The potential for time geography in health studies

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26. The potential for time geography in health studies

Anders Schærström

Time-geographical thinking, which was first conceived and launched by Torsten Hägerstrand, has developed into a well thought-out body of intellectual tools. However, for a long time, contacts between medical or health geography and time geography have been scarce. In a few cases, time geography has been used for analysing access to health care and the localization of hospitals, but epidemiological applications are hard to find. Further, the potential does not end with locational and access analyses or with epidemiology: various different health-related applications have emerged. Drawing upon a range of studies from a period of 30 years, I argue in this chapter that several types of health-related studies could benefit from time-geographical approaches.

Firstly, the general and coherent character of time geography makes it powerful enough for application in several epidemiological contexts. Its strengths are particularly the *integrated perspective on time and space* and its *flexibility* in terms of temporal and spatial scales.

Secondly, the focus on *individuals* (as opposed to aggregated data) opens possibilities for optional, flexible ways of grouping cases or individuals at risk. The point of time geography is to discover what may be hidden in aggregated batch data from macro-perspectives and cross-sectional perspectives.

Thirdly, time geography may provide a useful framework for *identifying alternative numerators* in epidemiological comparisons, accounting for substantial turnover of subpopulations.

Fourthly, time-geographical approaches can be used as tools to describe and analyse *personal geographies* and their interaction with ill health or disability, including relations between activities of daily living and health.

Fifthly, and on an individual level, it has been suggested that the time geography approach could be used as a framework for *anamnesis* in individual cases.

The sixth and possibly the least well-known strength of time geography, is the interactive *therapeutic applications*, by which people may become aware of their daily life contexts and behaviours, and even make improvements.

Time geography – back to basics

Time geography can be understood as a system of logical principles, in which the time dimension is added to – and sometimes even given priority over – conventional space dimensions. As a general framework, time geography can be applied in a variety of contexts.

Ultimately, time geography rests on the postulate that virtually everything in this world has a place or extension in time as well as in space. From this axiomatic statement, it follows that every piece of geographical information refers not only to a certain location but is also valid at a certain point or during a certain period in time. Thus, an essential element in time geography is the notion that the locations and movements of individuals can be perceived, followed, and visualized as *continuous paths* in the dimensions of space and time, named *trajectories*. Details of movements and events can be more or less clearly shown in graphs, depending on the study purpose and the temporal resolution of the data.

Time geographers have developed an arsenal

of concepts and methods for exploring and dissecting everyday life. Beside the trajectory, basically consisting of *stations* and *moves*, some vital concepts such as *constraints*, *domains*, *pockets of local order*, and *geobiographies* may be useful for analyses of health determinants and their effects.

Further, individual life paths weave a fabric that corresponds to the comprehensive term *landscape of processes*, coined by Hägerstrand (1992). A landscape of processes is different from a landscape that meets the eye; it is a landscape of processes comprising not only what are visible but also 'everything that is present within the geographical border, including everything that moves in and out across the border during the selected period of time' (Hägerstrand 1992, 10–11).

Time geography has been criticized from several points of view. Some critiques may have been justified but some criticisms may have been fostered by misunderstandings of time geography's objectives. For example, the time-geography approach has been accused of being too physicalistic, and void of interpretation, explanation, and understanding. In fact, the time geographical approach is no more physicalistic than are conventional maps. It adds an essential time dimension and thus a dynamic element, but interpretation and understanding have to be undertaken with other, different methods. An overview of the critique of time geography has been discussed by Åquist (1992).

Time geography and health issues

With regard to health contexts, time-geography applications have been comparatively few and relatively late. A couple of early studies analysing access to hospitals can be mentioned, one by Hägerstrand (1970) and one by Whitelegg (1982). Occasionally, epidemiological studies have referred to time geography (e.g. Kistemann et al. 2000; Cromley & McLafferty 2011). Although not explicitly designed for epidemiological applications, time geography certainly offers a useful framework, and some inspiring, but perhaps overlooked, contributions are mentioned below.

Possibly the most consistent efforts to understand health and ill health in the framework of time geography have focused on individuals in their closest space and time environments. Clearly, everyone has a close environment (i.e. a (micro-environment) that is more or less personal, and a wider environment (a macro-environment) that is shared by many others within a larger area. It may well be the case that a person's micro-environment per se plays a greater role in their health than the macro-environment, but the added outcome of micro-events will be readable as incidences, prevalence rates, and long-term trends.

Thus, somewhat simplified, we can make a distinction between the small world and the big world – between what is close to individuals and a population level, where major patterns and structures can be discerned. Next, I look at some various time-geography approaches to health issues, which seem worthy of consideration and follow-up (Figure 1).

The small world: the individual and situations in daily life

Health research has a tendency to separate studies of work environments, home environments, and external environments, even though we all live in all three of types of environment and are exposed to their influences. However, what is known about the combined health effects of the different types of environments? Certainly, conventional questionnaires and interviews may include questions related to both occupation and private life, but they fail to capture the sequence of health-relevant situations and variations in time. In the terminology of time geography, the complete view of personal *geobiographies* is missed out.

Dealing with situations and sequences of events in time and space is really the home ground of time geography and hence some basic time-geographical concepts are likely to be use-

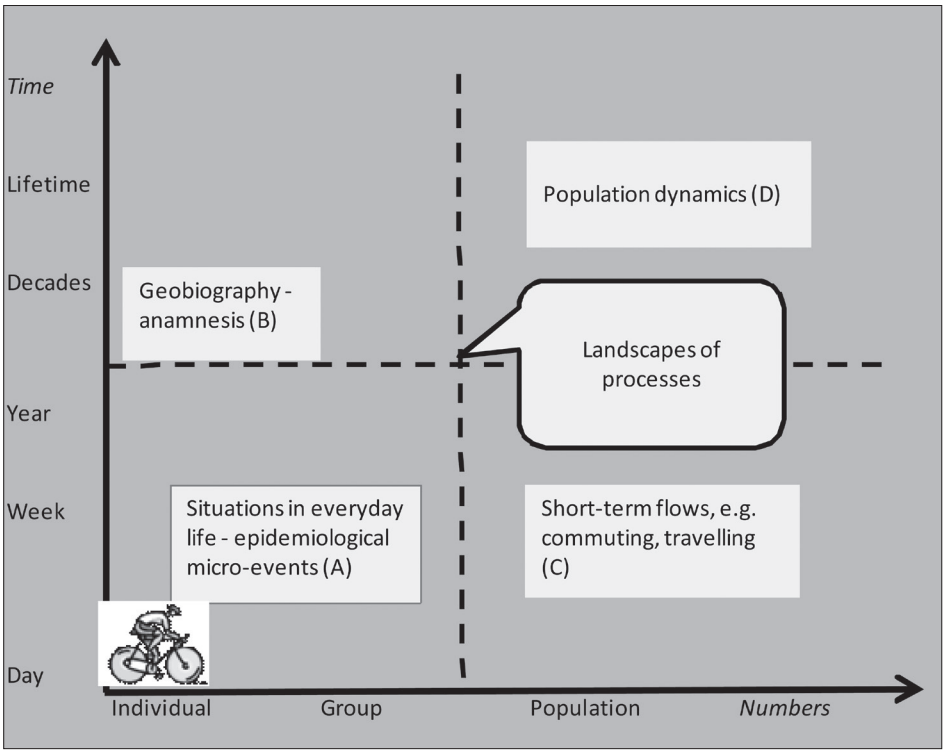

Figure 1. Typically, time-geographical analyses have focused on small numbers of individuals in a micro-perspective, i.e. situations in everyday life (A). However, the views can be extended in two dimensions. On the one hand, the temporal view can be extended to describe individual geobiographies or life paths (B). On the other hand, they may include larger numbers – and flows – of people (C). Ultimately, time-geographical thinking can be used for descriptions and analyses of the demographic turnover in different localities (D).

ful tools. The three types of *constraints*, which are vital in time geography and constitute the framework and limits of human life, are all highly relevant in analyses of health and harmful exposures. Much of human well-being can be viewed in terms of these constraints, but the relationship is not a one-way relationship, as discussed below.

In the present study, the time-geographical concepts *domain* and *pockets of local orders* are useful. We all spend our days and our lifetime moving between domains and pockets of local orders such as dwellings, workplaces, transportation systems, public places, shops, and recreation localities. When looking at life in such a 24-hour perspective, a few potential research issues become apparent (Figure 2).

Many time-geographical studies have been devoted to micro-scale analyses of individuals and households and their daily activities, contributing to a better understanding of the possibilities and constraints that shape human life. Several studies of working life have made use of time geography, such as car manufacturing (Ellegård 1983), dentistry (Nordell 2002), and medical practice and nursing (Thunborg 1999), although seldom with an explicit health-related purpose. Similarly, time-geographical approaches have been applied to school contexts (Kellegrew & Kroksmark 1999).

In recent decades, industrial and post-industrial working life has undergone several radical changes, yet the health effects of such changes are far from fully explored and understood. Many of these changes can turn out to be double-edged:

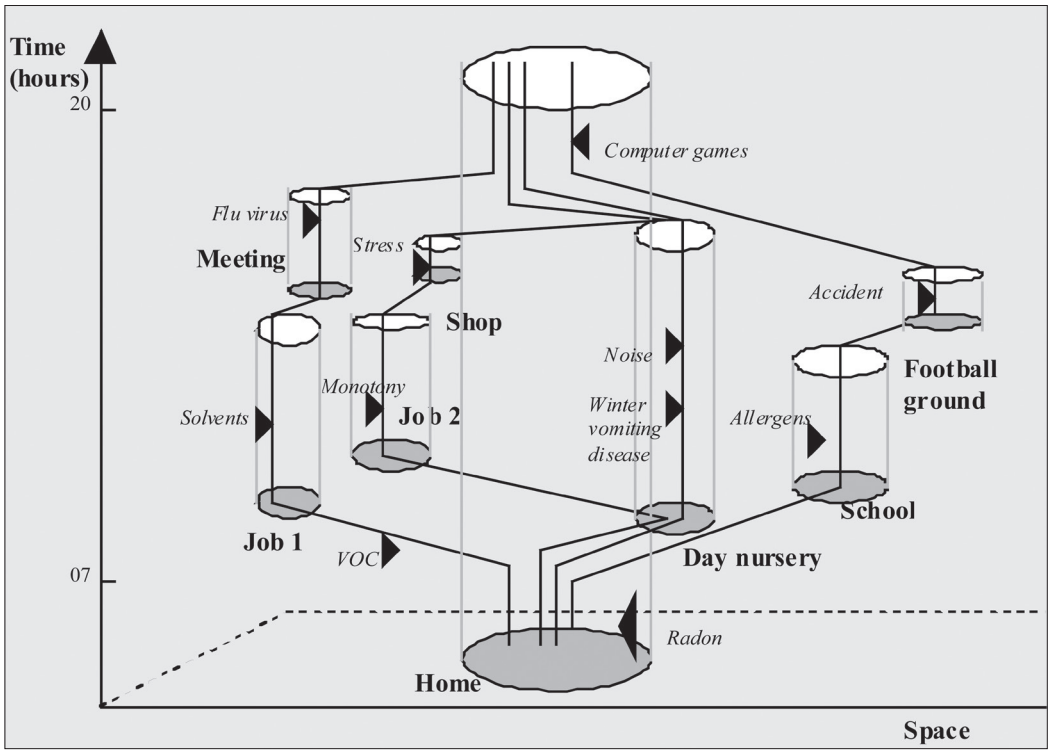

Figure 2. A day in the life of a family. The time-geographical diorama illustrates some of the pathogenic risks in our daily environment. The trajectories of two grown-ups and two children are shown. The black triangles and italicized text indicate physical and chemical risk factors, pathogens, and stressors or potential mental impact. (VOC = volatile organic compounds)

for example, teleworking implies flexibility in time and space, mobile work requires unconventional working hours, and contingent work implies frequent job moves and generous decision latitudes (at least in theory). To some extent, these novelties have brought a new freedom to workers but also a higher degree of insecurity and increased working pace. Since many of these phenomena clearly have time and space aspects, a time-geographical approach would be highly appropriate for studying them. Thus, it is conceivable that time geography could make a valuable contribution to addressing the work and/or life balance with which many people struggle. A time-space interpretation of the interplay between demands from working life and life outside work may facilitate an understanding of different working time arrangements and their potential health effects on private lives and health.

Further, a time-geographical approach would be able to take into account variations in daily exposure, such as the noise, pollution, and vibration caused by traffic. Certainly, it may appear insurmountable to capture and conceptualize this complexity of everyday life in a uniform, integrated way. Nevertheless, time-geographical logic could take us a few steps further in that direction.

It is easy to imagine relevant questions such as the following: To what extent does the structure of society allow health-promoting choices of routes in everyday life? Can health-related selection effects be ascribed to the social and physical structure? In other words, what possibility do we

have to choose health? These questions lead to the following approach.

Personal geographies and health

Whatever the circumstances, *personal life-conduct* or *behaviour* will often operate as keys to environmental exposure and to the effects of individual predispositions. Whether external or innate factors will have any pathogenic or protective effect, often depends at least in part on the individual's way of life.

Although all kinds of ailments – with the possible exception of purely inherited, genetic disorders – arise from malfunctions in the interplay between individuals and the physical and social context in which they live, the relationship is by no means a one-sided irreversible one. The health status of individuals as well as the general health status of a population evokes *reactions* or *responses*. Reactions may be *personal*, such from the affected individuals themselves or from members of their family. They may also be *collective* or *institutional*, initiated by institutions or the public in neighbourhoods and other communities, such as vaccination campaigns. The reactions and interventions may be directed towards a diseased individual (which may be the diseased persons themselves) or towards the social or physical environment.

Change of life-conduct is one kind of personal reaction, in order to prevent ill health or as part of a rehabilitation treatment; typical examples are taking up physical exercise, giving up smoking, and adopting a healthier diet. A more drastic example may be the profound effect on sexual behaviour and morals that the aids pandemic seems to have had (at least in some countries and cultures). Also, several individuals together may join their efforts and take concerted action to ameliorate the physical or social conditions, for example in their local neighbourhood.

Such individual reactions may have *spatial or temporal implications*. Thus, people who already suffer from an ailment or who fear that their health may deteriorate may choose to move from a place that is perceived as having adverse health effects to a healthier environment or to a dwelling closer to health care. Those who are already been affected by some disease or feel that they are approaching advanced age may move to a hospital or some other institution that provides a service for the disabled. If the disease has been contracted far from home, they may choose to move back home for treatment. Likewise, individual reactions may involve a change of *timing*. For example, commuters may try to change their travel timing in order to avoid crowds or elevated levels of air pollution during rush hours. If they succeed, the result might be an altered exposure situation, not only for each individual but also for the place and the commuters as a group.

By contrast, bad health implies a loss of resources and requires a response. Even a temporary episode of ill health, such as a headache, migraine attack, or a common cold will require a response such as deciding to stay at home or going home from work. Likewise, when a close relative, such as a dependent child, is taken ill, normal activity space and routines for a person taking care of the sick person will be disrupted. Permanent disability, infirmity, or long-term illness will require longer lasting rearrangements of personal time-space. Being taken to a hospital and becoming a patient imposes a new set of coupling constraints, as the patient must abide by hospital routines and be subject to its authority constraints.

In time-geographical terminology, illness means that *capability constraints* are imposed and consequently personal space will be constrained. Naturally, this in turn will affect *coupling constraints*, such as interaction with family, friends, and colleagues, and even hospital staff may enter the picture.

Changing one's personal geography could be a response to ill health as well as a strategy for improving access to health care, in order to adjust to deteriorating locomotion or to improve health. Such reactions would be motivated by reduced capacity caused by, for example, musculoskeletal disorders, multiple sclerosis (MS), and allergies. Thus, Dyck (1995) disclosed sev-

eral different space and place-related strategies in a geographical study of female MS patients. Struck with a disabling disease, the patients redefined the use and meaning of neighbourhood and city spaces. Strategies included more or less distinct spatial aspects, such as residential and occupational moves, rearrangement of working conditions, reordering household relations, and restrictions on personal activity space. Similar ideas, more explicitly rooted in time-geographical theory, have been expressed by Åström (2001) and geographer Anders Löfgren (2006), who described in time-geographical terms his personal experience of becoming disabled.

The meaning of place is an essential element in Kjellman's (2003) approach to marginalized people. In order to analyse how former drug addicts and mentally disabled persons, who were adapting to a new life outside the institutions where they have lived, she combined a time-geographical perspective with ideas from social geography to explore the obstacles and potentials in their everyday lives in different places.

It is not unexpected that the time-geography approach has been taken up by physiotherapists and occupational therapists. For example, Erlandsson (2003), an occupational therapist, used time geography to analyse everyday life for c.100 women with respect to the stressors and health effects. As expected, women with more complex everyday life programmes had lower scores on self-assessed health but their sense of coherence and well-being had not suffered (Erlandsson et al. 2004; Erlandsson et al. 2006).

In a separate study, the school routines of visually impaired, child aged 7 years were examined using a time-geography methodology (Kellegrew & Kroksmark 1999). A qualitative analysis of the time-geographical data indicated that time use, physical location, and social networks were inextricably linked. In addition, the structure of the classroom routines directly impacted the child's skills performance. This methodology appears to contribute valuable information that may facilitate collaboration between school-based therapists and other educational team members).

Åström (2009) applied time geography to explore how visually impaired children and adolescents used computers in their everyday life. By taking into account their complete everyday contexts, she studied how their schoolwork activities were combined with computer science at home and during leisure activities. Collin-Andersson's doctoral thesis describes 17 mentally disabled persons and their everyday life situations in their own home, using time geographical diaries (Collin-Andersson 2009). Her study partly analysed the actions and activities of public care, but also the actions and caring initiatives by parents and friends.

From describing and analysing the individual-level situations of disorders and impairments, it is a short step to using similar approaches for the treatment of patients or clients, as will be discussed in the following subsections.

Therapeutic applications

Therapeutic applications make up another branch of the personal approach, which probably is still in its infancy. Time geography has been applied interactively as a therapeutic tool. Such an approach, developed and applied by Nordell (2002), opens up an interesting perspective. Nordell revealed that by teaching persons suffering from a long-term illness to see their life contexts in a time-geographical perspective, they became equipped to cope more efficiently with their situation. For example, a group of women diagnosed with fibromyalgia and on long-term sick leave used time-geography to make it clear to themselves how their daily life and life as a whole was shaped. The women studied their own life contexts through their diaries, which they then analysed.

Long-term individual perspective: geo-biographies and anamneses

It has been suggested that the time geography approach could be used as a framework for anamnesis in individual cases. An inspiring approach was outlined by Lenntorp (1992), in whose view

the time-geographical approach could be used as a structure for anamnesis: 'The individual path can be seen as a line, to which information can be linked at any point.' Explicitly or implicitly, the *individual* is the starting point for any time geographical analysis. However, we can never escape the fact that individuals under observation are picked out of a wider totality (context) in time and space. Further, the biography of an individual is to some extent a projection of conditions in their surroundings (Lenntorp 1992).

The unbroken picture of the individual life path ensures that the sequence of events will be presented logically and correctly. Hence, it will be clear not only where events have taken place, but also what relations an individual had before and after events. Every point on an individual's path can be used as a focus for collecting information about that person's situation with respect to their physical and social environment, occupation, family, social networks, and daily routines, which can be seen in the perspective of their life phase (Lenntorp 1992, 68-69). Thus, a time geographical visualization of an individual's migration history will be a structure in which other pieces of information can be linked and integrated, eventually making up a personal biography. A person's life-path will reflect their social and environmental structures and, either directly or indirectly, their potential health consequences. Such descriptions could be termed *geo-biographies*. The term is meant to include more than just 'residential histories', which are a kind of elaborated description of the environments lived in and projections of environmental influence. Such a concept is very ambitious and probably difficult to realize. Nevertheless, it should be perceived as an ideal and a goal for time geographical analyses.

Using an approach similar to a time geographical approach, Sunnqvist et al. (2007) worked interactively with a group of former patients who had been hospitalized after attempted suicides. The time geography framework was used in semi-structured interviews in order to obtain 'life charts' for each person, anchoring stressful and otherwise important life events in time and place. The researchers concluded that the method may even have therapeutic value (Sunnqvist 2009). The 'life-course' approach in epidemiology (e.g. Kuh & Ben-Shlomo 2004), has certain similarities with the time geographical approach but seems to miss out the consistent chronological and spatial and activities of time geography, as well as its visual language.

Thus, a time geographical approach opens up the potential to *integrate* studies of external environments, work environments, and home environments. Micro-level studies of movements and contacts in daily life should be tested in order to supplement macro-level studies. Possibly a more realistic approach to exposure and risk calculations would be to search for *risk contexts* – combinations of individuals and external factors – instead of *risk areas*. Risk contexts would not necessarily be territorial or spatially contiguous. Having rediscovered Hägerstrand's ideas, a couple of American researchers (Sinha & Mark 2005). suggested a mathematical formula for comparing individual life paths in order to find similarities that may have been overlooked. In short, people who do not live in the same geographical area might become exposed to similar conditions, leading to the same kind of health effects. Their approach, which is essentially time geography, could be a way to explore the causal contexts of relatively rare disorders, which do not form readily apparent clusters.

Linking micro-perspectives to macro-perspectives

It should not be overlooked that a person's life-conduct is part of and a variation within wider social and cultural contexts. A personal way of life often depends on decisions made by a wide range of decision-makers, from the decisions that each us makes in daily life to the decisions made by employers, authorities, and politicians, often with very far-reaching temporal and spatial effects. As pointed out by Curtis & Jones (1998), contextual effects operate at different

geographical levels, such as at the level of immediate surroundings or at district and regional levels. This raises the question of to what extent we can really decide our and possible exposure to health hazards. For example, accidents may be seen as the results of certain unique situations. Traffic accidents involve certain individuals, vehicles, and circumstances prevalent at a certain place at a certain time, such as road conditions, weather, and visibility. Furthermore, the physical structure and social organization of a society play a role in whether an encounter resulting in a clash and casualties takes place. Thus, in a wider perspective the 'cause' of a road accident can be sought in, for example, work organization and stress (Hägerstrand & Lenntorp 1974). Following the same line of thinking, Forsström (1982) applied a time geographical perspective to analyse commuting accidents in a wider context. A similar approach might yield interesting results if applied to ailments caused by less obvious or immediate circumstances than impacts from physical accidents. Conceivably, many causes of stress can be found in the structure of society. Working conditions can certainly be a stress factor, but other stress-related phenomena, such as 'economic stress' and 'information stress' are rooted in the wider social structure.

Epidemiological studies often analyse areas and populations, but always many individuals together constitute such totalities and patterns. Furthermore, the larger structures are reflected in the life-paths and everyday lives of the individuals. The conditions of our everyday lives are shaped in the interface – and perhaps tension – between what is individual and what is structural. The conditions for health and disorders take shape in the tension between individual wishes, aspirations, and endeavours on the one hand and the restriction formed by nature and society on the other hand. Hence, it is highly desirable to forge a link between macro- and micro-perspectives, in order to explore health impacts from the big world in the 'small world'.

The big world – epidemiology

As pointed out by Kwan (2012), examining contextual health effects is afflicted by an 'uncertain geographic context problem', namely the spatial and temporal definition of relevant contexts, which is complicated by their dynamics, including mobility.

Population at risk is an essential concept in epidemiology. However, populations at risk can be identified in different ways, possibly with differing results. Principally, the starting points can be either a *place* (including its residents) or a *group* of individuals distinguished in some other way, such as by their occupation. In both cases, important geographical considerations have to be taken into account. In the former case, after defining the *place* (which poses problems of its own kind), the population at risk of any exposure in the area can be estimated in two different ways. The easiest and crudest way is to use the officially resident population. Another, more complicated, option is to calculate the number of people who spend more or less of their time in this specific place. By contrast, in the second case, taking *groups* or subpopulations as the targets for exposure calculations, a common approach is to use predefined social categories, employing socio-economic indicators such as occupation, education, income, or family status. Although it should not be denied that such circumstances are in one way or other correlated with health, such an approach partly forestalls the results and prevents an unbiased analysis.

Conventionally, epidemiological studies are either cross-sectional or longitudinal. The former type offers a picture of the situation in a population or an area at a certain point in time or during a limited period, whereas the latter follows a cohort through time. However, neither of the approaches captures the true dynamics in space and time. An alternative approach is offered by time geography.

Landscapes of processes – epidemiological landscapes

From a geographical point of view, health and ill health could be perceived as components in an invisible landscape (i.e. the properties of individuals). As such, the term *epidemiological landscape* is not new. However, it should be recognized that a landscape is dynamic and this insight should also be reflected in the definition of an epidemiological landscape. Thus, taking Hägerstrand's *landscape of processes* as the starting point, it can be stated that an *epidemiological landscape comprises all those components that might directly or indirectly affect the health of living beings favourably or unfavourably, being present within a geographical area, including everything that moves in or out across its border during a chosen period of observation* (cf. Hägerstrand 1992, 10–11).

A variation of the landscape approach has been developed by Szegö (1987; 1994). Even if his line of thinking also starts from individuals, his perspective is a *macro-scale* view. Although individual life-paths are not included, his models can be seen as aggregations based on the trajectories of individuals. Accounting for the fact that people often move in a rhythmical way, he introduces a new definition of population density, namely *structural density*, which in an urban area varies temporally and spatially with the commuting movements. This concept of population density can be applied in alternative calculations of positive or negative influence from the environment. Since people are more or less mobile, they are incessantly shifting their environments and external contacts. For example, the external exposure to air pollution is a function not only of the temporal and spatial variation of pollution but also of the way people move (Omstedt & Szegö 1990; Szegö 1994).

The above lines of development deserve special attention because they appear very promising for studies seeking the causes and circumstances of ill health. Especially, such a 'landscape of processes' approach would be useful for studying the occurrence of diseases and disorders with unknown or insufficiently known aetiology.

The daily routine perspective: commuting

For similar reasons to those stated in the preceding subsections, *repeated movements*, such as commuting, cannot be disregarded when health hazards resulting in diseases after lengthy and cumulative exposure are considered. The differences between the total population, daytime population, and night-time population, can be quite considerable. Therefore, a different approach has been suggested by Omstedt & Szegö (1990), who have calculated the exposure to fallout from air pollution in different parts of a city at different hours in relation to the diurnally shifting numbers of people present. Still, to date, it seems that few attempts have been made to analyse connections between *commuting* and health.

A descriptive study of commuting in Malmö clearly reveals not only the difference between night-time and daytime populations but also the fact that substantial numbers of people move between the city and surrounding municipalities (Szegö 1994). One potential health implication is the observation that large numbers of commuters are exposed to different environments, but also that epidemiological studies should take into account the fact that the background population is not simply the number of residents in a certain administrative unit but also a highly changeable mass of individuals.

In short, the starting point for identifying populations at risk could be a defined space and a certain population. The latter could simply be the night-time population or the daytime population, but it could also be based on age and gender, occupational categories, socio-economic characteristics, or even similarities in the *mobility* patterns of the included individuals.

How essential is 'spatial mobility' in epidemiological contexts? For the future, it seems increasingly important to be aware of increasing mobility as well as recent or potential environ-

mental changes. Those who have fallen ill already and those who may fall ill during the next few years have lived and been exposed to ecological and possibly pathogenic situations of the latter decades of the 20th century and the beginning of the 21st century – a period of great ecological changes. Thus, research design in epidemiology and health geography will have to account for a situation of even greater *change* as well as temporal and spatial variation.

The long-term perspective

What could be gained by the application of time geography in health geography? What advantages could the time-geographical approach provide? What would make such an approach different from conventional epidemiology? On a macro-level, the approach suggests a different way of *identifying the numerators (such as cases) and denominators (background populations and population-at-risk)* in epidemiological comparisons if one wants to account for how long people have lived or worked in certain places and environment.

Cases (numerators) are usually easy to identify. However, the *denominators* will remain unknown as long as the dynamics of the total population cannot be analysed in a corresponding way. This problem becomes particularly complex when there is a considerable turnover of inhabitants in a studied area. With modern computer power and computer-based records, it is conceivable that this problem may be overcome, at least for recent decades and for the future.

Epidemiological studies in societies that have passed through the epidemiological transition are complicated mainly by three circumstances. Many predominant diseases are characterized by long *latency*, due to the intensity and duration of exposure or repeated exposure. The human *environment* is rapidly changing due to a plethora of social, physical, and chemical novelties and rearrangements, and as people *move*, they become exposed to whatever potentially pathogenic factors in several places and environments. This problem has been described in a couple of empirical studies, using essentially a time-geographical approach (Schærström 1996; Sabel et al. 2000) (see Chapter 22 in this book).

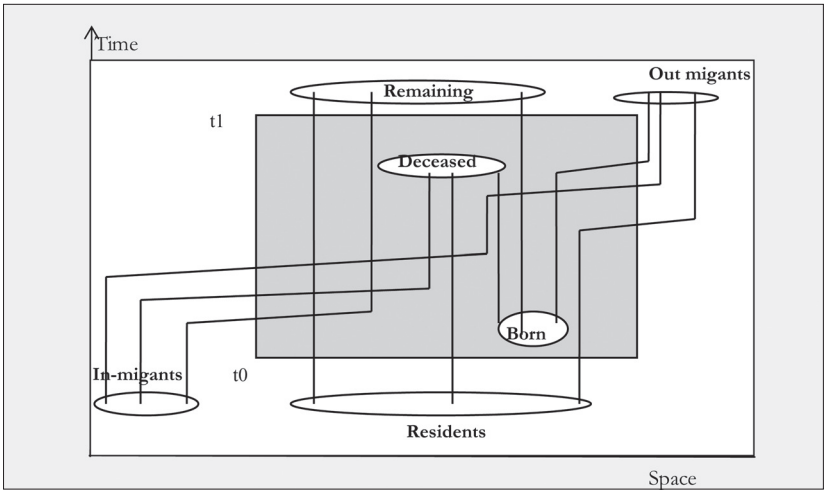

Figure 3: The general principles of demographic space-time flows. The base of the dark grey rectangle represents a given area and the vertical axis represents a period of observation (t0–t1). The trajectories represent subpopulations living in the area for some time – residents at the beginning, remaining at the end of the observation, moving in and out, being born and deceased during the observation period. (Based on Hägerstrand 1975).

Conventional demography counts the numbers of residents at certain points in time and the sums of born, deceased, in-migrants and out-migrants during standard periods. However, instead of just calculating these sums, we can imagine populations and demographic processes as flows in time and space. If one can imagine a certain location or area (such as a county, municipality, parish, or neighbourhood) and a give period of time (e.g. 1 year or five years), then one could perceive people 'flowing' through the time and space prism (Figure 3).

At the outset, a certain number of people are residents. People come and go during the period of observation: some are born, some die, and some move in and out. The aforementioned are the six categories usually displayed in demographic tables. However, the population in a particular area is divided into three 'entrance' categories (residents at the beginning, births, and in-migrants) and three 'exit' groups (remaining residents, deaths, and out-migrants), which yields nine combinations (Figure 4).

Out			
Deceased			
Remain			
	Resident	Born	In

Figure 4: The population in a particular area shown divided into three 'entrance' categories (residents at the beginning, births, and in-migrants) and three 'exit' groups (remaining residents, deaths, and out-migrants), totalling nine combinations.

Ten Swedish municipalities

In order to test the magnitude of population dynamics, a feasibility study was commissioned by the Swedish National Institute for Public Health (SNIPH) (Schærström 2010). In essence, the point of the study was to carry out demographic analyses for selected Swedish municipalities, based on the principles outlined above. In other words, the purpose was to describe the turnover of inhabitants in a way that went beyond conventional statistics. No health indicator was involved at that stage. The intentions were to find out whether this type of calculation was possible using existing data and, if so, to gain a preliminary impression of its significance.

The SNIPH study was based on *10 municipalities*, some of which had already been studied as part of a separate project. The municipalities represented five (out of nine) different types in the official categorization of Swedish municipalities. Their populations spanned between 5500 and 125,000 inhabitants. By the end of 2008, five of the municipalities had less than 10,000 inhabitants, and two had more than 80,000. In total, the 10 municipalities represented a population of 375,000 people (i.e. approximately 4% of the country's population). The period 1978–2008, divided into two subperiods of 15 years, was selected for study. There was never any intention to draw any conclusions about the studied places, but rather to test the particular approach. Could it be done? Yes, it could. It was successfully demonstrated that this alternative approach is feasible with existing population data, but excerpts from the population data base had to be ordered specifically. It seems evident that calculations based on the principles outlined in the previous section provide a demographic picture that differs from conventional population statistics. In other words, official data can be used to reveal a more realistic view of demographic changes (Figure 5).

If the above-described test of the population has provided an outcome that is sufficiently interesting, it would be tempting to use socio-

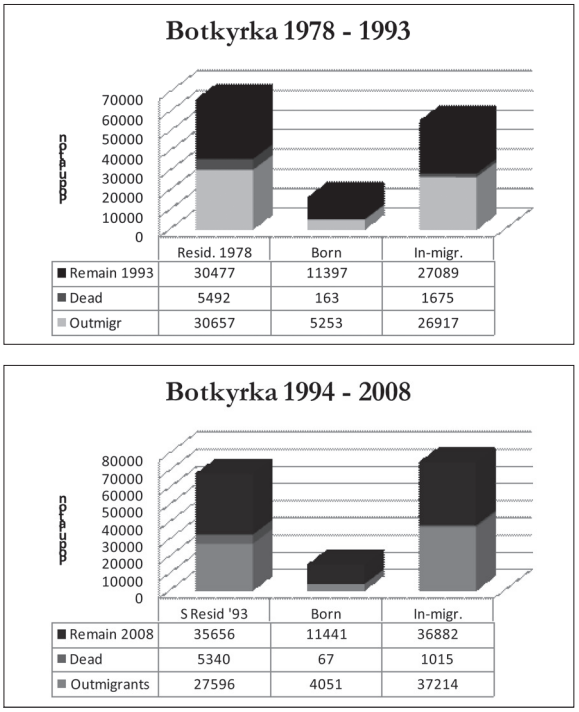

Figure 5. Population dynamics in Botkyrka, a suburb of Stockholm. The columns display nine subpopulations for two 15-year periods (Schærström 2010). For further information, please contact the author.

economic variables and health outcome in a comparative study. This would require case data at the individual level, which is possible, although such data would have to be anonymized.

Already available data could be used for a more profound analysis of age and gender structure in different subpopulations. Should the approach be considered reasonable enough for full-fledged analysis of health profiles, then the next stage would be to match the demographic data against selected health indicators and health outcomes.

Looking ahead: utility and data capture

What could be gained from the application of time geography in medical geography? What advantages can the time-geographical approach provide?

Several studies have shown that time geography adds value and insight into people's contexts and activities in daily living, including their interaction with ill health or disability. Also on an individual level, a time-geography approach could possibly be used as a framework for anamnesis and interactive therapeutic applications, to make people aware of their daily life contexts and behaviours, and their potential health outcomes.

However, the epidemiological potential deserves exploration. What would make such an approach different from conventional epidemiology – with cross-section and longitudinal cohort studies? There are at least three answers to this question.

First, the time-geographical approach suggests a different way of *identifying the numerators* in epidemiological comparisons. The focus on *individuals* (instead of aggregated data) opens up possibilities for flexible groupings. The point of time geography is rather to discover what is hidden in aggregated batch data in macro-perspectives and cross-sectional perspectives. Time geography will not make statistical and mathematical calculations irrelevant or superfluous, nor does it compete with laboratory experimentation. However, all measurements, calculations, and experiments require a logical, carefully meditated motive for choosing certain parameters, for measuring them in a certain way, and for relating them to each other. Time geography could serve this end by elucidating epidemiological processes.

Second, the *general character* of time geography makes it powerful enough for application in several epidemiological contexts. Its powers are particularly the *integrated perspective on time and space* and *its focus on individuals and the resulting flexibility* in terms of temporal and spatial scales.

The third answer has to do with *mobility and environmental change*. Undoubtedly, the migrating, travelling, and commuting fractions of a given population are sufficiently large that they

should be considered as at least as significant as are ethnic groups, smokers, or other categories that are commonly identified as important in epidemiological contexts. Furthermore, considering the present level and pattern of mobility and exposure, it will not become easier to make any geographical studies of diseases in the future. Future patterns of disease will to some, as yet unknown, extent reflect patterns of determinants today or even in the recent past. Some of the *white spots or blank areas in the epidemiological landscape* of days gone by are likely to remain *terra incognita*, as the necessary data cannot be retrieved retrospectively. However, looking ahead, it is time to take steps to facilitate continuous observations and mapping of evolving epidemiological landscapes.

Micro-level studies of movements and contacts in daily life should be tested in order to supplement the macro-level studies that have been in focus here. Possibly, a more realistic approach to exposure and risk calculations would be to search for *risk contexts* (combinations of individuals and external factors) instead of *risk areas*. Risk contexts would not necessarily be territorial.

However, time geography is not a panacea for all methodological problems. No method can yield results that are better than the input data, and in this respect time geography is no exception. It requires spatial and temporal precision as well as validity and reliability with regard to the data used. However, if reliable data on mobility and exposure can be provided, time geography offers an ideal ontological and methodological approach to the intricate problem of mobile populations and complex exposure situations. In other words, time geography offers possibilities for *combining* its fundamental logic with different explanatory theories, both social and medical. Further, time geography allows combinations of *individual geo-biographies* and *aggregated perspectives* as well as comparisons between them.

There is a growing need for geographical accuracy in epidemiological studies. Accepting the way pointed out by Lenntorp (1992), we need to collect data for biographies and anamneses in a way that is not only medically relevant but also geographically relevant. Taking the smallest indivisible unit in a landscape of processes as its starting point, the individual, time geography has the potential to meet the theoretical demands for temporal and spatial flexibility, for focus on individuals and for enhanced spatial and temporal precision.

The crucial question is *how to find data*? In some cases, data can be found in public registries. In such cases, researchers should be aware of matters of confidentiality, but even if data are recorded with very high geographical accuracy, there is no need to display the results with the same spatial resolution. Another possibility is to *interview* individuals about their daily movements or ask them to keep diaries according to time-geographical templates. If we want to measure some kind of physical or chemical exposure, we could *let test persons carry instruments to measure their exposures to pollution, noise, and radiation as well as their body functions, such as heart rates and blood pressure* and record their movements.

Currently, time geography is included in health geography courses and the training of, for example, nurses, at least in Sweden. And methods discussed above have been practised in student's fieldworks. There seems to be a future for time geography in health studies.

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For an introduction into the basics of time geography, see for example Ellegård & Nordell 1997, Hägerstrand (1970, 1991, 2009), Lenntorp 2004, 2010), or the network for time geography (link below).

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