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Visions for Sustainability

Visions for Sustainability is an indexed scientific journal published in open access by the Interdisciplinary Research Institute on Sustainability (IRIS). The journal promotes a debate on how the concept of sustainability can be addressed and applied in existing and foreseeable societies worldwide. Particular emphasis is placed on facilitating communication between researchers of different disciplines, supporting educational projects and examining the role of contemporary science in dealing with issues related to sustainability. Papers are welcome from researchers and scholars of natural, political, social and other sciences as well as philosophical and humanistic disciplines, and in particular from anyone wishing to make a contribution which combines multiple viewpoints. The aim is to host as wide a range as possible of multidisciplinary, interdisciplinary and transdisciplinary perspectives on sustainability. Discussions or comments on articles which have previously appeared in the journal are also welcome. All submissions will be refereed before publication.

Articles can be submitted directly online at the journal website http://www.ojs.unito.it/index.php/visions through the login procedure. Any further questions and/or submission enquiries can be addressed to g.barbiero@univda.it or martin.dodman@gmail.com.

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To connect or not to connect. Is that the question?

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Life matters

The current oxygen content of the Earth's atmosphere has been relatively stable at around 21% for almost 600 million years. This is principally determined and rendered sustainable by the connections and the interactions between producer and consumer organisms within the carbon cycle and is fundamental for most forms of life, including that of human beings. In a state of hypoxia, death or permanent cerebral damage can take just a few minutes. Even the most basic functions of the brain are unsustainable without oxygen. If one human being cries "I can't breathe!", then this is the most dramatic call for help possible, to which any other human being in a position to do so should respond with all available means.

Medical staff act to save lives as an existential (and ethical) imperative - for themselves and those they treat – through the spontaneous and reflexive exercise of the competences they have developed during their professional practice and learning. Others can try to intervene spontaneously by drawing on previous experiences that, within certain limits, may assist someone in need. In all cases, being human should mean connecting with each other by acting and interacting to do one's utmost to recreate the conditions necessary for the sustainability of life as such, and most particularly when it is in danger.

In recent weeks, we have all witnessed an atrocious paradox. Tens of thousands of nurses and doctors the world over have given and continue to give their all (including their own lives) to help fellow human beings counteract the potentially devastating consequences of COVID-19, a previously unknown viral infection causing a severe acute respiratory disease that can lead to hypoxia. At the same time, our attention has also been captured by an episode in which a number of police officers have deliberately caused a state of hypoxia in another human being and ignored

– or indeed – impeded all pleas or attempts to help him.

On the one hand, we could say that such a contrast defies imagination. Yet on the other, it renders with overwhelming clarity a vision of the immense contradictions that characterize humanity, its behaviours, its societies and its evolution as a species. These contradictions are part of a wider framework of connections and interdependence that form the very fabric of our lives, as of all life. If at times there is the need to cry out that "*black lives* matter", this is because *all lives* matter and *all life* matters, without discrimination. If, at times, there is the need to repeat that "if you hurt *one*, you hurt *all*", this is also because damage to life *anywhere* is damage to life *everywhere*.

Webs of connections and intersecting spheres

Like that of all species, the evolution of *Homo sapiens* has taken place – and continues to do so – within multiple webs of connections that, in turn, are both within and between intersecting spheres. The *biosphere* is the theatre in which constantly shifting *planetary and eco-systemic connections* give rise to – and are impacted by – interactions between us and all the other biotic and abiotic elements that are present. This in turn can lead to all-pervasive outcomes such as climate change and biodiversity loss and the cascading catastrophic consequences of these phenomena. The *resourcesphere* is the stage we have constructed on which our *social and economic connections* have given rise to highly complex – often uncontrolled and potentially explosive – interactions between different forms of what is commonly called *capital* – natural, produced, human, financial and social – as well as manifest and multiple levels of imbalance, inequity and injustice as regards the distribution, the use and the availability of each of these resources. Both the *noosphere* of our mental activity and the *infosphere* of our informational entities are platforms we have created on which *scientific and technological connections* have given rise to a massive expansion in knowledge building and sharing. At the same time, this process is inextricably connected to increasingly rapid digital innovations that greatly increase our capacity to store information and also rapidly transform and frequently – although not necessarily – distort both our communication flows and our processes of production and consumption.

As we write this editorial for the thirteenth issue of *Visions for Sustainability*, we find ourselves, like all humanity, in the middle of the dramatic COVID-19 pandemic, an *extra-ordinary* period of *e-mergency* (*e-mergere*: "come to the surface", "let what was hidden be seen"), in which a minute biological entity, Sars-CoV-2, has laid bare all the fragility – and the limits – of humanity's current dominant structures and trajectories. In the words of Partha Dasgupta and Inger Andersen, in an article published on June 5 by *The Independent* newspaper on the occasion of World Environment Day, "COVID-19 is nature sending us a message. In fact, it reads like an SOS signal for the human enterprise, bringing into sharp focus the need to live within the planet's means. The environmental, health and economic consequences of failing to do so are disastrous"[1].

At the same time, it is fundamental to recognize that nature's message is for one of its own parts – we human beings. Nature is not something external to us, something that periodically invests us with perturbations, disasters and destruction that we should be able to interpret as messages it send us, while at other times we can indifferently continue to exploit it for our own supposed benefit, extracting its resources and poisoning it with our waste. In the same way, the proliferation of pathogens like viruses is not just something that has *happened to us*. It has been significantly increased by human activity such as farming, transport, complex trade links and our congregation in dense cities. While economic models may separate the concepts of natural and produced capital for the purposes of analysis, these are in fact both inextricably entangled parts of cyclical feedback loops that we must incorporate into our ways of thinking and being – both as intelligent understanding of and intelligent action in the world we inhabit. This fact should induce in us above all a profound and wide-reaching reflection on ourselves first and foremost as *natural natives* (whether we were born before or after the advent of digital technology) in terms of our connections to and interactions with nature, the place (*oikos*) where all of us are born and that sustains our lives and all life. It is by now abundantly clear that all the crises that today most occupy our attention – climate change, loss of biodiversity, a virally-induced health crisis – are

[1] https://www.theguardian.com/world/2020/jun/05/coronavirus-is-an-sos-signal-for-the-human-enterprise

interconnected. This is because everything is systemic, in that every part of our world and everything that happens there is related to, affects and is affected by every other part and everything that happens there. Recognition of this means that all our thinking has to be systemic and thereby in-formed by the awareness this vision brings and the ensuing action it should guide.

Imbalance and inequity, inequality and injustice

The year 2019 gave rise to widespread protests and demonstrations, largely inspired by young people, that expressed particular concern about the dangers ensuing from changes in the Earth's climate and the need to take immediate action. The urgency of the threat posed was then dramatically highlighted at the beginning of 2020 by the wildfires that erupted in the region of the temperate forests in Australia and which captured public attention not only for the devastation caused but also for numerous examples of solidarity between animals (including humans) as they struggled to protect and care for each other.

It has long been recognised that human activities cause changes in the Earth's atmosphere in the quantities of greenhouse gases or aerosols that, in turn, contribute to climate change. The largest known contribution still comes from the burning of fossil fuels and the subsequent release of CO_2. Wherever this is emitted, it then travels everywhere through the air and causes global warming that invests the whole planet. There has also been growing recognition that the loss of biodiversity leads to a breakdown in the functioning of interdependent ecosystems and the roles played within them by different species in terms of ecosystem productivity and services, once again with planetary consequences. The Australian wildfires made it vividly clear to large numbers of people all over the world how climate change and the loss of biodiversity are interconnected. Even more recently, however, we have also come to understand how biodiversity loss, such as that caused by the destruction of rainforest, can give rise to the emergence of viruses hitherto confined to a particular habitat, but which possess an equal capacity to rapidly spread over the entire earth once they pass from one habitat to another and from one living organism to another.

Coronavirus is a formidable example of networking which connects people with a disarming and literally pandemic efficiency, using the very people it infects to infect others as they come into contact and thereby accelerating its own process of self-replication. This process generates a dramatic health crisis but also reveals the imbalance and inequity that characterizes the majority of inter-human connections and the extent to which social and economic structures determine health outcomes. In the words of Michelle Bachelet, UN High Commissioner for Human Rights, "this virus is exposing endemic inequalities that have too long been ignored. In the United States, protests triggered by the killing of George Floyd are highlighting not only police violence against people of colour, but also inequalities in health, education, employment and endemic racial discrimination". Moreover, "the fight against this pandemic cannot be won if Governments refuse to acknowledge the blatant inequalities that the virus is bringing to the fore". Efforts to come to terms with COVID-19 and to begin what many are calling the *recovery process* must necessarily be founded on an attempt to create a society in which "everyone's rights to life and health are protected without discrimination"[2].

As the rapid spread of pandemic contagion has covered all continents, many examples have emerged of human vulnerability and how this is exacerbated by inequality and injustice. A particularly striking example is that of the *New York Times* front page on May 24, which, for the first time in over 40 years, contains no photographs. Beneath the title "US deaths near 100.000. An incalculable loss.", readers find 1.000 short obituaries, representing only a tiny fraction of the total list victims in the US during the outbreak so far, thereby personalizing the tragedy in an endeavour to go beyond the inevitable *data fatigue* caused by daily reporting of the pandemic in terms of the official tolls, which are in turn almost certainty a gross undercount of the real numbers involved.

These deaths were the result of a political administration (by no means the only one in many different parts of the world) minimizing the importance of the pandemic and pretending that the virus would not reach or have any great impact on the most powerful nation of the world. Such a denial was a gross betrayal of the belief that all human beings should be able to share and place

[2] http://www.xinhuanet.com/english/2020-06/03/c_139109208.htm

in those that have the responsibility for administering society for the common good. All their stories are equally worthy of attention and, as time has passed, every New Yorker has many to tell, of neighbours, parents, spouses, partners and even children who died even within 48 hours of each other: colleagues, restaurant and shop owners, supermarket sales personnel and acquaintances from all walks of life. The pandemic exploded in the midst of total unawareness and unpreparedness, and – as the *NYT* editor remarks – "the 1.000 stories here reflect only 1% of the toll. None were mere numbers, they were *us*".

Moreover, there is a wider and even more devastating truth that is revealed by these numbers and these stories. The number of Afro-Americans in New York hospitals is three times higher the number of white Americans, although they represent only 12% of the population and their death rate has been reported as more than twice that of other groups. The Bronx and Queens are the worst hit areas, as well as being the poorest ones. While neoliberal economic doctrine has continued to claim that the unfettered market and unbridled private enterprise will generate wealth capable of providing equity and equality for all, one New Yorker in four can manage to feed themselves only thanks to the help given by volunteers, such as the *Food Bank for New York City*. This agency was founded in 1983, in the heyday of Reaganomics and, long before the arrival of the current pandemic, it had found it necessary to build a network with 1.200 emergency suppliers, able to provide around 400.000 free meals every day to people living practically next to Wall Street and Times Square, close to the gaze of the Statue of Liberty, not in slums or shanty towns dotted all over the world. Bad economics leads to bad health, wherever this takes place, and health is what most clearly reflects inequality and injustice. This is true at both macro- and micro-economic levels, as the profitability imperative has in recent decades led to an imbalance in research and development in terms of the concentration on chronic, non-transmittable illnesses at the expense of infective illnesses.

Furthermore, a study by Stanford University shows that some 40% of recently unemployed New Yorkers will not be able to return to their jobs and that 40 million people in the USA have been forced to ask for unemployment benefit. At the same time, in the richest country in the world, the hegemonic superpower, which spends 60 % of its annual federal budget in weaponry, found itself totally lacking in terms of adequate supplies of both the face masks and ventilators necessary for its own citizens. COVID-19 has indeed brought to the fore in a dramatic fashion how large areas and large numbers of people the world over suffer from imbalance, inequity and injustice as the economic and social connections played out on the stage of the resourcesphere render it essentially a gigantic *inequosphere*. Worse still, the pandemic has not only caused the extent of the inequality to emerge but risks aggravating it in all its manifestations. One example on a vast scale is that of the e-mergency of the plight of tens of millions (perhaps even one hundred million) of migrant workers in India, deprived in the space of four hours by a lockdown of everything (work, home, food, means of transport), first rendered invisible by ignoring them and then invested by measures supposedly designed to provide succour but which in most cases did nothing but worsen their suffering[3]. Moreover, both the USA and India are examples of democracies, but recent events should make it clear that, counter to what we would often like to think, democracy offers no immunity either to disease or to inequality and injustice.

Rethinking systemically the noosphere and the infosphere

The imbalances and inequalities of the resourcesphere are mirrored within both the noosphere and the infosphere. This, in turn, risks increasing the imbalances and the inequities in the relationship between the scientific and technological connections to the biosphere and, consequently, to the planetary and eco-systemic connections to which it is home. And the more the imbalances, inequities and inequalities increase, the more they cause human contradictions to emerge and worsen. For example, within the noosphere the lack of systemic thinking and vision due to the long-standing dominance of both individualist theories in fields such as economics and politics and reductionist perspectives in many sciences has tended to create various forms of tunnel vision and parcellation of the world into separable and quantifiable objects. This, in turn,

[3] https://ruralindiaonline.org/articles/the-migrant-and-the-moral-economy-of-the-elite/?utm_source=sendinblue&utm_campaign=NL_June_9_2020&utm_medium=email

has tended to condemn all that remains beyond the individualist and reductionist scope to invisibility, thereby often leading to the assumption of its non-existence.

While it is clear that analysis of all natural and social phenomena must start from individual inorganic or organic components, information first gathered at the level of unitary entities must gradually become part of a composition able to encompass increasing levels of interconnectedness. As expressed by the winner of the 1977 Nobel Prize for Physics Phil Anderson, in his description of the emergence of complexity in the transition from the subatomic world of quantum physics, to that of the sciences of chemistry, biology, psychology and anthropology, "more is different"[4], something which clearly emerges in the transition from the individual sets of data gathered on a daily basis to the developing epidemiological vision of the current pandemic.

The need to recognise how everything is interconnected, how at every new level a new vision emerges, and the illusion that comes from failure to do so, is also well described by Gregory Bateson: "… while I can know nothing about any individual thing by itself, I can know something about the relations between things" (1987, p. 157)[5]. Bateson constantly warned against the risk of rupture of the connections between mind and body, nature and nurture, organism and environment, self and society, and the ruinous outcome of this. At the same time, in recent decades, the idea of being connected has been potentially enriched, but at times risks being impoverished, by the advent of digital technology, which has perhaps brought out some of the most evident examples of human contradictions. There are massive contradictions in the fact that most human beings would openly declare their opposition to child labour or unjust exploitation of workers and to the indiscriminate production of human waste, while at the same time showing an ever more voracious appetite for consuming technological gadgets.

ICT has also led to a further immense human paradox, whereby our craving for "being connected" digitally means we are often dis-connected analogically, progressively losing direct contact with the biosphere, the eco-systems we are a part of, our spatially-defined places and the people, associations and institutions that inhabit them. Once again, the current pandemic has provided numerous examples of contradictions ranging from the risks involved in humanity being inundated with data it does not have the capacity to process to the advantages that may accrue from digital technologies and their impact on public-health strategies, or from the pitfalls caused by an unthinking belief in online learning to the disadvantages of being excluded from educational processes dependent on a totally unequally distributed access to the internet.

From one point of view, Tim Berners-Lee is quite right to underline how, "for many, the web has been the critical unifying force, enabling work, school, social activity and mutual support. […] But [these] are the lucky ones. Billions of people don't have the option to turn to the web in times of need or normality. A gross digital divide holds back almost half the planet when it most needs the web. This divide is most acutely experienced in developing countries. The position is particularly dire across Africa, where only one in four people can access the web and the benefits that so many of us take for granted. Women, in particular, […] are excluded …"[6]. At the same time, it would be utterly wrong to believe that all we need to do is eliminate the digital divide and enable the whole world to access the web. The mere extension of contradictions can only aggravate rather than resolve them.

Many of the contradictions specifically concerning digital technology and the infosphere were examined in a previous issue of Visions for Sustainability with a special section dedicated to "Slow-Tech", in which Norberto Patrignani and Diane Whitehouse argued for the need to develop "ICT that are good, clean, and fair, socially desirable, environmentally sustainable, and ethically acceptable"[7]. Yet the current extraction of many minerals necessary for the production of ICT devices clearly satisfies none of these criteria. Lithium is needed for the production of consumer electronics – including wireless earbuds, smartphones and laptops – but mining and refining it has devastated many ecosystems and communities in countries as far apart as Australia and Chile. The

[4] Anderson, P.W. (1972) More Is Different. *Science*, New Series, Vol. 177, No. 4047, pp. 393-396.

[5] Bateson, G. and Bateson, M.C. (1987). *Angels Fear: Towards an Epistemology of the Sacred*. Macmillan, p.57

[6] https://www.theguardian.com/commentisfree/2020/jun/04/covid-19-internet-universal-right-lockdown-online

[7] Patrignani, N. & Whitehouse, D. (2019). Slow Tech: Towards and ICT for the Anthropocene Age. *Visions for Sustainability*, 12: 35-39.

mining of cobalt, another component of such goods, is a direct cause of child labour in the Democratic Republic of the Congo.

Each of the same criteria could clearly be applied to considering recent and rapidly expanding projects for launching satellite constellations, such as those being implemented by SpaceX and OneWeb. These indeed offer evident examples of the dangers involved in the attempt to expand our resourcesphere to include the space around the Earth in order to extend the infosphere way beyond its current limits. Such dangers include the impact on the astronomical sky (since the earth may shortly be blanketed by tens of thousands of satellites) related to an immense increase in light pollution, with a consequent reduction of our ability to build new knowledge of the cosmos or simply indulge the joyous contemplation of the night sky as a thing of beauty. Long before such projects were envisaged, back in 1994 UNESCO realized the need to affirm that "persons belonging to future generations have the right to an uncontaminated and undamaged Earth, including pure skies; they are entitled to its enjoyment as the ground of human history of culture and social bonds that make each generation and individual a member of one human family". Once again the question concerns the relationship between the various forms of capital (in particular, but not only, natural and produced) exploited within the resourcesphere and perhaps above all the very notion of property – private and public, individual and common – in terms both of its definition and its application.

Visions of interconnectedness and interdependence

Each of the contributions to this issue of *Visions for Sustainability* offers a particular view of how human trajectories intersect with each of the spheres that comprise our world. Three original papers consider different aspects of human beings' interconnectedness with the biosphere and how scientific and technological developments can mediate that relationship in a positive way from the perspective of biophilia. In "Biophilic Design: How to enhance physical and psychological health and wellbeing in our built environments", Bolten and Barbiero examine recent findings on the relationship between man and nature to render artificial spaces more coherent with innate human biophilia. They argue that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological well-being and accelerates healing. They suggest that, taking account of the rapid growth of global urbanization, such benefits will become increasingly important in the design of our urban spaces, architecture and interiors.

In "Does sustainability address perceived restoration? An exploratory study on Biosphera 2.0, a net zero energy house.", Berto, Maculan and Barbiero illustrate how individuals are not passively affected by the physical characteristics of the environment and how they react to it and try to modify it. They argue that human beings' efforts in this respect tend towards environments more restorative and sustainable from a cognitive point of view, i.e. environments where daily life is less stressful and more satisfying. Their study aims to verify to what extent energy zero housing corresponds to these requirements in terms of a *Perceived Restorativeness Scale* by gathering participants' perceptions of such attributes as semiotic and sensorial attributes and the absence of environmental stressors.

In "Investigative Study of Relationship between Built Environment and Perceived Restorativeness: Cases of Colonial Churches of Dalhousie", Rai, Asim and Shree discuss how the built environment of a region can influence or dominate its ecosystems, services and can regulate the processes associated with human health and well-being. They argue that urban areas are considered central business hubs and are hence created with elements of attraction and benefits which can influence human satisfaction in a particular way, while rural areas are rich in nature and are claimed to be associated with psychological restoration due to their natural diversity. Their study focuses on aspects of a *Perceived Restorativeness Scale* through exploring some of the human preferences in nature-rich religious built environments.

Two original papers then address different aspects of how human beings are a high-level energivorous species and have only recently realized that it is no longer possible to continue indiscriminately putting additional demands on earth's resources. In "The Power to Change: A Brief Survey of the Wind Power's Technological and Societal Potential, Barriers to Use, and Ways Forward", Kopnina explores the history, technology, and barriers to acceptance of wind energy. She asks the question why, despite the problems associated with the fossil fuels, more ecologically

benign energy is still scarcely used. She shows how grassroots resistance is often fueled by the mistrust of the government and how the governments' reason for resisting renewable energy can be explained by their history of a close relationship with the industrial partners. She then argues that understanding of various motivations for resistance at different stakeholder levels and understanding the role of democracy in decision-making opens up space for better strategies for a successful energy transition.

In "Waste-to-wealth: The economic reasons for replacing waste-to-energy with the circular economy of municipal solid waste", Pagliaro argues sharing the same raw material, recycling and composting are in direct conflict with incineration of municipal solid waste in combined health and power plants. He then discusses the economic viability of municipal solid waste incineration to produce electricity and heat in the context of increasing the role of electricity production from renewable energy sources as well as of the emerging circular bioeconomy.

In his letter "For a health-promoting, inclusive and complex vision" Ferrara considers various aspects of collective and individual health and reflects on how COVID-19 is forcing us to rethink ideas concerning the relationship between so-called "diseases of progress" and transmissible illnesses. He argues that placing faith in technology to protect us is illusory. In the first place, because this would stem on an unsustainable dependence on the very technology that lies at the heart of the reciprocal strengthening of transmissible and non-transmissible diseases favoured by environmental deterioration. Secondly, because it reduces our relationships and connections to a surrogate form that can work only within nihilist and self-consolatory perspectives.

In "A Vision for Futures Education Promoting Knowing as Intelligent Action", their review of *Intergenerational Education for Adolescents towards Liveable Futures* by Kathryn Paige, David Lloyd and Richard Smith, Cambridge Scholars Publishing, 2019, Colucci-Gray and Dodman start from the premise that education is an essential investment that every society must make in terms of its own future and that the characteristics and the quality of both the education and the future are mutually interdependent. They argue that for the first time ever we have come to be aware that the future we are building must be liveable, something that has thus far been taken for granted, but which we now know we ourselves have radically jeopardized. Since it has recently become increasingly clear that the need to change human trajectories is perceived with the greatest urgency by the young people who most risk facing the increasingly devastating consequences of an unsustainable present, we thus need an education that is coherent with this awareness. They illustrate how in the authors of *Intergenerational Education for Adolescents towards Liveable Futures* propose a framework designed to meet that need.

Learning how to connect

The current global health crisis has given us the opportunity to experience first-hand how we can make a tangible impact on the lives of people around us (by working together to contain deadly infections), as well as on the lives of other living creatures (by containing our own ubiquitous presence). But there are also other, and more subtle dimensions to this process of awareness-raising. If we return to the earliest idea of James Lovelock's concept of Gaia, we can look at the planet we inhabit as a complex living system, with interdependent relationships, generating positive and negative feedbacks on a global scale. From this point of view, we can elaborate this encounter with the 'virus' as an instance of reflection on the quality of such relationships, upon which basis they are being established and maintained. For example, we could consider the quality of our lived environments, our homes and our cities. The rampant spread of metal and glass – the extraction of which leads to a massive ecological footprint – gives our cities the least life-enhancing framework possible. Metal and glass do not easily accommodate the labour of micro-organisms – such as lichens and mosses – which play a crucial role in the regulating and circulating the materials enriching the biosphere. Yet, such microorganisms continue to teach us about ways of *living together*, proving numerous examples of mutualism, reciprocity and cooperation.

As the Indigenous researcher Robin Wall Kemmerer demonstrates, the symbiosis between the alga and the fungus is suggestive of a creative and stable arrangement for the reciprocal exchange of sugar and minerals: "The resulting organism behaves as it were a single entity, with a single

name”[8]. Such symbiosis contributes to the fertility of soils, the health of the air, the distribution of minerals across food webs, in a dance of reciprocal give and take which supports life on Earth. Hence, we are constantly reminded that there are greater partnerships we seek to establish with the non-human world to enable ours and the sustainability of the earth of which we are a part.

It is indeed to be hoped that we will be able to rethink systemically our interactions with the biosphere we inhabit, the resourcesphere we depend on, the noosphere and the infosphere we have created and continue to develop. As Bruno Latour has pointed out, “the first lesson the coronavirus has taught us is also the most astounding: we have actually proven that it is possible, in a few weeks, to put an economic system on hold everywhere in the world and at the same time,

a system that we were told it was impossible to slow down or redirect”[9]. It is certainly too soon to understand if we have really learnt the lesson and will be able to translate it into vision and action. The task is immense. As Latour continues: “injustice is not just about the redistribution of the fruits of progress, but about the very manner in which the planet is made fruitful”. We could also add that it is also a question of how it has been rendered unfruitful.

Once again, India offers us an example of enormous proportions, whereby over the last thirty years the vast agricultural system has been destroyed, with the dual consequence of rendering the country much more vulnerable and unsustainable while creating a massive quantity of cheap labour ready to be exploited[10]. Returning to Latour, “[the lesson] means learning to select each segment of this so-called irreversible system, putting a question mark over each of its supposed indispensable connections, and then testing in more and more detail what is desirable and what has ceased to be so”.

The first few months of 2020 have given us a unique opportunity to realize what a virus has forced us to see that we have become. An emergency has made abundantly clear what we should never lose sight of. The sustainability of the human enterprise and its trajectories depends entirely on our ability for collaboration (helping each other when the need arises) and cooperation (working together to realize common objectives and outcomes that are our very reason for being). To connect or not to connect, and above all learning how to connect, is very much the question. The answer has to come through systemic thinking that will help empower us to build new technological awareness, new enterprises, new ways of producing and consuming. Our ability to develop collective intelligence and competent communities depends on being connected and achieving true understanding of how this means our vital (because life-giving) connection is to and through nature and how any form of illusory or partial connection that risks disconnecting us from that will ultimately be destructive.

[8] Wall Kemmerer, R. (2013). *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and the Teachings of Plants. New York:* Milkweed Editions, p. 271

[9]https://aoc.media/opinion/2020/03/29/imaginer-les-gestes-barrieres-contre-le-retour-a-la-production-davant-crise/

[10] https://ruralindiaonline.org/articles/who-will-carry-the-palanquins-of-the-rich-now/?utm_source=sendinblue&utm_campaign=NL_June_2_2020&utm_medium=email

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Biophilic Design: How to Enhance Physical and Psychological Health and Wellbeing in our Built Environments.

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Abstract

Biophilic Design is an applied science that takes into account the most recent findings on the relationship between Man and Nature to render artificial spaces more coherent with innate human biophilia. It is well known that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological well-being and accelerates healing. Considering the relentless process of global urbanization, these benefits will become increasingly important in the design of our urban spaces, architecture and interiors. The aim of the present study is to develop a conceptual framework for Biophilic Design, reducing the gap between scientific research and its translation into functional applications.

Keywords: Biophilia; Biophobia; Biophilic Design; Vernacular Design.

Biophilia

Biophilia is "the innately emotional affiliation of human beings to other living organisms" (Wilson, 1993, p. 31). It covers a variety of attitudes (Kellert and Wilson, 1993), emotions (Barbiero and Marconato, 2016) and values (Kellert, 1997) which, collectively, constitute our relationship with Nature (for a review, see Barbiero and Berto, 2016). Biophilic Design is an applied science, aimed at planning artificial spaces that reflect *biophilia*, the innate tendency of human beings to seek connections with Nature. It is well known that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological well-being and accelerates healing

Biophilia and biophobia

According to E.O. Wilson, "biophilia is not a single instinct but a complex of learning rules that can be teased apart and analyzed individually. The feelings molded by the learning rules fall along several emotional spectra: from attraction to adversion" (Wilson, 1993, p. 31). Attraction is biophilia, adversion is biophobia (Ulrich, 1993). During evolution, humankind had to face the hostile forces of Nature in wilderness environments. The learning rules of biophilia and biophobia rooted themselves in the genetic heritage of our species, according to the contribution they made to improving human efficiency in seeking resources and refuges. Wilderness environments trigger two types of physiological reaction: (1) the 'fight-or-flight' response, which translates into a hyperactivity of one of the branches of the autonomic nervous system, usually the over-expression of the sympathetic nervous system (Shimuzu and Okabe, 2007), which was linked to the concept of biophobia (e.g. Ulrich, 1993); and (2) the 'rest-and-digest' response, which manifests as the cooperation of both branches of the autonomic nervous system, with a prevalent influence of the parasympathetic nervous system. This assures better long-term resilience of the individual (Harvard Medical School, 2018), as it reduces stress (Ulrich, 1993) and enhances cognitive functions (Kaplan, 1995; Berto et al., 2015b). Although various scholars consider biophobia to be part of the biophilic system (e.g. Wilson, 1984; Ulrich, 1993), for the purposes of studying Biophilic Design, it would be more convenient to maintain a distinction between the two concepts of biophobia and biophilia (Barbiero and Berto, 2018). A reasonable objective of Biophilic Design could be to construct environments that can stimulate biophilia (Barbiero, 2011) and reduce the stress induced by biophobia: in other words, environments that can sustain and improve the equilibrium of the autonomic nervous system.

An evolutionary history of biophilia

Biophilia developed in the Paleolithic period. For approximately 95% of their evolutionary history, human beings survived by adopting a nomadic hunter-gatherer lifestyle. Humans have thus perfected a set of responses adapted to the various wilderness environments – mainly the savannah (Orians and Heerwagen, 1992) – aimed at recognizing the quality of an environment in terms of resources and refuges. Some of the environmental preferences which incorporated into Biophilic Design are based on innate learning rules derived from our ancestors' survival, and even today they form the primary, deepest core of our biophilia (Berto et al., 2015a). After farming was invented, approximately 14,000 years ago (Arranz-Otaegui et al. 2018), most of the human population became sedentary. Human beings started to distinguish the domestic from the wilderness environment. Their refuges became permanent, and the first human clusters were formed: villages and then towns and cities (Diamond, 1998). In this period, which covers approximately 5% of the evolutionary history of humankind, the biophilia structured in the Paleolithic period was adapted to the new cultural requirements. One example is proxemics. In the Paleolithic period, groups of *Homo sapiens* were few, and meetings between humans were rare, outside of their own clan. During the Neolithic period, village life required a level of socialization that imposed a hitherto unknown physical proximity, to which we have never fully adapted. This explains, for example, why many people seek outdoor spaces in Nature in which the human presence is rare. Finally, over the past 250 years – an irrelevant period from an evolutionary point of view: less than 0.2% of the evolutionary history of humankind – human beings developed their inclination to transform their environment permanently and irreversibly (Crutzen, 2006). During this period, human clusters gradually became larger and denser.

Compared to the wilderness environments in which humans evolved, towns and cities – now home to 53% of the world's population (Worldbank, 2018) – are characterized by a lack of green spaces, large crowds, and artificial lighting (Beatley, 2011). The lack of natural stimuli atrophied biophilia (Wilson, 1993; Berto and Barbiero, 2017a). After the industrial revolution, our detachment from Nature became even more pronounced. This detachment was so hard that many people feel the need to restore their biophilia by immersing themselves in Nature during their free time.

From biophilia to Biophilic Design

"Biophilic Design is the deliberate attempt to translate an understanding of the inherent human affinity to affiliate with natural systems and processes – known as biophilia – into the design of the built environment". This definition comes from Stephen R. Kellert (1943-2016), Tweedy/Ordway Professor of Social Ecology at Yale University. Kellert, together with E.O. Wilson, is the author of *Biophilia Hypothesis* (Kellert and Wilson, 1993). Like Wilson, Kellert is also an ecologist, who gradually developed an interest in artificial environments, culminating in the book *Biophilic Design* in which Kellert et al. (2008) collected the experiences of biologists, psychologists and architects joined by their common interest in artificial environments that respect human biophilia. The first chapter of this book (Kellert, 2008) continues to be a reference work for studies on Biophilic Design even today.

Design by Nature: the legacy of Stephen Kellert

The goal of Biophilic Design is only apparently simple. Kellert saw two limitations that hamper the introduction of effective Biophilic Design: "the limitations of our understanding of the biology of the human inclination to attach value to Nature, and the limitations of our ability to transfer this understanding into specific approaches for designing the built environment" (Kellert, 2008, p.3). Therefore, Kellert recognized two dimensions of Biophilic Design. The first was a *naturalistic* dimension, inspired by the biophilia that established itself genetically during the Paleolithic period. The second was a *vernacular* dimension, which developed after the Neolithic period. Kellert correlated these two dimensions to 72 characteristics of Biophilic Design (Kellert, 2008). These 72 characteristics has been implemented almost in their entirety into the *Living Building Challenge* certification system (Sturgeon, 2017) and provided a foundation for the *Biophilic Quality Index* by Berto and Barbiero (2017b). Kellert's research was interrupted prematurely in 2016. In the book *Nature by Design* (Kellert, 2018), published posthumously by his wife Cilla, Kellert sought to systematize Biophilic Design according to three categories: Direct Experience of Nature; Indirect Experience of Nature, and Experience of Space and Place, which led to a series of suggestions aimed at helping designers to incorporate the human affinity with Nature into the built environment. If used appropriately and specifically, instead of as a checklist applied indiscriminately, these suggestions offer a series of options for using Biophilic Design in an effective way (Kellert, 2018, pp. viii-ix).

The 14 Patterns of Biophilic Design by Terrapin Bright Green

A pragmatic approach to Biophilic Design has been proposed by the consulting firm Terrapin Bright Green (TBG), founded by Bill Browning and Cook&Fox Architects. TBG's proposal is based on a systematic collation of environmental psychology literature, concerning the effects of the built environment on human beings. TBG's aim was to identify patterns which have both a scientific foundation and a feasible application by architects in Biophilic Design (Browning et al., 2014). Particularly significant is the fact that the entire 'Nature of the space' dimension – which includes patterns 11 to 14 – raises the issue of considering, within Biophilic Design, environments that can support and improve the equilibrium of the autonomic nervous system which, as we have seen, is the biological root of biophilia.

Ten years of Biophilic Design theories: a comparative analysis

We compared the features of Biophilic Design described in the most scientifically relevant publications (Kellert, 2008; Browning et al., 2014; Sturgeon, 2017; Kellert, 2018) in order to

identify the issues that the authors unanimously considered to be basic to Biophilic Design (Table 1). We noted that the first four attributes (Light; Protection and Control; Air; Views) are considered in Evolutionary Psychology to be essential in the search for refuge, while the next three (Greenery; Curiosity; Materials and Finishing and Colours) are essential in the search for resources. It is not surprising that the characteristics of Biophilic Design considered to be universal follow the adaptive models that were developed by our species in its search for a habitat with reliable refuges and resources. It is also unsurprising that the top places are held by the issues most closely linked to our biology (the senses), and the cultural, experiential issues are lower down. Finally, we were quite amazed to note that the issue of 'quiet and silence' is never considered: this is an issue that in our view would deserve greater attention (Berto and Barbiero, 2014).

Kellert, 2008	**Browning, et al. 2014**	**Sturgeon 2017**	**Kellert 2018**	**Our summary**
Natural light	Dynamic and diffuse light	Natural light	Natural light	Light
Prospect and refuge	Prospect and refuge	Prospect and refuge	Prospect and refuge	Protection and Control
Air	Thermal and airflow variability	Air	Air	Air
Views and vistas	Visual connection with nature	Views and vistas	Views	Views
Plants	Visual connection with nature	Plants	Plants	Greenery
Curiosity and enticement	Mystery	Curiosity and enticement	-	Curiosity
Natural materials	Material connection with nature	Natural materials	Materials	Materials, Finishings and Colours

Table 1. Comparison of the most important features of Biophilic Design according to the most relevant studies. The final column on the right contains a summary of our proposal.

The future of the Biophilic Design

In the future, empirical attempts to test Biophilic Design 'in the field', as has happened in recent years, will no longer be sufficient (for a review, see Kellert, 2018, p. 111-188). We think that there is a need to go beyond the list of 'suggestions for designers' on what is important for proper Biophilic Design (Kellert, 2018, p. viii-ix). The aim of Biophilic Design is to design artificial environments that have a positive effect on individual health and wellbeing. These positive effects need to be measurable. To guarantee that the biophilic quality of projects continues to improve, in the future we will need to establish guidelines derived directly from the results of appropriate tests, conducted according to scientific criteria. In the next phase, these guidelines could then be converted into a handbook to assist designers in ensuring the success of their work, and this could be personalized and optimized for each specific case. Finally, in our view it is important to reconnect human beings with Nature (Kellert, 2018, p.14-16) rather than "bringing nature into the built space" (Browning et al. 2014). The practice of Biophilic Design touches on very deep parts of the human psyche, which are linked to the need, felt by many people, to rediscover an affinity with Nature and feel at one with it again (Barbiero and Berto, 2018). This also entails an acceptance of the dangerous side of Nature, which arouses biophobic reactions in us. Reconnecting with Nature does not mean returning to the Palaeolithic hunter-gatherer lifestyle but knowing and valuing those aspects that allow us to recover our physical and mental

equilibrium more quickly and efficiently. This will be the test bench for Biophilic Design.

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Does sustainability address perceived restoration? An exploratory study on Biosphera 2.0, a net zero energy house

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Abstract

Individuals are not passively affected by the physical characteristics of the environment, on the contrary they react to it and try to modify it; their efforts are towards environments more restorative and sustainable from a cognitive point of view, i.e. environments where daily life is less stressful and more satisfying. The aim of this exploratory research study is to verify how energy zero house answers to these requirements. To this aim 29 volunteers (M age = 33.68; 14 males and 15 females) accepted to spend a couple of days/nights in Biosphera 2.0, a passive house award winning prototype. Participants were administered the Perceived Restorativeness Scale, the semiotic and sensorial aesthetic attributes and a Post Occupancy Evaluation questionnaire. Results showed that Biosphera 2.0 is not restorative per se, participants - in particular women - appreciate the experience of being-away from daily routine for a couple of days. However, participants are satisfied on a few specific characteristics of the prototype usually lacking in our daily environments: the absence of environmental stressors. Biosphera 2.0 covers the basics to be a restorative environment. Though exploratory and with limitations this research study shows that sustainable doesn't mean restorative.

Key words: Attention Restoration Theory; Biophilic Design; Biosphera Project; Net Zero Energy Building; Perceived Restorativeness Scale; Post Occupancy Evaluation.

Introduction

This exploratory research study aims to verify how restorative is Biosphera 2.0, a housing module devised to be environment friendly. The purpose is to investigate to what extent a "sustainable" environment addresses the sphere of individuals' perceived restoration.

Theoretical framework

The theoretical framework of the study is Environmental Psychology, a discipline which studies environmental perception and cognition, affective appraisal (environmental preference), spatial behaviour and cognitive maps, memory for the environments, attitudes towards the environment, the impact of the physical environment on the behaviour and environmental stress: the way an individual perceives, evaluates, uses and reacts to the physical environment (Gifford, 2009). More specifically, Environmental Psychology offers interesting insights into the origins of human preference for the natural environment (Barbiero, 2009; 2014), together with the cognitive and physiological benefits deriving from exposure to Nature (Berto, 2019), and useful indications for turning the built environment into a restorative environment (Berto & Barbiero, 2017a; Bolten & Barbiero, 2020). Individuals are not passively affected by the physical characteristics of the environment. On the contrary, they react to it and try to modify it. Their efforts are towards environments more sustainable from a cognitive point of view (Berto, 2011) and more restorative (Berto & Barbiero, 2017a), i.e. environments where daily life is less stressful and more satisfying. How does energy zero house satisfy these requirements?

Environmental stress. A brief overview

Stress occurs when the individual cannot cope with the demands from the environment. This mismatch causes at first a state of discomfort and then symptoms and illnesses related to the stress response (Baroni & Berto, 2013). Environmental stress isn't due exclusively to the presence, indoor or outdoor, of so-called environmental stressors (noise, heat, cold, inadequate lighting, crowding, air pollution, traffic, architectural dysfunctions, etc.), but also when environmental information is too intense, complex or incoherent, and when the individual has no control over the environment (Figure 1). These situations cause negative physiological responses, the appearance of negative feelings and emotions and the decreasing of cognitive skills (see Figure 2).

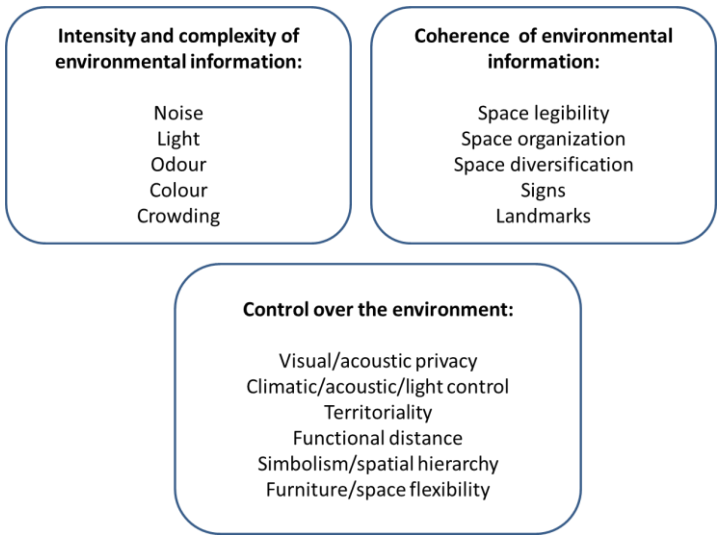

Figure 1: Physical characteristics of the environment that may cause the stress response in the individual. From: Baroni & Berto (2013).

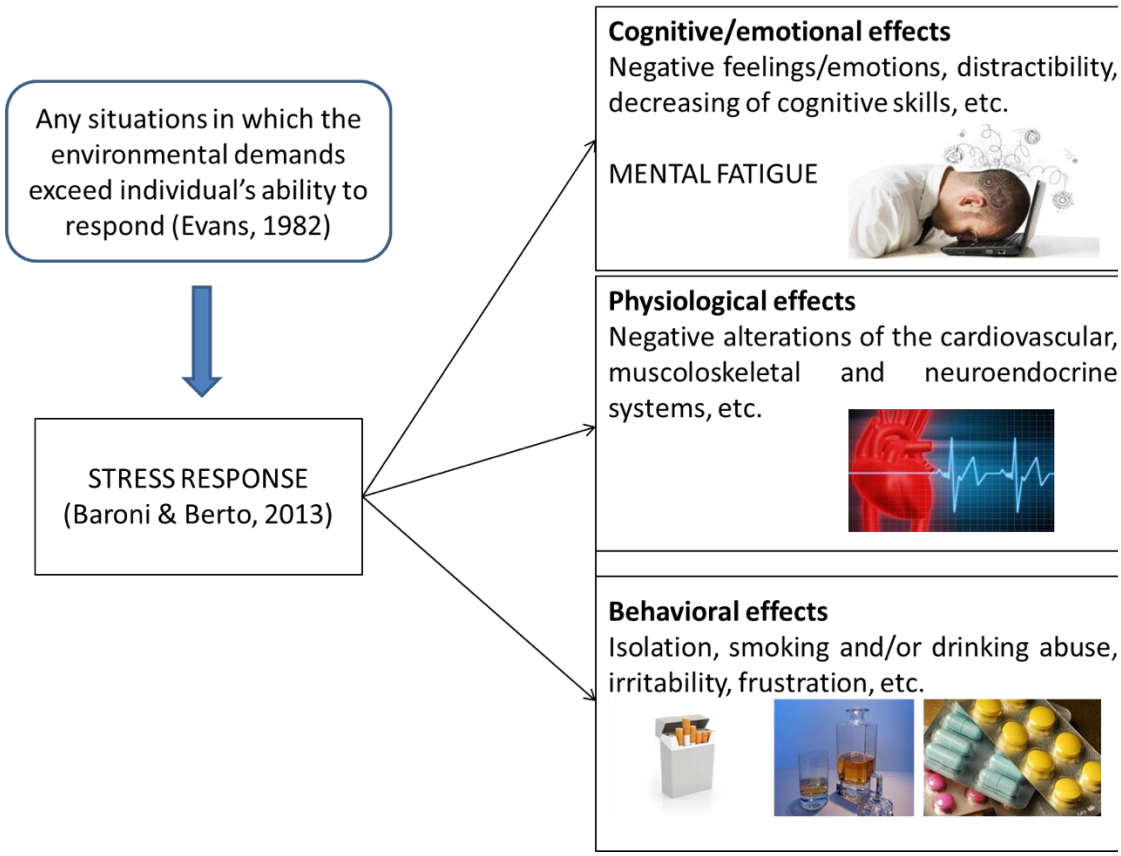

Figure 2: The negative effects of stressful situations on individuals' cognitive, emotional, physiological and behavioral response. Source: Berto, R. (2019b) Il Biophilic Quality Index: L'importanza di progettare ambienti di lavoro rigenerativi. Proceedings of the workshop *Il Design Biofilico per gli ambienti di lavoro rigenerativi*. April 4th, 2019, Milano, Italy.

The individual tries to contrast the effect of the stressors by enacting "coping strategies" (Lazarus & Folkman, 1984) to regain wellbeing. One of the quickest and most effective ways to recover from cognitive and physiological stress is exposure to natural environments (Berto, 2014). The natural environment, thanks to its restorative potential, brings benefits at a physiological and cognitive level, promotes recovery from stress, and plays an important role in the process of emotional regulation. Accordingly, restorative environments allow individuals to regulate the level of physiological activation (arousal), keeping it at an optimal level, to bring out positive emotions and feelings that consequently improve mood and produce a calming effect on the individual. Along these lines, Stress Recovery Theory and Attention Restoration Theory were developed.

According to Stress Recovery Theory (SRT; Ulrich, 1984) individuals' reactions to exposure to Nature have a parasympathetic component, not present in the response to urban scenes. The sympathetic nervous system allows human beings to respond quickly and easily to a general state of activation of the organism to threatening situations but involves fatigue and alterations in endocrine and cardiovascular chronic responses that may compromise individuals' health. On the other hand, exposure to Nature and the activation of the parasympathetic system promotes positive emotions, the increase of perceptual sensitivity and physiological changes of heart rate, muscle tension, skin conductance and blood pressure to optimal level (Barbiero et al., 2014; Berto & Barbiero, 2014).

For Attention Restoration Theory (ART; Kaplan 1995), exposure to Nature favours the regeneration of individuals' direct attention, the voluntary attention component that requires

intense mental effort to be maintained, and which needs to be restored after a state of mental fatigue. Exposure to natural environment allows directed attention to rest and be restored. Nature activates fascination, a type of involuntary attention which does not require any mental effort.

Restorative environments are therefore those places that offer the opportunity to reduce mental fatigue (ART) and recover from stress (SRT). Basically the process of attention restoration and stress recovery occur when an environment is characterized by (Kaplan, 1995): *being away*, i.e. it provides the opportunity for mental/physical distance from daily routine; *fascination*, i.e. it is characterized by elements which attract involuntary attention, e.g. natural elements; *compatibility*, i.e. it offers a wide range of activities which match personal interests; *extent*, i.e. it offers the opportunity to be explored in time and space, e.g. ecosystems to observe, paths to follow. Depending on the combination of the restorative factors, some environments are more restorative than others. The greater the presence of each component, the greater the restorative potential of the environment (Kaplan S., 1993; Hartig et al., 1996; Purcell, Peron, Berto, 2001, Peron, Berto, Purcell, 2002).

Buildings should provide a restorative experience for those living/working in them. To this end, each space within the restorative building has to be specifically designed to foster human wellbeing and a sense of *here-ness*, by providing an environment which allows recovery from urban stress and daily mental fatigue, and is configured in such a way as to allow the experience of relaxation, fascination and interaction with the environment, *enclosure*, *separation from distractions*, *environmental stimulation*, *coherence*, *complexity*, *affordances*, opportunities for *visual contact with Nature* and the presence of *biomorphic patterns,* characteristics that have to be carefully assessed in a building in order for it to be restorative (see the Biophilic Quality Index; Berto & Barbiero, 2017a).

Environmental preference

Natural environments are restorative not only because they favour the recovery from psycho-physiological stress and mental fatigue, but also because they evoke positive emotional reactions, which for ART and SRT are triggered by the innate preference of the individual for certain characteristics typical of natural environments. Environmental preference is directly related to the restorative value of the environment. High levels of preference are associated with high levels of perceived restoration and vice versa (Hernandez et al., 2001; Purcell, Peron, Berto, 2001; Berto, Magro, Purcell, 2004; Berto, 2007). The relationship between environmental preference and perceived restoration derives from the experience Humans had of the natural environment, i.e. the environment in which they evolved, in particular from the development of sensory mechanisms in response to natural stimuli (Balling, Falk, 1982; Kaplan, Kaplan, 1989) which makes the preference for natural environments innate (Berto et al., 2018). From this perspective, environmental preference and the need for restoration can be considered expressions of an adaptive behaviour that the individual enacts to get away from "potentially dangerous" environments, in order to find the most suitable refuge in a safer and more comfortable environment (Kaplan, 1992).

According to the Environmental Preference model (Kaplan & Kaplan, 1989), the most preferred environments are those characterized by the right combination of four factors: coherence, complexity, legibility and mystery. *Coherence* defines a space characterized by meaning, i.e. by the repetition of some elements or the presence of textures (e.g. the crown of the trees, the lawns) or well-defined areas. *Complexity* is given by the quantity of stimuli present in an environment. Usually environments offering a good level of stimulation – quantity and quality – are more appreciated than those with a lower level of stimulation. *Legibility* characterizes environments easily to understand which support orientation and wayfinding. Finally, *mystery* is the possibility of obtaining further information from the environment, which leads the individual to explore and discover (e.g. entering a forest and encountering curved paths and vegetation that partially obscures the view). These four predictors that affect individuals' preferences derive from the immediate or inferred satisfaction of two basic human needs: comprehension and exploration.

The most preferred environments (natural or built) show the right combination of the four

predictors, in that they are environment coherently complex, where environmental information is legible to sustain behaviour while maintaining an element of mystery to cherish interest and curiosity (Berto, Barbiero, 2017a). In addition to the four factors, the *content* of an environment, namely its degree of naturalness and the level of *familiarity* the individual has with it are two important aspects affecting environmental preference.

Biosphera 2.0: The energy zero house

The object of this research study is Biosphera 2.0, an experimental prefab dwelling, part of a broader project which started in 2014 and will end in 2020. Biosphera 2.0 is the second step of the project (see Table 1), and is built to Passivhaus and Minergie energy standards, i.e. Biosphera 2.0 produces as much energy as it consumes thanks to passive house design and rooftop solar panels. In 2016 Biosphera 2.0 was tested in a yearlong tour around Italy, where the prototype was located in six different locations and was inhabited by people as part of the research project. The 25-square-metre Biosphera 2.0 started with installation in the Italian town Courmayeur. From there the mobile home moved to Aosta, then Milano, Rimini, Torino, and finally Lugano (Switzerland). Indeed, thanks to the passive house design and effective insulation, the Biosphera 2.0 can adapt to a variety of environmental conditions, such as urban pollution, and temperatures from -21 degrees Celsius (-5.8 Fahrenheit) in winter to 39 degrees Celsius (102.2 Fahrenheit) in summer.

In spite of its small size, the zero-energy dwelling offers the comforts of a "real" home including a bedroom, a bathroom, a living area, a kitchen and outdoor deck. The interior air temperature fluctuates between 21 to 25 degrees Celsius (69.8 to 77 Fahrenheit) all year-round without the need for an external heating or cooling network. The home is also equipped with LEDs and constructed from PEFC-certified timber.

	Biosphera 1.0	Biosphera 2.0	Biosphera Equilibrium
Period	2014-2015	2016-2017	2018-2020
Concept	Passive house	The zero-energy house	The regenerative house
Focus	Modularity	Energy autonomy	Dwelling wellbeing

Table 1: The three concepts of the Biosphera project developed from 2014 to 2020.

Method

Participants

A total of 29 adults, recruited from different parts of Italy, voluntarily participated in this field study: 14 males and 15 females, mean age 33.68 (SD = 12.20). Participants were asked to spend a couple of days (mean permanence: 2/3 nights). Since Biosphera 2.0 was devised to host two people, participants were allowed to bring a friend.

The experimental setting: Biosphera 2.0

Biosphera 2.0, the setting of this study, was made up of (see Figure 3, 4 and 5):

- Living area with a fitness corner, a relaxation space and an induction kitchenette
- Sleeping area with two bunk beds
- Bathroom connected to the technical room
- Technical Room

Two full-height windows convey natural light into the living and the sleeping areas. The windows are positioned on angled walls, in order to maximize natural lighting inside the module. A third smaller window is placed on the opposite side, in the bathroom. The main building material is wood, chosen for its environmental sustainability and natural feel. It is used both for the load bearing walls (X-LAM) and the interior furnishing.

Figure 3: Biosphera 2.0 - External perspective view

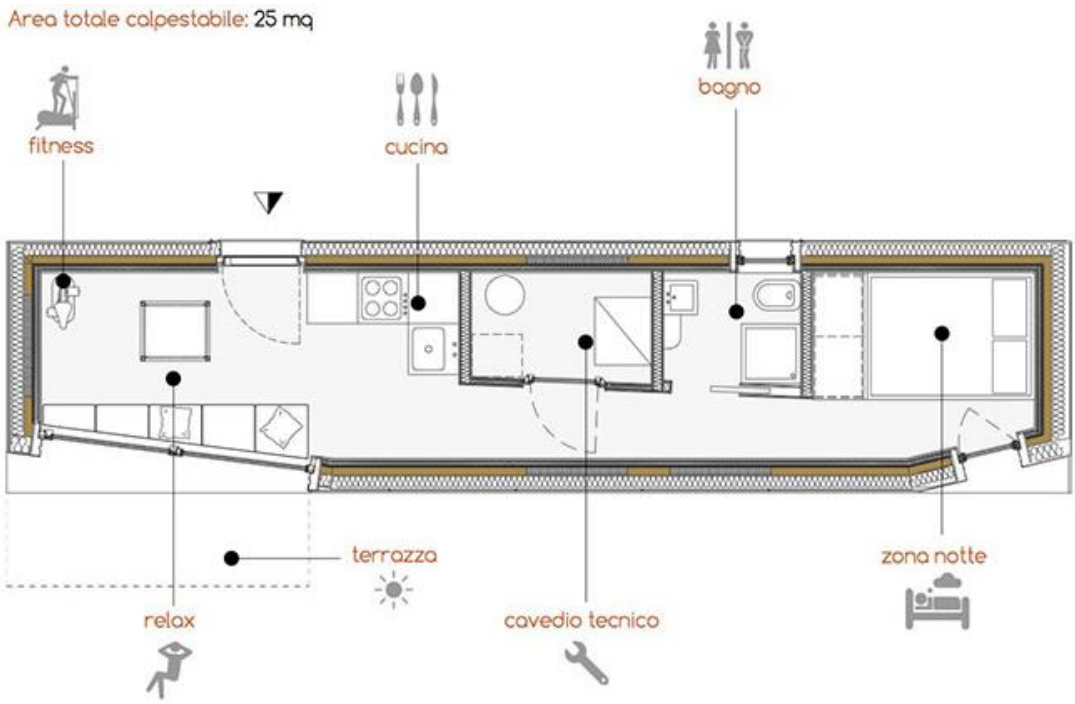

Figure 4: Biosphera 2.0 – Plan

Biosphera 2.0 is internally equipped to satisfy all the basic needs of inhabitants' everyday life. The module is characterized by cutting-edge installations, such as photovoltaic solar panels, LED lighting to reduce artificial lighting impact and new generation sensors to optimize energy performance, as well as others.

Figure 5: Internal view of Biosphera 2.0. The living area (on the left) and the sleeping area (on the right).

In a low impact perspective, occupants play an active role on Biosphera 2.0 “energy performance”. They can act at any time on an innovative monitoring system, providing personal control of the internal microclimatic conditions. This system collects and integrates data from 25 variables such as internal and external temperature, humidity, indoor air quality, dust, electromagnetic fields, outdoor and indoor noise, external and internal pressure, photovoltaic system production and power usage.

Instruments

Participants were administered a set of measurement instruments: The Perceived Restorativeness Scale (PRS-11; Pasini et al., 2014); the semiotic and sensorial aesthetic attributes (SSAA; Nasar, 1994); a Post Occupancy Evaluation questionnaire (POE).

The Perceived Restorativeness Scale-11

The Perceived Restorativeness Scale-11 (PRS-11; Pasini et al., 2014) measures the individual perception of the restorative value of the environment, which means how much the environment enhances fascination and accordingly the restoration of direct attention from mental fatigue. The self-report scale is made up of 11 items measuring the presence of four restorative characteristics of the environment: being-away (BA), fascination (FA), coherence (COH) and scope (SCO); coherence and scope derives from “extent”, (see section 1.3).
The items of the PRS-11 submitted to the participants were slightly adapted to the experimental setting, e.g., “BIOSPHERA 2.0 is a refuge from everyday concerns” (Being-away item), “In BIOSPHERA 2.0 my attention is attracted by many interesting things” (Fascination item), “There is a clear order in the physical arrangement of BIOSPHERA 2.0” (coherence item), “BIOSPHERA 2.0 can be explored” (scope item). Two items were added to the PRS-11: one to measure preference (PREF: I like BIOSPHERA 2.0.) and one for familiarity (FAM: BIOSPHERA 2.0 is familiar for me) for a total of 13 items in total. All items are assessed on an 11-point scale, from 0 to 10, where 0 = not at all, 6 = a lot and 10 = very much.

The Post Occupancy Evaluation questionnaire

The Post Occupancy Evaluation questionnaire (POE; Nasar, Preiser & Fisher, 2007) allows evaluating how much the individual is satisfied with the environment characteristics/features. Post-occupancy evaluation is defined as "the process of evaluating buildings in a systematic

and rigorous manner after they have been built and occupied for some time" (Preiser, Rabinowitz & White, 1988). Since the 1960s, the POE has been tackled from approaches which differ for the method adopted and/or for the criteria chosen for the evaluation. Since the 1990s the most common approach to address building POE is from a technical, energetic and environmental sustainability point of view. Our participants were administered a POE questionnaire made up as follows: two open questions asking about the positive/negative aspects found in the module: "what did you like most about Biosphera 2.0?" and "What did you like least?"; a list of 17 features assessing the design quality and the liveability of the module: exterior and internal aesthetic, interior lighting, acoustics, smell, floor, walls, ceiling, space, movement, arrangement, view to the outside, temperature, safety, installation, flexibility and accessibility. The level of dis/satisfaction is assessed on a scale from 1 (totally unsatisfied) to 7 (totally satisfied). Two final open questions that are: "According to you, list in order of importance what is missing in Biosphera 2.0"; "What do you suggest in order to improve Biosphera 2.0?"

The Semiotic and Sensorial Aesthetic Attributes

The Sensorial and Symbolic Aesthetic Attributes (SSAA; Nasar, 1994) are a list of 10 physical-aesthetic characteristics to be assessed on the following 5-point scale: 1 = nothing – 2 = very little – 3 = quite much – 4 = much – 5 = very much. The attributes are vegetation, variety, harmony, spaciousness, brightness, representative building, cleanliness, maintenance, recreational activities, and originality. Participants were asked to assess how much each attribute applied to Biosphera 2.0.

Procedure

Participants were administered the set of instruments when entering Biosphera 2.0 for the first time (pre-assessment) and when leaving it (post-assessment). Though literature shows that familiarity doesn't affect the perception of restorativeness (for a review see Berto, 2014), a recent study pointed out that familiarity together with the sense of connection to Nature may affect the individual's perception of the restorative value of an environment. To this end, the PRS-11 was administered at the first encounter and after the brief stay in Biosphera 2.0, i.e. when some familiarity has been built. Familiarity is expected to affect preference as well. The PRS-11 scores will be put in relation with the CNS scores to assess whether participants differ on this construct and also if differences in the CNS scores go with differences in PRS-11 scores. Finally, the relation between PRS-11 scores and the presence of the SSAA and the 17 features of the POE questionnaire will be considered. Instruments were administered as follows: Pre-assessment: CNS, PRS-11; Post-assessment: SSAA, PRS-11, and POE.

Results

To start, the average scores of the PRS-11, FAM and PREF were calculated for the pre- and the post- assessment on the entire sample (see **Table 2**).

	PRE assessment	POST assessment
PRS-11	5.97 (1.21) *	6.52 (1.19) *
PREF	8.78 (1.03)	9.15 (0.89)
FAM	7.68 (2.18)	8.47 (1.26)

Table 2: Average scores and standard deviation (in parenthesis) of the PRS-11, PREF and FAM across the two assessments. *statistically significant difference

Paired sample t-tests showed a significant difference between the two assessments for the PRS-11 score: $t(18) = -2.90$, $p = .009$ ($p < .05$), whereas no significant differences emerged for PREF ($p > .05$) and FAM ($p > .05$), though both variable scores increased from the pre- to the post-

assessment.

Paired sample t-tests were run again to verify whether, within the male and the female group, differences exist for the PRS, PREF and FAM scores from the pre- to the post- assessment (see **Table** 1). The only significant difference emerged for FAM in the male group: t (10) = -2.60, p = .02 (p < .05).

Independent sample t-tests run on the males' and females' scores of each assessment showed a significant difference between genders for PREF of the post assessment: t(17) = -2.91, p = .01 (p < .05), with females scoring higher (see **Table 3**).

	Males (N = 14)	Females (N = 15)
PRS-11 pre	6.04 (1.27)	5.87 (1.20)
PRS-11 post	6.51 (1.40)	6.54 (0.91)
FAM pre	7.00 (1.84) *	8.62 (2.38)
FAM post	8.27 (1.10)	8.75 (1.48)
PREF pre	8.72 (1.00)	8.87 (1.12)
PREF post	8.72 (0.90)	9.75 (0.46)

Table 1: Average score and standard deviation (in parenthesis) of males and females for the PRS-11, FAM and PREF. * = statistically significant difference

At this point the mean score of each restorative factor was calculated for the pre- and the post-assessment first on the entire sample, and then for the male and female group separately (see **Table 4**). From the paired sample t-tests a significant different has emerged for BA for entire sample: t (18) = -3.14. p = .006 (p < .05), and for the male group: t (10) = -2.82. p = .018 (p < .05). Pearson bivariate correlation was calculated between the scores of the restorative factors for each assessment. In the pre- assessment the correlation BA*FA and COH*FA turned out positive and significant (p > .05; see **Table 5**). In the post- assessment was positive and significant the correlation between SCO*FA (p > .05; see **Table 6**).

	Entire sample	Males	Females
BA-PRE	5.17 (2.64) *	4.60 (2.99) *	5.95 (2.00)
BA-POST	6.31 (2.74)	5.33 (3.01)	7.66 (1.65)
COH-PRE	5.29 (1.10)	5.10 (1.28)	5.54 (0.83)
COH-POST	5.57 (1.00)	5.66 (1.12)	5.45 (0.88)
SCO-PRE	6.65 (1.39)	6.27 (0.93)	7.18 (1.79)
SCO-POST	7.10 (1.52)	6.86 (1.70)	7.43 (1.26)
FA-PRE	7.00 (1.48)	6.96 (1.48)	7.04 (1.57)
FA-POST	7.35 (1.39)	7.30 (1.66)	7.41 (1.00)

Table 4: average scores and standard deviation (in parenthesis) of the 4 restorative factors across the two sessions for the entire sample and across the two genders. * = statistically significant difference

PRE assessment	BA	COH	SCO	FA
BA	1	0.263	0.135	0.397 *
COH	0.263	1	0.237	0.473 *
SCO	0.135	0.237	1	0.388

Table 5: Pearson bivariate correlation between the restorative factors for the pre- assessment. BA = being-away, COH = coherence, SCO = scope, FA = fascination. * = correlation is significant at the 0.05 level (two-tailed)

POST assessment	BA	COH	SCO	FA
BA	1	-0.072	0.401	0.395
COH	-0.072	1	0.250	-0.150
SCO	0.401	0.250	1	0.519

Table 6: Pearson bivariate correlation between the restorative factors for the post- assessment. BA = being-away, COH = coherence, SCO = scope, FA = fascination. * = correlation is significant at the 0.05 level (two-tailed)

The SSAA mean scores were calculated both on the entire sample and for the two genders separately. To all participants, the features that most characterize Biosphera 2.0 are: harmony, brightness, representativeness and originality (see **Table 7**). No significant differences emerged between males' and females' scores from the independent sample t-test ($p > .05$).

	Total sample	**Males**	**Females**
Vegetation	0.91 (0.94)	0.92 (1.03)	0.90 (0.87)
Variety	2.39 (0.98)	2.38 (0.65)	2.40 (1.34)
Harmony	**3.26 (0.63)**	**3.15 (0.68)**	**3.40 (0.69)**
Spaciousness	2.17 (0.83)	2.38 (0.96)	1.90 (0.56)
Brightness	**3.39 (0.78)**	**3.46 (0.51)**	**3.30 (1.05)**
Representative building	**3.34 (0.77)**	**3.38 (0.76)**	**3.30 (0.82)**
Cleanliness	2.91 (0.79)	2.76 (0.72)	3.10 (0.87)
Maintenance	2.73 (0.81)	2.61 (0.76)	2.90 (0.87)
Recreational activities	2.26 (1.00)	2.15 (0.80)	2.40 (1.26)
Originality	3.30 (0.97)	3.15 (1.14)	3.50 (0.70)

Table 7: Mean scores and standard deviation (in parenthesis) of the semiotic and sensorial aesthetic attributes for the entire sample and for males and females respectively. *Note*: attributes scoring higher than 3 (in **bold** in the Table) can be considered "**very present**" in Biosphera 2.0.

The level of satisfaction for the 17 characteristics measured by the POE was calculated for the entire sample and for males and females separately (see **Table 8**). On these scores independent sample t-tests were calculated. Significant differences between males and females emerged for: external aesthetic: t (20) = -2.32. p = .031 (p < .05) and for space t (20) = 2.33. p = .030 (p < .05).

At this point, the mean score for the CNS was calculated for the total sample (M = 2.44; SD = .38). The independent samples t-tests showed no significant difference between the males (M = 2.44. SD = .41) and the females' score (M = 2.45, SD = .36), (p > .05).

	Entire sample	Males	Females
External aesthetics	5.04 (1.86)	5.16 (1.74)	4.90 (2.07)
Internal aesthetics	5.81 (1.18)	5.33 (1.30) *	**6.40 (0.69)**
Lighting	**6.27 (0.76)**	**6.16 (0.71)**	**6.40 (0.84)**
Acoustics	**6.00 (1.53)**	**6.08 (1.56)**	5.90 (1.59)
Smell	**6.09 (1.13)**	**6.00 (1.41)**	**6.20 (0.78)**
Floor	5.50 (1.30)	5.41 (1.16)	5.60 (1.50)
Walls	5.59 (1.05)	5.66 (1.15)	5.50 (0.97)
Ceiling	5.72 (0.98)	5.66 (0.88)	5.80 (1.13)
Space	4.90 (1.19)	4.41 (1.31) *	5.50 (1.07)
Movement	5.09 (1.10)	4.75 (1.13)	5.50 (0.97)
Arrangement	5.81 (0.90)	5.83 (0.83)	5.80 (1.03)
View to the outside	**6.40 (0.85)**	**6.41 (0.99)**	**6.40 (0.69)**
Temperature	**6.45 (0.96)**	**6.66 (0.49)**	**6.20 (1.31)**
Safety	5.63 (1.04)	5.91 (0.99)	5.30 (1.05)
Installations	5.90 (1.10)	**6.00 (1.04)**	5.80 (1.22)
Flexibility	5.04 (1.53)	5.00 (1.65)	5.11 (1.45)
Accessibility	2.36 (1.39)	2.33 (1.55)	2.40 (1.26)

Table 8: Mean scores and standard deviations (in parenthesis) for the 17 features of the POE questionnaire across genders and for the entire sample. *Note*: scores higher than 6 (in **bold** in the Table) mean a **good level of satisfaction** with the feature. * = statistically significant difference

Pearson's bivariate correlation was calculated between the PRS-11 and FAM scores for each assessment (pre- and post-). The pre- assessment shows the correlation PRS* FAM and FAM*PREF and significant (p < .01) (**Table 9**).

PRE assessment	PRS	FAM	PREF
PRS	1	0.521**	0.327
FAM	0.521**	1	0.679 **

Table 9: Pearson's correlations between PRS, FAM and PREF for the pre- assessment. ** = correlation is significant at the 0.01 level (two-tailed)

The same correlation was calculated for the post assessment; again, the significant correlation PRS*FAM and FAM*PREF has emerged (see **Table 10**).

POST assessment	PRS	FAM	PREF
PRS	1	0.321	0.489*
FAM	0.321	1	0.532*

Table 10: Pearson's correlations between PRS, FAM and PREF for the post- assessment. * = correlation is significant at the 0.05 level (two-tailed)

Discussion

Results show that in spite of familiarity (as expected), preference and perceived restoration increase from the pre- to the post- assessment, while the only significant difference is for perceived restoration which increases for males and females. On the contrary, familiarity and preference show an opposite trend across genders. Males' familiarity increases from the pre- to the post- test, whereas females' preference increases. However, correlations show that perceived restoration, preference and familiarity assessments are related. The literature shows positive relation between preference and perceived restoration (see Berto 2014 for a review) whereas the role of familiarity on preference and in particular on perceived restoration has been shown recently (Tang, Sullivan & Chang, 2015; Berto et al., 2018). Moreover, in this study familiarity seems to play a role.

Looking at the perception of the restorative factors separately, only *being away* increases significantly across the assessments. This result was expected, since spending an average of 3 days and 2 nights in Biosphera 2.0 certainly provided a physical, and maybe even a mental, distance from daily routine. This is particularly true for females, who scored higher than males on being away (see also Berto & Pasini, 2007). The higher the sense of being away, the higher the preference for Biosphera 2.0.

As far as the semiotic and sensorial aesthetic attributes are concerned, here males' and females' scores correspond. Indeed, they both consider Biosphera 2.0 mostly characterized by harmony, brightness, representativeness and originality, whereas the least present characteristic is vegetation. In particular, participants are satisfied by the natural lighting (offered by the floor to ceiling windows) and view to the outside, by the indoor temperature and absence of any smell and sounds from the outside, features guaranteed by a good insulation of the module. On the contrary, participants show the lowest level of satisfaction with space and accessibility. This result doesn't come as a surprise, considering the spatial limitation of Biosphera 2.0 which doesn't allow accessibility to everyone. In particular, males are less satisfied than females with space and internal aesthetics, showing different gender expectation concerning internal space.

Conclusions

The aim of this exploratory research study was to verify how energy zero housing addresses perceived restoration. Though no attentional and/or physiological measures were collected, qualitative data obtained from the self-report instruments can give useful hints on this issue. Biosphera isn't restorative per se. Basically, participants appreciated the experience of *being-away* from daily routine for a while. However, participants appreciated a few specific characteristics of Biosphera 2.0, which are usually lacking in our daily environments, such as a lot of natural lighting, the absence of any smell and sound from the outside and the comfortable indoor temperature. Basically, participants appreciated the absence of environmental stressors. The absence of stressors is the prerequisite for an environment to be restorative. Biosphera 2.0 accomplished the basics, now it is time to improve this passive house award winning prototype in order to convert it from green to

restorative (Berto. 2011; Berto & Barbiero, 2017a). This transformation requires panoramic, trans-disciplinary thinking and coordinated actions, because sustainability does not really push architects to go beyond form and scale design to encompass the wellbeing and quality of life of users, which should be among the most important architectural considerations today.

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Investigative Study of Relationship between Built Environment and Perceived Restorativeness: Cases of Colonial Churches of Dalhousie

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Abstract

The built environment of a region can influence or dominate its ecosystems, services and can regulate the processes associated with human health and well-being. Built environments can be of any shape and size depending upon where they originate from and how they progress. They may be urban or rural, and this simple classification merely cannot explain the associated perception and satisfaction of the human population unless the Built environment is quantified in terms of its processes, resources and constituting elements in order to identify the major contributors, thus a larger scope of Built Environment comes into the frame. Urban areas are considered central business hubs and are hence created with elements of attraction and benefits which can influence human satisfaction; whereas rural areas are rich in nature and are claimed to be associated with psychological restoration due to their natural diversity. Studies in this aspect have covered either built environment or psychological health, there is still space for a multidisciplinary study which can explore the relationship between the built environments and how humans respond to it in a psychological manner. The relationship between these two is observed through a detailed study of two Churches of Dalhousie town in Chamba District, H.P. The study focuses on the four related aspects of Perceived Restorativeness Scale which can be influenced by the constituting elements of Built Environment. It also explores some of the human preferences in nature-rich religious built environments.

Key words. Biophilic Design, Biophilic Environment Variables (BEVs), Built Environment, Perceived Restorativeness.

Introduction

The term 'built environment' is fairly new. The built environment generally refers to: “manmade surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places” (Hollnagel, 2014). It corresponds to the need for a wide variety of disciplines and frameworks to find a common structure for interaction and growth that is concerned with this concept. During an age where environmental costs and long-term effects are of increasing concern, and where urbanization is affecting large areas of the Earth, the diverse notion of built environment becomes easier to express a wider perspective of ' systems, ' where there are complex interactions between a greater number of built components. The robust models originally developed for smaller buildings can be applied to entire cities, and trade-offs can be examined, for example, between the requirements of building design and infrastructure, or urban form and resource effectiveness.

Essentially, it is only possible to define the built environment as contrasted to the 'unbuilt' environment or the ecosphere. Ecosphere is often used as a descriptive term for the biosphere and as a term for zones in the universe where life as we know it should be sustainable (Huggett, 1999). The built environment as well as the ecosphere can be regarded as complex, dynamic self-producing systems in a system representation. As such, there is no relationship outside of history between the built environment and the ecosystem. On the contrary, it is constantly changing, representing and shaping the evolution of social systems in turn. Therefore, describing the built environment not as an object but as a social-ecological system is more reasonable. The paper will seek to analyse the background complexities of this human social-ecological system in further detail. It is expected that it will be possible to move towards an active theoretical basis for understanding the built environment by relying on a wider framework perspective.

Psychological Background of the Built Environment

Research from fields such as neuroscience, biology, psychology, environmental policy, medicine, nutrition, fitness and leisure, and exercise science has shown that physical activity in nature can have beneficial effects on human wellbeing beyond physical responses. Maller et al. (2008) argued in a study of the health benefits of nature exposure: ‘That the natural environment is a key determinant of health is unquestionable’. Increases in physical activity levels can gain various health factors and help combat diseases in the lifestyle, but the positive psychological benefits of exercise in natural environments alone cannot be explained by increased levels of physical activity. Such theories pose important concerns about the existence of psychological health benefits that may arise from natural physical activity (Brymer & Davids, 2013; Sharma-Brymer et al., 2015). Considering this growing awareness, several attempts have been made to provide a rigorous theoretical basis for understanding how physical activity in nature enhances psychological health and well-being. The interaction between physical activity and nature encounters was explored from different perspectives, including ecopsychology (Brymer et al., 2010), outdoor education and leisure, wildlife and adventure encounters, green exercise (Herzog & Strevey, 2008), medicine, public health (Beute et al., 2014) and horticulture (Wilson, 1984).

Studies have identified psychological benefits resulting from (i) observing nature, (ii) engaging in nature (Kaplan & Talbot, 1983) and green spaces in urban environments (Tzoulasa et al., 2007), (iii) effects of brief encounters and extended periods in nature (Hull, 1992). (iv) real nature viewing in contrast with simulated nature settings (Mayer et al., 2009). Psychological benefits identified include stress relief (Ulrich et al., 1991) and restorative activity (Wolsko & Hoyt, 2012), improvements in positive mood states (Maller et al., 2006), life skills improvement (O’Brien, L. et al., 2011; Mayer & Frantz, 2004), reduces mental fatigue and concentration (Maller et al., 2008) and to minimize violence (Kuo & Sullivan, 2001). Psychological and emotional advantages were also correlated with adventure activities

performed in green environments (e.g., Brymer & Oades, 2009; Brymer & Schweitzer, 2013). Several interventions have been developed to provide opportunities for psychological health awareness and enhancement, interpersonal development, self-esteem, self-efficacy, and self-confidence (Hattie et al., 1997). For example, Doucette and colleagues (2007) explored a wilderness camp where for a week student were immersed in nature to encourage an experiential exposure to nature instead of learning about nature in a classroom. Researchers concluded that students have benefited from an enhanced ability to deal with anxiety, improved self-confidence, increased self-reliance and a greater understanding of social cooperation benefits.

Restorative Quality of Environment

Fromm in 1973 introduced the term 'biophilia' as "the passionate love of life and of all that is alive" (Eckardt, 1992, p.233). Later Wilson in his book 'Biophilia' developed and defined it as "the innate tendency to affiliate with other forms of life" (Wilson, 1984, p.85). After Wilson presented his hypothesis the research on the restorative environment there developed two unique theories, Attention Restoration Theory [ART] by Kaplan and Kaplan in 1989 and Stress Reduction Theory [SRT] by Ulrich in 1991. Attention Restoration Theory [ART] highlights the efficiency of the natural environment that captures the attention in an easy way, enabling the mind to recover from a tired responsive system. Stress Reduction Theory [SRT] states how psychological stress and negative emotions can be eliminated by the natural environment like greenery and landscape. 'Restoration' is improvement of cerebral functions and mental stress through exposure to nature. Restorative environment is positive nature rich environment such as scenic views, natural water bodies, flora and fauna that enhances the restoration of human (Asim & Shree, 2019).

Perceived Restorativeness

Perceived Restorativeness Scale [PRS], a tool by Harting et al. (1997) to measure the restorative quality of the environment through evaluating the richness of the four restorative factors – being away, fascination, extent and compatibility. Being away: the experience of being away from the cause of mental exhaustion. Fascination: a simplistic process of taking involuntary attention. Extent: to have the ability to interact with the environment without being bored. Compatibility: the phase of certain comfort and understanding where the user intellects unnecessity to use the intelligent or reasoning effort in order to understand the environment (Rai et al, 2019). The PRS is a psychometric scale used by environmental psychologists to evaluate the subjective perception of the regenerative power of an environment. An instrument used by architects is, for example, the BQI, which uses the principles of the ART for an objective evaluation (Berto & Barbiero, 2017).

Biophilic Environment Variables (BEVs)

Biophilic Design is based on the original theories put forward in 'Biophilia' by American biologist E.O. Wilson, 1984. The term 'Biophilia' has ancient Greek origins (bios: life and philia: love) and Wilson called it 'the urge to join other life forms' (Kellert & Wilson, 1995, p.416). The concept of biophilia has been a part of human life for hundreds of thousands of years and it became a separate discipline of design after Kellert synthesized Wilson's original idea of Biophilia into design for the development of Biophilic design (Kellert et al, 2008). Frumkin (2001) categorized all aspects under the domains of Biophilia as Animals, Plants, Landscapes, and Wilderness.

Common Features of Biophilic Design (Kellert, 2008)	14 Patterns (Ryan et al., 2014)	
1. Natural lighting 2. Natural Ventilation 3. Natural Materials 4. Natural and Indigenous Vegetation 5. Ecological Landscape Design 6. Open Space 7. Water views and Vistas of Nature 8. Shapes and forms that mimic organic forms 9. Vistas characterized by refuge and prospect 10. Natural features that evoke mystery 11. Exploration and Enticement 12. Natural features characterized by order and complexity 13. Natural Rhythms 14. Natural processes and change 15. Aesthetic and recreational values of nature 16. Informational and intellectual values of nature 17. Emotional and Spiritual values of nature	Nature in the Space	1. Visual Connection with Nature 2. Non-Visual Connection with Nature 3. Non – Rhythmic Sensory Stimuli 4. Thermal and Airflow Variability 5. Presence of Water 6. Dynamic and Diffuse Light 7. Connection with Natural Systems
	Natural Analogues	8. Biomorphic forms and patterns 9. Material connection with Nature 10. Complexity and Order
	Nature of the Space	11. Prospect 12. Refuge 13. Mystery 14. Risk / Peril

Table 2. Biophilic Environment Variables (BEVs)

The concept of *biophilic design* reiterates the ecological understanding that all environments must possess the duo of biotic and abiotic elements in itself for improved psychological state of humans as well as for the appreciation of the natural realm of the environment (Downton, 2017). The most acknowledged versions of this are shown in Table 1, as introduced by Kellert & Wilson (1995) and later simplified under '14 patterns of Biophilic Design' by Ryan et al. (2014). These subcategories are detailed and identified as 64 separate distinguished variables called Biophilic Environment Variables [BEVs] (Asim & Shree, 2019).

Method

Aim

To examine how the human psychological responses and preferences towards built environment ecosystems are altered by changing the constituting elements (Biophilic Environment Variables).

Location and Built Environment

Two colonial churches of Dalhousie which is a small Himalayan town in the Chamba district of Himachal Pradesh, were selected to conduct the study; St. John's Protestant Church built in 1863 and St. Francis Catholic Church built in 1894.

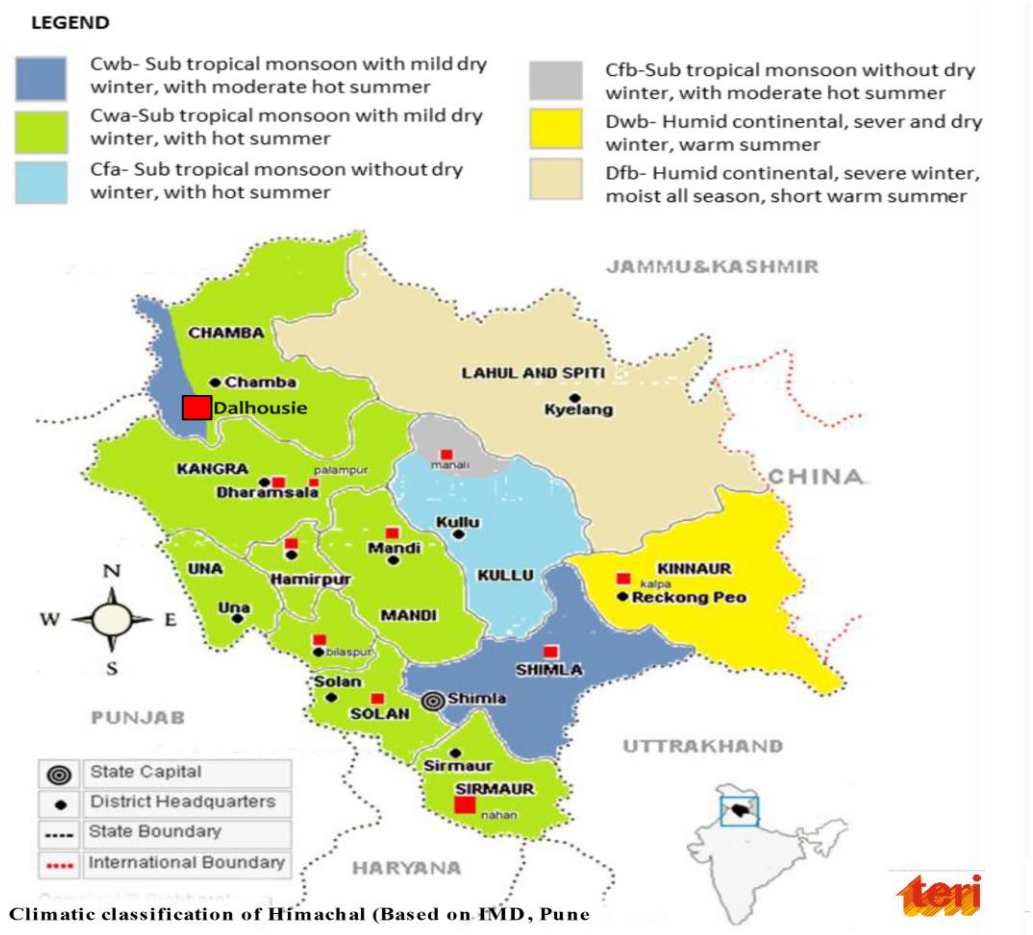

Figure 1. Climatic Classification of Himachal Pradesh with Dalhousie highlighted in Red (Source: TERI)

The town is situated on the ridge line of one of the hills of Pir Panjal range at an average elevation of 1970 meters from mean sea level with picturesque views of Chamba Valley and experiences moderate summer and freezing winters. The churches are the main tourist attraction in Dalhousie town and the architecture of the churches invites recognition for the town from all over the world over art, architecture and photography. They were built during the reign of British Imperialism in India under the European influenced style of architecture. St. John's Church stands at the Gandhi chowk with a library next to it, adjacent to it resides the local market and a segment of Tibetan market, a few hotels and a tiny sprawl of eateries and restaurants.

St. Francis' Church is on the uphill of Subhash chowk with few local food stalls and tourist infrastructure near the entrance. Both the churches are surrounded by abundance in diversity of flora on at least three sides and thus supports local fauna. The churches are at 1.4 kms apart from each other via 'Thandi Sadak', a road which acts as the logistical spine of the hilly town. The churches remain open to visitors from morning to evening; processions and church services are conducted on every Sunday.

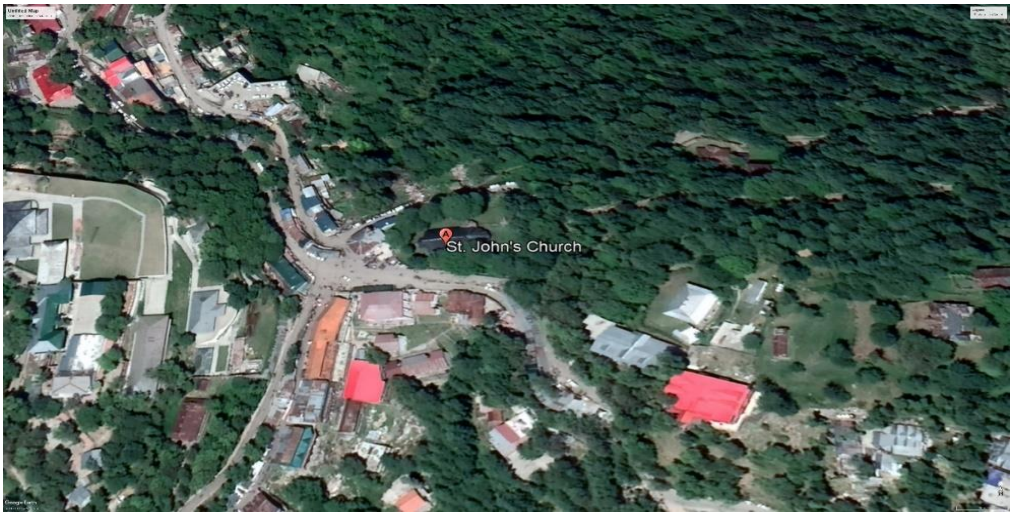

Figure 2. Location of St. John's Church at Gandhi Chowk, Dalhousie.

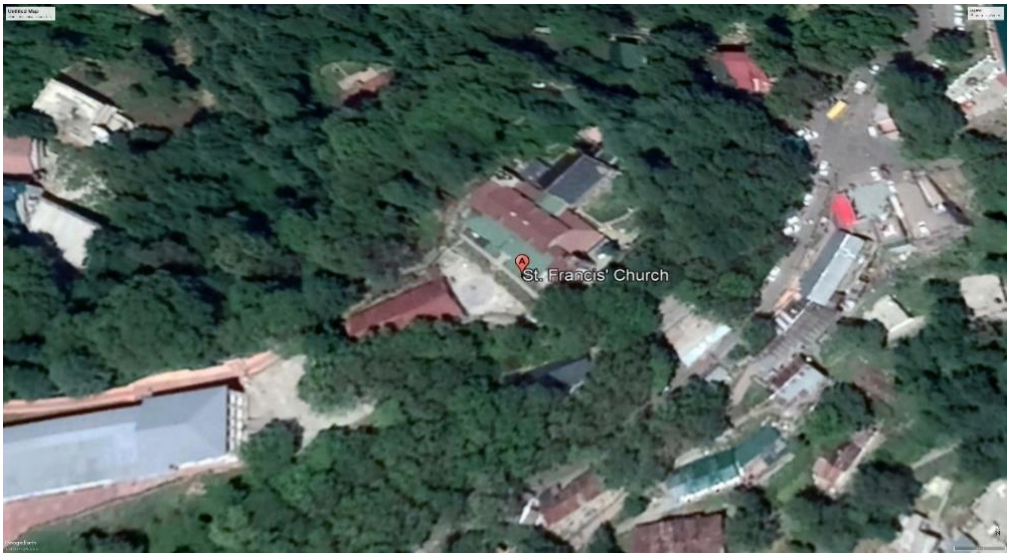

Figure 3. Location of St. Francis' Church at Subhash Chowk, Dalhousie. Brief Profile of Churches: Regional, Historical & Architectural Influence

St. John Church

Built in 1863, it was the first church in Dalhousie built by the protestant missionaries. Initially, it was a wooden structure until the arrival of John H. Pratt who gave the idea of turning it into a permanent stone structure, hence, it was named after him. The church is erected on a simple rectangular plan with separate entrance for the priest. The choice of materials for this church has been mostly locally available ones including slate stone and timber sourced from local Cedrus Deodara. Walls of the church are dressed in ashlar stone masonry and the timber is employed in doors, windows, flooring and roof structure as well as in door and window frames. The unique feature of the finishing of its roof structure is that it is covered with hexagonal shaped slate stone pieces which is an unconventional method in this region, it rests on the purlins and rafters of local wood. The piers support the scissor truss on which the heavy mass slate mounted pitched roof is rested. Belgian stained glass which was heavily imported to India in the nineteenth century is used in semi-circular arch windows and centre-mounted

rose window above the entrance. There are a total of eighteen windows punctured into the stone walls of the church for light and ventilation, with three doors – the largest of them acting as main entrance door in front of the nave, second one on the right-side beside the nave entrance, and the third one is dedicated exclusively to the priest on rear left of the church compound.

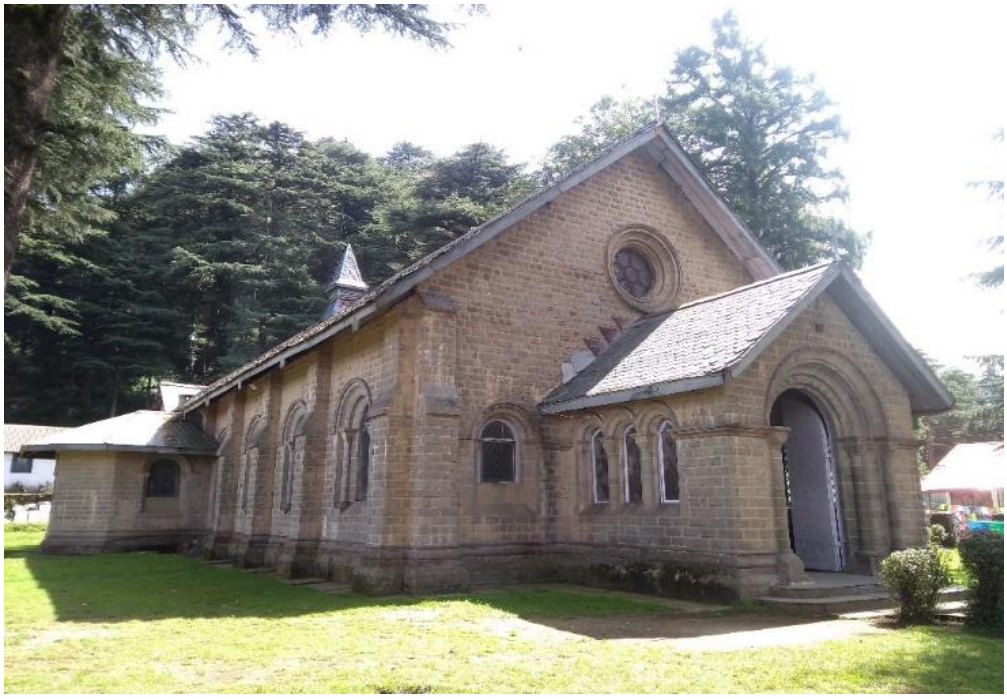

Figure 4. St. John Church, Dalhousie.

St. Francis Church

The church was built through the contribution of the civilians and the residing British officers of the town in year 1894. St. Francis Church is a catholic church maintained by the diocese of Jalandhar and it resides uphill on the Subhash Chowk. The church compound has murals depicting the story of Jesus' life, struggles and his preaching. It has a simple rectangular plan, with a side entrance due to the steep sloped retaining wall at the front. Most of the construction material used in the basic structure are same as that of St. John Church including ashlar stone masonry for walls, locally available timber for the roof truss, flooring, door & windows and their frames. Pitched roof is also covered with hexagonal dressed slates. Single lancet (gothic) arches have been used in door and windows and the windows are styled with Belgian stained glasses.

Figure 5. St. Francis Church, Dalhousie (Chamba Dist.)

Participants and Procedure

200 visitors (100 from each church as convenient sample) were asked to provide their responses about the church and its built environment on a 7-point scale on the original version of Perceived Restorativeness Scale (PRS-26) developed by Hartig et al. (1997)[11]. The presence and intensity of Biophilic Environment Variables were also recorded on a questionnaire for both the churches separately to understand the significance of Nature in the Space, Natural Analogues and Human-Nature Relationship in perceived restorative quality of the built environment. The following methods of data analysis were used to address the research aim. Comparison of means for the two churches on the PRS-26 parameters and BEVs was done along with a bivariate correlation analysis between the BEVs and PRS-26 responses. A regression model was created to develop and establish a relationship between the BEVs' subcategories 'Nature in the Space, Natural Analogues and Human-Nature Relationship' and the perceived restorative quality of the built environment.

Results and Discussions

Descriptive Statistics

An equal participant sample of 100 each was taken from the two cases, out of all the responding participants 73% were male and 27% were female who belonged to the age group 20 - 62 years with mean age 36.2 years. The respondents differed in their perception of the restorative environment as shown through Mean and Standard Deviations in Table 2. In the PRS domain of St. Francis & St. John, 'Compatibility' and 'Extent' recorded the maximum (10.26 and 7.349) and minimum (-4.12 and 4.685) mean and standard deviation respectively.

[11] The 7-point bipolar scale was validated under a pilot study conducted for the Masters thesis titled 'The Significance Of Built Environment In Psychological Restoration: Case Studies Of Technical Institutes Of Himachal Pradesh' submitted to NIT Hamirpur. The original and complete study was published in 'Asim, F., & Shree, V. (2019). The impact of Biophilic Built Environment on Psychological Restoration within student hostels. *Visions for Sustainability,* 12.

'Fascination' and 'Being Away' recorded the maximum (7.04 and 10.005) and minimum (6.09 and 5.787) mean and standard deviation. Standard deviation soared higher (10.005) for 'Fascination' and lower (4.685) for 'Extent'.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Being Away	200	-11	15	6.09	5.787
Fascination	200	-18	24	7.04	10.005
Extent	200	-12	9	-4.12	4.685
Compatibility	200	-7	27	10.26	7.349
Nature in the Space	200	6	50	30.59	13.134
Natural Analogues	200	1	21	11.53	6.838
Human-Nature Relationship	200	0	24	12.79	6.445
Valid N (listwise)	200				

Table 3. Mean and Standard Deviation of Perceived Restorativeness Scale and Biophilic Environment Variables

Figure 6 represents the comparison of means of Perceived Restorativeness Scale for both the churches. Means for all the Biophilic Environment Variables (BEVs): Nature in the space, Natural Analogues and Human Nature Relationship are shown in Figure 7.

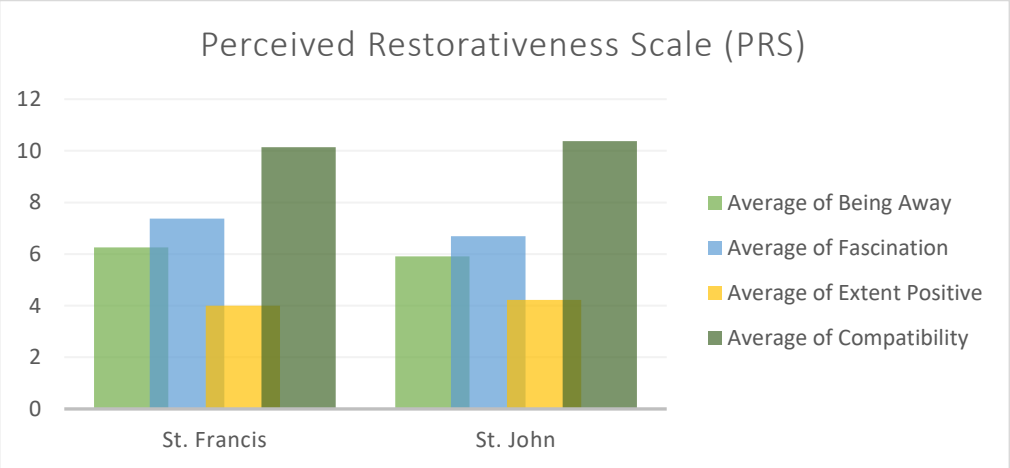

Figure 6. Perceived Restorativeness Scale Results for the Churches.

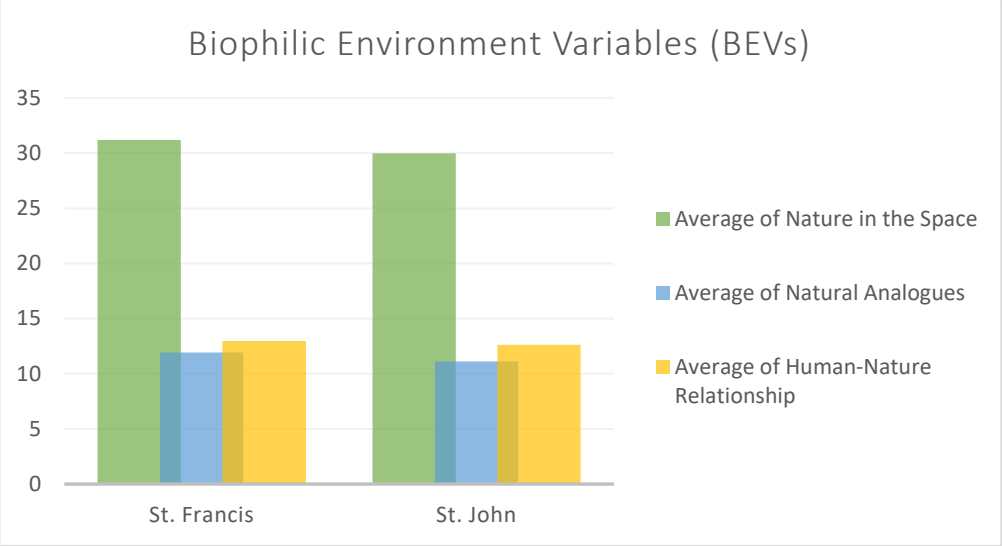

Figure7. Biophilic Environment Variables (BEVs) for the Churches.

Bi-variate Correlation Analysis

A bivariate correlation was run to understand the impact of major categorization of BEVs on the perceived restorativeness of the environment. Table 3 represents the results of the 2-tailed Pearson correlation. A strong and significant correlation was found between all variables of PRS with BEVs, except 'Extent' which showed no significant results out of the three correlations and the relationship could not be interpreted. The highest correlation (0.716 with $p < 0.01$) was observed between 'Nature in the Space' and 'Being Away' followed by 'Natural Analogue' and 'Being Away' (0.716 with $p < 0.01$). Out of the 12 different obtained correlations, 9 were found to be strong and significant.

		Nature in the Space	***Natural Analogues***	***Human-Nature Relationship***
Being Away	Pearson Correlation	**.716****	**.716****	**.595****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200
Fascination	Pearson Correlation	**.703****	**.691****	**.501****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200
Extent	Pearson Correlation	-.101	-.144*	-.112
	Sig. (2-tailed)	.155	.042	.114
	N	200	200	200
Compatibility	Pearson Correlation	**.519****	**.567****	**.683****
	Sig. (2-tailed)	.000	.000	.000
	N	200	200	200

Table 4. Correlation Results for PRS and BEVs. ***. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).*

Regression Analysis

A regression model was also prepared to testify and validate the correlation results considering the high impact of BEVs on the Perceived Restorativeness of the environment. BEVs were taken as the Independent Variables (IV) in the study whereas the PRS parameters were taken as Dependent Variables (DV). The results of the regression model are shown in Table 4 as standardized beta coefficient values along with their significant 'p' values and adjusted R square values. Independent Variable 'Nature in the Space' depicts a strong and significant relationship with 'Being Away' and 'Fascination', 'Natural Analogue' is entirely significant and strongly related to all four PRS parameters. 'Human Nature Relationship' is insignificant in 'Extent' and has a strong and significant relationship with the rest of the three PRS parameters.

BEVs / PRS	***Being Away***	***Fascination***	***Extent***	***Compatibility***
Nature in the Space	0.320***	0.390***	0.113	-0.035
Natural Analogues	0.299**	0.290**	-0.211	0.299*
Human-Nature Relationship	0.234***	0.105*	-0.053	0.279**
Adjusted R square	0.57	0.52	0.01	0.50***

Table 5. Linear Regression Model Results. Note: PRS = Perceived Restorativeness Scale. *p<.05. **p<.01. ***p<.001

The results of Comparison of Means, Bivariate Correlation and Linear Regression Model lead to the conclusion that the three major categorization of Biophilic Environment Variables (Nature in the Space, Natural Analogues and Human Nature Relationship) have significant impact on the perceived restorativeness quality of the environment. The PRS parameter 'Extent', however, fails to develop any significant relationship with the BEVs under the given environments.

Although both the churches were designed in the same architectural style and within the same era, they slightly vary in their perceived restorativeness quality due to richness and site context of their built environment's BEVs.

Discussion

The BEVs are strong proponents of creating restorative environments but their impact is highly influenced by the emotional state of the visitors. The BEVs Visual connection with nature, Non-visual connection with nature, Material connection with nature and Prospect & Refuge have direct influence on the emotional stability of the visitors, their impact can be maximized through experimental design solutions and in turn it increases the ability of the visitors to perceive their environments as restorative. Most of the visitors in these churches are tourists and hence they represent a higher number of 'Fascination' which reduces as they spend more time inside the church compound. 'Being Away', 'Compatibility' and 'Extent' however still an active role play in perception of the environment as restorative. The usefulness of Being Away depends on the personal traits of the respondents and are highly random and inexplicable; certain randomized attributes like clouds, shadows and open spaces which further supports prospect-refuge theory can be set up to increase the restorative impact through broadly establishing this aspect of PRS. The use of stone and wood is found to be unconventional in comparison to the city lifestyle and it is one of the reasons why the church environment is considered a highly loaded with attributes of 'Fascination'. Rich detailing of wood and pinnacles add to the mystery of the design and invites interest and intrigue from the visitors.

Conclusion

This study investigated the role of Biophilic Environment Variables (BEVs) in Perceived Restorativeness Quality of a built environment (Religious and historic in this case). It took

inferences from a different era and architectural style in order to standardize the responses to evaluate the data on the same bipolar scale. Future investigations can be conducted to explore the relevance of this study in preparing design guidelines for religious or tourism-oriented buildings which can serve the purpose of psychological restoration. Different built environments can also be studied using the same tool created in this study which uses BEVs and PRS-26 as their mode of data collection. The study promotes the use of natural features in architectural design to influence the human psychology in a constructive and balanced way. This is an attempt towards sustainable architecture which takes mental health of the user into account.

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The Power to Change: A Brief Survey of the Wind Power's Technological and Societal Potential, Barriers to Use, and Ways Forward

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Abstract

With the effects of climate change linked to the use of fossil fuels becoming more noticeable, political establishment and society appear ready for renewable energy. Yet, despite these expectations, fossil fuels still comprise nine-tenths of the global commercial energy supply. In this article, the history, technology, and barriers to acceptance of wind energy will be explored. The central question is why, despite the problems associated with the fossil fuels, more ecologically benign energy is still scarcely used. Having briefly surveyed some literature on the role of political and corporate stakeholders, as well as theories relating to factors responsible for the grassroots' resistance ("not in my backyard" or NIMBYs) to renewable energy, the findings indicate that motivation for opposition to wind power varies. While the grassroots resistance is often fueled by the mistrust of the government, the governments' reason for resisting renewable energy can be explained by their history of a close relationship with the industrial partners. This article develops an argument that understanding of various motivations for resistance at different stakeholder levels and understanding the role of democracy in decision-making opens up space for better strategies for a successful energy transition.

Key words. climate change; energy transition; NIMBYs; renewable energy; wind power

Introduction

The wide-spread public protests against air pollution caused by fossil fuels in Western countries have increased since the nineteen seventies (Zavestovsky, 2010; Perera, 2018). Concerns about climate change and increasing greenhouse gas (GHG) emissions that cause the greenhouse effect and consequently climate change have increased (Pinske and Kolk, 2009). With climate change linked to the use of fossil fuels, hope was expressed that political, corporate, and economic institutions, as well as society as a whole, will switch to renewable energy (Climate Economy Report, 2014; Barthelmie and Pryer, 2014).

Several proposals have emerged, propelled by a public and political interest in the development of renewable energy technologies (Barthelmie and Pryer, 2014; Renewable Energy World, 2015). Solar power and wind power are considered to be the most significant potential source of global low-carbon energy supply, without potential dangers of waste, as in the case of nuclear energy (Brown et al, 2014; Washington, 2015). Unlike fossil fuels, wind power does not contribute to GHG emissions, aside from its capture and storage devices (which can be made using renewable energy), and unlike partial renewables like biofuel, it does not involve replacing biodiverse habitats with monocultural plantations (Eggars et al, 2009; Braungart, 2013).

Yet, despite these expectations and technical innovations and increased affordability of renewable energy, and particularly wind power, at present, fossil fuels continued to supply almost nine-tenths of global commercial energy and climate mitigation efforts have been so far a large failure (IPCC, n.d). As of 2017, renewable energy accounted for an estimated 18.1% of total final energy consumption[1].

The global emissions continued to rise after the signing of the Paris agreement in 2015 (Leahy, 2019), partially because not all governments have signed the agreement or attempted to meet the targets (Luttikhuis, 2019).

Considering the importance of renewable energy to combat climate change, this article briefly outlines some of the technological, political, and social dimensions associated with wind power and the reason for opposition to it, outlining possible ways forward. The central question addressed here is why, despite the obvious risks and threats associated with the use of fossil fuels, there is still no radical shift to more ecologically benign forms of energy.

The Challenge of Climate Change and Renewable Energy

While there is a considerable body of research on climate change, renewable energy, wind power, and resistance to wind power from the governments and corporate stakeholders down to local communities, little has been written about understanding and comparing various motivations for resistance from different levels of stakeholder involvement. The problem of different motivations deserves new research due to the need to resolve inconsistencies between the apparent desire to avoid climate change on the one hand and the inability of governments as well as some communities to facilitate this change. The hypothesis that drives this desk research is that understanding and differentiating between different motives for resistance can help policy makers to make informed decisions concerning appropriate strategies. Linking theories of the role of political and corporate actors in addressing (or failing to address) sustainability challenges, and using theories relating to sociological and psychological factors responsible for grassroots resistance promises to bring new insights into the study of the energy transition. The brief background, technology, and politics involved in the production of and resistance to the use of renewable energy, and particularly wind energy, will be explored in the sections below.

Energy Supply: Brief Background

Between 1950 and 2005, fossil-fuels supplied over eighty percent of all energy production, igniting rapid changes first in the economically developed countries, and then globally (Nehring, 2009). Between 1950 and 2015, fossil-fuel production increased from 1.5 billion to

[1] https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf

over 10 billion metric tons (EPA, 2015), with carbon dioxide emissions constantly rising (Harvey, 2018). This is due to several factors: the increase in global population and its demands for higher living standards associated with a high level of natural resource consumption, relative peace, and economic competition dependent on exploitation of fossil fuels (Washington, 2015; Kopnina and Blewitt, 2018). As fossil fuel energy became omnipresent and increasingly affordable, it acted as a substitute for other energy inputs in transportation, agriculture, and construction (Smil, 1994; Pinske and Kolk, 2009).

The majority of commercial and private vehicles are running on fossil fuels (Smil, 1994), with car ownership increasing every year (Kopnina, 2011; Buehler, 2018). The number of airplane flights has also increased exponentially in the last two decades (Higham, et al 2014). Higham, et al (2014:336) noted that an increase in aviation is "fundamentally incompatible with radical emissions reduction and decarbonization of the global energy system". Coordinated action and strict government regulation of emissions are needed not just in aviation, but in all energy-intensive sectors (Higham, et al 2019).

In agriculture, the application of energy-intensive artificial fertilizers and pesticide production has increased 1,000 percent globally between 1950 and 2015 (Setboonsarng, 2015). Already in the nineteen sixties, it was noted that the adoption of intensive farming supported by fossil fuels has increased the capacity of productive land and so made possible a 'population explosion' (Ehrlich, 1968). Agricultural advances allowed humanity to appropriate almost half of the entire 'productive' landmass, used for cultivating wheat, rice, corn; and other grain (Kindall and Pimentel, 1994; Setboonsarng, 2015). Fossil fuels, in combination with better medical technologies and food production systems, have caused the global population to grow as never before in human history (Setboonsarng, 2015).

Concomitant with these developments, high per-capita energy consumption has been recognized as a necessary condition for high living standards (UN, 1987). Higher consumption also strengthened a positive feedback loop, forcing people to use land more intensively and to adopt technological innovations that make an even more intensive land use possible (Boserup, 1965). Critics showed that the argument itself is flawed. Eating high on the food chain has led to massive clearing to grow soybeans and corn for feedlots, not using land more intensively. Intensive and sustainable farming are contradictions. Thus, it was argued that with almost eight billion people, it would be unrealistic to strive to attain the same level of consumption for generations to come (Engelman, 2013; Washington, 2015), including consumption of energy. Yet, while research and technology associated with the production of renewable energy have been steadily advancing, energy alternatives have failed to displace the fossil-fuel regime (Mitchell, 2009).

Challenges to wind power

The intermittent (weather-dependent) nature of wind power has presented challenges to the system capacity (Fang et al, 2011).The wind power can be stored either as electricity in batteries, heat in such media as molten salt, or as hydrogen, compressed air, or pumped storage to a higher level, so that power is available on-demand (UCSUSA, n.d.). Improvement in the design of a battery energy storage system (BESS) has been crucial in attenuating the effects of unsteady power input from wind farms (Teleke, et al, 2009). The design of newer batteries determines the capacity of the BESS to ensure constant dispatched power to the connected grid, while the voltage level is kept constant (Zhao, et al, 2015).

Globally, such large projects have been somewhat less popular than the application of small wind systems that have demonstrated their ability as distributed energy resources (Akorede, 2010). Distributed energy resources refer to a variety of small, modular power-generating technologies that are combined to improve the operation of the electricity delivery system (Ibid). Yet, large scale use of wind energy is gaining in popularity as electricity storage systems improve (UCSUSA, n.d[2]). A study by the United States Department of Energy in 2008 found that expanding wind power to 20 percent by 2030 is feasible, affordable, would not affect the reliability of the power supply, and would create new jobs (UCSUSA, n.d.). One

[2] https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf

of the largest sites of high-voltage power lines spanning 3,600 miles was completed in Texas in 2014 at a cost of $7 billion, handling up to 18,000 megawatts and serve millions of households from Austin to Huston (Wald, 2014).

The challenge of integrating wind power into established electric power grids is described in the report *Technology Roadmap: Wind Energy by* the International Energy Agency (IEA, 2013). The Agency's assessment examines several case studies to determine the ability of anyone's national grid to accommodate renewables using storage, interconnection, and demand-side management (IEA, 2013). The report approximates that wind power could generate up to 18% of the world's electricity by 2050, compared with 2.6 % today. The Chinese onshore wind power projects have experienced rapid growth in wind power generation, with China projected to overtake OECD as the leading producer of wind power by 2025, with the United States ranking third (Han et al, 2009). IEA's recent report has estimated that the offshore wind capacity is projected to increase 15-fold due to approximate $1 trillion investment by 2040 (IEA, 2019). Today, wind energy can be modular for installations of any size (Sathyajith, 2006; Barthelmie and Pryer, 2014; Wald, 2014).

Sustainability and Wind Energy

Sustainability concerns have given the renewables a new impetus with internationally funded research exploring the potential role of wind energy deployment in climate change mitigation efforts (IPCC n. d.). After the signing of the Kyoto Protocol in 1997, the curbing of emissions has become a matter of international environmental politics (Pinske and Kolk, 2009). Scientists of the Intergovernmental Panel for Climate Change (IPCC) have established that it is still possible to limit GHG emissions to avoid the 2 °C warming threshold (IPCC, n.d.). To achieve this aim, it was calculated that the carbon-free sources could supply 10–31% of electricity worldwide by 2050 (Barthelmie and Pryer, 2014).

The quantity of energy generated by the wind is potentially limitless, and aside from harnessing, storage and transfer technology, cost-free (Lucas 2006; Cleveland and Morris 2013). Together with solar power, wind power represents one of the most clean and sustainable sources of renewable energy (Climate Economy report, 2014; UCSUSA). Considering all these developments, wind power has gained in popularity (Wind Europe n.d.).

However, the availability and increased affordability of renewable energy barely dent fossil fuel dependence, with Raval and Hook (2019) reporting that oil, gas, and coal are still expected to constitute about 85% of power by 2040. REN21 (https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf) states that in total energy use renewables are over 18% now, but you only quote electricity. Also, projections for a realistic meeting of Paris agreement targets are not optimistic (Leahy, 2019). For the full development of wind energy, some barriers, challenges, and limitations need to be removed: high generation cost, low on-grid price, and stagnating development of domestic manufacture (Han et al, 2009) as well as economic, social and political factors, outlined below.

Results: Barriers to Wind Energy and Failures to Address Climate Change

Critical scholars have noted that due to historical significance of fossil fuels in bringing about economic growth, and present fixation of neoliberal economics and politics on growth as a common-sense "good" (Washington and Kopnina, 2018), it has often been the governments, and not so much local protestors, that have prevented meaningful sustainable policies (Kopnina and Blewitt, 2018;). Part of this resistance to the sustainable transformation of energy can be explained by the entrenched power of the "carbon democracy" (Mitchell, 2009), or plutocracy based on oil oligarchy (Rozzi, 2015). However, it is not just the governments influenced by industrial and particularly fossil-fuel lobbies that impede the development of clean power.

NIMBY Protests

In a novel by Miguel de Cervantes written in 1605, Don Quixote is fighting the windmills as if they are ferocious giants. In his delusion, he believes that after defeating them he will be able

to enjoy fame and glory as a knight. As of the year 2019, the fight with the windmills, or their more modern incarnation, wind turbines, continues. In “Don Quixote on the Katwijk Boulevard” Marijke Visser (2016) describes local resistance in the Dutch coastal town to the plans to build an offshore wind park. The local community stakeholders, entrepreneurs, fishermen, and politicians complained about the lack of transparency regarding the costs and benefits of the project. This anthropological research also revealed various myths and (mis)conceptions about the reasons for having the wind turbines in the first place (Visser, 2016).

This local Dutch protest is reflected in many locations across the globe, preventing the meeting of the targets for renewable energy to address climate change. Known as NIMBY’s (“not in my backyard”) protests reveal the ‘social gap’ between scientific evidence, public opinion, and the local politics of wind energy (Visser, 2016). Social understanding and resistance to wind power installations has multiple causes, such as democratic deficit and qualified support (Bel et al, 2013), the inter-relationship between communities and the land related to place identity, perceived loss of security, a sense of marginalization (Pasqualetti, 2011), and in the case of those living in proximity to windmills, the noise, earth vibrations, obstructed views, and changing landscapes (Smith and Klick, 2007), or dislike of their visual impact (Eagle et al, 2018).

Visser (2016) notes that in Katwijk various forms of narratives and myths arose. As in more instances in the post-truth, fact-free world, stories about the evils of wind power are spread and perceived by stakeholders as ‘the truth’, supported by lay citizens’ “investigations and counter investigations” (perceiving offshore wind power as old-fashioned, non-profitable, and unsustainable) to falsify the claims of opponents (Visser, 2016). One reason for the opposition to wind power is its large scale, perceived as overwhelming (Firestone and Kampton, 2007). Often NIMBY protests are successfully used by those with interest to discredit wind power and to demonstrate that wind farms are unsafe, unhealthy, or even undemocratic as they ignore citizens’ objections (Bel et al, 2013; Feurtey et al, 2016; Visser, 2016; Eagle et al, 2018).

A more general issue might be not just that democracy is subordinated to populist, oligarchic, or plutocratic influences, but the very nature of democracy itself. As Novack (2019) has noted, the “problem is NOT that the system of democracy is imperfect. “Perfect” democracy might not lead to the solution of our situation either. The real point is that democracy, even when working perfectly, does not guarantee good, wise, or just decisions. All properly working democracy can do is deliver the decisions that the people want, for good or for ill”. For democracy to deliver decisions dealing with the ecological crisis the people have to want that more than they want other things. To make matters worse, this is a long-term problem. Novack has also stressed that he is not advocating for some system other than democracy as the alternatives are not better and most of them worse. Simply, however, there is nothing inherent about democracy that would guarantee the wisest, altruistic, or scientifically sound decisions regarding climate change Lidskog and Elander (2010). This is due to a myriad of psychological and political conflicting interests, self-interests, desire to fit socially and culturally within established consumerist norms, and the "brainwash" by the neoliberal media supported by entrenched power lobbies (Isenhour, 2010).

Environmental and Conservation Concerns

The opposition of some environmentalists concerned about wind turbines' damage to terrestrial nature, marine life/environmental impacts study of respondents opposing wind farms was recorded in Cape Cod, USA (Firestone and Kempton, 2007). Concerns over the negative ecological impacts of off-shore wind farms include habitat loss, collision risks, barrier effect, noise, vibrations and electromagnetic fields (Inger et al, 2009; Vaissière et al, 2014; Rodríguez-Rodríguez, 2016). In Europe, wind power is demonstrated to affect birds (particularly raptors, migrating birds and waterfowl) and bats, as well as marine mammals including small cetaceans, particularly harbour porpoises and harbour seals (Rodríguez-Rodríguez, 2016). Avian mortality is one of the most-documented concerns, with many collision victims being raptors and griffon vultures (De Lucas et al, 2008).

The Government's and the Media's Role in Opposition

Strategic use of public concerns with windmills in the media tends to underplay the long-term negative effects of fossil fuel energy (Washington, 2015). This is a dangerous trend – not just regarding the use of wind power in particular, but as a general tendency in which the severity of the environmental predicament is denied (Dunlap and McCright, 2011).

The present subsidy regimes that support fossil fuels lower the chances of meeting the post-Kyoto Protocol agreements (Leahy, 2019). Basically, the governments might be "in the pocket" of established power lobbies, deserving the name of "oil democracy" (Mitchell, 2009; Rozzi, 2015), with "fake news" and fabricated facts exaggerating the negative role of wind farms "research" sponsored by vested fossil interest groups (Rattiner, 2018).

Simultaneously, climate denial has been fueled by industrial lobbies' funding of certain research institutes and media keen to maintain the status quo (McRight and Dunlap, 2011). It is the deniers who claim they are sceptics, but true sceptics seek the truth, they do not run away from a truth they deny (Washington and Cook 2011). Recently, opposition to government interventions to regulate energy due to concerns about social and economic fairness, especially in recent years as manifested by the "yellow vests" ('gilets jaunes') movement, that among other things, demands low energy prices and resists a carbon price (Al Jazeera, 2019).

Other "Renewable" Alternatives

Another reason for the failure of climate change mitigation policy is that the alternatives to fossil fuel power, often misleadingly classified as "renewable" or "clean" (or at least "cleaner") energy have not been much better than fossil fuels, including initiatives such as substituting wood for coal (Reijn, 2019a, b). While the use of wood pellets in Europe has been branded as "renewable", the use of bioenergy derived from palm, soy, or other types of wood for energy has been said to deserve a label of 'environmental lunacy in Europe' (The Economist, 2013). The EU's Renewable Energy Directive continues to insist that energy derived from biomass is carbon-neutral, based on the assumption that trees regrow after being cut (Garson, 2019). The bulk of wooden pellets consumed in the European Union come from Eastern Europe (Reijn, 2019b) and the United States and Canada, as well as from developing countries (Kopnina, 2016; Garson, 2019). Despite presently plentiful supply from economically less developed to wealthier countries, the growth of "green" fuel plantations requires clearing originally biodiverse habitats, eliminating biodiversity but also their ability to serve as carbon sinks, as newly planted trees take a long time to grow before they are cut again (Eggers 2009; Kopnina, 2017; Garson, 2019). Also, plantations for biofuels were noted to disrupt food security, as well as related to fuel rebound effects, when people use more fuel or energy assuming it is 'sustainable' (Ghosh and Westhoff, 2019).

The Cost of Wind Power

Another principal argument against the renewables is that their costs of building and technology enabling effective distribution of wind energy still exceed those of conventional energy sources such as coal, oil, natural gas, and nuclear energy (Nemetz, 2013). Yet, REN21 and IRENA clearly show that renewables such as wind are cheaper than new coal-fired electricity! IRENA (2018) notes:

Electricity from renewables will soon be consistently cheaper than from fossil fuels. By 2020, all the power generation technologies that are now in commercial use will fall within the fossil fuel-fired cost range, with most at the lower end or even undercutting fossil fuels.

Jacobson et al (2018) note that in normal traditional economic terms, renewables are now of similar price to the current 'business-as-usual' fossil fuel systems. However, they point out that when one considers the *full costs* of energy + health + climate, renewables are only a *quarter* the cost of the current fossil fuel systems. They conclude (p. 247) that it is fully possible to reach: 'a fully integrated all-sector 100% clean, renewable, efficient, and reliable energy infrastructure by 2050, if not sooner'. Offshore turbines have higher costs because of

the need of higher maintenance due to increased force of marine windstorms, flooding, and saltwater-caused corrosion, that can damage wind farm installations (Greaves and Iglesias, 2018).

Discussion: Ways Forward in Addressing Resistance

Addressing the NIMBYs

Returning to Don Quixote in Katwijk, Visser (2016) writes that ways forward include a stakeholder involvement to decrease resistance. Both groups of opponents and proponents of wind power share certain similarities. While proponents of wind energy in Katwijk, like in many other localities in the world, demonstrate a clear awareness of the necessity of renewable energy, they also share the feelings of 'being unheard' by the officials (Visser, 2016). However, while proponents of wind power in Katwijk express distrust of their local officials, the opponents distrust the government officials. Stakeholder engagement can be increased by involving local people into decision-making processes, but simultaneously aiming to provide comprehensive, non-technical evidence for why wind power is not only sustainable but can be beneficial for this region and different groups of stakeholders (Visser, 2016).

What is also significant in this Dutch case, is that once the stakeholders are heard, some reasonable ideas emerge. Visser has discovered that a number of her respondents, even in the militant opposition to wind power "camp", point to new technologies to tackle the climate problem, like tidal wave power, 'blue energy' (energy generated from the interaction between fresh and saltwater) and solar power. Visser (2016:2) writes: "Acknowledgement of the regional specific circumstances and sensitivity for the socio-historical roots can strengthen the feelings of being heard". She also notes the need for transparent communication to enhance the trust between members of the local communities and project managers:

Explicit information about the pros and cons, and the facts and figures will increase the inhabitants' knowledge and awareness. To achieve an open and transparent stakeholder involved approach, consensus between national and local government about the facts and figures of the policy is required (Visser, 2016:2).

This approach to working with community-based protests can address some of the issues associated with "corrupt" democracies (Mitchell, 2009; Rozzi, 2015) or an even trickier issue of the relationship between democracy and climate change (Lidskog and Elander, 2010).

To address the interference of wind turbines with the landscape or noise pollution, and a sense of marginalization, considering the relationship between land and life by project planners, and discussions with local communities, can help smooth some potential conflicts (Pasqualetti, 2011; Visser, 2016). More pragmatically, offshore farms further from inhabited areas have been built, with project managers hoping to compensate for higher costs of offshore turbines by avoiding resistance.

Addressing Environmental and Conservation Concerns

In the case of marine life, Firestone and Kempton (2007) showed that the opinion-based beliefs appear to be factually incorrect. The negative effects of climate change and overfishing on the marine environment are much more significant than the impact of wind turbines (WWF, n.d). The negative environmental effects of wind farms in (among other things) disrupting bird migrations have been exaggerated by the media (Traube, 2004), while the positive role has been underplayed (Inger et al, 2009). The same media is less inclined to discuss the long-term effects of climate change disrupting not only birds, but endangering habitats and food supply that the birds and other species are dependent on, with profound changes leading to irrevocable changes or "tipping points" leading to extinction (Pimm, 2009; WWF, n.d.). Few griffon vultures killed by wind turbines (da Lucas et al, 2009), but most are endangered due to other factors, such as climate change, hunting, the use of agricultural pesticides, electrocutions, and lack of available food (Becker et al, 2010). The direct positives include the capacity of offshore wind turbine installations to act as "both artificial reefs and

fish aggregation devices", facilitating "restoration of damaged ecosystems", and "enhancing both biodiversity and fisheries" (Inger et al, 2009:1145).

It is, however, very important not to under-estimate some negative impacts of offshore wind farms, and the ocean environment needs monitoring and safeguarding while these technologies are developed (Pelc and Fujita, 2002; Inger et al, 2009; Neri et al, 2019). Environmental Impact Assessment in relation to wind farms and biodiversity needs to consider mitigation hierarchy, including measures that would avoid, reduce, and if possible offset significant adverse effects on ecosystems (Vaissière, et al 2014). Technological innovation, such as like floating turbines may help reduce current environmental impacts of marine windfarms (Rodríguez-Rodríguez et al, 2016). Overall, the effect of wind energy on biodiversity needs to be carefully weighed with alternatives such as fossil fuels or biofuels, that seem to have a much larger impact, long-term, directly or indirectly, on the flourishing of habitats.

Addressing the Government and Corporate Resistance

Critical scholars have maintained that many sustainability efforts have only worked to 'sustain the unsustainable' (Blüdhorn, 2007), for example promoting electric cars that still use electricity derived from fossil-fuels (Isenhour, 2010), with corporate and political greenwashing and window-dressing through 'sustainababble' (Engelman, 2013). Neoliberal governments have readily delegated responsibility for the choice of energy to citizens and refusing to make unpopular decisions that would limit economic growth (Isenhour, 2010). Despite the perceived risks of climate change, it seems that the public and politicians remain in the state of impassivity or even denial (Dunlap and McCright, 2011).

Considering this, the opposition to wind power remains problematic, directly or indirectly fuelled (pun intended) by the established power lobbies or prey to unrealistic expectations (Nemetz, 2013). For example, the Institute for Energy Research, which has been producing anti-wind energy research and media coverage, has board members in the oil and gas industry (Rattiner, 2018). The same lobbies, supported by media and some members of the public, argue that the fossil fuel economy secures jobs and leads to economic prosperity (Pinske and Kolk, 2009; Kopnina, 2016). However, since the effects of climate change are becoming to manifest themselves in the form of droughts floods and fires that hurt the economy and worsen refugee crises, this creates a new economic incentive for governments and corporate leaders to support renewable energy.

Addressing Other "Renewable" Alternatives

Unlike wind, trees or other sources of "green" matter have multiple ecological functions, outlined in the book *Cradle to Cradle* by Braungart and McDonough (2010). The authors explain the principle of eco-effectiveness (rather than eco-efficiency) by the central metaphor of a cherry tree, which blossoms every year. While most of these blossoms do not succeed in making more cherry trees through pollen or seeds, their reproduction is helped by other species that eat the berries and carry the seeds. The "waste" (this term is used herein a similar way that the wooden pallet makers argue that their product is made of "waste" material of timber production) serves an even more important purpose (McDonough and Braungart, 2010). This purpose is to replenish the soil that supports not only new trees but also billions of other smaller species, including grasses, fungi, and other microorganisms enabled to thrive and reproduce by this "waste". This nurturing process becomes impossible when vital biomass goes up in smoke for a short spurt of energy (Braungart, 2013).

These types of "alternatives" that pretend to be "circular" still require material inputs (Rammelt and Crisp, 2014). In comparison to other sources of renewable energy, including liquid and solid biomass and waste, wind power does not use material resources that can be exhausted, as in the case of burning waste, which actually contains valuable mixed materials (Braungart, 2013); or include potentially hazardous by-products such as nuclear waste (Sathyajith, 2006; Barthelmie and Pryer, 2014; Renewable Energy World, 2015). Clear communication of the Cradle to Cradle and circular economy framework can help to address the issue of best intentions and wrong choices in terms of "renewable" alternatives (Kopnina,

2018; Kopnina and Blewitt, 2018). Since renewable energy does not involve depletion of resources, aside from its capture and storage devices, and it should not be compromised by allowing fossil fuels to be part of the 'mix' and therefore ensuring that their use continues. indeed!

Addressing the Costs

The new technological improvements have helped to avoid jeopardizing a utility's ability to meet constantly fluctuating customer demand (Fang et al, 2011). The cost depends on the intention of the conventional power companies to buy excess power from many small, disseminated wind power sources at a reasonable price. This has been the subject of new rules and regulations, such as "feed-in tariffs", also known as FITs (Climate Economy report, 2014). FITs pay consumers, including households, landlords, businesses and organizations such as schools and care homes, for creating their own "green electricity" (http://www.fitariffs.co.uk/FITs/).

Another side for the solution is financial and long-term prosperity gains that both industrial and political stakeholders find most appealing, which is due to technological developments that make wind power more successfully stored and transferred (Fang et al, 2011). Technologies for generating and storing wind power have been rapidly improving. The significant enlargement of the grid system, linking a large number of geographically dispersed wind parks has helped to transfer power at great distances. This type of highly interconnected grid system could emulate the requirements of current energy supply systems (Fang et al, 2011). Increased awareness of economic benefits and actual job creation brought by wind farms is playing a positive role as well (Loomis et al, 2016).

What is helpful for addressing the costs is subsidies regimes established by governments, which can financially reward the producers and consumers directly, but also, significantly, indirectly through various "hidden" supports, such as rebates, tax exemptions, trade restrictions, limits to market access, and price controls (Pinske and Kolk, 2009; Ellis, 2010; Aldy, 2015).

While the wind power has not always been price-competitive, many newer technologies for harvesting, storing, and transferring wind energy have enabled greater market competitiveness (Climate Economy report, 2014; Watson et al, 2019). With the benefit of economies of scale, wind power has been able to realize substantial decreases in per-unit cost of electricity and provide hope for an environmentally benign generation of global energy (Brown et al 2014; IEA, 2019).

To be fair, we need to note that applying these technologies on the global scale to satisfy billions of people increasingly striving towards a high standard of living, requires a different type of commitment, adjustment, and indeed, perhaps short-term sacrifice than the current political and economic regimes have allowed for. Subsidies, "feed-in tariffs", as well as adjustments on the part of those that live next to the wind farms, and last but not least, cessation of fossil fuel industries' financial backing of anti-renewable energy policies, phasing out of fossil fuel subsidies, and enhanced access to the public stock markets (Tian, 2018) are all needed.

Discussing the Role of Democracy

While for years governments have been instrumental in subsidizing and otherwise supporting fossil-fuelled industries, the relatively recent interest of (some) governments in the shift towards renewable energy is relatively new (Pinske and Kolk, 2009). Considering that the dominant language of communication through the media has been (and in many cases continues to be) economy-centered (e.g. Washington, 2015), it is not surprising that sudden appeals to consumer responsibility, and possible sacrifices to living standards, presently meet both corporate and social (NIMBY) resistance. Since part of NIMBY protests are the distrust of government (e.g. Visser, 2016), and many governments' twists and turns in signing and complying to (or not) Kyoto agreement, or later the Paris agreement (Luttikhuis, 2019), within the relatively short periods between democratic elections, this

distrust is understandable. Scientific expertise backed up by goodwill and a clear communication strategy from policy makers towards the communities is necessary.

There are many groups within every society that actively support climate change efforts, and in fact climate protests have become common-place, or promote environmentally friendly behaviours such as veganism, avoid flying or driving, etc. However, other groups worry about losing their consumer privileges. Relying on the "wisdom of the people" in taking environmentally informed decisions should not be over-estimated (Lidskog and Elander, 2010). Rees (2008:7) suggests that 'intelligence and reason may not be the primary determinants of human behaviour at any social scale'. Far from being "rational consumers" and wise citizens, in the time of great decisions regarding climate change, our "reptilian brain stem" may override the rational cortex, and we might stick to safe paths (Rees, 2008). These safe paths might be supported by convenient but mistaken assumptions, such as the "goodness" of economic growth and the primacy of individual choices (Washington and Kopnina, 2018). Wanting to be popular with its electorate and avoid collisions with groups such as "yellow vests" who demand low energy prices (Al Jazeera, 2019), the government also has a stake in avoiding unpopular decisions (Isenhour, 2010), thus creating a kind of Faustian pact between the people and the government. Not sure this is unpacked properly? You mean both deny reality and let themselves be fooled (fuelled) by a more convenient lie? I think you can say this?

To escape the impasse, Rees (2008) suggests that despite these instincts, our capacity for 'consciousness, reasoned deliberation and willpower' allows us (with effort) to critically examine the "myths we live by" and articulate the necessary conditions for sustainability (Washington, 2015). The impasse between the people, the governments that, hopefully, really try to do "what's best for the people", can be perhaps overcome by the realization of common goals – the government wants to be popular, the people that elect it to have their self-interests (and sometimes altruistic interests) in mind. As Inger et al (2009) suggest in the case of environmental concerns (for the marine environment in this case) about the wind technology, understanding of the advantages of this type of power in comparison with other alternatives, is crucially important. Inger et al write that the deployment of marine installations has: "… the potential to cause conflict among interest groups including energy companies, the fishing sector, and environmental groups. Conflicts should be minimized by integrating key stakeholders into the design, siting, construction and operational phases of the installations, and by providing clear evidence of their potential environmental benefits" (Inger et al, 2009:1145).

Thus, a common language that can reach all stakeholders, explicate standpoints and expectations, and hopefully lead to the articulations of rational (e.g. on the basis of price, and, as cliché as it sounds, an understanding of the necessity of energy transition towards a better future for one's own children) as well as altruistic (perhaps trading in some of the high-consumption lifestyles for the sake of future generations and the environment itself) motivations is necessary to achieve energy transformation.

Conclusion and Policy Implications

The fact that wind energy harvesting technologies have existed for centuries testifies to the human capacity to invent and maintain sustainable energy systems. Yet social and political barriers to the widespread and acceptance of renewable energy in general and wind power in particular identified in this article still need to be overcome. I have inquired why, despite obvious risks and threats associated with the use of fossil fuels, renewable energy such as wind power has not (yet) resulted in a radical shift away from fossil fuels to renewable energy overstated, it is happening. As discussed above, presently, the 'energy mix' is still dominated by fossil fuels, without a radical transition from the types of technologies and lifestyles that threaten our planet's viability again overstated. Strict adherence to true renewables such as wind and solar power; rejecting "partial" renewables that involve depleting biomass, such as most of the biofuels, promise long-term positive effects in the energy transition.

This article has also discussed concerns with transmission, distribution, and acceptance of wind energy. Resistance to wind energy is fuelled by the entrenched power hierarchies, as industrial power lobbies often play a significant role in controlling and dominating the energy market, as well as in "not in my backyard" (NIMBY) protest movements. Support or resistance to wind power varies per stakeholder and within the groups of stakeholders. In some cases, it is the "top-down" regulation forces national governments to accept certain measures. In the case Katwijk protests, discussed here, the Dutch government's sudden support of renewables is due to the obligation to meet the European Union's sustainable energy targets. The mixed motivation for some to oppose, and for others to support wind farms, hinges on personal convictions, scientific (mis)understanding, (mis)trust of government, and many other factors. To gain public support for wind farms, despite their past policies supporting fossil fuels, the government's present motivation needs to be clearly articulated and translated into "local language". This can involve information campaigns, participation of local stakeholders, and compensation of those that might be (or feel) disadvantaged. Above all, the articulation of both rational (e.g. addressing climate change) as well as socially and ecologically altruistic (caring about future generations and the environment) motivations and sharing them with all stakeholders is necessary.

To sum up, research into renewable energy and the barriers to its acceptance briefly reviewed in this article indicates that wind energy is gaining more wind in its sails, and may yet become, together with solar energy, one of the two truly renewable and environmentally benign sources of global energy supply that can be a major part of reducing climate change.

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Waste-to-wealth: The economic reasons for replacing waste-to-energy with the circular economy of municipal solid waste.

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Abstract

Sharing the same raw material, recycling and composting are in direct conflict with incineration of municipal solid waste in combined health and power plants. Indeed, waste-to-energy plants in regions with high recycling rates import urban waste from other countries to use otherwise unused capacity and raise revenues. Using the case of Italy's second largest and economically most developed region, I discuss the economic viability of municipal solid waste incineration to produce electricity and heath in the context of the increasing role of electricity production from renewable energy sources as well as of the emerging circular bioeconomy. Four lessons and three guidelines aimed at local authorities and policy makers emerge from the present study.

Key words. Recycling, Composting, Waste-to-energy, Incineration, Municipal Solid Waste, Circular Economy, Green Jobs

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Waste-to-energy

Chiefly as a consequence of ingestion as the dominant exposure pathway for the public, the impact of urban waste incineration on human health is significant and of broad scope, including diverse adverse health effects, from infant deaths and miscarriage.[1] Furthermore, each municipal solid waste (MSW) waste-to-energy plant generates an highly toxic residue (fly ash) rich in heavy metals and hazardous organochlorines formed upon the partly removal of toxic compounds in the incinerator gas effluents.[2]

Originally introduced in Great Britain in the 1870s, when wood and biomass residues were abundant in urban waste, incineration has been, along with disposal in sanitary landfills, the main method of MSW disposal used across nations. The first plants in Britain were already able to burn waste at temperatures high enough to allow self-sustained combustion (*i.e.*, requiring no coal or wood) with minimal odors.[3]

Walsh has nicely recounted how refuse incineration in New York City where the first municipal incinerator was built in 1908, ended in the early 1990s with the voluntary closure of the three remaining municipal waste-to-energy plants due to absence of air pollution control equipment which incinerators "vulnerable to stricter government emissions limits, ultimately resulting in their premature closure and the decline of incineration as a waste management practice in the city".[3]

Today, incineration of urban waste in combined heat and power (CHP) plants often using the hot water with district heating systems[4] is widely employed across the world. Generally, relying on generous public feed-in-tariff incentives paid to the electricity generated burning MSW, numerous waste-to-energy plants have been built and put in operation in the last two decades, chiefly in western Europe[5] and in China.[6]

Mostly due to waste-to-energy plants in Germany, France, the Netherlands, Austria, Sweden and Italy, the amount of municipal waste incinerated in former 28 (currently, 27) countries of the European Union has gone (Figure 1) from 32 million t in 1995 to 70 million t in 2018 (+117%). However, the amount of MSW recycled has gone from 25 million t in 1995 to 75 million t in 2018 (+201%), whereas the amount of MSW composted went from 14 million t of 1995 to 43 million t of 2018 (+202%).[4]

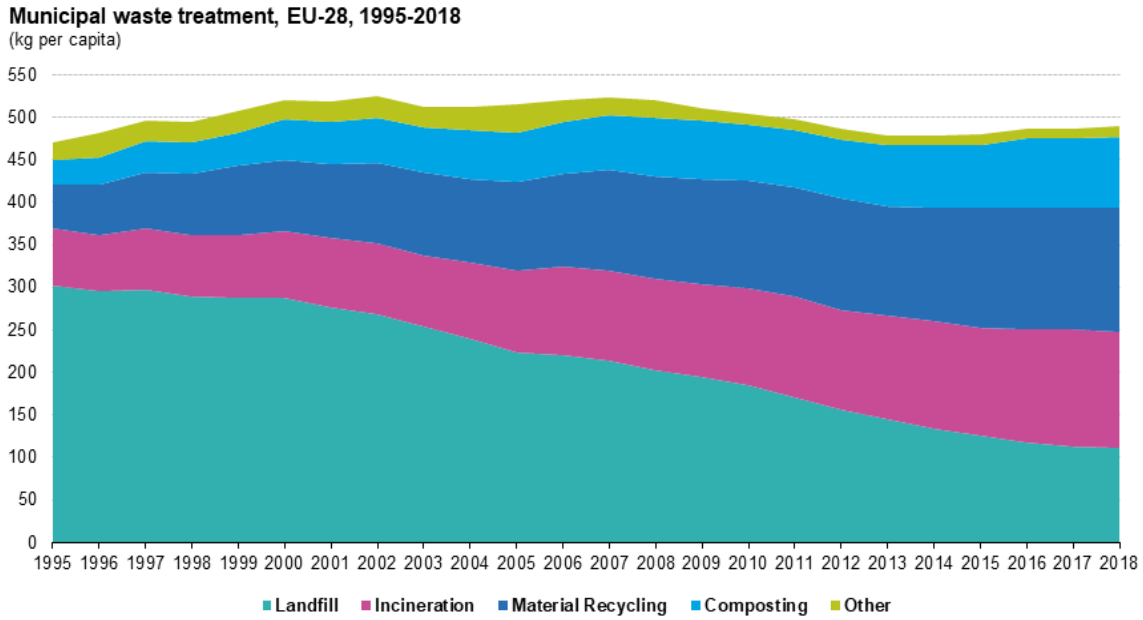

Figure 1. Municipal waste treatment in the 28 countries part of former European Union, 1995-2018 (kg per capita) [Image courtesy of Eurostat, Reproduced from Ref.5, with kind permission].

In the course of the last three decades (1990-2019), in other words, urban waste recycling and composting have become so widespread and successful that several world's cities and regions reached and even surpassed 70% recycling rates, making urban waste increasingly unavailable for incineration.

This further worsens the poor economic sustainability of burning MSW in waste-to-energy plants which traditionally has required generous public incentives in the form of prolonged (20 or even 30 year) power purchase agreements for electricity fed into the grid paid with generous tariffs (feed-in-tariff) with waste-to-energy electricity formally classified as "renewable".[7]

In this study, rather than using abstract models, I use real data mostly from Italy but also from other countries to show the economic reasons for replacing waste-to-energy with the circular economy of municipal solid waste.

The case study of Lombardy, Italy

In Italy, I further focus on Lombardy, the second largest and most economically developed and densely populated region, hosting 13 of Italy's 39 incinerators. Lombardy is used as a case study of an highly developed economic region which first opted for widespread uptake of MSW incineration and then had to face (and is facing) the quick rise of MSW recycling and composting rates up to percentages that require importing MSW to continue to operate the waste-to-energy plants. As such, the example will be useful for other regions of the world where policy makers are currently facing the dilemma whether to invest in incineration or in the circular economy of urban waste.

From the research methodology viewpoint, the study makes use of official data provided by Italy's public bodies as to the amount of recycling and composting rates, as well as of non-official data from reputed trade associations, newspapers and magazines as to the amount of MSW incinerated in Lombardy or the number of waste-to-energy plants promoted through feed-in-tariffs. The latter option was chosen so as to provide an updated picture.

In 2018, Lombardy collected for recycling and composting 61.7% of municipal urban waste, whereas 25.4% of urban waste was incinerated.[8] However, 400,000 out of 2.2 million tonnes MSW burned in the same year were imported from other Italy's regions.[9]

From the energy viewpoint, Morris has shown in 1996 that while recycling conserves energy that would otherwise be expended extracting virgin raw materials from the natural environment, burning refuse in a waste-to-energy plant equates to waste energy for 24 out of 25 typical municipal solid waste materials.[7]

Lombardy in 2018 hosted 64 composting plants, 6 aerobic and anaerobic integrated treatment, and 8 anaerobic digestion plants.[10] Together, these plants treated, respectively, 1,004,723 t + 762,522 t + 233,683 t namely an overall amount of 2,000,928 tonnes. In the same year, the region's cities sent 1,944,000 tonnes of residual MSW to the region's waste-to-energy plants.[10]

The cost borne by Lombardy's cities and other Italy's regions delivering their non recycled waste to Lombardy's incinerators in 2018 varied between €100/t and €150/t.[11] This led for example a 40,000 inhabitant Lombardy's city (Desio) to launch the separate collection for recycling of even diapers (which, alone, amount to over 15% of the previously non-recyclable waste).[11] Thanks to this and to other improvements and innovations in the collection of recyclable materials, in year 2018 the recycling rate in Desio reached 78.31%, from 61.81% in 2017.[12]

In this way, having reduced the amount of waste sent to waste-to-energy plants, the average waste tax rate paid by the average family in Desio diminished by €6,[12] and this regardless of the lower prices paid for collected paper and glass.[13]

In general, the more cities in Lombardy progress towards achieving high recycling rates transforming waste into wealth, the less urban waste becomes available for burning.

The conflict for municipal solid waste

Urban waste is far from being a "renewable" energy source. In Italy its combustion to produce power cannot be any longer subsidized as it happened for decades likewise to virtually all countries hosting waste-to-energy plants. In the United States of America, for example, tip fees at

incinerators were found to be two to three times higher than comparable recycling or composting fees, and yet as of late 2018, 23 States legally classified incineration as "renewable" in their energy legislation.[14]

As of 2017, in Italy only 6 out of 39 waste-to-energy plants still benefited from the feed-in-tariff incentives.[15]

The fact that waste-to-energy plants need large amounts of municipal waste to be economically viable, including plants using state-of-the-art combustion technology, is further demonstrated by the €540 million plant waste-to-energy plant *Amager Bakke*, near Copenhagen, which started operation on March 2017.[16]

Owned by five municipalities, in less than a year the value of the company managing the new plant "plummeted from plus 2.3 billion DKK to a negative 200 million DKK, corresponding to an overall loss of 2.5 billion DKK, or roughly 330 million euro" due to the fact, wrote a city councilman in his Master thesis dedicated to the plant, "that there was not enough garbage in the city to power the over-sized plant".[17]

Similarly, to use otherwise unused capacity, increase revenues and the low calorific content of MSW devoid of paper and plastics separately collected for recycling, since 2011 several countries with high recycling rates including Germany, the Netherlands, and Sweden started to import waste from Eastern and Southern Europe.[18]

Indeed, the analysis of municipal waste delivered to incinerators shows that a significant fraction (40%-60%) is recyclable or compostable.[19] For instance, recent analysis of municipal solid waste in the city of Johannesburg revealed that plastics and organic wastes constitute the highest waste content (28% plastics and 28% organic waste in the round collected refuse) almost independently of the season.[20]

Regions where recycling and composting rates are high produce a "fuel" whose calorific power is too low. Hence, waste-to-energy plants hosted in these regions need to import MSW from regions where recycling and composting rates are low in order to improve the calorific power of a "fuel" otherwise unsuitable for combustion.

However, driven by large societal and environmental megatrends, after two decades of false starts a large bioplastics industry is finally emerging across the world.[21] This will inevitably further lower the amount of post-consumer plastic waste available for burning at waste-to-energy plants.

The impact of renewable electricity and circular economy on waste-to-energy plants

The increasing share of renewable energy generation in all countries (including Italy)[22] with a significant penetration of power generation from renewable energy sources significantly lowers the wholesale price of electricity. The latter merit-order effect[22] directly impacts the revenues of non-subsidized waste-to-energy plants generating their revenues from the tip fees as well from selling power on the wholesale electricity market.

This is exactly the situation currently faced by Lombardy's waste-to-energy plants, where already in 2018 a significant fraction (18.2%) of the waste burned in its plants had to be imported from other regions and countries. In the subsequent year, the rate of recycling and composting has further increased and will inevitably continue to do so as shown by Lombardy's province of Mantova, where it already reached 87.1% in 2018.[23]

With the almost immediate ban of China on importing plastics and other recycled materials in 2018,[24] most of Italy's (and Europe's) recycling plants faced a dramatic fall in the prices (tariffs) awarded for collected paper, glass and plastics. For instance, in Lombardy the price paid for collected glass to certain public waste collecting plants went from €30/t to €5/t, whereas that of paper went from €120/t to €20/t.[13] Yet, the same company insisted on the need to further increase the rate of separate waste collection for recycling because, at the time, the tip fee for disposing for example solid municipal waste in Lombardy's plants doubled from €80/t to €160/t.[13]

In brief, recycling remains convenient even at low prices of the recycled raw material since the tip fees for disposal of municipal solid waste in landfills or in waste-to-energy plants "hungry" for municipal solid waste continue to increase. This is because of the need to cover the operational costs and the diminishing revenues stemming from the low and decreasing input of MSW from

surrounding cities and regions where rates of recycling and composting increase year after year to eventually exceed 80% rate.

It is also relevant to notice that one of the main problems that led to the deployment of so many waste-to-energy plants was the poor sanitary and environmental performance of first-generation composting plants processing the organic and biodegradable fraction of MSW (often more than half by weight) as well as from farming activities.[25] Today's composting plants do not emit bad odours and do not emit leachate in the soil. Only in Italy, in the 25 years between 1992 and 2017, more than 65 million t of organic waste were diverted from disposal in landfills or in waste-to-energy plants producing 23.5 million t of compost in a rapidly increasing number of plants (from about 30 facilities in year 1997 to more than 300 facilities in 2017, with a total treatment capacity higher than 8.5 million t).[26] This is equivalent to substituting about 300,000 t of N, 190,000 t of K and 170,000 t of P in the chemical fertilizer market,[26] for an overall value of 650 million €, while storing on Italy's soils 7 million t of organic matter, thereby fighting soil erosion and loss of productivity of Italian farms.[26]

Lessons and guidelines

Four lessons and three guidelines for local authorities and policy makers emerge as main outcomes of the present study.

First, policy makers should be aware that recycling and composting are not complementary, but rather in direct conflict with incineration, as all these technologies compete for the same raw material: municipal solid waste.

Second, policy makers should be aware that the low and decreasing wholesale price of electricity due to increasing penetration of power generation from renewable energy sources,[22] makes electricity generation by burning municipal solid waste increasingly less convenient, worsening the already poor economic viability of waste-to-energy plants.

Third, policy makers should learn that the rapid emergence of bioplastics started with the introduction of biodegradable plastic bags and now expanding to high value-added plastic resins,[21] will rapidly lower the availability of plastics in MSW, further impoverishing its already low calorific value.[7]

Fourth, policy makers need to be aware that waste-to-energy plants using capital intensive equipment able to handle large tonnages with few employees create a limited number of jobs (0.1 jobs per 1,000 tonnes).[27] On the other hand, the circular economy of municipal waste, starting with recyclable material collection from locations such as households, drop-off points, offices and firms, is a powerful way to create jobs, especially in manufacturing and in reuse and remanufacturing activity (Table 1).[27]

Three guidelines are suggested to guide effective policy action in transitioning from waste-to-energy to waste-to-wealth based on today's circular economy technologies and methods applied to municipal solid waste management.

Material	Collection (in 2008)	Processing	Manufacturing	Reuse/ Remanufacture
	Jobs per 1000 t	*Jobs per 1000 t*	*Jobs per 1000 t*	*Jobs per 1000 t*
Paper and cardboard	1.67	2.00	4.16	N/A
Glass	1.67	2.00	7.85	7.35
Ferrous	1.67	2.00	4.12	20.00
Aluminium	1.67	2.00	17.63	20.00
Non-ferrous	1.67	2.00	17.63	20.00
Plastics	1.67	2.00	10.30	20.00
Rubber and leather	1.67	2.00	9.24	7.35
Textiles	1.67	2.00	2.50	7.35
Wood	1.67	2.00	2.80	2.80

Table 1. Jobs created by management activity in the circular economy of selected materials in municipal solid waste [Adapted from Ref.27, with kind permission of the Tellus Institute].

First, inspired by the key principle of the circular economy to reduce, reuse, recycle and recover waste (the 4R concepts),[28] local authorities and policy makers should refrain from signing long-

term contracts to supply municipal waste to waste-to-energy plants, and rather focus efforts to maximize recycling rates for their MSW turned from a cost item (waste) into an earning item (wealth).

Second, consistent with the high recycling and composting rates achieved in a few years in many world's regions currently exceeding 70% and even 80%, policy makers should actively promote the development of a technologically advanced, second generation plastics recycling industry whose best companies, thanks to increased investment in waste collection, sorting, and recycling technologies are already able to recycle plastics to near virgin purity.[29] Finally, aware that management education plays a key role in the transition from a linear to the circular economy,[30] policy makers and local authorities should deploy new educational activities to convert urban waste management companies from companies collecting waste for incineration or sanitary landfill, into circular economy organizations operating, not only in the materials value chain steps of collecting and sorting, but also in the key steps of manufacturing, reuse and remanufacturing.[31]

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This work is dedicated to Delia Tusa and Simonetta Adelfio on the occasion of the 35th anniversary of our friendship started across our classroom desks.

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LETTER TO VISIONS DOI: 10.13135/2384-8677/4420

For a health-promoting, inclusive and complex vision

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Turin, April 7, 2020

Dear Editors,

it's not easy to comment on the recurrence of World Health Day when, this year, it comes at a time of the spreading of the Covid-19 pandemic, causing the death of increasing numbers of people all over the world. The fact that several months have passed since the virus first emerged, might lead us to think that political decisions in combination with the work of our healthcare systems would have been able to limit its impact. However, the infection seems to be able to bypass many people's immune systems in an irreversible way and to propagate its effects even beyond our worst predictions.

In the face of such trying times, in his epic theatre dramas (e.g. *Mother courage and her children,* and *The good woman of Setzuan*), Bertolt Brecht asked whether silence might be the best response, since it may be more dignified to avert our gaze from the sufferers if we are unable to go beyond social constraints to provide proper succour for their plight. If not, then we are at risk of being of very little help, becoming mere accountants of the bankruptcy of modern illusions. Conversely, in situations of need, Danilo Dolci exhorted those that could do so to "act quickly (and well) because people are dying", a phrase that echoes in the title of his book *Fate presto (e bene) perché si muore*. For this reason, we are compelled to reflect on the effects of this pandemic with as deep a perspective as possible, putting key issues such as prevention and solidarity, and even hope, at the centre of public discourse.

The current crisis lays bare many of the contradictions of our times, starting from the illusion that our collective and personal health is largely protected against the "ills of nature" by the health and welfare systems, an idea upon which our modern states were founded and are still based. Bio-politics – i.e. the increasing concern with the biological wellbeing of the population, including disease control and prevention described by M. Foucault in *The Birth of Biopolitics* is a statutory element of every model, whether in democratic or dictatorial states. The success or failure of welfare agencies based on global and local healthcare systems in the face of the contagion is now a central issue that sets a clear demarcation amongst different views of the future.

If – as it seems – we are dealing with failure, then a number of the apparent certainties of modernity are collapsing, despite the fact that we have come to take them for granted. The "diseases of progress"

– the degenerative pathologies (tumoral, neurological, dysfunctional) spread by environmental degradation, but not transmissible from human being to human being – have been ostensibly accepted, as long as the systems causing them would seemingly grant us defence against the "transmissible diseases", amongst which epidemics. Over the centuries, epidemics such as the plague, the typhoid fever etc. decimated humanity on several occasions, until they finally appeared to have been relegated to the margins of history – or so we believed. But our illnesses are indeed directly correlated with socio-economic models. Even the birth of agriculture 10 thousand years ago introduced problems unknown before the Neolithic age, due to nutritional deficiencies derived from a reduction of dietary choices and the rise of zoonosis by animal breeding.

We do not yet have definite confirmation, but if hypotheses concerning the insurgence of the new coronavirus as related to deforestation, biodiversity loss, the reduction of the biosphere are confirmed,– together with air deterioration due to industrialization and atmospheric pollution (which characterized most of the early hotbeds of infections) – then we are looking at something new which goes beyond conventional ideas of pandemics. A synergy which was never observed before, through the integration of "the diseases of progress" with the "transmissible diseases", raising the risk of rendering both increasingly devastating, if we are unable to revert the course of current development models.

In all cases, we must necessarily reconsider many of our priorities – rights or profit, equality or privilege, politics or greed – bearing in mind the need to define and maintain a coherent position. We can try to strengthen our defence against pandemics, leaving everything else unchanged, yet this will inevitably make the fortresses of the rich impenetrable and endowed with all-powerful sanitary and control structures which are only available to their inhabitants. Otherwise, we can act so as to endeavour to prevent the danger of pandemics at their poverty-steeped roots. We can try, for example, to reduce the risk of virus spill-over from other species to humans by ensuring hygiene, medicine, water, and food in every inhabited area, and ceasing to exploit terrestrial and marine habitats beyond sustainability. Also, we could contain the spread of the infection by curbing immoderate trafficking and trading, reconsidering urbanization, and providing shelter to the masses in exodus as long as we fail in thwarting war and misery.

Moreover, we must recognize that placing faith in technology to protect us is inadequate. Even if equality of access to, and competence in the infosphere were a reality, the option to rely on ICT devices for human relationships and sustenance in times of crisis is not a rational choice. Firstly, because this would be an unsustainable dependence on the very technology that lies at the heart of the reciprocal strengthening of transmissible and non-transmissible diseases favoured by environmental deterioration. Secondly, because it reduces relations to a surrogate form, that can work only within nihilist and auto-consolatory perspectives such as those proposed some 40 years ago by J.G. Ballard in *Myths of the next future*. As the social distancing rules now globally adopted show, the social control we adapt to, necessarily, even if reluctantly, requires efforts to homologate behaviour and thoughts according to the dictates of virtual and mechanical expedients; this is a situation which is not sustainable for everybody and one which in the longer term would lead human societies on a trajectory that goes in the opposite direction from that of creating stronger and resilient communities and individuals.

The overturning of priorities and perspectives this crisis must necessarily provoke, clearly illustrates the untenable paradox of a system that holds financial markets, weaponry and infrastructural projects to be the key, accepted priorities while considering health agencies, human relations and solidarity as dispensable or superfluous. In the name of "deregulation" and "liberalization", immoral and inefficient rules have been introduced, not to simplify trade and jobs or increase their freedom, but to make them succumb to the unpredictable and eventually disastrous laws of one given economic doctrine. If such ultimately illiberal and ill-causing courses of action had not been embarked on, fatal dysfunctions such as the lack of protective clothing and facemasks all over Europe would have been avoided, since with just rewards within an equitable labour market we would have not lost the capability of producing them.

In Italy the paucity of medical supplies in the very same territories where the disproportionately costly military aircraft taking off every day are well stocked with them, has led to dozens of citizens of the richest Italian regions being moved to intensive care units in Germany. The constant refusal to recognize civil and human rights to cohorts of immigrants has led them to abandon the fields of a country unable to protect its foreign workers with basic health and housing needs, leaving Italy more miserable, undefended and alone.

Many predict or hope for a quick return to the illusion of normality in place before the crisis, while others consider it impossible. Whatever happens, it will not be possible to look at the coming reality with the same illusions and prejudices we have harboured for so long. These have been so deeply rooted in our minds as to prevent us from realizing the significance of what was there before our very eyes, acted out on the screens of our smart devices: the distant images and messages of Chinese people afflicted by contagion, their stores closed and their lives disrupted, and no true care on our part to listen, understand and learn before it was too late.

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A Vision for Futures Education Promoting Knowing as Intelligent Action. *Intergenerational Education for Adolescents towards Liveable Futures* by Kathryn Paige, David Lloyd and Richard Smith, Cambridge Scholars Publishing, 2019

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Together with the maintenance of birth-rates and migratory flows, education is an essential investment that every society must make in terms of its own future. Moreover, the characteristics and the quality of both the education and the future are mutually interdependent. At this moment in our history, for the first time ever, we have come to be aware that the future we are building must be *liveable*, something that has thus far been taken for granted, but which we now know we ourselves have radically jeopardized. At the same time, it has recently become increasingly clear that this awareness is growing within all generations and that the need to change human trajectories is perceived with the greatest urgency by the youngest of these generations: those who most risk facing the increasingly devastating consequences of an unsustainable present. We thus need an education that is coherent with this awareness. In *Intergenerational Education for Adolescents towards Liveable Futures* Kathryn Paige, David Lloyd and Richard Smith propose a framework designed to meet that need.

Towards a learning-centred and life- centred framework

Until relatively recently, education has always been considered as an investment in a *foreseeable* future characterized by *progress* towards increasing levels of growth, consumption, life expectancy, wellbeing, etc. There has also been a direct correlation between this world view and a mainstream educational paradigm in which learners should follow the same pathways and receive the same type of teaching: learning should be conceived of in terms of sequences of discrete abilities to be developed, moving (in age-based groups) one year after another from what is simpler to what is more complex, measured as a series of foreseen results to be achieved via standardized and homogeneous inputs and activities.

On the contrary, a new awareness has led to a vision of learning as a process of change related both to oneself as a learner and one's world as an inhabitant. Perhaps now as never before there is recognition that change can come about only if learners both perceive the need or a desire to move towards new scenarios and outcomes and develop an ability to create and nurture interpersonal relationships - as learners of all ages become participants in learning communities. Within such communities, the dynamic interplay between learning and change is based on co-emergence (whereby objectives become manifest in terms of reciprocal needs) and co-specification (whereby outcomes are defined in terms of reciprocal answers). This is a form of *co- learning:* a process based on reflective dialogue, building meaning together through, experimenting, exchanging and conversing.

In the opening pages of the book, the authors set themselves the challenge of providing science and environmental educators with a framework for building such learning communities that are able to see themselves as members of wider ecological communities. This view is placed firmly within the context of examples from practice for how educators can help build understanding and enable capabilities orientated towards living for a more-eco- socially just and sustainable world (p.3). This is indeed no small task. The authors assume a critical stance concerning our idea of knowledge, calling into question the what, why and how of knowledge-building processes. In this respect, they present readers with a critique of school learning as conventionally divided into subject disciplines in order to advance a place- based, transdisciplinary approach to both planning and learning processes. Such an approach is not only learner and learning- centred, but also *life-centred*. If education aims at promoting liveable futures, then the stakes are indeed high and both decisions and actions are of vital importance. The eco-justice framework the authors propose has a deliberate post-humanistic stance, inasmuch as it foregrounds both the *rights* and *standing* of species other-than-human. Starting from this perspective, the authors are critical of a science education - with reference also to STEM education – which fails to recognize its own anthropocentric nature and argue for an education which engages students in viewing their wellbeing as inextricably linked to the wellbeing of all other forms of life on Earth. Such a vision goes beyond the boundaries of traditional approaches within ecological sustainability, in order to promote the cultural shift that is required from a viewpoint that measures the relative value of things, to a *view of care* which extends to the whole planet.

Building learning pathways

In curriculum development, contents are chosen to work on through methodological approaches in order to promote learning outcomes. The contents can be considered as the *what*, the methodological approaches as the how, and the outcomes as the *why* of the curriculum. The authors illustrate a particularly fertile mix between these components. For example, in Chapter 1 studying Gum trees and their inhabitants leads not only to understanding the characteristics, relationships and transformations of a particular ecological niche but also serves to illustrate what the authors call the *sustainability values* of a *Nurturing and Appropriate Technology*. In the same way, the contents of each of the following chapters furnish not only examples of ecological interdependency in order to facilitate understanding of the vital importance of this concept but also to offer models for developing action which contribute to building future scenarios and, above all, enact alternatives to current unsustainable practices.

In the same way, vision and action feed into and out of each other as the importance of each of the following key features of futures education emerges as part of interwoven sustainability values: *Cooperation Communal Care and Behavioural Adaptation* (Chapter 2)*; Structural Adaptation and Appropriate Design* (Chapter 3)*; Future- proofing Recreation, Cooperative and Nurturing Behavioural Adaptation, Inter- generational and Intra-generational Eco- social Equity* (Chapter 4)*; Interconnections, Cultural Adaptation, Resilience* (Chapter 5)*; Inter-Generational Wisdom and Sustainable Design* (*Chapter 6*)*; Individual and Community Activism and Biodiversity Enhancement* (*Chapter 7*). Each chapter brings together approaches and strands of inquiry which seldom come into contact within the field of science education and sustainability education. For example, some of the case studies presented in chapters 2 (on Water Literacies) and 7 (on the earthworm) contain a number of elements typical of classical environmental education/field studies activities that most primary and secondary teachers would be accustomed with. The difference, however, lies in the deliberate attempt to promote in learners' an

activist stance as they build knowledge and develop awareness. One of the teachers quoted explains this quite clearly: "[students] see themselves as instigators of something being changed, they are feeling worthwhile about what they are doing" (p.33). It is in this sense that the relationship between education and the quality of the future we seek to bring forth comes to matter both for the learners and their teachers and moreover also for the community at large. The teachers' planning for the learning pathways implemented is no longer shaped by pre-existing learning outcomes but by the desire to empower learners to research and to make a difference to one's own world, often not knowing where the journey is going to go, but at the same time knowing that it cannot only go where it has already been. What is gained is greater awareness of one's own place (both as an environment inhabited and as a role played by living in it) and greater connection between knowledge building and acting in that place.

Learning and languaging

Learning can be seen a process of adapting to experience, producing change in ways of understanding and being that is the outcome of that experience. Language plays a dual role in this process, because it mediates both the experience and the subsequent adaptation. Language permits the flow and the sharing of information between people and their environments, the dialogue and communication between individuals and inside individuals, which are the very essence of living and learning. As Maturana puts it: "we human beings exist and operate as human beings as we operate in language. Languaging is our manner of living as human beings" (2002: 27). In this respect, the framework proposed by the authors shows how, whether explicitly or implicitly, learning as adapting to experience involves a recurring process of problem- posing, whereby questions search for answers which, in turn are the occasion for new questions. A particular focus is on how scientific questions evolve (p.29) as learners experiment, discover and build knowledge through action. What are scientific questions? How are they formed? Where do they lead us? Formulating and reflecting on questions promotes a constant interaction between cognitive and linguistic levels, showing how language as a cognitive tool can lead in a variety of directions: "By focusing on students' questions, investigations followed in directions that the teachers were not expecting […] "(p.28).

Another feature of the dialogue between learning and languaging is the continuous interplay between human language (composed of phonemes, graphemes, words, speech and writing, discussion, ...) and visual language (composed of lines, shapes, sizes, colours, symbols, pictograms, diagrams, photos, images, ...). The way in which these two forms of language interweave and merge during the learning activities enriches the futures visions which emerge. The way in which this multimodal languaging stimulates thinking and re- thinking while developing futures scenarios is a rendered most explicit in Chapter 4, but is a constant focus throughout, as learners are encouraged to challenge current views, beliefs and behaviours, including their own.

Transdisciplinary approaches for crossing boundaries

In seeking to provide a framework which could guide the design, implementation and evaluation of the type of activism proposed within a framework of eco-just education, the authors draw frequently on Wilber's approach to transpersonal psychology and *integral theory*. This is another bold move in their attempt to challenge and go beyond mainstream educational paradigms based on learners as individuals and disciplines as particular sets of cultural practices typical of given fields of enquiry, experience and activity characterized by specific epistemological, linguistic and methodological features, thereby both crossing and bridging boundaries and mapping new territories. This reflects the authors' commitment to working close to the interface between teaching and learning and the experiential and reflective practice that gives rise to what is taught and what is learned. There is no attempt here to codify and standardize learning processes for the sake of making it easier for teachers and researchers to establish, track or map given learning progressions. The authors' intention is to constantly explore and narrate the experiences which are made possible through the transdisciplinary approach. Hence, as they describe it (p.50), individual and collective dimensions, interpretative and monological stances are constantly interwoven within the perspective of *integral experiencing*. Knowledge is never separate from values, decisions, emotions and relationships.

In this way, a transdisciplinary approach permits the building of new epistemologies, methodologies and languages that go beyond those of single disciplines in order to formulate and address new and common questions. Transdisciplinary approaches are cooperative, in that the members of learning communities come together to build new constructs that are the reason for being of the communities themselves. Moreover, transdisciplinary approaches should enable us to go beyond existing ways of languaging and ways of acting, which prove not only inadequate in the face of new problems but also a source of the self-same problems.

In summary, the authors have written a book that is not just a call for a new approach for futures education but also a series of innovative and well-documented proposals for realizing it. Moreover, their proposals clearly illustrate Dewey's idea that "knowledge is a perception of those connections of an object which determine its applicability in a given situation (1916: 353- 54)". Central to this idea is "maintain[ing] the continuity of knowing with an activity which purposely modifies the environment", inasmuch as "knowledge in its strict senseof something possessed consists of our intellectual resources - of all the habits that render our action intelligent" (1916: 400). If our action is to be intelligent, then it cannot be mere understanding and application of existing knowledge, but rather a complex construction based on questioning why, what, how to know and act in such a way as to maintain sustainability and build liveable futures. In this way education can enhance young people's engagement so they can be empowered to be a driving force for their own and other generations.

References

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