

A Framework for Developing Environmental Justice Indicators

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Abstract: Environmental justice (EJ) is a broad discipline that attempts to understand and redress unfair exposure to unhealthy environmental conditions. EJ is often made measurable with indicators, however the capabilities and the limitations of EJ indicators can be difficult for policy makers to understand. Using an exploratory review of EJ literature, this paper performs a research translation role by clarifying the key terms used to describe EJ indicators and by providing conceptual frameworks for developing locally valid EJ indicators for government and community. Issues such as the position of EJ in the context of the social determinants of health, indicator development, and definitions are explored. The exploratory literature review highlighted the potential and limitations of EJ indicators for measuring the extent and impact of EJ issues on human health and the environment. We found that EJ indicators are invariably (1) composed of two or more measures, and (2) developed iteratively, in consultation with those affected. To aid governments and communities, we present both a top-down and a bottom-up framework for developing EJ indicators, with the bottom-up framework guiding the combination of measures from four different core elements; environment, demography, epidemiology and procedures. A list of evidence-based example measures, from the literature, for developing EJ indicators is also provided. It is anticipated that the frameworks and list of EJ example measures will provide guidance for efficiently developing locally relevant EJ indicators.

Keywords: environmental justice; indicators; social determinants of health; distributional justice; correlational epidemiology; procedural justice; restorative justice; lead and lag; validity; reliability



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1. Introduction

The discipline of environmental justice (EJ) focusses on the distribution of environmental ‘bads’—particularly pollution—because of their harmful effects on human health. The discipline has long recognised that inequities in exposure to pollution are avoidable and has called on governments and agencies to redress inequities through policy and planning. However, this focus of EJ is changing with growing understanding that it is the full scope of conditions in humans’ environments that affects health [1]. A broader and arguably more holistic definition of EJ uses the same approach to understand and redress inequities in urban issues that, while outside the terms of reference of environmental protection agencies, are nevertheless within the capacity of governments to address [2–4].

Inherent in definitions of EJ are two core components: environments and people. However, within this broad scope is a wide range of terminology and concepts for understanding how exposure to different harmful environments impacts health. For example, within the EJ literature, the term justice is usually used to mean equity (c.f. [5]), giving most EJ literature an ethical, rather than a legal framing. Despite this, broader definitions of EJ do include the extent of voice and protection afforded to minority groups through legal and political systems and this is known as *procedural justice* [6–9]. Consistent with its broad scope, other sub-disciplines of EJ are *distributional justice*, *correlational epidemiology*, and *restorative justice*, the last of which is itself a relatively narrow sub-discipline of *procedural justice* that deals with the redress of illegal or unethical inequalities in exposure to

pollution [10]. Each one draws upon different kinds of evidence to understand a facet of EJ so that policies or government agencies can respond accordingly. Despite their importance, these terms are not always defined.

Environmental justice is often measured with indicators. An indicator is a phenomenon of community concern defined to a point where it is quantifiable and measurable [11]. In this paper, ‘measure’ is used to denote a single dataset, that could be objective or subjective, whereas ‘indicators’ are “signs or signals that relay a complex message, from potentially numerous sources (or measures), in a simple and useful manner” (p. 49, [12]). In environment and public health planning, an indicator typically quantifies an issue of concern in a simplified way, tracks its change over time, and is used to inform decision-making [13]. In essence, EJ indicators move EJ issues from the abstract to the specific and quantifiable. However, even when using indicators, some terminology is often used without complete explanation, as is the case with lead and lag indicators, which represent either forward looking or historical information [11,12].

Indicators are often used in health planning to prioritise issues for action, to evaluate the success of policy and, less appropriately (because they do not, in isolation, show what works [14,15]), to decide what to do to improve health or equity [13,16]. In contrast with indicators from other fields which often contain only one measure, an EJ indicator must, by definition, incorporate measures from two or more fields; most commonly, one or more demographic measures, usually as the independent variable, analysed against a measure of environmental condition as the dependent variable [17]. Indeed, in most cases, it is only by combining measures in this way that indicators capable of detecting existing or potential environmental injustice are created. Consequentially, while the term *environmental justice* is widely used, it is invariably defined and measured using locally specific indicators made up of context-specific measures (which may be objective or subjective) that are especially designed to answer an EJ question of interest to a specific community.

Aims

The discipline and terminologies of EJ are multifaceted. Similarly, while there is very well-developed scientific literature that uses EJ indicators, the potential of indicators; their power but also their limitations, can be challenging for government decision-makers and communities to understand. The aim of this paper is twofold. First, to consolidate what is known about EJ indicators to create clarity for those who wish to use them to inform decision making for improved health equity. Secondly, to conceptually and practically advance the use of EJ indicators through the use of frameworks for their creation. Specifically, in this paper we aim to:

1. Place EJ within the broader social determinants of health model;
2. Provide definitions of distributive justice, correlational epidemiology, procedural justice, restorative justice, and lead and lag indicators;
3. Provide guidance on methods for moving environmental justice from the theoretical to the measurable using frameworks that assist local governments, state government agencies and community groups to construct locally valid indicators; and
4. Provide a list of example measures from EJ and other literature that can be used to design locally valid indicators of environmental justice.

2. Definitions and Scope of Environmental Justice

In this section, three important aspects of EJ indicators are covered. The first of these is the conceptual convergence of EJ into an understanding of the broader social determinants of health and the opportunities for health equity that this presents. The second is an exploration of the sub-disciplines of EJ, and the roles that indicators of various types can play in improving health equity. The third is explanations of lead and lag indicators and of their potential in decision making intended to improve health equity.

2.1. Environmental Justice within a Broader Understanding of Social Determinants

Health is determined by the entire ecology of the places we live; the natural, built, social and economic environments in which we are born, live, learn, work, play and age [1,18]. This is exemplified by studies showing that a person's post code is a powerful predictor of their health [19]. The environments in which we live are the *upstream* causes of health [20], with poorer conditions coinciding with and exacerbating poorer health [21]. *Big data* from epidemiology and demographics have increased certainty about the relationships between environment and health [22]. They show that, while the relationships are complex [23], at the population level, health exhibits a social gradient: people who have more resources live in the most health promoting environments, which results in better health outcomes [24–28]. The social gradient is illustrated at the global scale by the *Preston Curve*. It shows that on average, individuals born in richer countries live longer than those born in poorer countries [29]. Illustrating this, urbanisation means that increasingly, human ecologies are designed and built [30,31], but in ways that result in inequitable distributions of health-giving or *salutogenic* environments [21,32] that contain for example, public open space, healthy food and affordable housing [2]. Marmot and Bell state that such inequities are avoidable because they “are the result of political choice” (p. 1171, [33]). These ideas are encapsulated in what has become known as *the social determinants of health (SDH) model* [18,28], adeptly illustrated by Dahlgren and Whitehead [1]. The literature includes several SDH frameworks, including The Commission for Social Determinants of Health's *conceptual framework* that covers the entire human ecology [34], and Barton and Grant's [35] *Health Map for the Local Human Habitat* that focuses specifically on the built environment.

In recent years, *liveability* has arisen as an ideal for which cities should strive and is used for city promotion on the international stage [36]. Yet definitions of liveability are inconsistent. Some emphasize city image and global economic competitiveness and others, determinants of health equity [37]. To bring some clarity to *liveability* as well as a social justice perspective that is missing from many conceptualizations of the term, Lowe et al. examined how it has been defined and measured in peer reviewed literature. They found that a liveable place, irrespective of its global location, is one that is,

safe, attractive, socially cohesive and inclusive, and environmentally sustainable; with affordable and diverse housing linked by convenient public transport, walking and cycling infrastructure to employment, education, public open space, local shops, health and community services, and leisure and cultural opportunities [38].

The qualities of liveability in this evidence-based definition are consistent with the social determinants of health model. They can be used as an important part of the definition of environmental justice, one that is supported by the broader literature and that extends beyond exposure to pollution—or negative environmental conditions—to include opportunities to be healthy provided by the built environment; positive environmental conditions. Including indicators of liveability in the broader discipline of EJ is a way of acknowledging that it is not just pollution, but humans' entire ecology [34], that determines their health [39]. Figure 1 shows how such issues (usually framed positively) can complement traditional, negative pollution-related EJ issues to facilitate the creation of a more holistic definition of EJ. The majority of EJ issues, because they are socially determined, could be redressed by political and/or policy decisions. Environmental injustice is therefore very much avoidable [33].

As is the case for the more traditional EJ indicators, poor liveability—measured with indicators such as those described above—generally correlates with certain demographics. For example, minority groups that are already disadvantaged are more likely to live in areas with environmental bads, amplifying existing disadvantage [23]. Liveability also interacts with negative issues such as pollution in complex ways with quality built environments compensating, to an extent, for pollution's negative impacts on health [40]. For example, walkable inner-city areas can have poor air quality associated with increased traffic compared to outer areas that are less walkable but have better air quality [41].

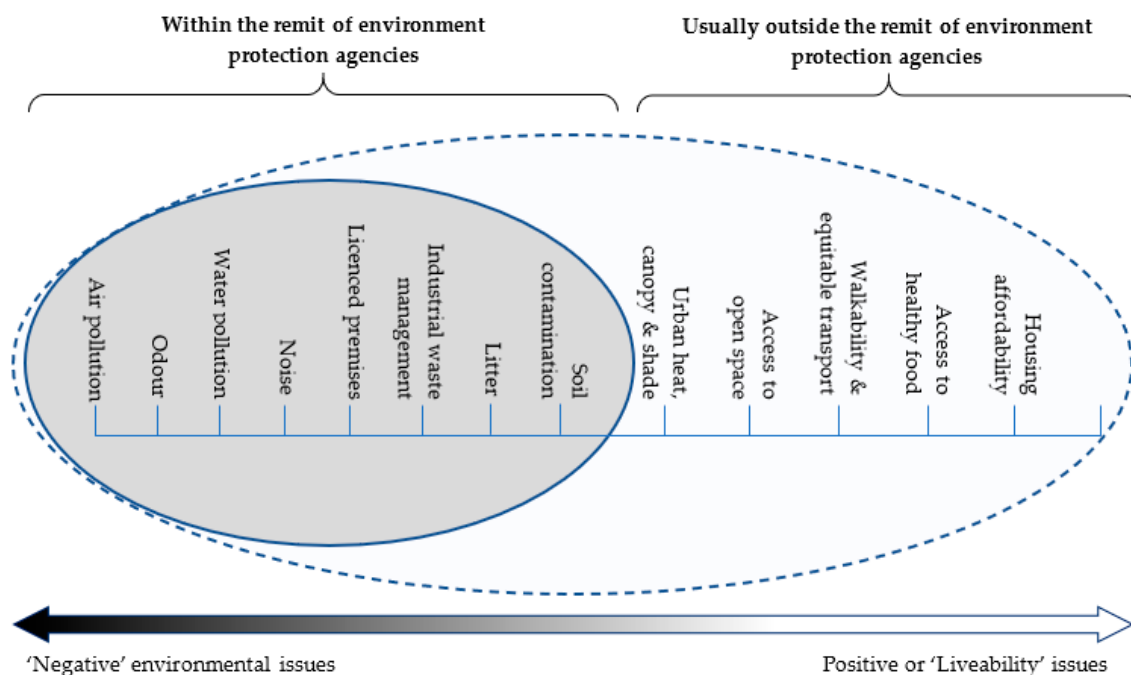


Figure 1. Environmental justice issues occur on a continuum and can be thought of as negative, e.g., pollution-related (to the left), or more positive, e.g., issues associated with liveability (to the right).

Despite a clear link between EJ and liveability, the social determinants model is not often explicitly acknowledged in empirical EJ literature, or if it is, *social determinants* is sometimes considered to be a separate concept see [42]. This may be due to EJ originating in the civil rights and environment movements [43], whereas the concept of social determinants has evolved out of ‘the new public health’ [18,44]. Another possible explanation is that EJ campaigns are often conducted in response to quite local issues, with empirical EJ studies generally examining inequitable exposure of specific communities at the low end of the social gradient and to one or two negative factors [2,3]. In contrast, the social determinants model considers such issues in the context of the whole raft of factors that inevitably affect populations differentially. Despite the public health and environment/civil rights movements apparent siloing, the links between them should be emphasised in situations when doing so can improve communication between practitioners that is important for creating healthier environments.

2.2. Key Definitions in Environmental Justice

Several different terms, that denote or often align with sub-disciplines within EJ, are used in the literature. Understanding the meaning of these terms, and how the concepts therein relate to each other and the broader discipline of EJ is foundational for understanding the multi-dimensionality of EJ issues, for making best use of the potential of indicators, and for developing appropriate policy responses. Chief among the terms are *distributional justice*, *correlational epidemiology*, *procedural justice* and *restorative justice*. The terms *lead* and *lag*, with reference to indicators, are also used. The following sections define these terms.

2.3. Terms That Denote Sub-Disciplines within EJ

Distributive injustice is the social patterning of unfair and avoidable exposure to industrial pollutants [45] and arguably stands at the core of the EJ discipline. Studies of distributional environmental justice generally use lead indicators, i.e., those that identify inequitable risk before poor health manifests, to look at the relationship between socioeconomic status (as independent variables) and pollutant levels (as dependent variables). In the literature, most indicators of environmental justice do this by analysing demographic

and environmental data together at a range of spatial scales to detect inequitable exposure to pollution or inadequate access to healthy environments.

The literature on *distributive injustice* covers diverse environment issues such as contaminated sites [46], noise [47], diffuse/ambient air pollutants [48], soil contamination [49], contaminated drinking water [50], hydrocarbon extraction or *fracking* (c.f. [51,52]), and floods [53]. As indicated above, *distributive justice* is also used in reference to access to housing [54] and other liveability issues, such as green open space [55,56], and beach access for recreational use [57], demonstrating that the concept is equally applicable to both environmental bads (such as pollution) and goods or salutogenic /liveable environments [58].

A wide range of demographic measures is used to characterise disadvantage (See Supplementary Materials for examples). Examples are age [59], education [60], gender [61], employment [62], economic resources [63], household income [60], English proficiency [17], Indigeneity [64], racial characteristics [50], students' eligibility for free meals [65] (US), marital status [66], indices of relative disadvantage [67] and multi-factor deprivation indices [68]. Occasionally behavioural epidemiology such as smoking or alcohol consumption is used as a proxy for disadvantage [69].

Various geographic scales are used in *distributive injustice* indicators. They include SA1, SA2 (≈ 400 and $\approx 10,000$ persons, respectively (Australia) [70]) Census block ($0\text{--}\approx 400$ people) and Census block group (≈ 600 to ≈ 3000 people) [71], school location [47], playground location [49], community water system area [50], a 200-metre grid (France) [72], and Intermediate geography zone (IGZ; $\approx 2500\text{--}\approx 6000$ people) [73] or local authority district (LAD; $\approx 2,300\text{--}\approx 1.1$ million people; UK) [66]. In general, studies show that people with more exposure to industrial pollution have lower socio-economic status. Strictly speaking, indicators of *distributive injustice* do not include measures of health. This can be because epidemiological data that are relevant to environmental equity issues are difficult to obtain cf. [7]. Where epidemiological data are available, combining them with demographic and environmental data evolves the indicator beyond one of simple distributive justice. This specializes the indicator, making it more powerful for examining the site or problem under investigation, since it relates to both the environment and the health of the people being affected by the pollution or EJ issue.

A second sub-discipline of EJ, referred to here as *correlational epidemiology*, is the identification of relationships between land uses and health. Studies of correlational epidemiology generally use lag indicators, i.e., those that identify reduced health and wellbeing in communities attributed to pollution, to identify whether there is a relationship (a *spatial coincidence* [2]) between land uses, particularly those assumed (or understood, from other studies) to be a health risk and indicators of health. These studies measure pollutants or refer to existing evidence to infer risk (e.g., 'coalfield communities' [66]). EJ indicators of this type use land-use, e.g., the location of industrial facilities, as independent variables and the incidence of disease as the dependent variable. They can sensitise decision-makers to likely equity issues, but, as with distributional justice, inequities in health can be further teased out when an additional element, in this case demography, is also factored in.

A third type, *procedural (environmental) justice*, describes processes [58], especially equitable access and use of procedures for preventing or redressing distributive injustices. Maantay [5] states that indicators of procedural justice also have the capacity to build organisational reputation through transparent disclosure and accountability. Issues of *procedural justice* include disparities (e.g., between demographic groups) in the inspection rates of potentially polluting facilities or in the enforcement of environmental regulations [46,74]. A further subset of procedural EJ is *restorative or corrective justice*, which Kuehn describes as actions that seek to redress illegal or unethical inequalities in, for example, exposure to pollution [10]. Studies of procedural EJ generally look at whether processes such as emission standards (and their enforcement), inspection regimes, timeliness of response to complaints and community consultation are provided equitably (see for example [75,76]). Consistent with the principle that "what we measure affects what we do" (p. 7, [77]), indicators of procedural justice have the capacity to attune policymakers to inadequacies in, for example,

fair investment into EJ issues, provided a demographic measure is included. For example, the simple (non EJ) indicator, ‘time to respond to community-reported pollution complaints’ does not measure procedural EJ because it includes no information about demographic differences [78,79].

Most of the empirical EJ literature falls into the category of *distributional environmental justice* and such studies are often published in scientific journals. However, Todd and Zografos [80] state that community environmental activists give greater weight to *procedural environmental justice* because the community is generally more interested in the redress of known injustices (or *restorative justice*) than it is in identifying existing injustice. Articles on *procedural justice* are typically found in social science and legal journals and tend to be more qualitative in their methods and approach.

2.4. Lead and Lag Indicators

Environmental justice indicators can also be broadly divided into *lead* and *lag* indicators. *Lead indicators* differentiate early warning indicators of inequitable risk before poor health manifests from *lag indicators* that detect health inequities that have occurred as a result of inequitable exposure to pollution or unhealthy built environments. The terms are not commonly used in the EJ literature but can nevertheless be useful for communicating, with professionals from industrial health and safety and business—disciplines which use the terms often [81,82]—indicators’ temporal relationships with each other and with the issue under investigation. In EJ, *lead indicators* often measure distributive justice. Examples of environmental measures in lead indicators are the location of polluting industries [17] and plume sites [83], releases of toxic chemicals [84], noise [85], soil contamination [73], nitrite levels in drinking water [50], location of coalfields (UK) [66] and diffuse air pollution [65] (See Supplementary Materials).

Liveability measures such as social, economic and built environment factors can also be used to create effective lead indicators. They have the capacity to alert decision-makers about the areas of a city that provide fewer opportunities to be healthy, before poor health manifests. In contrast, *lag indicators* identify reduced health and wellbeing in communities, usually as a result of pollution. Additionally, with the inclusion of liveability in EJ, issues such as chronic disease linked to, for example, poor walkability could also be considered lag indicators. Thus, lag EJ indicators include measures of epidemiology, demographics and occasionally, exposure [86,87] and example epidemiology measures in lag indicators are cancer incidence (US) [88], mortality (Australia) [89] and respiratory cases (UK) [73].

3. Developing Indicators; Top Down or Bottom Up

The most valid (i.e., relevant and useful, defined below) and effective indicators are developed consultatively and are relevant to community partners. The involvement of those who are closest to the issue, will be collecting data, and/or using the indicators to inform decision-making, is vital. The word *selection* is frequently used in regard to indicators (for example, in *indicator selection criteria* [90,91]). However, *indicator selection* can be misleading as it implies that a valid indicator can be easily chosen from a pre-existing list of candidate indicators. While there are certainly many measures that are common to environment indicators, there is a low likelihood that a fully formed indicator, selected from a repertoire of indicators, would be sufficiently valid for understanding a local issue. This is even more the case for an EJ indicator which must necessarily incorporate two or more context- and issue-relevant measures (most commonly a demographic measure and an environmental measure) if it is to successfully elicit useful information about an issue. Therefore, rather than *selecting* an indicator, it is perhaps more accurate to think in terms of *creating* an indicator. Consistent with this distinction, the creation of environmental justice indicators can be thought of in two ways; *top-down* and *bottom-up*. While the frameworks are presented separately, they are not exclusive: ways of thinking from both can be used to inform each occasion that EJ indicators need to be developed. The frameworks are detailed below.

3.1. Top-Down: From Concepts, to Issues, to Indicators

A *top-down* approach to the development of EJ indicators occurs when *environmental justice* is successively defined to the point where it becomes measurable. The top-down approach is useful for ensuring that all possible issues of environmental injustice are detected and may be of interest to a local government or an environmental protection agency that needs to establish and demonstrate that it has oversight of EJ issues in its jurisdiction and is monitoring them. Figure 2 illustrates how a hypothetical indicator might be developed using an increasingly focused, top-down approach, moving from the broad and loosely defined concept, into something specific and measurable. The figure illustrates this with the example of coal seam gas (CSG) extraction; or *fracking*, as it affects Aboriginal Australians. The figure also shows that other divergent refinements can be thought of as branching off to result in indicators that measure quite different aspects of EJ.

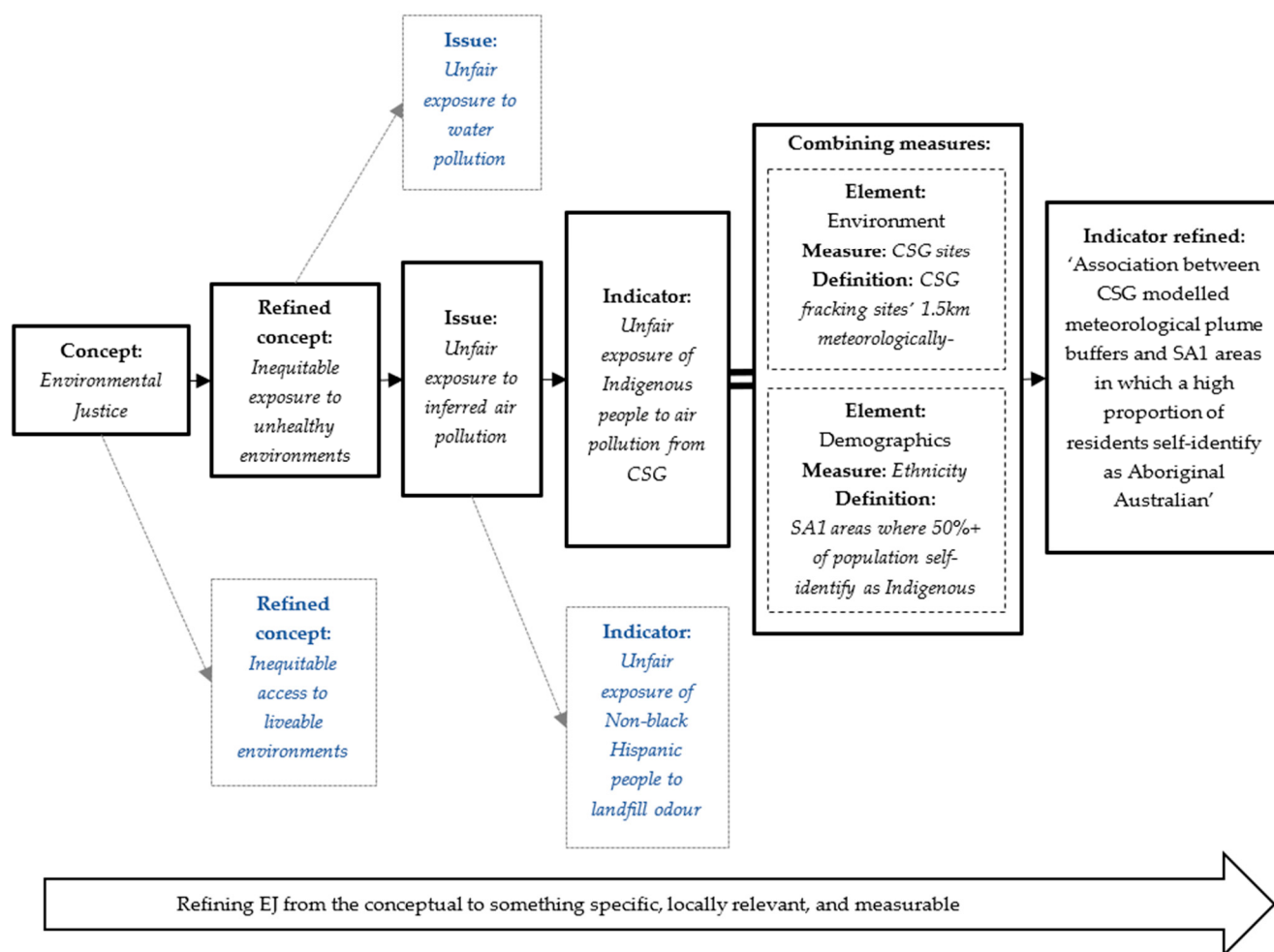


Figure 2. A hypothetical example of how the concept *environmental justice* is moved from the abstract to a locally specific and measurable indicator.

When developing indicators using a top-down approach, careful consideration of data availability, and of the cost implications of sustained monitoring are needed. The approach demonstrates that conceptual refinement (rather than *selection*) is likely to provide the most useful indicators. Nevertheless, when moving from the broad to the specific, useful indicators can often be created using existing datasets combined in new ways. In other cases, datasets capable of quantifying the elements of interest may not exist, and so new data collection protocols and monitoring programs will need to be established.

3.2. Bottom-Up: A Framework for Environmental Justice Indicators

A top-down approach might be useful for surveilling (e.g., by a government monitoring agency) a region for possible environmental injustices. However, the diversity of EJ indicators used in the literature suggests that it is more common, and practical, for indicators to be developed from the bottom-up, in response to known or suspected issues, and to answer the questions of specific audiences. In a bottom-up approach, a consultative process of problem definition to determine the exact nature of the issue of concern [92], and therefore which measures should be combined to form the indicator, is used. Thus, a context driven, locally relevant expression of EJ is created. This requires careful consideration of the nature of the issue itself (i.e., problem definition), of existing and new data sources, and of analysis capabilities.

To facilitate the bottom-up approach, Figure 3 shows how constituent measures can be grouped into a theoretical framework of four broad elements. Consistent with the OECD (2008) regarding theoretical frameworks, Figure 3 shows that the elements can be combined to create environmental justice indicators for different purposes. In the upper left, the framework includes both harmful (e.g., pollution) and salutogenic (e.g., liveability) issues under the core element, *Environment*. The framework is also founded in the idea that an understanding of equity, enabled through demography, is foundational to the issue of environmental justice, and places *Demographic* measures lower left. Next, because the health of communities is important for understanding many (but not all) environmental justice issues, *Epidemiology* is included upper right. Finally, *Procedures* are included lower right because they are important for creating indicators capable of measuring procedural justice (See Figure 3). Alongside the framework, the Supplementary Materials lists measures from the literature that have been used to define and quantify the elements. The framework can thus be thought of as a recipe for creating useful environmental justice indicators, while the example measures are a small selection of possible ingredients. The framework emphasises that the most locally valid EJ indicators will be created by combining existing, or newly created measures, rather than *selected*. Several examples are given, and for each, component measures are or could be drawn from existing literature that appear in the Supplementary Materials. Four of the examples—shaded green in Figure 3—are explored in more detail.

Example indicator 1, ‘Variation in exposure to air pollution by SES’, a lead indicator, can be created by analysing, for example, socio-economic status using the *Index of Relative Socio-economic Disadvantage* at SA1 level [93] as the independent variable, against an air pollution measure such as 24h average PM_{2.5} concentrations [94]. Similarly, Indicator 2; ‘Asthma cases by proximity to licensed facilities’, a lag indicator, can be created by analysing, for example, 1.0 km radial buffer around EPA-licensed polluting sites [17] as the independent variable against hospitalization rates per 10,000 residents using hospital discharge data [95] as the dependent variable.

A third example, Indicator 3, combines three measures: asthma from *Epidemiology*, low socio-economic status from *Demographics* and locations of licensed facilities from *Environment*. It is a composite indicator that can identify who is affected and also draw some inferences about why. Composite indicators such as this, especially when they are monitored over time, have the capacity to build evidence and refine knowledge about a specific site-related issue. They can thus move beyond simple correlation to demonstrate causality, where it exists. A fourth example (Indicator 4) is another composite indicator. It would combine data from each of the *Environment*, *Demography* and *Procedures* elements to map the location of facilities for which license breaches were successfully prosecuted, against the socio-economic status of the surrounding area. Such an indicator can detect whether there is equitable provision of legal services to all sectors of the community, or whether service provision favours those who are well-resourced and thus better able to advocate on their own behalf [96]. More refined indicators such as this (i.e., created by analysing three or more datasets together) have the capacity to answer uniquely local EJ questions.

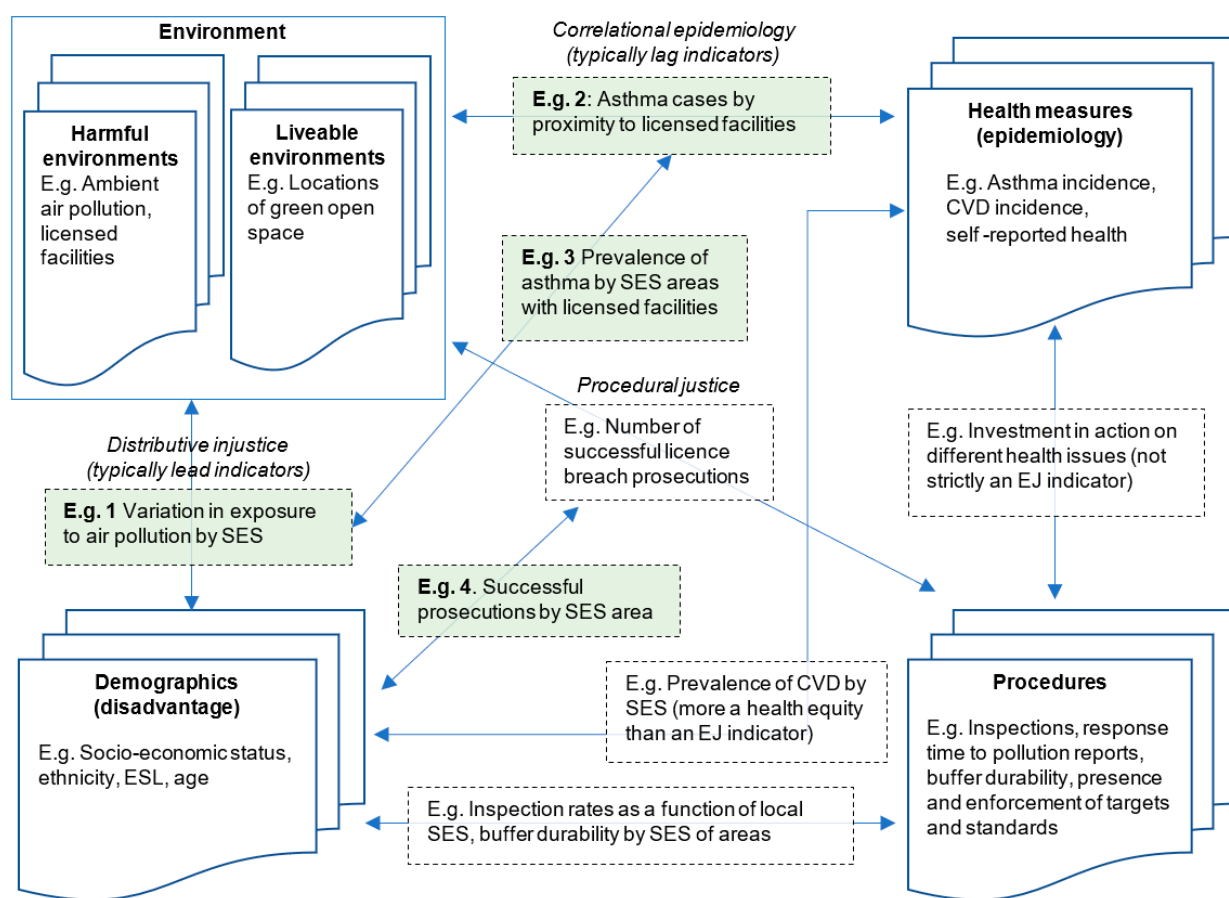


Figure 3. The EJ indicator framework showing the four core elements of EJ. Examples of the ways that the literature has defined each of the four aspects can be found in Supplementary Materials. Some example indicators are shown in dashed-bordered boxes.

3.3. Principles for Building and Using Indicators and Indicator Suites

As with all indicators, to be most useful, EJ indicators must be designed with thought and consultation regarding the knowledge that needs to be created [97]. Both subjective and objective measures may be combined with the resulting indicators of each type thought of as complementary rather than congruent. Regardless of the constituent measures, the analyses that are conducted, or how the data are displayed, it is essential that indicators fulfil their intended purpose and that they use best practice techniques to provide useful information about the issue of concern.

At the most basic level, the data for an indicator must be reliable. This is a relatively straightforward quality meaning that an indicator's constituent measures, regardless of the elements under investigation, must have been constructed using consistent and trustworthy data collection methods [98]. Frequent and longitudinal data collection are essential for EJ indicators. Sustained monitoring using reliable methods at a frequency capable of creating longitudinal data that can detect changes as a result of policy is essential. Additionally, indicators must be valid, meaning they must accurately describe the phenomenon of interest. Validity is a multifaceted quality because that is unique for each indicator. The following qualities, derived from Davern, Gunn [15], and Niemeijer and de Groot [90] are a summary of best practice principles for helping to ensure validity when either selecting existing candidate indicators or designing new ones. Firstly, indicators should measure what they are intended to measure (*construct validity*). This means that clarity about the issue of concern should be created with all stakeholders. Going through the process of refining the issue with stakeholders, e.g., using Figure 3, can assist with this and will also help ensure that the indicator is policy-relevant; able to both inform decision-making and

to detect the effects of policy change. The indicator should also fully represent what it aims to measure (or *content validity*). That is, the indicator should be sensitive to change and be able to detect trends over time. Indicators should also be widely understood, correspond to lived reality and should engage the public, e.g., in their design, monitoring and in policy responses (or *face validity*) [99].

For increased accessibility, the information that indicators elicit should be displayed using appropriate data visualisation (e.g., mapping, charts, or simple infographics such as traffic light systems [5,100,101]). Finally, the power of indicators can be increased when they are used in suites, provided that the indicators therein are complementary, rather than overlapping which unnecessarily increases the monitoring burden.

In addition to the values of reliability, validity and complementarity which are indicator specific, environment protection agencies should monitor sites and industries known to be hyper-polluters, or ‘the worst of the worst’ [102] in terms of pollution. Likewise, environment monitoring should focus on areas of known low socio-economic status as this is a powerful proxy indicator of reduced health and wellbeing due to both negative (e.g., pollution) and absence of positive (i.e., liveability) factors.

4. Conclusions

Globally, significant inequities remain in both exposure to pollution and in access to environments that support health. With evidence suggesting that health equity is at least as important for an efficient and stable society as is a high average level of health [103,104], preventing unequal health outcomes attributable to pollution and poor liveability is vital. A range of indicators about *distributive injustice*, *correlational epidemiology*, *procedural justice* from within the broad discipline of EJ is essential for eliciting different information, detecting the presence of, and enabling a nuanced understanding of EJ issues. However, the capabilities of EJ indicators of various types are not always well-understood, nor are the terms used in the EJ literature always defined. This paper has aimed to define these terms and to offer guidance on the development of suitably valid and reliable indicators of environmental justice.

The paper has shown that useful EJ indicators are invariably made up of at least two measures from a combination of the environment, demography, epidemiology or procedures elements. Furthermore, the way that measures are combined determines the type of EJ indicator that is created, enabling different facets of an issue to be understood.

These foundational principles were then applied in frameworks exploring both the top-down and bottom-up creation of EJ indicators. Alongside the frameworks, example measures (in Supplementary Materials) show the range of ways that the literature has defined and measured the four elements, constituting a short list of possible measures that might be recombined to create new, locally valid indicators.

It is hoped that the frameworks will build indicator literacy amongst those working in the EJ space, including environment protection agencies, local governments and community groups, so that they can quickly develop locally valid indicators for detecting environmental injustices, a first step in redressing such injustices and for creating greater health equity.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/standards2010008/s1>, Table S1: Elements and example measures for building environmental justice indicators. References [17,47,48,50,51,59–65,67–69,73,74,83–85,88,89,93–95,105–157] are cited in the supplementary materials.

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