Title: Developing Sustainability Indicators and Indices

Stephen Morse

Centre for Environmental Strategy,

University of Surrey

Guildford

Surrey GU2 7XH

Telephone +44 (0) 1483 686079

Fax +44 (0) 1483 686671

Email: s.morse@surrey.ac.uk

Abstract

This paper and takes as its starting point the apparent disconnect one sees between the creation and development of Sustainability Indicators and Indices (SIs) and an assessment of their use. Assessing the use of SIs is challenging for a variety of reasons. In this paper the focus was upon the reporting of SIs by newspapers as one means of such assessment. Results suggest that for a group of eighteen SIs there was a statistically significant difference between them in terms of extent of reporting in newspapers, with some (especially footprint-based SIs) being more successful than others. It is argued here that SI developers should take into account the use of their SIs far more than they currently do, as this would help introduce an element of natural selection that should spur SI evolution. A parallel is made with the concept of memes. This process would move SIs away from a development largely driven by more technical concerns towards SIs more attuned to the needs of users.

Keywords: Sustainability Indicators and Indices, Sustainable Development, use, newspapers

Introduction

Sustainability indicators and indices (SIs), where an index is an amalgam of indicators, are translation tools ostensibly designed to help with the practical achievement of sustainable development (Bell and Morse, 2003). They help to simplify complexity so as to provide guidance to those who plan interventions to help make sustainable development a reality (Turnhout et al., 2007). However, this raises many practical challenges that will be very familiar to the readers of this journal, including the basic need for data of the required quality in order to calculate the SI (Turnhout et al., 2007), but technology is moving fast and developments in fields such as remote sensing can provide some grounds for optimism even if there is still much that needs to be done (Trinder, 2008). It is perhaps not surprising that SIs often tend to be heavily contested, and the literature tends to be polarised between those who argue that SIs are indispensable tools and those who suggest that trying to capture something as tenuous as sustainability in simple metrics is untenable (Hinkel, 2011), that they have a low utility for decision making in practice although they can be useful for communication (Preston et al., 2011) and can provide dangerously simplistic visions of the world (Barnett et al., 2008; Klein, 2009). This paper will not attempt to argue the case for SIs one way or the other but will start from the premise that, rightly or wrongly, they exist and are promoted by a number of important groups. The focus instead will be upon the use of SIs.

All SIs have a purpose; they were created with a desire (albeit not necessarily a unanimous one) of trying to help point society in a certain direction. Yet the SI literature is dominated not so much by analyses of purpose and assessments of achievement of that purpose but by the technicalities of SI creation and setting out the rationale for decisions made over what elements to include and how they should be combined and presented. These are typically set out almost as an objective and scientific process, although in reality there can be much more

to this including, of course, the influence of so-called 'political norms' (Rametsteiner et al., 2011). Various researchers have attempted to set out a causal chain between SIs and their use within the policy domain (Lyytimäki et al., 2013), and an example of a taxonomy of use is provided as follows (after Hezri, 2004, 2005; Hezri and Hasan, 2004; Hezri and Dovers, 2006):

- Instrumental: where SIs directly lead to decisions and impacts. This is perhaps the type of SI use that many assume to be the most desirable.
- Conceptual: where SIs catalyse learning and understanding (see, for example, Rydin, 2007 and Turcu, 2013). The use of SIs for communication could also fall under this category although there is some overlap with tactical and political use.
- Tactical: SIs substitute for action and deflect criticism. They may also provide a ritualistic assurance. This is akin to the symbolic use identified by a number of authors such as Gudmundsson (2003) and Eckerberg and Mineur (2003).
- Political: SIs may be used to support a pre-determined position.

The sustained instrumental use of SIs may be difficult to achieve in practice (Preston et al., 2011) and some of the other categories, such as conceptual, are quite subtle and may be hard to detect. However this categorisation is nonetheless a useful reminder that 'use' has many meanings. More recently frameworks have emerged designed to evaluate the utility of SIs, albeit in a more instrumental sense. An example is provided by Ramos and Caeiro (2010), but as yet these SI evaluation frameworks would appear to be under-employed. Indeed much of the existing literature on use of SIs tends to focus on policy and governance contexts, which is perhaps not surprising given that many of the SIs have been designed mainly with policy makers in mind (McCool and Stankey, 2004; Hezri and Dovers, 2006; Turnhout et al., 2007).

Also, there has been the rise in importance of more evidence-based approaches to policy and governance and thus one would expect this group to be more embracing towards SIs as translation tools that help them address what can be very complex issues in sustainable development. The use of SIs by other groups, including civil society, the public and the media, has not been explored to any great extent. This paper therefore addresses these points through the lens of a particular set of SI 'users', namely newspaper journalists.

The media has long been regarded as having an important role in communicating sustainable development within society (Corson, 1995). Holliman (2004) has highlighted the role that newspapers can play in so-called 'scientific citizenship'. Indicators and indices are also widely used by reporters as communication tools (Frønes, 2007). As a result of their popularity amongst journalists there have been some analyses of the reporting of SIs in newspapers. For example, Morse (2011a, 2011b) looked at the reporting the Human Development Index (HDI), Corruption Perception Index (CPI) and Ecological Footprint (EF) in the UK press and concluded that the degree of 'use' of the three indices varied between them and over time. It also varied qualitatively in the sense that journalists used them in different ways; sometimes to provide a validation for a claim (e.g. that corruption may be rife or that development may have improved in a particular country or countries) but also to help provide background context for an article. These uses of SIs by newspapers fit better within the conceptual than instrumental category. However, the study was limited to just three indices and newspaper reporting in the UK. This paper will present the results of a study that extends that analysis to a more global scale and also by covering a larger number of SIs. The question being asked is similar to that asked in Morse (2011a, 2011b) i.e. whether there are differences in reporting between SIs. The focus is again upon the conceptual (communication) use of SIs rather than instrumental use. Assessing the degree of reporting of

SIs can take a number of forms, and one of them is simply to look at the number of articles that mention an SI at least once. This implies examining whether there is evidence that index A is reported in a larger number of articles than index B, and if so why this might be the case. Even if there are differences in the scale of reporting between indices A and B it is possible that the pattern of their reporting over time is similar. For example, both indices could have a gradual increase in article count up to a point and then start declining. What would such patterns indicate? Use of indices by newspaper reporters is, of course, not the same as use by policy makers and managers and the distinction is an important one. While policy makers and indeed the public may be influenced by what they see and hear in the media, and while these groups can also influence the media (Walgrave et al., 2008), this does not necessarily translate into a policy 'use' of SIs. Hence media reporting of SIs equates to 'use' in a very narrow context by just one set of 'consumers', but it is nonetheless instructive given that journalists are typically not SI technicians. Indeed journalists may not always have the necessary expertise to report accurately upon some of the more scientific aspects of sustainability (Boykoff and Mansfield, 2008). Nonetheless, it seems reasonable to assume that the availability of SIs that allow technical complexity to be condensed into single values could be useful for this group, and that this would help facilitate the communication of important considerations in sustainable development for society as a whole.

Methodology

Newspapers have a number of advantages as research material, given that the articles are archived and can be searched using a number of on-line commercial services. Looking for the reporting of indices via TV and radio is far more challenging as the material is vast and often

not transcribed so as to facilitate searching. The creators of SIs certainly see the media as one 'consumer' of the information encapsulated by the indices. Indeed the launch of indices such as the HDI and EF is often accompanied by media events and 'press packs'.

There are many indices that are published on a regular basis, covering just about every aspect of human endeavour. A review of indices measuring development at a country level is provided by the UNDP (Bandura, 2008). The report lists a total of 178 indices covering various aspects of development spanning economic, social and environmental dimensions. Not all these indices claim to be 'Sustainability Indices', but together they cover the three dimensions of sustainable development. The UNDP report provided the basis for the selection of the sample of SIs (presented as Table 1) employed in this research. The SIs in Table 1 are complex in the sense that they have many components blended together mathematically using a variety of techniques. The Environmental Performance Index (EPI) and its predecessor the Environmental Sustainability Index (ESI) are examples of complex SIs. Others such as the Human Development Index (HDI) are simpler in the sense that they have far fewer components and the arithmetic involved in combining them is less convoluted. The subset was selected based upon a number of criteria. Firstly, only those indices having been published at least10 times since their creation and up until December 2012 were included. The HDI, for example, had been published by the United Nations Development Programme (UNDP) a total of 23 times from 1990 till the end of 2012. Second, SIs were selected that are relevant globally rather than only at the regional scale (e.g. the European Union or the 'Middle East'). However this is a problematic criterion given that some SIs may only be calculated for relatively few countries but cover a topic of much wider relevance. An example is the Commitment to Development Index (CDI) which is only applied to some of the more developed countries but would of course be of interest to many of the less

developed countries as well. Thirdly, all of the selected SIs were created and promoted by major organisations, such as international Non-Governmental Organisations (NGOs) (e.g. World Wide Fund for Nature, Save the Children and Transparency International), publishers (The Economist magazine) and groupings (World Economic Forum) as well as international agencies such as the UNDP. Finally, an attempt was made to select SIs from the Bandura (2008) report that together would span all the dimensions of sustainable development. If one employs the oft-used representation of sustainable development as three overlapping circles, then the SIs in Table 1 can be mapped onto that representation as shown in Figure 1. While some of the dimensions in Figure 1 have more SIs than others an attempt was made to have as wide a spread as possible across the three dimensions of sustainable development.

<Table 1 near here>

<Figure 1 near here>

It is true that few of the SIs occupy the middle ground of Figure 1 and it is also true that most of them rest firmly within one of the three circles rather than at the overlapping spaces. The only significant omission is in the overlapping space between economics and the environment although the Genuine Progress Indicator (GPI) does address that in part.

The number of articles reporting each of the SIs in Table 1 up until December 2012 was found using the subscription-based Nexis database and search tools available via LexisNexis (internationalsales.lexisnexis.com/english-is/home.page). The sources selected were 'All news, All languages' and at the time of the search this spanned a total of 6,760 publications in the following languages; Arabic, Danish, Dutch, English, Finnish, French, German, Italian, Malay, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish and Turkish. The

newspapers included in the sample of 6,760 titles span the globe and are not restricted to Europe and North America. No adjustment was made to allow for differences in the extent of readership. It should be noted that even in non-English publications an SI is often reported using its English name. However this may not always be the case and hence the search returns using the Nexis database are likely to be an underestimation. For each year the Nexis database was used to provide the number of articles per newspaper referring to the SI at least once, while other categories of print media such as magazines and trade journals were not included. Hence the definition of a 'newspaper' was that employed within the Nexis database.

The data were analysed via the use of the General Linear Modelling (GLM) approach to Analysis of Variance (ANOVA) as well as via the use of correlation coefficients. In both cases the data were transformed by taking Logarithm (base e) of the article count/year plus one ($z = LN(x + 1)$). ANOVA was used to check for differences in the number of articles published each year for each index. The 'time' variable was addressed by allocating a number for each year beginning with 1 in the year when the index was first reported by newspapers. For example, with the HDI the year 1990 was given the code 1, 1991 was coded as 2 and so on up until 2012. ANOVA showed whether there were significant differences between the SIs and in the reporting of a given index over time. Mean separation was employed in order to identify those SIs that differed significantly from others. Mean separation after the ANOVA was conducted using the Bonferroni Simultaneous Test. The Bonferroni method is one of the more conservative approaches to mean separation that helps to minimise 'false positives' when making many comparisons. 'False positives' denote situations when a mean separation appears to identify a statistically significant difference between two SIs when it does not exist. However, its conservative nature can create 'false

negatives'; i.e. suggest that two SIs are not significantly different while in fact they may be. Given that the analysis involved eighteen SIs it was decided to err on the side of being conservative. The means were also compared using the Dunnettt and Turkey tests and the results produced groupings identical to that of the Bonferroni test.

While ANOVA and mean separation were employed to look for differences in reporting between the SIs, other methods were needed to check whether the pattern in reporting of the SIs was similar over time. Two SIs may be statistically different in terms of the number of articles published per year but have a similar pattern of change over time (e.g. increase to a peak before declining). Correlation coefficients were therefore used in order to compare the SIs in terms of the patterns of change in article count/year over time.

The aim with these analyses was not to look for differences in reporting of the SIs across countries or between types of newspaper. The latter could include the frequency of newspaper publication (daily, weekly etc.), circulation and its political leaning. These would no doubt be interesting questions to pursue in future research, but here the aim was only to look for differences in reporting between the SIs

Results

The average count of newspaper articles mentioning a given index at least once is presented in Table 1 along with the first year the index was reported by the newspapers and the number of years it was reported by newspapers up to December 2012. From these data it can be seen that the range of reporting is very wide indeed. At one end of the scale there is one SI

reported in less than five articles on average per year - the Gender related Development Index (GDI) – while at the other end of the scale the Carbon Footprint (CF) has an average annual article count much higher than any of the other indices; indeed the average is in the thousands per annum and is higher than the averages for all of the other SIs combined. Interestingly, the Ecological Footprint (EF) also ranks high on the list, just behind the HDI.

The results of an ANOVA on the transformed article count data are shown in Table 2. Both 'Time' and 'Index' are statistically significant ($P<0.001$) suggesting that transformed ($z = LN(x + 1)$) article count/annum does vary over time and between the SIs. The results of a mean separation test (Bonferroni Simultaneous Test) are shown in Table 3. On the basis of the transformed article count data, SIs can be classified into three distinct groups:

1. CF
2. HDI, CPI, EF and the Press Freedom Index (PFI)
3. Others

<Tables 2 and 3 near here>

The average count of newspaper articles published per year is but one aspect of reporting of indices and the picture presented in Tables 1 to 3 is admittedly rather a static one. Also of importance is the pattern of reporting of the SIs over time. Figure 2 shows the pattern of reporting over time for each of the indices in Table 1 divided in terms of 'environment', 'community' and 'economy' to help make the patterns more digestible for the reader. In order to fit the SIs onto the same graph the article counts per year were transformed using logarithms ($z = LN (x + 1)$). It is readily apparent that there are differences in the pattern of

reporting of the SIs over time, with some such as the footprint indices, HDI and CPI having a rapid increase in the extent of reporting while the reporting of others (GDI, MI etc.) remained more stable over time. Interpretation of these patterns is challenging given that the newspaper industry is also in a state of flux. New titles emerge while old ones disappear, formats change (including length) as do ownership structures, hence potentially influencing the editorial line of the newspaper. However, while acknowledging these factors and also that the newspaper industry is in a crisis (Boczkowski, 2012), the differences in the trend of reporting between the indices nonetheless appear as significant.

<Figure 2 near here>

In order to provide a more statistically-based comparison of the patterns over time seen for the SIs in Figure 2 the yearly counts (after transformation using logarithms) were compared using correlation coefficients. The results are shown in Table 4. A statistical significance in this table (cells with shading) means that the compared SIs exhibit a similar pattern of reporting over their lifetime. The analysis shows that one group containing nine SIs (BMI, CF, CPI, EF, EPI, GCI, HI, HDI and PFI) stands out as having a similar pattern of reporting over time. There are a few other interesting groupings , such as for the two gender-based SIs GEM and GDI which have a correlation coefficient of 0.6 ($P<0.01$), but this 'group of nine' SIs dominates the pattern in Table 4; out of the 38 statistically significant correlation coefficients 32 are between the SIs in the 'group of nine'. Each of these nine SIs has a pattern of an increase in reporting over time, sometimes followed by a levelling off (BMI, CPI, CF, EF, HDI,) while others (HI, PFI) continue to increase in reporting up until December 2012.

<Table 4 near here>

Discussion

The research reported here explores 'use' of SIs in a very narrow sense of press reporting. Assessing the newspaper reporting of an SI is not the same as assessing its use in policy or other interventions, and neither does it cover the influence that such reporting might have on the readership. However, even this limited assessment of use through the analysis of a sample of eighteen SIs reveals some interesting findings.

The apparent popularity of the two footprint indices, but especially that of the CF, is intriguing. While they share a similar title the two 'footprint' indices differ from each other quite considerably. Perhaps the most widespread version of the EF (that of the WWF) is the bioproductive land area required (in 'global hectares'; gha) per person in a country. The EF is calculated by summing 'footprints' for six components of consumption: crop land, grazing land, forest land, fishing, built-up land and carbon uptake land. The methodology involved is complex, with many assumptions regarding important variables such as average crop yield and the amount of forest needed to absorb carbon.

The CF is defined as:

"*A measure of the total amount of carbon dioxide (CO_2) and methane (CH_4) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as carbon dioxide equivalent (CO_2e) using the relevant 100-year global warming potential (GWP100).*"

Wright et al. (2011)

The global warming potential is a relative measure of how much heat a gas traps in the atmosphere (relative to a similar mass of CO_2) over a period of time, typically 100 years. Thus CF is a measure of the release of gasses into the atmosphere that have the potential to induce global warming (Pandey et al., 2011), and is also a measure of impact albeit in a way that is quite different to that of the EF. The methodology for the CF is also complex, with assumptions about both the CO_2e release during the use of a product, for example from driving a car, but also the CO_2e that was used to construct the car in the first place (embodied carbon) and what would be used at the end of its life to recycle any components or to dispose of them.

Criticism against both footprint indices has largely centred upon the assumptions underlying the creation of the indices. The interested reader is referred to reviews provided by van den Bergh and Verbruggen (1999, 2000), van Kooten and Bulte (2000), Ferguson (2002), Fiala (2008) and Kitzes and Wackernagel (2009) for the EF and Čuček et al. (2012) for the CF. Johnson (2008) provides a concise illustration of the impacts that changing assumptions can have on estimations of CF of a single product. Both footprint SIs provide highly variable results since many methodologies exist for estimating them (Čuček et al., 2012) and they have been designed for just about every level from the individual up to the nation state. This provides the sort of flexibility in scale of applicability referred to by Dahl (2012) as a positive contributor to the use of SIs.

A number of the SIs discussed here are strongly promoted by some major international agencies and publishing houses. The CF and EF have no single champion although a version of the EF is published on a regular basis by the WWF. The HDI and related indices (GDI,

GEM, HPI) are heavily promoted each year by the UNDP and its chain of country-based offices worldwide, the CPI by Transparency International, the BMI by the Economist and the GCI by the World Economic Forum. The highly varying size, influence and range of these organisations raises the question as to why the two footprint-based indices have proved to be so popular? What features do they have that seem to resonate with journalists in the newspapers that were searched? Both footprint indices may seem like odd 'winners' in the sense that no single version of them exists and neither is 'owned' or promoted by a single and influential agent. Also, both emphasise the environment rather than social or economic aspects of sustainability and arguably this is not the dimension that may be expected to receive the bulk of the attention from reporters. Indeed the lack of expertise amongst the press on more scientific and environmental aspects of sustainability has been noted as an important constraint for engaging the public (Boykoff and Mansfield, 2008). One would perhaps expect that SIs located more within the community and economics 'circles' of Figure 1 would have a greater appeal than the environment-focused indices. Indeed, among the indices included in Table 1 both footprint indices are amongst the most difficult even for a specialist let alone to journalists or the public at large to understand. Many of the other SIs are also complex, of course, but they tend to be collections of indicators that have been pooled together by averaging. Maybe it is the flexibility of the footprint indices in terms of their nature and 'ownership' that makes them so popular. One can estimate them using tools readily available on-line - including the estimation of one's own footprint – whereas this is not possible with most of the other SIs in Table 1. This makes CF and EF personal in a way that the other SIs cannot emulate. All of the other indices relate to nation states, even if in some cases, such as the HDI, some countries have made efforts to create versions that apply at the intra-country level. Also, the very idea of a 'footprint' - of an impact on the Earth that caused by an individual, a household, a city or a country - is an evocative and personal one ,

especially as this impact of consumption on the world evokes greed (Bell and Morse, 2003; page 14). Hence it may be indices most often mentioned in the press are those that capture aspects of human endeavour and existence that resonate with the reporters. There is some resonance here with the 'interpretative flexibility' mentioned by Turnhout (2009) as an important consideration in the effectiveness of indicators in nature conservation policy. Interpretive flexibility is not a characteristic of the SI itself but a social factor which depends on shared values and preferences. Hence the footprint SIs can on the one hand be interpreted as measures of avarice, while others (Newman, 1998) have argued that the EF could be interpreted as a measure of relative success of countries in the international competition for world's resources:

"*For example, we are told that Southampton's Ecological Footprint is 719,044 hectares or 138 times the area of the City and that this implies that it uses '2.33 times its fair share of the earth's productive land' (Southampton Environment Centre, 1998 p1). A person who believed in the concept of competitive capitalism might see this information as an indication of the relative success of the municipality. They might say that it is a sustainable outcome because other less successful cities will have to make do with less of the world's resources. Having worked in the field, I can envisage how the City's Industrial Development Office could use the data to encourage potential inward investors to take advantage of the highly skilled and motivated work force that could produce this result*!" (Newman, 1998)

Hence the EF could in theory be reported in terms of its relationship to both avarice and competitive success. This flexibility could help enhance its resonance with reporters and subsequent presence of the index in newspaper articles.

Indeed one concept that may have some traction here is the notion of a meme, in essence ideas that can be transmitted from one person to another, first expressed by Richard Dawkins in his bestselling book 'The Selfish Gene' published in 1976. He described them as:

"Examples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches. Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation."

Dawkins saw memes as a sort of cultural equivalent metaphor to the physicality of genes, and subject to the same process of natural selection; in effect they are 'cultural replicators'. Just as genes can mutate, then so can new memes emerge, and memes that are popular will, by definition, be selected and hence thrive in a population (Cardoso and Atwell, 2011; Weng et al., 2012). In both cases - genes and memes - if the outcome is an improvement then the new form will increase in terms of frequency. The meme concept has certainly had its critics (McNamara, 2011; Burman, 2012), but given that the use of SIs is influenced by a web of social factors and not just their technical excellence, the concept may have relevance here. If the SIs can be thought of as embodiments of memes (i.e. an empirical representation of ideas in sustainability) then in some cases the ideas they represent are very broad, such as the desire that the press be free (PFI), human development be better (HDI) or women be more empowered (GEM). Indeed sustainable development can be thought of as a meme and all of the SIs in Table 1 capture some aspect of it. There is potentially something of a duality here as the SIs can also help frame an idea, a point made by Rydin (2007). Thus 'human development' can be a rather nebulous concept, even if it is one that is desired, and the HDI

can help frame an understanding of what human development is. The fact that the HDI can also become associated in the eyes of some journalists with other ideas related to human development such as 'quality of life' is interesting. However the HDI is but one measure of human development, even if it is a popular one amongst journalists. Other indices do exist that can capture human development or indeed quality of life, but they have received nothing like the same exposure in the press as that shown for the HDI (Morse, 2011a, 2011b). This returns to the question set at the start of this paper - why are some SIs widely used by newspaper journalists in their reporting while others are not? In turn this raises the question as to whether it is possible to conceptualise a selection pressure for the SIs that are meant to capture ideas in sustainable development?

Indices have evolved over time, and indeed their creators often argue that they must evolve. The HDI has one of the longest histories of all those in Table 1, having been created by the UNDP in the late 1980s and first published by them in 1990 within the Human Development Report (HDR) of that year (Morse, 2013). Updates of the HDI have been published annually (for the most part) since 1990, although it has remained an amalgam of three indicators - income per person, life expectancy and education - all with the same weight (Stapleton and Garrod, 2007). The HDI has never had an environmental component, although some have suggested that it should and the UNDP has in fact experimented with 'green' versions of the HDI (Morse, 2003a; Neumayer, 2012). The decisions on what to include and what to leave out from the HDI have been explained and justified yet these decision nevertheless entail value judgements (Morse, 2003b). The methodology of the HDI has since 1990 changed many times, and these changes have resulted in shifts in the ranking of nation states in the HDI 'league tables' (Morse, 2013). The pressure for these modifications has largely been technical; in essence the HDI 'managers' have responded to criticisms from other SI

specialists, albeit largely in the academic literature, and the details of the changes and why they were made have been set out in the various HDRs published since 1990. An interesting example is provided by the way in which the GDP/capita figures have been adjusted so as to avoid a dominance of this component in the HDI (Morse, 2013). By way of contrast there is no published account to date in any of the HDRs for any change in the HDI that would have been sparked directly by the 'use' of the HDI among its intended 'consumers'. Instead, the changes were primarily driven by technicians seeking to address perceived deficiencies in the HDI and thereby make the index 'better' suited for its purpose.

As happens in evolutionary process in general some indices have also died out entirely. The HPI gave way in 2010 to the Multidimensional Poverty Index (MPI), and the ESI was discontinued in favour of the EPI, although ironically the ESI is the one in the sample of SIs that arguably comes closest to occupying the overlap between all three circles in Figure 1. None of these changes were influenced by an assessment of the respective use of the SIs but were often made for more technical reasons such as availability of up-to-date and/or better quality datasets and changes in the assumptions used to construct the indices (what components to include and how 'best' to combine them). As with SI evolution, the decision to discontinue an index has typically emerged as a result of feedback provided to the SI developer by other experts in the field and the usage of an SI has not had an overt influence. Thus even some of those indices that rank lowest in Table 1 still continue to be updated and promoted. Indeed, one rarely comes across any attempt to methodically assess the use of an SI by its creators. Therefore, to date it can be reasonably surmised that SIs have faced little, if any, selection pressure related to their use.

Given that the key reasons for existence of all the SIs discussed here is to help with a promotion of the ideas they are meant to encapsulate then it may seem odd that little (if any) consideration is given to whether the intended 'consumers' of the information make use of the SIs. There has been some effort to develop frameworks for the evaluation of the use of SIs (Ramos and Caeiro, 2010), but these have not ostensibly fed into the evolution of SIs. Arguably what is needed is a far greater emphasis upon usage of an SI as a selection pressure to help spur development. Just as some memes lose out under such selection pressure so too could some SIs disappear. The difference is that an important idea in sustainability can be represented by a multitude of SIs. The idea may remain popular - greater empowerment of women for example - but perhaps there are better ways of capturing this in an SI than for example GEM, and maybe these new SIs could help make empowerment more likely. Such evolution of SIs might be brutal process, but the outcome should be a better set of indices that resonates with their intended consumers.

But much depends upon answers to important questions about who are the users and why they presumably want the SI. In this paper the focus has been upon just one small, albeit influential, group of users whose use of SIs can be readily assessed, but other approaches could equally well be applied for analysing the use of SIs in policy. These include the Ramos and Caeiro (2010) framework designed to assess the utility of SIs, and, of course, a suite of participatory approaches (Bell and Morse, 2003). However, given the potential benefits from greater attention to the use of SIs as a feed into their evolution, one may ask why this is not already happening. There are probably a number of reasons. In the following I shall provide some tentative hypotheses as a basis for future research on reasons for the lack of emphasis on use as a pressure in SI evolution. Firstly, there may be an innate tendency to maintain a status quo as far as possible. Making changes to SIs is costly, of course, but more importantly

it can render comparisons and tracking progress over time more difficult. This has been a major argument made by the UNDP, for example, for limiting changes to the HDI and explains why UNDP has not produced a 'green' form of the HDI that also includes an environmental component. Secondly, monitoring success of an SI as outlined above would require resources and a number of institutions 'owning' the SIs in Table 1 are NGOs with many demands on their limited resources. Thirdly, there can be a tendency for SIs to become almost an end in themselves; almost a talisman that must be published even if it is not used by anyone to bring about desired change. Also, of course, some people would have invested a lot of resource into an SI and may be loathe to acknowledge failure. There is little doubt that all of the owners of the SIs in Table 1 would dispute these points but it would be interesting to look for evidence of such 'index inertia' and explore why the index managers are resistant to change. Fourthly, there may be a perception amongst the owners of the SIs that they already listen to the voices of potential and actual users of the information and make changes to their indices as a result. Hence, they may argue that their SI has already evolved by taking use into account, and that there would be no need for more detailed analysis. Again, to what extent this really is the case rather than just a defensive claim would be interesting to explore. One suspects that all four of these explanations, and indeed others, may well be at play, but there is clearly a need for much more research. If this helps with the achievement of a more sustainable development then all of society would benefit.

Acknowledgements

The author would like to thank the three anonymous reviewers for their helpful suggestions for improvement of the paper.

References

Bandura, R. (2008). Survey of Composite Indices Measuring Country Performance: 2008 Update. UNDP/ODS Working Paper. Office of Development Studies, United Nations Development Programme, New York.

Barnett, J., Lambert, S.,and Fry, I. (2008). The hazards of indicators: insights from the environmental vulnerability index. *Annals of the Association of American Geographers*, 98(1), 102-119.

Bell S and Morse S (2003). *Measuring sustainability. Learning by doing*. Earthscan: London

Boczkowski PJ (2012). Making sense of the newspaper crisis: A critical assessment of existing research and an agenda for future work. *New Media & Society* 14, 1375-1394

Boykoff M, Mansfield M (2008). 'Ye Olde Hot Aire': reporting on human contributions to climate change in the UK tabloid press. Environmental Research Letters 3(2), Article Number: 024002

Burman, JT (2012). The misunderstanding of memes: Biography of an unscientific object, 1976–1999. *Perspectives on Science* 20(1), 75-104.

Cardoso GC and Atwell JW (2011). Directional cultural change by modification and replacement of memes. *Evolution* 65(1), 295–300

Corson WH (1995). Priorities for a sustainable future: The role of education, the media, and tax reform. *Journal of Social Issues* 51(4): 37–61.

Čuček L, Klemeš JJ and Kravanja Z (2012). A Review of Footprint analysis tools for monitoring impacts on sustainability. *Journal of Cleaner Production* 34, 9–20

Dahl AL (2012). Achievements and gaps in indicators for sustainability. *Ecological Indicators* 17, 14–19

Dawkins, R (1976). The Selfish Gene. Oxford: Oxford University Press.

Eckerberg K and Mineur, E (2003). The use of local sustainability indicators: Case studies in two Swedish municipalities. *Local Environment: The International Journal of Justice and Sustainability* 8(6), 591-614

Fiala, N (2008). Measuring sustainability: Why the ecological footprint is bad economics and bad environmental science. *Ecological Economics* 67(4), 519–525

Frønes I (2007). Theorizing indicators. On indicators, signs and trends. *Social Indicators Research* 83(1), 5-23.

Gudmundsson H (2003). The Policy Use of Environmental Indicators - Learning from Evaluation Research. *The Journal of Transdisciplinary Environmental Studies* 2(2), 1-12.

Herzi, AA (2004). Sustainability indicators system and policy process in Malaysia: a framework for utilisation and learning. *Journal of Environmental Management* 73(4), 357-371.

Hezri AA (2005). Utilisation of sustainability indicators and impact through policy learning in the Malaysian policy processes. *Journal of Environmental Assessment Policy and Management* 7(4), 575-595.

Hezri AA, Hasan MN (2004). Management framework for sustainable development indicators in the state of Selangor, Malaysia. *Ecological Indicators* 4, 287-304.

Hezri AA, Dovers SR (2006). Sustainability indicators, policy and governance: Issues for ecological economics. *Ecological Economics* 60, 86-99.

Hinkel, J. (2011). Indicators of vulnerability and adaptive capacity: Towards a clarification of the science-policy interface. *Global Environmental Change* 21(1), 198-208.

Holliman R (2004). Media coverage of cloning: a study of media content, production and reception. *Public Understanding of Science* 13(2), 107-130

Johnson E (2008). Disagreement over carbon footprints: A comparison of electric and LPG forklifts. *Energy Policy* 36, 1569–1573

Kitzes J and Wackernagel M (2009). Answers to common questions in Ecological Footprint accounting. *Ecological Indicators* 9(4), 812-817

Klein, R J (2009). Identifying countries that are particularly vulnerable to the adverse effects of climate change: an academic or political challenge. *Carbon & Climate Law Review* 3(3), 284–291.

Lyytimäki J, Tapio P, Varho V and Söderman T (2013). The use, non-use and misuse of indicators in sustainability assessment and communication. *International Journal of Sustainable Development & World Ecology* 20(5), 385-393

McCool SF and Stankey GH (2004). Indicators of Sustainability: Challenges and Opportunities at the Interface of Science and Policy. *Environmental Management* 33 294–305

McNamara A (2011). Can We Measure Memes? *Frontiers in Evolutionary Neuroscience* 3:1. doi: 10.3389/fnevo.2011.00001. Available at www.ncbi.nlm.nih.gov/pmc/articles/PMC3118481/

Morse, S (2003a). Greening the United Nation's Human Development Index? *Sustainable Development* 11(4), 183-198

Morse, S (2003b). For better or for worse, till the Human Development Index do as apart? *Ecological Economics* 45(2), 281 - 296.

Morse S (2011a). Harnessing the power of the press with indices. *Ecological Indicators* 11(6), 1681-1688.

Morse S. (2011b). Attracting attention for the cause. The reporting of three indices in the UK national press. *Social Indicators Research* 101(1), 17-35.

Morse S (2013). Bottom rail on top: The shifting sands of sustainable development indicators as tools to assess progress. *Sustainability* 5(6), 2421-2441

Neumayer E (2012). Human development and sustainability. *Journal of Human Development and Capabilities* 13(4), 561-579

Newman, P. (1998). Can sustainability be measured? Accessed on line at www.business.u-net.com/~parkway/resource/measures.html on the 13th September, 2014,

Pandey D, Agrawal M and Pandey JS (2011). Carbon footprint: current methods of estimation. *Environmental Monitoring and Assessment* 178(1-4), 135-160

Preston, B. L., Yuen, E. J., and Westaway, R. M. (2011). Putting vulnerability to climate change on the map: a review of approaches, benefits, and risks. *Sustainability Science* 6(2), 177-202.

Ramos TB and Caeiro S (2010). Meta-performance evaluation of sustainability indicators. *Ecological Indicators* 10(2), 157–166

Rametsteiner E, Pulzl H, Alkan-Olsson J and Frederiksen P (2011). Sustainability indicator development—Science or political negotiation? *Ecological Indicators* 11, 61–70

Rydin Y (2007). Indicators as a governmental technology? The lessons of community-based sustainability indicator projects. *Environment and Planning D: Society and Space* 25 610-624

Stapleton LM and Garrod GD (2007). Keeping things simple: why the Human Development Index should not diverge from its equal weights assumption. *Social Indicators Research* 84(2), 179-188

Trinder JC. (2008). Remote sensing for assessing environmental impacts based on sustainability indicators. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B8. Beijing 2008. Pages 1421-1427

Turcu, C (2013). Re-thinking sustainability indicators: local perspectives of urban sustainability. *Journal of Environmental Planning and Management* 56(5), 695-719

Turnhout E (2009). The effectiveness of boundary objects: the case of ecological indicators. *Science and Public Policy* 36, 403-412

Turnhout E, Hisschemoller M and Eijsackers H (2007). Ecological indicators: Between the two fires of science and policy. *Ecological Indicators* 7, 215–228

van den Bergh JCJM and Verbruggen H (1999). Spatial sustainability, trade and indicators: an evaluation of the 'ecological footprint'. *Ecological Economics* 29(1), 61-72

van den Bergh J and Verbruggen H (2000). An evaluation of the 'ecological footprint': reply to Wackernagel and Ferguson. *Ecological Economics* 31(3), 319-321

van Kooten GC and Bulte EH (2000). The ecological footprint: useful science or politics? *Ecological Economics* 32(3), 385-389

Walgrave S, Soroka S, Nuytemans, M. (2008). The mass media's political agenda-setting power - A longitudinal analysis of media, Parliament, and government in Belgium (1993 to 2000). *Comparative Political Studies* 41(6), 814-836

Weng, L., Flammini, A., Vespignani, A.and Menczer, F. (2012). Competition among memes in a world with limited attention. *Scientific Reports* 2, 335; DOI:10.1038/srep00335

Wright, L., Kemp, S. and Williams, I. (2011). Carbon footprinting: Towards a universally accepted definition. *Carbon Management* 2 (1), 61-72

Table 1. The list of Sustainability Indices included in the analysis.

Index	Acronym	Article count/year Mean (SD)	Starting year	Number of years reported
Carbon Footprint	CF	5541.83 (5833.28)	2001	12
Human Development Index	HDI	221.48 (283.64)	1990	23
Ecological Footprint	EF	216.9 (252.82)	1993	20
Corruption Perception Index	CPI	177.24 (200.99)	1996	17
Press Freedom Index	PFI	56.73 (50.99)	2002	11
Happiness Index	HI	54.50 (96.22)	1987	26
Global Competitiveness Index	GCI	48.82 (70.6)	1996	17
Big Mac Index	BMI	35.44 (32.3)	1988	25
Bribe Payers Index	BPI	16.50 (15.78)	1999	14
Living Planet Index	LPI	15.40 (28.56)	1998	15
Environmental Performance Index	EPI	14.53 (22.22)	1996	17
Genuine Progress Index	GPI	13.16 (6.77)	1994	19
Human Poverty Index	HPI	11.69 (8.75)	1997	16
Commitment to Development Index	CDI	10.10 (10.56)	2003	10
Mothers Index	MI	8.25 (4.9)	2001	12
Environmental Sustainability Index	ESI	7.92 (8.75)	2000	13
Gender Empowerment Measure	GEM	5.78 (5.61)	1995	18
Gender related Development Index	GDI	3.78 (4.88)	1995	18

Notes: Number of years reported refers to the period from the first year of reporting (starting year) in newspapers up until December 2012.

Table 2. Results of a General Linear Model analysis of variance applied to the transformed article count/year data for the eighteen SIs of Table 1.

Transformation: z = LN (x + 1)

Source	DF	Sequential SS	Adjusted SS	Adjusted MS	F-value and significance
Time	25	251.523	253.943	10.158	7.74***
Index	17	457.438	457.438	26.908	20.51***
Error	260	341.1	341.1	1.312	
Total	302	1050.061			

R^2 (adjusted) = 62.27%

*** P<0.001

Table 3. Results of a Bonferroni Simultaneous Test on the transformed article count/year data employed in the ANOVA shown in Table 2.

SI	Sample size	Mean article count	Grouping
Carbon Footprint	12	5.95	a
Human Development Index	23	4.802	b
Corruption Perception Index	17	4.597	b
Ecological Footprint	20	4.368	b
Press Freedom Index	11	3.461	b
Big Mac Index	25	3.017	c
Genuine Progress Indicator	19	2.523	c
Bribe Payers Index	14	2.517	c
Global Competitiveness Index	17	2.515	c
Happiness Index	26	2.458	c
Human Poverty Index	16	2.327	c
Mothers Index	12	2.076	c
Commitment to Development Index	10	2.06	c
Living Planet Index	15	2.017	c
Environmental Sustainability Index	13	1.846	c
Environmental Performance Index	17	1.703	c
Gender Empowerment Measure	18	1.592	c
Gender related Development Index	18	1.226	c

Table 4. Correlation coefficients between the log number of articles published per year.

	BMI	BPI	CF	CDI	CPI	EF	EPI	ESI	GEM	GDI	GPI	GCI	HI	HDI	HPI	LPI	MI	PFI
BMI	1																	
BPI	0.06ns	1																
CF	0.86***	-0.14ns	1															
CDI	-0.14 ns	-0.22ns	-0.57ns	1														
CPI	0.87***	0.05ns	0.76**	-0.36ns	1													
EF	0.88***	0.10ns	0.74**	-0.39ns	0.99***	1												
EPI	0.80***	0.22ns	0.66*	-0.55ns	0.87***	0.82***	1											
ESI	-0.38ns	-0.25ns	-0.17ns	-0.22ns	-0.37ns	-0.37ns	-0.28ns	1										
GEM	0.37ns	0.17ns	-0.07ns	0.12ns	0.38ns	0.31ns	0.33ns	-0.38ns	1									
GDI	-0.03ns	0.39ns	-0.60*	0.44ns	-0.02ns	-0.08ns	0.05ns	0.09ns	0.60**	1								
GPI	0.34ns	-0.08ns	0.24ns	-0.18ns	0.32ns	0.34ns	0.02ns	0.01ns	0.09ns	-0.12ns	1							
GCI	0.79***	0.26ns	0.59*	-0.60ns	0.91***	0.89***	0.91***	-0.56*	0.31ns	-0.02ns	0.11ns	1						
HI	0.79***	0.01ns	0.70*	-0.49ns	0.65**	0.70***	0.69**	-0.45ns	0.14ns	-0.19ns	0.22ns	0.70**	1					
HDI	0.86***	0.09ns	0.86***	-0.33ns	0.85***	0.85***	0.73***	-0.26ns	0.13ns	-0.32ns	0.25ns	0.75***	0.88***	1				
HPI	-0.34ns	0.20ns	-0.47ns	-0.14ns	-0.19ns	-0.23ns	-0.01ns	0.42ns	-0.10ns	0.29ns	-0.06ns	-0.18ns	-0.16ns	-0.41ns	1			
LPI	0.33ns	0.10ns	0.18ns	-0.10ns	0.40ns	0.31ns	0.70**	-0.43ns	0.32ns	0.12ns	-0.19ns	0.54*	0.45ns	0.18ns	0.18ns	1		
MI	0.278ns	-0.23ns	0.48ns	-0.20ns	0.12ns	-0.04ns	0.50ns	0.18ns	-0.14ns	-0.23ns	-0.29ns	0.21ns	0.19ns	0.40ns	0.02ns	0.27 ns	1	
PFI	0.88***	-0.06ns	0.82**	-0.19ns	0.92***	0.89***	0.56ns	-0.14ns	-0.15ns	-0.51ns	0.26ns	0.53ns	0.40ns	0.93***	-0.42ns	0.05 ns	0.30ns	1

ns = P>0.05
* P<0.05
** P<0.01
*** P<0.001

Figure 1. Placement of the 18 Sustainability Indices in the spaces of sustainable development represented by the three overlapping circles of economy, community and environment.

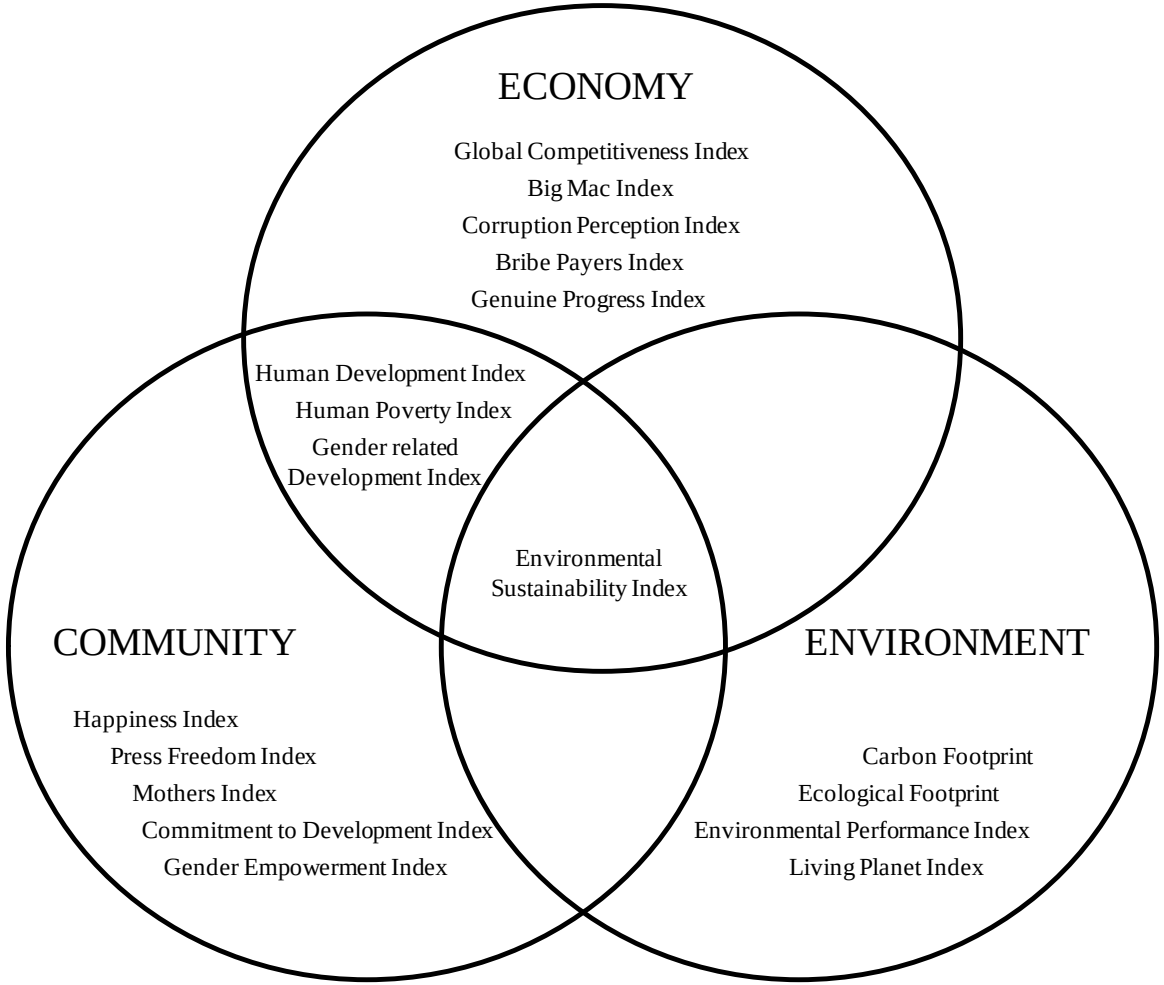
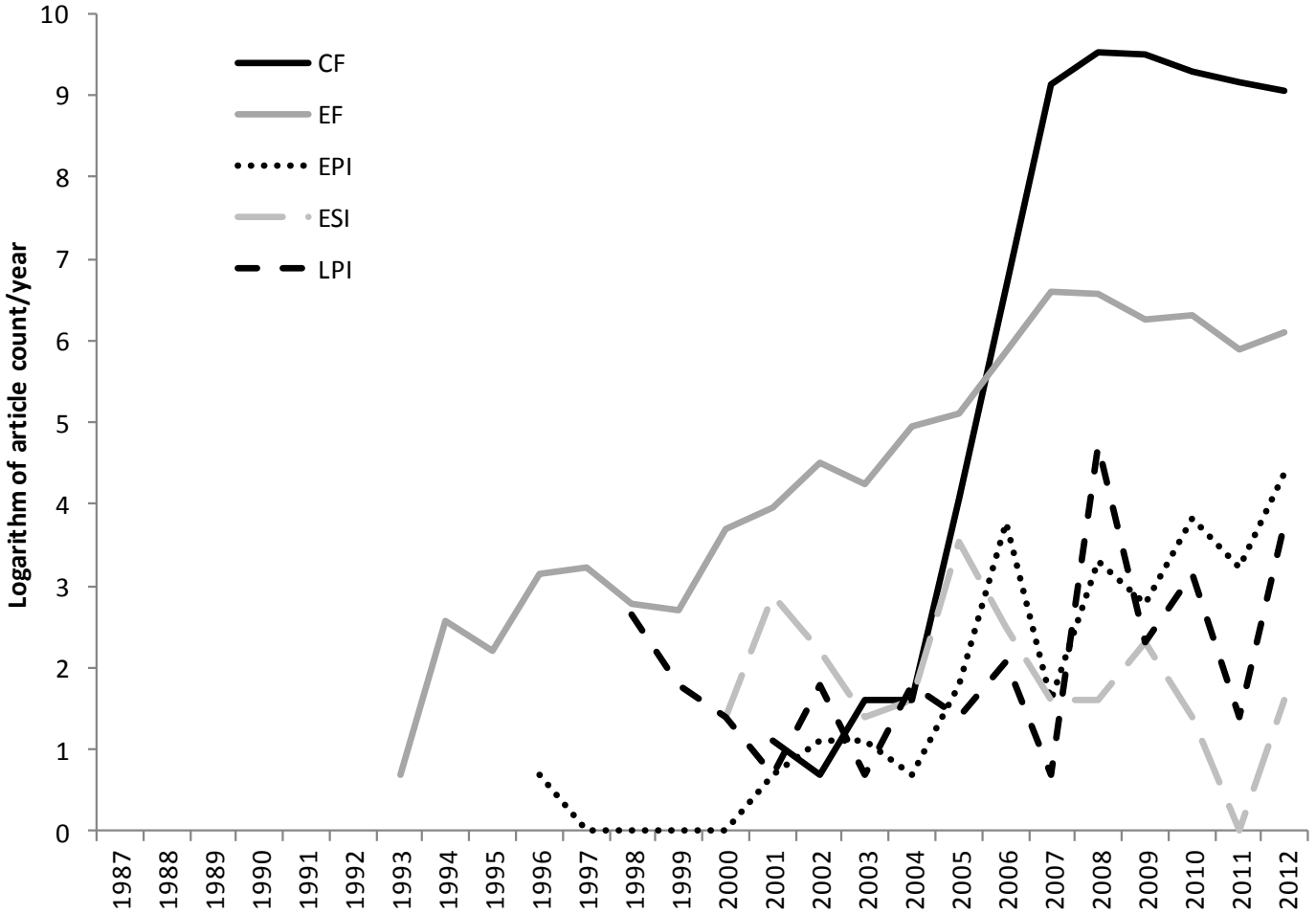
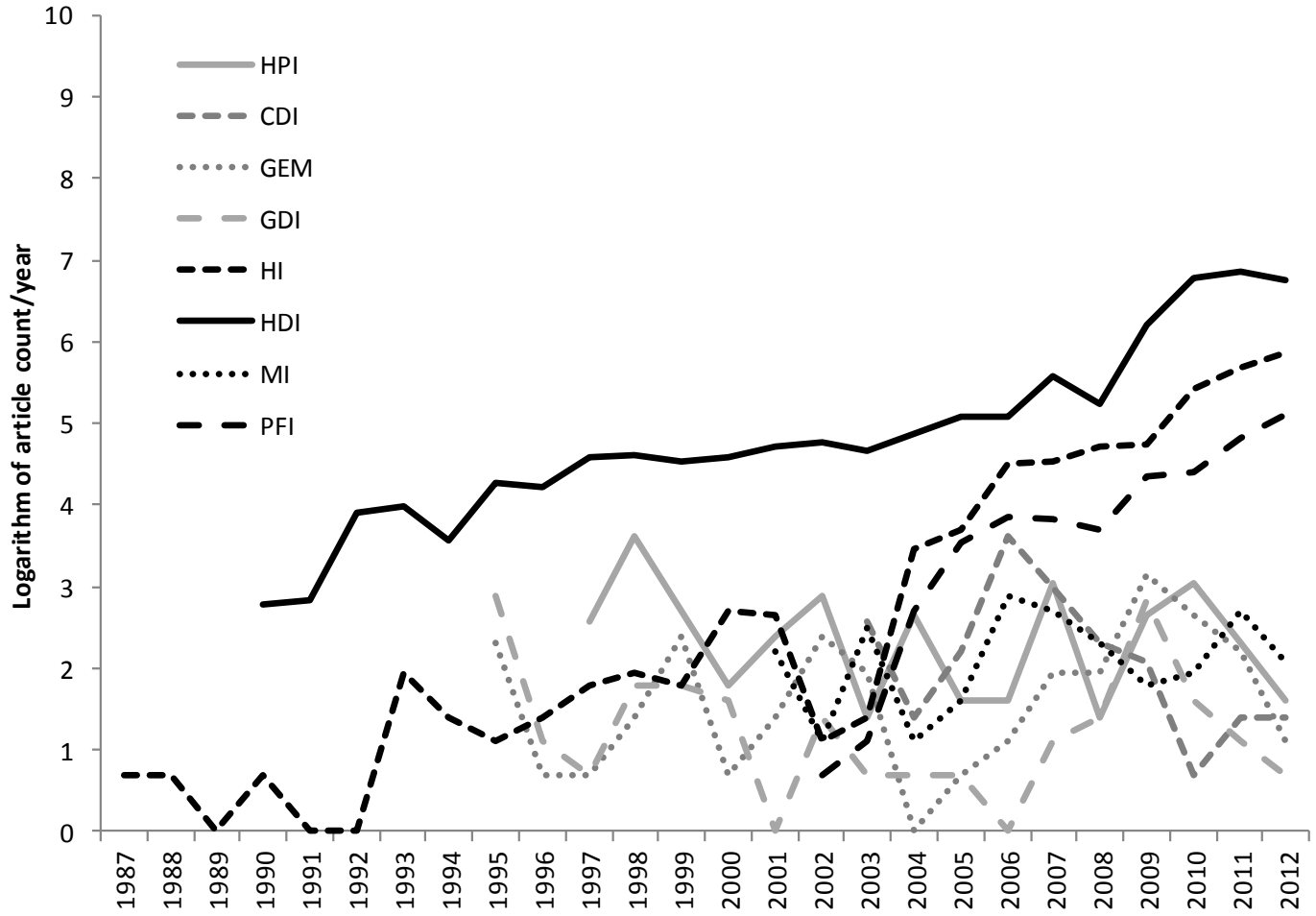


Figure 2. Trends in newspaper reporting of SIs over time (1987 to 2012)

(a) Environmental SIs



(b) Community SIs



(c) Economic SIs