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The Collapse of Place: Derelict Land, Deprivation, and Health Inequality in Glasgow, Scotland

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The Collapse of Place: Derelict Land, Deprivation, and Health Inequality in Glasgow, Scotland

The population of Glasgow, Scotland has very poor health, compared to Scotland as a whole and the rest of the U.K., and even compared to other post-industrial cities with similar levels of deprivation and worklessness. This research maps and analyzes several health indicators to examine health inequities *within* Glasgow and explore the spatial correspondence between areas of poor health, high deprivation, and proximity to derelict land, much of which is contaminated from past industrial uses. People in high deprivation areas are significantly more likely to be hospitalized for respiratory disease and cancer; have low birth weight infants; and for men to have much lower life expectancy than those not living in the high deprivation areas, indicating substantial health inequities within Glasgow. They are also much more likely to live in close proximity to derelict land. A methodology is described for creating an index (PARDLI - Priority Areas for Re-use of Derelict Land Index), combining scores for these health, deprivation, and environmental variables. The Index is used to select and prioritize communities for resource allocation and planning efforts, and is transferrable to other locations. Potential strategies are outlined for re-using the derelict land for the communities' public health benefit and neighborhood regeneration, including urban agriculture/community gardens, urban forestation, active and passive recreation areas, and linkage to existing open space networks and natural areas. This research is part of a larger project comparing Glasgow and New York City regarding the relationship between environmental health justice and aspects of the built environment.

Keywords

Health inequities, deprivation, Glasgow, post-industrial, vacant and derelict land, brownfields, PARDLI index, open space, greenspace, urban agriculture, community gardens, community regeneration, urban planning

Acknowledgements

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INTRODUCTION – THE COLLAPSE OF PLACE

“The decline in [community] health is the inevitable outcome of the collapse of place” (Fullilove and Fullilove 2000).

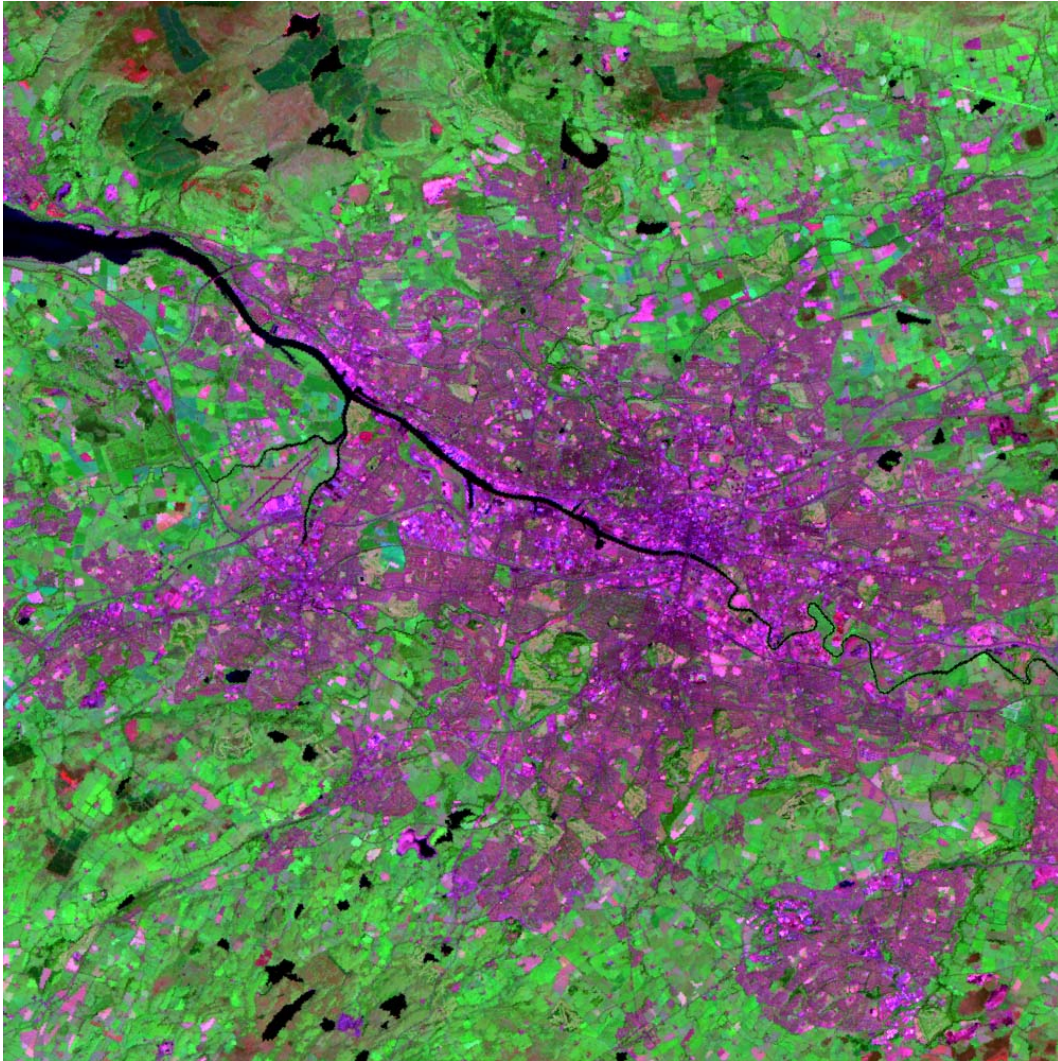


Figure 1 False-color satellite image of Glasgow, the purple areas showing the extent of urbanization. *Data Source:* NASA Socioeconomic Data and Applications Center (SEDAC), *Urban Landsat: Cities from Space*, (1999–2003)

Glasgow is Scotland’s most populous city, with nearly 600,000 people. It covers an area of 68 square miles, and is located along the north and south banks of the River Clyde in West Central Scotland. [Figure 1] Since World War II (WWII) it has become one of the quintessential examples of a post-industrial city

whose fortunes suffered a sharp decline and many of whose peoples' lives epitomize the tragedies of the "dependency culture" of the modern welfare state, rapid deindustrialization, urban blight, multi-generational worklessness, hopelessness, and random violence, some of which was instigated by faulty policies at the national level (such as those pertaining to trade labor unions, deindustrialization, and rapid slum clearances). Although the city began to turn itself around economically in the 1980s, these negative perceptions and realities remain an influence on the health status of its residents.

The enduring poor health status of Glasgow's population has been well-documented. According to the World Health Organization's Commission on Social Determinants of Health (2008), life expectancy for males in some Glasgow neighborhoods is only 54 years, a shocking figure for an affluent nation, especially one with universal access to health care. This life expectancy is lower than that of many less-developed countries whose people have minimal access to health care and are exposed to communicable diseases that by and large have been eradicated in Scotland. Although the alarming WHO statistics on Male Life Expectancy (MLE) only apply to a small part of Glasgow, overall MLE is still considerably lower than Scotland as a whole and the rest of the U.K. In comparison studies between Glasgow and other formerly highly-industrialized cities, both in the United Kingdom and abroad, Glasgow's mortality rates are much higher, and health is not improving as quickly (Halon et al. 2005; Mitchell et al. 2006; Taulbut et al. 2009; Walsh et al. 2010). In "*The Grim Reaper's Road Map*," a recent atlas of mortality and other health indicators for all U.K. constituencies, Glasgow consistently shows up as a dark blotch on nearly every map, the dark color indicating the worst possible value for nearly every health variable being mapped (Shaw et al. 2008). Scotland as a whole suffers from inequalities in health, based on degree of deprivation, as compared to other parts of the U.K. and Europe, (MacIntyre 2007) but even within Scotland, Glasgow stands out as having worse health overall and sharper inequalities. There seems to be no obvious explanation of why Glaswegians tend to have such poor health outcomes, even when compared to cities such as Liverpool and Manchester, whose populations are similarly economically deprived, under stress from worklessness, and share a similar industrial history and culture (Gray 2008).

The extreme health disparities between Glasgow's population and the rest of Scotland and the U.K. include metrics such as low life expectancy, high proportion of low birth weight babies, and high rates of hospitalization for diseases such as diabetes, cancer, respiratory illness, and heart disease (Crawford et al. 2007; Glasgow Centre for Population Health 2008). However, these figures represent city-wide averages. In Glasgow, the figures for individual neighborhood

health outcomes vary widely, and the health disparities/inequities that exist *within* Glasgow (differences in health outcomes amongst the wards, census districts, and neighborhoods of Glasgow) need to be comprehensively mapped and analyzed spatially in order to compare these within-Glasgow differences and ascertain the magnitude of health inequities within the city.

This paper reports on a mapping study of a selection of adverse health outcomes by census Data Zones within Glasgow, in relation to deprivation status and a specific category of environmental burdens – namely, vacant and derelict land (VDL). The main goal of this study is to develop an objective index, combining demographic, socio-economic, environmental, and health variables, which will be used to rank the neighborhoods in order of need, vulnerability, and exposure, thus providing decision-makers with guidance to prioritizing resources required to assist those areas most in need of mitigation.

The Deprivation-Health-Environment Connection

The connection between deprivation and poor health has been understood since at least the early 19th century (Chadwick 1842). After a fever epidemic struck Glasgow in 1843, Dr. Robert Perry, a surgeon at the Glasgow Royal Infirmary, mapped the homes of the fever victims in relation to socio-economic status in the various wards of the city, which also served as a proxy for housing and general environmental conditions. There was an extremely high degree of spatial correspondence between the two variables. On the map Dr. Perry produced, it is very striking how the affluent neighborhoods of the city had very few fever victims, but in the poorer areas - where clean water was not readily available, refuse and human waste piled up on the streets, overcrowding was rampant, housing did not have sanitary provisions, and industrial facilities with their attendant pollution were in close proximity to the homes -the epidemic was rampant (Perry 1844). Dr. Perry's maps and statistics successfully show the links between poverty, adverse health outcomes, and poor environmental conditions.

It may seem obvious to us today that there is a connection between deprivation and poor health, but there is also a link between deprivation and environmental burdens that has been less often acknowledged, especially prior to the environmental justice movement having brought it to the public's attention starting in the late 1980s - early 1990s (United Church of Christ's Commission for Racial Justice 1987; Bullard 1994; Johnston 1994; Bryant 1995). In the United States, this connection between high deprivation populations and proximity to environmental burdens has an important racial and ethnic component. However, because minorities are disproportionately represented in the lowest economic

subgroups, race/ethnicity and socio-economic status are inextricably linked in the U.S., and it is difficult to separate the effects of income/poverty level from race (Maantay 2001; Maantay 2002). In Scotland, race/ethnicity may also be a factor in environmental health justice, but because of the relatively much lower numbers/proportions of racial/ethnic minorities in Glasgow, and the high numbers of poor non-minority people, it is believed that the multiple deprivation index alone suffices to measure the possible connections between health inequities and proximity to environmental burdens.

Reporting on a study pertaining to all of Scotland, Fairburn et al. (2004) state that *“For industrial pollution, derelict land and river water quality there is a strong relationship with deprivation. People in the most deprived areas are far more likely to be living near to these sources of potential negative environmental impact than people in less deprived areas.”* Glasgow, having more of its share of industrial activities over the past few centuries than other parts of Scotland, would therefore also likely see these effects experienced more severely by the poorer populations than many other places.

There is another connection that has not been examined as much as would be expected – the link between poor health and environmental burdens. *“Although much environmental justice research tacitly assumes that unequal environmental exposures produce geographic disparities in adverse health outcomes, very few empirical environmental justice studies have tested that assumption,”* (Grineski et al. 2013: 31).

This is a crucial part of the “triple jeopardy” of social, health, and environmental inequalities. *“While the framework of ‘environmental justice’ has long been used to consider whether disadvantaged groups bear a disproportionate burden of environmental disamenities, perhaps surprisingly, the research fields of environmental justice and health inequalities have remained largely separate realms,”* (Pearce et al. 2010:522). In their 2010 study, Pearce et al. developed the Multiple Environmental Deprivation Index (MEDIX), for every census ward in the U.K., and found that multiple environmental deprivation increased as the degree of income deprivation rose, but more telling was that even after controlling for age, sex, and the socio-economic profile of each area, area-level health progressively worsened as the multiple environmental deprivation increased. This points out *“the importance of the physical environment in shaping health, and the need to consider the social and political processes that lead to income-deprived populations bearing a disproportionate burden of multiple environmental deprivation,”* (Pearce et al. 2010: 52).

The Landscape of Industrial to Post-Industrial Glasgow

In the 18th through the early 20th century, Glasgow was called “The Second City of the Empire,” due to its importance as an industrial center and economic engine for the United Kingdom and the entire British Empire. Many of the industries prevalent in Glasgow and the Clyde River Valley at that time were “dirty” ones, with high levels of air pollution, toxic and dangerous chemicals routinely used in industrial processes, and environmental degradation of the surrounding areas. These industries included shipbuilding, steelmaking, coal mining, textile fabrication, dye works, brick works, rope works, tanneries, distilleries, railway locomotive works, cast iron foundries, chemical manufacturing, and the transportation industry (Hume and Moss 1977; Gibb 1983; Fraser and Maver 1996; Smyth 2000).

The population of Glasgow increased dramatically during the period of intensive industrialization, and by the end of the 19th and beginning of the 20th centuries, Glasgow had one of the highest population densities in the world: about 700,000 people concentrated in three square miles of central Glasgow. Most of the city’s population lived in overcrowded conditions in 3- and 4-story sandstone tenement buildings, often entire large families in one or two rooms (Russell 1888; MacGregor 1967; Horsey 1990; Pacione 1995; Crawford et al. 2007; Faley 2008). There was little in the way of provisions for clean water and sanitation, and both communicable and chronic diseases were endemic. In the 1920s and 30s, these areas were acknowledged as being the worst slums in Great Britain. In the inter-war and post-WWII periods, large portions of Glasgow’s tenement neighborhoods were demolished and people were relocated to new housing estates and high-rise blocks of flats, often in peripheral areas at a distance from city centre. These new housing schemes, while offering modern amenities not previously available in the tenements (such as bathrooms within each dwelling unit, modern kitchens, and increased space and privacy), had important drawbacks: they were typically not well-constructed, were difficult and expensive to heat well, had inadequate transportation connections to the rest of the city, negligible shopping provisions, and helped to destroy the existing community life and strong social infrastructure of the old tenement neighborhoods (Horsey 1990).

By the 1960s, Glasgow was no longer the industrial powerhouse that it had been, owing to shifts in the global economy, changes produced by increasingly technological processes, and policy decisions at the national level designed to de-industrialize Scotland and diminish the strength of its highly unionized workforce. Factories and shipyards closed by the dozens, and the aftermath of this process was the visual blight of de-industrialization and

abandonment in large swathes of the city, and the multi-generational worklessness that afflicts many Glaswegian families to this day. This problem of worklessness, in turn, has led to physical and mental health problems amongst the residents (Craig 2010).

There are many anecdotal (and somewhat controversial) explanations for Glaswegians' poor health, primarily circulating around individual behavioral issues of excessive drinking, smoking, drug use, violence, and poor diet (Craig 2010). Poor quality housing, with damp and mold, is also offered as a possible reason for poor health. The poverty and worklessness also translate into stress-related problems, mental breakdowns, feelings of hopelessness, loss of confidence in the future, alienation, and lack of control over their own lives, which can have direct and indirect physical health consequences (Burns 2012). Doubtless these are all valid reasons, and surely explain, at least partially, Glasgow's overall poor health, which is likely due to a complex combination of factors, and not any one thing.

But what about the external environment? Might not some of the high levels of poor health and health disparities be due to environmental factors? And even if causal links between environmental burdens and the overall poor health in Glasgow cannot be definitively demonstrated, wouldn't it be worthwhile to apply the precautionary principle in the absence of evidence to the contrary, and improve environmental conditions in the most deprived and least healthy places, where people are the most vulnerable? "*When an activity raises threats of harm to human health or the environment, precautionary measures should be taken, even if some cause and effect relationships are not fully established scientifically,*" (Raffensperger and Tickner 1999). The precautionary principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk.

Environmental Justice and Vacant and Derelict Land in Glasgow

Environmental justice (EJ) is the concept that environmental benefits and protections should be distributed equally amongst all populations, and environmental burdens should not disproportionately impact any subpopulation or region (Hofrichter 1993). Most often, however, low-income communities, immigrant neighborhoods, and communities of color bear a disproportionate burden of our pollution problems, whilst experiencing fewer environmental benefits and protection. There is a substantial body of evidence from previous research that has accumulated over the past 2 decades, as evaluated in a 2011 comprehensive review of the literature by Brender, Maantay, and

Chakraborty, that has found that proximity to environmental pollution is linked to poor health outcomes, and that this tends to disproportionately affect poor and minority populations (Brender et al. 2011).

The issues surrounding environmental justice in Scotland have been less often-researched, and EJ appears to be a more recent concern here than, for instance, in the United States. However, EJ in Scotland has been discussed in several books and papers covering environmental conditions, although health inequities are not the major focus, and differences amongst communities within any particular city are not addressed (Dunion 2003; Dunion and Scandrett 2003; Scandrett 2007; Scandrett 2010).

Due to the preponderance of vacant and derelict land in Glasgow, and the fact that the sites appear to be located primarily in the most deprived areas, this research concentrates on vacant and derelict land as an environmental burden and a potential environmental justice concern. There are 1,300 hectares of vacant and derelict land in Glasgow, with 927 individual sites, many of which are contaminated from past uses (Glasgow and Clyde Valley Strategic Development Planning Authority 2010; Scottish Government 2012). This constitutes nearly 4% of Glasgow's total land area, and Glasgow's vacant/derelict land makes up over 12% of all Scotland's vacant/derelict land. Amongst Scottish Local Authorities, Glasgow has the highest amount of urban vacant land, in terms of both absolute number of hectares, as well as percentage-wise, by a very wide margin (Crawford et al. 2007). Approximately a third of the VDL sites have been vacant or derelict since 1990 or earlier, with about 10% of the VDL sites vacant or derelict since 1980 or earlier, or more than 30 years.

Over 60% of Glasgow City's population lives within 500 meters of a derelict site, and over 92% live within 1,000 meters of a derelict site. [Figure 2] Five hundred meters is a generally accepted distance threshold in environmental analysis for assessing potential impact or exposure to contaminants, and was used in the Scottish Government's 2012 *Vacant and Derelict Land Survey* as an impact distance threshold (Chakraborty and Armstrong 1997; Neumann et al. 1998; Sheppard et al. 1999; New York City Mayor's Office of Environmental Coordination 2001; Scottish Government 2012). I have added a 100-meter buffer to the map to show a more conservative alternative exposure zone. A 1000-meter buffer, also used in the government's survey, would blanket virtually the entire city. Glasgow has the highest percentage of people living in close proximity to VDL of any local authority in Scotland (Scottish Government 2012). Most of this vacant and derelict land lies within the most deprived data zones - thus, VDL is an important and significant aspect of environmental injustice in Glasgow. The

distribution of VDL disproportionately affects the poorest populations who, for many reasons, may also be the most vulnerable, health-wise. Previous research has demonstrated that given the same exposure to pollution or other environmental hazards, the people of lower socio-economic status will be more susceptible to their effects than the more affluent, due to existing health and quality-of-life vulnerabilities, material deprivation, and psychosocial stressors (O'Neill 2003). The impact of neighborhood blight and incivilities and the perceptual attitudes must also be taken into account in assessing risk to vulnerable populations (Ellaway et al. 2009). The effects of living near VDL transcend impacts on purely physical health, and encompass mental health as well.

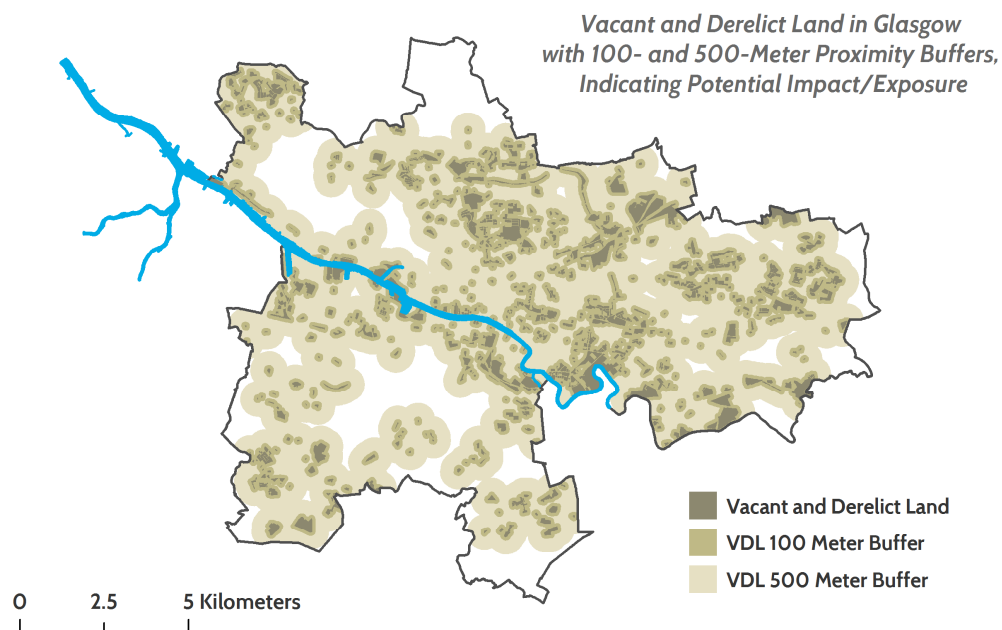


Figure 2 Vacant and Derelict Land in Glasgow, with 100- and 500-meter proximity buffers, indicating areas of potential impact/exposures. *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL)

What types of industries in the past were occupants of the now-derelict land, and what might the specific contaminants be that remain? Based on the known industries located in Glasgow (as mentioned in the section above) there are a number of carcinogenic or otherwise harmful substances likely in use and emitted to the environment. See the sidebar below for a list of potential contaminants.

Potential Contaminants likely found in Glasgow VDL:

(based on known former industries in Glasgow and likely land uses) (Data Source: United Kingdom DoE, 1995)

- Bonding agents, e.g., formaldehydes, and plastic compounds (polyurethane, acrylics and polyvinyl);
- Asbestos;
- Coal tar/creosote;
- Phenols;
- Cyanide & sulphur;
- Heavy metals, e.g., cadmium, lead, barium, chromium;
- Phytotoxic metals (damaging to plants), e.g., copper, nickel, zinc;
- Plating salts, e.g., various compounds, some containing cyanide;
- Aromatic & chlorinated hydrocarbons, e.g., benzene, trichloroethane, trichloroethylene, toluene, ethylene, xylene;
- Fuel additives, e.g. MTBE, hydrochloric acids, chloride & sulphide compounds;
- Solvents, e.g., kerosene, white spirit;
- Fuels and fuel byproducts, such as diesel, petroleum, aromatic hydrocarbon fractions, mineral oils, hydraulic fluid, engine oils, anti-freeze, petrol additives, diesel additives and detergents;
- Inorganic compounds, such as borates, bromide, fluoride phosphate & ammonium compounds (salts);
- Chlorinated organic compounds, e.g., TCE, PCE;
- Sizing agents, e.g., PVA, poly-acrylic acids.

These contaminants can live on in the environment long after the industry that produced or used them is gone. Exposure to the contaminants is an on-going concern, particularly because children and youth often make use of VDL for impromptu playgrounds and football fields. There are a number of potential health impacts and pathways of exposure. Research has linked proximity to contaminated sites with pre-term and low birth weight infants, fetal deaths, congenital malformations, heart disease, various cancers, and respiratory disease (Eizaguirre-Garcia 2000; Vinceti 2001; Litt and Burke 2002; Lit et al. 2002; Baibergenova 2003; Malik 2004; Ding 2006; Kuehn et al. 2007; Wang 2011).

Contaminant exposure may occur through airborne means, especially when soil is disturbed; through dermal contact; or ingestion of soil or groundwater (although Glasgow's drinking water supply does not rely on the City's groundwater). Aside from direct exposure to contaminants, VDL is often unsafe and hazardous land to enter, and the effects of the resultant visual blight of vacant land reduces quality-of-life and may result in additional day-to-day stressors on residents (Greenberg et al. 1998), which can have direct effects on physical health as well as adverse mental/emotional ramifications.

Many areas of Glasgow have become little more than "sacrifice zones" - areas where the physical conditions are so poor that in an urban planning triage situation, given limited resources, some planners and economists consider that the sensible thing to do is to put the resources where there seems to be a hope of a turnaround, rather than throwing good money after bad, as it were [personal communications with Scottish urban planners and economists]. Thus, the very worst areas in terms of deprivation and health frequently do not get the additional resources to make a difference, due to planners feeling helpless to effect change in the face of a continuing downward spiral. This is not due to any malicious intent or negligence on their part, but rather due to a sense of realism and pragmatism about the limits of available resources. Another related problem, which is common in virtually all cities and is not particular to Glasgow alone, is that governmental resource allocation is often not based on a rational objective assessment of need, but is decided on a more case-by-case basis, often driven by political expediency, or from opportunities that arise unpredictably for private investment. This analysis seeks to replace the subjective approach by providing decision-makers with a more quantitative, evidence-based foundation for determining priority areas.

Objectives

"Rebuilding brownfields neighborhoods through an integrative public health and planning approach will be essential for improving the odds for sustainable redevelopment and securing long-term gains in public health," (Litt et al. 2002).

Taking into account the spatial distribution of deprivation and health inequities, and examining the spatial correlation between these indicators and the locations of VDL and potentially contaminated sites, where might we prioritize community participatory interventions to utilize these derelict lands for the benefit of the affected communities? In other words, based on the spatial analysis, which areas in Glasgow have high deprivation, poor health outcomes, large amounts of vacant

and derelict land, and would benefit from additional neighborhood parks, natural areas, greenspaces, or other community uses?

What kinds of “ecological services” might these derelict lands provide the affected communities and the larger region? These ecological services might be flood control, stormwater management, urban agriculture, open space, natural areas, or recreational space for the surrounding communities or wider region. Temporary uses could also be considered, such as containerized gardening, or planting for phyto-remediation or phyto-stabilization, with eventual harvesting of the trees (Brack 2002; Eadha Enterprises 2012).

The aim of this research is *not* to prove causality between vacant and derelict land and adverse health outcomes. This would be extremely difficult to do, considering the lack of data available on three key variables: specifics on the actual type and magnitude of site contamination in Glasgow; records of individual health outcomes; and residential mobility (since many diseases, particularly cancers, have long latency periods). However, there is very likely to be a risk associated with living near many of these vacant and derelict sites, given the history of industrial land use in Glasgow, especially since even a vacant site formerly used for housing might have originally been built on land contaminated by industry.

Regardless of whether or not the actual risk of exposure involved can be demonstrated, the populations in these areas are very vulnerable on a number of levels: they are already suffering from higher than expected rates of many diseases, do not enjoy long life expectancy, and have to bear the stress of poverty and other forms of deprivation. Therefore, there is a strong environmental health justice imperative in determining which neighborhoods in Glasgow have the highest need for planning and implementation interventions and resource allocation.

METHODOLOGY AND ANALYSIS

Rationale for Decisions about the Spatial Analysis

The boundaries of the City of Glasgow were selected as the extent of the study area, in order to provide a high level of consistency, availability, and comparability of data. Some of this consistency would have been sacrificed if the study area extent had been expanded to include surrounding suburbs, which make up the Greater Glasgow region, and lie within several different local authorities. The government’s census Data Zone (DZ) was selected as the most appropriate

unit of data aggregation, since each data zone comprises ~750 people on average, which is small enough to get a reasonably fine-grained perspective of the issues, and to conduct detailed spatial analysis, but not so small that the statistical problem of “small numbers” would be a problem in most cases. There are 694 Data Zones in Glasgow. For some variables (e.g., Life Expectancy), it was necessary to use the larger-extent Intermediate Data Zone (IDZ) as the spatial unit, since data at a smaller extent would be unreliable due to small numbers, and for some variables the IDZ was the smallest extent available. There are 134 Intermediate Data Zones in Glasgow.

Exploratory Spatial Data Analysis

Exploratory Spatial Data Analysis (ESDA) is intended to allow relationships, patterns, and correlations to be revealed, clarified, and better understood. It is primarily used to generate hypotheses, and as a screening technique to indicate potential areas of fruitful further inquiry and research. A number of variables were mapped in order to formulate research questions and hypotheses, to investigate the issues on a first-pass screening basis, and to ascertain by visual inspection whether or not there are likely health inequity issues within Glasgow City. These variables are the following: the Scottish Index of Multiple Deprivation (SIMD); Health Decile, per DZ (derived from the SIMD’s Health Domain); Rates of cancer hospitalization per 100,000, per DZ (CANCER); Rates of respiratory disease hospitalization per 100,000, per DZ (RESP); Low Birth Weight Infants as a percentage of all live births, per DZ (LBW); and Male Life Expectancy, per IDZ (MLE). These data were all obtained through the Scottish Government’s National Statistics – Scottish Neighborhood Statistics website (Scottish Government 2009).

The SIMD is a weighted index, and is frequently used as a proxy metric for allover deprivation. It is compiled from 38 indicators in 7 domains, which are income, employment, education, housing, health, crime, and geographic access. The income and employment domains carry the most weight in the Index, at 56% combined. By contrast, the health domain, itself made up of 7 variables, is weighted at only 14%. The health indicators in the SIMD are: standardized mortality ratios; alcohol-related hospital episodes; drug-related hospital episodes; comparative illness factor; emergency admissions to the hospital; proportion of the population being prescribed drugs for depression, anxiety, etc.; proportion of low birth weight infants (Scottish Government 2009). The Scottish government uses a threshold of the most deprived 15% of the DZs for analysis and comparison purposes, particularly in longitudinal studies, looking at change over time. The SIMD was used in this analysis rather than a simple “income” or “poverty”

variable, since the SIMD encapsulates a variety of deprivation measures, not just monetary ones. However, by mapping income deciles it was seen that there is almost total spatial correspondence between the worst income deciles and the 15% worst ranks (i.e., the highest deprivation levels) of the SIMD, by DZ. The SIMD rank data are for 2009, the most current year available at the time of the study. [Figure 3]

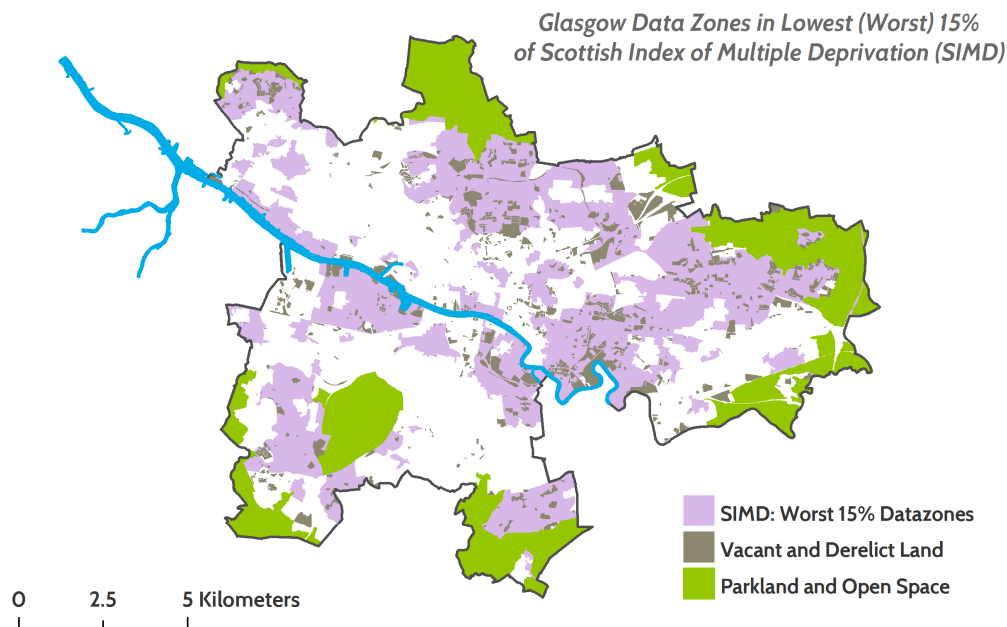


Figure 3 *Glasgow Data Zones in Lowest (Worst) 15% of SIMD.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Scottish Index of Multiple Deprivation, General Report and Technical Report, Scottish Government Census, 2009 (SIMD data)

Health data are from 2010, covering the years 2005-2009. The health variables used in this study were selected as being salient factors in the overall poor health in Glasgow, and are fairly representative of the major types of health concerns. Arguments could be made that using more or different categories of health outcomes would have yielded better or different results. However, through consultation with a number of public health and medical geography professionals working in Glasgow and very familiar with its health conditions, it is believed that these variables as selected accurately capture the overall health status of each DZ. Additionally, because the SIMD's health domain for the most part includes different variables than the ones selected here, there was a lesser risk of magnifying or double-counting the effects of health, or having confounding factors, yet by using both indices, achieve good coverage of a variety of health outcomes. [Figure 4]

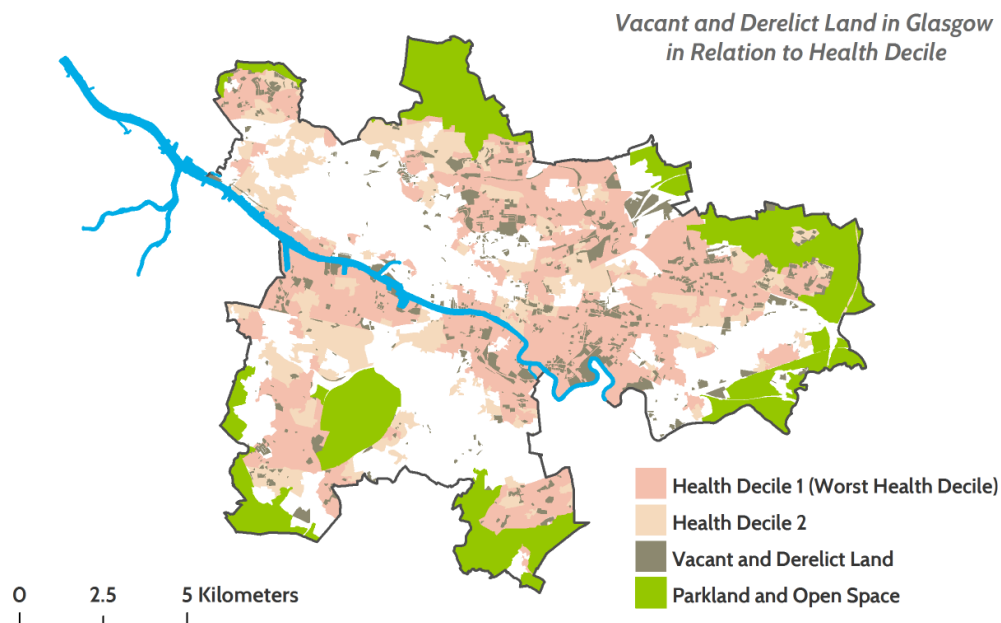


Figure 4 *Vacant and Derelict Land in Relation to Health Decile.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

These SIMD and health indicators were then examined in relationship to the location of the vacant and derelict sites, which were then also buffered with 500-meter and 100-meter exposure buffers. The vacant and derelict land data (non-spatial attribute data) were obtained from the Scottish Government's Survey on Vacant and Derelict Land, 2011, published in January, 2012. The spatial data for the vacant and derelict land was obtained through the Glasgow City Council's Development and Regeneration Services. The variables were all mapped and visually examined in relationship to the location of vacant and derelict land. [Figures 5 – 8]

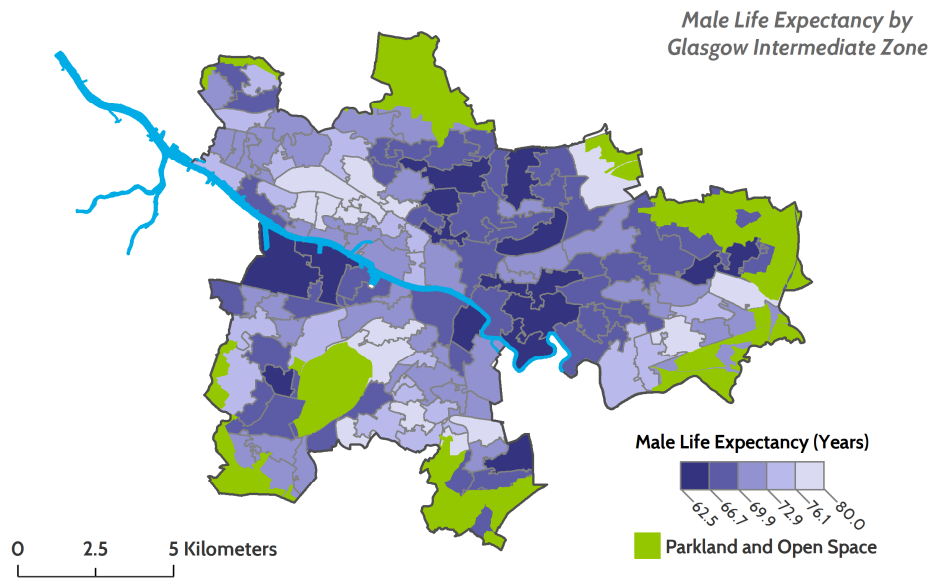


Figure 5 Male Life Expectancy (MLE) by Glasgow Intermediate Zone. *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

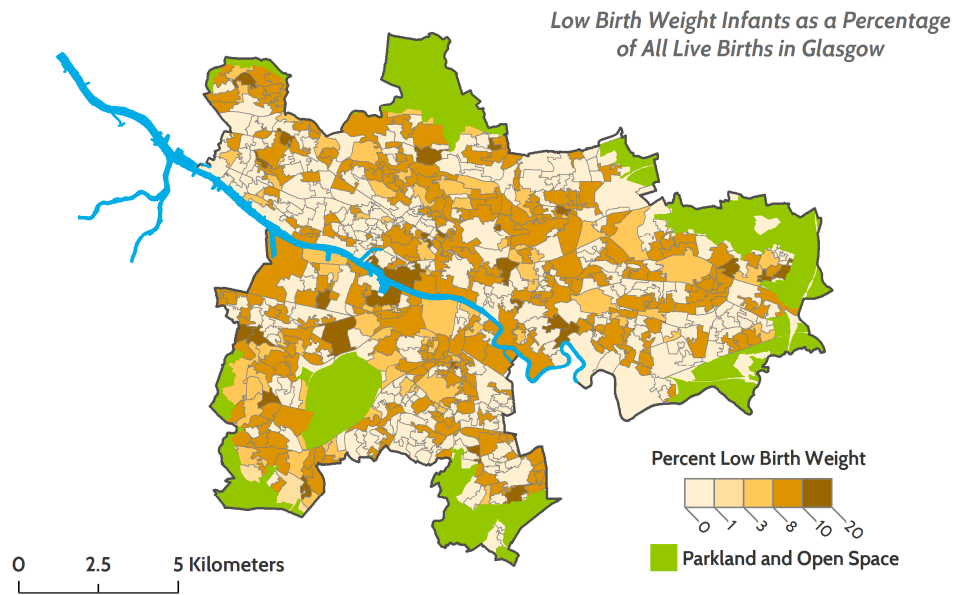


Figure 6 Low Birth-Weight Infants as a Percentage of All Live Births in Glasgow. *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

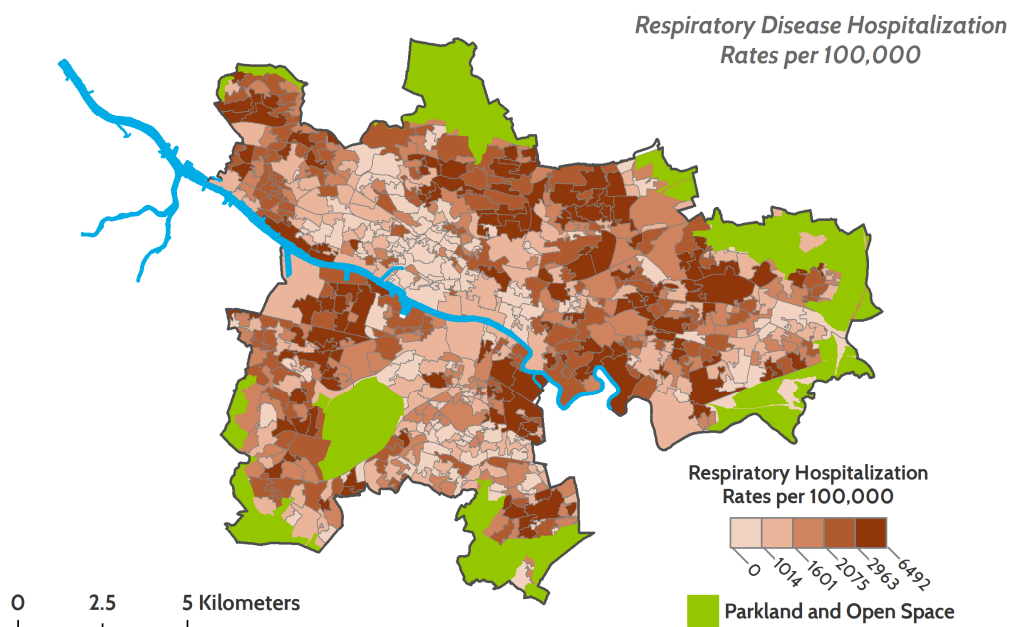


Figure 7 *Respiratory Disease Hospitalization Rates per 100,000 by Glasgow Datazones.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

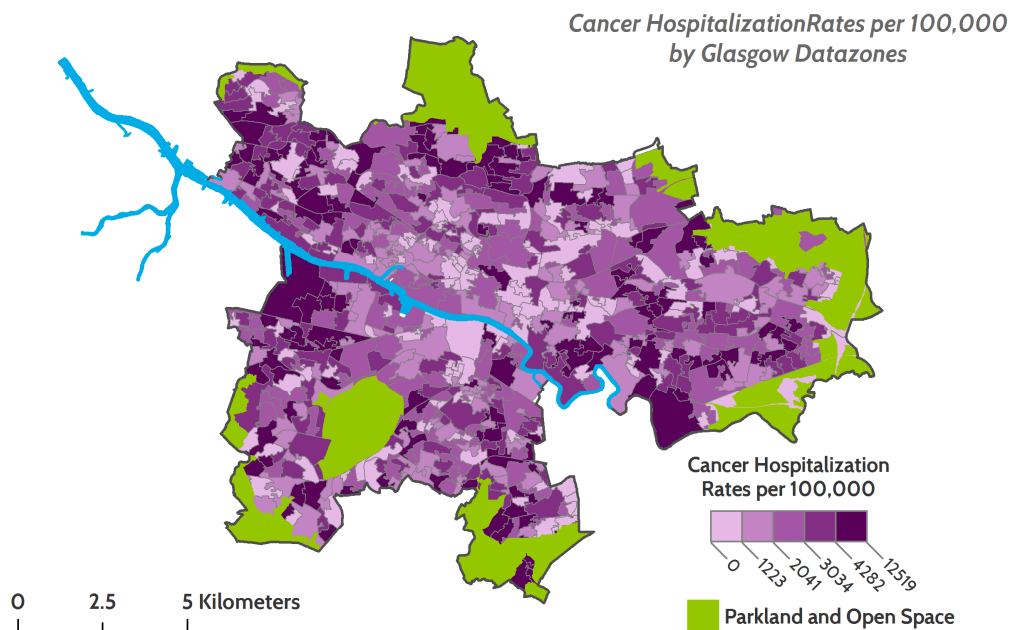


Figure 8 *Cancer Hospitalization Rates per 100,000 by Glasgow Datazones.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

Cluster Analysis, Geographically Weighted Regression, Descriptive Statistics, and Odds Ratios

After mapping the health variables and analyzing them visually, the cancer hospitalization rate dataset was selected as an example for further ESDA. Cluster analysis using Moran's I (Song and Kulldorff 2003), and Geographically Weighted Regression (Fotheringham 2002) were performed on the data in order to determine more specifically where inequities existed, where potentially anomalous high- and low-rate areas were located, and if any spatial patterns could be observed. [Figures 9 and 10]

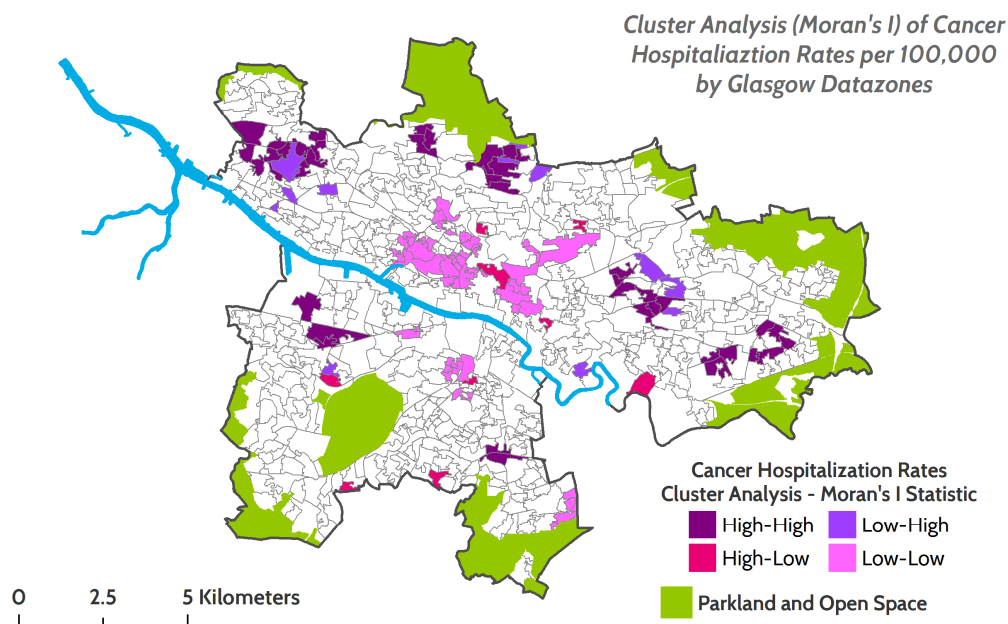


Figure 9 Cluster Analysis (Moran's I) of Cancer Rates per 100,000 by Glasgow Datazone. *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

In Figure 9, mapping the Moran's I clusters reveals areas which have high rates of cancer hospitalization surrounded by other high rate areas, and conversely, areas with low rates surrounded by other areas of low rates - in other words, the conditions which might be expected based on the principle of spatial autocorrelation, where *"Everything is related to everything else, but near things are more related to each other than distant things,"* (Tobler 1970: 236). These, then, would be the concentrated clusters of high or low rates, (high-high or low-low, respectively). The anomalous areas are the areas of high rates surrounded by areas of low rates (high-low), and areas of low rates surrounded by areas of high

rates (low-high). These are the areas which would potentially be fruitful to investigate further to find out why they are different from their immediate neighbors.

Similarly, the map in Figure 10 portrays the residuals of the Geographically-Weighted Regression (GWR), indicating the areas (in dark and medium orange) where the observed (actual) rates are one or more standard deviations above the rates that would be expected based on the relationship between cancer rates and the SIMD of that area. Conversely, the areas in dark and medium blue are one or more standard deviations below the overall rates of cancer hospitalization for Glasgow, indicating that these areas have a lower actual rate than would be expected based on the relationship between cancer rates and the SIMD.

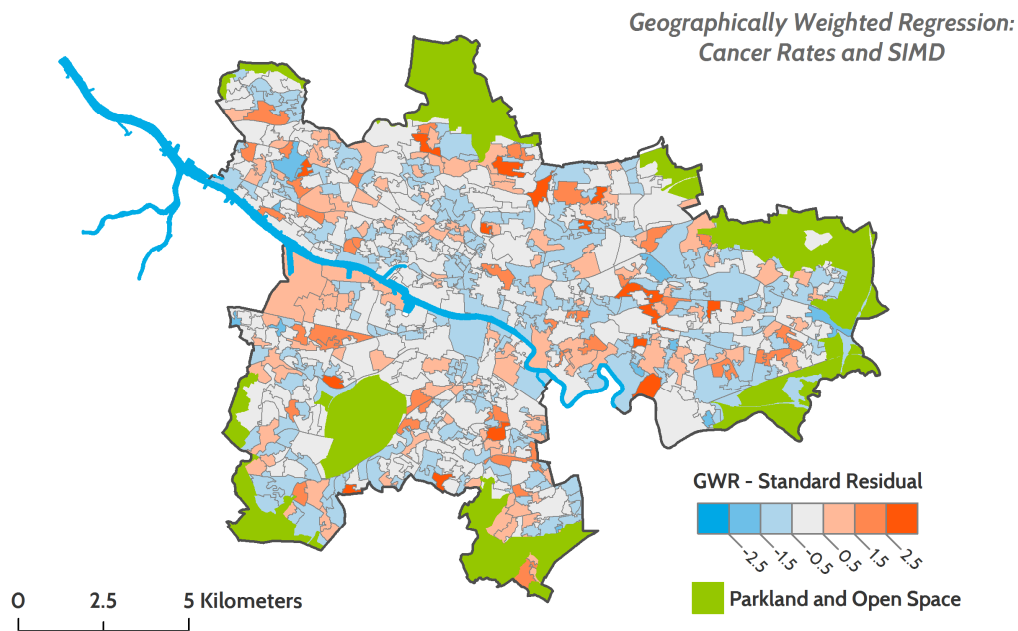


Figure 10 *Geographically Weighted Regression (GWR) of Cancer Rates and SIMD.* Data Sources: U.K. Ordnance Survey (basemap layers); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data); Scottish Index of Multiple Deprivation, General Report and Technical Report, Scottish Government Census, 2009 (SIMD data)

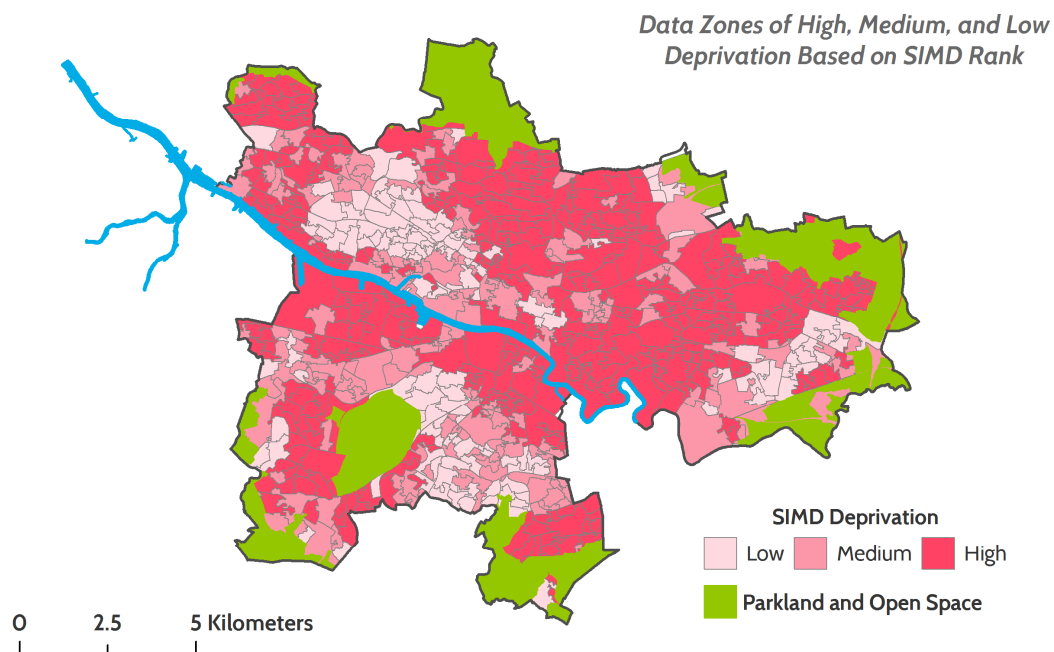


Figure 11 *Datazones of High, Medium, and Low Deprivation, Based on SIMD Rank.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Scottish Index of Multiple Deprivation, General Report and Technical Report, Scottish Government Census, 2009 (SIMD data).

Subsequently, the 694 Data Zones of Glasgow were segmented into three classes, based on SIMD rank: High Deprivation DZs; Medium Deprivation DZs; and Low Deprivation DZs. [Figure 11] The descriptive statistics for each deprivation class were then calculated for each of the variables. Odds Ratios (OR) were also calculated for the three health indicators for which data was consistent with the process of developing ORs.

The Use of Vulnerability Indices in Environmental Hazard Assessment

In order to select Priority Areas for further analysis, and ultimately to recommend priority for these areas most in need of resource allocation and planning initiatives, an index, the Priority Areas for Re-Use of Derelict Land Index (PARDLI), was created to rank each DZ on the variables as analyzed, and then combine the ranks to obtain an overall score. The PARDLI scores thus reflect a combination of three categories: a measure of need, based on deprivation and social vulnerability through the inclusion of the SIMD; health vulnerability through the health outcomes indicators; and an exposure metric of proximity to VDL.

Traditionally, hazard assessment focused more on the physical exposure to the environmental hazard, with the assumption that any population in a hazardous area or exposed to a certain hazard, for example, would be equally impacted. However, this approach does not include the very real additional risk of social vulnerability, meaning that populations that are disadvantaged through poverty, poor housing conditions, poor health, disability/special needs, lack of technology, age (either very young or elderly), racial/ethnic minority or immigration status, language barriers, and unemployment, would be more likely to be adversely affected by the same magnitude hazard as more affluent populations without those disadvantages.

“People’s vulnerability is generated by social, economic, and political processes that influence how hazards affect people in varying ways and differing intensities....By ‘vulnerability’ we mean the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard,” (Blaikie et al. 1994: 5, 9). Equity issues are of particular importance in risk assessment of environmental burdens and other natural and technological disasters. The socially and economically vulnerable, particularly if they have limited or no social support structure, may bear additional burdens than “mainstream” or more affluent populations when exposed to identical physical phenomena (Maantay and Maroko, 2009).

In addition to an area’s population characteristics, differences in communities themselves also play a role. Place-based vulnerability, such as the degree of urbanization, population density, infrastructure, economic weakness, etc., can add to the inequities between places that translate into increased vulnerability in the face of the identical hazard (Mitchell 1999).

A number of indices have been developed in the past 20 years or so to help assess a population’s vulnerability to hazards, most of which have focused on natural hazards such as flooding, hurricanes, and so forth. Vulnerability to environmental hazards is identified by assessing the potential exposure to the physical hazard; a measure of social resilience to the hazard; and an integration of the potential exposures and social resilience in a particular region.

One of the best-known vulnerability indices is the Social Vulnerability Index or SoVI (Cutter, Boruff, Shirley, 2003). This utilizes a hazards-of-place model of vulnerability. The SoVI was prepared on a county level for the entire United States, and utilizes census variables in a very similar way to the indicators included in the SIMD, as used in the PARDLI. After testing for multicollinearity amongst over 250 census variables, 42 variables were selected for principal

components analysis, to reduce the index to 11 composite factors. The SoVI, as in the PARDLI, utilizes an additive model, so as not to make any subjective assumptions about the relative importance of the factors. Unlike the PARDLI, however, the SoVI is strictly a social vulnerability index and does not include any measures of exposure. Additionally, PARDLI is constructed at a finer resolution than the SoVI, allowing a more nuanced picture of vulnerability because the unit of analysis is much smaller, as is appropriate for a city-wide as opposed to a national level analysis.

Similar to the SoVI, the U.S. Centers for Disease Control and Prevention (CDC) has developed a Human Vulnerability Assessment model (HVA), which uses 15 U.S. census variables at the census tract level (US CDC 2008). The model calculates the percentile rank of ninety or higher for each variable. If a variable is within the ninetieth percentile, it receives a score of 1. The overall vulnerability is determined by summing the scores for all variables, which are not standardized and are weighted equally. The variables are similar to those used in the SoVI and the PARDLI, although the PARDLI represents an improvement as it includes an exposure component as well as more detailed health indicators.

Other researchers have adapted the HVA by modifying and augmenting the national-level index in order to construct a locationally-relevant vulnerability index, by incorporating geographically-specific datasets and including a biophysical component, which neither the HVA or the SoVI includes (Maantay, Maroko, and Culp 2010). In this way, the New York City Hazards Vulnerability Index (NYCHVI), which was designed for a specific location, taking into account the particularities of that location, and incorporating an exposure component, is most similar to the PARDLI.

Since the SoVI was first created, researchers have performed assessments and sensitivity analyses on vulnerability indices (Jones and Andrey 2007; Schmidlein et al. 2008; Tate 2012). Although, in general, some differences were discerned when re-doing the analyses by altering indicator sets, analysis scale, methods of weighting, etc., it is likely that a one-size-fits-all approach (where the index performs equally well in every situation in every region) will be, by necessity, less than optimal. The best indices will be created for specific locations or regions, and reliant on expert guidance of those knowledgeable about the region.

“The quick, broad assessments of vulnerability provided by quantitative indices are useful guides for the selection of study areas in which more intensive, qualitative analyses may be conducted....Once a region’s most vulnerable subareas are delineated in a systematic fashion, case-study research on the local

drivers producing the pattern of vulnerability can begin, leading to reduced social vulnerabilities, and improved local resilience to environmental threats where and whenever they occur,” (Schmiddlein et al. 2008: 1112). This type of “screening” index, to be used primarily for the selection of case-study areas for more detailed analyses, was the concept behind the creation of the PARDLI.

“Index development involves a multi-stage sequential process, which includes structural design, indicator selection, choice of analysis scale, data transformation, scaling, weighting, and aggregation. During each stage, modelers must make choices between multiple legitimate options...There is not necessarily a right, wrong, or best answer to these questions,” (Tate 2012:327). With this in mind, the construction of the PARDLI is described below, acknowledging that, while there is a defensible rationale for all the decisions made, and the model was vetted with experts and their input was taken into account, no index will be a totally comprehensive reflection of reality, or a definitive predictor of risk, and there is always room for improvement and refinement. Undoubtedly, the PARDLI scores would have been calculated differently if different variables had been selected, if a different unit of analysis was used to aggregate the data, if different or additional environmental exposures were included, if the data had been classified in a different manner, or if the index had been weighted. The very nature of index creation entails that there will be assumptions made about which indicators best portray the conditions. The biggest limitations are that indicator data thought to be useful may not, in fact, exist or be available, and that not everything that should be included is known.

Development of PARDLI scores – Priority Areas for Re-use of Derelict Land Index

The PARDLI scores, intended to aid in the decision-making process of resource allocation, combine three aspects of vulnerability: overall high deprivation (need/social vulnerability), adverse health conditions (health vulnerability/need), and proximity to an environmental burden (VDL) (exposure). The following section outlines how the Index was constructed.

Health variables (LBW, RESP, and CANCER) were re-classed into three categories: High, Medium, and Low, by classifying the rates and percentages by standard deviation. Numerical scores of 1, 2, and 3 were used to represent Low, Medium, and High, respectively. Any value above the first standard deviation over the mean received a “3” signifying the worst (or Highest rate) class. Any value below the first standard deviation below the mean received a “1” signifying the best (or Lowest rate) class. The middle group, between one standard deviation

above and one standard deviation below the mean received a “2” signifying the middle (or Medium rate) class. For the LBW indicator, it was possible for a DZ to be assigned a score of “0,” if the number of LBW infants for the years surveyed was zero. Nearly half of the DZs had no LBW infants, while in some DZs, as many as 1 in five infants were low-birth weight babies.

Male Life Expectancy data was given by IDZ, (Intermediate Data Zone, a larger unit than the DZ) so in order to be able to incorporate MLE into the Index, MLE values had to be assigned from the IDZ to the DZs within each larger zone. This is accomplished by spatially joining the DZs and the IDZs. The DZs nest hierarchically within the IDZs, so theoretically there should have been no overlap or gap issues. However, in the spatial database there were often slight boundary mismatches and therefore incorrect assignment of DZs to IDZs when spatially joining the polygons. In order to circumvent this problem, the centroids (points representing the geometric center of the polygon) of the DZs were spatially joined to the IDZ polygons instead. DZ centroids within a given IDZ were then assigned the MLE value of its parent IDZ, and the table containing the centroid values was joined to the original DZ polygon spatial database.

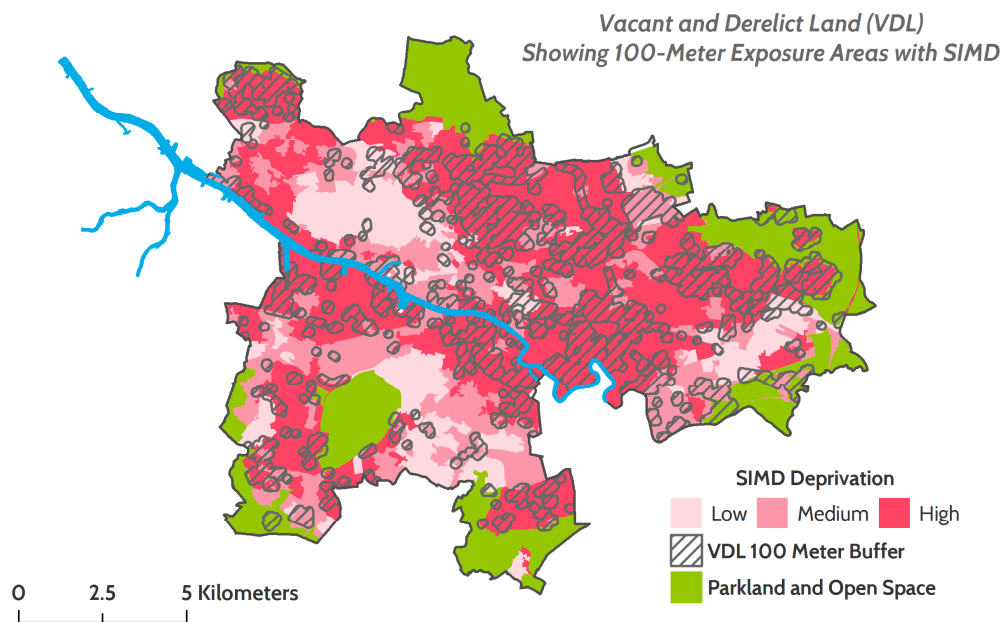


Figure 12 *Vacant and Derelict Land, showing 100-meter Exposure Areas with SIMD.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Scottish Index of Multiple Deprivation, General Report and Technical Report, Scottish Government Census, 2009 (SIMD data)

Vacant and derelict land was buffered with 100-meter buffer distance, and any DZ that intersected one or more of these buffers was considered to be in proximity to a vacant and derelict land site. The 100-meter distance, rather than the 500-meter distance, was used, since so much of Glasgow was covered by the 500-meter buffers that the result would have been rendered almost meaningless. Additionally, 100 meters is a more conservative estimation of impact, from the standpoint of both visual blight and quality-of-life factors, as well as any potential impact from contamination. This metric appears in the Index as a binary feature: the DZ is either proximate, in which case it received a score of “3,” or not proximate, in which case it received a “0,” to a vacant or derelict site. [Figure 12]

In the absence of any compelling rationale for weighting one variable higher than the others, the Index was created by simple addition of the six variables' scores. Combined PARDLI scores ranged from a low of 4 (best, lowest priority area) to a high of 18 (worst, highest priority area). A score of “4” indicates that the DZ has the lowest (best) scores possible for all variables: four “1”s and two “0”s. A score of 18 indicates that the DZ has the highest (worst) possible scores for all six variables: six “3”s. The scores were then divided into the three classes of Low, Medium, and High, as before for the individual variables.

Selection of Case Study Priority Areas

The intention of developing the PARDLI scores is to select the areas with the highest need on an objective, quantitative basis. [Figure 13] These areas would presumably have the highest deprivation scores, worst health outcomes scores, and be proximate to vacant and derelict land. The following neighborhoods (using the Intermediate Data Zone boundaries as representing more accurately actual neighborhoods than do the individual DZs) meet those criteria: from west to east in Glasgow: Drumchapel South; Govan-Linthouse; Possil Park; Calton-Gallowgate-Bridgeton; and Old Shettleston-North Parkhead. [Figure 14]

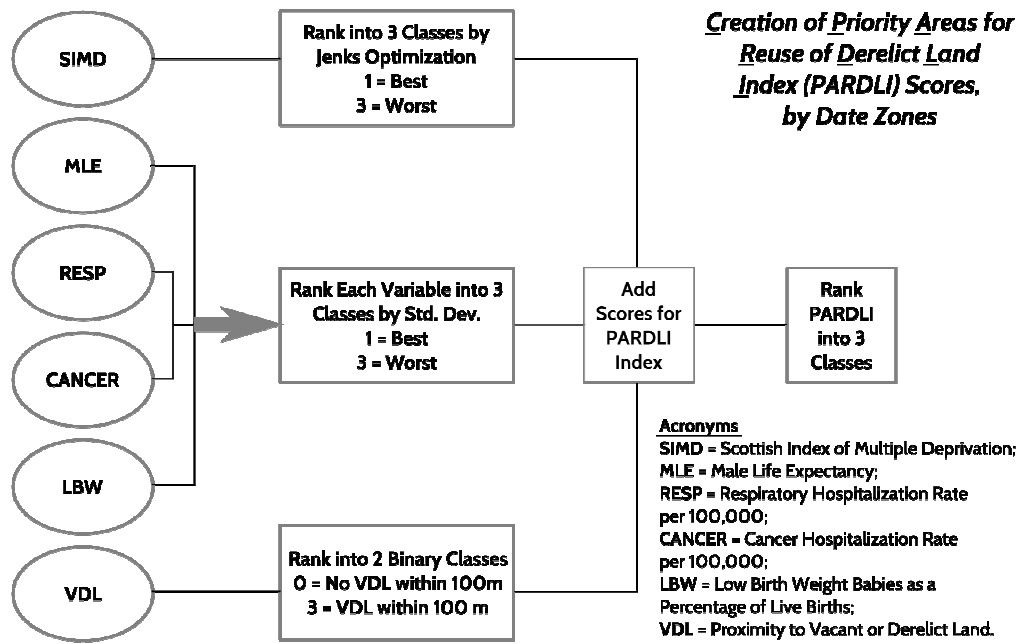


Figure 13 Flow Diagram Depicting the Development of the PARDLI Index

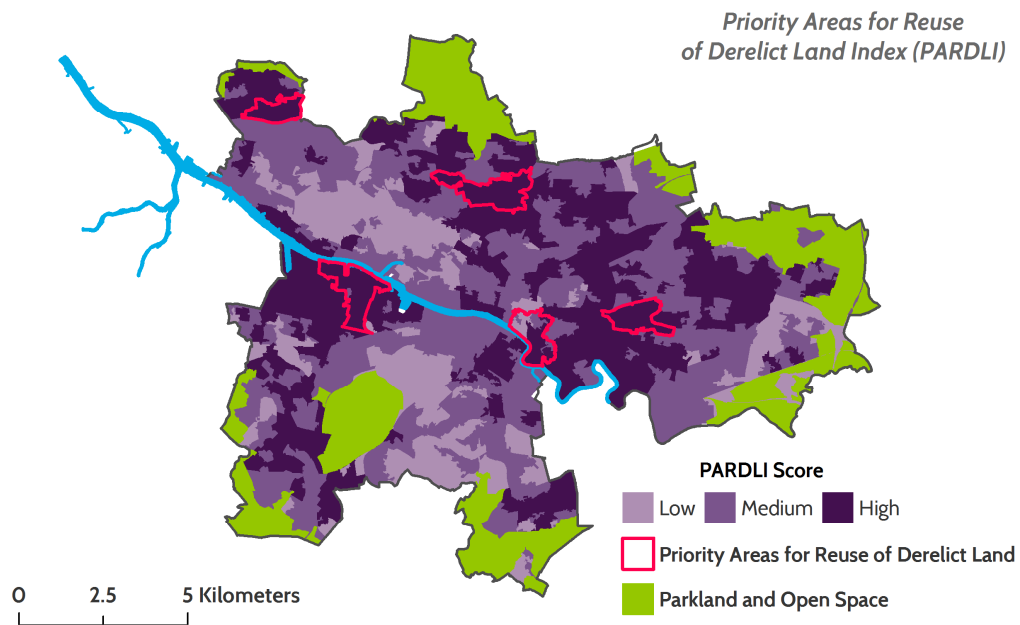


Figure 14 Priority Areas for Reuse of Derelict Land Index (PARDLI). Areas outlined within red boundaries, from west to east in Glasgow: Drumchapel South; Govan-Linthouse; Possil Park; Calton-Gallowgate-Bridgeton; and Old Shettleston-North Parkhead. Data Sources: U.K. Ordnance Survey (basemap layers); Maantay (PARDLI scores, see Figure 13 for datasets included)

The selected Priority Areas will be the focus of a more detailed analysis, to consider the role of historic land use and settlement patterns; possibly more detailed health data from surveys rather than just aggregated statistics; a quality assessment of parks and open space; existing and proposed development initiatives; and existing community organizations and activities taking place in each neighborhood. Although there is a flurry of diverse planning initiatives ongoing or in the development stages for Glasgow, these appear to be somewhat disjointed, with perhaps some gaps, overlaps, and conflicts amongst them. They might benefit from a more unified focus and implementation strategy. [Figure 15]

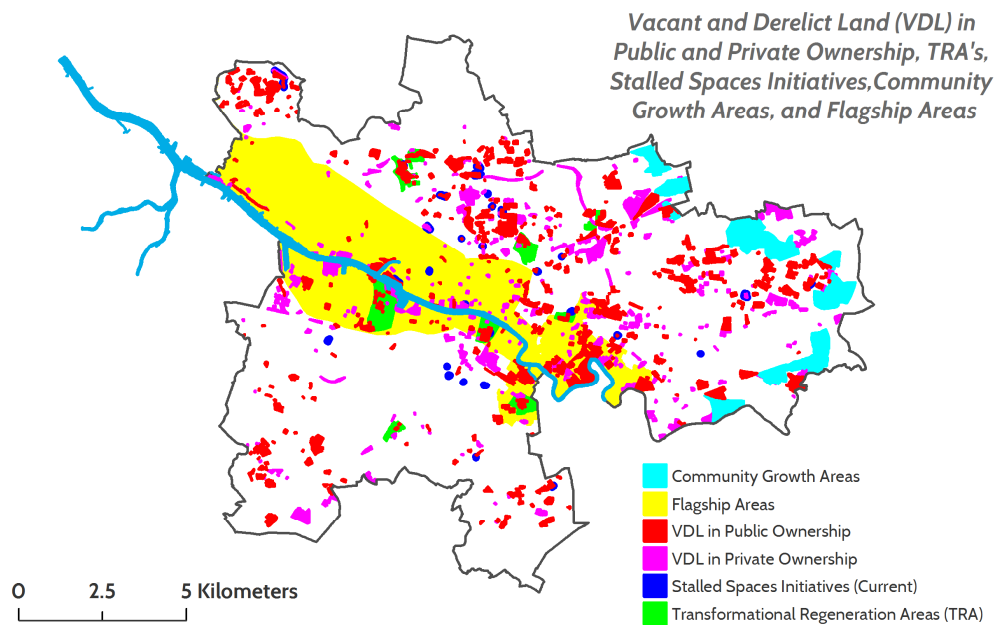


Figure 15 *Vacant and Derelict Land in public and private ownership, Transformational Regeneration Areas (TRAs), Stalled Spaces Initiatives, Community Growth Areas, and Flagship Areas.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Glasgow City Council Development and Regeneration Services; Glasgow and Clyde Valley Green Network Partnership

For instance, various agencies and committees have designated areas within Glasgow and the Greater Clyde Valley region as “Transformational Regeneration Areas (TRAs), “Community Growth Areas,” and “Metropolitan Flagship Areas.” In addition, there are the property lots associated with the “Stalled Spaces” Initiative, which promotes the temporary use of vacant lots by the community that may have previously been slated for development of one type or another, but now are lying fallow until the developer (usually a private owner) decides that the time is right to proceed with the original plans (Glasgow City Council 2013a). The objective of the Transformational Regeneration Areas,

according to the Glasgow City Council’s website, is to transform disadvantaged neighborhoods by major re-structuring and to retain the current community and to attract people back into these areas (Glasgow City Council 2013b). The program is not just for housing but is intended to also deliver local opportunities such as jobs, education, training, and community facilities, and is considered one of the most ambitious programs of urban renewal in the U.K. (Glasgow and Clyde Valley Structure Plan Joint Committee 2006; Fletcher 2011). Community Growth Areas have been identified by the Glasgow and Clyde Valley Structure Plan Joint Committee as primarily residential areas in need of expanded master urban planning efforts, especially additional housing opportunities, along key transportation corridors (Glasgow and Clyde Valley Structure Plan Joint Committee 2006). Metropolitan Flagship Areas “are central to the restructuring of the Metropolitan Area and to the competitiveness of Scotland. They also continue to offer opportunities to accommodate major investment, for example associated with the bid for the Commonwealth Games 2014. The National Planning Framework and Regeneration Policy Statement recognises the Clyde Waterfront, Clyde Gateway and Ravenscraig as national priorities for regeneration and renewal,” (The Scottish Government Directorate for Planning and Environmental Appeals 2012). The Flagship Initiatives, in particular, support the development of green networks and reuse of brownfields.



Figure 16 The proposed Govan Priority Area – An example of looking at the health data at the local level. Brown areas are the VDL. The darker the blue, the lower the male life expectancy (MLE). Most of Govan is in the worst or second worst MLE class, out of the original five classes mapped. *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Scottish Neighbourhood Statistics, Scottish Government, 2010 (health data)

A detailed perspective of the specific Priority Areas, drilling down in the data to the largest possible scale, or “looking through the spatial microscope,” is an important step in developing effective policy recommendations and implementation schemes. Basic science enables the generation of general principles, which are likely place-less. But the application of scientific knowledge to policy, especially to local policy, requires a thorough understanding of spatial variation at the local level, at a high level of resolution, and is rooted in “place-ness;” thus, the necessity of delving deeper into the micro-environment to ferret out the impact of neighborhood effects (Goodchild et al. 2000). [Figure 16]

“Place is not merely a setting or backdrop, but an agentic player in the game – a force with detectable and independent effects on life,” (Werlen 1993, as paraphrased in Gieryn 2000:466). Researchers typically use such units of analysis as census tracts or data zones, populated with socio-demographic data. But these, as such, are not places, merely a convenient area in which to bundle variables. In order to be “place-sensitive,” we need to include information about *“the relative location of the census tract [or datazone] within the metropolitan area, the pattern of streets or significance of particular buildings, such as churches or markets, and the perceptions and understandings of the place by the people who might live there or not,”* (Gieryn 2000:466).

This more detailed exploration of “place,” “place-ness,” and “emplacement” is the purpose of selecting the case-study areas for further analysis. The next phase of this research is to conduct a three-pronged approach: 1) an analysis of historical conditions in the PARDLI neighborhoods, particularly regarding the prior land uses of the VDL; 2) more detailed health analysis; and 3) incorporation of the quality assessment of the parks and open spaces. Additionally, we will be surveying the communities as to extent of social capital as evidenced by community-led organizations, neighborhood improvement activities, influence on local politics, and community cohesiveness. The potential for PARDLI neighborhoods to respond to problems of deprivation is an important aspect of the future research. An investigation into the existing community organizations and activities in each PARDLI area will help to evaluate how these organizations might be able to mitigate the negative impacts of the VDL.

Although individual behavioral factors undoubtedly account for some of the poor health of Glasgow’s most deprived populations, neighborhood effects are also an important consideration, and include such influences as differential exposure to stressors and differences in social infrastructure (Diez-Roux 2001; MacIntyre 2002; Kawachi and Berkman 2003; Croucher et al. 2007). Scotland’s Chief Medical Officer, Sir Harry Burns, believes that these stressors and their

concomitant health impacts go a long way in explaining the poor health here (Burns 2012).

Greenspace Analyses

Many research studies have examined the relationship between access to open space and health benefits, and although the link has not been definitively and consistently demonstrated, a number of studies have found correlations between health benefit and access to open space and areas promoting physical activity (De Vries et al. 2003; Bedimo-Rung et al. 2005; Giles-Corti et al. 2005; Gordon-Larsen et al. 2006; Groenewegen et al. 2006; Maas et al. 2006; Roemmich et al. 2006; Diez-Roux et al. 2007; Mitchell and Popham 2007; Mitchell and Popham 2008; Rundle et al. 2008). Ideally, some measure of access to or amount of greenspace for each DZ could have been included in the PARDLI Index. After all, if we are thinking about creating priority areas for re-use of vacant and derelict land for the possible augmentation of existing greenspace, or in some way to compensate for the lack of accessible greenspace, this would have been a logical indicator to have incorporated. However, there are some rather unique factors involved with the quantity and distribution of Glasgow's existing greenspace, as well as some more typical problems of arriving at a true estimate of greenspace access, which are the same in an analysis of any city's greenspace.

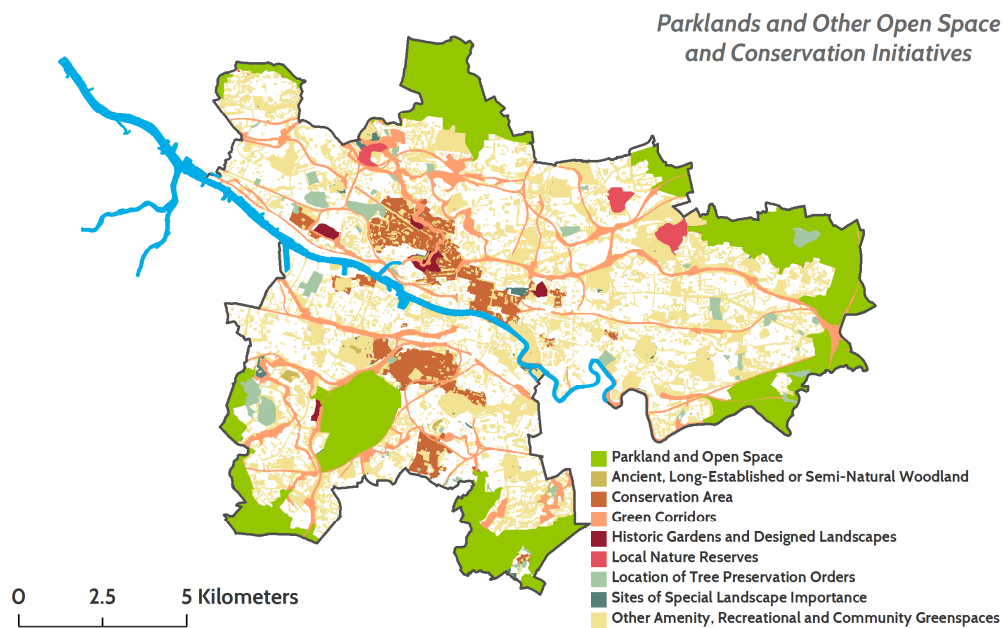


Figure 17 *Glasgow's Open Space. There are 33 separate categories of public open space designated. Data Sources: U.K. Ordnance Survey (basemap layers); Planning Advice Notice (PAN) 65 Planning and Open Space, Scottish Government, 2008, (open space data)*

Glasgow is extremely well-endowed with parks and other publicly-available open space. There is a sizable greenbelt area which nearly encompasses the perimeter of the city, and several large parks are centrally located throughout the city. Additionally, there are myriad other categories of designated open space and active recreational facilities, as well as a significant quantity of land protected as natural habitat areas. There are 33 separate categories of public open space designated, including parks, gardens, sports areas, amenity spaces within developments, green corridors, protected natural areas, nature reserves, historic landscapes, and ancient woodlands. Indeed, when we look at a map with all these classes of open space plotted out, Glasgow is practically covered with greenspace of one kind or another. [Figure 17]

Several comprehensive analyses by other researchers have explored access to greenspace and greenspace quantities in Glasgow. The Center for Research on Environment, Society, and Health (CRESH) at the Universities of Edinburgh and Glasgow developed a model to predict percentage of open space in each ward of the entire United Kingdom (Pearce et al. 2008; Richardson et al. 2010; Shortt et al. 2011). [Figure 18]

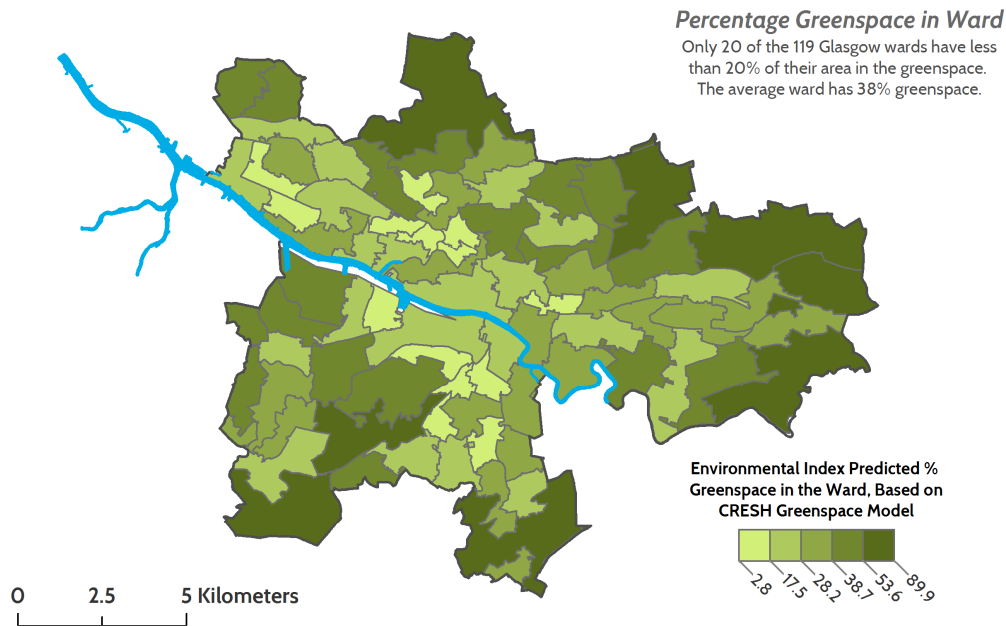


Figure 18 *Percentage Greenspace in Ward.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Developing Summary Measures of Health-Related Multiple Physical Environmental Deprivation for Epidemiological Research, Richardson, et al., 2010 (CRESH model data)

When extracting and mapping just the Glasgow wards from their data, one can see that the only wards to have less than 20% of their area in open space are the more highly urbanized parts of the city centre, and indeed the wards have on average 38% of their area in open space. A few wards have nearly 90% of their areas in open space, which is an extraordinarily high figure, and these wards tend to be near the peripheral areas and in some of the more deprived areas of the city.

A separate analysis, “Networks for People,” conducted by the Glasgow and Clyde Valley Green Network Partnership, was intended to show “connectedness” to greenspace by using actual network walking distance from each property lot to the greenspace entrance, taking into account physical barriers such as motorways and rivers. The city was divided up into a tessellation of 100-meter hexagonal cells, and a value assigned to each cell, indicating the degree of connectivity, based on the network analysis. [Figure 19] The white cells on the map indicate excellent connectivity, and the darker the color, the worse the connectivity. The vast majority of the cells show very good connectivity, with some patches of disconnectedness, again, as with the CRESH analysis, most prevalent in the more densely built-up centre city areas, which in many cases correspond to the more affluent parts of the city (Glasgow and Clyde Valley Strategic Development Planning Authority 2011).

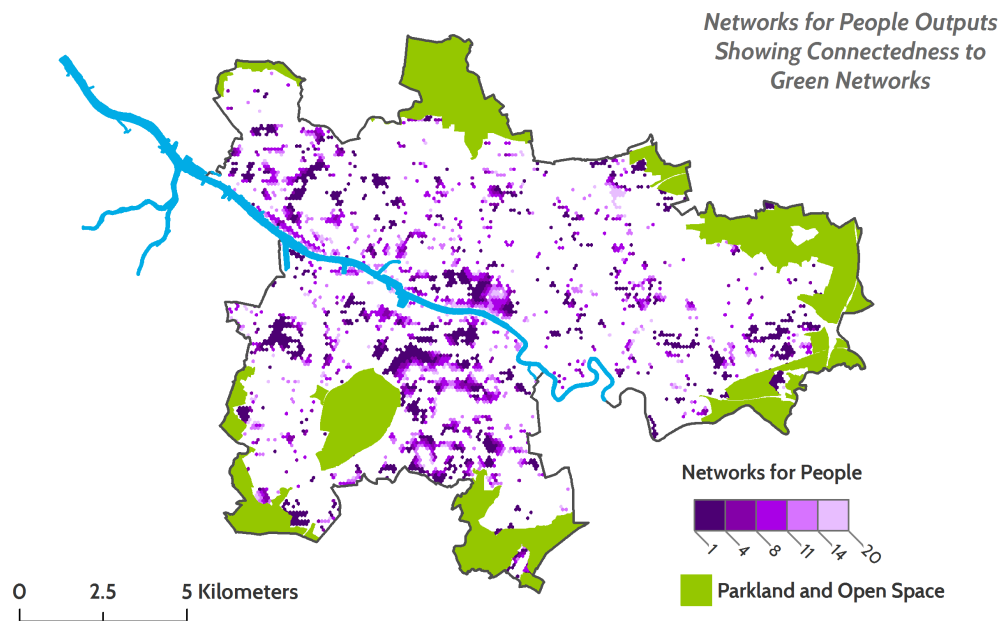


Figure 19 *Networks for People Outputs, showing connectivity to Greenspace. The lower the NfP score, the more disconnected that 100 m cell is from the Green Network (model output of green network). Data Sources: U.K. Ordnance Survey (basemap layers); Glasgow and Clyde Valley Green Network Partnership, 2011*

Based on these two analyses and my own observations of the greenspace data from the Planning Advice Notice 65 (PAN 65) and Integrated Habitat Network (IHN) datasets (Scottish Government 2008; Smith et al. 2008), Glasgow appears well-provisioned with greenspace, and moreover, the less affluent areas often have a higher proportion of greenspace and in closer proximity than the more affluent areas. However, neither of these analyses takes into account the quality or usability of the greenspace for any beneficial purpose (Maroko et al. 2009; Miyake et al. 2010). Oftentimes the so-called greenspace is little more than a dumping ground for old sofas and rubbish, or else is viewed as a dangerous place to the local residents, who do not make use of it. In some cases it is just an impassible overgrown area with no amenities, or for some other reason is not user-friendly. There is a survey currently being undertaken to assess greenspace quality, but it is only partially completed at this time. Without an assessment of quality, it would be very difficult to base any greenspace access score on geographic access or quantity of greenspace alone, and therefore this would be rather meaningless as an indicator to incorporate into the PARDLI scores. However, since this inventory is a work in progress, it is hoped that by the time the Priority Areas are looked at in a detailed format, the greenspace quality data will be available for use.

FINDINGS

The spatial analysis of disease and other health metrics by Data Zones within Glasgow shows that some neighborhoods, and therefore some populations, suffer from poor health and low life expectancy disproportionately more than others. Many of these areas correspond spatially to areas of high deprivation and areas with excessive vacant and derelict land - often former environmentally-noxious land uses - making these populations vulnerable in more ways than one. The areas of highest deprivation and worst health deciles spatially correspond almost totally with the location of the VDL.

When looking at the results of the cluster analysis using Moran's I for cancer hospitalization rates as an example, the clusters of DZs having high rates that are surrounded by other DZs with high rates also correspond to these areas of particularly high deprivation. Likewise with the GWR analysis, in some areas the regression models predict much lower rates than the actual observed values. In certain DZs the observed rate of cases is more than 2.5 standard deviations above the predicted, based on the regression relationship with deprivation rank, and therefore the reality of the cancer hospitalization rates in these areas is much worse than what would be predicted based on deprivation alone.

| <i>SIMD Data Zones</i> | <i># Data Zones</i> | <i>Population</i> | <i>Vacant & Derelict Hectares per 1,000 Pop</i> | <i>% Total VDL Hectares</i> | <i>Cancer Hospitalization Rates/100,000</i> | <i>Respiratory Hospitalization Rates/100,000</i> | <i>% Low Birth Weight of Total Live Births</i> | <i>MLE by IDZ</i> | <i>Male Life Expectancy Range</i> |
|---------------------------|---------------------|-------------------|---|-----------------------------|---|--|--|-------------------|-----------------------------------|
| High Deprivation | 375 | 298,224 | 3.7 | 69 | 3,807 | 2,571 | 3.55 | 66.5 | 62.5-74.7 |
| Medium Deprivation | 180 | 139,325 | 2.5 | 23 | 2,852 | 1,637 | 2.87 | 73.2 | 67.4-77.4 |
| Low Deprivation | 139 | 99,775 | 1.2 | 8 | 2,781 | 999 | 1.55 | 75.8 | 69.9-80.0 |
| SUM/AVG. | 694 | 537,324 | 2.4 Mean | 100% | 2,872 Mean | 2,014 Mean | 2.9 Mean | 71.3 Mean | 62.3-80.0 |

Table 1 *Descriptive Statistics for High, Medium, and Low Deprivation Areas in Glasgow*

The descriptive statistics show the difference in amount of vacant and derelict land, health outcomes, and life expectancy, as differentiated by High, Medium, and Low Deprivation DZs. [Table 1; Figures 20-23] As shown in the tables and graphs, there are 3.7 hectares of vacant and derelict land per 1,000 people in High Deprivation DZs, as opposed to 1.2 hectares of VDL per 1,000 people in Low Deprivation DZs. Likewise, Male Life Expectancy averages 66.5 years in High Deprivation DZs, while it is 75.8 years on average in Low Deprivation DZs. Hospitalization rates for cancer and respiratory disease and the percentage of low birth weight infants are correspondingly much higher in High Deprivation DZs, as well.

Percent Vacant and Derelict Land

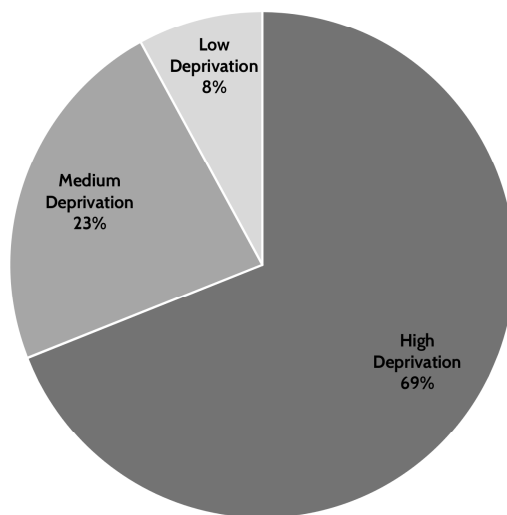


Figure 20 *The Breakdown of Vacant and Derelict Land in Glasgow, by High, Medium, and Low Deprivation Areas*

Hospitalization Rates per 100,000 for Cancer and Respiratory Disease

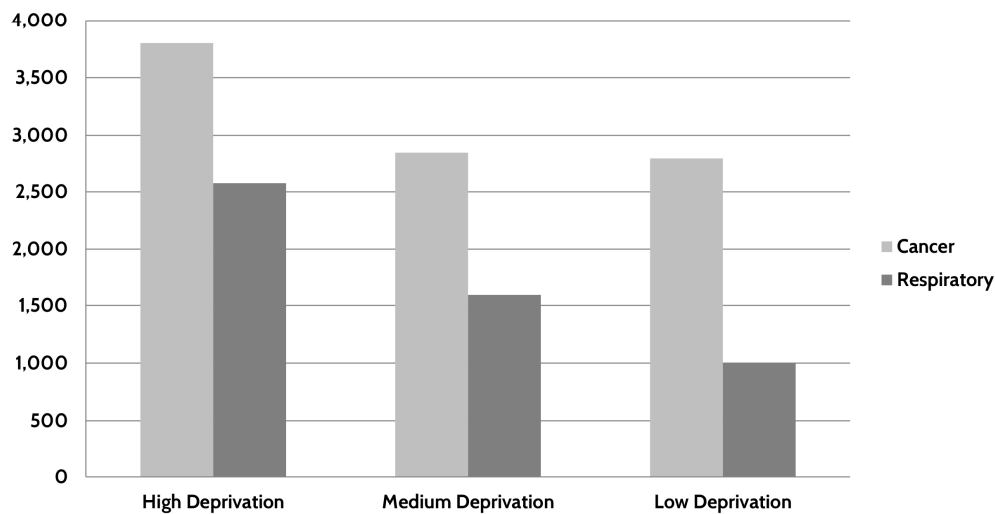


Figure 21 *Hospitalization Rates per 100,000 in Glasgow for Cancer and Respiratory Diseases, by High, Medium, and Low Deprivation Areas*

Male Life Expectancy in Years

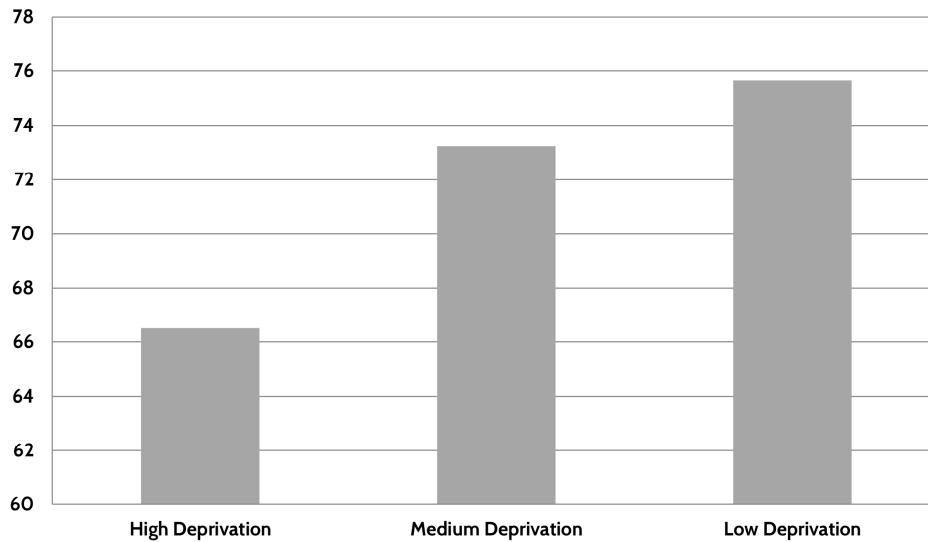


Figure 22 Male Life Expectancy in Glasgow by High, Medium, and Low Deprivation Areas

Percent Low Birth Weight Infants

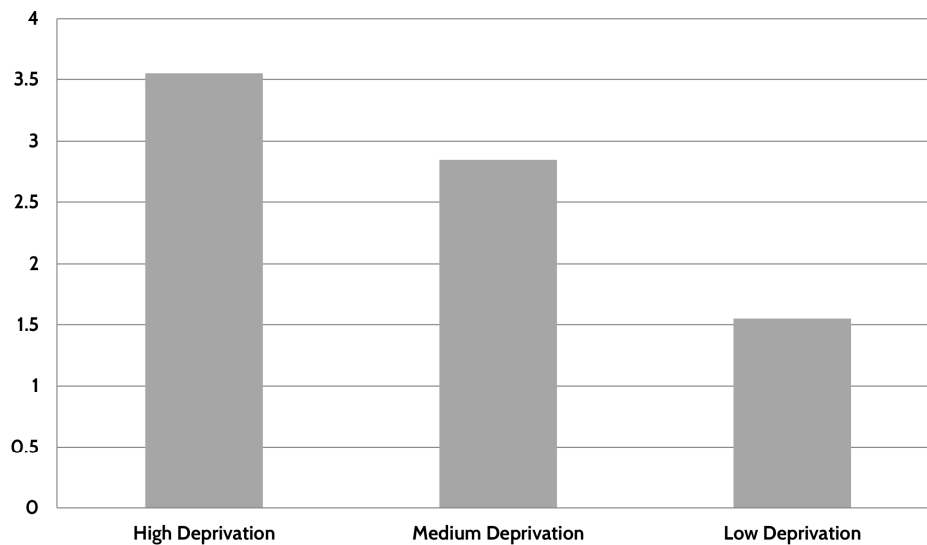


Figure 23 Percentage of Low Birth Weight Infants in Glasgow, by High, Medium, and Low Deprivation Areas

By calculating the Odds Ratios, it can be seen that the differences in these health variables between the High Deprivation DZs and the other DZs are statistically significant. [Table 2] Calculating Odds Ratios is a way of comparing data from two different populations in order to obtain a quantitative evaluation of real significance in the differences between the two groups. Odds Ratios are a surprisingly simple, yet powerful way to show statistical associations in health. They are particularly helpful in demonstrating health inequalities. The Odds Ratio is the odds of disease or health outcome among exposed individuals (in this case, people living in a High Deprivation DZ) divided by the odds of the disease or health outcome among the unexposed (in this case, people living in a DZ that is not High Deprivation).

| Health Outcome | Odds Ratio |
|-----------------------------|-------------------|
| Respiratory Hospitalization | 5.5 |
| Cancer Hospitalization | 1.3 |
| Low Birth Weight Infants | 1.6 |

Table 2 Odds Ratios for Health Outcomes in Glasgow in High Deprivation Areas
95% CI, with $p = < 0.0001$

Results of the OR analysis show that populations in High Deprivation DZs are much more likely to be hospitalized for respiratory disease (5.5 times more likely) or cancer (30% more likely), and much more likely to have low birth weight infants (60% more likely), than those not living in High Deprivation DZs. The analysis of risk factors for unfavorable health outcomes is based on a comparison between cases and non-cases in High Deprivation DZs, and cases and non-cases in non-High Deprivation DZs. All results are at the 95% Confidence Level, with $p = < 0.0001$.

The creation of the PARDLI results in five areas in the highest scoring categories for deprivation, health outcomes, and proximity to VDL. There is a high degree of spatial correspondence between the areas with concentrations of VDL and the DZs with the highest PARDLI scores. [Figure 24]

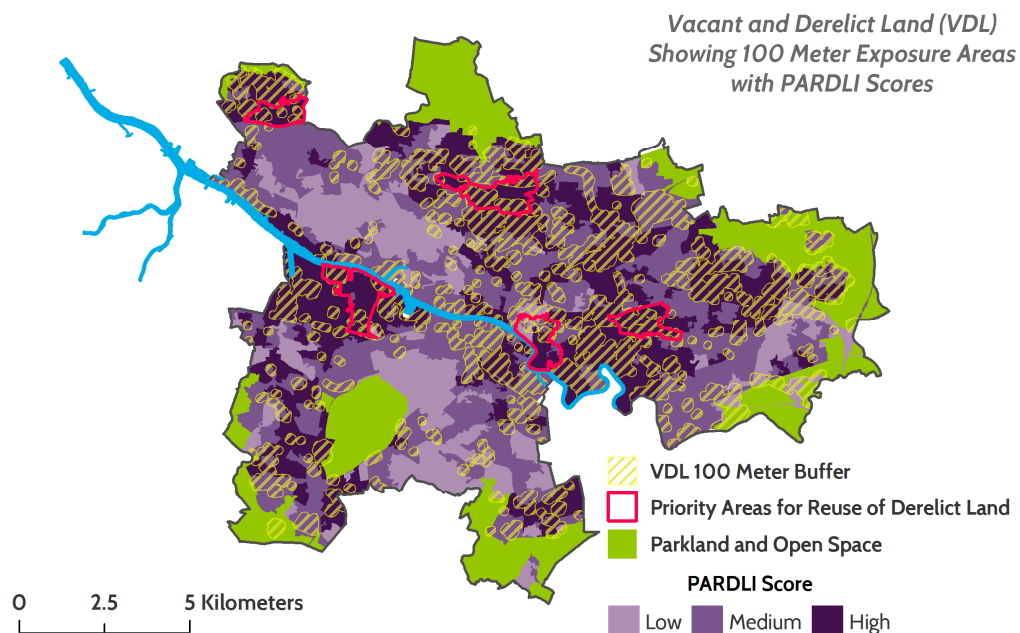


Figure 24 *Vacant and Derelict Land showing 100-meter Exposure Areas with PARDLI Scores.* *Data Sources:* U.K. Ordnance Survey (basemap layers); Vacant and Derelict Land Survey, Scottish Government, 2012 (VDL data); Scottish Index of Multiple Deprivation, General Report and Technical Report, Scottish Government Census, 2009 (SIMD data)

CONCLUSIONS, RECOMMENDATIONS, AND FUTURE DIRECTIONS

The PARDLI scores appear to accurately reflect areas within Glasgow that 1) are exposed to the blight and potential environmental burdens of vacant and derelict land; 2) have high levels of social vulnerability; and 3) have high needs due to poor health conditions. Whilst the PARDLI approach can be transferred to other locations, we believe that vulnerability indices such as PARDLI are perhaps better used as guidelines for other locations, and should be adjusted, if used elsewhere, to better accommodate local conditions and issues. As mentioned earlier in this paper, broad-brush indices are best if utilized mainly as a “screening” device for selecting case-study areas for more detailed study. This paper has discussed the development, assumptions, and limitations of such an approach, as an illustration of index creation for a specific location.

The five Priority Areas as determined by the highest PARDLI scores will be analyzed further in terms of incorporating more detailed data in order to make cogent community-specific recommendations regarding the reuse of the VDL within each of these areas, as mentioned above. The methodology described in this paper can be applied to any other local authority in Scotland, and indeed, to

any location where the VDL, health, and deprivation data exist. In countries not using a standardized index of deprivation, other salient variables could be substituted as proxies for deprivation, such as income or poverty levels.

For policy and planning initiatives, we need to start thinking differently about how best to serve these communities that have ended up in this analysis with the highest PARDLI scores. Perhaps it is worthwhile to examine the differences between re-use of VDL for “regeneration,” versus using it for “development,” and think more seriously about who usually benefits most from regeneration or development. In the parts of the city where VDL is most prevalent, it seems unlikely that there will be high interest from private investors to construct profit-making facilities (i.e., “development”). It might be better to acknowledge this and move on to realistic re-use concepts for the VDL, and plan for uses that would more directly benefit the surrounding community and serve their needs directly, as opposed to being held for a regional use or general tax-generating purpose. Regeneration for primarily community use can result in substantial gains in many aspects, including health and other more non-quantifiable benefits. It can also have an economic multiplier effect and may serve to bolster the local economy, and even have ripple and spill-over effects to neighboring communities. Regeneration of this nature should not be discounted just because it does not involve constructing a commercial or residential building complex. There are also valid reasons for *not* encouraging housing to be built on VDL sites, as argued by Greenberg in “Should housing be built on former brownfield sites?” (Greenberg 2002).

It is important for the community to not only participate and be involved in the decision-making process, but to actually take the lead on devising plans and implementation strategies for the VDL. This needs to be a bottom-up planning initiative, not one led by professional planners, but rather one optimizing community leadership while drawing on planning expertise. This will better ensure community satisfaction with the eventual project, as well as serve to bolster capacity building in the community, so that the end product can be self-sustaining and successful, and engender a sense of community ownership and a source of local pride.

More than half of the VDL sites in Glasgow are in public ownership (572 out of 927 sites), representing approximately 783 out of the 1,300 total hectares of VDL. This means that Glasgow city government could effectively grant highly deprived communities more than 700 hectares of land to be used for community good. This might be urban agriculture in the form of communal gardens (as opposed to individual “allotments”), provided that urban agriculture is appropriate

for that community, as determined by the community itself, and of course using raised bed planting methods in areas likely to have contaminated soil. In New York City, and in other cities around the world, community gardens have proved to be an effective way to get some very positive constructive results without substantial financial outlays, and the health and other benefits of community gardens and urban agriculture have been well-documented (Armstrong 2000; Schukoske 2000; Holland 2004; Ottmann et al. 2010; MacKeen 2011; Ottmann et al. 2012).

Benefits include:

- Improvements in community cohesiveness and neighborliness;
- Increases in healthy food options, especially where highly deprived communities are likely to be “food deserts”;
- Expansion of environmental awareness for children and youths;
- Provision of a strong geographic focal point for community cultural and educational activities;
- Improvements in neighborhood aesthetics;
- Enhancement of property values;
- Reduction in crime rates, due to more “eyes on the street,” increased pride and involvement in the neighborhood by residents, and created constructive opportunities and activities for children and youth;
- Development of community participation in other important issues, and energizing their activities.
- Promotion of community building, capacity building.

Policy and planning recommendations for re-use of VDL by community members or organizations can include such strategies as:

- Creating a database of publicly-owned vacant sites that are accessible from the street, and making this list available to the public;
- Developing a signage program for each of these sites advising community members who to call to discuss community-led use of the site. These could be simple hand-lettered signs, similar to the ones put up on VDL sites in NYC by the non-profit group known as 596 Acres (which refers to the amount of VDL in Brooklyn, NYC) (Leland 2012; 596 Acres 2012).
- Establishing a standard protocol for leasing the land to a community group, and have a small support team within government to help with logistics of community-led use of the vacant land;
- Thinking more flexibly about appropriate uses, whether temporary or permanent. Community uses could be urban agriculture, passive or active recreation spaces, market spaces for weekly “flea” markets or farmers’

markets, and cleaned up natural areas that might connect with other open space networks;

- Allow and facilitate true community planning. Rather than top-down planning for the vacant space, community participation (and even community initiation of the project) at the earliest stages would be more likely to ensure community “buy-in” to the decisions and community involvement in the continued success of the use to which the land is put;
- Consider small grants of money for community-led groups to create containerized gardening on sites that may be contaminated, and that can be moved to another vacant site if the gardening site is eventually required for brownfields remediation and housing development;
- Using the land temporarily for urban forestation projects. These urban forestry plantings could help clean up contamination through phyto-remediation, help restore endangered tree species, and create economic benefit, while leaving land available for future housing development or other community use. Urban forestation can also be a permanent use (Eadha Enterprises 2012).

This research is part of a larger project involving a comparison of Glasgow and New York City (NYC) regarding the relationship between environmental health justice and the built environment. Preliminary findings of the NYC analysis reveal that similar conditions exist regarding the approximate percentage of city land in the vacant and derelict category (4% for Glasgow, and 5% for NYC) and also that the land is disproportionately located in the less-affluent communities in both cities. It is expected that at the end of the comparison study some conclusions can be drawn about best management practices and strategies for use of the VDL, drawing upon what has been found to work in these cities. The environmentally-responsible re-use of vacant land is an important issue for many post-industrial cities, and therefore the findings and recommendations have wide application beyond the two case study cities, especially in those urban areas with severe inequities in economic power, health outcomes, opportunities for healthy active living, and other quality of life concerns.

As in Glasgow, much of New York City’s vacant land is located in the poorer neighborhoods. A major issue in NYC with re-use of vacant and derelict land for development is the displacement of poor people through gentrification. Ironically, this has often occurred in areas where community gardens have improved property values, enhanced neighborhood aesthetics, and reduced crime rates sufficiently to interest developers in investing in the neighborhood, whereby the community rightfully feels as though their hard work has sown the seeds of their own destruction (Smith and DeFilippis 1999; Von Hassel 2002). Policies

must be in place for community-led improvements in vacant and derelict land to benefit the community and not punish them.

Actively promoting the re-use of vacant and derelict land in high deprivation areas with vulnerable populations will have long-term beneficial use to the residents, and is an important step in combating health inequities and environmental injustice in these communities.

“[A] society that allows such a pattern of coincidence [between poor populations and poor environment] to persist has failed to equally protect its citizens. This failure, itself, constitutes an environmental injustice. Whether the result of...putting economic profits over the health of people, or benign neglect, this disproportionate risk can and does lead to disastrous results,” (White 1998:75).

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