Landscape diagnosis and Bionomics Functionality (BF)

An excellent correlation between the Biological Territorial Capacity of Vegetation (BTC) and the Human Habitat (HH), that is between *the flux of energy needed by a living system to reach and maintain a proper level of organization and structure* (BTC) and *the measure of the human control and limitation of the self-regulation capability* of natural systems (HH), was found (Ingegnoli [1, 9]): this is a *systemic* function, capable to evaluate the anatomy and physiology of a LU. As we can see in Fig.1, it was possible to build the simplest mathematical model of bionomic normality, available for *the first framing of* landscape units' dysfunctions. Below normal values of *bionomic functionality (BF*= 1.15- 0.85), with a tolerance interval (0.10-0.15 from the green curve of normality) we can register three levels of altered *BF: altered* (*BF* = 0.85-0.65), *dysfunctional* (*BF* = 0.65-0.45) and highly *degraded* (*BF* < 0.45).

The vertical bars divide the main types of landscapes, from Natural-Forest (high BTC natural) to Dense-Urban: each of them may present a syndrome. Again, this model is indispensable in reaching a first *eco-bionomics diagnosis* on the health of an examined landscape unit (LU), controlling the effects of a territorial planning design, studying the landscape transformations, etc. Note that it is a complex model because both HH and BTC are not two simple attributes, and their behavior is not linear.

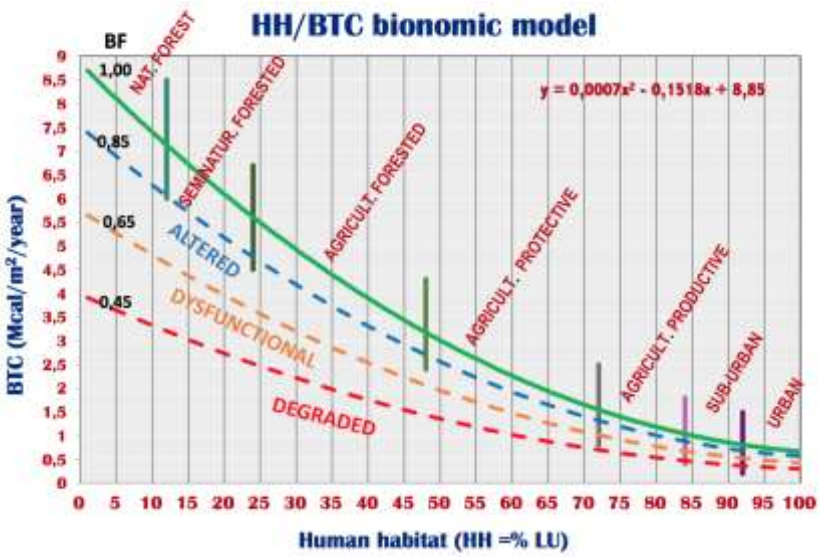

Figure 1: The HH/BTC model, able to measure the bionomics state of a LU. Dotted lines express the BF level, which is the bionomics functionality of the surveyed Landscape Unit. The different main types of landscapes are written, from natural forest to dense urban. The green curve represents the normal status of LU in temperate regions.

3. Materials and Methods

As mentioned in the Introduction, the research made on bionomic functionality (BF) related to the mortality rate (MR) in the Monza-Brianza Province and Milan City (Ingegnoli [1]; Ingegnoli and Giglio [22, 23]) was the basilar study, which allows the deep knowledge of the state of the environment following bionomics principles. So, the methodology has to start from this study.

Pollution (ESA [24]) could be considered as homogeneous in our sample land area (Figure 2, left).

The biological territorial capacity of vegetation (BTC) was estimated using field surveys (LaBiSV method, *sensu* Ingegnoli [6]; Ingegnoli and Giglio [25]; Ingegnoli and Pignatti [26]) mainly referred to forest patches. Figure 2, right, exposes the most significant set of forest assessment surveyed on the field. The fair value of the mean BTC = 5·84 Mcal/m^2/year (a low value) is confirmed by the presence of 57·14 % of altered and weak forests, Vs. only 19·05 % of good ones.

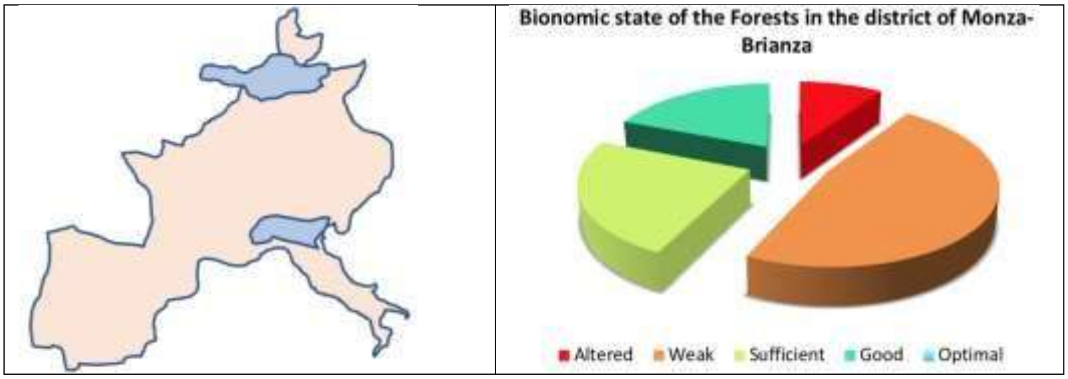

Figure2: In the Po plain, the distribution of air pollution is relatively homogeneous and one of the highest in the EU. Not only Milan but also Monza-Brianza are inserted in this wide polluted area. (right) The bionomic state of the forest formation on the Province of Monza-Brianza shows only 19·05 % of the right conditions, and no one is truly optimal.

As plotted in Figure 3, the blue line indicates a territory covered by the 55 municipalities (landscape units) of the province of Monza-Brianza (left). This is compared with the bionomic metropolitan area of Milan (red), the N-E part of which is comprised in Monza-Brianza, covering about 50% of the territory. In the MR-BF research the city of Milan (divided in 9 LU) and other 8 municipalities have been added. Applying the bionomic methods, it was possible to find the landscape gradient, composed by six types (from agricultural to dense urban) and its relations with the mortality rate (MR), the bionomic functionality (BF) and the population Age (PA). In Figure 3, we can see that the decrease of BF (blue) is related with the increase of MR (red). Elaborating the bionomic parameters, it resulted a mean of BF = 0.78 (low value) indicating an altered environment.

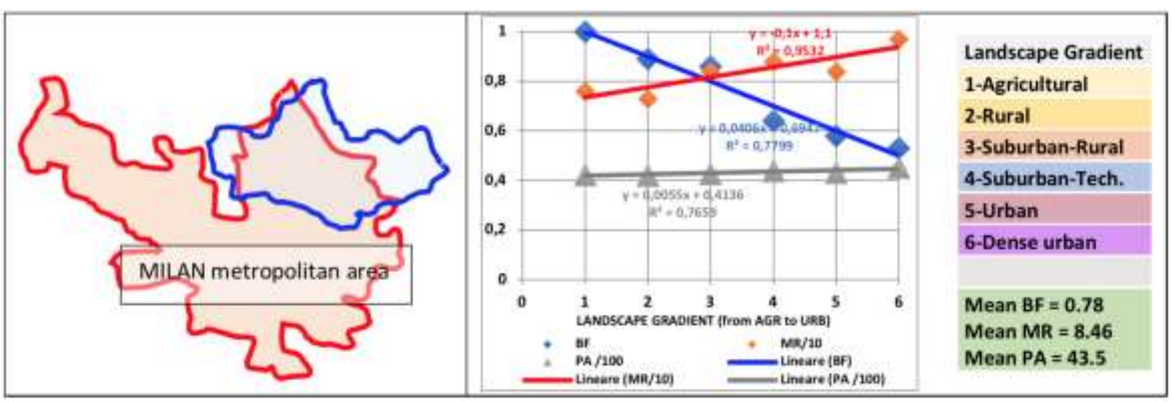

Figure 3: The blue line indicates the land area of experimentation: Monza-Brianza [Milan City is just South of Monza]. This territory covers 405 Km^2 with a population of 0,9 x 10^6 inhabitants and with a gradient of 6 landscape Types (base map from DUSAF-Ersaf). Note, in the plot, the inverse proportionality between MR (red) and BF (blue), while PA remains near constant.

ab 2018	**Municipality**	**% FOR**	% URB	% AGR	**HH (%)**	**BTC**	HS/HS*	**BF**	**COVID19**	**% covid19**
8.797	TRIUGGIO	28,86	29,83	41,09	66,46	2,06	0,49	1,11	**66**	0,75
6.078	BRIOSCO	24,16	32,40	43,18	69,93	1,82	0,56	1,10	**49**	0,81
3.033	CORREZZANA	21,27	29,75	48,92	71,59	1,71	0,66	1,09	**23**	0,76
8.530	COGLIATE	23,54	32,32	44,05	70,40	1,80	0,44	1,10	**66**	0,77
7.415	BELLUSCO	8,04	9,82	82,15	77,89	1,21	0,57	0,95	**82**	1,11
15.902	LENTATE SUL SEVESO	20,35	38,29	40,22	72,84	1,60	0,49	1,06	**103**	0,65
5.109	ORNAGO	7,94	21,33	70,55	79,39	1,13	0,90	0,94	**35**	0,69
4.320	VEDUGGIO-COLZANO	19,86	39,07	40,90	73,71	1,58	0,41	1,08	**44**	1,02
6.572	CERIANO LAGHETTO	14,46	34,38	50,77	76,53	1,35	0,68	1,02	**61**	0,93
10.799	CORNATE D`ADDA	8,88	21,05	64,90	76,15	1,14	0,79	0,84	**102**	0,94
15.532	BESANA IN BRIANZA	12,97	30,30	56,56	77,19	1,31	0,58	1,01	**195**	1,26
5.597	MISINTO	16,97	38,30	44,73	75,61	1,45	0,58	1,05	**38**	0,68
2.156	CAMPARADA	16,19	37,13	46,68	75,98	1,42	0,49	1,05	**19**	0,88
4.334	SULBIATE	4,15	16,72	79,12	81,39	0,99	0,87	0,87	**27**	0,62
7.769	LAZZATE	15,33	37,27	47,41	76,58	1,38	0,40	1,04	**66**	0,85
10.325	USMATE VELATE	12,14	36,66	50,49	78,37	1,23	0,59	0,98	**92**	0,89
2.096	AICURZIO	8,03	30,15	61,61	80,46	1,08	0,68	0,92	**12**	0,57
4.499	MEZZAGO	6,40	25,92	66,76	80,74	1,03	0,58	0,89	**36**	0,80
8.535	LESMO	18,85	48,85	31,56	75,44	1,46	0,40	1,06	**92**	1,08
4.755	RONCELLO	4,07	24,09	71,36	82,23	0,93	0,74	0,85	**40**	0,84
6.785	BUSNAGO	3,75	28,77	67,48	83,23	0,89	0,72	0,84	**112**	1,65
3.503	RONCO BRIANTINO	6,35	36,73	56,17	82,24	0,95	0,54	0,87	**28**	0,80
5.171	CAPONAGO	2,37	30,80	66,72	84,38	0,81	0,64	0,79	**56**	1,08
11.209	BERNAREGGIO	4,68	34,19	60,89	83,22	0,90	0,40	0,84	**133**	1,19
17.945	CARATE BRIANZA	13,44	48,73	34,73	78,11	1,19	0,33	0,94	**239**	1,33
4.246	BURAGO-MOLGORA	6,70	41,36	51,92	82,88	0,95	0,47	0,88	**20**	0,47
26.114	VIMERCATE	3,34	34,60	61,40	84,02	0,83	0,46	0,80	**305**	1,17
17.933	ARCORE	12,85	51,92	34,21	79,74	1,16	0,30	0,97	**174**	0,97
7.361	CAVENAGO BRIANZA	4,75	36,56	52,49	81,15	0,84	0,40	0,73	**103**	1,40
35.053	LIMBIATE	12,76	52,34	31,65	78,74	1,13	0,21	0,92	**397**	1,13
7.336	CARNATE	7,68	47,19	44,81	82,87	0,95	0,27	0,88	**83**	1,13
4.032	RENATE	4,34	43,20	52,15	84,59	0,82	0,44	0,81	**49**	1,22
15.598	AGRATE BRIANZA	3,75	44,28	51,07	84,85	0,78	0,51	0,77	**149**	0,96
7.019	BARLASSINA	16,24	65,50	18,25	79,63	1,24	0,25	1,03	**87**	1,24
23.502	MEDA	19,04	66,90	12,77	77,46	1,35	0,21	1,05	**176**	0,75
6.375	ALBIATE	4,69	50,03	45,28	85,36	0,80	0,32	0,80	**44**	0,69
15.706	CONCOREZZO	1,62	44,11	53,82	86,48	0,69	0,35	0,72	**227**	1,45
7.309	MACHERIO	7,72	59,93	32,19	84,54	0,87	0,29	0,86	**60**	0,82
8.346	SOVICO	8,35	62,65	27,72	84,04	0,88	0,26	0,84	**53**	0,64
23.731	SEVESO	9,99	65,85	24,07	83,84	0,90	0,22	0,86	**206**	0,87
12.250	BIASSONO	6,09	62,61	30,66	85,74	0,77	0,25	0,79	**176**	1,44
39.150	CESANO MADERNO	9,69	70,74	19,34	84,62	0,89	0,19	0,88	**395**	1,01
26.066	GIUSSANO	5,72	67,51	26,49	86,84	0,73	0,28	0,77	**290**	1,11
15.933	BOVISIO MASCIAGO	4,27	66,49	29,07	87,72	0,67	0,22	0,72	**126**	0,79
41.942	DESIO	0,84	58,76	39,03	88,57	0,55	0,25	0,61	**501**	1,19
44.985	SEREGNO	1,85	62,37	35,54	88,78	0,58	0,20	0,65	**440**	0,98
13.596	VAREDO	1,16	62,97	35,65	89,33	0,54	0,23	0,62	**116**	0,85
35.064	BRUGHERIO	1,72	61,42	33,38	87,22	0,55	0,19	0,59	**429**	1,22
9.280	VERANO BRIANZA	7,12	72,81	16,15	85,25	0,73	0,23	0,73	**82**	0,88

23.586	MUGGIO`	0,74	65,25	33,25	89,49	0,50	0,16	0,58	**244**	1,03
13.992	VILLASANTA	1,25	69,13	27,05	89,12	0,49	0,23	0,56	**163**	1,16
23.514	NOVA MILANESE	0,50	63,91	29,48	87,34	0,46	0,17	0,50	**242**	1,03
46.017	LISSONE	1,51	77,78	19,72	90,71	0,46	0,17	0,55	**462**	1,00
123.397	**MONZA**	**0,92**	**80,02**	**18,42**	**91,54**	**0,42**	**0,17**	**0,51**	**1648**	1,34
7.578	VEDANO AL LAMBRO	0,49	89,17	10,29	93,24	0,34	0,16	0,44	**100**	1,32

Table 2: Ecological and Bionomic Data on the 55 municipalities (LU) of the Monza-Brianza Province. Survey of October, 20th 20.

A frame of the main data concerning the ecological and bionomics aspects of the 55 land units (LU), is synthesized in Table 2. These data (elaborated from ERSAF [27] are: Population (2018), FOR % (forest cover), URB% (urbanized), AGR % (cultivated land), HH% (Human Habitat), BTC (Mcal/m^2/year), HS/HS* (Carrying Capacity), BF (Bionomic Functionality). To these data we added the Covid-19 (infected people) and Covid-19 (%). The data are ranked related to rural, suburban and urban type of landscapes. Note that the bionomic data (HH, BTC, HS/HS*, and BF) are complex indicators obtained applying the principles and methods of Landscape Bionomics, as exposed in the cited volume Biological-Integrated Landscape Ecology (Ingegnoli [1]).

The Covid-19 incidence in this Province presents two acute phases: (a) March-May, about 500 to 5,000 infected, and (b) September-October 6,400-14.500. The surveys to verify possible correlations with bionomic and ecological parameters were three: (a) April 19 (4,098 infected), (b) July 31 (5,880 infected), (c) October 20 (9,363 infected). The tested parameters where: (a) Forest Cover (FC, %), (b) Bionomic Functionality (BF, %), (c) Human Habitat (HH, %), (d) Population Age (PA, years), (e) Urbanization (URB, %), (f) agricultural fields, and (g) Carrying Capacity. Remember that, as exposed in Figure 1, the most important bionomic parameter is BF, being able to relate FC and HH.

4. Results

We have to report three results: (a) the former research BF Vs. MR, without which it should have been impossible to have in few months (2020) what it was elaborated in two years (2013-2015), (b) the relationships Forest cover Vs. Covid-19 at regional scale, (c) the correlations of Covid-19 with Forest cover, Bionomic Functionality, Human Habitat, and the other mentioned parameters.

4.1 The former research: MR as function of BF

This research demonstrated that the mortality rate (MR) is correlated with the BF (Figure 4). Note that even the population age (PA) is growing with the degradation of the LU, but the increase of MR is more than four times the increase of PA (0.76 Vs. 0.24); so, the raise of MR with Landscape degradation is mainly due to other physiologic and bionomic processes, first of all the landscape diseases (Ingegnoli [1]; Ingegnoli Giglio [22, 23]). To evaluate a preliminary *Risk Factor* from the MI-MB Model [*BF = 0.78*]:

$$\Delta MR_{BF\,=}\ (MR_{BF} - MR_{BF=1}) \text{ x } 76\% = (8.34 - 7.64) \text{ x } 0.76 = 0.532 \text{ x}10^{-3}$$

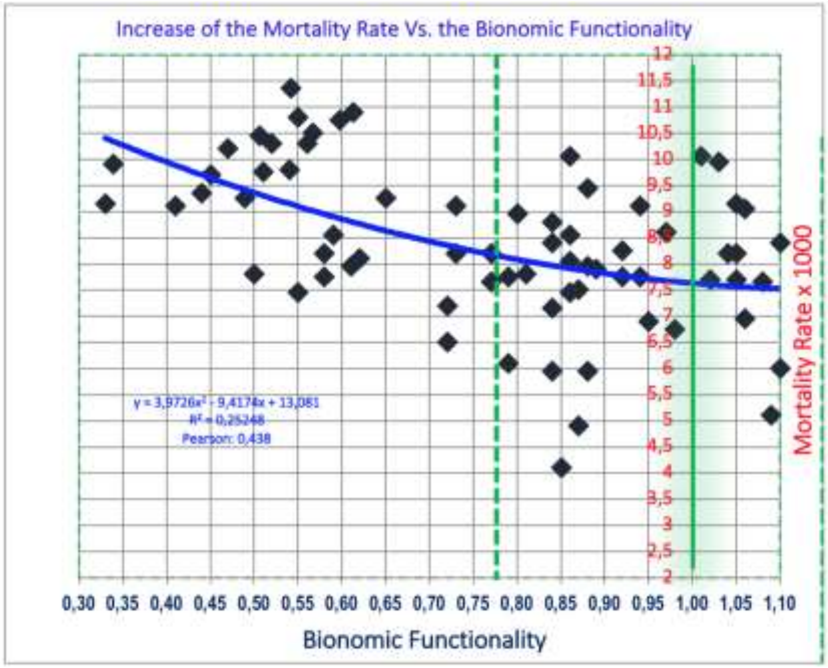

Figure 4: An apparent increase of mortality rate MR [x 1000] is correlated with the increase of landscape dysfunction: we pass from MR = 7.64 in not altered landscapes (BF = 1.0) to MR = 9.5 in the landscape with deprivation of 50% (BF = 0.50) of the normal state. The correlation significance (Pearson) is 1.752.

4.2 The relationships forest cover Vs. Covid-19 at regional scale

Following bionomics' principles, it becomes evident that Lombardy presents serious problems related to the forests. In opposition to the administrative staff, which underlines the growth of forest cover (near 6% in the last decade), bionomic studies (Ingegnoli [12]) demonstrate (a) an incorrect distribution of the forest cover and (b) an insufficient BTC and bionomic efficiency (CBSt). Note that 90% of the population (> 9 million!) live in plains and hills, where the forest efficiency is heavily insufficient, as plotted in Figure 5.

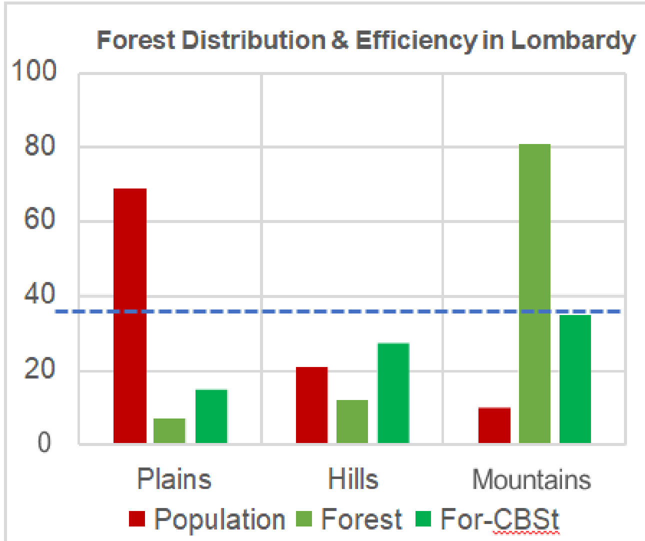

Figure 5: Following the bionomics principles and methods, it is possible to demonstrate that 90% of the population should need 2.7 times of forest cover/capita and 2.1 times of bionomic efficiency (CBSt). The blue dotted segment is the minimum acceptable CBSt threshold.

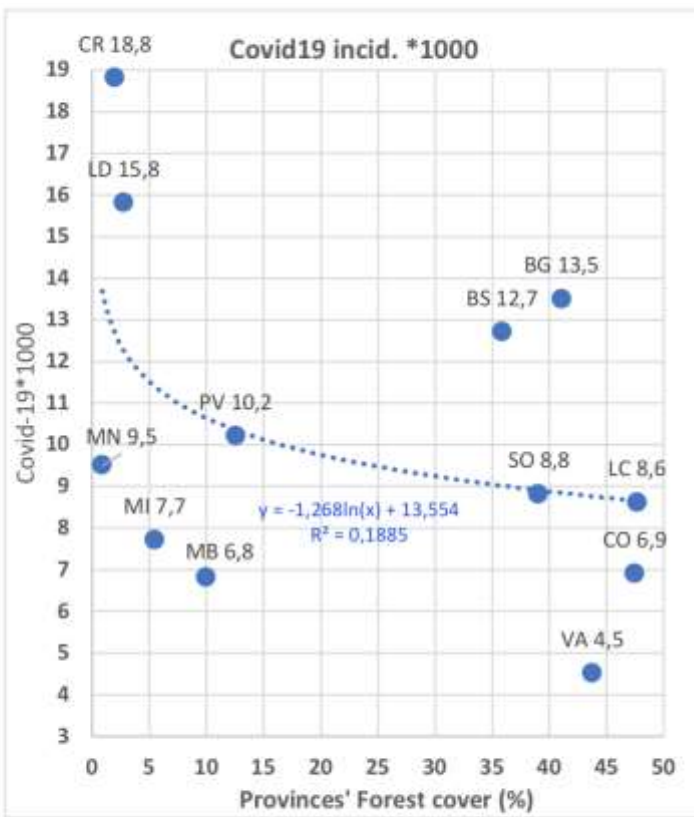

Figure 6: Plotting the 12 Lombardy Provinces Vs. their Forest cover, is evident a possible correlation, presenting a Pearson Correlation Significance of 0.58. Deepen studies are needed at the district scale.

This population may count on 130 m^2/capita of forest protective standard habitat (For-PRT-SH) Vs. 348 (the minimum to express the forest protection on HH), and forest CBSt = 17.2 Vs. 36.0 (min. to express forest efficiency). That is why, if we relate the Covid-19 prevalence to the Forest Cover (FC) of the 12 Lombard Provinces (Oct-07), a first trend emerges: from Covid-19 = 12.5/1000 at FC = 2.5%, to Covid-19 = 8.5/1000 at FC = 50%, see Figure 6 (R^2= 0.189). At Provincial scales (Figure 6), the correlation significance is low (Pearson significance = 0.58) because for instance, in Bergamo and Brescia Provinces FC = 41.1% and 35.9% but 80.5% and 78.6% of their population may count on FC = 4.80% and 4.0%, the remnant being on the mountains. So, we have to deepen the research at a more detailed scale and with other bionomic parameters to add to Forest CBSt.

4.3 The correlations Covid-19 Vs. other bionomic parameters

The first correlation is presented in Figure 7. The trend line has a modest R^2 value (0.1513) but its Pearson Coefficient (Garson [28]) is sufficiently high (0.38). So, *at right* bionomic functionality conditions, *BF=1.0, Covid-19=0.90 %, while at BF=0.45, Covid-19=1.2 % (+133%).* The statistical population of 55 LU of Monza-Brianza province registers a minimum Pearson Coefficient value pair to 0.266. So, the correlation Covid-19 Vs. BF results 0.38/0.266 = 1,45: an available significance of correlation.

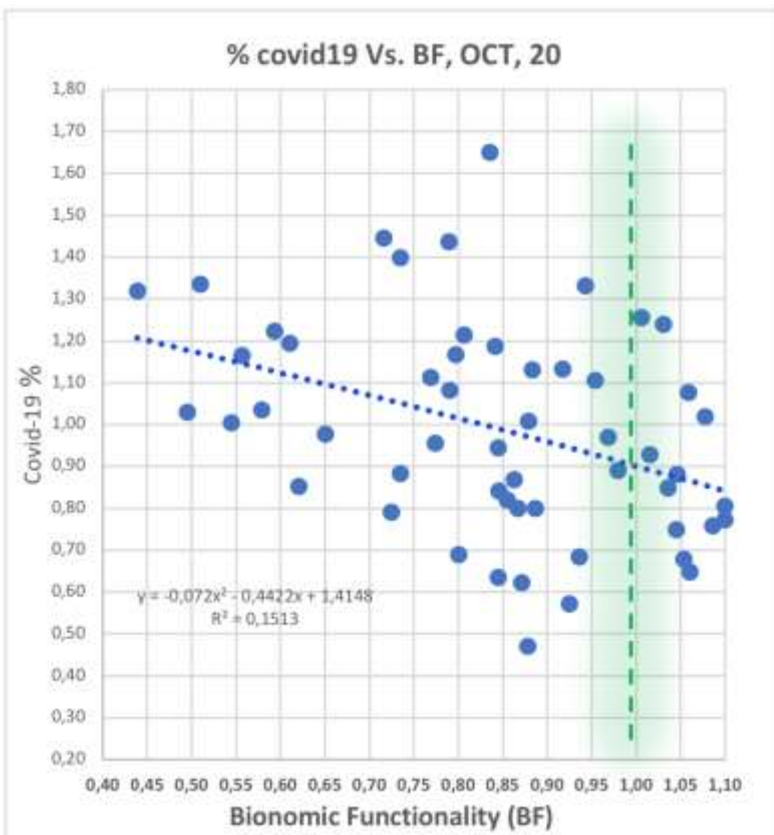

Figure 7: The correlation Covid19 with bionomic functionality (BF) of the 55 landscape units (municipalities) is evident; at BF=1.0, Covid-19=0.90 %, while at BF=0.45, Covid-19=1.2 % (+133%).

In the Table 3, we present the seven bionomic parameters studied in the Monza-Brianza province. The correlation significance of them had shown similar behaviours with increasing precision in the three surveys (Apr-19, Jul-31, Oct-20), so we can show (Table 3) the most recent one (October-20).

October, 20th	**Pearson coeff.**	**Correl. Level**	R^2	**correl.**	**rel. %**
Bionomic Functionality BF	0,38	1,45	0,151	best	100,00
Forest cover %	0,35	1,31	0,146	good	90,34
Human Habitat HH %	0,35	1,33	0,127	good	91,72
Carrying Capacity	0,29	1,10	0,103	good	75,86
Urbanization %	0,23	0,87	0,066	middle	60,00
Population Age (years)	0,14	0,53	0,020	low	36,55
Agricultural fields (%)	0,12	0,44	0,020	low	30,34

Table 3: Significance of the correlations of the bionomic parameters related with Covid-19.

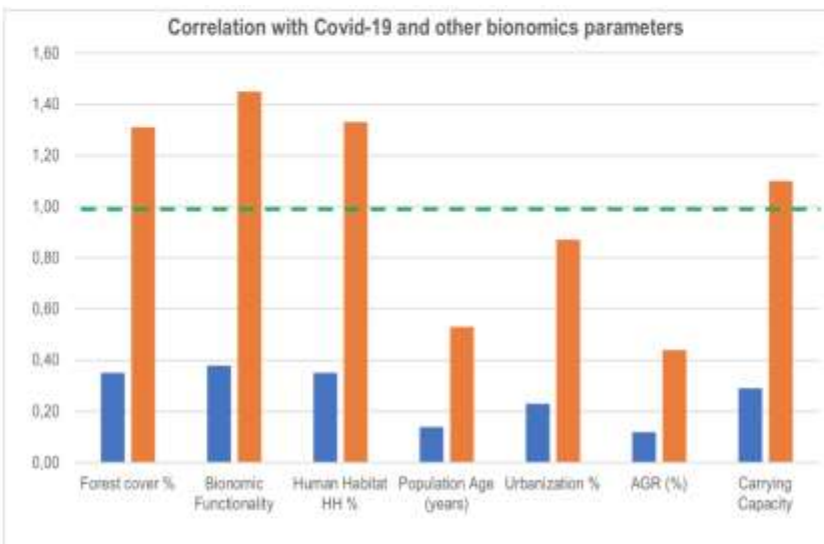

Figure 8: Correlations of the main ecological 'driver parameters' of Covid-19 infections and comparison with BF (systemic index of Bionomic Functionality). Note that BF can synthesize the integration of the parameters of FC and HH. Blue bars = Pearson Coeff., orange bars = correlation significance. Green line is the Significance threshold.

Only four are truly significative (Correlation level >1), even if the other present some partially logical reasons (e.g., urbanization). The bionomic Carrying Capacity, which represents the heterotrophy of a LU, has a modest but evident correlation with Covid-19 %: the less autotrophy of a LU is linked with higher Covid-19 incidence.

As exposed in Figure 8, Forest cover and Human habitat (and first of all BF) have a correlation level CL > 1.30, while the other shows weak-correlations, except the carrying capacity. Population age and Agricultural fields present lower correlations, which increases the importance of the other bionomic parameters. Very similar conditions were found for the Covid-19 Death rate.

5. Discussion and Conclusion

Today both ecology and medicine pursue few systemic characters and few correct interrelations: this fact was underlined in the introduction. Medicine prefers to attend *sick care* than *health care* and rarely follow a complete systemic view, while conventional ecology does not recognize the organization of the environment in complex biological systems. Both Ecology and Medicine reject systemic concepts and have difficulty even to suppose that: (i) a territory is in reality a living entity, identifiable with scientific concept of landscape; (ii) the living entity *Landscape* own a proper evaluable normal health state and is subject to complex pathologies; (iii) these pathologies and dysfunctions (enlightened by a bionomic approach) lead to human disease. However, the health/environment altered relations may bring many etiological paths, as shown in Table 4. In this table, we can see that all the main etiological sets have interferences with the other and that (a) landscape/human pathologies are not limited to pollution, (b) the most critical landscape syndromes derive from structural and functional alterations, and (c) it is necessary to check how these landscape pathologies should be dangerous for human health.

POLLUTION		**INFECTIVE AGENTS**		**AGROFOOD DYSFUNCTIONS**		**ENVIRONMENTAL STRESS**		**LACK OF DEFENCE CONTRIBUTIONS**		**LACK OF HIERARCHICAL RELATIONS**	
direct toxicity	endocrine disruptor	viral & bacterial	fungal & protozoa	OGM Cultivars	Hyper-homogeneous Crops	neural path	hormone path	gut microbiome	phytoncydes	lack of disturbances incorporation	hierarchical disruptions
cumulative impact		cumulative impact		cumulative impact		cumulative impact		cumulative impact		cumulative impact	
complex combined and cumulative impacts and interferences											

Table 4: Health/Environment main etiopathogenesis paths.

It is a fundamental question because any scientific demonstration of these threatening linkages may profoundly change our responsibility and actions to protect our health. Moreover, the recreational factors of the environment changed in the last decades, being today generally far from residential areas and expanding to reach. Today, many environmental components are altered at a wide-scale (e.g., an entire landscape unit, LU, or even a Province), and an alarming stress condition is more diffuse, often in an unconscious way. For these reasons, the spontaneous rebalance of stress has become more complicated, and many illnesses are growing.

A logic flow chart for a wider frame of processes like Stress/Infections is shown in Fig.9. Note that we have to consider two different situations related to the environment and the necessity to refer to both ethology and bionomics. The relation *man/environment* via compared ethology and landscape bionomics presents two different aspects enhanced by the *value judgment* (order Vs. disorder), and these two are linked with two more expansive fields: (a) nature alteration and disease onset (violet) and (b) harmony with nature and defense against diseases (green).

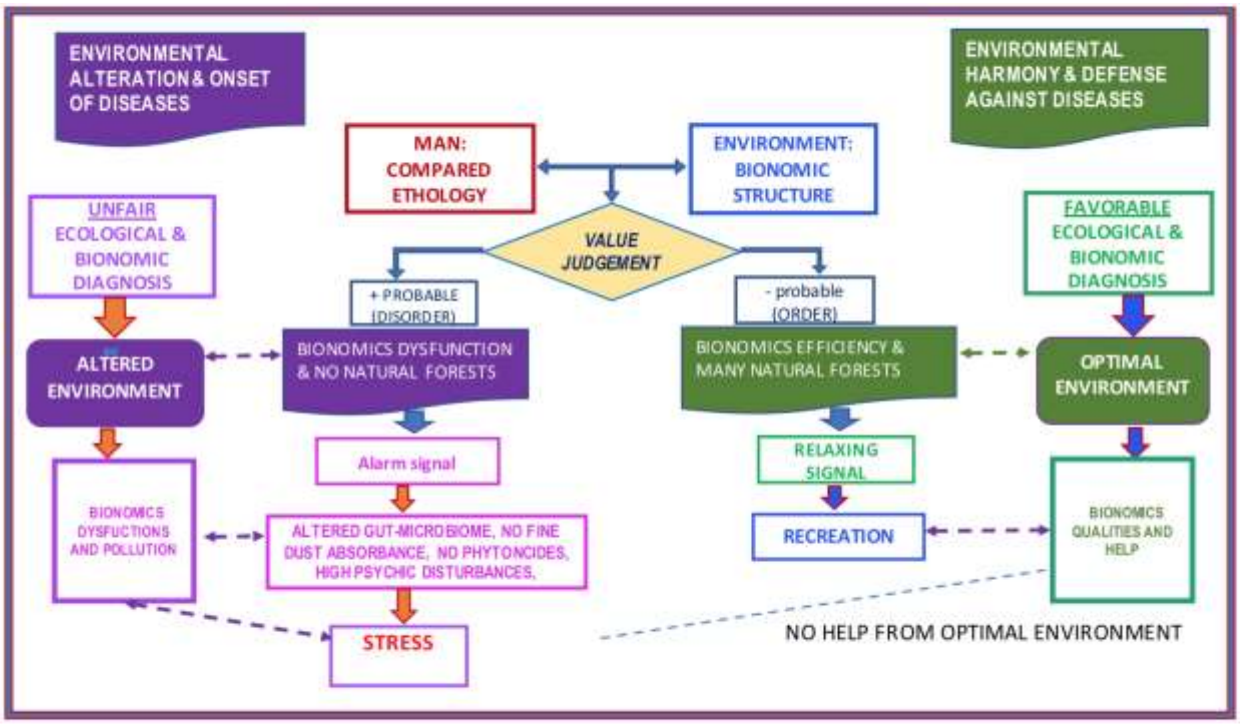

Figure 9: A logic flow chart for a wider frame of processes like Stress/Infections. Note that we have to consider two different situations related to the environment: (a) nature alteration and disease onset, (b) harmony with nature and defense against diseases. Even if the second is becoming rare, we must consider it because prevention is concerned with the rehabilitation of (b).

Even if (b) is becoming rare, we must consider it because prevention is concerned with rehabilitation and therapy. For instance, the increase of nutraceutical components in right food production depends on the *entire bionomic condition* of the environment. Both altered environment and optimal one lead to sequences of processes concerned with our health, interacting with stress and recreation and linked to landscape pathologies and the *pruning effect* (sensu Gogtay et al.,) [29]. It is necessary to enlarge also these fields.

We have to underline that BF/Covid-19 correlation can be referred to Fig.9 because BF depends on the relationships Forest (cover and efficiency) Vs. Human Habitat (nature alterations). The alteration of BF leads to health damages. Many of the stressors are due to landscape structural dysfunctions, *even in the absence of pollution*. An Ethological Alarm Signal leads to *environmental stress*, which can be *chronic*. Stressors simultaneously activate:

- Neurons in the hypothalamus, which secrete CRH (Corticotropin-releasing hormone), and
- Adrenergic neurons.

These responses potentiate each other (Berne and Levy [30]). The final effect of the activation of neurons that secrete CRH is the *increase in cortisol* levels, *while* the net effect of adrenergic stimulation is to *increase plasma levels of catecholamine* (Dopamine, norepinephrine, and epinephrine). The negative feedback exerted by cortisol can limit an excessive reaction, which is dangerous for the organism. However, *when the stress became chronic***,** the circadian rhythm *melatonin/cortisol is altered*. Plasma cortisol levels bring to a *dominance of the Th2 immune circuit*, with typical catecholamine (e.g., IL-4, IL- 5, IL-13) and the circuit Th17. Note that the Th2 immune response is not available to counteract *viral infections, neoplastic cells, and auto-immune syndromes,* requiring a Th1 response. *So, unexpected death risk increases.*

Moreover, the alteration of the vegetation components of a landscape, *especially forests*, leads to other health damages. In short synthesis, these damages are due to:
a- Increase of fine dust (Pm 10 and 2.5),
b- Dysfunctions of Gut Microbiome (GM),
c- Lack of phytoncides (forest essential oils),
d- Lack of Bionomics Range compensations,
e- Increase of zoonotic diseases,
f- Agro-food dysfunctions due to lack of hierarchical relations,
g- Lack of emotional activation and mental being (linked with interferon-gamma).

In summary, we found a convergence between the cited research on the mortality rate (MR) Vs. landscape bionomic dysfunctions (the year 2011-13) and the Covid-19 incidence Vs. BF (the year 2020), working on the same territory, very peculiar, characterized by a gradient of at least five-six landscape types in only 20 km (e.g., Brugherio-Renate). This result also reinforces the PHA (Planetary Health Alliance) sensu Almada et al., [31], whose mission is to understanding and addressing global environmental change and its health impacts.

References

1. Ingegnoli V. Landscape Bionomics. Biological-Integrated Landscape Ecology. Springer, Heidelberg, Milan, New York (2015): XXIV + 431.
2. Fani Marvati F, Stafford RS. From sick care to health care-reengineering prevention into U.S. system, New Engl J Med 367 (2012): 889-891.
3. Bottaccioli F. Epigenetica e Psiconeuroendocrinoimmunologia, le due facce della rivoluzione in corso nelle scienze della vita. Edra spa, Milano (2014).
4. Bottaccioli F, Bottaccioli AG. Psiconeuroendocrinoimmunologia e scienza dellacura integrata. Il manuale. Edra spa, Milano (2017).
5. Ingegnoli V. Landscape Ecology. In: Baltimore D, Dulbecco R, Jacob F, Levi-Montalcini R. (Eds.) Frontiers of Life. Boston, Academic Press 4 (2001): 489-508.
6. Ingegnoli V. Landscape Ecology: A Widening Foundation. Berlin, New York. Springer (2002): XXIII+357.
7. Agazzi E. Science, Metaphysics, Religion. F. Angeli, Milano (2014).
8. Urbani-Ulivi L. The Systemic Turn in Human and Natural Sciences. A Rock in The

Pond. Springer-Nature Switzerland (2019).
9. Ingegnoli V. Bionomia del paesaggio. L’ecologia del paesaggio biologico-integrata per la formazione di un medico dei sistemi ecologici. Springer-Verlag, Milano (2011): XX+340.
10. Ingegnoli V, Bocchi S, Giglio E. Landscape Bionomics: a Systemic Approach to Understand and Govern Territorial Development. WSEAS Transactions on Environment and Development 13 (2017): 189-195.
11. Coker ES, Cavalli L, Fabrizi E, et al. The Effects of Air Pollution on COVID-19 Related Mortality in Northern Italy. Environmental and Resource Economics 76 (2020): 611-634.
12. Ingegnoli V. Infrastrutture Ecologiche e Diagnosi dell’Ambiente. In: Bonizzi, Cordini & Campana, Il Governo dei Parchi. Aracne Ed. Roma (2019): 173-212.
13. Odum EP. Fundamentals of Ecology. Saunders, Philadelphia, USA (1971).
14. Odum EP. Principles of Ecology. Saunders, Philadelphia, USA (1983).
15. Lovelock J, Margulis L. Atmospheric Homeostatsis by and for the Biosphere: the Gaia Hypothesis. Tellus (1974): XXVI.
16. Lovelock J. The Revenge of Gaia: Why the Earth is Fighting Back and How We Can Still Save Humanity. Penguin Books (2006).
17. O’Neill RV, De Angelis DL, Waide JB, et al. A hierarchical concept of ecosystems. Princeton Univ. press, Princeton, NY (1986).
18. Allen TFH, Hoekstra TW. Toward a unified ecology. New York, Columbia University Press (1992).
19. Naveh Z, Lieberman A. Landscape Ecology: theory and application. Springer-Verlag, New York, Inc. (1984, 1994).
20. Forman R.T.T.- Godron M. Landscape Ecology. New York, John Wiley and Sons (1986).
21. Ingegnoli V. Concise evaluation of the bionomic state of natural and human vegetation elements in a landscape. Rend. Fis. Acc. Lincei (2013).
22. Ingegnoli V, Giglio E. Landscape Project Can Limit Bionomics Dysfunction Risk Factor vs. Premature Death Increase. In: Modern Environmental Science and Engineering 2 (2016): 435-444.
23. Ingegnoli V, Giglio E. Complex environmental alterations damages human body defence system: a new bio-systemic way of investigation. WSEAS Transactions on Environment and Development (2017): 170-180.
24. E.S.A. Global air pollution map produced by Envisat's Sciamachy. Heidelberg University, Institute of Environmental Physiscs (2004).
25. Ingegnoli V, Giglio E. Ecologia del Paesaggio: manuale per conservare, gestire e pianificare l’ambiente. Sistemi editoriali SE, Napoli (2005): 685+XVI.
26. Ingegnoli V, Pignatti S. The impact of the widened Landscape Ecology on Vegetation Science: towards the new paradigm. Springer, Rendiconti Lincei Scienze Fisiche e Naturali 18 (2007): 89-122.
27. ERSAF-Dusaf. Land-Use/Land Cover in Lombardy. Regione Lombardia, Milano (2015).

28. Garson GD. Correlation. Statistical Associates "Blue Book" Series Book 3 (2013).
29. Gogtay N, Giedd JN, Lusk L, et al. Dynamic mapping of human cortical development during childhood through early adulthood. Proceedings of the National Academy of Sciences of the United States of America 101 (2009): 8174- 8179.
30. Berne RM, Levy MN. Principles of Physiology. The CV Mosby Company, USA (1990).
31. Almada AA, Golden CD, Osofski SA, etal. A case for Planetary Health/Geo Health. Geohealth 1 (2017): 75-78.