Chapter 1: Blue space as an essential factor in environment and health

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Introduction

In this chapter, we attempt to locate the growing knowledge about the public health importance of urban blue spaces within a much longer evolution and history of understanding about the environment and human health. To begin with, we will briefly review the interest in physical environment as a determinant of human health, which dates back several millennia. Within an environmental frame of reference, we then present a more detailed analysis of the changing perspectives on human health and its determinants, from the beginning of modern public health to the present day – a period of approximately 200 years. With the subject matter of this book in mind, our review concludes that the provision and maintenance of urban blue and green spaces, aligned to the needs of the surrounding community, are wholly consistent with the most modern perspectives on public health. Specifically, the topic of blue space speaks to 21st-century public health aspirations going beyond health protection and promotion. These can be summarised as embracing prevention, equity and the urgent need to reduce damage to the Earth's biophysical systems.

In his 'grand narrative' on the progress of public health from pre-Socratic times to the immediate post-Second World War era, George Rosen observed that humanity's major health problems have always "been concerned with community life", especially the control of transmissible disease, the management and improvement of the physical environment, the provision and safety of the food supply, medical care and the relief of disability and destitution (Rosen, 1958/ 1993). While noting the ever-shifting emphasis among these activities over time, for Rosen, they formed the basis of public health as it was understood in the 1950s.

From a 21st-century perspective, Rosen's and other post-Second World War narratives (e.g. Sands, 1952) sound a rather triumphalist note, tracing progress in 'taming' epidemic and endemic diseases over nearly two centuries powered by science, medicine and improvements to the physical environment (Porter, 1999). Later, Thomas McKeown (1976), in an equally celebrated text, courted some controversy by attributing only a very limited role to clinical medicine in improving health outcomes and related population growth. Instead, he identified improved nutrition and environmental reforms as the major contributors.

Events since the 1980s have demonstrated mid-20th-century optimism over the containment of infectious disease to be misplaced, serving to emphasise the dynamic nature of public health. As Rayner and Lang have observed, "public health is wrapped around the reality of change" (Rayner and Lang, 2012). Rosen, Sands, and even McKeown, wrote at a time before the emergence of HIV, Ebola, SARs and, more recently, COVID 19; before widespread concern over the catastrophic potential of antimicrobial resistance; and, of course, well in advance of today's understanding about the grave health implications of human impact on the natural world in terms of climate and other environmental change. Yet their observations concerning the centrality of environmental factors and implicitly the importance

of towns and cities as crucibles for public health action are enduring. Indeed, these insights have, if anything, been reinforced by the socioecological and planetary perspectives which now dominate the public health discourse.

The classical perspective

Rosen's definitive textbook, *A History of Public Health*, offers conclusive evidence of sanitary/environmental provision in ancient towns and cities, plausibly driven by a concern for community health (Rosen, 1958/ 1993). By drawing on the archaeological record, Rosen cites evidence from excavations covering different civilisations and multiple places dating back over 4000 years. Sites in India, Southern Europe, the Middle East and North America variously reveal evidence of sewer lines; water supply arrangements; and, within buildings themselves, bathrooms, drains and even water-flushing arrangements for toilets. Moreover, the layout of many ancient cities indicates a measure of conscious planning and, putatively, a form of building regulation.

However, the key common early point of reference for commentators on public health and its environmental dimension is the so-called Hippocratic Corpus (Adams, 1891). Set out in 62 books, the Hippocratic Corpus emanated from Greece between 430 and 330 BC. In their original content and their selective assimilation of ideas from others, the books of the Corpus are now considered the bedrock of western medicine. Importantly, they depart from ancient notions of diseases as products of evil spirits and the curative potential of magical incantation and potions (Frumkin, 2005). Of particular relevance to this narrative, these books were the first example of a systematic attempt to present a causal relationship between human disease and the environment.

The Hippocratic treatise, *Airs, Waters and Places* (Adams, 1891) introduced several ideas foreshadowing much later thinking on the environment and health. The book recognises, as we do today, the potential of food, water and wider environmental conditions to be sources of disease and, more generally, that health is unlikely to thrive in poor environmental conditions. By alluding to the health relevance of perturbations in discrete environmental compartments, the text presages a 'compartmentalised' way of thinking about the environment that many would recognise in conventional approaches to environmental management and indeed in environment and health activity (Morris and Saunders, 2017).

The Greek writers inevitably lacked a 'planetary perspective', as we would understand it based on 21st-century knowledge of the Earth's systems, their connectivity and their fragility, yet, in parts, the texts convey acceptance that humans have capacity to damage the natural environment in health-relevant ways. Also consistent with current thinking, they saw humanity as situated in nature, subject to its rules and composed of natural substances – the body, within its environment, as a composite whole. This perspective lies at the core of 21st-century concepts such as ecological public health (Rayner and Lang, 2012), planetary health (Whitmee et al., 2015) and one health (www.onehealthcommission.org/en/why_one_health/what_is_one_health/).

It would be wrong, though, to imply a continuum of enlightened ecological thought stretching from Hippocrates over two millennia to the present day. In his book, *Ecological Transition*, published in the 1970s, the celebrated American anthropologist John Bennett observed that the history of the human species is marked by increasing denial of nature in, and by, humankind. Bennett believed this denial to be strongly stimulated by the Western Renaissance (with its anthropocentric orientation) and subsequently accelerated by later processes of industrialisation (Bennett, 1976; Rayner and Lang, 2012). Nash (2006) goes still further in asserting that the dichotomy that separates human beings from nature "underwrites the very discipline of history".

Modern public health: from miasma to ecological public health

We will now direct an environmental focus on the more recent history of public health and to a period sometimes termed the 'modern public health era' – an interval starting from the early 19th century to the present day. We deliver our narrative in two parts. The first part takes its structure from a chronological framework created by South

African-born, American epidemiologists Susser and Susser to analyse and predict developments in epidemiology (1996). Epidemiology is public health's underpinning science and is the study of the distribution of disease in the population and the determinants of this distribution (Baker and Nieuwenhuijsen, 2008). Given our more specific focus on the environment, in the second part of our narrative, we uncouple and review the mix of ideas, principles, shifting cultural norms and so on which profoundly shape today's perspectives on the environment in public health. We support this where appropriate by the use of conceptual models.

In the Sussers' conceptualisation, the period from the early 19th until the closing decades of the 20th century can be seen as a succession of three 'eras in epidemiology'. They identified, within each era, an underpinning paradigm concerning disease and its causation in which those seeking to understand and control disease adopted particular analytical and preventive approaches. We draw on this conceptualisation to reflect on how the role of environment in health was perceived within each era and whether there is a contemporary legacy.

From the 1990s onwards, conceptual models increasingly featured in the public health literature, including the subdiscipline of environment and health (Morris et al. in Nieuwenhuijsen and Khreis, 2019). Conceptual models are, in essence, simple representations of complex real-world situations. In public health, they are invariably schematic diagrams showing relationships among the broad domains whose interactions generate health, disease and inequity. In an interdisciplinary area like public health, conceptual models can become common points of reference, offering a common language (and visualisation) for discussion and collaboration among different constituencies of policy and practice. Some generic models may be 'populated' to analyse quite specific challenges or outcomes. Equally, they may support health impact assessment, gap analysis or the configuration of information or surveillance systems. However, in their simplest terms, conceptual models might best be understood as tools with which to think and communicate (McIntosh et al., 2007; Reis et al., 2015).

The environment in an Era of Sanitary Statistics

Most accounts of modern public health choose as their starting point the Industrial Revolution, first in Britain and then mirrored closely thereafter in mainland Europe and the United States. In Britain, at least, rapid industrialisation was spawned in the late 18th and early 19th centuries by a convergence of technological innovation, abundant coal supplies and a supportive economic and political context. Notably, industrialisation initiated and accelerated several major societal-level transitions (Morris and Saunders, 2017). The subsequent interactions of urban, energy, nutritional, economic, cultural and other major transitions have shaped the conditions for the pursuit of population health and equity ever since, defining and redefining the public health challenge (Rayner and Lang, 2012).

Industrialisation was famously the source of prosperity for some, but for others (notably the urban poor), life in towns and cities was characterised by poverty, squalor, severe overcrowding and an absence of wholesome water or sanitation. These conditions supported endemic diseases (such as typhus and tuberculosis) and sustained successive waves of epidemic disease (notably cholera) with attendant mortality. Also contributing greatly to chronic diseases and reduced life expectancy, and otherwise compounding the misery of urban life, were appalling working conditions and polluted air.

By choosing the term 'Era of Sanitary Statistics' for a period which endured for much of the 19th century, the Sussers discerned that the launch, and the early success, of the new public health movement was not founded on an intimate understanding of disease processes and causation (Susser and Susser, 1996). Rather, progress came through linking statistics on morbidity and mortality to a developing range of district-level social and environmental data, notably on overcrowding, housing and working conditions. The finding that the worst health was co-located with the most squalid insanitary and overcrowded conditions fuelled a sanitary revolution, which, over a period of several decades, would transform the living conditions of city dwellers, improving health and extending life expectancy. The promotion of sanitary measures – largely a mix of slum clearance and the provision of water-borne sewerage and

pipled water supplies – was entirely consonant with the prevailing ‘miasmatic paradigm’ which postulated that diseases were spread through noxious vapours in air (Baker and Nieuwenhuijsen, 2008).

Several observations relevant to environment and health can be sustained from an overview of the Era of Sanitary Statistics. The first is that, while biologically flawed, the miasma paradigm suffused the nascent public health movement with an environmental conceptualisation of challenges and solutions but one in which environmental and social variables were interlaced. Second, for sanitary reformers and politicians, aspects of the environment were seen solely as hazardous to health, with little recorded reference to the health-generating potential of good environments. Third, continuing a tradition enshrined in so-called ‘bills of mortality’ for different locations analysed so compellingly by John Graunt (1662/1939), sanitary reformers were concerned with the health of communities, as opposed to individuals.

The environment in an Era of Infectious Disease Epidemiology

Spanning a period from the late 19th century until the years immediately following the Second World War, the Era of Infectious Disease Epidemiology was founded on the ‘germ theory paradigm’. Enabled by developments in microscopy, the existence of micro-organisms was already known, yet the belief that they might be causally linked to disease substantially derived from Jacob Henle’s 1840 text, *Miasma and Contagion* (www.worldcat.org/title/jacob-henle-on-miasmata-and-contagia/oclc/31767786); John Snow’s work on epidemic cholera in mid-19th-century London; and research on micro-organisms by Louis Pasteur from the late 1850s onwards (Vinten-Johansen et al., 2003; Bynum, 2008). Building on techniques for growing micro-organisms pioneered by Pasteur, in 1882, Robert Koch revealed the bacterial cause of tuberculosis (Foster, 1970; Collard, 1976; Brock, 1999). The capacity to isolate micro-organisms from the human body had transformational diagnostic and the treatment implications, while isolating the same organisms in environmental carriers opened up preventive opportunities, such as the control of water and food supplies and improvements in living and working conditions.

The germ theory actually vindicated the thrust of 19th-century public health reforms and accorded scientific validity to an established environmental, local and community perspective on disease. Nor, for a time, was any contradiction perceived between long-established notions of the human body in constant interaction with, and closely dependent on, its local social and environmental context and the altogether narrower, more reductionist perspectives of laboratory science (Nash, 2006). A combination of sanitary and social measures and scientifically evidenced isolation and immunisation strategies greatly reduced the burden of infectious disease in Western society over a few decades. However, justifiable excitement over bacteriology’s explanatory power and the potential for good masked more insidious processes which would negatively and enduringly impact public health as a discipline.

Beguiled by scientific possibility, 19th- and early 20th-century physicians understandably sought microbial explanations for a very broad spectrum of hitherto unexplained diseases. Of greater concern, though, doctors became complicit in forging a narrower definition of ‘health’ – making it solely an absence of disease. More subtly, but of importance to this narrative, developing diagnostic and therapeutic power shifted the emphasis of medical science towards the maintenance of ‘self-contained’ human bodies in contrast to the body in its social and environmental context (Nash, 2006).

It is necessary to note the increasingly medical focus of disease in the inter-war years did not, in practice, lead to wholesale abandonment of social and environmental approaches in public health. Conscientious preventive societal-level action, including on the environment, continued, albeit with a lower profile than before. Yet we argue that a previously embedded sense of common cause in pursuit of population and community health between doctors and sanitarians was substantially eroded. Also, while it was an incremental process, by the time society transitioned to a new epidemiological era in the years following the Second World War, a tendency to regard health and disease as the sole property and responsibility of individuals rather than communities and social groups had taken root (Morris and Saunders, 2017).

The environment in an Era of Chronic Disease Epidemiology

Western society emerged from the Second World War to a changed health landscape. Most obviously, the historical preoccupation with infectious disease was being rapidly supplanted by concern over the growth in chronic diseases of presumed non-infectious aetiology. The origin of this 'epidemiological transition' was, in part, a century's progress in understanding and addressing infectious scourges but also wider social, economic and cultural change (Omran, 2005; McKeown, 1976).

In the preceding infectious era, those vulnerable to disease were typically the very young, the old and those whose immune response was in some way compromised. However, heart attacks, strokes, cancers, stomach ulcers and so on targeted those in middle years and, disproportionately, men (Susser and Susser, 1996; Kessel, 2006). Using an approach known as risk factor epidemiology (RFE), a close association was soon demonstrated between the diseases and the lifestyle and individual behaviour of those affected, for example, in relation to diet, smoking and activity levels. Yet RFE has relied in its statistical analyses of data for its precision on its capacity to control, methodologically, for complicating factors in any relationship under investigation. This is despite the real-world co-existence and policy-relevance of such factors. Often these 'complicating factors' are social or environmental and have a profound bearing on outcome. That RFE's outputs are 'abstractions' clearly matters in a complex, multivariate world, particularly where these outputs become the basis for policy (Susser and Susser, 1996; Kessel, 2006).

Although it had proven efficacy in isolating specific influences bearing on a health outcome, where the problem was ultimately driven by societal problems, RFE could not elucidate the point(s) or levels where interventions would be most effective. By extension, the failure to control the epidemics of the late 20th century was significantly rooted in a failure adequately to understand how illness was generated in a social context (Susser and Susser, 1996). Citing the example of HIV transmission, an infection with a demonstrably complex web of causation, Susser and Susser noted that, while all that was known indicated societal behaviours had to change, very little was known about how to change them. There are surprising but striking parallels here with the current climate crisis and its implications for health.

From an environment and health perspective, the decades following the Second World War present something of a mixed picture. Efforts to understand and address new epidemics of chronic disease were unquestionably blunted by reductionism in medicine and epidemiology. Moreover, the progressive individualisation of health status across society was relentless, further divorcing disease and health from its social and environmental context and diminishing the influence of public health. Yet, at the same time, local environmental and public health agencies and their professional staffs continued to strive, within established legal and administrative frameworks, to secure healthy environmental standards. A blend of monitoring, inspection and enforcement was typically directed towards the food chain, water quality and aspects of the housing and occupational environments. These largely successful efforts helped to contain toxic and infectious pressures but had generally low visibility, only attracting attention on rare occasions when the 'protective envelope' was breached, leading to an incident or outbreak.

Importantly, though, the period did witness some very high-profile air pollution incidents which have left a lasting legacy on perceptions of the environment in health. Most infamously, the London Smog of 1952 reminded society that environmental hazards retained the capacity to exert huge tolls in morbidity and mortality, even in the cultural hub of an advanced country (Baker and Nieuwenhuijsen, 2008; Royal College of Physicians and Surgeons, 2016). Alarm over urban air pollution in the 1950s gave rise to much stricter controls on domestic and industrial emissions. Thus, in summary, while interest in the environment as a determinant of health was evident and did inform health protection activity in the decades following the Second World War, it remained within the narrow, hazard-focused and compartmentalised framework defined for it by the laboratory sciences – primarily toxicology and microbiology.

An evolution of 'ideas'

Thus far, the concept of successive eras in public health, each underpinned by a dominant paradigm about health and its determinants, has provided a useful framework in which to describe changing perspectives on the environment in health. However, the utility of the framework diminishes, becoming constraining, when considering the recent history of the environment in health. Since the 1970s, influential ideas about health and its determinants, including the environment; about society's priorities and norms; and about mankind's relationship to nature have emerged or achieved much greater currency. We argue later that not until the last decade have the often distinct and separate trajectories of these 'ideas' coalesced to represent a paradigm of health and its determinants, capable of sustaining a new era. Here we introduce some of these ideas.

A socioecological model

In our analysis to this point, we have plotted an incremental detachment of health and disease, as experienced by the individual, from its social and environmental context, diminishing the influence of public health and blunting the preventive approach. One consequence is that society has placed disproportionate and increasingly unrealistic reliance on curative medicine to maintain a healthy citizenry.

One of the earliest, most influential statements on the paucity of the medical model came in the Canadian white paper *A New Perspective on the Health of Canadians* published in 1974 (Lalonde, 1974). This, often termed the 'Lalonde Report', recognised an impending crisis in Canada's capacity to fulfil a growing and seemingly insatiable demand for healthcare services. Placing emphasis on prevention, Lalonde's core argument was that any health problem could be traced to one or more of four elements: lifestyle, environment (physical and social), human biology and healthcare organisation. Attention to all of these domains could reduce the burden of disease.

Later, citing Lalonde as a precedent, Evans and Stoddart (1990) were to produce an elegant conceptual model of the determinants of health (Figure 1.1). Significantly, they presented the physical environment, alongside the social environment and genetic endowment, as the primary drivers of health outcome, notably relegating behaviour to the status of a dependent variable. Other popular representations of the so-called 'socioecological model' take the form of 'rainbow' images. That produced by Dahlgren and Whitehead (1991) (Figure 1.2) is among the most frequently cited examples and has had particular resonance in efforts to understand inequalities in health and disease and the factors which influence them.

Notwithstanding the many policy, cultural and other difficulties of operationalising a socioecological model of health, it implied a need for environment and health to reach beyond narrow pollutant and infectious boundaries to understand a richer and more subtle contribution to health from the environment. Socioecological perspectives also called for a greater understanding of how environmental factors, especially in the proximal context, helped to create and sustain inequalities and shape health-relevant behaviours. Much of the rhetoric around socioecological complexity hinted, too, at what, for a time, was the largely disregarded potential of health-generating environments.

Health inequalities

A desire to understand and address inequalities in health substantially drove early 19th-century public health, retaining importance, too, for the germ theorists of the late 19th and early 20th centuries. Yet, with the progressive individualisation of health status and the increasing dominance of the medical model, the political and societal profile of health inequalities diminished. That the topic was 'rediscovered' in the 1970s and would, on occasions, be catapulted to the forefront of political debate owes much to socioecological perspectives but also to a number of sentinel analyses and reports.

Figure 1.1
The framework of the determinants of health
 (Source: Anna Wilczyńska, based on Evans and Stoddart, 1990)

Figure 1.2
The social determinants of health
 (Source: Anna Wilczyńska, based on Dahlgren and Whitehead 1991)

Figure 1.3a and b

a) The original DPSEEA model; b) the modified or mDPSEEA model

(Sources: a) Anna Wilczyńska, adapted from Corvalán et al., 2000; b) Anna Wilczyńska, adapted from Morris et al., 2006)

The Black Report (Townsend and Davidson, 1982) had a particular impact in the United Kingdom and internationally (see also Whitehead, 1987; Marmot et al., 1978; Marmot and Davey Smith, 1997). Coming much later, the 2008 final report of the Commission on the Social Determinants of Health (CSDH, 2008) gave a global profile to health inequalities and their roots in the interplay of societal-level influences. The environmental dimension of this has often been discussed under the rubric of ‘environmental justice’, which focuses on the fair distribution of environmental burdens and benefits. More recently, in a European context, the issue has been developed through the concept of ‘environmental inequalities’ (WHO, 2012, 2019). A key realisation has been that capturing data which allow spatial/social comparisons of environmental variables within and between different neighbourhoods, cities and countries is central to progress in tackling health inequalities across the world.

A comparison of two related conceptual models (Figures 1.3a and 1.3b) illustrates how socioecological complexity and social patterning can be more expressly considered in the field of environment and health.

The drivers–pressures–state–exposure–effect–action or ‘DPSEEA model’ (Figure 1.3a) was conceived in the 1990s as an integrated framework for decision-making in environmental health (Kjellstrom et al., 1995). By linking a ‘drivers–pressures–state’ sequence, used in environmental science, with a classical environmental health approach (in essence, a ‘state–exposure–effect’ sequence), DPSEEA offered a much more integrated (and policy-relevant) ‘full chain’ representation of the relationship among human activity, the environment and human health. By elegantly fusing the aspirations of environmental science with those of public health in any location where it is applied, DPSEEA

has proved enduringly useful and has generated a family of conceptual models (Morris et al., 2006; Reis et al., 2015; Van der Vliet et al, 2018). In its original form, however, DPSEEA generally supported a traditional environment and health approach without compelling consideration of socioecological perspectives or, necessarily, a divergence from exclusively hazard-focused traditions.

Later, the ‘modified DPSEEA’, or mDPSEEA, model (Figure 1.3b) was developed as a configuring framework for a Scottish government policy initiative on environment and health (Scottish Government, 2008). Among the aspirations of the *Good Places, Better Health* initiative was a desire to translate into policy a richer understanding of the environmental contribution to health inequalities and to recognise, too, the potential of the environment to impact positively health and well-being. This was achieved by emphasising, first, that a very broad spectrum of interacting driving forces generates and sustains quite different environmental states in different locations and, second, that these environmental states can be hazardous but equally health generating. By incorporating a ‘context bubble’, the modified DPSEEA model recognises the fact that whether an individual or social group is exposed to or experiences a specific aspect of environmental state in their neighbourhood is influenced by a diverse set of interacting factors which include socioeconomic circumstance, demography, behaviour and even environmental co-exposures. Moreover, whether an individual goes on to experience a health effect (positive or negative) linked to exposure or experience of the environment is dependent on a usually different set of contextual factors which confer individual vulnerability/susceptibility (Morris et al., 2006).

Heightened concern over mental health and well-being

Concern over the effects of modern life on mental health and well-being has rightly gained a much higher profile in recent decades. The idea that health embraces both mental and physical well-being is long established and indeed has very noble provenance in the original WHO definition of health as “a state of complete mental, physical and social well-being and not merely an absence of disease or infirmity” (1946). Yet it is only comparatively recently that the role of the environment in mental health and mental illness has been properly explored. This research has established the health-generating/promoting (or ‘salutogenic’) environment as one of the core ideas of modern public health and one with obvious policy relevance. Indeed, this book is motivated in part by a desire to operationalise these ideas in the urban context. Chapter 2 gives an overview of the evidence for the potential health and well-being benefits of urban green, blue and natural spaces and the biophysical and psychological mechanisms which appear to explain these benefits.

The environment and health constituency is not unique in its rather tardy engagement with mental health and well-being issues. A number of factors are contributory. First, although mental health problems may have an organic aspect, they are not always definable in organic terms. Second, the physical environment is only one aspect of the neighbourhood context, which interacts in complex ways with individual characteristics to generate stress (e.g. poorer neighbourhoods are more likely to experience violence, air pollution, etc.). Third, as Rayner and Lang (2012) have observed, an abiding question must be that even where an organic malfunctioning is identified, did this precede or follow the environment stress? Each of these factors is challenging for the traditional reductionist environmental and health approach.

However, what is beyond reasonable challenge is that aspects of the physical environment, whether discernible to the unaided senses or not, can generate stress to the detriment of both mental and physical health. Understanding of stress biology plausibly connects environmentally induced stress to a spectrum of chronic diseases, including cancers and cardiovascular disorders. There is also ample evidence that deprived communities are not only frequently more *exposed* to environmental hazards but also more *susceptible* to their effects (Goodman et al., 2011; Carder et al., 2008; Richardson et al., 2011, 2013; Vinikoor-Imler et al., 2012). It is believed that stress, however generated, at both community and individual levels, can, in the long term, weaken body defences against external insult and influence the internal dose of toxins from environmental sources (Gee and Payne-Sturges, 2004).

Environmentalism and ecologism

While there is ample evidence of environmentalist sentiment dating from much earlier (see, for example, Thoreau, 1854; Darwin, 1859; Wallace, 2003, cited in Smith and Wallace, 2003), Rachel Carson's hugely influential book *Silent Spring* is generally regarded as the origin of modern environmentalism and public interest in ecology (Carson, 1962; Nash, 2006). Ecology is the branch of biology concerned with the relations of organisms both to one another and to their physical surroundings.

Published in 1962, *Silent Spring* is a book about the impact of pesticides on wildlife. Yet its central concern was, in fact, human health (Nash, 2006). It contained, for example, a chapter dealing with the impact of pesticides on cells and genetics and another considering their carcinogenic potential. Perhaps most indicative of Carson's ambitions and prescience lies in her stated intention, revealed in communication with her editor, to set the new threats to human health "within the general framework of disturbances to the basic ecology of all things" (Carson, quoted in Nash, 2006).

Carson died in 1964, well in advance of, for example, today's heightened concerns over shrinking biodiversity or even the coalescence of scientific opinion around the notion of anthropogenic causes of a warming planet. However, *Silent Spring* stands as the seminal text of modern environmentalism. Of specific relevance to our narrative, and contrary to Carson's intention, we believe the environmentalist and public health movements maintained largely distinct and separate trajectories for perhaps three decades post-Carson, only establishing true common cause in this century against a backdrop of the climate crisis, the COVID-19 pandemic, unprecedented biodiversity loss and devastating damage to other Earth systems.

Ecosystem services and well-being

The concept of ecosystem services first appeared in the 1970s, but its transition to standard terminology in the scientific literature is traceable to 1981 (Ehlich and Ehlich, 1981). The purpose of 'ecosystem services' is to determine the (measurable economic) services that ecosystems provide to humanity. While unquestionably useful, the ecosystem services concept has proved controversial, not least in the implication that nature exists solely as a resource for humanity. Moreover, the implied dichotomy between humans and the natural world, to any reasoned interpretation, underestimates the importance of humans and integral components of ecosystems and their intimate links (especially through their social and economic activity) to biodiversity and to biological and biophysical processes (Reis et al., 2015).

An important milestone in the evolution of ecosystem services and in its operationalisation in a public health context came with the Millennium Ecosystems Assessment (MEA). Specifically, the MEA explored the links between ecosystems and human well-being (MEA, 2005). The MEA identified four broad categories of ecosystem services. These were *provisioning services* – covering products obtained from the ecosystem such as water, food, timber, fibres and pharmaceuticals; *regulating services* – through which nature controls issues like climate, rainfall, pollination, the spread of disease, the purification of water and the filtration and breakdown of organic waste; *cultural services* – which encompass a spectrum of non-material ways in which people benefit from ecosystems; and, last, *supporting services* – which underpin the production of all other ecosystem services. These include soil formation, which implicitly supports many provisioning services, photosynthesis and primary production (which includes assimilation or accumulation of energy and nutrients by organisms) and nutrient cycling – most importantly, the cycling of nitrogen and phosphorous.

For public health, the MEA made a significant contribution by observing that the interruption of ecosystem services might damage health in five distinct ways: (i) by interruption of the flow of material goods (so-called "material minima"), (ii) through disrupting social relationships, (iii) by reducing security, (iv) by denying freedom of choice and (v), most obviously, through direct damage to mental and physical health. Of direct relevance to the subject matter of this chapter, the MEA articulated very pragmatic reasons for respecting the natural environment in the interests of society, the economy and human health.

Damage to earth's biophysical systems

Through the work of Rachel Carson, and countless other contributions in the intervening years, generations alive today are afforded unprecedented insight into humankind's dramatic and damaging impacts on the natural world and the implications for economies, societies and health everywhere. Indeed, few today doubt that the anthropogenic changes to the Earth's biophysical systems now underway profoundly threaten human existence. Rockström and colleagues encapsulate the gravity of the problem in a much-cited paper (2009), later updated by Steffen and co-workers (2015).

In summary, these researchers nominate nine Earth systems which they define as 'planetary boundaries'. The systems are chosen because, in the absence of urgent corrective action, it will not be possible to maintain a "safe operating space for humanity". Where the evidence supports it, thresholds are proposed for the systems beyond which non-linear, abrupt and potentially catastrophic system changes might occur. The nine systems are inter-related, such that changes in one system may have profound implications for the others. The researchers note that in the preindustrial era, all nine parameters were within the safe operating boundaries but, by the 1950s, changes were discernible, most obviously in the nitrogen cycle. By 2009, according to their analysis, three planetary boundaries had been transgressed, specifically those concerned with climate change, biodiversity loss and the nitrogen cycle. Although, perhaps inevitably, aspects of the planetary boundaries concept have proved controversial, it emphasises that the health and existential threats to humanity from our impacts on the planet extend beyond climate change and biodiversity loss.

In 2015, informed by the MEA's four classifications of ecosystem services and their links to human well-being, Reis and colleagues (2015) developed an 'Ecosystems-Enriched or eDPSEEA Model'. Their intention was to convey, within a DPSEEA format, how, in combination, similar driving forces to those which created health-relevant changes to the proximal or local environment could also damage health in locations throughout the world through damage to global ecosystems and the services they provide for local populations and humanity as a whole.

The health-promoting potential of urban blue green and natural spaces

Just as historical accounts leave no doubt that the health-damaging potential of the environment is long recognised, acceptance that individuals and communities may benefit from experience of a good environment is also evidenced. The ancient Greeks appeared to embrace such notions and, while perhaps not translating into conscious efforts to manipulate the environment, the perceived benefits of contact with nature appear, often, to have influenced the choice of places to live (Carmona, 2018; MacKerron and Mourato, 2013). Similar 'pro-nature' sentiments can be discerned in various guises ever since.

The Romantic Movement – an artistic and intellectual development approximately contemporaneous with the rise of the industrial era in the late 18th century – was characterised by attention to individual sensitivity and emotion as counterpoints to Enlightenment perspectives which presented 'reason' as the foundation of all knowledge. An appreciation of, and desire to connect with, nature in many forms was an inevitable concomitant of Romanticism, yet, simultaneously, the industrial revolution was robbing individuals and communities of access to nature with its attendant benefits. Despite this, and driven by moral rather than evidence-based imperatives, there are countless examples of philanthropic gifting of areas of open and recreational space for use by the working classes. Such provision, and the subsequent development of public parks by local municipalities, was perhaps inevitably inconsistent, patchy and ultimately vulnerable to erosion by ill-conceived development but has left an imprint on many towns and cities (Morris and Saunders, 2017).

Regardless of perspective and in any era, good-quality green, blue and natural spaces make the places in which we live, work and play more attractive, yet not until the late 20th century did robust evidence of the true health benefits begin to build. This affirmed the capacity of green spaces to reduce the incidence of certain diseases (Villeneuve et al.,

2012), extend life expectancy (Faculty of Public Health, 2011), improve mental health (Faculty of Public Health, 2011) and reduce health inequalities (Mitchell and Popham, 2008). Of direct relevance to the subject of this book, the particular importance of blue space has materialised as a key element of public health's evidential landscape (see Chapter 2).

Not only does this call for reflection on what constitutes healthy urban design, it underlines the penalties for health and well-being which have unwittingly accrued through sustained disregard for the rivers, canals and other 'blue' components which have been part of the urban environment for so long. By highlighting the health promoting potential of access to high-quality blue, green and natural spaces as one of the key 'ideas' which can sustain a new epidemiological era, we recognise a special potential of such provision simultaneously to drive the equity, well-being and sustainability agendas so central to modern public health.

Discussion

We have described how, throughout two centuries of modern public health, the perceived contribution and importance of the environment to health has varied. In the immediately preceding section, we identified a number of 'ideas', each with an environmental dimension, which have become prominent in public health and wider society. We argue that in combination, these ideas have a profound bearing on how public health aspirations must now be framed. We have noted that, despite many conspicuous successes and continuing relevance, traditional reductionist approaches in public and environmental health have struggled to respond to these ideas.

A consequence is a failure fully to unmask the environmental contribution to many contemporary public health challenges, including the obesity epidemic, diminishing mental health and well-being, diabetes and, critically, stubborn inequalities in health and environment between social groups. Importantly, traditional environment and health approaches struggle for traction in the face of a health and existential crisis from the human destruction of the natural world.

Eras and paradigms

The term "ecological public health" encapsulates the need to build health and well-being, henceforth, on ecological principles (Rayner and Lang, 2012). Distilled to a simple graphic, the dynamics of ecological public health are illustrated in Figure 1.4.

The image is helpful in reinforcing, first, the inextricable connectivity between human beings and natural systems and humanity's reliance on the natural world for health and well-being. Second, it implies a necessity for those concerned with the environment and human health to think on a vastly extended temporal and spatial scale. Yet,

Figure 1.4

The dynamics of ecological public health: a simple model

(Source: Anna Wilczyńska, based on Rayner and Lang, 2012)

abstracted from Rayner and Lang's compelling text, the graphic cannot alone convey the true enormity of "reshaping the conditions for good health" now and in the future.

Despite specific differences and separate provenances, the concepts of ecological public health, 'Planetary Health' and 'One Health' convey broadly similar messages about the urgency, complexity, extended scales and need for intersectoral collaboration in confronting the 21st-century public challenge. Of direct relevance to this narrative, all three concepts are 'environmental conceptions of health'.

Drawing on the Sussers' notion of eras in epidemiology, we argue it is now important for the 21st century to become an "Era of Ecological Public Health" if humankind is to confront its pressing challenges. Framed in positive terms, the corresponding paradigm for the pursuit of health and well-being, equity and, necessarily, sustainability in such an era might be *respect for, and the sensitive integration of, the social ecology* (which underpins the socio-ecological model of health) *and the natural ecology*. History portrays a protracted, damaging and wholly perverse disconnect between these "inescapable ecologies" (Nash, 2006). However, if it is to have utility, the Era of Ecological Public Health must have not only an underpinning paradigm but also effective analytical and preventive approaches.

An analytical approach

A core theme throughout this chapter and especially in later sections is complexity. In essence, health and disease are products of multiple factors which interact within a connected whole. This is sometimes called a 'complex systems model of health', and the literature contains frequent calls for a corresponding 'complex systems approach' to analysis (Diez Roux, 2011; Fink and Keyes, 2017). Rutter and colleagues elegantly summarise the case for 'complex systems research' in public health but emphasise the considerable challenge of moving from away from simple linear causal models (2017).

We wholly concur that complex systems research can create a superior evidence base when seeking a step change in health and health and environment equity. Similarly, we support Rutter and colleagues in their view that there is some considerable way to go. Public health lags well behind but in time may learn from other disciplines such as climate change science and economics where complex systems methodologies are already established. However, given the urgency of the challenge, a fundamental question for the present must be, 'what extant analytical approaches and tools are available which may be deployed to progress ecological public health?'

In this chapter, we have expressed enthusiasm for the versatility and operational utility of conceptual models as tools in public health, not the least because human brains are wired for visual images. We recognise that many different models have comparable utility but focused on a 'family' of essentially linear, conceptual models derived from the DPSEEA model (Kjellstrom, 1995), which, in the direct experience of the authors, allow complex issues to be mapped in simple and policy-relevant ways. Even against the unprecedented complexity of the ecological public health challenge, we argue there is currently a role for the enlightened use of more fully articulated versions of the DPSEEA model (Reis et al., 2015; Van der Vliet et al., 2018).

Preventive approaches: a local response

A further theme of our narrative has been the enduring importance of towns and cities as key theatres for public health and environment and health activity. While the current ecological crisis manifestly demands action on an international and global scale, the local and proximal contexts are vital for ecological public health. The concept of the 'triple win' was first articulated in the EU Horizon 2020-funded INHERIT project to encapsulate the shared 21st-century public health policy goal for all local constituencies of policy and practice. A triple-win policy or intervention must have demonstrable capacity to deliver improved health and well-being, greater equity plus environmental sustainability (Van der Vliet et al., 2018). A key benefit of the triple-win concept is that it enables local actors to relate the global challenges of ecological public health to a local scale and to their immediate sphere of influence. This is both

motivating and empowering. Not every local intervention or policy has the potential simultaneously to deliver all three dimensions of the triple win. Yet, in delivering one or more of the three elements, it should not prejudice the capacity to achieve the other element(s).

Place and health versus environment and health

In many situations, it is both more inclusive and practical to speak in terms 'healthy places' as opposed to 'healthy environments'. The concept of 'place' integrates the social, economic, physical, cultural and historical aspects of a location. In combination, the characteristics of place generate health outcomes, good and bad, and often reproduce them, generation to generation (Scottish Government, 2011). Notions of place may be particularly useful when planning 'triple win' policies.

Conclusions

Our narrative has charted significant change over time in how the environment is viewed within public health. We have identified the origins of these shifting perspectives in a complex interaction of societal-level transitions with scientific and technological advances and constantly shifting societal norms and values. Looking forward, and consistent with this analysis, we have listed some key influences or 'ideas' which, in our view, militate in favour of an entirely new epidemiological era, one which reinstates the environment at the heart of the public health project but in ways which goes far beyond environmental health's narrow, hazard-focused and compartmentalised traditions.

Acknowledging overlap with other environmental conceptions of health (notably Planetary Health and One Health), we adopt the term 'Ecological Public Health' Rayner and Lang, 2012) as a shorthand for the product and process of achieving meaning change. We submit that an appropriate paradigm for the pursuit of health, equity and environmental sustainability in the 'Era of Ecological Public Health' must be 'respect for, and sensitive integration of, natural ecology with human social ecology'. If embraced, this will terminate a protracted, damaging and wholly perverse disconnect between humanity and the natural world on which we so evidently rely.

Again, consistent with the Sussers' elegant concept of 'eras in epidemiology', there is an implicit need for innovative analytical approaches to secure progress in the new era with its inherent complexity. We concur with the widely stated view that the deployment of complex systems research/approaches in public health holds great promise and is overdue. However, public health's existing analytical toolbox is far from empty and certainly not irrelevant in the context of ecological public health. An array of generic conceptual models, of which the DPSEEA model and its derivatives are only one type, can help frame or map issues in a policy-relevant way with reference to a wide range of issues which bear upon them. Logic modelling approaches are also effective in public health as a means to test and communicate the theories, assumptions and reasoning behind policies or programmes and, in this way, constructively challenge whether a programme and the like can be expected to produce the desired outcome.

Although public health's temporal and spatial scales are now greatly expanded and its goals reframed in terms not just of health, well-being and equity but also global environmental sustainability (a triple win), the importance of the local and proximal is undiminished. The proximal environment of our towns and cities remains the key theatre for environmental health activity for individuals and communities. The concept of the triple win as the goal for local policy is more than simply an aspiration. It can be the basis for evaluating existing or proposed initiatives in the proximal environment.

An output of the Horizon 2020-funded INHERIT project (www.inherit.eu) is a series of case studies where local projects are evaluated in terms of the triple win using qualitative and quantitative methodologies, including cost benefit analysis. INHERIT identified triple-win outcomes as most likely to exist in the domains of: 'living', for example,

Figure 1.5
The schematic diagram of the paradigm of the era of ecological public health
 (Source: The authors and Anna Wilczyńska)

initiatives seeking to improve home energy efficiency or the quality of or access to green and natural spaces; ‘consuming’, for example, initiatives which promote consumption of locally produced foods; and ‘moving’, for example, active travel. The goal of a triple win at the local level has the potential to unite in common cause the disparate local actors whose input is essential while being genuinely empowering in the face of global crisis.

Figure 1.5 provides a schematic representation of the concepts introduced above. In summary, the Era of Ecological Public Health is motivated by the need for public health to respond more effectively to six ‘Ideas’ which, we submit, must profoundly shape the conditions for health and well-being in the 21st century.

As an environmental conception of health, ecological public health demands respect for, and integration of, natural ecology and human social ecology. Complex systems research holds alluring middle- to long-term analytical potential, while there is an enduring role for the active evaluation of interventions in terms of their capacity to deliver the triple win. Temporally and spatially tagged data on environmental and social variables are an important resource for all analysis. A successful preventative approach to delivering the triple win in an Era of Ecological Public Health will exhibit some generic characteristics, which can be reflected in specific preventative interventions.

The immediately succeeding chapter of this book presents a summary of the compelling evidence of the capacity of natural, green and blue spaces in towns and cities to improve population health and well-being through a variety of mechanisms, following different types of exposure. Chapter 2 also points to a small but growing and persuasive body of evidence suggesting a positive impact from access to high-quality blue spaces on health inequalities.

Accordingly, we are confident in saying that the provision and maintenance of urban green, blue and natural spaces aligned to the needs of the local community can plausibly contribute to at least two elements of public health's triple win. This general assertion will invariably be verifiable through evaluation of particular cases in specific localities and communities. The third element of public health's triple win – the contribution to global sustainability – is near impossible to evaluate for specific blue, green and natural spaces, and often the only recourse is to draw on the literature to conduct a general assessment as to the potential to contribute to global sustainability.

Using conceptual models in the BlueHealth project

We have chosen to conclude our deliberations by discussing the use of conceptual models to support the H2020 BlueHealth project (<https://bluehealth2020.eu>), of which this book is one major output, aimed at helping to operationalise improvements to the potential for better human health and well-being from well-planned and design blue spaces. Although we do not pretend that we have covered the full scope of the uses and applications of conceptual models (Robinson et al., 2015), in our following discussion, we believe that our own journey with conceptual models in BlueHealth may be of interest within the overall theme of this chapter and also set the scene for the rest of the book.

Throughout the project, we used a series of conceptual models at the individual work package and overall project levels, primarily as diagrams/figures, for a variety of purposes:

- A cooperative visualisation process
- Identifying the research pathways and linkages
- Identifying evidence gaps
- Rapid communication of the overall concept of the project

Conceptual models can also be used to involve stakeholder groups in a group understanding of the challenges and towards co-creating approaches to address these challenges (Reis et al., 2015). Probably the most important task of the appropriate use of conceptual models is to identify the specific target group and the question(s) that need to be answered (e.g. just for use within the research group or for use with other external audiences) and to make sure the design and content are suitable for the target audience.

When we began creating the BlueHealth project proposal over a nine-month period in 2014–2015, we were interested primarily in a conceptual model (Figure 1.6) which would communicate to the proposal reviewers (mostly researchers) that we were aware of the complexity of the subject, as well as the potential pathways and linkages. In addition, this model helped the evolving research group to identify the linkages and research gaps which we were proposing to explore in our proposal. We also took pains to base and build this model upon the understanding of the area as evidenced in the existing scientific literature (Hartig et al., 2014).

After the Project was funded and started in 2016, we revisited our conceptual model as part of developing a protocol paper to serve as a consensus road map for our future work. In this case, the conceptual model was an influence diagram (Figure 1.7) describing the causal chain between drivers and impacts under investigation in the BlueHealth project (Grellier et al., 2017). The target audience was the wider scientific community, as well as being useful internally to make sure we were covering all the areas of interest around blue space, human health and well-being and other factors.

Figure 1.6
Early BlueHealth conceptual model
(Source: Anna Wilczyńska and the BlueHealth consortium)

Figure 1.7
Second-generation BlueHealth conceptual model
(Source: Anna Wilczyńska based on Grellier et al., 2017)

Figure 1.8

The final BlueHealth conceptual model version reading from, or starting from, the left with the environmental context and moving to the impact on population health at the right

(Source: Anna Wilczyńska and the BlueHealth consortium)

Figure1.9

The final BlueHealth conceptual model version, which starts with the outcome, population health and well-being, at the left side, working back to the determinants towards the right

(Source: Anna Wilczyńska and the BlueHealth consortium)

As the BlueHealth project proceeded, it became increasingly important to communicate with diverse audiences; inherently this meant that we needed to simplify the conceptual model both in terms of its concepts and its presentation. We ultimately developed two conceptual models that are interesting from the point of view of the overall development of conceptual models/frameworks in public health described throughout this chapter. For a more scientific audience, we tended to use the conceptual model that “started” on the left with the “exposures” of climate change and blue space leading to the “impacts” on human health on the right of the diagram (Figure 1.8). This was particularly important for experts with an environmental science point of view and background.

However, when communicating with more human-focused audiences, including public health/medical experts, planners and some decision-makers, as well as general audiences, we often used the conceptual model (Figure 1.9) that started with humans on the left side and moved out to the exposures that we wanted to identify and understand

Figure 1.10
The final BlueHealth conceptual model, with a range of project outcomes mapped to each of the steps in the causal chain

(Source: Anna Wilczyńska and the BlueHealth Consortium)

on the right side of the diagram. Of note, there was considerable discussion within the BlueHealth project team about all of these conceptual diagrams throughout the project!

Finally, as we neared the end of the project, we wanted to use the conceptual model as part of an overall effort to integrate the evidence and outcomes of the project. We also hoped that this would help us to identify and communicate the major messages of the overall project. Therefore, we used the diagram (Figure 1.10) to map our outcomes relative to the different components of the model.¹ This exercise was primarily internal to the BlueHealth team, although it also helped with the development of our final outward communications about the accomplishments of the project (<https://bluehealth2020.eu/resources/>). Of interest, this mapping exercise also clearly demonstrates where there are still gaps in the evidence for future research and exploration.

Note

- 1 Susanne Wuijts, Emma Squire, Mare Löhmsundström, James Grellier, Simon Bell and Mathew P. White contributed to the H2020 BlueHealth Project research model and integration described at the end of this chapter.

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