Complex environmental alterations damages human body defence system: a new bio-systemic way of investigation

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Abstract. Few studies focus on environment in its biological dimension, relating territorial/landscape alteration and human health, beyond pollution impact. The growing importance of risk factors in medicine and the new ecological advancements in Landscape Bionomics impose to deepen these studies. The landscape is a living entity, in which man and territory form a complex biological level of life organization. So, a landscape must be investigated in its physiology and behaviour by the discipline of Landscape Bionomics. This to check "if", "how" and "how much" landscape alterations could reflect on human health, independently form pollution. First evidences of a clear correlation subsist, concerning an increase of mortality rate within Milan hinterland (Italy). The Landscape dysfunctions are correlated with the increase of mortality rate MR. All the environmental alterations are registered as 'stressors' by a basilar ethological alarm process. So, bionomic landscape dysfunctions may attempt our health bringing to an excess of cortisol, which reduces our hormonal, immune and nervous system defences. This enlarges the W.H.O. estimation of the environmental MR and the importance of applications impose a true effort in landscape rehabilitation.

Key Words: scientific paradigm, ecology, bionomics, landscape, vegetation science, human health, complex systems, psycho-neuro-endocrine-immunology

1 Introduction

1.1 Change of scientific paradigms

W.H.O. published many reports on the relationships health/environment [1]. How much disease could be prevented through a better management of our environment? The environment influences our health in many ways — through exposures to physical, chemical and biological risk factors and through related changes in our behaviour in response to those factors.

Premature death due to environmental factors results quite heavy: in Italy W.H.O. estimated 14% of mortality due to environmental diseases (91,000 death/year) about 8,400 of which due to lung cancer (atmospheric pollution). In general, we have to underline that the relations health-environment are known to be almost exclusively generated by pollution. Globally, pollution was linked to 1 among 8 deaths in 2012 it is the biggest environmental-health problem [2].

But in recent years many ecologists observe also a strong increase of landscape alterations. The landscape is a specific level of life organization on Earth, therefore it is a living entity as organism and population are [3, 4, 5] and may be afflicted by many pathologies [6, 7, 8]. We find landscape structural and functional pathologies, but also syndromes related to transformation or metastability processes or to 'out-of-scale' disorders.

The aim of the present research is to check the existence of a direct correlation among these pathologies (often related to not responsible human behaviour) and human health.

In facts, very few studies have been made concerning the relation health/environment, independently from pollution. As we can read even on the most important scientific journals, their results are weak [9, 10] or uncertain [11], because of the inadequate methods to assess landscape dysfunctions. They use to consider the percentage of "green spaces" (i.e. urban green, agricultural green, natural green) at a given distance from urbanised areas, that is a poor ecological and non-systemic method. Anyway, the new ecological advancements in landscape diagnosis and the growing importance of risk factors in medicine impose to deepen even these studies. We need a change of scientific paradigm.

Therefore, we must go over the limits of General Ecology, still too reductionist: a new approach to the environment is needed. The discipline of Ecology or *"Speech on our House"* is necessary, but not sufficient: we need also the Bionomics or "*Doctrine of the Laws of Life Organization on the Earth*", within which the landscape is recognised as a proper biological organisation level, characterised by a wide exchange of information between man and his territory. This new perspective inevitably leads to significant changes in how to investigate and manage the environment.

All the branches of Medicine (human, veterinarian, botanical, ecological) are passing a transition phase: this means to pass from a "strong causality" diagnostic criterion, e.g. the infective illness of the past, to a "weak causality", concerning degenerative alterations for which a cause-effect relation is rather not understandable [12, 13]. So, the concept of *risk factor* linked to the 'stress illness' *sensu* Selye [14] is prevailing and Medicine is going to consider more holistic and systemic visions. For instance, neurogenesis may depend on environmental stimuli which bring to stress and this can stop the production of new nervous cells in the hippocampus [15].

Moreover, the epigenetic control of gene expression proves that the phenotype is not directly dependent on genotype [16] and, even, that fractions of the genome methylation pattern can be transmitted in Lamarckian way: that mean to pass from a mechanistic vision, e.g. the 'dogma of Biology' [17], to a complex and systemic one. The expression of DNA is regulated in an epigenetic way by the variations of information transmitted by the environment and by the related human behaviour, so the environment plays a very important role: the genome is programmed by the epigenome [41].

We must underline that the consequences of a risk exposition may surge after quite a lot of time, evermore depending on the efficiency of defence systems both of the organism (man) and the bionomic system (landscape unit). So, we must examine if a risk factor for our health is truly linked to landscape dysfunctions.

1.2 Research in context

The numerous papers related to "landscape alterations and human health" can be divided into four groups, due to: (a) scenery of genetic mutations, (b) effect of toxins from pollution, (c) influence of degraded urbanisation on psychic diseases (d) destruction of ecosystem services. The first set uses the term landscape in a metaphorical way pertaining only to genetics and bio-molecular medicine. The second is the wider one and mainly pertains to toxicology. The third especially concerns major depression disorders (MDD) in degraded suburban areas. The fourth is related to very large areas degradation and climate change, mainly concerning water or food scarcity and alteration.

The present study on bionomics syndromes and human health is probably, to our knowledge, the first to interpret the bio-ecologic state of a landscape unit (LU) –that is the alteration of its structure and functions- as a direct environmental stressor Vs. population living in, at a given diffuse level of pollution, influencing their mortality rate through a reduction of their body defence systems. This greatly enhances our responsibility in environmental protection and rehabilitation.

2 Methods

2.1 The Bionomics theoretical principles and its method

The present methodology is referred to "Landscape Bionomics," or "Bio-integrated Landscape Ecology" [6, 7, 18]. This discipline radically transforms the main principles of traditional Landscape Ecology by being aware that the landscape is a living entity [3, 4, 5] , rather than merely the spatial distribution of species and communities on the territory, often analysed in separate themes (water, species, pollution, etc.) or considered only as beautiful scenery. To be more exact, the landscape is identified as the "the level of life organization integrating a set of plants, animals, and human communities and its system of natural, semi-natural and human cultural ecosystems into a unitary living entity (i.e. an hyper-complex biological system), characterised by proper emerged properties and a certain spatial configuration." The Information Theory, the System Theory, the Non-Equilibrium thermodynamics, the Emerging Properties Principle, an holistic approach become the keys to understand Landscape behaviour [19, 20]. In summary:

a) the *landscape is a complex, adaptive, dynamic, self-organising, hierarchical system* able to exchange and process information, energy and matter, able to grow up, reproduce itself and die in a proper peculiar way. Following this perspective, it must be investigated!

b) landscape bionomics must be considered as *a discipline like medicine*, biologically based and transdisciplinary; the landscape scientist, which we call "ecoiatra", must act as a physician of a more wide and complex level of life;

c) a *normal health state* for each type of landscape can be defined through specific parameters (structure-function, simple-complex, ecology-bionomics) and their *optimal reference frame*;

d) landscape pathologies, but also their *influence on human health*, which may be dangerous *even in absence of pollution*, *must be diagnosed and healed* through a clinical-diagnostic methodology (*the physiology/pathology ratio)*, after a good analysis and anamnesis;

e) a *path to recovery can be prepared, quantified and monitored*, step by step, for each real checked landscape unit, going beyond the out-of-date concept of 'man impact on nature to be restored' with the new concept of *rehabilitation strategy of a living entity*.

In brief, many new principles and methods to study the environment as a complex system are proposed by Landscape Bionomics. Summarising:

f) new systemic functions, e.g. biological territorial capacity (BTC), general landscape metastability (g-LM), efficiency of vegetation (CBSt), Human Habitat (HH) and Standard Habitat per capita (SH), structural- (ψ), functional- (τ) and complex landscape diversity (ω);

g) a new landscape bionomics survey of vegetation (LaBiSV), a method no more based on reductionism and on s urpassed ecological concepts (e.g. climax or linear succession), but referred to systemic concepts and measures (e.g. bionomic quality, bionomic –ecological parameters, BTC, etc.),

h) a new method of human habitat analysis (LaBiSHH), in which all the landscape types have to be recognised as living entities, even the urban one. This fact is confirmed from experiments on real landscape conditions (see Fig.3).

2.2 Updating the correlation Green Space-Urbanisation

The real prevalent importance of vegetation components in the landscape structure and functions has been emphasized by many scientists, which underlined even the necessity to develop new paradigms in vegetation science [21]. These new paradigms were given by the principles of Landscape Bionomics [8, 22, 23] (Fig. 1).

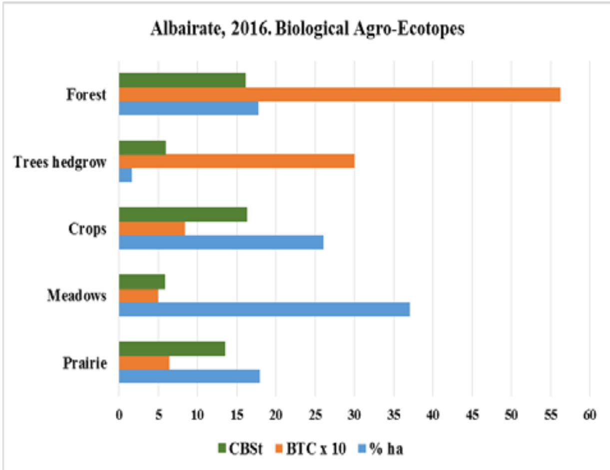

Fig. 1. *Comparison among BTC and CBSt values and the simple surface extension (%ha) of different vegetation types in Albairate rural landscape (Milan): figure shows the inadequacy of evaluating green space only through its surface extension.*

The most synthetic landscape function of vegetation is the biologic territorial capacity or BTC [4, 24, 25] based on:

(1) the concept of resistance stability ;
(2) the principal types of vegetation communities;
(3) their metabolic data (biomass, gross primary production, respiration, B, R/GP, R/B).

This synthetic landscape function is able to evaluate the degree of the relative metabolic capacity of principal vegetation communities and the degree of the relative antithermic (i.e. order) maintenance of the same main vegetation communities. Therefore, it is proportional to the metastability level of a landscape unit. The BTC can be expressed as an energy flux [Mcal/m^2/year] and can be estimated through opportune equations.

An integrated deepen evaluation focus on the *efficiency* of vegetation, through the new bionomic index of Concise Bionomic State of Vegetation CBSt [6, 18, 28], relating the maturity level MtL of a vegetation coenosis and its bionomic quality bQ, both always resulting from a f ield parametric survey.

The previous two indexes allows to express systemic estimations *both of natural and h uman* vegetation types (Fig. 2) and, consequently, to better understand the concrete role played by the examined vegetation community on respect to other basilar landscape parameters, e.g. human health.

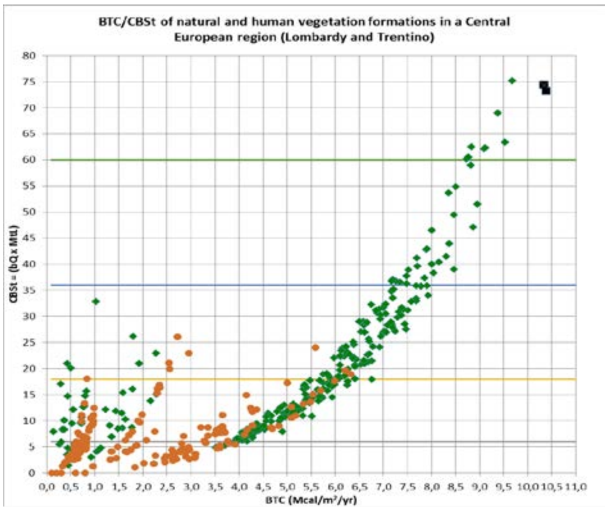

Fig. 2. *Correlation between the BTC and the evaluation of its CBSt, from 430 samples of natural (green) and human (red dots) vegetation, from Lombardy and Trentino (Northern Italy), compared to two case studies from Bialowieza Forest (Poland). Vegetation communities with lower resistance strategy (hence lower BTC) reach a lower bionomic state and show less efficiency.*

Focusing on the human component of the landscape, the basilar function is the HH, human habitat, which gives us a quantitative measure of the areas permanently managed by human population, adding subsidiary energy, so limiting the self-regulation capacity of natural systems (NH): thus, HH goes beyond a simple survey of the urbanised surface.

After the study of 45 landscape units (mainly in North Italy) an exceptional correlation between BTC and HH was found, with an R^2 = 0.95 and a Pearson's correlation coefficient of 0.91 (about three time the minimum value of significance). From this experiment, it was possible to build the simplest mathematical model of bionomic normality (Fig. 3), available for a first framing even of the dysfunctions of landscape units (LU). Below a tolerance interval (0.15 from the curve of normality) we can register three levels of altered *bionomic functionality (BF):* normal BF (1.15-0.85), altered BF (0.85-0.65), dysfunctional BF (0.65-0.45) and degraded BF (< 0.45).

Following bionomic principles the carrying capacity (σ) of a LU, too, can be measured, as the ratio between the standard habitat per human capita (SH) and the theoretical minimum SH*. This SH index, deduced from nutritional and ecological parameters [6, 7] (available also for the fauna component, with proper values), gives also the level of heterotrophy of a landscape unit, whose minimum may be considered SH = 0.75-0.80.

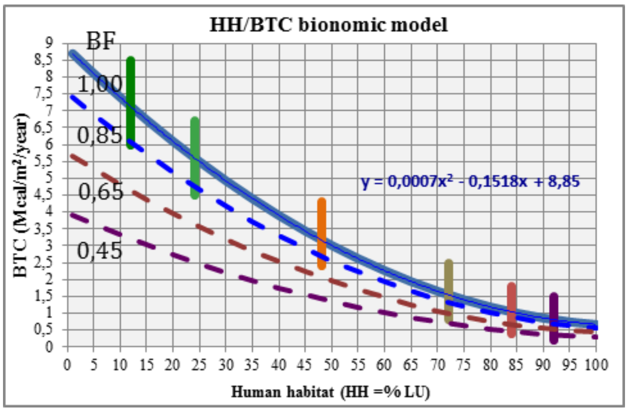

Fig. 3. *The bionomics model HH/BTC (Human Habitat-Biological Territorial Capacity of vegetation) in which the BF curves (dotted lines) indicate the functionality of the examined LU.*

2.3 The frame data for investigation

The choice of a land area of experimentation presenting an available gradient of 5-6 types of landscape (from dense urban to agricultural-forested) was facilitated by living in Milan, one of the largest metropolitan areas of Europe (close to 5 million inhabitants).

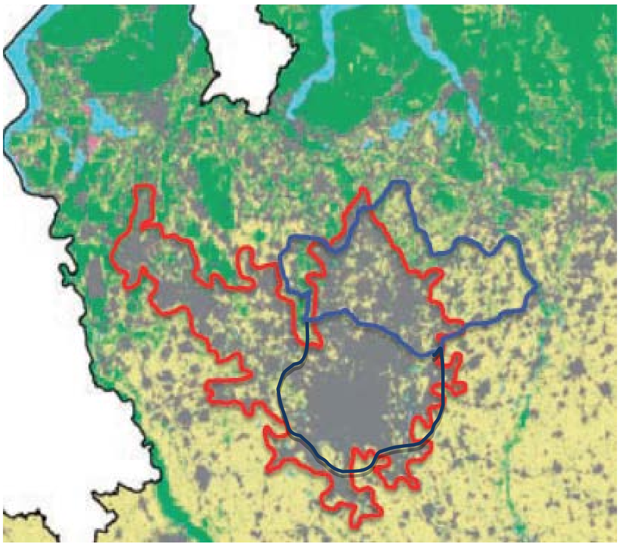

Fig. 4*. The blue-grey lines indicate the land area of experimentation, consisting of Monza-Brianza province (North) and the city of Milan (South), within the great hinterland of the town of Milan (red line). This territory cover 655.9 Km^2 with a popul ation of 2.5 x 10^6 inhabitants and with a gradient of at least 5-6 landscape types. [26].*

As plotted on Fig. 4, the blue-grey lines indicate a territory covered by the province of Monza-Brianza (North) and a portion of the province of Milan (South): in summary 655.8 Km^2, 2.5×10^6 inhabitants with a gradient of at least 5-6 landscape types (Tab. 1).

Tab. 1. Six landscape types and their bionomic characters in the study area

Landscape Type	HH	BTC	MR	PA	BF
Agricultural	72,00	1,68	7,11	42,38	1,08
Rural	*78,16*	*1,25*	*8,33*	*42,66*	*0,98*
Suburban-Rural	*83,62*	*0,89*	*7,62*	*42,57*	*0,84*
Suburban-Tech.	*88,41*	*0,61*	*8,66*	*43,47*	*0,67*
Urban	92,17	0,44	9,45	44,75	0,54
Dense urban	*93,65*	*0,39*	*9,57*	*45,08*	*0,41*
Mean	*84,67*	*0,88*	*8,46*	*43,49*	*0,78*

MR = mortality rate; PA = Population age; BF = bionomics Functionality

Note (Fig. 5) that not only Milan, but also Monza and Brianza are contained within one of the most air-polluted area of Europe [27], therefore pollution could be considered as homogeneous in our sample land area.

We have to note that the city of Milan was analysed by being divided into its 9 administrative sections, to have data comparable with the other municipalities, both in surface and population. Remembering the carrying capacity $\sigma = SH/SH^*$, few municipalities reach its minimum value in our territory, thus being heterotrophic.

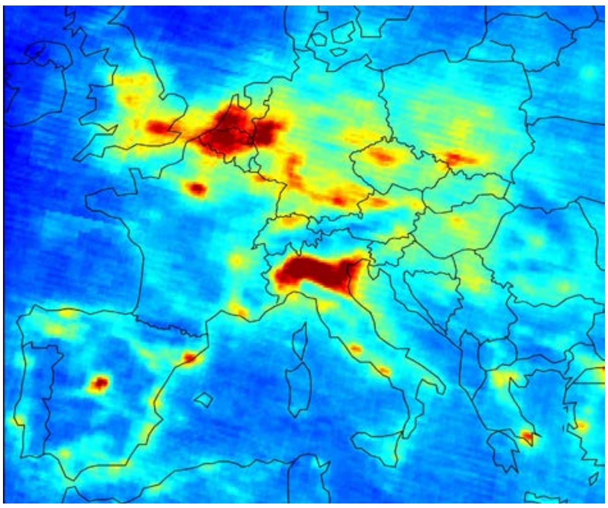

Fig.5. *In the Po plain the distribution of air pollution is quite homogeneous and one of the most high in EU. Not only Milan but also Monza-Brianza are inserted in this wide polluted area (from E.S.A [27])*

The biological territorial capacity of vegetation (BTC) was estimated both with field surveys and the registered statistical data on the main types of vegetation. The evaluation of concise bionomic state of vegetation (CBSt) better allows the assessment of the forest vegetation in the entire Monza-Brianza Province. vegetation". Fig. 6 exposes the most significant set of forest assessment surveyed on the field. The modest value of the mean territorial capacity, BTC = 5.84 Mcal/m^2/year, is confirmed by the presence of 57.14 % of altered and weak forests, Vs only 19.05 % of good ones.

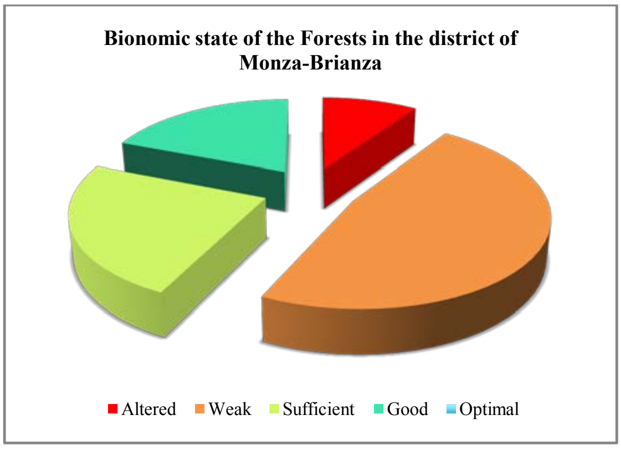

Fig. 6. *The bionomic state of the forest formation on the Province of Monza-Brianza shows only 19.05 % of good conditions and no one in optimal one.*

Considering our 72 LU, these range of values were registered: human habitat HH = 66-97 (% of LU); biological territorial capacity of vegetation BTC = 2,01-0.24 (Mcal/m^2/year); mortality rate MR = 4.10-11.35 (x 1000 inhabitants); population age PA = 38.6-47.1 (years); level of alteration or degradation of functional bionomic state BF = 1.10-0.34.

Only 30.56% municipalities (22/72) were found in a normal condition (BF ranging between 1.15-0.85), while 34.72% of them (25/72) were in dysfunctional or degraded condition, the other being altered. These levels of BF were obtained comparing the mean BTC of each LU with the value given by the BTC model (see Fig. 3) corresponding to the LU value of HH.

3 Results

Plotting the results of the previous Tab.1 related to the unit, we reach a first evidence of the increase of mortality rate (MR) when the bionomic functionality (BF) is decreasing from normality (BF = 1.0)

Traditional ecology states that the increase of the mean age of a population (PA) indicates a very developed country and also less negative environmental factors. On the contrary, in figure 7 we see that the increase of population age is linked to an increase of landscape degradation: causes and effects need further investigations. However, the contrast between traditional and bionomic interpretation is not so strong as it may appear. We may observe that PA is correlated with the landscape dysfunction in a way very similar to MR (Fig. 7).

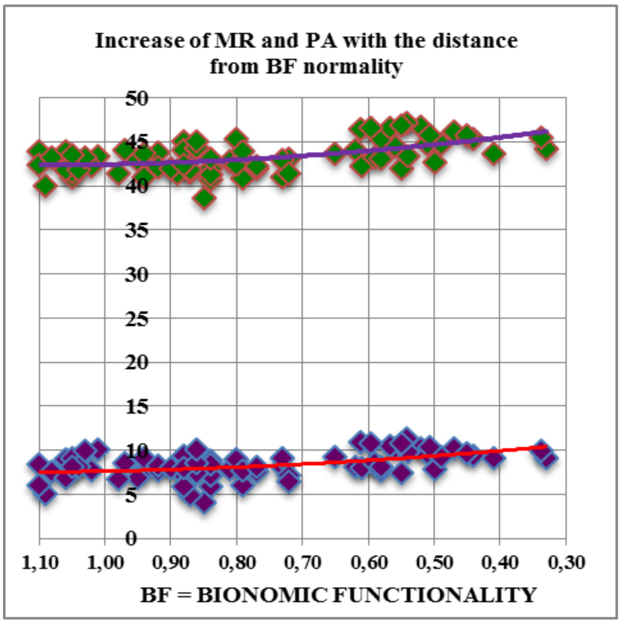

Fig. 7. *MR (mortality rate, violet and red) and PA (population age, green) plotted in function of BF.*

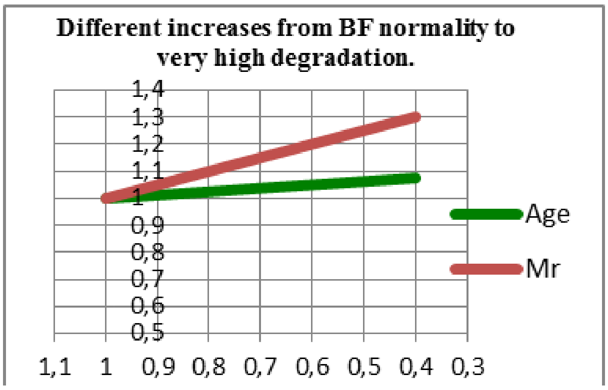

Fig. 8. *Different increases of MR and PA related to the decrease of BF (from 1 to 0,4)*

Note that the increase of *PA = f (BF)* cannot be read as the reason for the parallel increase of MR. If we examine our two comparing functions, *MR = f (BF)* and *PA = f (BF)* (Fig. 8), we note a sharp difference: e.g. going from the point of full normality (BF = 1,0) to a point of very high degradation (BF = 0,4), PA increases only 7.3 %, while the MR increases 30.3 %. This signifies that merely 24 % of the MR increase can be attributed to the PA, therefore 76 % being due to other causes as, remember, all the area presents the same level of pollution. Being very contained, the increase of PA seems to imply limited negative environmental factors.

Detailing the 72 LU, the correlation MR/BF (mortality rate/bionomic functionality) emerges (Fig. 9). The result of *MR = f (BF)* presents the $R^2 = 0{,}252$, but the Pearson's correlation coefficient is (-0,438) that is twice the minimum value of significance: therefore MR increases with BF diminishing. At full normality BF is pair to 1.00 and MR = 7.64, becoming MR = 7.95 at BF = 0,85 but MR =10.27 at BF = 0.35, enlightening deep dysfunction.

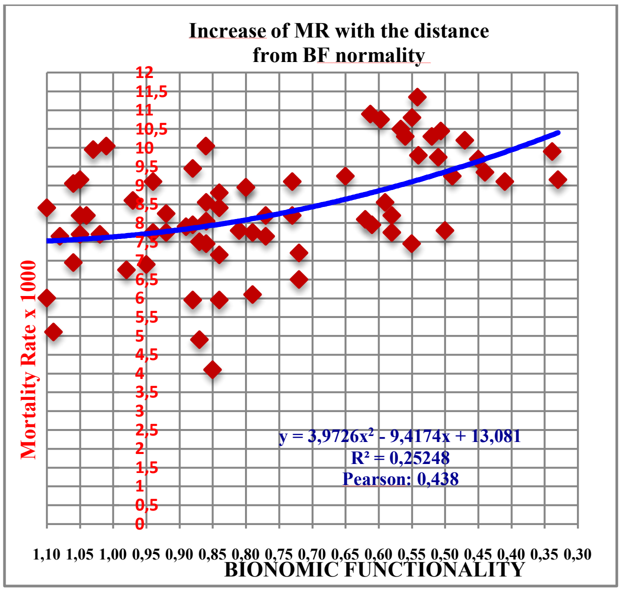

Fig. 9. *Correlation between Mortality Rate and Bionomic dysfunction in 72 Landscape Units of the Milano-Monza (MI-MB) Area. The Pearson coefficient is twice the minimum values of significance.*

A first base to estimate a Risk Factor can be deduced from Tab. 1: the mean BF is 0.78, therefore

$$\Delta MR_{BF} = (MR_{BF} - MR_{BF=1}) \times 76\% =$$

$$(8.34 - 7.64) \times 0.76 = 0.532 \times 10^{-3}$$

Consequently, the estimation of premature death (PD) probability due to BF (PD_{BF}) can be measured remembering that the total population in the study area is 2.524 millions:

$$PD_{BF} = (2{,}524 \text{ x}10^{6}) \text{ x } (0.532 \text{ x}10^{-3}) = 1{,}342.7/\text{year}$$

This huge number of premature death/year can be compared with the total death number (TD) in this area, that is TD = 21,050 people/year. The rate

$$PD_{BF}/TD = 6.4\%$$

This high Mortality Rate results similar to the fine dust premature death (PD_{FD}) = 7.0 % related on the Milan Metropolitan Area.

4 Interpretation

4.1 Theory explaining the results

First of all, there is a basilar ethological question, linked to information, meaning and survival, therefore to the concept of "values-judgment" [29]. This implies a correspondence between the perception of values and the passage from the most probable and disordered to the most ordered and improbable. The scale of values derived from this fundamental process can be applied to judge the health of an organism or of a landscape. This ethological process has an alarming meaning [7]: so it registers all the environmental alterations, which remains memorized within our cells. To reach this goal the ethological process have to be innate and unconscious, because to de-codify environmental signals we must reduce emotions. Remember that subconscious mind is able to process $20 \text{ x } 10^{6}$ environmental stimuli/sec, Vs. only 40 stimuli/sec. of the conscious mind.

The ethological information on the state of our environment can be elaborated following the principles of psychoneuroendocrinimmunology [15, 30]. For instance, an emotional or alarm signal registered in dACC is correlated with an increase of plasmatic levels of a basilar inflammatory cytokine (type II of TNF). So, a direct relation between psychic stress and inflammation is demonstrated [31]. Moreover, the effects of hormones on immune system depend mainly on nervous systems and the hemato-encephalic barrier is today considered as a mistake.

Berne and Levy within their book "Principles of Physiology" [32] section VIII "Endocrine System" (written by Saul. M. Genuth) [33], discuss the integrated responses of the body to stress. The sympathetic nervous system and the hypothalamus-pituitary-adrenal axis mediate the integrated responses of the human organism to stress. The main factors that cause stress (stressors) simultaneously activates neurons in the hypothalamus, which secrete CRH and adrenergic neurons [34].

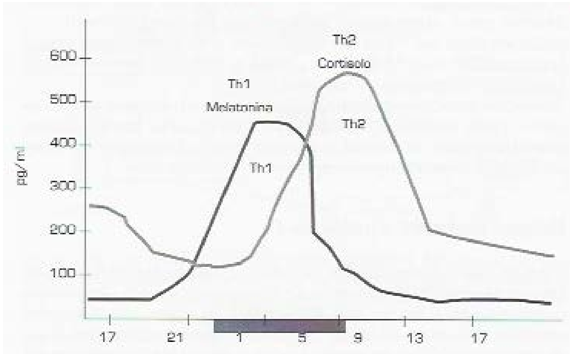

Fig. 10. *The complementary circadian rhythm of melatonin and cortisol is strongly influenced by chronicle stress. Note the relations with the type Th1 and Th2 of immune circuit [35].*

These responses potentiate each other, both at the central and the peripheral level. The final effect of the activation of neurons that secrete CRH is the increase in plasma levels of cortisol, while the net effect of adrenergic stimulation is to increase plasma levels of catecholamine. The negative feedback exerted by 17-hydroxicorticosterone (cortisol) has the function to limit an excessive reaction, which is dangerous for the organism. But when the stress became chronicle the circadian rhythm melatonin/cortisol (Fig. 10) is altered. Consequently, plasma levels of cortisol brings to a dominance of the Th2 immune circuit, which a production of typical catecholamine (e.g. IL-4, IL-5, IL-13) and of the circuit Th17 [18].

Remember the Th2 immune response is not available to counteract viral infections, neo-plastic cells, auto-immune syndromes, which should need a Th1 response. We can deduce that the majority of illness is linked with chronicle stress conditions, confirming the intuitions of Selye [15]. A strong increase of morbidity inevitably brings to an increase of mortality rate (MR).

In his book "Landscape ecology, a widening foundation" [7] within section 5.5 "Landscape pathology and human health", Ingegnoli noted that the abovementioned stressors can be frequently due to landscape degradations. In facts, psychic disorders, aggressiveness and high morbidity are evident in many degraded urban peripheries [36] or in many rural areas altered by monoculture, destruction of trees and hedgerows, highways, industrial buildings. In the case of landscape disorders due to structure degradation and the alteration of normal bionomic processes (even in the absence of pollution), the stressors tend to be chronic and the physiologic mediation of cortisol may become insufficient. Therefore, landscape dysfunctions, even in absence of pollution, may attempt our health bringing to an excess of cortisol, which reduces our hormonal, immune and nervous system defences. The increase of the most common syndromes depend also on this process: first of all cardiovascular diseases, cancer, but even minor diseases such as allergies.

Today we may complete this theoretical interpretation of the increase of illness, therefore of MR, in dysfunctional landscapes. Landscape bionomics allows to assess and measure the level of environmental dysfunction, as exposed in the second paragraph (method).

Theoretically, even in absence of pollutants the environmental stress can be alarming, because an excess of cortisol can reduce our hormonal, immune, nervous and mental system defences. Anyway, it assumes a wider importance in case of high pollution, when our defence systems have to fight strongly to avoid the effects of toxins and degenerative diseases. Moreover, the increase of population age (PA) implies a decrease in birth rate, that traditional ecology asserts to be caused by social and economic reasons. But landscape bionomics observes that birth decline is due also by environmental degradation which may inhibit sexual fertility and reproduction [32].

4.2 Main consequences of Landscape Pathologies on Human Health

As expressed in the introduction, the environment influences our health through exposures to physical, chemical and biological risk factors, and through related changes in our behaviour in response to those factors. So, we must note that in case of landscape pathologies not only insidious stressors and consequent illness compare, but also an altered behaviour which in turn worsens the conditions of the alteration of the landscape, initiating a dangerous exalting feedback.

Today we know that, during adolescence, different parts of the brain mature at different rates. Neural connections increase after the birth to about 5 years. An average decrease in "grey matter" volumes between ages 5 and 20, thanks to the "pruning" of neural connections (for best environmental fitness) has been demonstrated. Areas that mediate "executive functioning" mature later than areas responsible for basic functions [37]. Therefore, artificial environments seems to attract more and more young people and to submit urban green to technology as sign of a New Babylon.

Let us observe that the two processes we exposed before, the 'growth & pruning neural synapsis' and the 'environmental stress alarm', have to be obviously integrated in relation to landscape pathologies and human health. In figure 10 a logic flow diagram tries to explain their main linkages and loops.

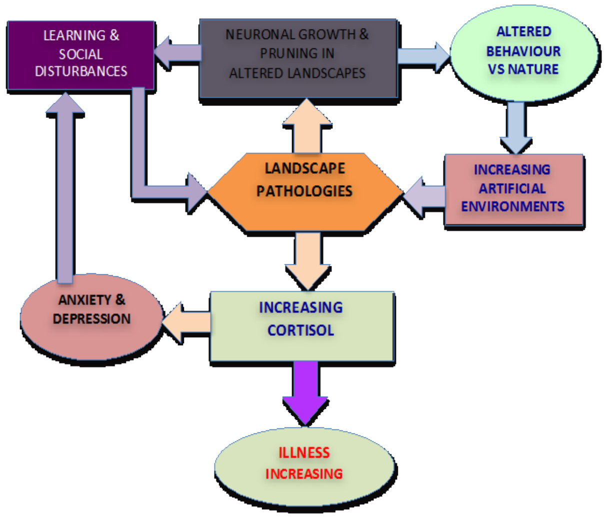

Fig. 11. *Logic flow diagram on the main consequences of landscape pathologies on human health. Note the formation of three feedback loops, which can aggravate the landscape syndromes, therefore the consequences on illness and MR.*

If neuronal growth and pruning process operates in altered landscapes, all this can results in an altered behaviour Vs. Nature, bringing to increase artificial environments, than intensifying landscape pathologies: a typical positive feedback loop. But another behavioural feedback loop appears when an increase in cortisol brings to increase arousal and aggression; then learning and social disturbances lead to act against natural lows, thus degrading ecological components and producing a new intensification of landscape pathologies. Chronically elevated cortisol levels have been linked to problems including abdominal fat gain, cognitive decline and compromised immune function. Note that learning and social disorders are reinforced by the altered neuronal growth & pruning.

4.3 Importance of applications

In presence of pollution, drastic changes of impact assessment derive from the found correlation MR/BF (Fig. 12). When pollution is strong, the BF risk factor enhances the effects on premature death.

The case study of Vado Ligure carbon-powered plant of electric energy can be of great significance. Lung cancer mortality (x 100.000 inhabitants) results 54.6 in Italy, 83.5 in Savona Province, but 112.3 in Vado Ligure. This municipality is not only polluted, it's heavy altered by landscape syndromes (Fig. 12), from industrial and harbour areas to forest and agricultural degradations. Therefore, after the cited theory, the so high MR is due not only by chemical pollutants, but also from BF alterations, when our defence systems have to fight strongly to avoid the effects of toxins and degenerative diseases.

Fig. 11. *The municipality of Vado Ligure (Liguria, Italy), with the carbon-powered electric plant.*

This fact must be added to the effects of endocrine disruption chemicals (EDC) in humans. It is well known [38] that, for a clinician taking care of an individual patient, numerous challenges in ascertaining EDC involvement in a particular disorder are possible:
- each person has unique exposure to a variety of both known and unknown EDCs. Considerable variability in the half-life and persistence of EDCs, as well as their degradation in body fluids and tissues, are created by individual differences in metabolism and body composition;
- Susceptibility to EDCs may vary according to genetic polymorphisms. In addition, human disorders are more likely the result of chronic exposure to low amounts of mixtures of EDCs. The latency between exposure to EDCs and occurrence of clinical disorders creates further challenges when one attempts to establish a relationship at the level of a given individual.

Anyway, even if the International Association for Impact Assessment (IAIA) correctly indicates 'cumulative impacts' as the most important health/environment studies [39], today the procedure to evaluate a case study like Vado Ligure is the scheme limited to the left of Fig. 12. The difference with the right part of this figure is sharp.
The effects of landscape pathologies on human health bring not only to an integration among different types of EDC and geo-physics parameters, but even among the biologic-structural parameters of the landscape (see the flow chart differences!). Thus, the bionomic indexes and models become very important also in bio-monitoring and we need to refer to a new professional figure, the ecologist-physician or "ecoiatra", able to face the diagnostic evaluation of the landscape.

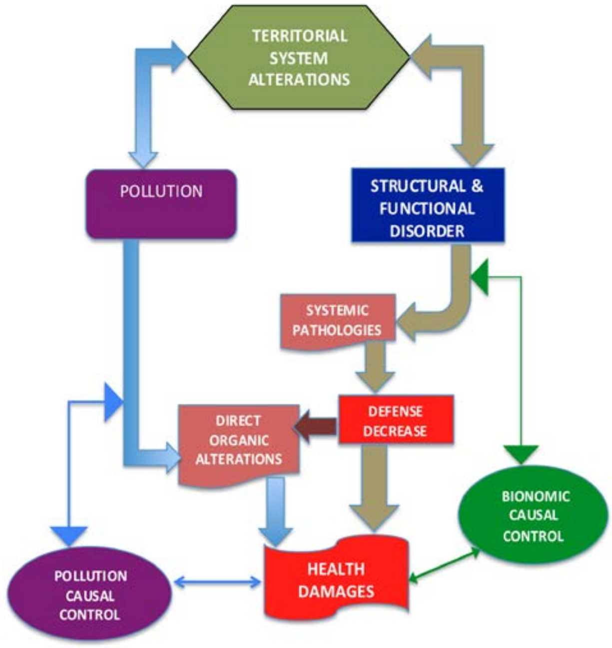

Fig. 12. *Logic diagram of the screening for a c ase study like Vado Ligure. Note that the health damages go beyond the direct organic alterations.*

5 Conclusion

To understand better the relation between the environmental dysfunctions and human health, the new discipline of Landscape Bionomics confirms to be indispensable. It allows the formation of an "ecoiatra" as the physician of the environment. Also a d eeper exchange between Medicine and Ecology-Bionomics should help these researches, as proved after the Seminar on this argument hold by Ingegnoli (2016, May) at the Sapienza University of Rome, Department of Experimental Medicine.

The Author is in touch with IAIA (International Association for Impact Assessment) for the same argument. In facts, the importance of environmental protection and rehabilitation may be reinforced by the linkage health-environment, while in too many cases people follow banal urban-gardening solutions. It must be known that we cannot arrive to protect even the human health if we do not follow a true scientific approach on environmental rehabilitation [40].

Evident limits are related to the dominant reductionism in scientific researches. For instance, in the evolution processes, an overvaluation of the genetic determinism comes from the underestimation of the environment. Therefore, a new approach to the environment is needed. The discipline of Ecology or *"Speech on our House"* is necessary, but not sufficient: Bionomics or the "*Doctrine of the Laws of Life organisation on the Earth*", even outside the organism, is needed too; the landscape has to be recognised and investigated as a peculiar biological level. This new perspective inevitably leads to significant changes in how to assess and manage the environment.

We hope that a study like the one exposed in this paper should be repeated in other countries both in Europe and in USA, to arrive to a better definition of risk factor on the estimation of premature death (PD) probability due to BF (PD_{BF}).

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