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Towards human and social sustainability indicators

A multidimensional approach

H.B.M. Hilderink

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RIVM, P.O. Box 1, 3720 BA Bilthoven, telephone: 31 - 30 - 274 91 11; telefax: 31 - 30 - 274 29 71

Abstract

Ever since the Brundtland Commission presented its report on sustainable development in 1987, various institutions have either adopted or tried to refine the approach used in the report. Currently, there is a broad collection of concepts that are often highly related to sustainable development. These concepts do not seldom include aspects like poverty and development, security issues and quality of life. The operationalization of these concepts has resulted in a broad collection of indicators and composites of indicators, the so-called indexes. Important examples of successful operationalization are the Human Development Index and the Millennium Development Goals.

Most of these collections of indicators have no, or hardly any, theoretical foundation. Furthermore, the precise description of the underlying process that these indicators try to indicate is lacking and the availability of data seems to be the guideline for selection. Selection of indicators should be based on a list of criteria such as sensitivity to changes, transparency and redundancy. Applying the Pressure-State-Impact-Response mechanism can improve the selection and use of indicators since causal relationships are distinguished and underlying processes interlinked. Further refinement can be obtained by the use of a hierarchical representation, resulting in a transparent and traceable indicator framework. Maslow's theory of needs connects these aspects with the human/social sustainability domain. Applying this theory to the selection of indicators results in a well-founded, but still practical, collection of indicators for possible use in further depiction of social and human aspects of sustainable development.

Samenvatting

Sinds de Brundtland commissie het rapport ten aanzien van duurzame ontwikkeling heeft gepresenteerd, heeft een groot aantal instellingen getracht deze te operationaliseren en/of the verfijnen met andere, gerelateerde concepten. In deze nieuwe concepten komen aspecten als armoede en ontwikkeling, bestaanzekerheid en kwaliteit van leven vaak terug. Operationaliseren van deze concepten heeft geleid tot een grote verzameling van indicatoren en samengestelde indicatoren (zogenoemde indices). Belangrijke voorbeelden zijn hiervan de Human Development Index en de Millennium Development Goals.

De meeste van deze indicatoren zijn echter niet of niet goed theoretisch onderbouwd. De precieze omschrijving van wat deze indicatoren beogen te beschrijven ontbreekt vaak en de selectie van indicatoren lijkt soms meer gebaseerd te zijn op beschikbaarheid van data in plaats van een ex-ante set van criteria. Selectie van indicatoren kan worden gedaan op basis van criteria als gevoeligheid voor de te meten veranderingen, transparantie en redundantie. Met het toepassen van het Pressure-State-Impact-Response raamwerk komen indicatoren beter tot hun recht doordat er causaliteit onderscheiden wordt, en er een duidelijke relatie wordt gelegd met het onderliggende proces. Daarnaast levert het gebruik van een hiërarchische representatie een transparant en traceerbaar indicatorenraamwerk op. De theorie van Maslow, waarin de sequentie van levensbehoeften wordt uiteengerafeld, sluit hierbij goed aan en is dan ook gebruikt om een beter gefundeerde, maar nog steeds praktische collectie van indicatoren te krijgen voor het sociale domein van duurzame ontwikkeling.

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1. Introduction

Several indicators have been widely accepted and applied in daily life as a means to indicate the state of a system. Life expectancy is a good example for the human system, while temperature and gross domestic product are commonly used for the climate and economic system, respectively. In general, indicators are used to monitor developments and gain insight into the dynamics of a complex reality. Such a complex reality, like the human system, can be characterized by a huge collection of variables reflecting the underlying interactions and relationships. By using indicators, this large quantity of data can be reduced, while retaining the most essential information. The most striking example within the scope of population dynamics is the attempt of the UNDP 'to map the concept of human development' in one simple composite index and to produce a ranking of human development achievement (UNDP, 1996, p. 28). This has resulted in the Human Development Index (HDI), which was accompanied later by several other, broader indicators such as the Human Poverty Index and the Gender Empowerment Measure, all introduced by the UNDP.

With the introduction of the concept of sustainable development, the need for indicators to monitor current trends and assess future developments became even more pinching. Firstly, including *time* with (the need of) future generations, and *place* with no transferal of responsibilities to people living elsewhere, brought with it an enormous increase in complexity. Secondly, the concept of sustainable development broadened the traditional, mainly single-disciplinary oriented, objectives. Not only was the whole global system to be covered, but also the interaction and feedback between subsystems could not be left out. The World Bank developed a methodology in which various domains of sustainable development were distinguished and defined as capital stocks. The United Nations Commission on Sustainable Development used these domains in their indicator framework and tried to refine it further by an implicit inclusion of (causal) relationships. These indicator initiatives and others brought us a wide collection of all kinds of variables, hopefully indicating processes that are relevant for that indicator. However, a clear theoretical foundation and a justification of the operationalization are often lacking. And even more often, the argumentation and criteria used for selection of indicators is either not properly described or simply omitted.

In this report, several concepts that are closely interlinked with sustainable development will be described and discussed (Section 2). Section 3 will provide an overview of the most important indicators currently used for sustainable development. The focus in this report lies in the human/social domain of sustainable development, although this cannot be done in a single-perspective approach. Nevertheless, the debate on sustainable development was strongly orientated to environment and might need a more balanced

approach, including the human/social system. Unfortunately, the number of studies in social science that include long-term projections associated with the 'next generations' is relatively limited. The occurrence of events in social sciences tends to be multi-causal in nature (Blossfeld and Rohwer, 1995) and seems to be more difficult to capture in regularities than (some) events described by natural sciences. The main purpose is to come to a selection of indicators covering the human/social domain of sustainable development, while meeting certain criteria. These criteria represent requirements like transparency, availability of data but also a clear description on what the indicators are supposed to indicate. Selection of indicators often takes place arbitrarily. Section 4 briefly considers the theoretical foundation and criteria for indicators and indicator frameworks, followed by a few recommended sets of indicators (Section 5) applied to several countries and regions.

2. Concepts and definitions

The concept of sustainable development, or sustainability, originated in the 1970s, with the Club of Rome's *Limits to Growth* as one of the earliest attempts to operationalize this concept. The refinements, new definitions and use (but also misuse) of the sustainable development concept has been expanding enormously ever since, although consensus on a clear-cut definition is still lacking. With this expansion, many other alternative facets were defined as being important for, or strongly related to, 'the' concept of sustainable development. The purpose of this section is not to provide an extensive list of available concepts and definitions, but to give a brief overview of concepts that are very closely related to the indicators described in this report. Sustainable development will be described first, followed by a selection of other aspects such as poverty, security and well-being.

2.1 Sustainable development

There are numerous definitions of sustainable development. One of the most commonly used is still the definition of the World Commission on Environment and Development (WCED), sometimes referred to as the Brundtland Commission. The WCED report 'Our Common Future' of 1987 (WCED, 1987) established the link between environment and development issues and lay the basis for use of the term 'sustainable development'. WCED defined sustainable development as *'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs'*. Since then, many refinements, additions and alternatives have been introduced, for example, as in the IUCN, UNEP and WWF definitions: 'development that improves the quality of human life while living within the carrying capacity of supporting ecosystems' (IUCN et al., 1991).

Although these concepts, especially the one provided by the Brundtland Commission, have been more-or-less unanimously adopted by politicians, scientists and environmentalists as a starting point for describing sustainable development, taking the next step of operationalizing this idea results in more discrepancies. This idea of sustainable development has also received lots of criticism attributable to its normative nature. Partly due to its immense scope, sustainable development has as many definitions (or operationalization) as projects dedicated to it. Sustainable development encompasses the human/social, environmental and economic domains on an equilateral basis. This is a perspective that might not be shared by relatively poor developing countries; they may, in fact, be unable to handle the immediate costs of stricter measures to achieve social and environmental goals. This might enforce the idea that the orientation of sustainable development is seen too much from Western perspective, in which development is strongly associated with economic growth. This is encountered by

Daly (1987) who makes a clear distinction between economic growth as the quantitative increase in the scale of the physical dimensions in the economy; i.e. the rate of flow of matter and energy through the economy and the stock of human bodies and artifacts. However, development represents a more qualitative consideration seen in the qualitative improvement of physical stocks and flows (Daly and Townsend, 1993). The intergenerational character of the concept forms another point of weakness. First of all, it requires being able to assess or explore future developments. And, secondly, assessing the need of future generations assumes that we know the needs of future generations and live in a society that is most likely completely different from the current one.

In spite of these shortcomings, the concept of sustainability may serve as a guideline for social, economic and environmental issues as recognized by many individuals, institutions and governments around the world (Biosphere-2-Center, 2002); applications of sustainability also provide valuable insight into possible earlier unanticipated broad consequences.

2.2 Human development

In the context of sustainable development, human development can be regarded as (one of) the outcomes of the earlier mentioned human/social domain. Human development comprises *'the process of enlarging people's choices at three essential capabilities to lead a long and healthy life, to be knowledgeable and to have a decent standard of living*' (UNDP, 1994). Many opportunities for sustainability cannot be achieved if these capabilities are not fulfilled. A difference with sustainable development is that human development puts people more-or-less exclusively at the center of development, with the other domains functioning as a means to achieve this development. However, in sustainable development, ecosystems and economic growth potential are seen more as the end of development in itself.

2.3 Poverty

For many years poverty was interpreted in economic terms. Average income or consumption over a specific period was used as a proxy for economic welfare of individuals (or households). People were then considered poor if they had an income under a certain level, comprising the so-called *headcount poverty index*. This level may be relative, for example, assuming a level of 50% of the average income of a country, or absolute, assuming, for example, a level of US$1 adjusted for power purchasing parity (PPP), indicating the so-called extreme poverty line. Expressing income in power purchasing parity, which is based on a set of basic goods and services, consumption capabilities of different countries could be more adequately compared than using official exchange rates. In addition, a level of US$2 PPP is taken as a second level, also indicating a poverty state.

This concept has recently been broadened more and more to include other dimensions of poverty. The UNDP (1997) states that *'human poverty is more than income poverty, more than a lack of what is necessary for material well-being. Human poverty is the denial of choices and opportunities most basic to human development - to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-esteem and the respect of others'*. Nevertheless, in the operationalization of poverty in the Human Poverty Index most of the previously mentioned facets are not fully taken into account. Others include inequality (both within a country or region and within a household), health, education, security, political voice and discrimination in their definition (e.g. Putnam et al., 1993, Sen, 1981, Sen, 1983). In the 2000/2001 World Development Report, the World Bank groups the different dimensions of poverty such as opportunity, empowerment and security.

2.4 Human security

A common definition of security found in the dictionary includes freedom from danger, poverty or apprehension. (Lonergan, 1997). Initially, human security was interpreted even more narrowly as meaning threats to the physical security of the person. The Universal Declaration of Human Rights adopted by the UN in 1948 states that '*everyone has the right to life, liberty and the security of person…*'. This includes economic, health and environmental concerns, and has also broadened this definition of human security. Human security issues can be regarded as part of, or conditions for, human development and along with this, sustainable development. It indicates whether people have options necessary to end, mitigate or adapt to threats to their human, environmental and social rights, actively participate in attaining these options, and have the capacity and freedom to exercise these options (GECHS, 2002).

The UNDP Human Development Report 1994 introduced the concept of human security as having two main aspects: a) safety from such chronic threats as hunger, disease and repression, and b) protection from sudden and harmful disruptions in the patterns of daily life—whether in the home, jobs or communities. The definition of human security, which has been adopted by the project on Global Environmental Change and Human Security, is derived from UNDP and includes seven categories that can be threatened:

- Economic security (assured basic income)
- Food security (physical and economic access to food)
- Health security (relative freedom from disease and infection)
- Environmental security (access to sanitary water supply, clean air and a non-degraded land system)
- Personal security (security from physical violence and threats)
- Community security (security of cultural integrity)
- Political security (protection of basic human rights and freedoms)

King and Murray (King and Murray, 2000) link human security to poverty issues by defining it as 'the number of years spent outside a state of generalized poverty', where generalized poverty is determined by a certain threshold level of any key domain of human well-being. Key domains of well-being are income, health, education, political freedom and democracy, and represent those that have been important enough for human beings to fight over or to put their lives or property at great risk.

These different elements of and threats to human security seem to lack a clear underlying framework and applications, leaving much room for criticism. The lack of such a framework makes the selection of threats rather indiscriminate, or has at least this appearance. The interdependencies and overlap between these categories can be quite strong (e.g. the first four categories are strongly related). Without making these more explicit, the randomness of selecting indicators based on such a concept might be high.

2.5 Health, well-being and quality of life

Health is one of the topics that is included in more or less each of the above listed concepts. The WHO Constitution defines health as '*not merely the absence of disease or infirmity, but rather, a state of complete physical, mental and social well-being*' (WHO, 2001). This is a broad definition and encompasses the conditions for an individual, community or society to achieve an acceptable state of health. However, in operationalizing health more quantitatively, it is often narrowed down to mortality levels using life expectancy or an age-specific mortality rate (e.g. child mortality) in spite of the broad availability of both definitions and data/models.

In many of the qualitative concepts health is directly associated with quality of life and well-being. As the WHO (WHO-QOL, 2002) states, quality of life is 'an individual's perception of their position in the context of the culture and value systems in which they life and in relation to their goals expectations, standards, and concerns. It is a broad-ranging concept incorporating, in a complex way, the person's physical health, psychological state, level of independence, social relationships, personal beliefs and relationships to salient features of the environment'. It is beyond the scope of this paper to elaborate on the enormous number of conceptual concepts of quality of life issues. An extensive overview of existing literature is given by Leidelmeijer (2002). One of related issues is the concept of reproductive health (e.g. UNFPA, 1997). At the 1994 International Conference on Population and Development (ICPD), 179 countries agreed that population and development are inextricably linked, and that empowering women and meeting people's needs for education and health, including reproductive health, are necessary for both individual advancement and balanced development. This topic represents one of the essential choices in life, i.e. that women are able to have control over their own fertility. This will be made possible through universal education, access to contraceptives, including condoms to prevent infection from sexually transmitted

diseases with HIV/AIDS as the main target, and access to reproductive health care for reducing infant, child and maternal mortality.

2.6 Conclusions

As previously mentioned, the list of concepts could easily be extended with other relevant themes (vulnerability, well-being, safety, risk etc.). However, there is an enormous overlap of themes, despite several clear differences in approach and emphasis. A whole range of frequently used indicators, ranging from poverty to health and happiness, can be extracted here. One of the themes to be addressed - sustainable development - is closely connected with the other concepts, even though some of the approaches are more human-centric. Development implicitly or explicitly includes the time dimension and is clearly emphasized, not only by the intergenerational element of SD, but also by coping with threats that nowadays may already be observed but may only have potential impact in the future.

3. Existing indicators and indicator frameworks

Now that the stage for sustainable development has been set, the focus will move to indicators. The discussion on developing a set of human and social indicators for sustainability will precede the discussion on selecting indicators. Presentation of an overall organizing structure with a top-down approach will be followed by more specific indicator definitions. The different domains, positioned at a high aggregation level (Section 3.1), are followed by an elaboration of particular indicators, such as the previously mentioned HDI and other UNDP concepts, e.g. Gender-related Development Index (GDI), Human Poverty Index (HPI) and socio-economic status (SES).

3.1 Indicators for sustainable development

There have been several attempts to develop indicator frameworks or systems. The OECD (1993) used the Pressure–State–Response-approach to structural environment-oriented indicators, while the World Bank (1995) proposed a different approach by focusing on different types of capital. The World Bank approach makes a distinction between indicators, reflecting the monetary aspects of economic, social and natural domains, and the degree to which people have access to such a capital domain. A fourth domain, the institutional one, was added later (see Figure 1). This World Bank concept, which has been used several times (Spangenberg and Bonniot, 1998; De Vries et al., 1997), can serve as an organizing framework to position various indicators.

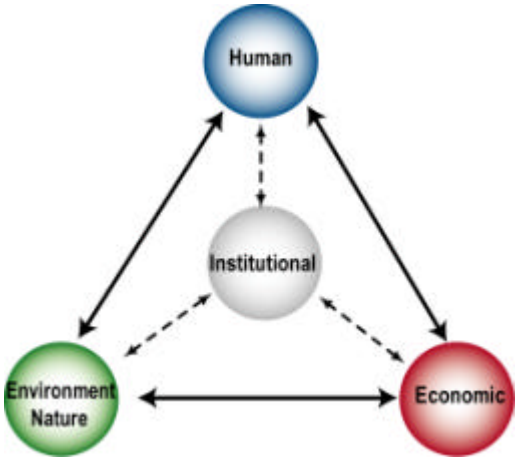


Figure 1. Domains of sustainable development as proposed by the Wuppertal Institute (Source: Spangenberg and Bonniot, 1998).

The United Nations Commission on Sustainable Development (CSD) developed a framework of indicators allowing easier interlinkage with simulation models (UN, 1996). The purpose of the CSD framework was to point the way to sustainable development, although a precise definition of sustainable development is lacking. A

selection of approximately 130 variables has been made for both the human and environmental systems. Based on the action program for sustainable development, Agenda 21 (UN, 1992), the CSD has classified the variables in the Driving force–State–Response framework. This is similar to the Pressure-State-Impact-Response-mechanism which is applied several times (e.g. Hilderink, 2000b; Rotmans and De Vries, 1997). The resulting indicators-for-sustainable development (ISD) framework distinguishes four categories: social, economic, environmental and institutional indicators. Since the social section is most relevant within the scope of this report, the description and discussion will therefore be restricted to this section. Table 1 gives an overview of the indicators for social aspects of sustainable development.

Table 1. The CSD indicator framework of social indicators.

Indicator	Driving force	State	Response
Combating poverty	Unemployment rate	Head count index of poverty Poverty gap index Squared poverty gap index Gini index of income inequality Ratio of average female wage to male wage	
Demographic dynamics and sustainability	Population growth Net migration Total fertility rate	Population density	
Protecting and promoting human health		Basic sanitation: percentage of the population with adequate excreta disposal facilities Access to safe drinking water Life expectancy at birth Adequate birth weight Infant mortality rate Maternal mortality rate Nutritional status of children	Immunization Contraceptive prevalence Proportion of potentially hazardous chemicals monitored in food National health expenditure devoted to local health care Total national health expenditure related to GNP
Promoting education, Public awareness and training	Rate of change of school-age population Primary and secondary school enrolment ratio (gross and net) Adult literacy rate	Children reaching the fifth grade of primary education School-life expectancy Difference between male and female school enrolment ratios Women per hundred men in the labor force	GDP spend on education
Human settlement	Rate of growth of the urban population Per capita consumption of fossil fuel by motor vehicle transport Human and economic loss due to natural disasters	Percent of the population in urban areas Area for and population of urban formal and informal settlements Floor area per person House price to income ratio	Infrastructure expenditure per capita

Source: UN, 1996.

The ISD framework provides a comprehensive, well-documented selection of social indicators. However, the ISD framework can be criticized and improved in several ways. First, the criteria used for the selection of the variables are unclear. Secondly, the use of the Driving force–State–Response structure suggests an underlying causal structure between the last three columns in Table 1. Although most variables are obviously related, the description of the causality of the relationships is lacking in the ISD framework. Thirdly, the selected variables incorporate much redundant information. For example, the calculation of life expectancy is partly based on infant mortality rate, two factors that are consequently highly correlated. Finally, several important social aspects are missing. For example, an indicator representing the age structure of a population is completely lacking in the category 'demographic dynamics and sustainability'. These deficits can be eliminated by better establishing the indicator framework and testing it for existing situations.

3.2 Millennium development goals

One of the more recent initiatives for developing a framework of indicators is defining the Millennium Development Goals. By assigning eight goals (listed below), the policy targets for the coming 15 years are set out. It was an ambitious agenda for reducing poverty and improving lives that world leaders agreed on at the Millennium Summit in Johannesburg in September 2000. The goals are:

1. Eradicate extreme poverty and hunger;
2. Achieve universal primary education;
3. Promote gender equality and empower women;
4. Reduce child mortality;
5. Improve maternal health;
6. Combat HIV/AIDS, malaria and other diseases;
7. Ensure environmental sustainability;
8. Develop a global partnership for development.

Associated targets and indicators to measure progress for all these goals are presented in the Appendix. The strength of this list is the broad support it enjoys, with 191 nations adopting the Millennium Declaration. There is little doubt that the aforementioned list does not include aspects that indicate aspects of sustainability, although it does list the associated 48 indicators that can hardly miss that target. Another difficulty is the way to achieve the goals, especially in combination with the mutual relationships between the underlying processes. 'Can poverty and hunger be halved by 2015 (Goal 1), while ensuring environmental sustainability (Goal 7)?' - a question fairly relevant in the context of sustainable development. The redundancy of the list is illustrated by the primary education goal, which will also have the indirect effect of reducing child mortality.

3.3 Human Development Index (HDI)

The UNDP defines human development as a process of enlarging people's choices. In principle, these choices can be infinite and can change over time. But at all levels of development, the three essential choices are: 1) leading a long and healthy life, 2) acquiring knowledge and 3) having access to the resources needed for a decent standard of living. The Human Development Index (HDI), introduced in the human development report 1990, has been refined several times since (UNDP, 1994, UNDP, 1995, UNDP, 1996, UNDP, 1997). The HDI, containing three dimensions, measures the average achievement of a country in basic human capabilities. Dimensions of the HDI are life expectancy at birth, representing a long and healthy life; educational attainment, representing knowledge, and real gross domestic product (GDP in purchasing power parity (PPP) dollars), representing a decent standard of living (UNDP, 1995).

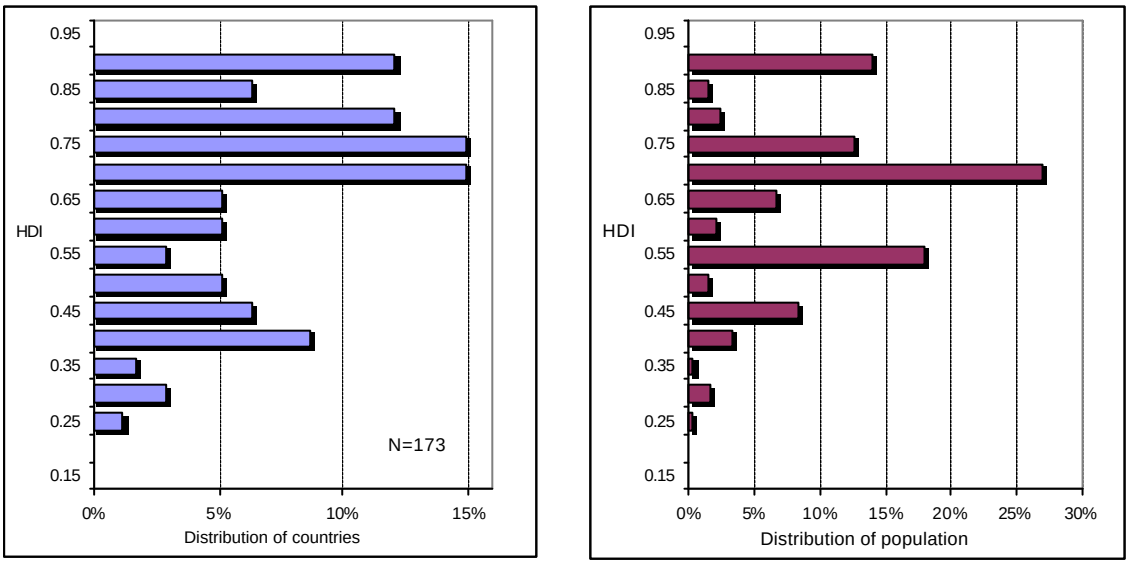


Figure 2. Distribution of the Human Development Index (HDI) for 2000 for 173 countries and HDI values weighted by population size.

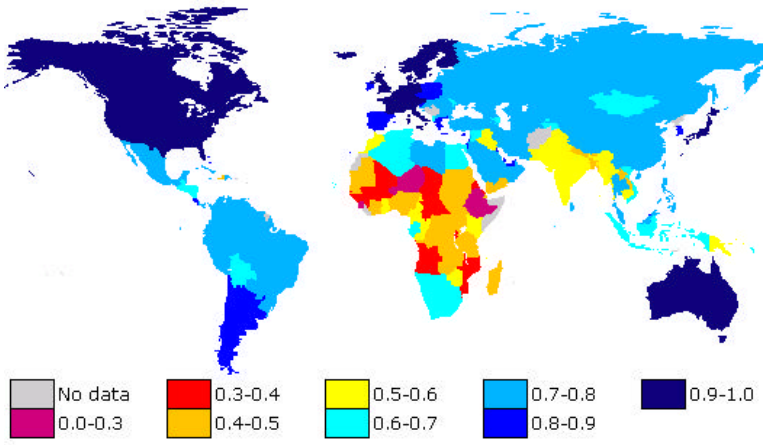


Figure 3. HDI values worldwide, 1998.

Nowadays, the HDI is accepted as an overall development indicator that allows us to compare countries. Nevertheless, criticism aimed at various aspects of the HDI does exist. A fairly obvious remark is that the use of the average implies a loss of information on distributional aspects such as inequities (Sagar and Najam, 1998, Hicks, 1997). One way of dealing with the inherent loss of information that goes along with indexes is the disaggregation of the HDI by distinguishing region/country, race/ethnic group or gender. Although such a disaggregation provides more detailed information on the distribution of HDI values, it disregards the question of whether the concept of the HDI covers the level and process of human development. One of the restrictions is that the HDI only yields insights into a certain dimension of human development; it does not include additional choices like political freedom, guaranteed human rights and self-respect (Desai, 1991, Kelley, 1991).

The choice for the first two dimensions is subject to hardly any criticism. However, based on correlation analysis, one of the conclusions drawn is that the HDI represents yet another redundant inter-country composite development indicator (McGillivray, 1991). With the exception of a minority of country groups, the index hardly provides more information than the more traditional indicator, GDP per capita. On the other hand, income is included in the HDI; however, it can be questioned if this is an adequate representation of standard-of-living.

3.4 Gender-related indexes (GDI, GEM)

The HDI only reflects the development of a country or region on a high aggregation level; one of the omissions of the HDI is the loss of information on the (in)equality among the genders. 'Providing equal rights and equal access to resources and opportunities to women and girls -as well as to men and boys - is crucial to the goal of reducing poverty, illiteracy and disease among all people. Gender equality is an essential aspect of human development' (UNDP, 1995, p. 99). Therefore, the Gender-related Development Index (GDI) (UNDP, 1995) was developed to overcome the loss of the inequity between men and women by imposing a penalty for gender inequality. The GDI is a downward-adjusted HDI. In other words, the three components used for the HDI are calculated separately for the genders and aggregated using a penalty function. The penalty function is represented by an aversion factor of gender inequality. If 0 is taken for the aversion factor, the GDI is equal to the HDI, given small discrepancies due to the use of male and female population weighting. The higher the aversion factor, the higher the reducing effect of inequality in the penalty function.

The values for 1995 were analyzed to determine whether the GDI has an additional value compared to the HDI. The analyses presented in Figure 4 show a very high correlation between the HDI and the GDI, with differences between the HDI and GDI observed in Saudi Arabia, Oman and Iraq.

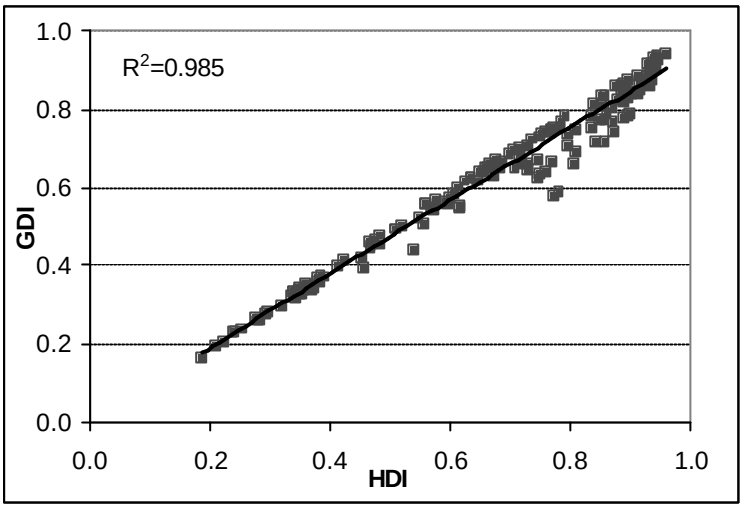


Figure 4. Human Development Index (HDI) and Gender-related Development Index (GDI).

The HDI and GDI show only one dimension of human development, namely, the capabilities of people. Another dimension is how these capabilities are used to take advantage of opportunities in life. The Gender Empowerment Measure (GEM) concerns the participation of men and women in economic and political life, and decision-making. Analyses show this index to produce a deviating pattern when compared to the HDI. Especially at higher levels of human development, the GEM is more distinctive and may provide a more detailed picture of gender inequities. However, due to absence of models and data of the underlying political and detailed economic processes, the possibility of applying it is fairly limited.

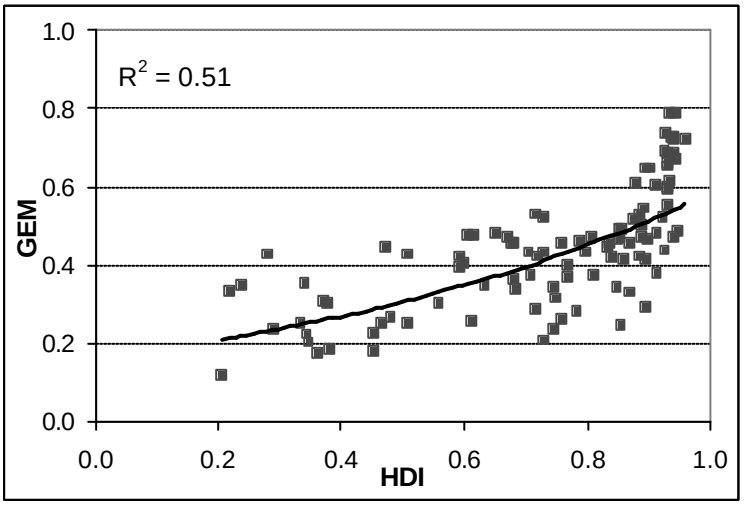


Figure 5. Human Development Index (HDI) and Gender Empowerment Measure (GEM).

3.5 Human Poverty Index (HPI)

The new indicator, Human Poverty Index (HPI), is defined in the UNDP's 'Human Development Report 1997' (1997). This indicator represents a further refinement of the Human Development Index (HDI) through the addition of new variables and the different way of constructing the overall HPI. The HPI focuses on a broader and more representative set of variables than the HDI and is supposed to be a measure of population affected by the following three key deprivations: a short life, represented by the percentage of people expected to die before the age of 40; lack of basic education, measured by the percentage of adults who are illiterate, and lack of access to health services, safe drinking-water and food. The HPI takes the opposite direction compared to the previous indicators: the lower the value, the less the poverty. Figure 6 shows the 1997 value for available countries.

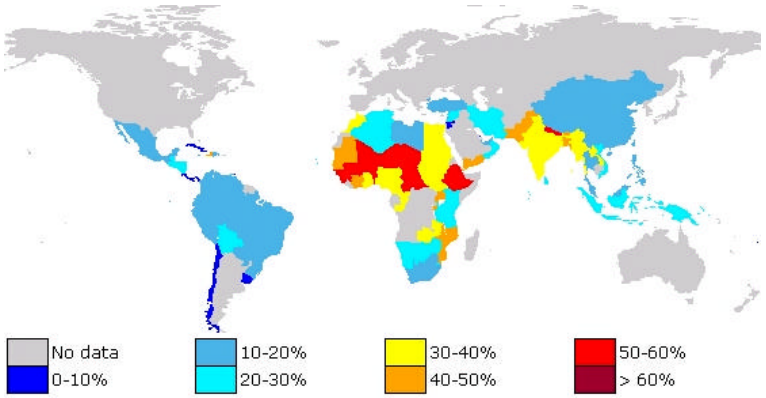


Figure 6. Human Poverty Index for 77 countries, 1997.

This HPI has been worked out for 77 countries, ranging from 3.3% for Trinidad and Tobago to 62% for Niger. Most levels for the remaining 174 countries are below 3.3%. This definition of measuring poverty is only characteristic of developing countries. However, poverty and deprivation are not only a problem of the developing countries. More than 100 million people have an income below 50% of the median personal disposable income in OECD countries. Other factors of deprivation mentioned by the UNDP are unemployment, especially among the youth, the homeless and those who will probably not survive beyond the age of 60. An adapted version of HPI has been introduced to capture the dimensions of deprivation. This new formulation is called the HPI-2 and the definition given by equation 6.5 is referred to as HPI-1. The associated criteria for valuing the HPI-2 dimensions are the percentages of the population who: are not expected to survive to age 60, are functionally illiterate, have an income below 50% of the median personal disposable income and, finally, are social excluded, measured by the percentage of those unemployed longer than 12 months.

A comparison of the HDI and the HPI-1 shows several remarkable differences in development for several individual countries. For example, China and Egypt have

similar levels of overall development but the HPI-1 for China is only 17%, while that for Egypt is 34% (UNDP, 1998). However, if the HDI and HPI-1 values are analyzed more thoroughly, the additional value of the HPI will be limited. Cross-national analyses of the 1995 values for both indicators show a high correlation between the HDI and HPI-1 (see Figure 7). The HPI-2 was calculated for only 17 countries, with HDI values ranging from 0.922 (Italy) to 0.96 (Canada).

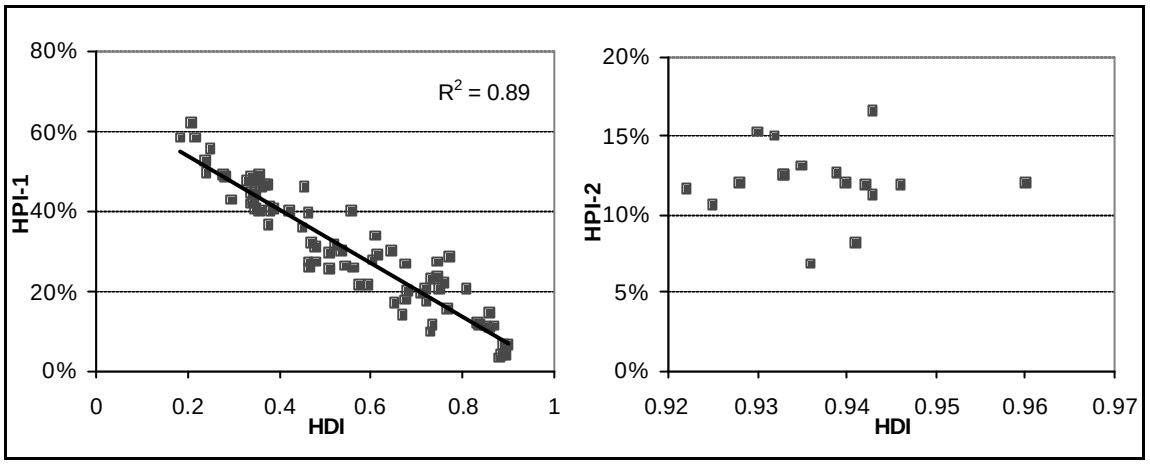


Figure 7. Human Development Index (HDI) and Human Poverty Index (HPI-1, HPI-2).

3.6 Socio-economic indexes, income distribution and poverty

Although the HDI, GDI and HPI are useful for inter-country comparisons, they indicate only the level of development or poverty of a country and cannot be used to distinguish sub-populations. Nevertheless, a classification of sub-populations based on social and economic aspects of individuals is often used for analyses of health outcomes. The characterization of people on the basis of social class or *socio-economic status* (SES) represents a classification of 'a person's location within the economic and occupational strata of society' (Najman, 1993, p. 158). An individual's socio-economic status can be indicated using income and other social markers, like education, occupation and residence. These basic indicators are similar to the components of the HDI, except for longevity. However, there are differences between these two. Firstly, the SES classification is based on attributes of an individual, while the HDI reflects population averages. And secondly, on the basis of SES, people can be classified and subdivided contrary to the HDI, providing an average value between 0 and 1.

The classification has been more useful in distinguishing the population in the high and low SES exposure categories than employing a proximate like the HDI. Nevertheless, an unambiguous application is hard to find since a local-specific interpretation of a person's location is inevitable. Some applications (e.g. Hilderink, 2000b) use only elements of

this concept, the economic dimension forming one of them. The correlation between average income and poverty might be a justification for this assumption (see Figure 8).

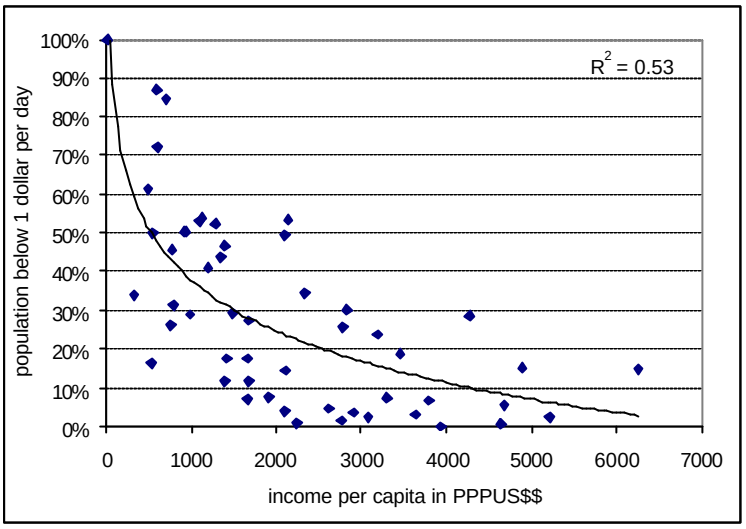


Figure 8. Income per capita and percentage of the population below the poverty line of less than PPP US$1 per person per day (Source: World Bank, 2002).

Another way of looking at income distribution is through the GINI coefficient (see Appendix). The GINI coefficient does not represent the absolute number of poor but gives an indication of the distribution of a country's income over its population. The calculation is based on a cumulative distribution of the population by cumulative income. Unfortunately, lack of data restricts the use of this index. The figure below depicts the (average) data of the GINI and per capita income for the 1990s. Noteworthy here is the wide variation.

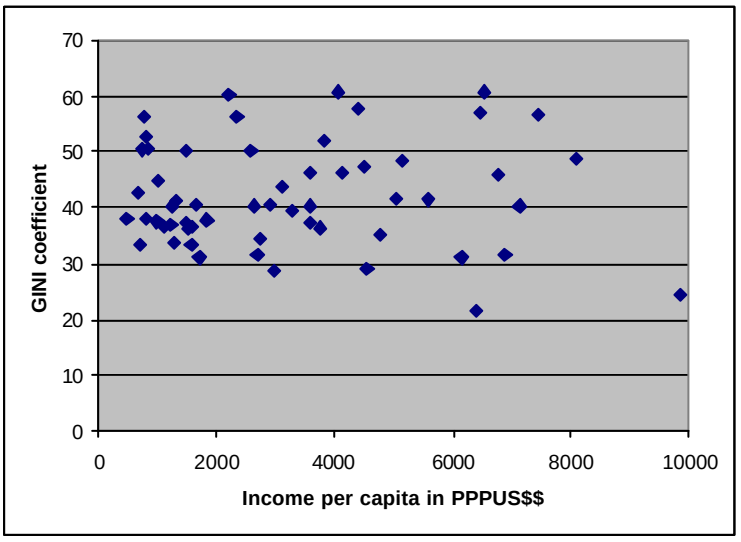


Figure 9. Income per capita and GINI coefficient, 1990s average (World Bank, 2002).

3.7 Index of Human Insecurity (IHI)

The IHDP Global Environmental Change and Human Security (GECHS) Science Plan (IHDP, 1999) suggests developing a system of indicators to express the environmental contribution to human security. Its secondary and primary share in insecurity originating from such factors as both violence and conflict, and deprivation and illness, needs to be addressed. Lonergan (2000) has proposed a set of 16 indicators combined with an Index of Human Insecurity (IHI). The IHI uses a 1 to 10 scale, giving equal weight to each individual indicator going into its construction. These indicators cover environmental, economic, social and institutional issues, as shown in Table 2.

Table 2. Indicators for constructing the Index of Human Insecurity as proposed by Lonergan.

Domains	Indicator
Environmental	Net energy imports Soil degradation Safe water Arable land
Economic	Real GDP per capita Real GDP per capita growth Adult illiteracy rate Value of import and export goods and services
Society	Urban population growth Young male population Maternal mortality ratio Life expectancy
Institutions	Public expenditures on defense relative to education Degree of democratization Index of human freedoms Gross domestic fixed investment

All of the listed variables are weighted between 1 and 10 using cluster analyses and then taking the average. The additional value of the IHI compared to the HDI is fairly limited, given the high negative correlation between HDI and IHI, as shown in the figure below. Whether the lack of a perfect correlation is due to additional variables used in the IHI and indicate a more-or-less insecure situation remain open to question.

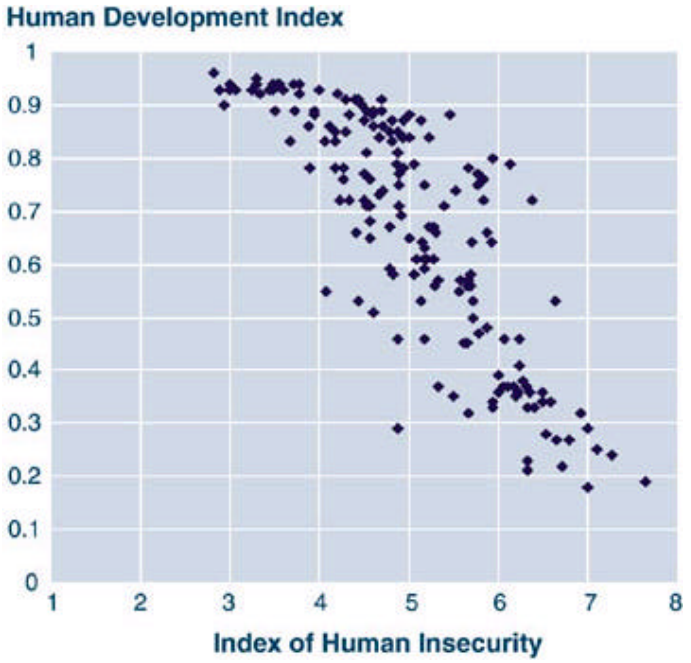


Figure 10. HDI and IHI compared (derived from Lonergan et al., 2000).

3.8 Quality of Life Indicators (DALY/HALE)

Traditionally, the state of health of a population has been indicated through various epidemiological data such as mortality rates, death by cause and life expectancy. These measurements do not take into account the loss of quality of life due to all kinds of diseases. The concept of combining the prevalence of state of health of a population with mortality data in a life table, so as to generate the expected years of life in various health states, dates back to the 1960s and has resulted in the health expectancies and disability-free life expectancy. However, these measurements did not take into account the various levels of severity of disability. The WHO's Global Burden of Disease project developed several measures to describe population health that combine information on the impact of premature death, and of disability and other non-fatal health outcomes. The DALE (Disability-Adjusted Life Expectancy) which has been renamed recently to HALE (Health-Adjusted Life Expectancy, or short healthy life expectancy) is based on conventional life tables using severity weights reflecting social preferences for seven severity levels of disability. These severity weights range from 0 (representing a state of ideal health) to 1 (deceased) and represent the equivalent of loss of quality of life due to a certain disease.

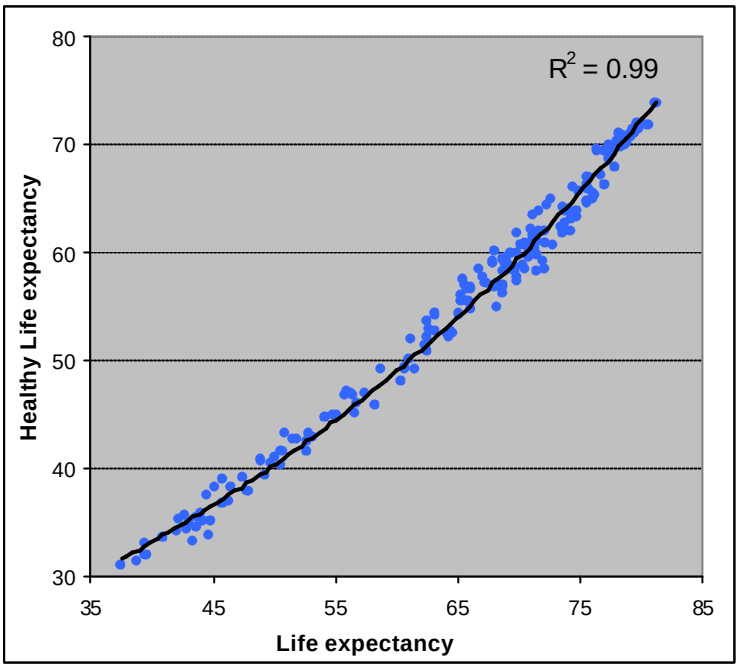


Figure 11. Life Expectancy versus Healthy Life Expectancy (Source: WHO, 2000).

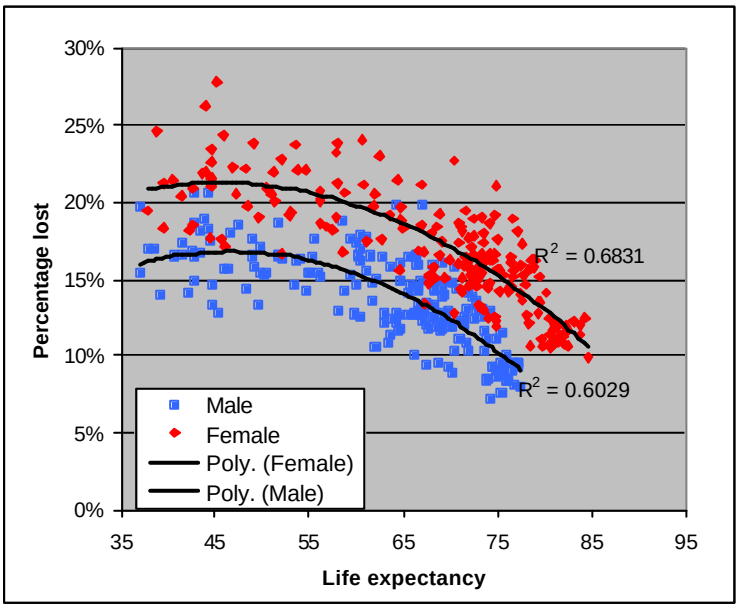


Figure 12. Loss of Healthy Life Expectancy as percentage of total Life Expectancy (Source: WHO, 2000).

The Disability-Adjusted Life Year (DALY) was introduced in 1994; this too is constructed from a mortality and a disease component, taking into account the incidence, prevalence and duration of the disease period, but also the severity of the disease. In addition, the DALY includes age weighting (with a highest weight for a person of 25 years) and a discounting factor representing the time preference. This means that people prefer to be ill sometime in the future and not at the moment.

The time factor plays an important role in both measurements and the link-up with the concept of sustainability. Especially the DALE, with age-specific figures and expectancies, can -perhaps somewhat faulty- serve as an intra-generational indicator. Besides, these indicators fit into the hierarchical approach of the previously described indicator framework. One can track down the underlying components of mortality and disease, and even distinguish an environmental-related component (Melse et al., 2001).

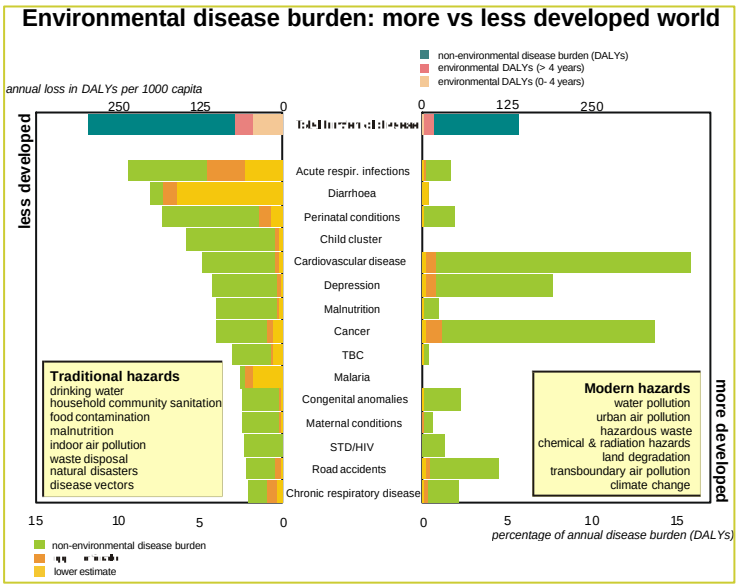


Figure 13. Environmental disease burden for developed and developing regions expressed in disease-specific DALYs (Melse et al., 2001).

3.9 Conclusions

Most of the indexes are of a static (or comparative-static) construct. Although time plays an important role in the concepts, as already mentioned in section 2, the HALE and DALY are more-or-less the only indexes including explicit time dimensions, represented by the age dimension. This is mainly the consequence of the use of age-specific data and the life-table approach. The underlying processes are reflected in an implicit stratification of causes (for example, in the environmental component of the DALY), but the outcome is a high abstraction level indicator, which leaves a lot of room for interpretation. The operationalization of the other concepts into sets of indicators seems to be largely directed by the availability of data (for example, by using mortality as representative for health).

Nevertheless, all these indexes cover the social/human domain of sustainability to a large extent. A more systematic and structured approach, adequately making use and positioning these indicators, along with pointing out white spots, could be very helpful. Using the World Bank framework (including the institutional domain) to describe

different aspects of sustainable development, one can position existing indicators (see Appendix for a complete overview of all the indicators).

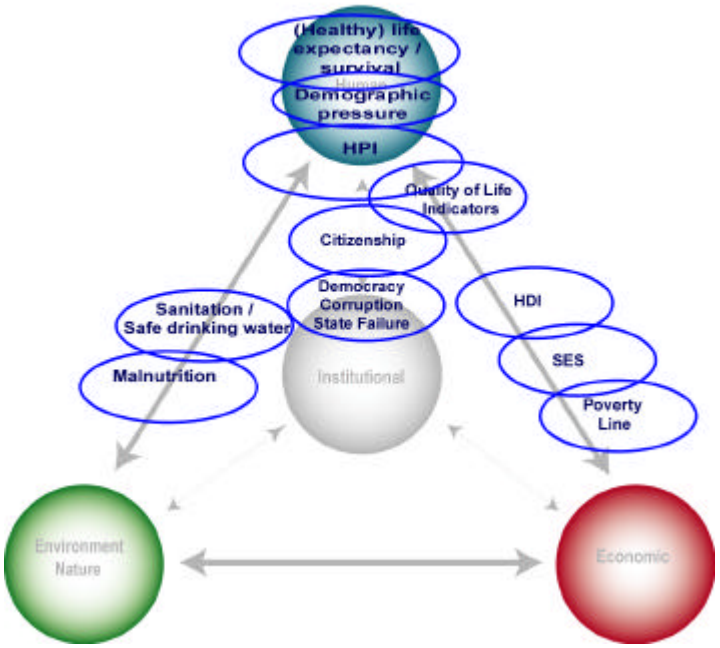


Figure 14. Position of sustainability indicators in the four domains.

4. Indicators revisited

The list of indicators can probably be endlessly extended. However, the most relevant aspects of indicators and indexes for sustainable development will be considered and discussed in the next sections, using the indicators and indexes described above.

4.1 Pitfalls and beacons

Although the terms 'indicator' and 'index' in the description of existing indicators are often mixed up and considered interchangeable, an attempt to clearly distinguish them will be made. An *indicator* is defined as a measurable quantity such as population and income. An *index* is defined as a multi-dimensional composite made from a set of indicators. The dimensions of an index may be valued differently and thus represent a weighted entity contributing to the value of that particular index. To overcome these misunderstandings, an 'indicator framework' is used for all sets of indicators and indexes. To arrive at an indicator-framework for human and social sustainability, the following pitfalls will have to be avoided (Meadows, 1998):

- Over-aggregation causing loss of too much information on the underlying processes or not representing them adequately. For example, an average income as used in the HDI covers up income inequality.

- The selection of indicators is often focused on what is measurable rather than what is important. Gender-inequalities are important but not properly reflected by the GDI, since the additional value of the GDI compared to the HDI turned out to be rather limited.

- Incompleteness and overconfidence. Indicator frameworks provide only a reflection of a system, not the real system. The UNDP claims that the HPI results in a percentage suffering from poverty; however, this is only a mathematical composite of three components closely associated with poverty.

- Some variables are only derivatives of the process for monitoring. For example, mortality rates are not exclusively determined by the availability of health services, but a broad spectrum of other factors as well.

- Be clear about what indicators are supposed to indicate and, even more important, what not. The use of vague and broad concepts such as human security might be a good starting point for the development of an indicator framework, but is far from sufficient. By describing the underlying processes aimed at in the monitoring, the use of such concepts named above can be avoided.

- Redundancy and/or mixing-up causal relationships. Elements comprising an index are often related and can cause redundancy (e.g. income and life expectancy in HDI, IHI). This is why the function of a separate indicator in an indicator framework should be regarded in relation to other indicators. In such a framework, causal-effect and the time dimension become relevant to distinguish. The UNCSD framework suggests making such a distinction; however, what is lacking is a description of the underlying relationships between the indicators.

- Transparency. The mathematical construction of an index involves many unavoidable choices about weighting and aggregation. It should therefore be possible to zoom in on the underlying indicators. This will require a transparent indicator framework.

4.2 Developing an indicator framework

The next step involves selecting criteria that a variable should meet to be included in the framework and avoiding the pitfalls previously mentioned. Criteria often used are: clear in value and content, relevant to policy context, sufficient, sensitive to changes, hierarchical, appropriate to scale, complementary instead of redundant, feasible to measure and showing comparability. Nevertheless, only a few of these criteria are suitable for operationalization purposes, the ultimate goal of this. As a matter of fact, fulfilling some criteria can only be verified after implementation, contrary to a priori imposed prescriptions. The loss of information due to over-aggregation should first be quantified and put in the right perspective before judgement can be passed. This loss of information can be analyzed by combining indicator frameworks with simulation models.

Interlinkage of indicators with simulation models

The relationship between indicator frameworks and simulation models is two-sided. On the one hand, the existing selections of variables included in the framework probably represent the most relevant questions policy makers and analysts would like to address. The inclusion of these variables in simulation models will, in this manner, promote the communication between modelers, and policy makers and analysts. However, application of an existing indicator framework will be restricted by the feasibility of translating existing issues into quantitative model terms. On the other hand, the use of an indicator-framework linked to a simulation model will provide an instrument to analyze the relevance and sensitivity of existing indicators and indexes. This interlinkage deals with several of the pitfalls. The underlying simulation model structure reflects the process an indicator is supposed to monitor; this is displayed in the lower layer in Figure 15 representing model variables. Secondly, causal relationships, but also inevitably occurring interdependencies between indicators, are made more specific. The time dimension is taken care of through this distinction of causalities.

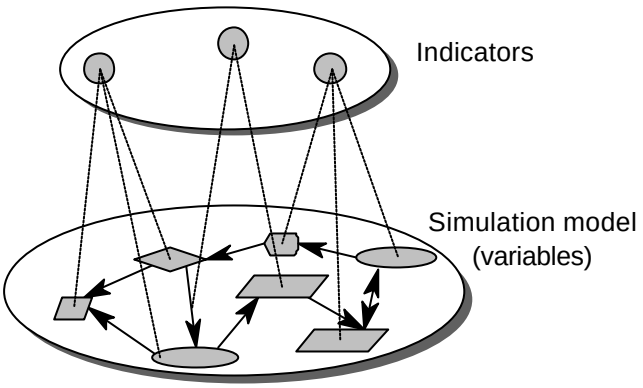


Figure 15. Interlinkage of indicators with (simulation) model variables.

Integrated indicator framework

In order to analyze the indicator definitions, they will have to be included in an overall framework of indicators. A Pressure-State-Impact-Response (PSIR) structure, described below, can be used as an organizational principle for the development of the indicator framework:

- Pressure System represents the driving forces or factors of influence on the state variables of the system.
- State System represents the system's actual state and its changes.
- Impact System represents the impacts of changes in the state subsystem.
- Response System represents all kinds of human intervention, like policy actions or individual responses; these responses can be initiated or stimulated by feedbacks, i.e. information flows from the impact subsystem.

The PSIR structure allows closure of the subsystem's cause-effect chains by linking the four subsystems, i.e. Pressure-State-Impact-Response, resulting in *vertical integration*. By structuring the indicators in the same way, the vertical integration of the indicator framework is safeguarded, thus forming the first dimension. The application of the PSIR structure for the total subsystem provides a comparison of the overall Pressure, State, Impact and Response indicators for the whole system. This is referred to as *horizontal integration*, the second dimension.

Hierarchical indicator framework

Such a model-based framework could consist of a hierarchical structure representing the underlying processes at different levels of aggregation. This third dimension, the *aggregation level*, is also included. This dimension is characterized by the distinction of various aggregation levels within each branch of the framework. The *absolute indicators*, consisting of observable and measurable variables, are included in the lowest level of the framework (e.g. the size of the population or income). The third-lowest level

contains *relative indicators* obtained from absolute indicators (e.g. income per capita or mortality rates). To attain the next level, the *aggregated index*, further aggregation will be required. The *index*, the multi-dimensional composite of two or more weighted *relative indicators* (e.g. life expectancy as composite of age-specific mortality rates), is used exclusively at this level. This same procedure can be applied to the different indexes to arrive at the *top-level index*. The HDI, in which life expectancy, literacy and income are included, is an example of such a top index, although no PSIR specification is given.

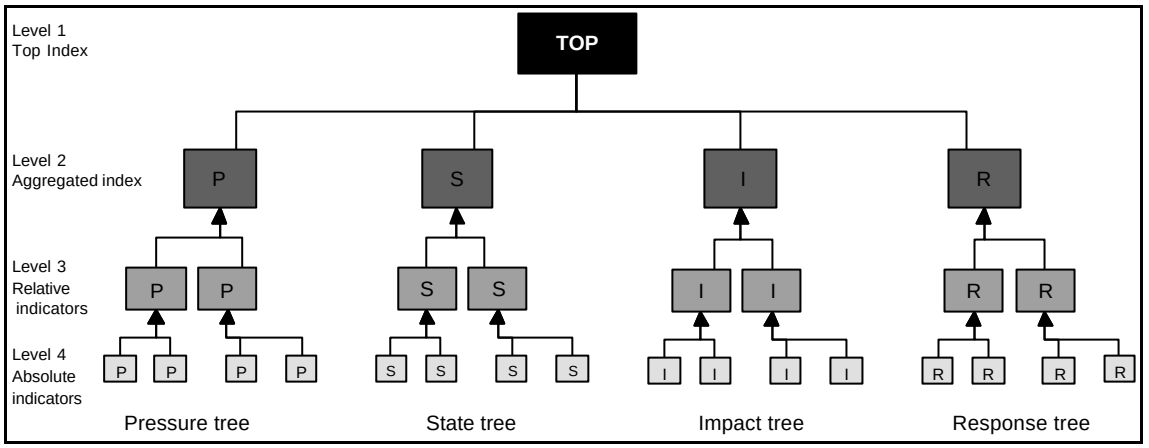


Figure 16. Hierarchical framework of indicators.

4.3 Human/Social sustainability: theory

Now that the procedure for developing an indicator framework is in place, the focus can shift to the main purpose of the study, i.e., the human/social domain of sustainable development. The main question here is 'what to indicate?' Addressing the UNDP's human development definition, 'how to have a long and healthy life in a stable society that facilitates people's choices and possibilities' can easily result in a random or unsystematic selection of indicators if no further specification is given of the underlying conceptual structures. For this, there are several useful available approaches attempting to address the 'most important' aspects of life. The most commonly cited might be Maslow's Holistic Dynamic Needs Hierarchy, which describes in sequential order a person's needs - from survival-related through to physical and on to fulfillment of one's life. The sequential order of the different layers implies that a person does not strive for a higher need unless the lower need is satisfied. In practice, the various levels of needs may not have such a clear boundary, even though the conditional character is present. To fulfil the security need, for example, a person's first aim might be to achieve his/her biological needs.

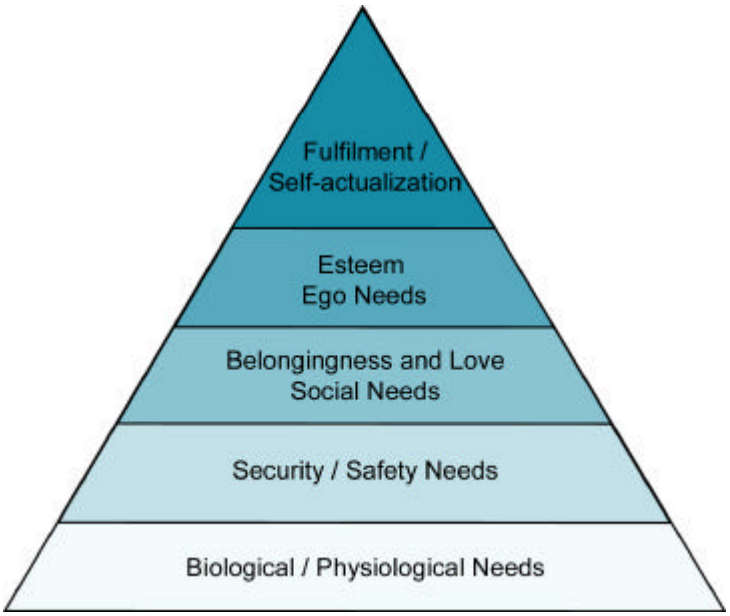


Figure 17. Maslow's hierarchy of needs.

The pyramid of needs in Figure 17 suggests that the higher one goes the narrower one can focus on associated needs. In practice, the shape could be reversed, so that the higher one goes in the pyramid, the higher the diversity will be. The basic needs at the bottom can be fulfilled in a straightforward fashion with food, water and shelter, while gaining life fulfillment may require a broad spectrum of all kinds of possibilities. See Table 3 for the associated description and indicators for the various need levels.

Table 3. Maslow's hierarchy of needs.

Needs	Description	Indicator
Self-actualization / fulfillment	Even when needs are satisfied, people expect that new discontent and restlessness will soon develop, i.e. unless the individual is doing what he/she, individually, is fitted for. Musicians must make music, artists must paint, poets must write if they are to be ultimately at peace with themselves. What humans can be, they must be. They must be true to their own nature.	
Esteem / ego	People in our society have a need or desire for a stable, firmly based, and usually high evaluation of themselves, for self-respect or self-esteem, and for the esteem of others.	Desire for strength, achievement, adequacy, mastery and competence, confidence, dignity
Belongingness and Love / Social	These involve relations among people in general, and have to do with giving and receiving affection. When unsatisfied, a person will keenly feel the absence of friends, a mate or children	Loneliness, ostracism, rejection, lack of friends, and feeling of being rootless
Security / Safety	Once the physiological needs are relatively well-gratified, a new set of needs emerges, which we may categorize roughly as the need for safety.	Security, stability, dependency, protection, freedom from fear and anxiety and need for structure
Biological / Physiological	Anything the physical organism needs to survive. Very fundamental life or death needs	Food, water, oxygen, shelter

Maslow's approach for describing sustainable development is limited, even though several other 'guiding lights' have used it. Both Daly (1990) and Bossel (1999) apply a similar kind of hierarchy, Daly making a primary distinction between means and ends, which are next classified as 'intermediate' and 'ultimate' (see Figure 18). The base of the pyramid is characterized by natural and physical systems, while the layers built on this base include human resources and behavior. Well-being is found at the ultimate end point or 'top' of the pyramid. Daly follows the World Bank capital approach to describe the (lowest three) levels. Bossel's approach seems slightly different, and the Maslow and World Bank approaches are also visible.

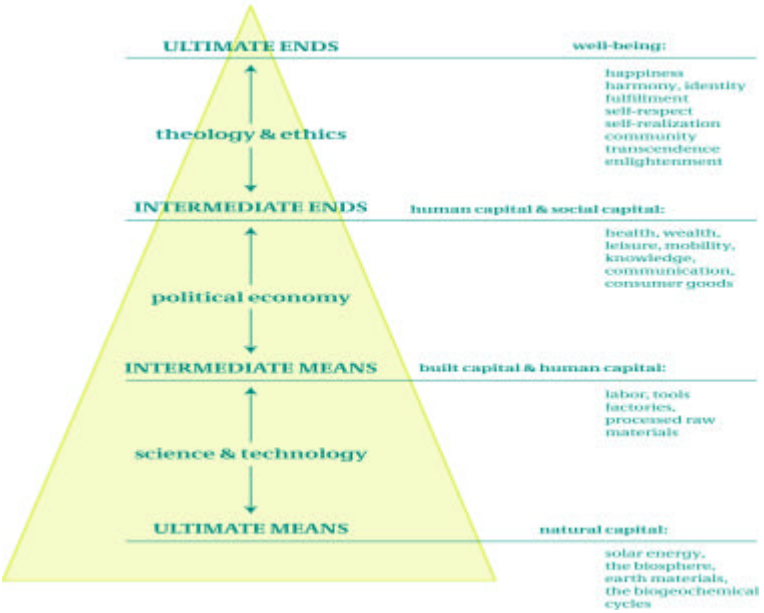


Figure 18. Daly Triangle (Daly, 1990).

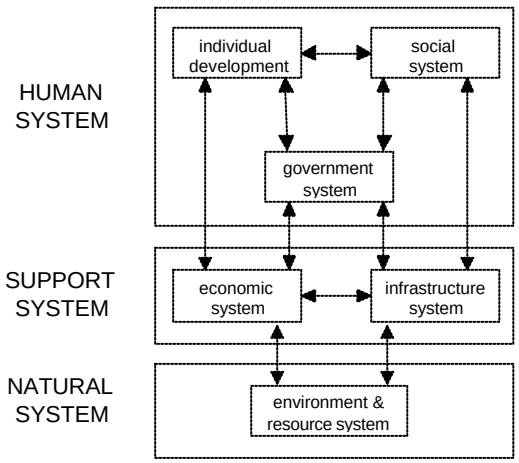


Figure 19. Bossel's framework for sustainability (Source: Bossel, 1999).

The capital approach, originating in the World Bank, has been mentioned several times. Although it can easily be confused with a purely economic approach (e.g. expressing goods in dollars, or seeing the population merely as a labor supply), its applications have now been extended.

First of all, human and social capital should be considered separately. **Human capital** is a valuation of characteristics and capabilities embedded in an individual or a homogenous group of individuals. From an economic perspective, being educated and healthy are indicators used to express human capital as a labor source. One is not educated for the mere purpose of obtaining a higher income, but education could be seen as a more fundamental skill for use in choosing a career, and for family planning and health issues. Broadening the economic perspective of human capital can occur similarly for health. A healthy state is not primarily being fit for work, but to live a life as long and happy as possible. The human capital of a country/region is obtained by summing all the individual capital of that country/region.

Social capital, on the other hand, refers to characteristics between (groups of) persons. It is the valuation of the connections between and cohesion of individuals that enable all kinds of (individual) activities. Social capital can be seen as the social infrastructure of a country/region. The World Bank uses the definition of social capital referring ‘to the institutions, relationships and norms that shape the quality and quantity of a society's social interactions’. These interactions can be regarded horizontally by focusing on the association between people; this consists of social networks that have an effect on community productivity and well-being (Woolcock and Narayan, 2000). The other, vertical dimension represents the association between people and organizations or/and institutions. This can be a negative association (corruption, suppression) or a positive (people participating in decision processes, freedom of religion and access to information).

Human and social capital have several interlinkages and are closely associated. Without the social capital or infrastructure, educating people is not possible, while, on the other hand, a social infrastructure including all kind of norms, values and laws might be difficult to obtain without people being at least literate. Serageldin (1987) combines these forms of capital by defining social sustainability as a result of the two. The two capital forms discriminate by the fact that a country looses human capital as a result of emigration, while migration has no direct influence on social capital. This idea of social sustainability might be nearest to the approach of Maslow, in which elements of social and human capital are also entangled.

4.4 Quality and quantity of stocks

The capital approach has a strong systems dynamics association (see e.g. Bossel, 1999; Daly, 1990; Rotmans and De Vries, 1997; Hilderink, 2000b). A system can be described as a collection of all kinds of stocks or reservoirs connected by the inflow and outflow of these stocks. The occurrence of an event initiates one or more flows determining changes in the system. The valuation of a stock results in the capitalization of stocks, or just capital. Capitalization can be done in an economic way by expressing a stock in Euros (e.g. value of oil resources), but also in an ecological (see Ten Brink, 2000) or social way (such as education level, see Lutz and Goujon, 2001). In line with this approach, two dimensions, the quantity and quality of a stock, can then represent stocks. These dimensions can be applied to life as seen in Figure 19.

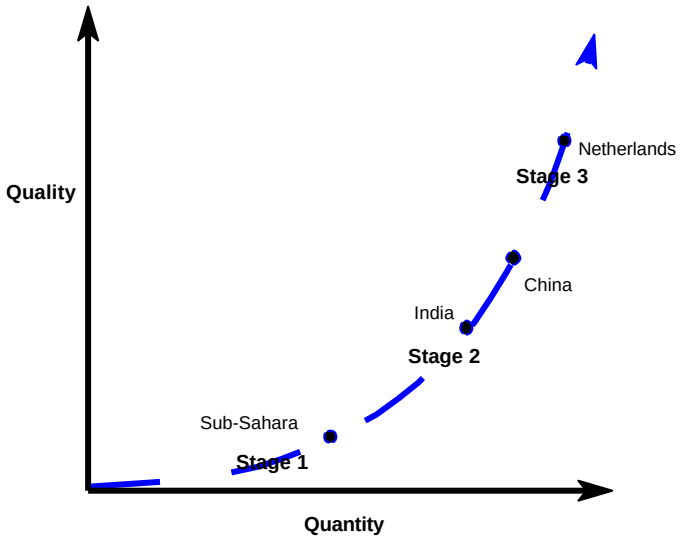


Figure 20. Trajectory of the least to less, and more developed countries on two dimensions, Quantity and Quality.

The quantity of life might be adequately indicated by life expectancy. There have been many attempts to value the stock called 'life'. Figure 20 depicts a health transition pathway, illustrating the sequence of Maslow's needs. First, quantity of life (i.e. life expectancy) will be increased, while in the later stages, the aim of mortality reduction is accompanied by striving for an increase of the quality of life (i.e. HALE). A cautious, next step could be to connect these pathways with (normative) goals. Reducing mortality rates (thereby increasing life expectancy) should be accompanied by compression of morbidity. Possible targets for these pathways are depicted in Figure 20. This is only an illustration on how targets can be combined with an indicator framework in a follow-up of this study. The scope here is, first of all, concerned with the development of such a framework.

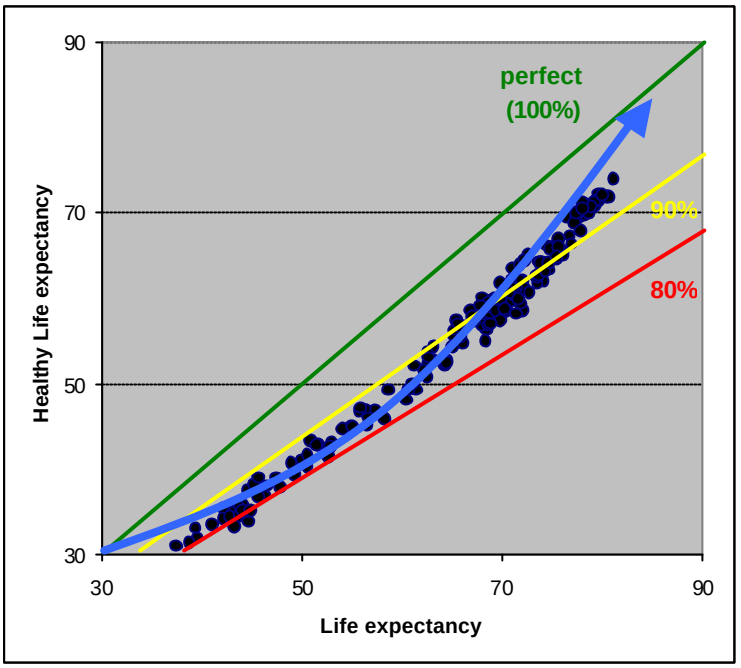


Figure 21. Healthy Life Expectancy (HLE) targets as percentage of Life Expectancy (LE).

5. Towards an indicator framework: first steps to implementation

The next step is to find synergy in the theoretical foundation and the practical operationalization of indicators. Coming up with the ultimate set of indicators for social sustainability is like searching for a pot of gold at the end of the rainbow. Not only will it be impossible to get consensus about this set if the definition of sustainable development is still not agreed upon, but the broad scope of sustainable development will result in an equally broad spectrum of issues which will not be covered completely by an ultimate set. Here we are not only concerned with the various domains but also with the geographical aggregation level and time horizon.

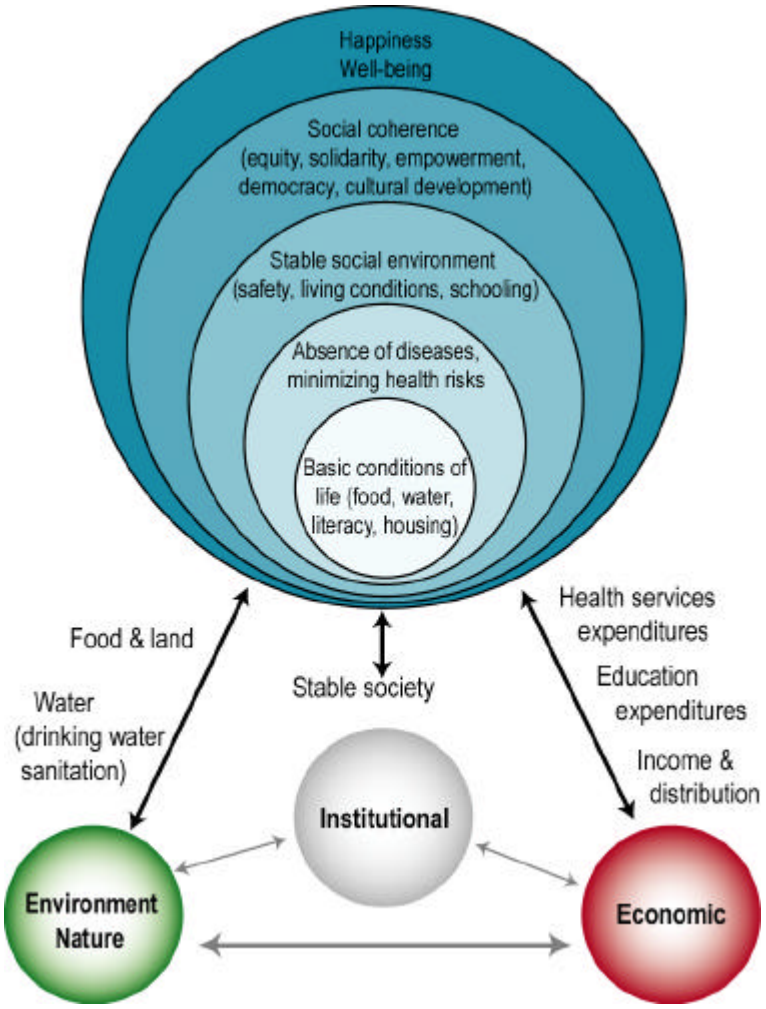


Figure 22. Different levels of needs and goals related to other domains of sustainability and existing indicators.

To construct an indicator framework that is flexible, applicable and covering not all, but a substantial part of the sustainable development issues, the following four essential

aspects will be applied. Firstly, Maslow's sequence of needs will be taken as the starting point, resulting in a reduced form. Secondly, only existing indicators or indicator constructs will be used to describe the different levels of needs. Thirdly, given the importance of the time dimension, underlying causal-effect relationships will be explicitly distinguished through a PSIR approach. And fourthly, the World Bank capital approach, including clear relationships of the Social domain with the Ecological, Economic and the subsequently added Institutional domains will be included. The application of these four aspects results in an indicator framework (see Table 4).

Table 4. Human and Social indicators: Maslow interlinked to the World Bank and UNCSD.

Level	Pressures	State variables	Impact indicators
1-2 (basic needs and capabilities)	Access to: social resources (medical services, education, contraceptives), natural resources (food, drinking water), economic resources (income and distribution)	Population malnourished, no safe drinking water, below poverty line, illiterate, no access to contraceptives Population related to deaths and diseased Population using modern forms of contraceptives / number of unwanted births Population by SES (educational level, income)	Life Expectancy Literate Life expectancy Years spend in generalized state of poverty / HPI WTFR / TFR Healthy Life expectancy
3-4 (Opportunities & Social structure)	Education and participation levels Demographic changes GINI coefficient for income	Economically, politically and socially active population Population by age	Citizenship / Participation (political, economic, social) Demographic pressure (old & young dependency ratio) Level of democracy Conflicts
5 Well-being / Happiness		Population by state of well-being	Well-being expectancy

These indicators will be worked out further in the following sections and applied to a selection of countries and regions. The focus will be on impact indicators, although in some cases, underlying pressure and state variables can be useful as additional information. Response indicators are left out of the description since this is beyond the scope of this report. Nonetheless, the importance of the (policy) responses is recognized and will be included in further steps. The indicators will, as far as possible, be presented at different aggregation levels. First, at a high aggregational, global or regional level countries and sub-regions will be presented at a particular moment in time (preferably with the most recent data). Second, at a lower level more detailed information will be picked out and a comparison made between differences in time for various regions/countries. Future developments will be illustrated showing the IPCC A1 scenario (for more detailed background information see Hilderink, 2000a and Hilderink, 2004). Country-specific (e.g. age-specific) data will be shown at the lowest most detailed level.

5.1 Basic needs and capabilities: quantity and quality of life

The lowest levels show a strong individual character. The ultimate indicator for these levels is life expectancy. Life expectancy is one of the most commonly used indicators to **quantify** the capital stock, 'life'. It is defined as the number of years a newborn is expected to live at the time of birth. Keep in mind that the life expectancy is only a reflection of *current* mortality rates of all ages and does not necessarily reflect the realization of the number of years to live. This difference is known as the difference between the period and cohort dimension. In a period-approach the current information of all age groups is combined, while in the cohort-approach, information is obtained by following a group of people born in a specific period. The (period) life expectancy for a newborn is relatively low due, for example, to an outbreak of disease, while the child can still become older even if there are outbreaks in the future.

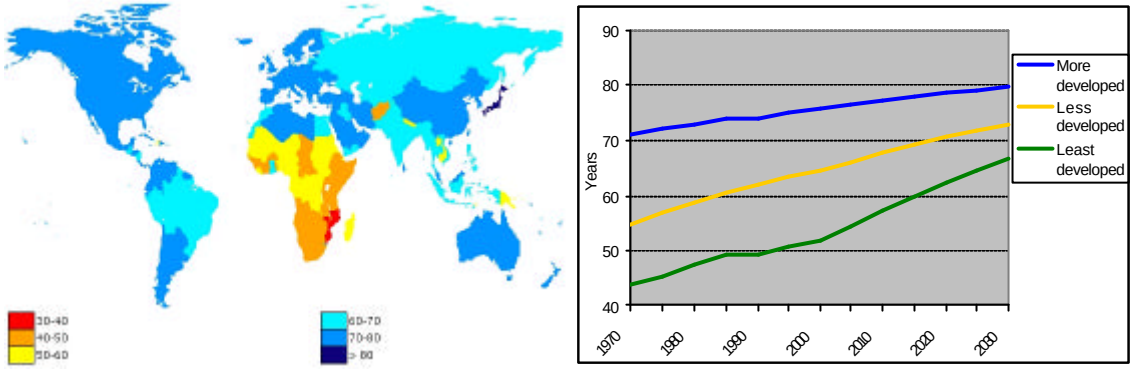


Figure 23. Life expectancy at birth for all countries for 2000 and major regions for 1970-2050 (UN, 2000).

The dominance of the age dimension pre-eminently reflects the aspect of time. While the intergenerational dimension might be more difficult to see, it at least has an intra-generational facet. This age dimension enables us to explore the various forms of state in the context of a life cycle. Another way of presenting life expectancy at a more detailed level is to show the life expectancy at various ages (see Figure 24). This figure shows a life expectancy at birth for inhabitants of Angola, as a least developed country, to be around 46 years (red line). Surviving the first years of life increases a person's life expectancy, for example, to 53 years at age 5, implying a life span of 58 years, and a remaining life expectancy of 21 years at age 50, implying a life span of 71 years. At the age of 90 years, life expectancy is around 3 years, but from that point onwards the three countries do not differ that much anymore. A second kind of measurement is survival by age (e.g. measurement used in the Human Poverty Index), representing the percentage of the population surviving to a certain age. In Angola, 20% of the population does not reach 5 years of age, while in the Netherlands 20% reaches the age of 70.

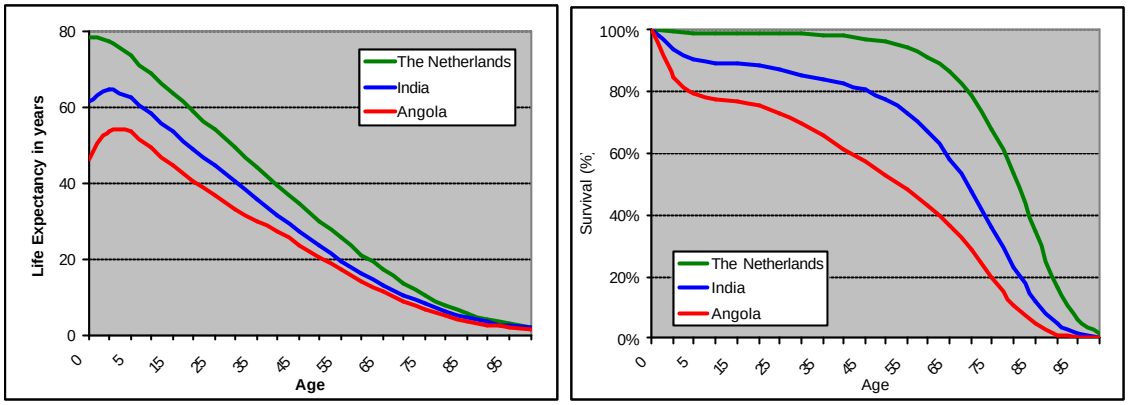


Figure 24. Life expectancy by age (number of years a person is expected to live at a certain age) and survival by age, 2000.

In referring to a subsequent level of needs, we will look at a second dimension, the **quality** of a person's life. The quality dimensions can be represented by relatively simple measurements such as those covering people living below the poverty line, and those confronted with illiteracy and poor sanitation, going on to more advanced indicators such as Health-Adjusted Life Expectancy or Human Poverty Index. Using the advanced methodology of the life tables, the age-specific information can be translated to the expected number of years living in a particular state of quality of life. Obviously, this requires age-specific data, which are not always available.

5.1.1 Literacy

One of the most basic requirements of life is the ability to understand, read and write short, simple statements on everyday life. This is the most commonly used definition for literacy. Illiterates lack the basic capability to make their own choices on all facets of their daily life. Adult literacy rates are displayed in the figures below for all countries for 2000 and, for developing and developed countries for the period 1970 – 2000.

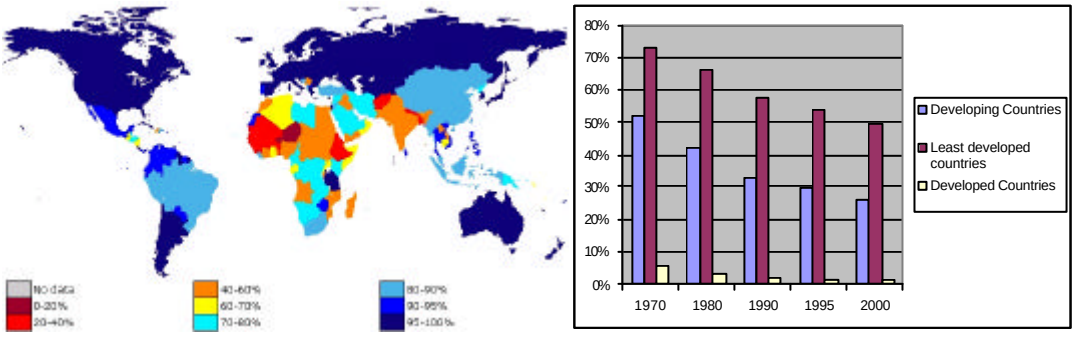


Figure 25. Literacy rate for all countries for 2000 and major regions for 1970-2000.

Some countries publish age-specific literacy rates. These age-specific data are applied to life tables to obtain the Literate Life Expectancy (LLE), expressing the number of years a person can expect to be literate. The figures below show country-specific data. In 1970 life expectancy at birth in India was 48 years, with an LLE of only 14 years. In 1980 the

Mexican LE was 64, while the LLE reached 44. The Netherlands' case shows the limitations of using literacy. In 1990, persons are expected to be literate for 69 years of the total 74 years of life expectancy, more or less the upper level, assuming that schooling starts around the age of 5. In the situation of developed countries, educational attainment data for various levels can be used (see Section 5.2).

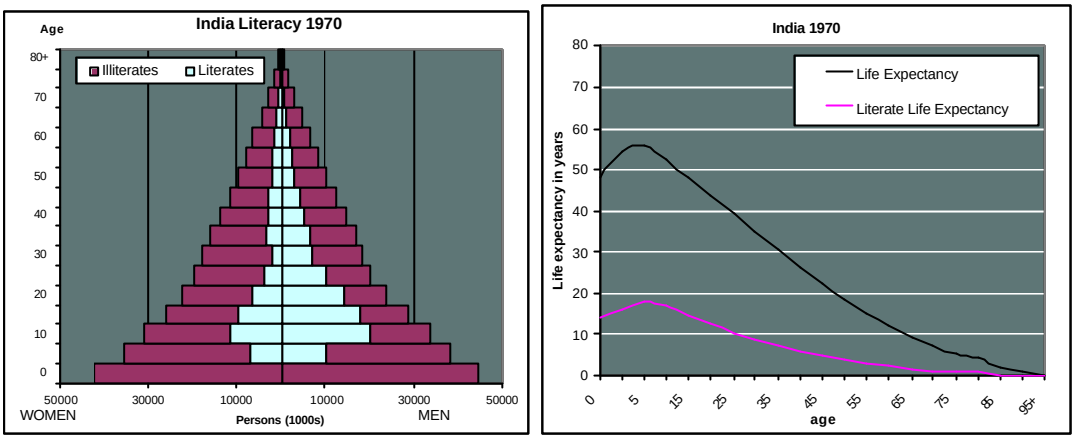


Figure 26. Literacy by age and sex, Literacy Life Expectancy, India 1970.

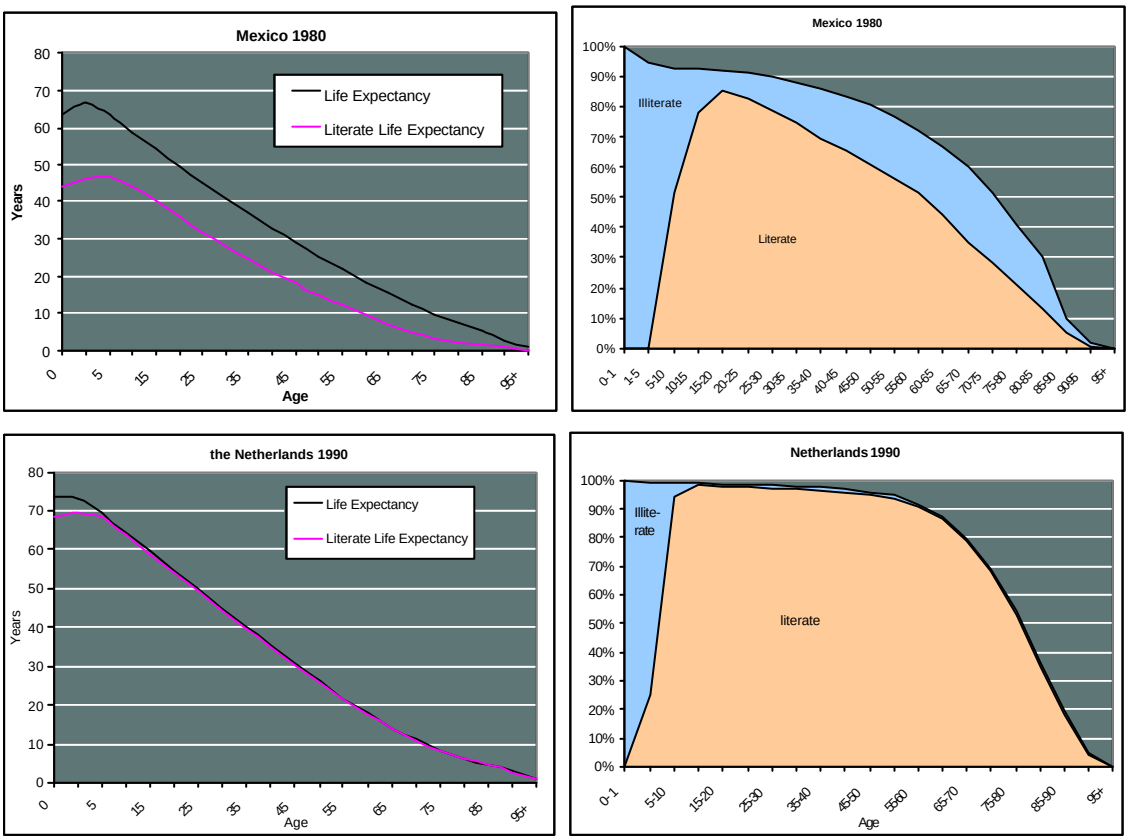


Figure 27. Literate life expectancy (LLE) and Literate survival, Mexico 1980; The Netherlands 1990.

5.1.2 Poverty

Another basic necessity for people to be able to make desired choices is access to financial possibilities. Poverty might be used here for the lowest level, represented by the percentage of persons below the poverty line of US$1 per day. However, global coverage of these data on a country level is impossible due to the lack of data, necessitating use of the HPI (at a regional level) employing the PHOENIX results (Hilderink, 2000b). Combining these data with the population projection of PHOENIX (Hilderink, 2000a) results in the number of people living in poverty according to the UNDP HPI definition. Age-specific data (based on different low-income levels) are available for two countries, the Netherlands and USA. These are combined again with the life-table data, resulting in the Poverty Life Expectancy (PLE).

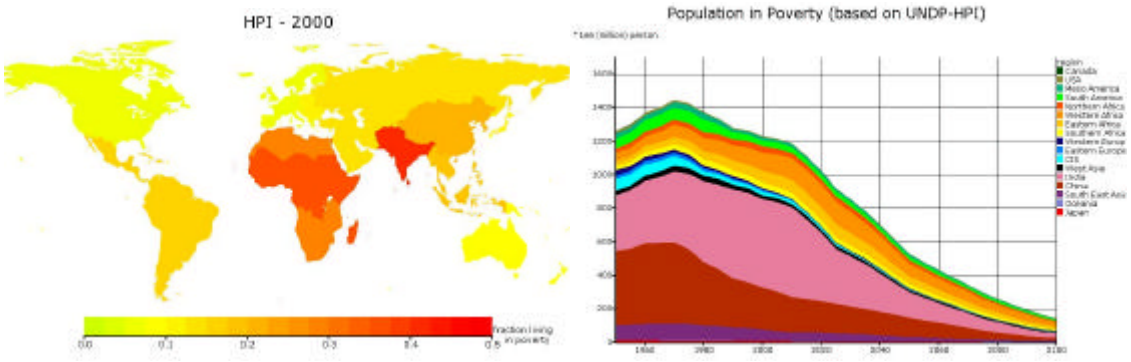


Figure 28. Human Poverty Index (HPI) and population living in poverty in major world regions, 1950-2100 (A1 scenario).

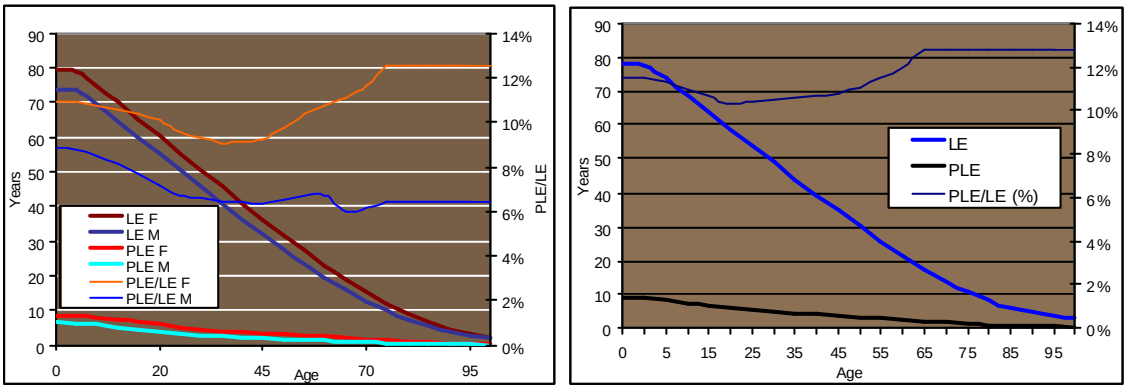


Figure 29. Poverty Life Expectancy (PLE), both sexes for the USA in 1997 (left) and the Netherlands in 1999 (right), along with the percentage of years that we expect people to live in poverty (PLE/LE).

5.1.3 Health

Moving up in the pyramid, the need - still a basic one - is to live a healthy life, both as an outcome and capability to achieve the life one wants. The WHO methodology is applied here for the HLE. Figure 31 presents the age-specific data.

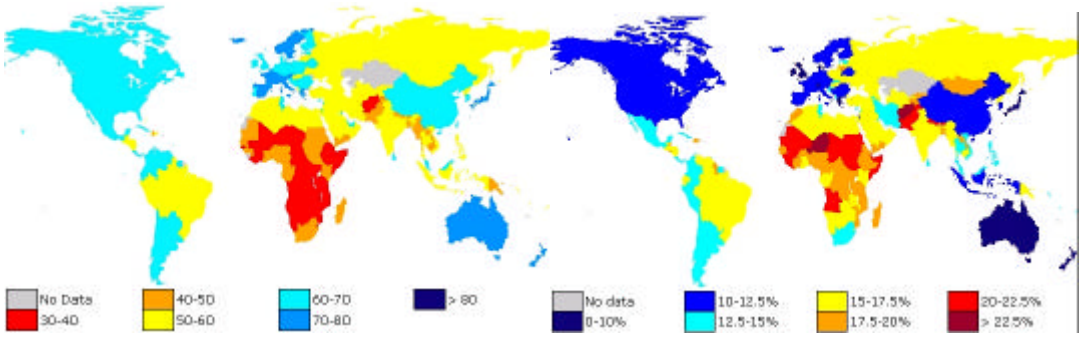


Figure 30. Healthy Life Expectancy (HLE) and Loss of Healthy Life Expectancy as percentage of Life Expectancy in years for all countries, 1999.

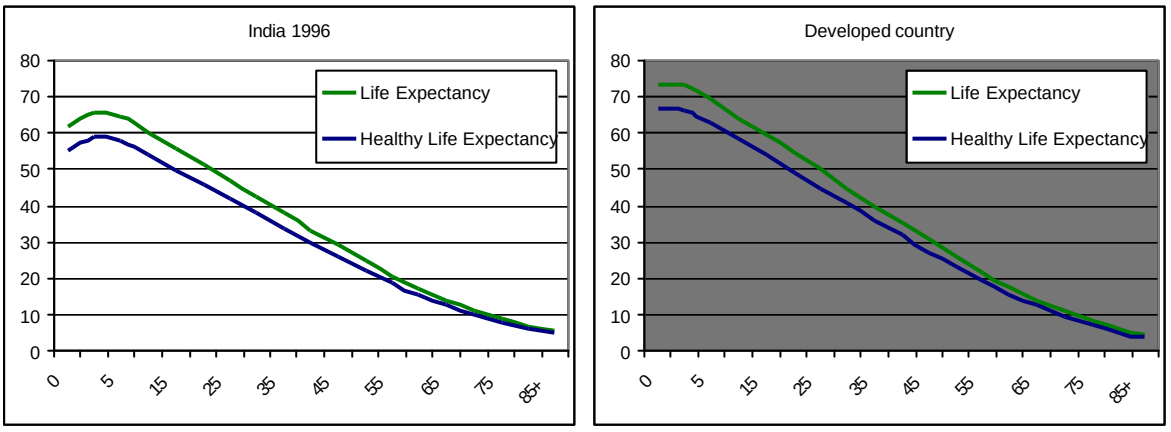


Figure 31. Healthy Life Expectancy (HLE) and Life Expectancy (LE) in India and a developed country.

5.2 Opportunities and social cohesion

Indicators for opportunities and social cohesion represent the next levels of needs. The selected indicators for participation are labor-oriented. Due to lack of (global) data, other participation aspects, as mentioned in Table 4, are not included here. Overall participation rates expressed as the ratio between labor force and total population are shown first. These are followed by depiction of unemployment rates and the female working force. This opportunities indicator is again a more individual-oriented indicator, which makes it possible to combine with the life-table method. Social cohesion is represented by demographic pressure as an indication of the age balance in society. Secondly, the institutional dimension is indicated by level of democracy and political

stability; the cumulative number of conflicts illustrates the final outcome of social instability.

5.2.1 Citizenship/participation (labor)

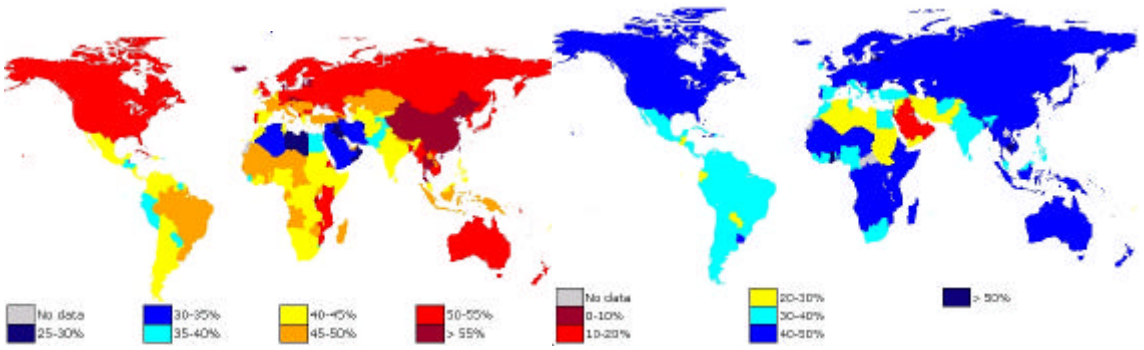


Figure 32. Participation rates: labor force (unemployment included) as a percentage of the total population for 2000 and the female population active in the labor force (as percentage of total) for 1999 (Source: World Bank, 2002).

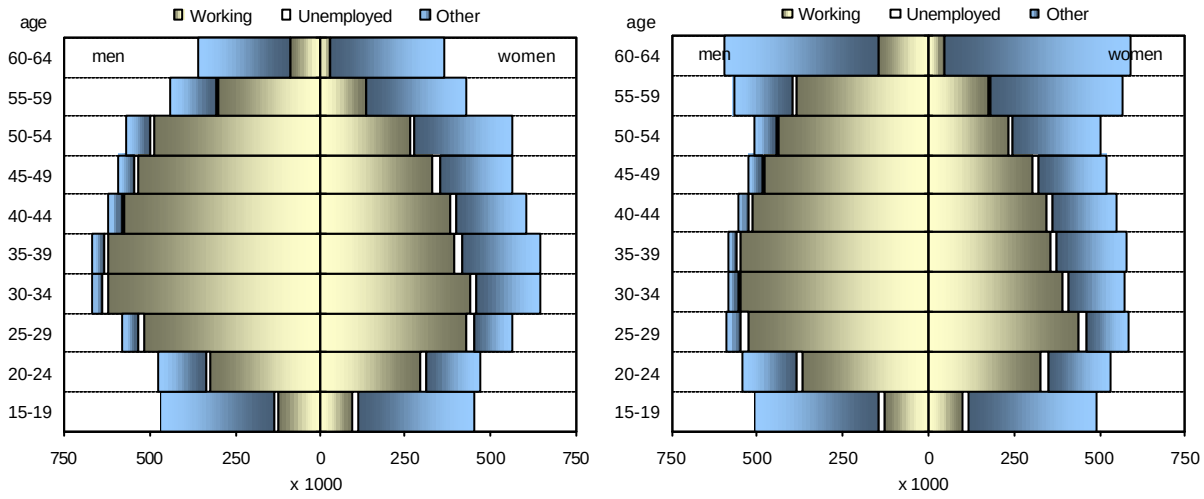


Figure 33. Population according to position on the labor market in the Netherlands, 2000 and 2030 (constant participation rates), derived from NiDi.

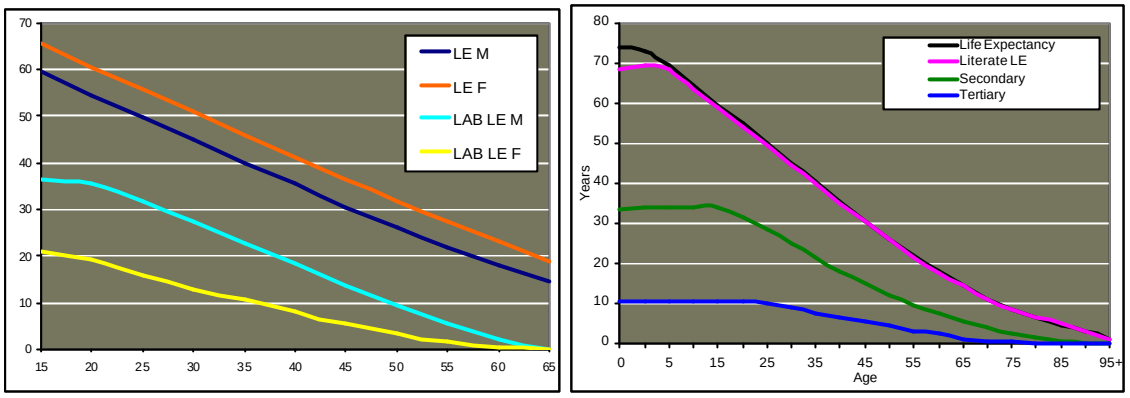


Figure 34. Labor Life Expectancy (LAB LE) and Life Expectancy (LE) (based on net participation rates), and education life expectancy for different levels (literate, secondary, tertiary), in the Netherlands.

5.2.2 Demographic pressure

Most commonly used is the demographic pressure or dependency ratios for young (green) and old (gray) to relate those (potentially) in need to those who are potentially independent and can support those in need. Green pressure is defined as the number of young people (0-15 years) in proportion to the number of persons in the active category (15-64 years). Gray demographic pressure is similarly defined (65 and over as a proportion of 15-64 years). The sum of these two components results in the total demographic pressure.

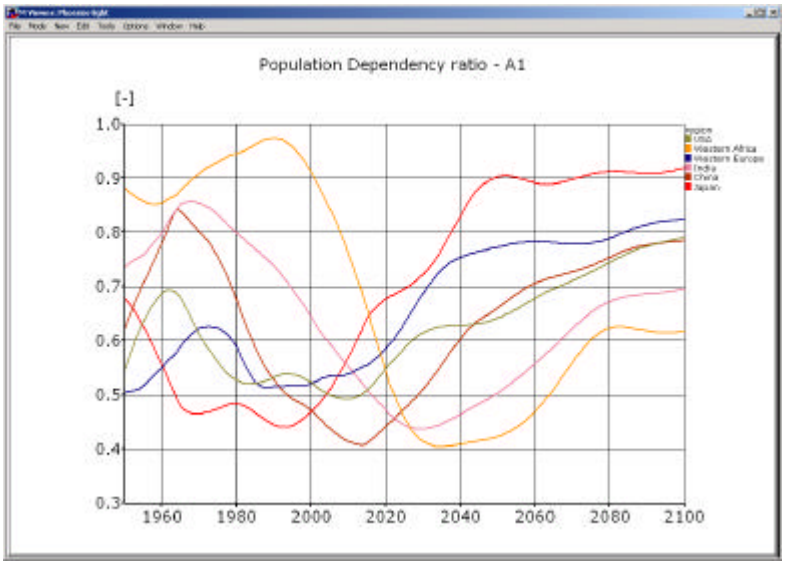


Figure 35. Dependency ratio for six selected regions, scenario A1.

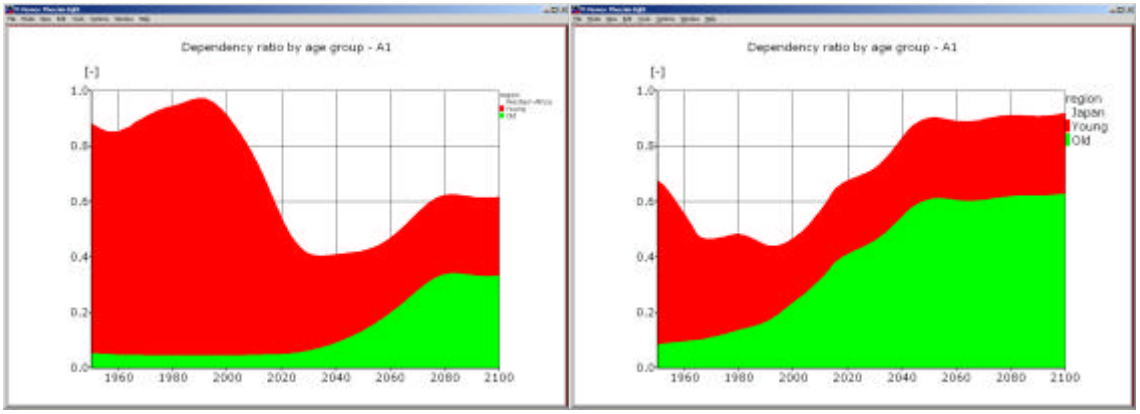


Figure 36. Young and old dependency ratios for Western Africa and Japan, IPCC scenario A1.

5.2.3 Democracy and political stability

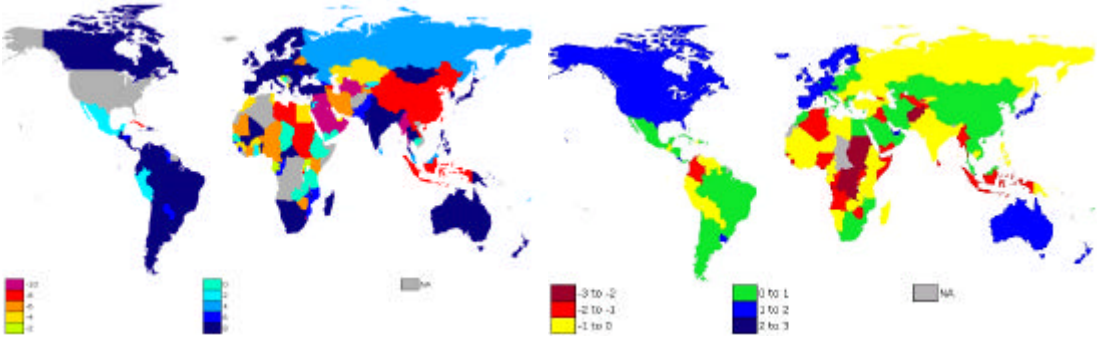


Figure 37. Democracy Indicator and Political Stability Indicator (-3 = very low, 3 = very high) for 2000 (Source: World Bank, 2002).

5.2.4 Conflicts

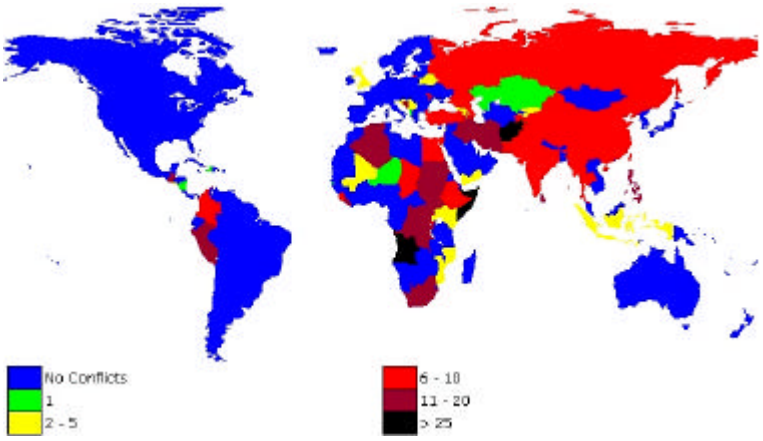


Figure 38. Number of cumulative conflicts between 1990 and 1999 (Source: State Failure Task Force, 2003).

5.3 Happiness and well-being

Arriving at the top of the pyramid, we find well-being and happiness as the selected indicators. At this level, there are countless variations in operationalization. This level will only tentatively be illustrated with references to the Netherlands using some of the available data. First, psychological well-being is illustrated by three facets, namely self-esteem, mastery and sense of coherence. These aspects can be seen as outcomes or achievements of the previous steps in the pyramid. The final presentation is the happiness indicator, representing the top of the pyramid, which reflects how happy people consider themselves.

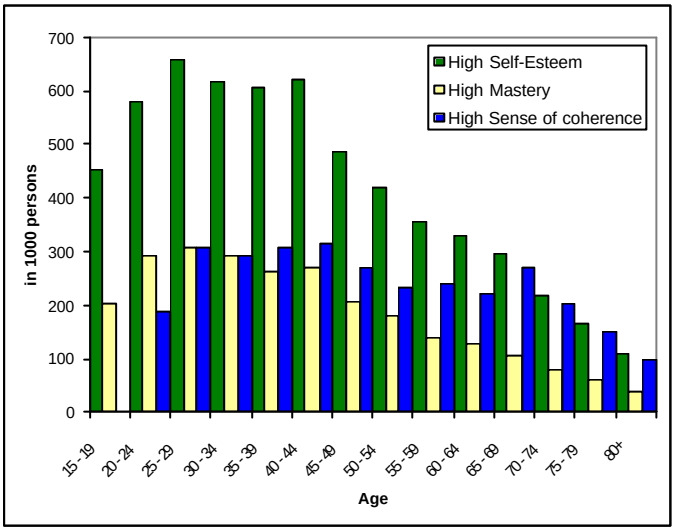


Figure 39. Psychological well-being for the Netherlands in the1990s derived from Canadian data on well-being.

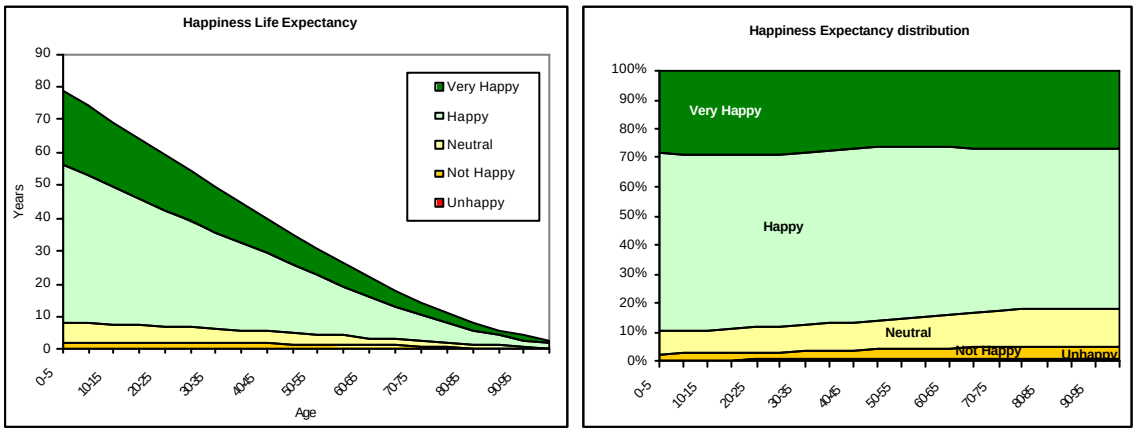


Figure 40. Happiness Life Expectancy for 2000 (Source: CBS, 2002).

6. Conclusions

- There is no such a thing as an ultimate list of indicators for sustainable development. This could be especially true for the human and social domain of sustainable development, partly due to the complexity of the sustainable development concept, but also to difficulties in describing the human and social domain more systematically. Processes in the human and social domain tend to be multi-causal, and usually only associative relations can be distinguished. Nevertheless, there is a strong need for a set of sustainability indicators. The UNCSD made a substantial attempt in defining an extensive list of indicators for sustainability, although a theoretical foundation seemed to be lacking. Other concepts, such as the Human Development Index and Human Poverty Index provided by the UNDP, are examples of widely used indicators, although the linkage with the underlying concept and process is unclear or at least indirect. However, the collection of existing indicators provides a wide range of all kinds of concepts, which can be used instead of coming up with a completely new set of indicators.

- The time factor is an important dimension in sustainable development and also in the other mentioned concepts. In spite of this importance, most indicators seem to be based on a static approach or are comparably static. The UNCSD approach suggests that this is taken into account by including the pressure-state-impact classification. In the ideal situation, an indicator framework for sustainable development should be directly interlinked with a simulation model, safeguarding this time factor. However, the availability of models that cover the broad spectrum of sustainable development is rather limited. Unfortunately, there is again a similar disproportional lack of simulation models for the social area.

- The complex nature of sustainability demands a thorough foundation to develop an indicator framework, which covers the most relevant aspects of well-being and avoids pitfalls. Maslow's theory of hierarchy of needs provides a good guiding light to be used in combination with other approaches specifically aimed at sustainable development. It is particularly the hierarchical positioning of different pyramid layers, without considering them independently, which will provide a sound basis for use.

- The indicator framework, as presented in this report, is flexible, makes a clear distinction between causes and effects, and allows investigating indicators at various levels of detail and theoretical foundations. It is not meant as a complete new framework but comprises existing definitions and concepts. In this way, indicators can be easily replaced or completed by others without compromising the underlying

ideas. This framework can assist the process of consensus-building for use of a better set of indicators in the human and social sustainable development domain.

Appendix

Millennium Development Goals (MDG)

A framework of 8 goals, 18 targets and 48 indicators to measure progress towards the Millennium Development goals was adopted by a consensus of experts from the United Nations Secretariat and IMF, OECD and the World Bank. (Road Map towards the Implementation of the United Nations Millennium Declaration, A/56/326). Each indicator below is linked to millennium data series and to background series related to the target in question.

Goals, Targets and Indicators

Goal	Target	Indicator
1 Eradicate extreme poverty and hunger	1 Halve, between 1990 and 2015, the proportion of people whose income is less than US$ 1 per day.	1. Proportion of population below US$1 (PPP) per day (World Bank) 2. Poverty gap ratio (incidence x depth of poverty) (World Bank) 3. Share of poorest quintile in national consumption (World Bank)
	2 Halve, between 1990 and 2015, the proportion of people who suffer from hunger.	4. Prevalence of underweight children under five years of age (UNICEF - WHO) 5. Proportion of population below minimum level of dietary energy consumption (FAO)
2. Achieve universal primary education	3. Ensure that children everywhere, boys and girls alike, will, by 2015, be able to complete a full course of primary schooling.	6. Net enrolment ratio in primary education, girls, boys, total (UNESCO) 7. Proportion of pupils starting grade 1 who reach grade 5, girls, boys, total (UNESCO) 8. Literacy rate of 15-24-year-olds, women, men, total (UNESCO)
3. Promote gender equality and empower women	4 Eliminate gender disparity in primary and secondary education, preferably by 2005, and to all levels of education no later than 2015.	9. Ratio of girls to boys in primary, secondary and tertiary education (UNESCO) 10. Ratio of literate women to men of 15- to 24-year-olds (UNESCO) 11. Share of women in wage employment in the non-agricultural sector (ILO) 12. Proportion of seats held by women in national parliament (IPU)
4. Reduce child mortality	5. Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate.	13. Under-five mortality rate (UNICEF - WHO) 14. Infant mortality rate (UNICEF - WHO) 15. Proportion of 1-year-old children immunized against measles (UNICEF - WHO)

5. Improve maternal health	6. Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio.	16. Maternal mortality ratio (UNICEF - WHO) 17. Proportion of births attended by skilled health personnel (UNICEF - WHO)
6. Combat HIV/AIDS, malaria and other diseases	7. Have halted by 2015 and begun to reverse the spread of HIV/AIDS.	18. HIV prevalence among 15-to-24-year-old pregnant women (UNAIDS, UNICEF, WHO) 19. Condom use rate of the contraceptive prevalence rate (UNICEF, UN Population Division)b (not yet available) 20. Number of children orphaned by HIV/AIDS (UNICEF-UNAIDS)
	8. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.	21. Prevalence and death rates associated with malaria (WHO) 22. Proportion of population in malaria risk areas using effective malaria prevention and treatment measures (UNICEF - WHO)d 23. Prevalence and death rates associated with tuberculosis (WHO) 24. Proportion of tuberculosis cases detected and cured under directly observed treatment short course (DOTS) (WHO)
7. Ensure environmental sustainability	9. Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources.	25. Proportion of land area covered by forest (FAO) 26. Ratio of area protected to maintain biological diversity to surface area (UNEP-IUCN) 27. Energy use (kg oil equivalent) per US$1 GDP (PPP) (IEA, UNSD, World Bank) 28. Carbon dioxide emissions (per capita) (UNFCCC, UNSD) and consumption of ozone-depleting CFCs (ODP tons) (UNEP-Ozone Secretariat) 29. Proportion of population using solid fuels (WHO) (not yet available)
	10. Halve by 2015 the proportion of people without sustainable access to safe drinking water.	30. Proportion of population with sustainable access to an improved water source, urban and rural (UNICEF - WHO)
	11. Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers.	31. Proportion of urban population with access to improved sanitation (UNICEF - WHO) 32. Proportion of households with access to secure tenure (owned or rented) (HABITAT) (not yet available)
8. Develop a global partnership for development	12. Develop further an open, rule-based, predictable, non-discriminatory trading and financial system. Includes a commitment to good governance, development and poverty reduction - both nationally and internationally.	<u>Official development assistance</u> 33. Net ODA, total and to LDCs, as percentage of OECD/DAC donors' gross national income (OECD) 34. Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation) (OECD) 35. Proportion of bilateral ODA of OECD/DAC donors that is untied (OECD) 36. ODA received in landlocked countries as proportion of their GNIs (OECD) 37. ODA received in small island developing States as proportion of their GNIs (OECD)
	13. Address the special needs of the least developed	<u>Market access</u>

	countries. Includes: tariff and quota-free access for exports from least-developed countries; enhanced program of debt relief for HIPCs and cancellation of official bilateral debt; more generous ODA for countries committed to poverty reduction.	38. Proportion of total developed country imports (by value and excluding arms) from developing countries and from LDCs, admitted free of duties (UNCTAD) (not yet available) 39. Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries (UNCTAD) (not yet available) 40. Agricultural support estimate for OECD countries as percentage of their GDP (OECD) 41. Proportion of ODA provided to help build trade capacity (OECD, WTO) e (not yet available)
	14. Address the special needs of landlocked countries and small island developing States (through the Program of Action for the Sustainable Development of Small Island Developing States and the outcome of the 22nd special session of the General Assembly)	<u>Debt sustainability</u> 42. Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative) (IMF - World Bank) (see indicator 43 below) 43. Debt relief committed under HIPC initiative, US$ (IMF - World Bank) 44. Debt service as a percentage of exports of goods and services (IMF - World Bank)
	15. Deal comprehensively with the debt problems of developing countries through national and international measures to make debt sustainable in the long term.	
	16. In cooperation with developing countries, develop and implement strategies for decent and productive work for youth.	45. Unemployment rate of 15- to 24-year-olds, each sex and total (ILO)
	17. In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries.	46. Proportion of population with access to affordable essential drugs on a sustainable basis (WHO)
	18. In cooperation with the private sector, make available the benefits of new technologies, especially information and communications.	47. Telephone lines and cellular subscribers per 100 population (ITU) 48. Personal computers in use per 100 population (ITU) and Internet users per 100 population (ITU)

Calculation of modified Life Expectancy

Sullivan's method to calculate life expectancies is based on age-specific death rates (ASDRs, represented by ${}_nm_x$). For an abridged life table ASDRs are given per five-year age groups (the youngest cohort can be further distinguished by younger than 1 and 1 to 4 years olds). These ASDR calculations are based on the mid-year population in age interval x to x+n and the number of deaths between ages x and x+n during the year. The calculation of the different elements of the life table are (briefly) described in the following way:

${}_nm_x \sim {}_nM_x = {}_nd_x / {}_nL_x$
= number of deaths in cohort between ages x and x+n / number of person-years lived in the cohort between ages x and x+n

and the probability of dying is:

${}_nq_x = {}_nd_x / l_x$ = number of deaths in cohort between ages x and x+n / number of person-survivors in the cohort
$= n\ {}_nm_x / (1+n/2)_nm_x$

$l_{x+n} = l_{x+n}\ (1- {}_nq_x)$ where $l_0 = 100000$

Then:

${}_nL_x = n\ l_{x+n} + n/2\ {}_nd_x$

And finally:

$e_x = SUM(a = x \text{ to ages}, {}_n L_a) / l_x$

To calculate a modified life expectancy in which the prevalence of particular state is taken into account, a YL (years lost, e.g. because of being ill or illiterate or in a state of poverty) is introduced for all ages. The equations are:

${}_nML_x = (1- {}_nYL_x)\ {}_nL_x$

and

$me_x = SUM(a = x \text{ to ages}, {}_nML_a) / l_x$

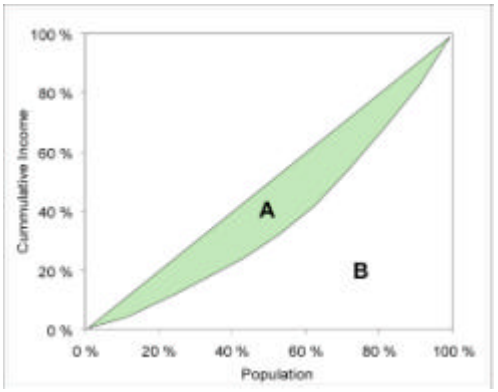
In the table below, the different life table values are given for the Netherlands for 2000. The YL here represents 'not in a good health status'

Abridged and Modified Life Table for the Netherlands 2000 (Source: CBS, 2002)

Age x	$_nq_x$	$_nD_x$	1,000 $_nm_x$	l_x	$_nL_x$	e_x	YL_x	ML_x	me_x
0-5	0.00648	768	1.3	100,000	498,486	79	0.450	493,501	37.7
5-10	0.0005	164	0.1	99,352	496,645	74	0.450	491,679	35.4
10-15	0.0005	107	0.1	99,302	496,397	69	0.450	491,433	32.8
15-20	0.001998	107	0.4	99,253	495,805	64	0.410	485,888	30.2
20-25	0.002497	258	0.5	99,054	494,699	59	0.410	484,805	27.6
25-30	0.002497	367	0.5	98,807	493,464	54	0.410	478,660	25.0
30-35	0.002996	347	0.6	98,560	492,118	50	0.410	477,355	22.4
35-40	0.004491	419	0.9	98,265	490,304	45	0.430	470,692	19.9
40-45	0.007474	581	1.5	97,824	487,426	40	0.430	467,929	17.4
45-50	0.012428	921	2.5	97,093	482,666	35	0.500	463,360	15.0
50-55	0.018834	1,510	3.8	95,886	475,239	31	0.500	456,230	13.0
55-60	0.030559	2,686	6.2	94,080	463,714	26	0.500	449,803	11.1
60-65	0.047427	4,627	9.7	91,205	445,935	22	0.500	432,557	9.1
65-70	0.079424	7,347	16.5	86,879	418,203	18	0.510	401,475	7.3
70-75	0.128207	10,662	27.3	79,979	375,600	14	0.510	360,576	5.7
75-80	0.206658	14,690	45.9	69,725	313,927	11	0.550	301,370	4.2
80-85	0.330698	17,776	79.1	55,316	231,263	8	0.550	222,012	3.1
85-90	0.497032	17,116	133.9	37,023	137,428	6	0.550	131,931	2.2
90-95	0.68	19,544	220.7	18,621	57,764	4	0.550	55,454	1.6
95+	1		355.6	5872	16,515	2.8	0.550	15,855	1.1

Lorenz curve and the GINI coefficient

This index can be used to measure the degree of inequality in the distribution of family or individual income in a country. The index is calculated from the Lorenz curve, in which cumulative income is plotted against the cumulative number of persons or families ordered from the poorest to the richest. The index is the ratio of the area between a country's Lorenz curve (see green shaded area (A) in figure below) and the entire triangular area under the 45-degree line (green shaded area A plus area B). The more nearly equal a country's income distribution, the closer the Lorenz curve to the 45-degree line and the lower its GINI index. The more unequal a country's income distribution, the farther its Lorenz curve from the 45-degree line and the higher its GINI index. If income were distributed with perfect equality, the Lorenz curve would equal the 45-degree line and the index would be zero. If income were distributed with perfect inequality, the curve would coincide with the horizontal axis, with a steep increase at the right end of the horizontal axis to the level of 100%. The GINI would be almost 1.



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