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NEW TRENDS IN URBAN ENVIRONMENTAL HEALTH RESEARCH: FROM GEOGRAPHY OF DISEASES TO THERAPEUTIC LANDSCAPES AND HEALING GARDENS

ABSTRACT. Urban living style is associated with various negative impacts on human health, e.g. connected with the environmental problems. Thus, promoting health of urban population is nowadays one of the most challenging issues of the 21st century together with the growing needs for sustainable development and establishment of the biophilic or livable cities. It is increasing awareness among researchers and health practitioners of the potential benefits to the health from activities in natural settings and especially from regular contact with nature, which can be perceived as a preventive medical tool. This paper discusses the close relationship between the concepts of health-supporting landscapes and sustainability in modern cities based on literature review and case studies from EU, Russian and Australian projects. We first review the historical and modern paradigms (of the various disciplines) which determine the discourse in nature – human health and well-being research. This includes examination of Hippocrates «naturalistic history», Humboldt’s concept of natural garden design; Oertel’s ‘Terrain Kur’; «salutogenic approach» of Antonovsky; McHarg’s Design with Nature; Ecopolis programme, Wilson’s biophilia and some other approaches. Then there is a comparative analysis of structural similarities and differences in the past and current scientific schools devoted to understanding human – landscape interaction. One of the principal arguments is that nature also has another value for health, regardless of natural remedies. It includes, for example, the healing of space, outdoor training trails in parks, everyday use of urban green spaces and peri-urban recreation areas for sport and exercises. We provide an analysis of some examples based on the modern concepts of biophilic cities, therapeutic landscapes, healing gardens, green infrastructure and nature-based solutions. This article also discusses the main types of healing gardens and therapeutic landscapes and suggests the framework of design principles of healing and therapeutic landscapes. The analysis proved that healing gardens and therapeutic landscapes provide multiple benefits and can be regarded as nature-based solutions. These essential aspects of multifunctionality, multiculturalism and social inclusion are well intertwined with the approach of biophilia.

KEY WORDS: urban environment, environmental health research, therapeutic landscape, healing garden, biophilic cities, nature-based solutions

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INTRODUCTION

Modern cities worldwide face a number of problems relevant for all the cities of the 21st century – so called societal challenges, such as urbanization, climate change, ecological issues, environmental quality and sustainable development (Raymond et al. 2017). Urban living style is associated with various negative impacts on human health, e.g. connected with the environmental pollutants such as carbon and nitrogen dioxides, heavy metals, radionuclides, benzene, etc. There is a greater connection between urban pollution and health problems confirmed by the research results from highly polluted urban sites from around the world (Dushkova and Evseev 2012; Hankey and Marshall 2017; Janke et al. 2009; Landrigan and Fuller 2015; WHO-UNEP 2008). These pollutants are associated with environment connected diseases such as stroke, cardio-vascular problems, lung cancer, and both chronic and acute respiratory illnesses, headaches and dizziness, disruption of reproductive and immune systems, and premature death. Among the other adverse health consequences of urban living are high-fat diets, sedentary lifestyles, and increased levels of social and psychological stress (Beyer et al. 2014; Groenewegen

et al. 2006; WHO-UNEP 2008). Thus, promoting health of urban population is nowadays one of the most challenging issues of the 21st century (EC 2015; Marcel et al. 2019; Souter-Brown 2014; Tzoulas et al. 2007) together with the growing needs for sustainable development and establishment of the biophilic or livable cities. The concepts of «healthy urban landscape» and «livable city» have acquired a new significance as an area of integration and balanced interaction of urban development processes, natural and cultural contexts and challenges of creating favorable environment for the urban citizens. Moreover, the concepts of biophilic cities, compact and sustainable cities, nature-based solutions and integrated blue-green infrastructure have the potential to become the theoretical foundation for health-supporting landscapes (EC 2015; Ignatieva 2018; Russo et al. 2017). There is a great number of research worldwide underlying the positive evidence / relationship of direct experience with natural environments to a wide range of health benefits (Beyer et al. 2014; Dushkova and Haase 2020; Hartig et al. 2014; Maas et al. 2009; Soga et al. 2016) and the key role of nature in achieving a healthy society (Brink et al. 2016; Groenewegen et al. 2006; Tzoulas et al. 2007). It is increasing awareness among researchers and health practitioners of the potential benefits to the

health from activities in natural settings and especially from regular contact with nature, which can be perceived as a preventive medical tool (Frumkin et al. 2017; Groenewegen et al. 2006, Maller et al. 2005). A contact with nature in cities in forms of urban gardening, sport activities and community gardens increases life satisfaction, psychological wellbeing, social inclusion and social cohesion, sense of community, and cognitive function (Soga and Gaston 2016; Wood et al. 2016). Moreover, engagement with nature activities (for example, urban gardening, urban farming) was defined as not only a cost-effective health intervention and a type of nature-based solution (Dushkova and Haase 2020; Frumkin et al. 2017; Williams 2017) but also as a treatment for several physiological and mental health problems, so-called «therapeutic landscape and healing garden therapy» (Hartig et al. 2014; Söderback et al. 2004; Wood et al. 2016). The main goal of this article is to discuss the role of nature for creation of sustainable urban living spaces and to analyze, based on the literature review, the development of the concept of health-supporting landscapes for urban citizens. It suggested a historical discourse and analysis of different worldwide examples from ancient time to nowadays. The starting hypothesis for our analysis is that researching historical precedents of landscape – health relationships can be beneficial to current and future planning of urban green spaces and making better the quality of life of urban population. We first review the development of the disciplines within the environment – human health interactions from theoretical and practical perspectives. This includes examination of the impact of changing the paradigms and re-thinking the problem. We then compare structural similarities and differences in the past and current scientific schools devoted to the human – landscape interaction, in order to provide a historical ground and a foundation for achieving more positive human – nature relationships. And finally, we provide some interesting examples based on the modern concepts of biophilic cities, therapeutic landscapes, healing gardens, green infrastructure and nature-based solutions which represent the results of collaborative systems thinking by involving different disciplines and professions in order to build healthy cities. These results were obtained from literature review and research projects based on case studies from Europe, Russian Federation and Australia. Compared to the recent publications on environmental health which primarily focused on potential threats from the natural and environmental surroundings (e.g. pollution, ecosystem disruption and different ecosystem disservices such as natural disasters, vector-borne pathogens and allergens), this paper focuses on how nature positively impacts on human health and wellbeing. One of the current societal challenges is to apply an interdisciplinary approach to researching resilient sustainable biophilic cities (with people and for people), which adopt an integrated conceptual framework based on human ecology, environmental health research, nature-based solution and therapeutic landscape concepts.

MATERIALS AND METHODS

In order to understand the evolution of the concepts in environment – health research, this article reviews and discusses the existing scientific evidence on the human – environmental relationships and health benefits from the contact with nature for individuals and at community scale, based on a number of different research methods and publications from different research disciplines. This review is primarily based on peer-reviewed literature. Furthermore, the article features numerous practical examples from around the world. We used the results of the project «Mathematical-cartographic assessment of medico-ecological situation in cities of European Russia for their integrated ecological characteristics» (2018–2020) under Grant number No 18-05-00236/18 supported by the Russian Foundation for Basic Research (RFBR); the Horizon 2020 Framework Programme of the European Union project «Connecting Nature» under Grant

Agreement No 730222 and the research project «Perth as a biophilic resilient city model in the time of climate change» by the University of Western Australia (UWA) FABLE research grant (2018 – 2019). Some selected examples of good practice of urban green infrastructure, nature-based solutions and biophilic cities concepts were analysed in details. Another methodological approach of this article includes an explorative survey, which was carried out to assess to what extent the principles, and concepts that were revealed during the analysis of the literature and research within the above-mentioned projects, can be recognized and applied in urban planning and governance in cities. Thus, we identified different categories of innovative practices which incorporate those nature-based solutions and biophilic approaches that related to health and human well-being. We analyzed in detail to what extent these selected cases contribute to the creating and maintaining of resilient, sustainable biophilic cities and providing the health-supporting benefits for their citizens. In addition, a detailed on-site analysis was conducted, including a survey and a series of interviews with experts dealing with the issues of urban greening, landscape planning, health environmental research. This analysis provided additional insights into different aspects of nature-health relationships. The analysis was based on the methodical approaches proposed for assessment of therapeutic values of landscape (Belčáková et al. 2018; Williams 2017), healing gardens (Cooper Marcus and Sachs 2013; Frumkin et al. 2017; Hartig et al. 2013) and co-benefits from nature-based solutions, especially those related to human health and well-being (Marcel et al. 2019; Raymond et al. 2017).

The evidence brought together from a review of the literature and real-life applications has been discussed with a wider range of experts in the field of landscape ecology, health and social research working at local, regional, national or international levels at different project-related workshops (e.g. Connecting Nature partners workshop in Malaga on 30 September – 03 October 2019; IGU Moscow 2018 Special session: Health Geography – XII International Symposium for geospatial health on 5 June 2018; 25th IAPS Conference Transitions to sustainability, lifestyles changes and human wellbeing: cultural, environmental and political challenges, Rome, Italy, 8-13 July 2018; roundtables with environmental health experts at the Centre for Human Adaptation in the Arctic of the Kola Science Center of Russian Academy of Sciences on 12-13 August 2019 and 27 July 2018 and the seminar at Polar-Alpine Botanical Garden-Institute in Apatity, Russia on Perspectives and potentials of landscape therapy in the city on 26 July 2018; workshop at Humboldt university Berlin on Urban Biodiversity and Nature-Based Design: methodology and practical applications for interdisciplinary research on 27-29 November 2019, etc.). The discussions and insights from these workshops and round tables have been integrated in this article and have helped to formulate conclusions about using nature-based approach for solving health and social challenges across the cities worldwide. We also included the results from international summer schools «An interdisciplinary perspective on ecosystem services and human well-being» (2015–2019) and master's courses on «Environment and human health», «Landscape biophilic design», «Design with nature», «Green infrastructure as nature-based solutions» which were created and taught by authors at Humboldt university Berlin, Lomonosov Moscow State university and at the University of Western Australia.

RESULTS AND DISCUSSION

1. History of the development of the disciplines devoted to the environment – human health interactions from the theoretical perspective

The connection between nature and health is not new. Rather, nature has always had a high, often very well realized relevance to human health. Table 1 summarizes the evolution of disciplines dealing with environment – human health relationships. The

Table 1. The historical and modern paradigms (of the various disciplines) which determine the discourse in nature – human health and well-being research (created by authors)

Scientific approach / school, year(s)	Key concept and its definition	Theoretical background	Key publications
«Super-natural theory of disease» (prehistorical time)	Religious and beliefs often attributed diseases outbreaks or other misfortunes	Disease and human health were correlated with witchcraft, demons or the will of gods	see Lips-Castro (2015)
«Naturalistic theory» of classic world (from 460 B.C.)	Complex web of interconnections that influence health, well-being	One of the most frequent causes of diseases is the bad quality of environment	Hippocrates, ancient scientists philosophers
«Dark ages of medicine and health research» (5 th -16 th centuries)	n/a	Practical medicine turned back to the primitive one with domination of dogma, irrationality and superstition	See Valencius (2000)
Empirical research on environment and health, medical meteorology, 16 th -17 th centuries	Quantitative approach to the study of the environmental factors of illness	Era of empirical study of relationships between climate, topography, weather, geography, and disease was started and new science of medical meteorology emerged.	Thomas Sydenham (1676) – e.g. research on epidemics in London)
Foundation of classical medical geography as a discipline (18 th century)	Theory of the natural tendency of zoonotic diseases to become localized in a specific habitat	Distribution of each of the diseases was related to the local environment of the place where they occurred. Further research on the interactions of health and environment (geographical pathology)	Finke (1792), Mühry (1856), Hirsch (1883–1886)
Medical geography, Humboldtian medicine and healing gardens (end of 18 th – 19 th centuries)	Medical geography as an exercise in mapping, cartography, and charting diseases and people. Healing gardens as example of design-with-nature concept.	Systematic study of the global variable of human diseases, making use of the concepts, terminology and representational forms of the new plant geography	A. von Humboldt and his followers
Terrain Cur and medical geography (especially, after cultural turn)	The concept of Terrain Kur – physical training in the form of walks over special routes with the positive influence of the nature's beauty for the treatment of several diseases.	Therapeutic landscape as places with natural or historic features for the maintenance of health and well-being, for achieving physical, mental and spiritual healing. Four dimensions: natural environment, built environment, symbolic environment and social environment.	Oertel (1886), Oblonsky (1901), Gesler (1992)
Ecology of Human Diseases	Description of the epidemiological constraints of various diseases	The main influenced environmental factors: inorganic, organic and socio-cultural were defined. Foci of infectious, zoonotic diseases.	Jacques M. May (1959), Pavlovsky (1966)
Ecological psychology and sociology (20 th century)	Salutogenesis as theory of health and illness	Salutogenic environment and therapeutic landscape. Theories of environmental affordances; ecological psychology	Antonowsky (1976)
Environmental health, Health geography, Epidemiology (20-21 st centuries)	Health and environmental pollution – health risks from natural disasters and anthropogenic health risks, use of spatial analysis	Health geography consists of two distinct elements: 1) geographies of disease and health involving descriptive research disease frequencies and distributions, and 2) analytical research to find what characteristics make an individual or population susceptible to disease	Curtis (2004), Landrigan and Fuller (2015), Kearn and Moon (2002), Malkhazova et al. (2019), Revich (2018)
Environmental psychology (a) (already in ancient China, Greek and Rom, with revival in 20-21 st centuries)	Restorative environment	Attention-restoration theory, four features as restorative environment: being away, extent, fascination, and action and compatibility	Kaplan and Kaplan (1992)
Environmental psychology (b) (already in ancient China, Greek and Rom, with revival in 20-21 st centuries)	Therapeutic landscapes and healing garden	Esthetic-affective theory, psycho-evolution theories, three features of healing gardens: relief from physical symptoms, illness or trauma; stress reduction for individuals dealing with emotionally and/or physically stressful experiences; and an improvement in the overall sense of well-being	Cooper Marcus and Sachs (2013), Williams (2017)
Horticultural Therapy (already in ancient China, Greek and Rom, with revival in 20-21 st centuries)	Healing garden and therapeutic garden	Theory of «flow experience»; sensory stimulation theories. Gardens and landscape that facilitate health and well-being	Söderback et al. (2004), Jiang (2014), Souter-Brown (2014)
Biophilia, green-blue infrastructure and nature-based solution concepts (20 th – 21 st centuries)	To design with nature, to promote nature as a source of sustainable solutions as an answer to challenges associated with climate change	«Biophilic cities» inspired by and referred to human needs to have connections with nature. NBS inspired and supported by nature, which are cost-effective and provide multiple co-benefits (environmental, social and economic benefits and help build resilience)	McHarg (1969), Pötz and Bleuze (2012), Wilson (1986), Russo et al. (2017), EC (2015), Agavelov et al. (1985), Ignatieva (2000, 2018)

ancient scientists and philosophers such as Hippocrates (who wrote the book «On airs, waters and places») have already intuitively dealt with the complex web of interconnections that influence human health and well-being (Lawrence et al. 2017). According to Hippocrates, one of the most frequent causes of diseases is the bad quality of air. This approach was defined as a «naturalistic theory» and its development was intervened with cultural development of some civilizations (Table 1). However, in prehistorical time humans rather refer to «super-natural theory of disease» when disease was correlated with witchcraft, demons or the will of gods (Lips-Castro 2015). But with development of a hygiene and curative aspects of a disease as a powerful brunch of medicine, this super-natural approach has been abandoned.

The period of Middle Ages was rather defined as dark ages of medicine when the practical medicine turned back to the primitive one with domination of dogma, irrationality and superstition. Only in the late sixteenth – beginning of the seventieth century, the interest to the investigation in health relationship was arisen, thus, a number of studies appeared from Italian, British, French and German scholars in form of notes, letters, articles and monographs (Dzik 1997). Among them are works of Thomas Sydenham on epidemics in London who applied a quantitative approach to the study of the environmental factors of illness (Valencius 2000). Since this time the era of empirical study of relationships between climate, topography, weather, geography, and disease was started and the new science of medical meteorology had emerged. German researcher Leonhard Finke with his work «Versuch einer allgemeinen medizinisch-praktischen Geographie» (1792) was defined by many researchers as a founder of modern medical geography. In particular, Finke stressed that distribution of each of the diseases was related to the local environment where they occurred. In the late ninetieth century, other German scientists continued the research on the interactions of health and environment – Adolf Mühry (*Die geographischen Verhältnisse der Krankheiten, oder Grundzüge der Nosogeographie*, 1856) and August Hirsch «Handbook of Geographical and Historical Pathology» (1883–1886).

Famous German geographer and explorer Alexander von Humboldt (1769–1859) had also a great contribution to the medical geography, which is based on mapping, cartography and charting diseases and peoples. Humboldt had also developed the concept of natural garden design. In his «Ideas for a Physiognomy of Plants» («Ideen zu einer Physiognomik der Gewächse») published in 1806, he referred to the «patriotic plants characters» (vaterländische Pflanzengestalten) and addressed the «decisive impact» provided by the native vegetation on the development of individual cultures. He also underlined the role of gardens in healing by proposing to design with nature and thus, the quality of existing environment. Further, the so-called «Humboldtian medicine» has expanded the scope of the Humboldtian approach and included a systematic study of the global variable of human diseases, concepts, terminology and representational forms of the new plant geography (Valencius 2000).

However, there was a down part of such disease-map-approach which later resulted in development of the nationalistic view declaring the specific pathway of nations and populations according to particular climate and region (Valencius 2000). This was a period of development of colonial geo-medicine and race distribution, used also for the purpose of nationalistic ideas.

There are several fundamental works in the field of medical geography – environmental health relationship from Russia and the Soviet Union. Russian physician Nikolay Oblonsky in the beginning of the twentieth century (1901) adopted and developed further on the concept of Terrain Kur suggested by the German physician Max Joseph Oertel (1886). «Terrain Cur» or Klima-Terrain-Kur (Terrain Curorte) means a scheduled physical exercise in the form of long walks over steep ascending routes (terrains) as a special positive treatment (Kur) by nature's beauty for several

diseases (e.g. cardiovascular, mental etc.). Since this period, several routes were established in Russia (mostly in Caucasus Mountains) where the concept of landscape therapy was defined as one of the important drivers in the treatment of diseases. Another fundamental Russian concept developed by Evgeni Pavlovsky at early 1950's was the theory of the natural tendency of zoonotic diseases to become localized under the influence of a specific habitat. Pavlovsky identified the foci of infectious, zoonotic diseases by analyzing the associations of vegetation, animal and insect, soil and precipitation regime and other elements of the natural landscape (Pavlovsky 1966). Further research on such diseases caused by agents circulating in natural environments independently from humans was continued by Malkhazova et al. (2019). Even the concept of natural related diseases is not directly connected to therapeutic landscape, we intentionally include it in the list of research devoted to the analysis of the environment – human health relationships. This concept deals with the ecosystem disservices (risks and undesirable effects from direct contact with nature).

The Ecology of Human Diseases (1959) was introduced by the American geographer Jacques M. May. He described the epidemiological constraints of various diseases and defined the main influential environmental factors: inorganic, organic and socio-cultural.

The shift in research on human – environment relationship appeared in the 1970s with the «salutogenic approach» (health-illness continuum) developed by Aaron Antonovsky. The salutogenic perspective tries to explore how health is produced and what are the protective factors and resources designated for the good health (Antonovsky 1979). The concept concerned how specific personal dispositions serve to make individuals more resilient to the stressors of daily life and identified the characteristics, which claimed to help a person better cope with them (and remain healthy).

In the last decades, a great number of research in the field of medical to health geography appeared, focusing on the relationship between health and environmental pollution (Dzik 1997; Kearns et al. 2002; Landrigan et al. 2015; Revich 2018) and especially analyzing priority indicators of the life quality in cities, including urban environment indicators such as ambient air quality, level of noise pollution, temperature waves, population density, and the urban greening rate. The research of Curtis (2004), Malkhazova et al. (2019), Schweikart and Kistemann (2013) etc. presents a comprehensive analysis of how geographical perspectives can be used to understand the problems of health and its inequalities by explaining and demonstrating how different methodologies in the geography of health, both quantitative and qualitative, can be applied in research.

In this time, also the new concepts were established, which aim to create, design and planning healthier, sustainable and resilient urban environments. Among them is «green infrastructure» or «blue-green infrastructure», which in fact began in the 1870, when urban farming and allotment gardens were introduced as a special tool for providing healthy recreation activity and good air in polluted industrial cities (Pötz et al. 2012). «Design with nature» concept was introduced by I. McHarg in 1969 (McHarg 1969) with the direct message to respect component of the environment and natural process while designing and planning. Russian programme «Ecopolis» of the late 70s based on the concept of the «coherent development of nature and humans» and V. Vernadsky's concept of «Noosphere» aimed to create a new type of harmonies urban settlements. This new generation of human settlements is based on minimal ecological footprints (biophysical), which can maximise human potentials (human ecology) to repair, replenish and support human life (Agavelov et al. 1985; Ignatieva 2000, 2018).

The ideas of «Ecopolis» (Agavelov et al 1985) and «biophilic cities» inspired by Wilson (1986) referred to human needs to have

everyday connections with nature. The recently emerged (in the 2000s) concept of nature-based solutions (NBS) was established to promote nature as a source of sustainable solutions and as an answer to challenges associated with climate change. The concept of NBS has been supported and broadened by the International Union for the Conservation of Nature and later by the European Commission. It defined NBS as solutions that are «inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience (EC 2015). The concept has emerged as a way to operationalize and to promote the ecosystem services approach within spatial planning policies and practices (Russo et al. 2017). The opportunities of nature-based solutions for climate change adaptation are also particularly discussed in relation to nature conservation, public health, landscape architecture and urban planning (Marcel et al. 2019).

At the beginning of the 21st century, in addition to the global and regional changes in the natural resources supply and provision of the healthy living conditions, other aspects of the relationship between humans and nature and health are becoming increasingly important.

On the one hand, this is the direct, usually health-promoting (according to the concept of salutogenesis) effect of «nature» on humans and their health and well-being. Analysis of the publications in recent years from the field of natural medicine, has shown that the relationship of environment / nature and health is in the basic focus of the scientific and public debate. There are many direct links between nature and human health and well-being. Thus, connection with nature, in addition to satisfying elementary human needs (e.g. food and natural resources supply), heals or mitigates the most diseases and can be defined as a health resource (which keeps people healthy) (Groenewegen et al. 2006; Kabisch et al. 2018). The recreational and healing value of nature for physical health and mental well-being has long been discussed (Beyer et al. 2014; Hartig et al. 2014; Maas et al. 2009; Soga and Gaston 2016; Souter-Brown 2014). Thus, the effect of nature on humans was already treated in antiquity. Natural remedies (medicinal herbs, mineral waters, muds, extracts, etc.) are used through the thousands of years. Traditional medicine, holistic, complementary and alternative medicine – e.g. traditional Chinese medicine, Ayurveda, Hildegard's and Kneipp's teachings, homeopathy and many others have nature as the essential healing point of their approach. However, nature also has another value for health, regardless of natural remedies (though often not consciously perceived). For example, the healing of spas, outdoor training trails in parks, everyday use of urban green spaces and peri-urban recreation areas for sport and exercises (cycling, jogging and Nordic walking). These health aspects of outdoor nature are used

for promotion healthy life-style, especially for children, through the active nature experience, since many children in urban spaces no longer have the opportunity to acquire nature in everyday life experience (Kabisch et al. 2018). Thus, as a source of healing, and source of inspiration, nature plays an important role in the identity of people and in the development of its own «sense of place» (Gesler 1992; Frumkin et al. 2017). The most important challenge for modern cities is to design urban landscapes accordingly with the idea of harmonic co-existence based on the concept of biophilia. Under the increasing urbanization and alienation of nature the creation of so-called health regions within the cities become the high priority.

2. Therapeutic landscape and healing gardens or where should you go when you are sick

In order to better explore the environment – human health relationship, we have to refer to the definition of a health which according to WHO/UNEP (2008) is «a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity». Such broad interpretation includes also the aspects of physical and psychological wellbeing. It means the high relevance of potential positive effects on health which can be caused by positive emotions (e.g. quality of life, life satisfaction, sense of community and happiness) and the minimization or absence of negative emotions (e.g. anger, loneliness, confusion) (Groenewegen et al. 2006; Söderback et al. 2004; Sullivan and Chang 2017). Being on nature promotes physical activities and supports healthy life style and minimize the risk of a number of modern urbanization-connected diseases (e.g. obesity, mental problems, stress etc.). These healthy activities connected to nature include not only outdoor sport, but also gardening when people grow, cultivate, and take care of plants (flowers and vegetables) for non-commercial use as well as activity in domestic gardens (including allotment and community gardens). In this case horticultural therapy often defined as a practice which helps to improve the physical, psychological, and social health (Jiang 2014).

Landscapes of healing were defined by Gesler (1992) as places, settings, situations, locales and milieus that encompass the physical, psychological and social environments associated with treatment or healing. According to them, there are four essential parts of such landscapes: a) natural, b) built, c) symbolic, d) social environments. All these parts of healing landscapes include a variety of elements, which characterize the relevance of natural and artificial (built) environments (for example, green elements, architectural style, scenic views, aesthetical features), their cultural / social / ritual value (such as social support, sense of place, sacrality) and political significance (especially, (inter)national connectivity, nation-building feeling etc.) (Figure 1).

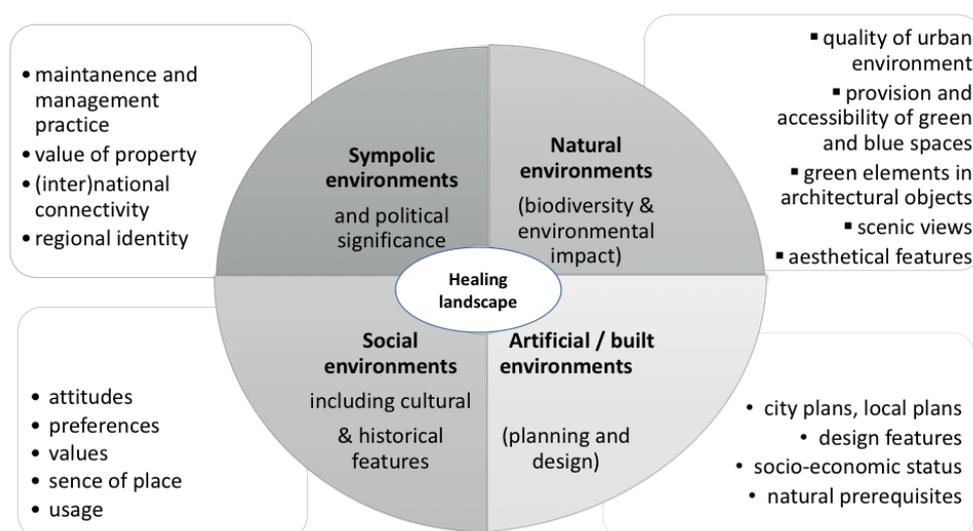


Fig. 1. Healing (therapeutic) landscape and its essential elements (source: authors)

The healing capability and potential of nature for health and well-being is discussed in the stress reduction theory (Cooper Marcus and Sachs 2013), which defines the main powerful and thus valuable factors of nature influencing the healing process, improving health and well-being (Table 2). This table illustrates the analysis of therapeutic impact of the selected nature-based solutions which were studied within authors' research projects and by applying current approaches (Cooper Marcus et al. 2013; Raymond et al. 2017; Dushkova et al. 2020).

Evidence from literature review revealed a broad spectrum of health effects from contact with nature (Table 3). There is a wide range of health benefits and other positive effects for humans from direct experience of natural environments and implemented nature-based solutions (Beyer et al. 2014; Dushkova et al. 2020; Hartig et al. 2014; Maas et al. 2009; Soga et al. 2016). Nature plays a key role in achieving a healthy society (Brink et al. 2016; Groenewegen et al. 2006; Tzoulas et al. 2007). A number of research (Frumkin et al. 2017; Groenewegen et al. 2006, Maller et al. 2005) highlighted benefits to the health from activities in natural settings and especially from regular contact with nature, which can be perceived as a preventive medical tool. A contact with nature via urban gardening, sport activities and community gardens increases life satisfaction, psychological wellbeing, social inclusion and social cohesion, sense of community, and cognitive function (Soga and Gaston 2016; Wood et al. 2016). Engagement with nature

activities (for example, urban gardening and farming) was defined as not only a cost-effective health intervention and a type of nature-based solution (Dushkova and Haase 2020; Frumkin et al. 2017; Williams 2017) but also as a treatment for several physiological and mental health problems, so-called «therapeutic landscape and healing garden therapy» (Hartig et al. 2014; Söderback et al. 2004; Wood et al. 2016). According to Cooper Marcus and Sachs (2013), the garden is intended to be a healing garden: a garden that, in different ways, influences the visitor in a positive way.

The interest to the creation of gardens for healing purposes goes back to ancient Chinese, Greek and Roman cultures. Current research proposes the theories of healing effects of gardens. There are three main approaches (Stigsdotter et al. 2002):

1. *The Healing Garden School*. The health effects are derived above all from the experiences of the garden room as such, its design, and contents.
2. *The Horticultural Therapy School*. The health effects are derived primarily from the activities in the garden room.
3. *The Instorative or Cognitive School*. The health effects are derived from the experiences of the garden room as such, from the activities in the garden room, and the visitor's background and character: experiences of which give the visitor a feeling of belonging and an identity.

Based on the literature review, we can figure out the framework for the analysis of the potential of an urban environment to be designed as a healing or therapeutic

Table 2. Analysis of therapeutic impact of selected nature-based solutions based on the results from the Connecting Nature project

Factors of nature influencing the healing process, improving health and well-being	Type of NBS (selection from the database of EU Connecting Nature project)						
	Public parks	Community gardens	Educational facilities (sport-/playgrounds)	Allotment gardens	Healing gardens	Terrain kur (walking in special routes)	Touching / smelling gardens
the feeling of control over own body and environment when being on nature	grey	grey	grey	grey	grey	grey	grey
the opportunity to feel the support from the fellows by spending time together	grey	grey	grey	white	grey	grey	grey
the positive motivation to start physical exercise inspired by nature	grey	grey	grey	white	grey	grey	white
the feeling of calmness, serenity – positive impact produced by nature through reduction of stressful condition	grey	grey	grey	grey	grey	grey	grey
support the treatment	grey	grey	grey	grey	grey	grey	grey
Reduce depression	grey	grey	white	grey	grey	grey	white
decrease the effects of heart conditions	grey	white	white	white	grey	grey	white

Note: grey – contribute based on the scoring methods and analysis of project impact / benefit assessed using approaches of Raymond et al. 2017, Cooper Marcus and Sachs 2013; white – not relevant.

Table 3. The positive evidence / relationship of direct experience with natural environments – health benefits from nature-based solutions (healing gardens and therapeutic landscapes)

Type of NBS	Methodical approach	Health effects (evidence based)	References (study area)
Healing gardens	Evaluation of therapeutic designs, questionnaire survey	Support the treatment of patients, sociality, gives sense of control (person loses control in a hospital, led by the conditions and staff of medical facility), enable physical movement; access and bond to nature; general, various positive distractions	Belčáková et al. 2018 (Pezinok, Slovakia)
	Landscape evaluation using different criteria, questionnaire survey, scoring method	Well-designed healing hospital gardens form a social atmosphere through saving the patients from the monotony that the clinic environment has and positively affect the clinical results of the patients through reducing stress, and thus they enable patients to feel themselves good psychologically and physiologically	Duzenli et al. 2017 (Trabzon, Turkey)
	Epidemiological survey, psychological and physiological monitoring methods	Preventing stress and promoting mental health, it also demonstrates how environmental enrichment works (e.g. neuropsychological responses which improve behavioural and health outcomes) and how physical activity on nature reduces obesity and non-communicable diseases	van den Bosch and Bird 2018
	A quasi-experimental field study and a true experiment, multimethod assessments	Natural landscape areas of healing gardens reduced depression because nature takes people's interests and attention in an effective way and it takes negative thoughts away	Kaplan et al. 1992; Hartig et al. 2014; Rohde and Kendle 1994 (various)
	Remote sensing for NDVI measures, GIS, medical data	Natural spaces relieve people, create less anxiety and enhance sincerity	Gupta et al. 2012 (Delhi, India)
	Landscape design analysis, participatory approach, questionnaire survey	Feeling of self-confidence, self-respect, self-reliance and personality and self-development	Stigsdotter et al., 2002 (Alnarp, Sweden)
	Literature review	Healing gardens provide patients with healthy living environments through refreshing their memories, increasing motivation and physical activities which decreases the effects of heart conditions and other risky diseases	Elings 2006, Söderback et al. 2004 (various countries)
Therapeutic landscape	Landscape planning analysis, participatory design, questionnaire survey, medical data	Positive distraction (to help users get away, both physically and emotionally, from the stress and pain of interior environment), engagement with nature (biophilia), physical and emotional comfort, incl. safety, security and privacy	Cooper Marcus and Sachs 2013 (various cities of USA), Williams 2017 (concept)
	Literature review, biomedical studies; exposure science; epidemiology of health benefits	Reduced stress, better sleep, improved mental health (reduces depression and anxiety, greater happiness and life satisfaction), increased prosocial behavior and social connectedness	Beyer et al. 2014, Frumkin et al. 2017, Maas et al. 2009, Sullivan and Chang 2017
	Biomedical studies; exposure science; epidemiological survey, remote sensing, GIS	Lower blood pressure, improved postoperative recovery, improved congestive heart failure, reduced obesity, reduced diabetes, improved immune function, improved children health, including child development (cognitive and motor)	Kabisch and Haase 2018, Li et al. 2010, Van den Bosch and Bird 2018

landscape. This analysis should be done using an interdisciplinary approach based on the conceptual ideas of medical as well as environmental sciences, geography and sociology. For this purpose, different kind of data can be used:

1. Environmental data which encompasses the assessment of natural environment with specific elements such as green and blue spaces, fresh-water springs, scenic views which give a high aesthetic pleasure using different environmental indicators
2. Medical statistics data on public health
3. Results of sociological surveys including the participatory observation, questionnaires, semi-structured or short interview etc.
4. Geographical information which can be derived from the cultural landscape research – not only by reading the contemporary landscape but also looking at the history of its development (by exploring its palimpsest created throughout the time).

3. Design with nature to support the human health in cities: evidence from the cities worldwide

Here we provide some examples of successful application of biophilic design and nature-based solution concepts in urban settings which resulted in a wide spectrum of physical, mental and behavioral benefits.

The key idea of biophilic design is to create good and comfortable habitat for people as a biological organism in the modern built environment that advances people’s health, fitness and wellbeing. Together with the main purpose of the nature-based solution approach the both concepts seek to

prevailing paradigm of co-design and co-development with nature in creating sustainable, livable and resilient cities based on needs of their residents and in order to face the current urban societal challenges (e.g. climate change, food and water security or natural disasters). At the same time nature-based solutions provide wider benefits to human well-being and biodiversity. Nature-based solutions based on biophilic design help the urban societies to effectively solve environmental issues.

The most common nature-based solutions include parks and urban green areas which provide a range of natural benefits such as intercepting dust, toxins and noise, sheltering and cooling property, sinking carbon and buffering flooding, creating place for recreation, fostering well-being, and a host of other social benefits.

To the nature-based solutions also refer traditional healing or therapeutic gardens which can be found within or adjacent to indoor healthcare settings – mental health hospitals, schools and centers for the disabled, hospices and nursing homes. Along with the «green care», «farm care» and «farming for health» they represent a new social movement, which uses the benefits of horticultural therapy and dynamically develop throughout Europe, America, Australia and New Zealand. Different types of urban healing or therapeutic gardens, which in the same time can be described as nature-based solutions due to multiple co-benefits they provide, presented in the Table 4.

Thus, as the selected cases show, all types of healing gardens and therapeutic landscape provide multiple benefits (as nature-based solutions) and are developed according with the principles of biophilia. They mostly free assessable-

Table 4. Main types of healing gardens and therapeutic landscapes which characterize current socio-environmental health related movement in cities (Photos: D. Dushkova, M. Ignatieva)

Types	Selected case 1	Selected case 2	Main purpose and co-benefits
1. Touching and smelling gardens	 Friedenspark of Leipzig, Germany	 Botanical garden in Perth, Australia	Assessable-designed recreation for blind and visually impaired people in order to support learning about plants and flowers, social inclusion tool
2. Special green education facilities	 Participation in planting activities in Campus of Uppsala University, Sweden	 Palmgarten in Leipzig, Germany – place of recreation, environmental education, co-creation with nature	improved social interaction and integration, less hostility and aggression
3. Co-designed gardens (nature as healing tool for ill children)	 Summer Garden S.-Petersburg, place for co-creation (projects of children with hearing, sight, physical and mental problems)	 Green project of Association for children with mental and physical health problems, Duisburg, Germany	Work in garden provides health benefits to its users, improving both their physical and mental condition. Important element of such green projects – to create opportunities for patients to wrench away from health problems, arouse involuntary attention and fascination

4. Community gardens as urban farming and recreation	 <p>Annalinde community garden, Leipzig</p>	 <p>McDugall Farm Community Garden, Perth, Australia</p>	Urban farming as a recreation space, cultural hotspot and educational source for residents (to enjoy tasting organic fresh foods, and learn environmental stewardship)
5. Sensory gardens and nature playground	 <p>Playground in King's Park, Perth (Australia)</p>	 <p>Healthy track in kinder garden Moscow region, explore nature</p>	Outdoor environments that have a series of curved, raised and by different types of concrete-covered surfaces' tracks enclose a number of «activity stations» and provide space for sensory exploring and plantings. It not only promotes children's health but also allows children to explore different textures, learning and experiencing nature around
6. Terrain cur within the city	 <p>Terrain in park Khimki /Moscow (Russia)</p>	 <p>Terrain cur in park of Bad Dübén (Germany)</p>	Walking in such specially developed routes has not only therapeutic effect, but also directs attention from difficult internal experiences to an attractive, friendly outside world. It gives possibility of performing various types of recreation – active rest, relaxation and rehabilitation in a natural environment, by introducing a sense of peace, order and harmony

designed and open to the larger community what gives people sense of social inclusivity and social cohesion, enable the needs of disabled users to accommodate and experience the nature. This explain why they became a perfect area for recreation and rehabilitation and more and more attract people as welcoming space that could be used for exercise, gardening and an escape from the normal nursing home routine. These essential aspects of multifunctionality, multiculturality and social inclusion are well intertwined with the approach of biophilia (Ignatieva 2018; Dushkova et al. 2019; Dushkova et al. 2020):

1) They incorporate the elements of natural ecosystems in form of interconnected plants, animals, water objects, rocks, and geological forms.

2) *Natural colors* and materials as well as naturalistic shaped forms which are drawn from design principles and characteristics of the natural world – they can stimulate and reflect the dynamic properties of organic matter in adaptive response to the stresses and challenges of the everyday life (Figures 2a, 2b).

3) *Biomimicry* – using of forms and functions found in nature, especially among other species, whose properties have been adopted or suggest solutions to human needs and problems. Examples include the lawn presented by the native species (Figure 3 a), sustainable urban-drainage systems (Figure 3 b) etc.

4) *Place attachment* – culturally relevant designs can promote a connection to place and the sense that a setting has a distinct human (and also regional) identity, and provide emotional attachment to an area, particularly an awareness

of local landscapes, indigenous flora and fauna, and finally motivate people to protect and sustain the environment of their living.

CONCLUSIONS

One of the tasks of this article was critical review of the historical and modern paradigms that determine the discourse in nature – human health and well-being research. Several concepts from various disciplines were overviewed, for example, Hippocrates «naturalistic history», Humboldt's concept of natural garden design; Oertel 's 'Terrain Kur'; «salutogenic approach» of Antonovsky; McHarg's Design with Nature; Ecopolis programme and Wilson's biophilia.

In the beginning of the 21st century the most important concepts are biophilic cities, therapeutic landscapes, healing gardens, green infrastructure and nature-based solutions.

Analysis of the publications presented in the paper shows, that there are a great number of research which presents the empirical findings by applying a set of different indicators / variables to measure varying exposures to natural elements within a landscape: character and coverage of vegetation within a neighborhood, proximity to parks, participation in outdoors activities in urban green and blue spaces, proximity to water, other contacts with nature (urban gardening etc.). There are also publications which refer to the quality of the nature experience by presenting evidence from the impact of different landscape elements and features on mental, physical, and social health and also their relation to / or value for quality of life, wellbeing, mood states and children's



Fig. 2. a) Playground of Nachbarschaftsgarten – one of the oldest community gardens in Leipzig, Germany, (use of natural materials, forms and colors as alternative to conventional playgrounds as well as planting native vegetation attractive to wildlife and edible for humans). **(b)** Public park of Perth, Australia, with native vegetation (Photos: D. Dushkova, M. Ignatieva).



Fig. 3. (a) Interpretation of nature-based solution in SLU (Swedish University of Agricultural Sciences) Ultuna Campus-grass free (tapestry) lawn (alternative to conventional lawn biodiverse community attractive for human and wildlife); **(b)** Low Impact Design practice example (rain garden) in the center of Oslo, Norway (Photos: M. Ignatieva).

health. Another big number of related research deals with the assessment of physical health parameters and analysis of meaning of contact with nature for fixing health problems (cardiovascular diseases, brain functioning, birth outcomes, asthma, heat-related accidents, etc.). Some research revealed that exposure to neighborhood street trees, small parks, or views of nature from a window all have salutary impacts on health. However, it is still not clear – what is the minimum threshold of contact with nature for urban citizens (e.g. the frequency and duration of exposure to nature to provide health benefits as well as density of nature to which people are exposed on health outcomes). The vast majority of the

evidence demonstrates that more frequent contact with nature predicts better health outcomes.

The analysis of therapeutic impact of the selected nature-based solutions which were studied within authors' research projects and by applying current approaches revealed the factors of nature influencing the healing process, improving health and well-being. Among them are the opportunity to feel the support from the fellows by spending time together, the feeling of control over own body and environment when being on nature, the positive motivation to start physical exercise inspired by nature, reduction of stressful condition, support the treatment, reduce depression, decrease the effects

of heart conditions. It was shown that the particular benefit is connected with the type of nature-based solutions.

By analyzing a variety of nature-based solutions studies within the above-mentioned research projects, we also revealed and characterized the main types of healing gardens and therapeutic landscapes, their main features and different benefits provided by them. We also discussed the multiple benefits of the selected healing gardens and therapeutic landscape (as nature-based solutions) and highlighted the essential principles of biophilia which were used by their creation and development. They include the incorporating of the elements of natural ecosystems, using of natural colors, materials and naturalistic shaped forms, biomimicry (using of forms and functions found in nature), and idea of place attachment (culturally relevant designs which promotes a connection to place and the sense of belonging in order to motivate people to care of and protect it).

Nevertheless, there are several important questions to address in future research: a) we still need to understand about the dose – response (dose – effect) relationship between exposure to natural elements in the landscape and health outcomes; b) what kind of contacts with nature (visual / tactile, direct / through a window / on a screen) can more effectively promote health?

Different types of urban healing gardens and therapeutic landscape, which in the same time can be described as nature-based solutions due to multiple co-benefits they provide, discussed in the paper, provides the evidence demonstrating that exposure to landscapes with natural elements has pervasive, positive, prolonged impact on human health.

New generation of such research is needed to go deeper and explore the process of human – nature relationship and especially their potentials and real benefits in different parts

of the world. This is the acute issue and one of the main challenges for the modern cities and their citizens: How we can co-design and co-work with nature in order to have the healthy environment and opportunity to have a long and happy life? As Henry D. Thoreau said „Nature is but another name for health» (Thoreau 1965: 364-365, cited in Da Rocha 2009). It highlights the importance of being in touch with the natural world, posing ourselves as part of nature and thus always have the opportunity of the healing value of nature. And continuing the words of Thoreau that «Health resides in nature» (cited in Da Rocha 2009), the urgent task of urban societies today is to reside and to rediscover the nature in the cities that it can be further source of life, living environment, educational tool, sacral place, inspiration and healing landscape.

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