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Follow the North Star: Why Space, Place, and Power Matter for Geospatial Approaches to Cancer Control and Health Equity

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Geospatial. Coined by geographers a half-century ago, it is a phrase literally grounded in this planet that we humans populate (1, 2). As a term, it conjures up maps, spatial structures, spatial distances, spatial layers, and spatial connections (1). It hearkens back to and extends the first principles of mathematics expressed in geometry, first worked out over 5,000 years ago, and whose elaboration required that people pay careful attention to not only the features of the earth, but also the location of the sun, the length of shadows cast, the gyrations of our neighboring visible planets, and the changing positions of the stars (3, 4).

By itself, "geospatial" is solely a physical construct. It is notably bereft of biology, time, people, and power. Referring solely to "space," it is also silent about "place," a term that encompasses the processes and relationships between people and the rest of the biotic and abiotic world that exists in specific locations and their dynamic interactions, which necessarily bear the stamp of time (5–7). Who and what, after all, interacts in and moves between which locations? Whose rules, past and present, shape the contours and boundaries of who and what may be where? Who and what is deemed out of place, by whom? Where are social, economic, natural, scientific, and medical resources concentrated? – versus scarce, ravaged, or degraded?

Although these questions can be asked from the vantage of myriad sectors and disciplines–think only political science, economics, ecology, geography, sociology, anthropology, law, urban planning, criminal justice, and military sciences, to name a few (7, 8), they are also questions crucial to population health sciences and to the analysis of who and what drives population distributions of disease, for good or for ill (9, 10). Among the hallmarks of disease distribution is its spatiotemporal and social patterning (7–9), and when it comes to geospatial analysis, cancer provides a singularly compelling case in point (11, 12). Not only is there a long history of mapping geographic variation in cancer mortality rates, extending back to the 1830s (12), but cancer has set the model for population-based disease registries [the first cancer registry having been established in the United States in 1935 in Connecticut (13, 14)]. Revealing enormous global heterogeneity in cancer incidence and mortality rates, the 2015 second edition of The Cancer Atlas reports extreme contrasts in age-standardized rates (per 100,000, for 2003–2007) for such sites as esophageal cancer (men: 102.5 in Yanting County, China vs. 0.7 in the U.S. state of Ohio), lung cancer (men: 86.8 in Edirne, Turkey vs. 3.3 in rural India), liver cancer (men: 60.9 in Khon Kaen, Thailand vs. 1.5 in Einthoven, the Netherlands), cervical cancer (women: 65.1 in Yangcheng County, China vs. 2.1 in Nuoro, Italy), colorectal cancer (women: 45.4 in the Northwest Territories in Canada vs. 1.9 in rural India), and melanoma (women: 35.4 in Queensland, Australia vs. 0.1 in Singapore) (15). Explaining place-specific cancer incidence and mortality rates and their spatiotemporal distribution in turn requires tackling: (i) issues of exposure in relation to the range of issues across the cancer continuum, including the often lengthy etiologic period for many types of cancer, and (ii) issues involving population mobility, access to health services, spatial variation in availability and accuracy of data for both the cancer cases and the population denominators, and also the spatiotemporal distribution of relevant confounders and effect modifiers (11–15).

Indeed, as made eminently clear by the September 2016 NCI conference on "Geospatial approaches to cancer control and population sciences," (11) precondition to meaningful geospatial analysis of cancer, and by extension, any other health outcome, is deep engagement with the dynamic lived realities of place. The public health challenge, as articulated by the ecosocial theory of disease distribution, is to understand how people and other organisms literally embody, biologically, the place-bound and historically contingent societal and ecological relationships in which we and other beings live and die, thereby shaping population patterns of health, disease, and well-being (9, 10).

In other words, there is no escaping the fact that geospatial analysis of population health, involving one or many layers of phenomena occurring at a particular set of geographic coordinates, is never simply a technical exercise involving health data, whether for cancer or any other health outcome. The increasing sophistication of geospatial technologies and statistical techniques, including as applied to population health (12, 16–19), cannot blind us to the stark realities of the sharply skewed distributions of health determinants and outcomes by place and positions of power, playing out in arrangements that simultaneously involve nations, communities, households, and individuals, and also the global agreements that bind our lives (e.g., the Universal Declaration of Human Rights) (6–10, 20–23).

My argument extends beyond the baseline premise that all technologies are inherently imbued by values, as argued by Franklin and others (24, 25). Rather, in public health, we count for accountability: to document trends in population health, for good and for bad, and to do research that can reveal not only what but who drives population patterns of health and health inequities (9, 10). We consequently must be mindful of the agendas that power and are powered by these data, sometimes for good, other times causing great harm (think: population data used for eugenic analyses and policies) (9, 24–26). The data deployed and knowledge created are critical for altering who and what drives population and health inequities. Core to the mission of public health is the prevention of preventable suffering, with the twin goals being, as declared by both global and national health

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agencies, both to improve population health and promote health equity (20, 27). By definition, health inequities constitute preventable suffering, for they are avoidable inequalities in outcomes between societal groups within and between countries that are unfair, unjust, and unnecessary (9, 20, 28, 29). Moreover, as far as health inequities are concerned, we do not simply live in unjust societies; we live in places, and no matter how much of our lives or livelihood may roam around in cyberspace, or be engaged with nongeographically defined communities or diverse interest groups, issues of residence, economics, power, and health are tightly bound.

Indeed, my first forays into geospatial analysis and cancer epidemiology were when, as a newcomer to public health in the mid-1980s, I was frustrated by the lack of socioeconomic data in U.S. cancer registries, even as racial/ethnic data were provided, as my interest was in understanding how the social class contributed to observed U.S. black/white inequities in breast cancer survival (30, 31). I wanted to contribute evidence to refute the then, and still, dominant racialized approaches to analyzing racial/ethnic patterns of health in the United States, which locate the source as being "race" rather than racism (9, 32–34). Out of that project grew my interest in developing and linking area-based socioeconomic measures (primarily at the census tract level) to individual health records, thereby allowing for computation of population-based incidence, survival, and mortality rates, as both the numerators (i.e., the cases) and denominators (from the U.S. census) can be characterized in relation to these measures (30, 31, 35–37).

More recently, I have turned my attention to the profound and startling lack of empirical research on the impact of residential segregation, both racial/ethnic and economic, on the population burden of cancer, from incidence to death [according to PubMed, as of 25 November, 2016, fewer than 25 such studies have examined this eminently geospatial issue (38)]. For this work, I have developed a novel extension of the Index of Concentration at the Extremes, originally designed by Massey to measure the extent to which an area's population is concentrated into the most privileged and most deprived economic strata (39), so that it can quantify the jointly experienced phenomenon of racialized economic segregation (40–43). The new set of studies in which I have used this measure suggests it can be more sensitive to health inequities than conventionally used area-based measures of either solely racial segregation or poverty (40–43). The implication is that geospatial research on cancer etiology and control would benefit from addressing the enormous gaps in knowledge regarding the adverse health impact of residential segregation, jointly in relation to socioeconomic position and structural racism, especially if this work is to be useful for new work on place-based interventions to improve population health and reduce health inequities (20, 21, 33, 34, 44).

A related new focus of my research, involving both time and place, concerns the enduring impact of Jim Crow, that is, legal racial discrimination in the United States, which was abolished only in 1965 – that is, 50 years ago – which is a mere instant when reframed in terms of historical and biological generations (9, 34, 45–47). Whether in relation to infant mortality rates and premature mortality rates (45, 46) or even breast cancer estrogen receptor status at the time of diagnosis (47), the long reach of Jim Crow birthplace remains apparent in the health of the U.S. populace. Yet, empirical population-based research on this topic remains scant [fewer than a half-dozen studies indexed by "Jim Crow," for cancer or any other outcomes, were listed by PubMed as of 25 November, 2016 (38)]. This gap in the literature speaks reams about the types of public health inequities that could be, but are not yet, critically addressed through a historically informed approach to geospatial analysis of health data.

Also of concern is the misuse of geographic constructs in framing health inequities, including for cancer. Examples that readily come to mind include "African" cancer (fill in the type) and, related, cancer among people of "African ancestry." Falsely invoking the idea of "Africa" as a unitary place, these phrases ignore how the vast African continent, the second largest in the world, is currently home to 58 highly heterogeneous nations, each replete with economic inequality, ethnic diversity, and disparate urban/rural divides (48); presently, the United Nations recognizes 20 countries in Eastern Africa, 9 in Middle (or Central) Africa, 7 in Northern Africa, 5 in Southern Africa, and 17 in Western Africa (49). It is thus implausible there could be any one phenomenon termed "African" cancer or any one "African" population. Yet, using breast cancer as but one example (50), articles routinely make misleading generalizations about "African" breast cancer and blandly refer to breast cancer among women of "African descent" (51–54), even as other analyses point both to the deep problems with adequate population-based data within myriad African countries and also to the profound heterogeneity in breast cancer burden within these countries (55–58). The same concerns of course apply to populations and places linked to other global regions and continents, whether "Asia," "East Asia," "Pacific Islands," "Indian subcontinent," "Europe," "Latin America," or "North America." The larger point is that the use of geographic terminology is not and has never been a substitute for place-informed geospatial analysis, which instead necessarily must take into account who and what makes populations and boundaries, whether legal, cultural, ideological, or ecological, and the consequent implications for heterogeneities and health inequities (6–10, 59).

In closing, it is worth considering the highly insightful and useful map metaphor for scientific theory (9, 60). This metaphor renders concrete Harraway's influential critical analysis of science as a human endeavor necessarily involving situated knowledge and partial perspectives, deeply grounded in people's lived experience, including in relation to social injustice and its justifying ideologies (61). As articulated by Ziman, both theories and maps necessarily have a viewpoint and scale, an intended use, provide purposeful generalizations, and are both constructed and undetermined, such that there is never a "map of everything" (60, p. 131–2). A productive tension exists between the objectivity afforded by the public testing of hypotheses by independent investigators and the subjectivity as to who deems what theories, assumptions, hypotheses, and methods are, or are not, conducive to creating durable knowledge (9, 60). It consequently is imperative always to be aware not only of who and what is on and off the "map," in terms of both theory and empirical analysis, but also who does and does not have access to creating and critiquing such mental and empirical maps in the first place (9, 17).

As scientists and practitioners from diverse disciplines join together in bringing the tools of geospatial analysis to issues of cancer control, it is thus essential that all involved keep their eyes on the proverbial North Star: the human quest for freedom, dignity, and well-being. Serving both as a guide for enslaved persons fleeing north to escape the slave states of the United States (62, 63) and also as the title of the highly influential

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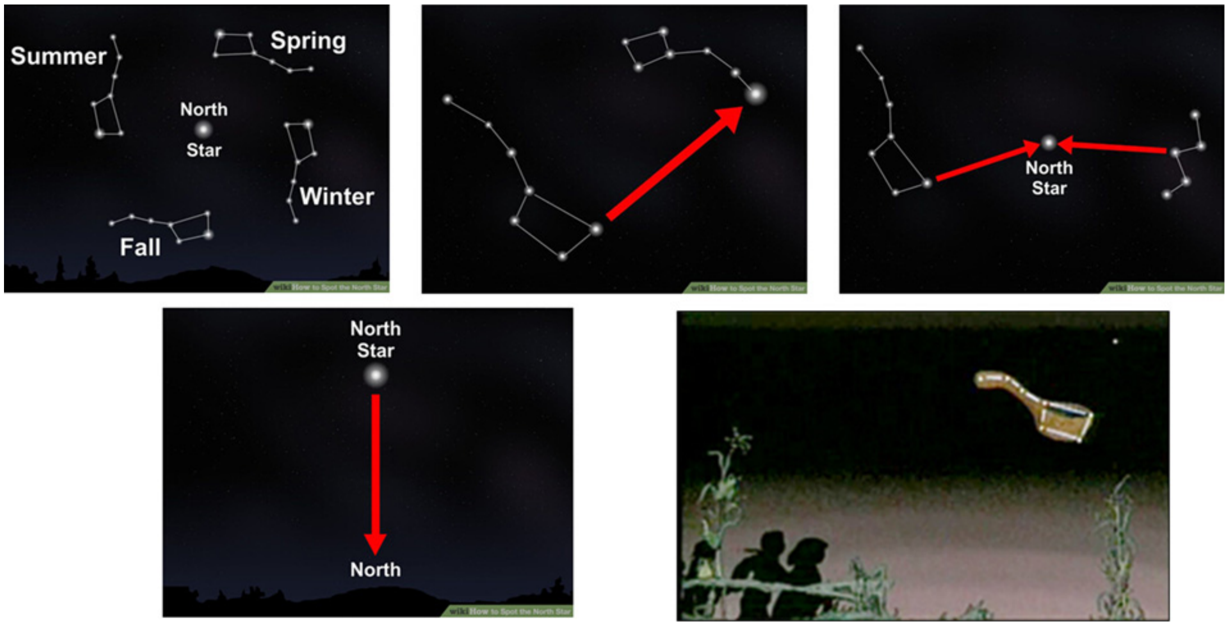

Figure 1.
Finding and following the North Star. Sources: (i) WikiHow (http://www.wikihow.com/Spot-the-North-Star); no permission required to reprint (Creative Commons copyright); and (ii) NASA (https://www.nasa.gov/images/content/247759main_185_Drinking_Gourd.jpg); no permission required to reprint (NASA images not copyrighted).

abolitionist newspaper published from 1847 to 1863 by Frederick Douglass (1818–1895), who himself had escaped slavery (64), the North Star as an entity and an idea profoundly illustrates the interplay of location and both literal and metaphorical vision that lies at the center of analyses of space, place, and people's well-being (Fig. 1).

It was the stars, after all, that enabled people to invent geometry and deepened curiosity about space and time (3, 4), thereby setting the basis for developing the mathematics and tangible tools that now allow scientists to explore spatiotemporal scales of inquiry spanning from cosmic to nano (2, 7, 8, 12, 16–19, 25). For population health sciences, including those focused on cancer prevention and control, the common metric that must bind this work is that of health equity.

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No potential conflicts of interest were disclosed.

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