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Sustainable Human Development Index—a pragmatic proposal for monitoring sustainability within the affordable limits

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Abstract

Two powerful concepts – of 'sustainable development' and of 'human development' – have evolved over the past three decades mutually enriching each other to gradually merge into the idea that a development path cannot claim to be 'human' unless it is 'sustainable'. UN conferences on sustainable development have regularly called for better measurement of sustainable human development, but an agreed measure is still far from sight. With the adoption of the ambitious, complex, and transformative Sustainable Development Goals at the UN Sustainable Development Summit in September 2015 and the cautiously hopeful outcome of the of the COP21 meeting in Paris in December 2015, the issue of robust and reliable indicators to monitor sustainable human development moved a step closer from the realm of academic research and advocacy toward informing policies.

While the Human Development Index (HDI) is well established as an index of human development, an agreed and equally intuitive measure of **sustainable** human development is still absent despite numerous proposals in that direction. The challenges it faces are related both to the selection of indicators and to the way the concept of sustainable development is applied. Apart from preserving the environment, 'sustainability' also entails both economic and social aspects: the ability to sustain an achieved level of wellbeing over time without depleting the available stocks of natural, human-made and social capital). This is the logic behind the Brundtland Commission's original definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". However, it is not easy to define what is to be sustained today and what needs are to be met in the future.

This paper proposes a pragmatic compromise approach to sustainable human development measurement. It builds on a specific understanding of 'sustainability' as "ability to sustain the achieved level of human development without relying on debt of any kind" (inter or intra-generational). It looks into two aspects of development: the achieved **status** (the level of well-being reflected in the HDI) and the **process** (the way the status has been achieved). The **status** is the development aspect captured in the four dimensions of the HDI (the traditional three plus one dimension covering the environmental aspects of development). In our approach, the state of the natural environment has an intrinsic value similar to the other three dimensions of HDI.

The four dimensions capture only the **status** of human development. They show *what* has been achieved but not *how* (in a sustainable or unsustainable way). As numerous examples show, countries can improve their development status in ways that often boil down to 'borrowing from future generations, saddling them with debt (monetary, demographic or environmental, just to mention a few). We factor this in by adding the second – sustainability – aspect defined as **'ability to sustain'** the status in each human development dimension. The index reflects the 'ability to sustain' through a loss function deflating the reported status for unsustainability.

Using the conceptual framework outlined above, we developed and tested an index of sustainable human development based on the existing HDI with an additional 'environmental' component and deflating the achievements in each dimension for unsustainability. The combination of monitoring the achieved status in all four human development dimensions checked for the (un)sustainability of the development path (the way the status was achieved) in a single robust index is the methodological contribution of this paper.

Keywords: human development index, sustainability, environment

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1. Background

In the course of the last 25 years, the concept of human development has gained global appeal. Its quantification tool – the Human Development Index – emerged as a better proxy of societies' progress than GDP. It may be a crude indicator based on a number of implicit assumptions but still, it reflects the complexity of human development challenges better than purely monetary measures of poverty or estimates of societies' wealth. At the same time, it is free from subjective perception bias – unlike a range of "happiness quantification" estimates.

Throughout its 20 plus year history, the HDI has experienced a number of methodological adjustments (Kovacevic, 2011; Klugman et.al, 2011; Sagar and Najam, 1998). Efforts have been made both to reflect additional aspects of human life, as well as to improve the computation methodology. One of the areas of potential improvement since 1994 was the effort to reflect environmental concerns in the index.

Human development centers on people's opportunities to live the lives they have reason to value. The three traditional dimensions of HDI (long and healthy life, good education, and the incomes necessary to live decently) reflect the core of the most important of these opportunities. In its initial form, the HDI was built on the assumption that environmental degradation is implicitly reflected in the health component of the HDI. This assumption is however difficult to defend – one can easily imagine living a life free of major diseases in highly polluted and degraded environments given sufficiently high expenditures for medical services or other technical infrastructure that would offset the implication of the polluted environment to reach that 'healthy life' outcome. It would be definitely more expensive and perhaps less comfortable, but not impossible. Given the fact that the additional expenditures would contribute to the GDP (and increase the income component of HDI), such an approach would in fact account 'healthy life in an unhealthy environment' as human development progress – a travesty from the human development and capability perspective.

People increasingly value the opportunity to enjoy living in an unpolluted environment and in harmony with nature. Respectively, the environment is increasingly being valued not just instrumentally, as a source of natural resources and ecosystem services but also for its intrinsic value. Apart from its 'meeting basic needs' dimensions, "breathing fresh air, drinking clean water, living among an abundance of plant and animal varieties, and not irrevocably undermining the natural processes that produce and renew these features" is increasingly seen as an integral part of the very meaning of well-being and human development (World Bank 2003: 13). Following this logic, the Republic of Armenia with the support of UNDP had developed an environmentally adjusted HDI already in 1995, adding the fourth missing dimension to the HDI.

The current paper builds on the understanding that aspects such as air quality, water and sanitation, environmental amenities and biodiversity have a direct impact on health, living standards, gaining and applying knowledge, and they also have an intrinsic value for what people can currently do or be (Fuentes-Nueva, Pereira 2010: 29). We join those adding a fourth dimension to the traditional HDI construction – but as an important indicator of the quality of human life and human capabilities and not as sustainability indicator.

1.1. Defining and quantifying 'sustainability'

Defining environmental quality as an area of intrinsic value for people says little about the sustainability of the development process. The very understanding of sustainability has been evolving over time and depending on the approach adopted, different indicators can be defined, yielding different results (UNDP 2011: 25; Stiglitz, Sen and Fitoussi 2009: 64).

The attempts to develop an integrated measure of sustainability date back to the mid-70s when environmental sustainability was brought onto the agenda (Schumacher 1973, Meadows et al. 1972). Although significant progress has been made in defining sustainability, there are fundamental challenges in measuring and monitoring it, particularly from a human development perspective. One is related to the way in which "sustainability" is defined, another – to the ways it is quantified.

The conventional way of thinking, also applied in sustainability studies, is often based on snapshot studies observing the state of a system at a single point in time. These studies usually depict systems as exhibiting stable equilibrium states and linear causality. Consequently, they conceptualize sustainability as a defined stable target or state (Bagheri & Hjorth, 2007; Hjorth & Bagheri, 2006). The concept of sustainability may evoke images of stability or maintenance of a certain state, thus preventing a system from shifting to alternative states. Worth noting is the fact that in a number of European languages the meaning of the equivalent of the term 'sustainable' is closer to 'stable' or 'lasting'. It is '*nachhaltige Entwicklung'* in German and *'développement durable'* in French. The case is similar also in most Slavic languages – '*устойчивое развитие'* in Russian; '*устойчиво развитие'* in Bulgarian, '*сталий'* in Ukranian; '*ўстойлівае* развіццё' in Belorussian. It is 'balanced' (*zrównoważony)* in Polish*.* The closest to "sustainable" as 'possible to sustain' it is in Serbian (*održivi razvoj*), Slovak (*udržateľný*) and Czech (*udržitelný rozvoj*). Words matter, hence the extent to which the very concept can be understood and taken into consideration beyond a narrow group of experts with knowledge of its genesis and technical application is questionable.

Over the last decades a general consensus is emerging that 'sustainability' is not limited to 'environment' and 'environment' is not limited to 'ecology'. The two concepts – of 'human development' and of 'sustainable development' – gradually become closer, mutually enriching each other. Today 'sustainable development' is broadly understood as a three-pillar approach. Apart from its environmental pillar, it entails also social and economic sustainability. The Rio+20 outcome document explicitly calls to "acknowledge the need to further mainstream sustainable development at all levels, integrating economic, social and environmental aspects and recognizing their inter-linkages, so as to achieve sustainable development in all its dimensions" (UN, 2012a). All three pillars are equally important and a 'sustainable human development index' should reflect them. Therefore, we require a new metric of development, which would not only tell us *what* we have achieved, but also *how* we achieved it, and if we could *afford* to maintain this level of development without "decreasing the capacity to provide non-declining per capita utility for infinity" (Neumayer 2001). In other words, the question is can we *afford* "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). The idea that the two aspects of sustainability measurement – "assessment of *current well-being* and an assessment of *sustainability,* whether this can last over time" (Stiglitz, Sen and Fitoussi 2009: 11) – also underpins the logic of the approach proposed in this paper.

The three-pillar approach reflects the systems thinking applied to sustainability and is much better able to explain its complexity. Systems thinking acknowledges the importance of feedback loops as well as the relationships among the parts of a system, rather than their individual isolated properties or their sum (Hjorth & Bagheri, 2006). It also facilitates participatory modelling, while promoting process-based social learning and adaptation (Mirchi et al., 2012; Bagheri & Hjorth, 2007). These aspects of systems thinking are particularly relevant to sustainability studies because the three pillars of sustainability require the involvement and coordination of highly diverse multi-stakeholder, multi-decision maker groups in an inter- or even trans-disciplinary manner (Hjorth & Bagheri, 2006; Boulanger & Bréchet, 2005). The need for systems thinking in approaching sustainability is an important argument in favour of an integrated approach to sustainable human development quantification.

The definition of sustainability largely determines the approach to quantifying it. There are various approaches to assessing and quantifying the anthropogenic pressures on earth ecosystems and natural cycles, all of which offer potential sustainable development indicators, resulting in an 'Indicator Zoo' (Pintér, Hardi, Bartelmus 2005). Given the complexity of the interactions between humans and natural ecosystems, it is difficult to construct one single indicator to comprehensively reflect the impact of the anthropogenic pressure. One common approach is to use CO_2 emissions based indicators as a proxy. But greenhouse gas emissions (and CO_2 is just one of them), as powerful and dangerous as they are, are not the only indicator of unsustainability. They are related to, but do not include the impact of human-generated waste that is absorbed by ecosystems, natural capital depletion, water resources depletion, etc. Moreover, CO_2 emissions primarily track production (where the goods accountable for the emission are produced) and not consumption (the place/individuals ultimately responsible for the emission). As a result, the CO_2 accounting can be skewed in favour of developed economies capable of "outsourcing" carbon-intensive industries by importing manufactured products with the associated emissions accounted for elsewhere (Peters et.al. 2011; Slay 2011), and in addition miss other GHG emissions, which could be more dangerous, with different emission structure.

Approaching the issue of sustainability from the perspective of natural cycles (water, nitrogen, phosphorus etc.) is more comprehensive, albeit more complex. To a certain extent, this approach is conceptually close to the one underpinning the 1972 Club of Rome report, "The Limits to Growth" (Meadows et al., 1972). Rockström et.al. (2009) define 'natural boundaries' and 'tipping points' for each of the nine vital "Earth processes." Apart from climate change (reflected in CO_2 emissions and an energy imbalance at the Earth's surface) these are: ocean acidification, stratospheric ozone depletion, atmospheric aerosol loading, biochemical flows (phosphorus and nitrogen cycles), global freshwater use, land-system change, and biodiversity loss, as well as chemical pollution. For each of the processes a tipping point is defined beyond which change becomes uncontrollable. The estimates were updated in 2015, proving the robustness of the approach (Steffen et al., 2015).

The 'natural boundaries and 'tipping points' method is an example of the 'dashboard' approaches that have enormous informative power, but are not always easy to communicate. Also, they miss the human development aspect. Human development is defined as: "the expansion of people's freedoms to live long, healthy and creative lives; to advance other goals they have reason to value and to engage actively in shaping development equitably and sustainably on a shared planet" (UNDP 2010:2). But how does one reflect all these aspects in a quantitative indicator that would be understandable and easy to communicate (i.e. encourage the people to act accordingly)?

The latter is critical if the message is to go beyond a narrow group of experts on sustainability and reach the majority of the seven and a half billion consumers (or at least those contributing most to the strain of the planetary ecosystems). At the end, sustainable development is "enhancing the possibilities for improvement in the quality of life for all people on the planet… respecting and living within the limits of ecosystems" (Baumgartner 2011: 613). The major purpose of sustainability indicators is to lower pressure on the Earth ecosystems by influencing behavioural change and shifts in consumer patterns.

The 'footprint' concepts (CO2 and ecological) serve just that purpose by being easy to communicate and understand. They are extremely popular, although not 'backed' by the administrative and programmatic machinery of a powerful international organization as in the case of HDI – most probably because of their focus on individual impact rather than an aggregated nation-state level (Morse 2015). The ecological footprint is an example of an aggregated ecological outcome indicator that consolidates different aspects of the anthropogenic pressure into one common indicator, namely the "global hectares" of land needed to offset the impact of human activity (renewing the resources withdrawn and absorbing the pollution discharged). In fact, it serves the same purpose that money serves in representing the value of myriads of products and services, integrating the different types of anthropogenic pressure into one indicator without major loss of informative power (Wackernagel, Rees 1997; Moran et al, 2008; Kitzes, Wackernagel 2009; GFN, 2010, Wackernagel, Cranston, Morales and Galli 2014). With all its imperfections (Fiala, 2008), ecological footprint is one of the best proxies of anthropogenic pressure on Earth ecosystems reflecting the idea of 'strong' sustainability. However, it reveals nothing about the development process that produced that anthropogenic pressure, and thus nothing about the trade-offs involved. While the ecological footprint is a good proxy for the price paid, it does not say what was achieved for that price. Whether the level of human development improved and people's freedoms and opportunities expanded – or the resources consumed fuelled further wars or deepened global inequity.

The wide range of proposed sustainability indicators and the lack of one single 'frontrunner' indicates the complexity of the challenge. The multiple dimensions of the concept of 'sustainability' invites a variety of approaches. Most of them are complementary, some are contradictory, but all can be methodologically justified logically argued. While this provides those stakeholders interested in the issue with a wide range of choices, the policy benefit of this diversity of options is doubtful.

1.2. The inter-temporal dimensions – what to pass on? [1]

Another important dimension further complicating the task of is the temporal duality of 'sustainable development'. As Neumayer points out, 'sustainability' is largely oriented toward the future, while 'development' focuses on the present. Both are difficult to reconcile.

This challenge can be formulated in another way, namely how to determine what to sustain and for whom. The Brundtland commission's classic definition of 'sustainability' is intuitively appealing, but difficult to put into practice. Does achieving sustainability entail an obligation to leave the Earth in the same condition as we received it from our parents (the approach underpinning orthodox conservation policies)? As desirable as this may be, it is obviously impossible, both for reasons related to demography (expanding human populations claiming more resources and generating more waste), and technological progress (every next generation enjoying opportunities unimaginable to the previous one). "The environment is not only a matter of passive preservation… the environment can also include the results of human creation" (Sen 2009: 249) and this is why the concept of sustainability is dynamic. Thus,

[1] This section was largely shaped by Albena Ivanova, project executive at Veolia UK, who made explicit the idea of the future generations' capabilities as a 'moving target' questioning the feasibility of foreseeing their 'future needs'.

defining a monitoring framework is addressing a moving target. The results of human creation today, along with current natural capital (passed to the next generations), contribute to the opportunities and freedoms of future generations that the current generation has the responsibility to secure.

Demographic pressure, however, continuously alters natural ecosystems and, even assuming hypothetically that starting from tomorrow humanity's ecological footprint would magically drop down to meet the planet's absorption capacity, natural ecosystems will not revert. Their resilience has been altered and they have already entered a new equilibrium. Moreover, the lack of immediately observable impact suggests that the effects of the many anthropogenic activities on the ecosystems (such as global warming or nutrient loading), may only be detected after the system's resilience is too low to mask them, leading to catastrophes with potentially heavy financial and wellbeing costs to society (Scheffer et al., 2001). This will happen most probably during the lifetime of the subsequent generations and we cannot foresee now what the consequences for their human development opportunities and freedoms would be. This is why the most we can do today is deal with the future relying on present assumptions, rather than through (likely inaccurate) predictions (Mirchi et al., 2012; Hjorth & Bagheri, 2006; Elmqvist et al., 2003).

Progress in genetic engineering[2] is a case in point. Genetically modified organisms are often seen as an integral part of humanity's response package to the challenges of climate change and growing populations. They may indeed be – bringing anthropogenic and environmental systems into a new state of stability, which is different from that of today or yesterday. We do know that the relationships between resources, anthropogenic outputs and their development outcomes would vary with technical progress (Sen 2013: 9) but we cannot know exactly how and in what direction that relationship would evolve. In other words, from today's perspective we cannot foresee the parameters of tomorrow's anthropogenic and environmental systems – similarly to, say, the telecoms industry in the 1970s, which could not foresee the decline of fixed-line telephony as the core source of revenue within three decades.

In that regard, 'intergenerational equity' is to a lesser extent a problem of depriving future generations of certain assets (natural capital). "Each generation stands in this asymmetric relationship to subsequent ones: choices made today could, in principle, reduce the range of free choices available to subsequent generations" (Norton 2007: 41). It is more a matter of future generations' lack of voice, the non-representation of their interests in the decision-making process over the conversion of the current natural capital into other forms of capital and the management of the capital stock. The next generations will be affected by today's generation decisions but are not involved in determining to what extent the components of human-made capital newly added by the current generation are worth the price of the natural capital converted into those gadgets and services. Are the new computer gadgets, self-driving vehicles or smart home appliances worth sacrificing another species lost, another chunk of rainforest vanished or the stock of plastic waste replacing the fish stocks (Ivanov 2011). Seen from this perspective, using one's iPhone to launch a biodiversity preservation campaign on social media through 4G networks represents an internal contradiction because the tools applied (smart phones, 4G networks and social media), are inseparable from the overall human progress that contributed to (was achieved at the price of) the loss of species in the first place.

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[2] The term 'genetic engineering' is used as synonym to 'genetic modification'. The former however resonates with 'social engineering' attempts which left heavy marks on the 20th century. A number of organizations are cautious about 'genetic engineering' implications in the long run (Greenpeace 2016).

One elegant approach to the problem of temporal divergence is to apply the concept of ‘capital’: assessing the total capital stock and monitoring its value over time to determine the value that we (today’s generation) pass on to our children and grandchildren (the future generation). This approach underpins the Adjusted National Savings or ‘Genuine Savings’ concept. It measures the change in a country’s real wealth, including manufactured, natural, and human capital (World Bank 2015: 77; Hamilton, Naikal 2014), and monitors the performance of the capital stock of all forms of capital, monitoring investment, depreciation, and the depletion of a number of natural resources.[3] If the Genuine Savings is negative, it means the country is on a non-sustainable development path. ANS however favours highly developed countries, where the investment in human and man-made capital are high enough to outweigh the depreciation of capital (Neumayer 2003: 139-143; Stiglitz, Sen and Fitoussi 2009: 69). The prices used for factoring in resource depletion and environmental damage are also problematic – since “these are not tradable commodities, relative prices may differ markedly across countries” (Stiglitz, Sen and Fitoussi 2008: 23). The valuation of human capital through educational expenditures is similarly problematic for a number of reasons. First, expenditures on education are a highly imperfect proxy of human capital. Applying this approach to health, would mean measuring healthy life based on health expenditures, rather than health outcomes. Moreover, “each year people die and take their human capital with them” (Dasgupta 2001: C10). Migration and brain-drain make the use of educational expenditure as a proxy of human capital additionally problematic. Also, regardless of the metrics applied (expenditure on education, years spent in education, teachers/pupils ratio, etc.), education is a necessary but not sufficient precondition for knowledge. Moreover, similar to the distinction between ‘wealth’ and ‘capital’, the possession of knowledge is no guarantee of the effective application of it – and its application may be constructive or destructive. Finally, ANS is also natural resource-centric. For example, assessing the value of forest depletion based on the stumpage value of its commercial timber does not take into consideration “what happened to the land that is being deforested” and respectively does not account for the “social worth of the land” (Dasgupta 2001: C10), which would differ depending on the deforested land use. Moreover, it is close to impossible to put a price tag on the broad range of forest ecosystem’s products and services other than timber (such as CO2 absorption, plant products, maintaining species’ genetic diversity etc.).

1.3. Integrating ‘sustainability’ and ‘human development’

Most attempts to integrate sustainability and human development apply various ways of deflating the value of the reported HDI to reflect the depletion of natural capital. Others build dashboards of indicators to account for the degree to which humanity has reached (or exceeded) the ‘planetary boundaries’ and has altered vital natural cycles. These are all relevant, but their purpose is primarily informative. The planetary boundaries are global (that’s why they are ‘planetary’), but the measurable contribution and impact are local. It is not just a matter of responsibility (who contributed the most to reaching the boundaries hence who should bear most of the adaptation costs). It is equally a matter of distribution, sector specialization and history.

[3] Adjusted Net Savings is the sum of Net National Savings (the Gross National Savings less the consumption of fixed capital) plus the public current operating expenditures in education (including wages and excluding capital investments), less the value of depletion of natural resources (energy resources, minerals, and net forest), and less the value of damages from pollutants (World Bank 2006: 36-38).

The wide range of environmental sustainability indicators captures the ecological externalities of human progress, the price that humanity, both its current and future generations, will pay for the standard of living the 7.5 billion people today on average enjoy (regardless of the inequality of opportunities different individuals or groups experience). The big question is how to integrate the two aspects of human progress – its development outcomes and ecological externalities – in a single measure that would be statistically robust and based on available (or feasible to produce), data and would also be easy to communicate and still retain its informative power. “If we want to draw attention of public opinion or policy makers on sustainability issues, one would also like to have some synthetic headline figures able to compete with the popularity of GDP” (Stiglitz, Sen and Fitoussi 2009: 248).

Numerous efforts have been made to do so well before the introduction of the HDI in 1990.[4] Nordhaus and Tobin propose in 1972 a "measure of economic welfare" (MEW) in an attempt to reflect important “socially productive assets” (like environment), on the balance sheets. The services to producers and consumers of these ‘socially productive assets’ “are not valued in calculating national income. For the same reason, no allowance is made for depletion of their capacity to yield services in the future… Growth of output per capita will accelerate ever so slightly even as stocks of natural resources decline” (Nordhaus, Tobin 1972: 13-14). Repetto et al. point out (in line with Schumacher’s approach to natural capital), that “only capital investments in durable structures and equipment used in the industry are subject to depreciation, not the resources themselves” (Repetto et al., 1989: 13), and propose adjusting GDP for a country for the degree of its natural resources depletion. Herman Daly, John B. Cobb and Clifford W. Cobb proposed in 1989 the Index of Sustainable Economic Welfare (ISEW) that balances consumer expenditure (both personal and public-non-defense), by income distribution, cost associated with pollution (environmental degradation), and depreciation of natural capital (Daly et al., 1994). The Genuine Progress Indicators (GPI) follows the same logic (Kubiszewski et. al. 2013).

Between 1999 and 2005 the Yale Center for Environmental Law and Policy (Yale University) and the Center for International Earth Science Information Network (Columbia University) proposed the “Environmental Sustainability Index” integrating 76 variables in 21 indicators in five groups (Esty et al. 2005). The high number of variables and the mix of process and outcome indicators, however, makes it difficult to establish causal relationships.[5] The ESI was later transformed into the Environmental Performance Index (EPI). Unlike ESI (with a strong focus on outcomes), EPI has a more explicit focus on economic governance and process indicators.

Talberth, Cobb and Slattery propose the Genuine Progress Indicator, which follows the same logic and deducting the costs associated with crime and adding the benefits of volunteer work (Talberth et al.,

[4] For a detailed overview of the most popular attempts to factor sustainability in composite indices see Stiglitz, Sen and Fitoussi 2009: 65-67; Alkire 2010: 20-22; Frugoli et.al. 2015.

[5] The “Environmental Systems” component includes indicators of ‘air quality’, ‘biodiversity’, ‘land’, ‘water quality’ and ‘water quantity’. The “Reducing Environmental Stresses” component includes indicators ‘reducing air pollution’, ‘reducing ecosystem stress’, ‘reducing population pressure’, ‘reducing waste and consumption pressures’, ‘reducing water stress’, and ‘natural resource management’. “Reducing Human Vulnerability” component includes ‘environmental health’, basic human sustenance’, and ‘reducing environment-related natural disaster vulnerability’. “Social and Institutional Capacity” component includes indicators of ‘environmental governance’, ‘eco-efficiency’, ‘private sector responsiveness’, and ‘science and technology’. Finally, the index includes component “Global Stewardship” with indicators for ‘participation in international collaborative efforts’, ‘greenhouse gas emissions’ and ‘reducing transboundary environmental pressures’ (Esty et al. 2005).

2007).[6] De Kerk and Manuel (2008) propose the 'Sustainable Society Index' (SSI) that integrates 22 indicators grouped into five categories ('Personal Development', 'Clean Environment, 'Well-balanced Society', 'Sustainable Use of Resources' and 'Sustainable World').[7] Various approaches to modify the weighting and aggregation of the individual indicators have been proposed since its introduction (Sironen et. al., 2015).

Shortly after the introduction of HDI as a more comprehensive measure of human progress than GDP, various attempts at 'greening' the index were undertaken. Already the third global HDR called for developing an "environmentally sensitive HDI" (UNDP 1992: 24), but HDRO never actually implemented the idea. Instead, various researchers proposed a variety of options.

The approaches can be clustered into two groups. One is adding a fourth dimension to the HDI to reflect natural resource depletion and/or pollution (Armenia pioneered the first of these in 1996). An example could be the Human Sustainable Development Index (HSDI), which adds a fourth component—carbon emissions per capita—to the regional HDI (Bravo, 2014). Another approach is to reflect environmental effects through other indicators 'tweaking' the HDI's individual indicators but keeping the core HDI construction intact. For example, Morse (2003) proposed to hybridize the HDI with the Environmental Footprint (EF). Neumayer (2004) suggested using GNS for the income dimension of the HDI. Following the same logic, Constantini and Monni (2005) proposed a 'Sustainable Human Development Index' replacing GDP with GNNP (Green Net National Product), and replacing life expectancy with a 'Social sustainability' dimension using the unemployment rate as a proxy and adding a 'quality of natural environment' dimension (Constantini, Monni 2005: 337). King et al. (2007) modified the HDI, multiplying its value by the percentage of a nation's total *emergy*[8] use that comes from renewable sources. Siche et. el. (2008), also suggest constructing an index of sustainability combining the ecological footprint with a renewability *emergy* index. Bravo (2014) also added an environmental dimension to the HDI. Constantini and Monni suggested 'sustainable HDI' that reflects the quality of the natural environment, uses GNNP instead of GDO as a proxy of "access to resources" and unemployment rates as a proxy of social stability (Costantini and Monni 2005). De Carvalho proposed a quantitative definition of sustainability structured on the principles of minimum and maximum entropy production (De Carvalho 2011: 1074). UNECE proposed a small set of sustainable development indicators structured in two domains, "foundational well-being" and "Economic well-being" with both domains having separate "stock" and "flow" sets of indicators (UNECE 2008: 79).

In the last decade the focus of 'greening HDI' seems to have shifted towards different ways to define one or several proxy indicators for environmental impact and weighting the individual components of the index or its entire value to deflate for unsustainability. These attempts follow the logic of the inequality adjusted HDI proposed by Douglas A. Hicks (Hicks 1997) and adopted in a modified form by HDRO in 2010 (UNDP 2010). Depending on the choice of the indicator for the loss function, the results differ. In 2009 De la Vega and Urrutia proposed a "pollution-sensitive human development index"

[6] For detailed overview of the various indexes that 'correct' the GDP or propose other alternatives to quantifying human well-being beyond GDP see Constanza et al, 2009.

[7] The first dimension has 6 indicators ('Healthy Life', 'Sufficient Food', 'Sufficient to Drink', 'Safe Sanitation', 'Education Opportunities' and 'Gender Equality') that are closest to the broadly defined dimensions of human development (de Kerk, Manuel 2008: 231).

[8] "Emergy" is the energy that is consumed in direct and in indirect transformations needed to make a product or service (Odum 1996).

(HDPI), which deflates the value of the economic component of the standard HDI by an 'environmental behaviour' factor, measured by CO_2 emissions from industrial processes per capita. Zhu et al. (2015) proposed the 'Ecological Well-being Performance' indicator weighting HDI by normalized Environmental Footprint (Zhu et al. 2015: 335). Jose Pineda proposed a similar approach deflating individual countries' HDIs for their proximity to the four 'natural boundaries' as defined Rockström et.al. (2009); the closer a country is to the 'planetary average', the higher the value of its loss function (Pineda 2012).

These are just a few examples of 'tweaking' the HDI. All reflect in one way or another natural capital depletion, but do not capture sufficiently the broader range of the environmental externalities of human progress that are not adequately reflected in a manageable number of proxies. On the other hand, adding the equally complex and multidimensional indicators of sustainability would result in an exponential increase of complexity.

2. The Sustainable Human Development Index within the affordable limits

We propose a different approach. We cannot foresee the future, but we can concentrate on the present by attempting to meet the needs of today's generation while living within our limits – those determined by the existing stock of capital and the available technologies.

The link to the concept of 'natural boundaries' and 'tipping points' is deliberate. But these concepts and measurement frameworks serve primarily informational purposes. They register the aggregated (planetary level), outcome of the development path taken and inform us that *humanity* is on an unsustainable development path. This aggregated outcome is the result of seven and a half billion individual behaviours and consumption strategies influenced by nation-state development policies and corporate business strategies. If these are structured with the goal of 'living within our limits' or 'of what we can afford' encouraging individual behaviours in the same direction, the chances of the aggregated outcome fitting within the limits determined by the planetary boundaries might improve.

This logic leads to a non-expansionist development model based on a 'sufficiency consciousness' logic rooted in Buddhist thought (Hettiarachchi 2012; Schumacher 1973), that has influenced prominent sustainable development scholars. The dominant economic system has effectively reversed the relationship between output and human development, detaching commodity from functionality and capability. The marginal 'capability utility' of each consecutive increase in commodities (and the associated 'processing' of natural capital), is declining. The consumer is increasingly flooded with cheap 'disposable' goods that may meet demand, but only less (if at all), expand human capabilities. Over the last decade, the growth of production and output increasingly became an objective in its own right, subordinating consumption needs and thus turning people's capabilities into a macroeconomic residual (Ivanov 2009: 8-10).

Given all the above, we propose a narrower and more practically-oriented approach to sustainability defined as the ability to sustain the achieved level of development while living within our means – or, in other words, without running into debt of any kind (financial or ecological, inter or intra-generational).

2.1. The assumptions behind the proposed index

We define 'sustainability' as 'ability to sustain' the achieved development outcome (reflected in the HDI).[9] We share the belief that "the debate about *what* should be sustained is as important as *how* to sustain it" (Neumayer 2010: 3) and propose an index that measures **what** we have achieved (the human development status reached) and **how** we achieved it (in a sustainable or unsustainable way).

We assume further that it is impossible to foresee and define the freedoms and opportunities the future generations would like to enjoy drawn from the volume and the type of inherited capital stock that will reflect the type of the development path pursued today. Thus, putting a price tag on current natural capital and monitoring the overall capital stock today does not tell us much about the opportunities of future generations. It is possible, however, to determine whether the development path today is **affordable,** or is development 'running on debt' (financial, environmental, or other), that will be passed on to future generations. Applying the definition of 'sustainability' as 'ability to sustain', we assume that if today's generation does not live beyond its means, it will stay within a sustainable development path. Thus, from a policy perspective, the imperative is to maintain an affordable development path.

Finally, we also assume that environmental quality has an intrinsic value, qualifying as a fourth dimension of the HDI (the ability to live in clean and balanced environment).

Based on these assumptions we propose the **Sustainable Human Development Index** within these affordable limits (SHDI-A). It belongs to the "family of HD indices." We add a fourth 'environmental' component to the existing HDI to reflect environmental quality as an integral dimension of human life. But we go further and deflate the reported human development achievements in each dimension for ***un***sustainability, defined as non-affordability.

The index follows the logic of the inequality-adjusted HDI, in which the "potential" level of the indicator is deflated to account for the inequality of distribution in each dimension to reflect the "actual" level, accounting for inequality. In the case of the SHDI-A, the "potential" level of the EHDI (HDI plus environmental dimension) is deflated by the degree of unaffordability of the achieved status.

The proposed index builds on prior experience and shares the Neumayer proposition that due to the co-existence of "mutually related factors within one integrated indicator of welfare and sustainability… as the indicator rises or falls we do not know what rises or falls…[and] that one needs two separate indicators to trace two distinct concepts" (Neumayer 2004: 5). We solve this problem applying a two separate tracks approach: monitoring the human development **status** and **the way it was achieved**. The difference between the EHDI not deflated by the degree of unsustainability and SHDI-A reflects both the magnitude and the major contributors to unsustainability. The ideal situation would be when this difference is zero (no penalty for unsustainability). In that regard the index follows the logic of the earlier GHDI (Gender sensitive Human Development Index).

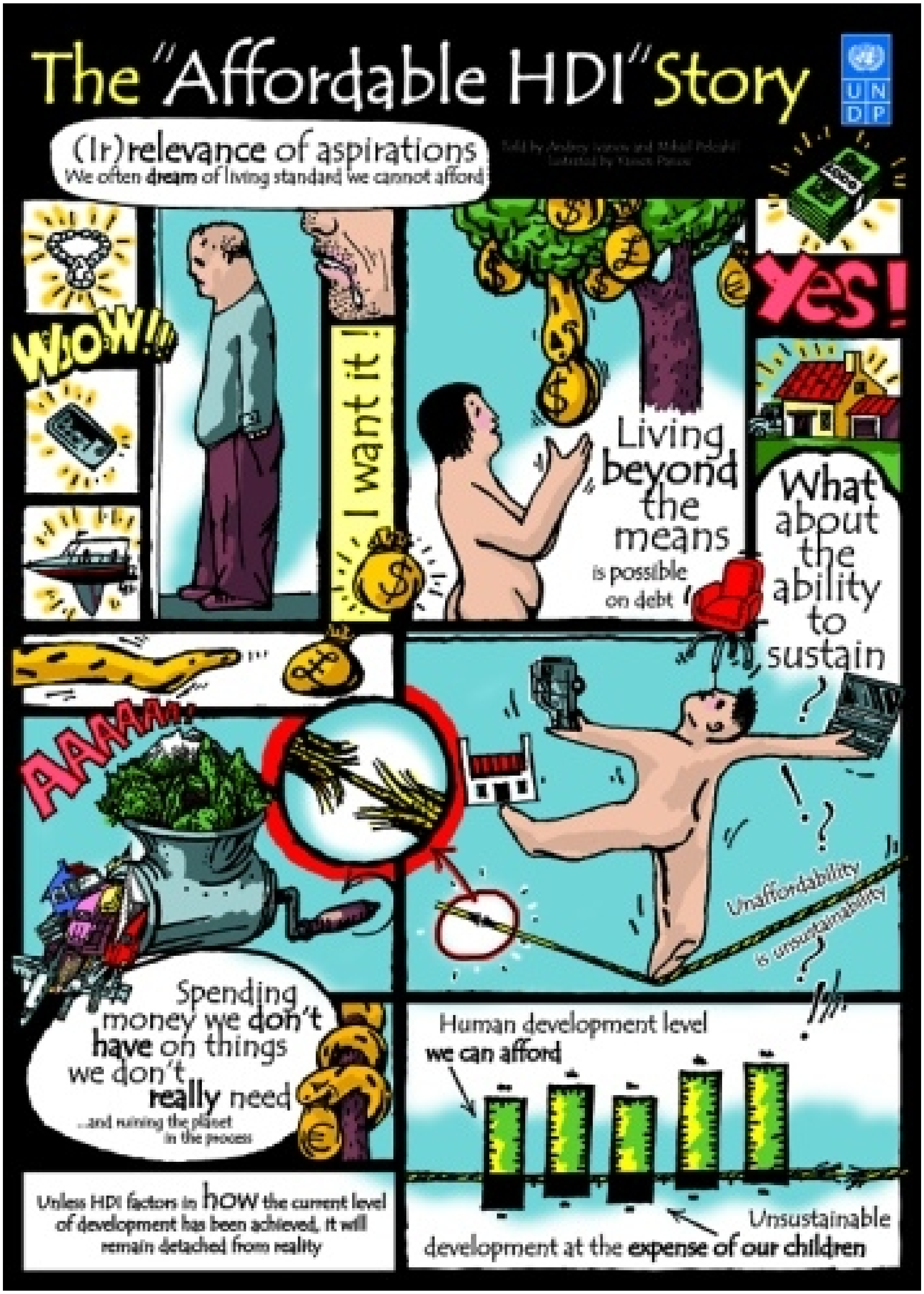
Finally, an important benefit of the index is data availability – it is based on publically available data. We present a detailed discussion of indicators tested for Sustainable Human Development Index within the affordable limits (SHDI-A) as well as results achieved globally and for selected countries of ECA region below. We also provide comparisons to the quantification of sustainability using other approaches and discuss the policy applicability of the SHDI-A index for sustainable human development monitoring at the country and regional level.

[9] At this point we do not deal with the confusion between development inputs, outputs and outcomes in the HDI – an issue deserving a broader discussion. However, by design we try to put more emphasis on outcomes.

The novelty of the methodology proposed in this paper is that it goes beyond simply expanding the traditional HDI by one environmental dimension to arrive at an EHDI. Instead, we also address in a logical and statistically robust way the second understanding of sustainability as 'ability to sustain' the achieved value of the EHDI.

Thus, we understand 'sustainability' in two ways. One is the **sector-specific** and the other is **process-specific**. The sector-specific understanding of sustainability is reflected in the four dimensions of the SHDI-A with the 'health' and 'education' dimensions constituting the social pillar. This approach follows the logic of the many attempts at 'greening' the HDI undertaken since the early 1970s. But the **process-specific** dimension of sustainability is equally important – and has been previously neglected. It is defined as 'ability to sustain' the achievements (the status) in each dimension. Without this 'ability to sustain' aspect, the EHDI loses its informative and policy prioritization power. Figure 1 visualises the idea of the index.

We summarize the methodological assumptions made during development of the index in Table 1 to make these assumptions clear and explicit for all readers.



Concept: Andrey Ivanov; art design: Yassen Panov

Figure 1. Sustainability as affordability

Table 1. Summary of the methodological assumptions

Question	Adopted methodological choice
The purpose of the exercise	To construct internationally-comparable national-level index The index was calculated for 47 countries from Europe and Central Asia. Time series were calculated for one country, Armenia.
Weighting	"No weighting" approach with the implicit assumption of equal significance (and hence weights) for individual dimensions
The meaning of the index	Achieved level deflated for inability to sustain the level.
Way of integrating the environmental aspects[10].	Directly through the fourth dimension and indirectly through the 'unsustainability penalty'
Approach to sustainability	Broad, integrating the three-pillars of sustainable human development and 'ability to sustain' the achieved status
Link to other human development indicators	The index a standalone one but part of the HDI family
Which approach to sustainability is behind the index (weak or strong; if weak – how weak)?	Any strict 'compartmentalization' of the proposed index in terms of approach to sustainability is difficult. Generally, the index assumes limited substitutability that is limited to a different extent across dimensions in Tier A, which puts it 'sustainability approach' axis between "weak" and "strong" somewhere in the middle[11]. The usage of geometric means for aggregation is to certain extent an imbedded penalty for imbalance between dimensions. The same applies for the 'penalty indicators' in Tier B. In order to keep the index in the "medium sustainability", the risk of crossing environmental thresholds needs to be reflected and accounted for.
Attribution of the ecological damage—by [place of] production or by consumption?	By consumption as reflected in the status of the five components of the fourth dimension.

[10] Human Development and Environment are linked very closely. It is out of scope of current paper to explore conceptual link as to how the environment is connected with human development, as the body of literature is available on this, for instance global Human Development Reports 2011 "Sustainability and Equity: A Better Future for All", 2007/2008 "Fighting climate change: Human solidarity in a divided world", 2006 "Beyond scarcity: Power, poverty and the global water crisis", and many more.

[11] Neumayer (2010) pointed out that way of adjustment the HDI to include sustainability aspect implicitly result in adoption of weak sustainability approach, as HDI formula includes perfect substitutability between components. However, with geometric mean used in HDI formula since in 2010 substitutability is no longer perfect. In addition, tier structure of proposed index allows for strong sustainability – if one component of index is absolutely non-sustainable, whole index turns to zero.

Our index meets the core criteria of a good sustainability indicator outlined by Spangenberg (2015). It is built on a reliable, but easily understandable information base; it allows for monitoring the progress (or regress), achieved; it is easy to communicate to the public at large. Moreover, it consists of independent indicators that are limited in number; each of them is meaningful in itself, and it reduces the complexity of the inter-linkages between human development and sustainability in a plausible and meaningful manner (Spangenberg 2015).

2.2. *The environmental component of the index*

Human development is a measure of people's opportunities to live the lives they have reason to value. The three traditional dimensions of HDI (long and healthy life, good education and incomes necessary for decent living) reflect the core of the most important opportunities, however, they do not include the desire to live in an unpolluted environment and in harmony with nature.

Attempts to incorporate environmental aspects into the Human Development Index have a long history, with both proponents and opponents of this approach. A. Gaye and S. Jha (2010) in the review of conceptual and measurement innovations in national and regional Human Development Reports suggest that tackling environmental issues should be a priority for future reports as well as improvements in measurement. We strongly argue for the inclusion of an environmental component in the Extended Human Development Index, as an area of life people value or have a reason to value. The first and foremost concern related to the inclusion of environment is a vague formulation of those "capabilities" related to ecology. We offer a broader view of environment and argue that the environment has not only an instrumental but also an intrinsic value in that people value the "ability to live in clean, non-polluted and balanced environment".

Incorporating the environmental aspects into the HDI is not a clear-cut issue and there are arguments against it. One relates to the impact of the environment on other components of human development, especially health. This might indeed be the case, but in fact the environment is no exception, because *all* components of the human development index are interrelated – poor health affects education and incomes, low income affects health and education, etc.

Another concern is the apparent lack of conceptual clarity as to what exactly environmental indictors are measuring – the state of environment or its capacity to "meet the needs of the present without compromising the ability of future generations to meet their own needs". To resolve this methodological issue we clearly divided the indictors into two groups – those of status and those of affordability (sustainability), see Table 2. The former measure the "ability to live in clean, non-polluted and balanced environment", while the latter measure how sustainable this environment is.

Last but not the least issue is related to selection of indicators. It is extremely difficult to find one unique indicator of "environment". Proposed lists include dozens of indicators, which raises the valid concern that an overloaded index risks becoming both messy and meaningless. Given the multidimensional nature of the phenomenon 'sustainable development' itself, the indicators that are intended to capture it are numerous and often a mix of input, process, and outcome indicators with complex links between them (UNECE 2014: 68-76). We resolve this issue by considering a limited, but comprehensive block of environment indicators (summarized in Table 2) with one indicator per block. The proposed index is intended to be national one, thus we tried to exclude highly geographically specific indicators, which implicitly discriminate among countries based on their geography.

Table 2. Ideal Environmental Indicators

Area	Environmental Status Indicator	Environmental Sustainability Indicator
Water	Water pollution	Sustainability of water resource use
Air	Air pollution	Purification of air emissions
Soil	Share of degraded soils	Rate of soil degradation
Forest	Loss of forestation relative to base year	Rate of forestation loss relative to base year
Biodiversity	Loss of biodiversity relative to base year	Measures to protect biodiversity
Habitat	Share of population covered by waste collection and processing	Share of waste processed or recycled

2.3. The construction of the index

Constructing an HDI comprehensively reflecting various aspects of sustainability faces an important challenge: how to prevent falling into one of the two extremes, of oversimplification and of over-complexity. The first results in not grasping important aspects of the phenomenon that the index is supposed to reflect. The second may lead to low comparability across countries, insufficient statistical robustness and difficulties to understand/communicate the message. The option outlined in this paper is a reasonable compromise between those two extremes.

The three tiers of the SHDI-A

Unlike other attempts at integrating human development and sustainability, the index is not just one aggregate figure but a three-tier construction – integrating the achieved status of human development, the way it was achieved (sustainable or not) and the broader context of the development process. The first two tiers are reflected in quantitative indicators aggregated in a composite index; the third tier allows to see it in a broader perspective, by bringing in qualitative indicators as well. This construction allows for controlling for a major risk most composite indices are facing – that of oversimplification and sending "misleading policy messages if they are poorly constructed or misinterpreted" (OECD 2008: 13).

Tier A consists of the **quantification of the status** in the individual dimensions. It is the Extended HDI (EHDI) – the standard HDI extended by the 'status of the environment' dimension. This tier includes indicators of status, which describes outcomes, current situation. As such, they say a lot about *what* was achieved, but virtually nothing about *how* it was achieved.

Tier B consists of indicators reflecting the **affordability (sustainability) of the status** achieved (and recorded by the indicators in Tier A). This is the SHDI-A. It reflects the 'ability to sustain' the achievement in each dimension in the long run. It consists of a number of indicators used as weights to deflate the respective values of Tier A for unsustainability. These indicators tell *how* status has been achieved[12], and says nothing about status per se. For instance, mean years of schooling says about average achieved level of educations, but says nothing about ability to sustain this level. If enrolment rates are low or quality of education suffer, achieved results will not stay long.

Tier C is the **broader context** of sustainable development political, institutional) that has obvious implications for the human development status and its sustainability in the long run but that are difficult to quantify (if possible at all). Context indicators are of extreme importance, however, they could not be quantified and included in the index.

The logic of the proposed approach is similar to the one used in the inequality-adjusted HDI (Alkire, Foster 2010) in which the "potential" level of the indicator is deflated for inequality distribution in each dimension to achieve the "actual" level accounting for inequality. In the case of the current research, the "potential" level is the EHDI that is later on deflated for unsustainability to achieve the "sustainable HDI". We do not adjust for inequality assuming that internal disparities in distribution are already reflected in the Tier A through the application of geometric mean for aggregation of individual indicators.

The three-tier construction of the index has some common elements with the 'Structure-Process-Outcomes' indicators framework developed by the Office of the High Commissioner for Human Rights (OHCHR 2012).[13] The S-P-O framework, similarly to the approach proposed in this paper, also looks beyond outcomes to capture the processes that are supposed to translate the resources invested into outcomes and the structures (the legal standards and frameworks) in which the processes unfold. Both approaches reflect complementary dimensions of the complex monitoring process and it is possible to reconcile them. 'Process' indicators can bring in additional element to efficiency monitoring in tier B – looking, for example, at the unit cost of results achieved in individual dimensions (FRA 2016c: 2-3). Given the fact that in most cases 'structural indicators' are not numerical and they *indicate* the existence (or lack) of legal frameworks and commitments, they logically fit into the broader context of the SHDI-A methodology proposed in this paper.

Selection of indicators

One of the toughest methodological choices one would face in construction of an index that would be both substantively relevant and statistically robust is the selection of **adequate** indicators – those that matter for people's lives and for which data is available to populate them. On the one hand, very often we don't have indicators to measure things we are interested in. On the other—indicators, which are available measure things only partially or measure only certain aspects of broader phenomenon. Also striking a balance between international comparability and national adequacy is a must (in fact one can rarely have both with the former coming at the expense of the latter). A detailed discussion of the methodological choices, strengths and weaknesses behind each indicator is provided in Table 3, and Annexes 1 and 2.

[12] These indicators includes costs of achievement – for instance, debt-to-GDP ratio or energy efficiency of economy, and investments in sustaining achieved status – for instance, persistence to last grade of primary school.

[13] FRA adopted the S-P-O framework applying it first to the right to political participation of people with disabilities (FRA 2014). Later FRA has worked on the development of rights indicators the areas of access to justice, rights of the children, migrants' integration, hate crime and Roma integration (FRA 2016b).

Table 3. Selection of indicators for SHDI-A

Dimension	Ideal and Available indicator(s)	Methodological choices, strengths and weaknesses
Status indicators		
Long and healthy life	Life expectancy at birth	Standard HDI indicator
Knowledge	Mean Years of Schooling Expected Years of Schooling	Standard HDI indicator
A decent standard of living	GNI per capita (USD PPP)	Standard HDI indicator
Clean and balanced environment		
• Water	Ideal: Quality of water Available: Water pollution: Access to improved water source	Water pollution data are available in a number of observation points, which does not provide overall picture of water pollution in country. Access to improved water source is a good proxy, as it shows access of population to reliable and safe source of water.
• Air	Ideal: Quality of air Available: Air pollution: Air pollution PM2.5	Best available data, which, however, could miss a lot of other components of air pollution. In addition, it averages exposure over the year and do not capture peaks in pollution. Should be treated with caution, as in some cases pollution could be caused by nearby countries.
• Soil	Ideal: Share of degraded soils Available: Not available	Share of degraded soils indicator was available for Armenia from National Statistical Service, but not available for other countries on regular basis.
• Forest	Ideal and available: Loss of forestation relative to base year: Forest area, % relative to reference year (1990)	
• Biodiversity	Ideal: Loss of biodiversity Available: Not available	Biodiversity data are scattered and highly country specific – some countries have initially large biodiversity, some have small. Red List Index and similar indicators do not provide basis for quantitative comparability.
• Habitat	Ideal: Quality of habitat Available: Share of population covered by waste collection and processing: Access to improved sanitation facilities	Best available data. Waste management data are available for Armenia from National Statistical Service, but not available for other countries. Access to improved sanitation facilities is a good proxy for ability to keep habitat clean and balanced
Status indicator		
Long and healthy life	Ideal: Healthy Life Expectancy Available: Disability adjusted life years	Difference between life expectancy and disability-free life expectancy is a good outcome proxy of health, better than health care system inputs (health care expenditures) or outputs (Physicians, Nurses and midwives, or Hospital beds), which are included in context indicators
Knowledge	Ideal: Quality of education and its equal distribution Available Survival rate to the last grade of primary education, both sexes (%)	Implicitly, sustainability of education system is included in form of Expected Years of Schooling (School Enrollment). Survival rate to the last grade of primary education is relatively weak, not well available. Comparable International Test results (like OECD PISA) are available only

Dimension	Ideal and Available indicator(s)	Methodological choices, strengths and weaknesses
		for selected countries. National testing results are available only for selected countries (i.e. Kyrgyzstan) and not comparable.
A decent standard of living	Ideal: Costs incurred / Debts accumulated in achieving standards of living Available: • General government gross debt (% of GDP) • Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP)	Two proxies of financial and environmental non-affordability of consumption model. Caveat—energy efficiency could be linked with geography. General government gross debt is a bets available indicator, which however is not without limitations—non-government debt could be significant and affecting sustainability; and level of debt say nothing about ability to service it. CO2 emission is excluded because it is calculated by place of production, not consumptions, therefore introducing huge bias.
Clean and balanced environment		
• Water	Ideal: Sustainability of water resource use Available: Water withdrawal as share of internal resources	Cross-border consequences should be carefully considered, as countries could share same pool of water and nationally sustainable water withdrawal could be regionally non-sustainable.
• Air	Ideal: Purification of air emissions Available: Not available	Indicator was available for Armenia from National Statistical Service, but not available for other countries.
• Soil	Ideal: Rate of soil degradation Available: Not available	Indicator was available for Armenia from National Statistical Service, but not available for other countries.
• Forest	Ideal and available: Rate of forestation loss relative to base year	Biodiversity data are scattered and limited.
• Biodiversity	Ideal: Measures to protect biodiversity Available: Share of terrestrial and marine protected areas	
• Habitat	Ideal: Share of waste processed or recycled Available: Share of renewable and sustainable energy	Best available data. Waste management data are available for Armenia from National Statistical Service, but not available for other countries.

Regarding Tier B of the ‘Economic’ dimension, an ideal indicator for (un)sustainability penalty would have been “share of economic output coming from economic entities meeting circular economy criteria”. Although current data constraints do not allow for that, a possible improvement of the index in that direction is worth pursuing. Developed economies (like for example the EU) might take the lead in that regard. Such efforts would fit into the efforts for reaching ‘resource efficient Europe’ (EC 2011: 6).

When the environmental status indicators are factored in the Human Development Index, we should clearly distinguish between stimulants (environmental factors, which reflect positive features, like access to improved water and sanitation source or maintaining certain level of forestation) and de-stimulants (environmental factors, that reflect negative features, like increased air pollution). In the case of stimulants, we use direct scaling, i.e. increase in stimulant indicators improves EHDI, while in the case of de-stimulants—reverse scaling, i.e. increase in de-stimulant indicators reduces EHDI.

Table 4 presents the indicators used in the four dimensions and the three tiers of the index.

Table 4. Sustainable Human Development Index within the affordable limits – dimensions, tiers and indicators

Sustainability pillars	Social		Economic	Environmental
HD dimensions	Health	Knowledge	Living standards	Environment
Tier A: status	Life expectancy at birth	Mean years of schooling Expected years of schooling (years)	GNI per capita (PPP$)	Access to improved water source (share of population with access); min = 50 (observed); max = 100 Air pollution PM2.5; min = 5; max = 30 (3 times WHO guidelines) Forest area, % relative to reference year (1990 or next available); min = 33; max = 100 % of population with access to improved sanitation facilities; min = 50; max = 100
Tier B: affordability (ability to sustain the status)	Health adjusted life years (HALE) years; min = 20; max = 85 (observed)	Persistence to last grade of primary education (% of cohort); min = 50 (observed in the Europe and Central Asia region); max = 100	Debt/GNI ratio (external debt stocks as % of GNI); min = 20; max = (observed) Energy efficiency (oil equivalent per 1000 PPP$ GDP); min = 70; max = 100 (observed)	Water withdrawal - % of internal resources; min = 10; max = 100 (close to observed) Biodiversity – share of terrestrial and marine protected areas (% of total territorial area); min = 0; max = 25 (close to observed) Share of renewable and sustainable energy; min = 0; max = 50 (close to observed)
Tier C: context indicators (examples)	Public expenditure on health (%GDP) Private expenditure on health (%GDP) Inequality in access to health Inequality in health status	Public expenditure on education (%GDP) Private expenditure on education (% of GDP) Quality of education (PISA test results) Inequality in access to education	Income and expenditure inequality Dependency on remittances Sustainability of consumption models	Environmental protection institutions Major conventions ratification Expenditure on ecologic investments

Levels of comparability and caveats

The index has been constructed using the officially available data in Armenia but with international comparability in mind. This is another area in which a compromise was necessary – between the desired set of indicators and data availability for cross-countries comparisons with sufficiently long time series. All of the indicators used for Tiers A and B are monitored by national statistical agencies as part of obligations from ratified treaties and conventions and are available from internationally available sources, some should be available from the national statistics. Summary of data sources are provided in Annexes 1 and 2.

At this point, the index is computed in two versions: broad (with all indicators that we believe should be included) and narrow (with a scope of indicators reduced to the internationally available only). We believe that in the long run the index can be applied in its long version. However here we face another choice: between global comparability (which comes at the cost of a crude reflection of the reality) and national policy relevance (at the cost of global comparability). We believe that a reasonable compromise could be sought in applying the index and monitoring the status for groups of countries sharing some similar characteristics. Those groups can be defined either by geographic principle (regions) or by substantive characteristics (typologies of countries). Further research both on the application of the index and on its refinement is necessary and he hope will follow.

Despite the improvement, the method behind the index still replicates the old problem the HDI faces – confusion of inputs, outputs and outcomes. Sustainable human development is about development *outcomes*. The modified HDI (the SHDI-A) is more focused on development outcomes but some of its indicators are of 'dual nature' – they can be interpreted both as outcomes of development endeavors in one dimension and inputs for improving the outcomes in other dimensions.

The range of the environmental indicators proposed for the fourth dimension of the index is outcome-level to the extent possible. All fife indicators used reflect **the status of the environment** in which people live (water, air, waste, soil, biodiversity).

A number of the indicators used for assessing the 'ability to sustain' the status in the four SHD dimensions and also of dual nature being both outcomes of certain processers as well as determinants of further changes in other dimensions. All of them have been chosen as directly related to the respective dimension indicator (like debt/GDP ratio in regards to living standards) or as relevant proxies for unsustainable development path (like energy use per unit of GDP as a proxy of unsustainable growth model). Hundreds of other indicators may be used for this purpose and some of them may be more appropriate but the issue of international comparability dramatically reduces the potential list.

Some indicators are very crude proxies and not suitable for international comparisons. For example, energy efficiency of the economy is largely dependent on the structure of the economy and the dominating sectors. Tourism or light industry is obviously less energy intensive than, say, metallurgy or cement production. In order to achieve relevant international comparability in that area the indicator should be computed by individual sectors of the economy. Although it is technically not complicated and data is available, it makes the entire formula too complex and this is why this approach was not currently applied. But it may be applied in the future if the index receives a broader application.

Computational formula and application of the index

The modified index is following the pattern of the existing HDI. It uses geometric means for aggregating both individual sub-components and the dimensional indices ($I_{Dimension}$)[14].

Extended Human Development Index

$$EHDI = \sqrt[4]{I_{Health} \times I_{Knowledge} \times I_{Income} \times I_{Environment}}$$

Environment dimension index is calculated as geometric mean of indexed indicators

$$I_{Environment} = \sqrt[5]{Water \times Air \times Soils \times Forests \times Habitat}$$

Penalty indexes (A_x) in Decent standards of living and Environment areas are calculated as geometric mean of indexed indicators. The **Sustainable Human Development Index** within the affordable limits is calculated as geometric mean of deflated area indexes

$$SHDI - A = \sqrt[4]{(A_{Health} \times I_{Health}) \times (A_{Knowledge} \times I_{Knowledge}) \times (A_{Income} \times I_{Income}) \times (A_{Environment} \times I_{Environment})}$$

Relative losses due to non-affordability are calculated through comparison with EHDI:

$$\%Losses = \left(1 - \frac{SHDI - A}{EHDI}\right) \times 100\%$$

In most cases it applies observed minimum and maximum for indexation (unless in clearly stated and substantiated cases). It doesn't apply weights between individual dimensions assuming that all four are equally important from sustainable human development perspective. More precisely, the ecological component has the same weight as three other traditional components of the index (based on the assumption assuming that people value "environment" equally as they value long and healthy life, knowledge opportunities or incomes). This assumption falls in the mainstream of the conceptual thinking on the issue.[15]

When aggregating and indexing individual indicators, we are clearly distinguishing between stimulants (indicators that reflect positive features, like life expectancy) and de-stimulants (indicators that reflect negative features, like mortality rate). In the case of stimulants, we use direct scaling; in the case of de-stimulants reverse scaling is used.

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[14] It should be specifically noted that even when the use of geometric means limits substitutability across the different dimensions of the HDI, this does not directly relate to substitutability. In fact, adding a 4th environmental dimension necessarily implies a weak sustainability approach, if we don't take into account the possibility of crossing environmental thresholds of potential global risk. See section "The methodological assumptions behind the SHDI-A" for more detailed discussion.

[15] A number of studies, both statistical and participatory, came out with equal or close to equal weights for components of HDI, see for instance G. Nguefack-Tsague et al. (2011)

The description of each indicator and the detailed computation formulas are presented in Annex 1. The data sources used are presented in Annex 2.

3. Discussion

We tested proposed index for countries in Europe and Central Asia region[16] using publically available data. Figures 2-4 summarize the results.

Losses due to non-sustainability (non-affordability) appear both in countries in Eastern and Central Europe and Central Asia as well as in Western Europe. The magnitude of the losses varies but it is indicative and correlated with the individual countries' pattern of economic development. In most countries, the environmental and income dimensions of non-affordability contribute most to the human development losses due to non-sustainability. In some cases however contribution of education and health are also significant.

An in-depth analysis of the specific country cases and the contribution of the individual dimensions as well as the correlation of the SHDI-A with the national development policies goes beyond the scope of this paper. Nevertheless, this is exactly what can (and should) be done as a next step. The proposed SHDI-A with its tiers of indicators (and particularly with the context indicators) provides the opportunity for going beyond pure advocacy and make the index a policy-relevant tool informing national governments about the long-term implications of the development policy choices and the price the societies may pay in the future in case such choices are short-sighted.

The set of indicators used is the "best available" but still far from the ideal. The indicators are not carved in stone though. They are open for further discussion and revision. We hope this paper will trigger such a discussion.

Applying different indicators would yield slightly different results in terms of human development losses, country rankings etc. The rankings however are less important. What does matter is the logic and the major idea that unless human development is within what societies can afford (economically, environmentally, socially, and demographically), the achieved level of development it would inevitably crash at high human cost. In that regard the logic of the index is more important than the set of particular indicators and the results they yield.

[16] Including 30 countries in Eastern and Central Europe and Central Asia and 17 countries in Western Europe. We used most recent available data, in majority of cases these are 2009 and 2010.

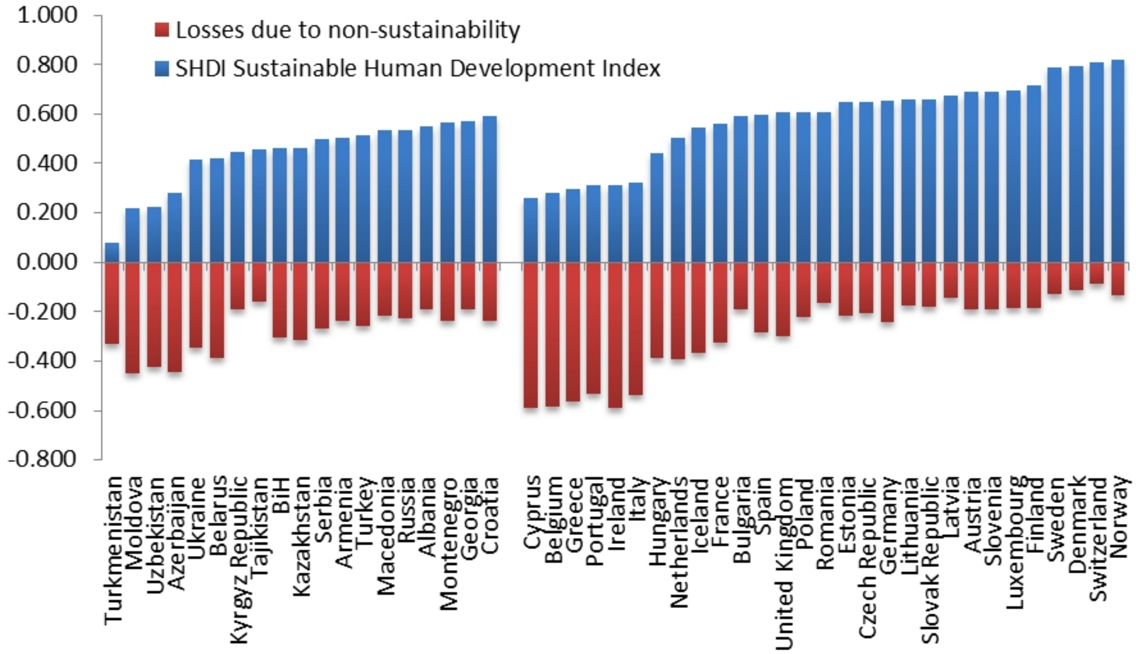


Figure 2. EHDI, SHDI-A and losses due to non-sustainability for countries of the region, 2013

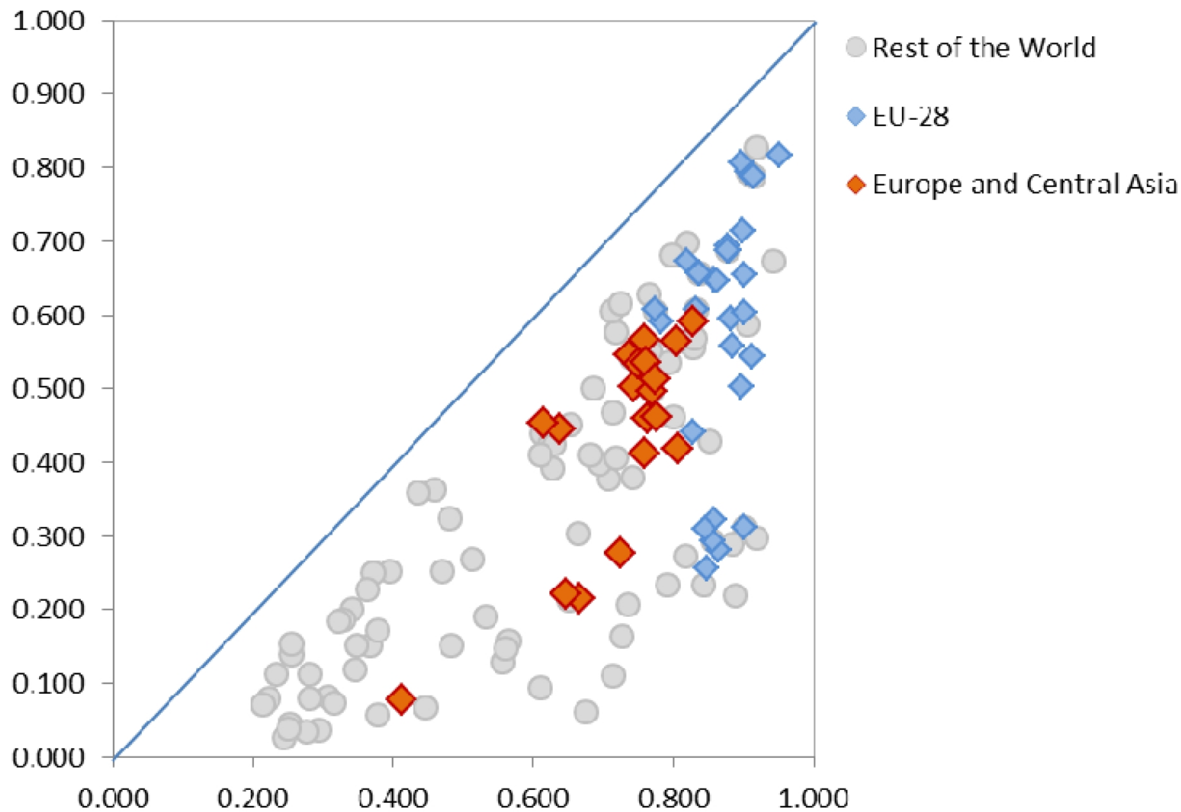


Figure 3. To what extent the level of human development achieved in 2013 was within the 'affordable limits'?

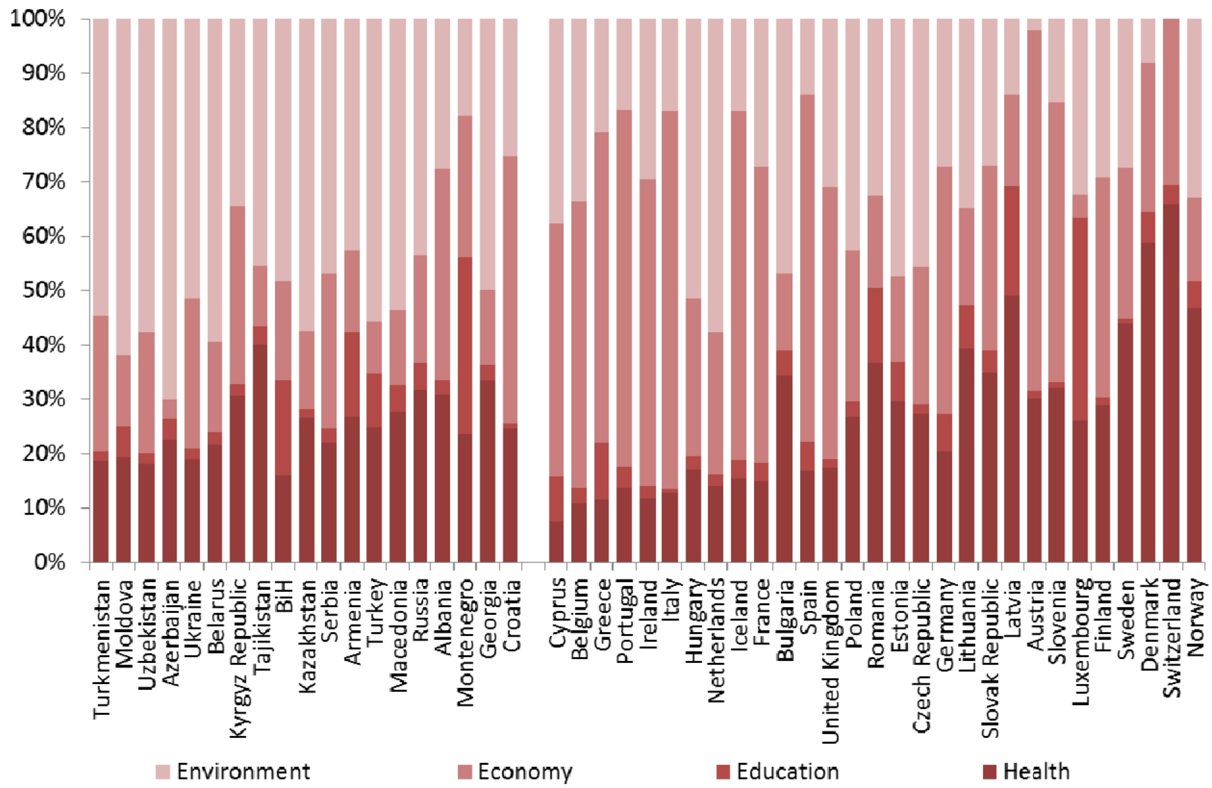


Figure 4. Contribution to non-affordability, 2013

The obtained Human Development Indices were correlated against core environmental and governance indicators (see figures 5, 6 and 7 below[17]). Correlation between HDI and EHDI is relative strong, which is understandable as EHDI simply expand HDI with one dimension. However, HDI is much weekly correlated with SHDI-A, suggesting that the latter captures additional information compared to the former. While HDI is strongly correlated with ecological footprint (a well-known fact[18]), the correlation is weaker for EHDI and SHDI-A (figure 6). This might be due to the fact that ecological footprint is a relatively narrow indicator of strong sustainability, capturing footprint of consumption expressed in "global hectares". While generally development is associated with increased ecological footprint related to increased consumption, **how** development happened is equally important. The ecological footprint does not capture that – unlike SHDI-A. In other words, while ecological footprint reflects the implications of people consuming stuff, SHDI-A captures also how the consumed stuff was produced (in a sustainable way or not).

[17] The figures plot individual countries for which data were available from publically-accessible sources in June 2016.

[18] http://www.footprintnetwork.org/pt/index.php/GFN/page/fighting_poverty_our_human_development_initiative/

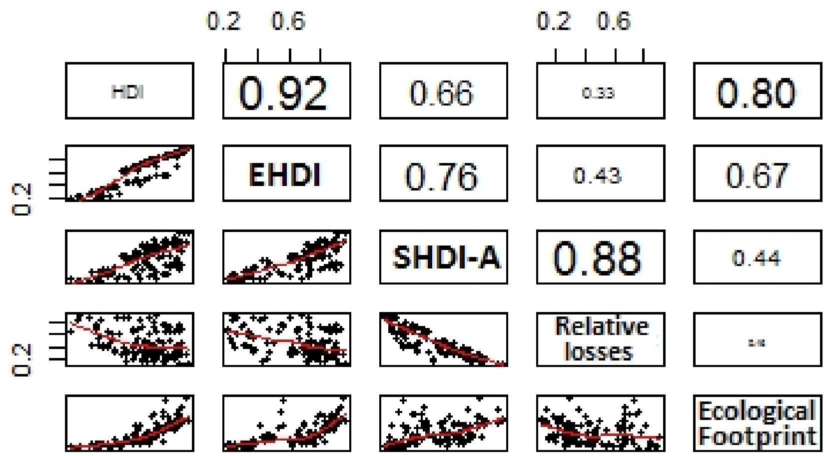


Figure 5. Correlation of SHDI-A with HDI and Ecological Footprint

CO2 emissions indicators (both per capita and per unit of GDP) show similar lack of correlation with SHDI-A. The major reason is the fact that CO2 emission is accounted by the place of production, not of consumption, therefore it is not that good indicator of sustainability of development. At the same time SHDI-A shows relatively strong correlation with Environmental Performance Index,[19] a more complex index related to sustainable development. AHDI-A is correlated both with "Environmental Health" (EPI-EH) and "Ecosystem Vitality" (EPI-EV) dimensions of EPI (figure 7).

[19] Environmental Health and Ecosystem Vitality are the EPI's two main objectives that provide an umbrella for the Index's issue areas and indicators. Environmental Health measures the protection of human health from environmental harm. Ecosystem Vitality measures ecosystem protection and resource management. These two objectives are divided into nine issue categories that encompass high-priority environmental policy issues including Agriculture, Air Quality, Biodiversity and Habitat, Climate and Energy, Forests, Fisheries, Health Impacts, Water Resources, and Water and Sanitation. See more http://epi.yale.edu/

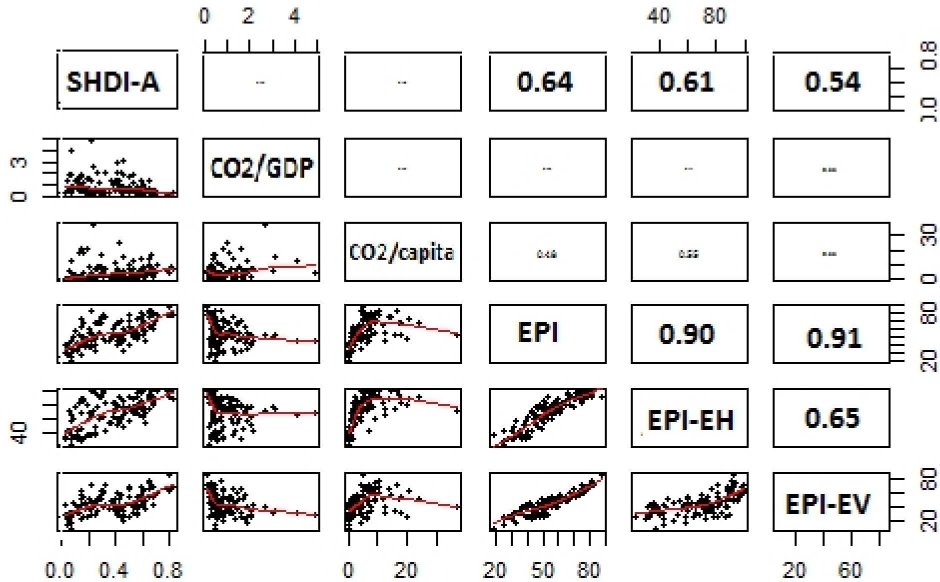


Figure 6. Correlation of SHDI-A with CO2 emissions and EPI

How sustainability of development results are related to quality of governance? The index sheds light on this issue as well. Figure 8 visualizes the correlation between SHDI-A with three Governance Indexes—Government Effectiveness (GE), Rule of Law RoL) and Voice and Accountability (VaA). Interestingly correlation is relatively strong in all three indicators but particularly with rule of law suggesting that enforcing environmental protection legislation (in many countries existing primarily on paper) is an important determinant of achieving sustainable development path. This also underscores the central message of our paper—in development what matters not only *what*, but (increasingly) *how*. This conclusion resonates with Angus Deaton's message that development is more about quality than quantity (e.g. quality of years of life, rather than mechanical extension of longevity). For *how* development governance matters a lot and these correlations should come as no surprise.

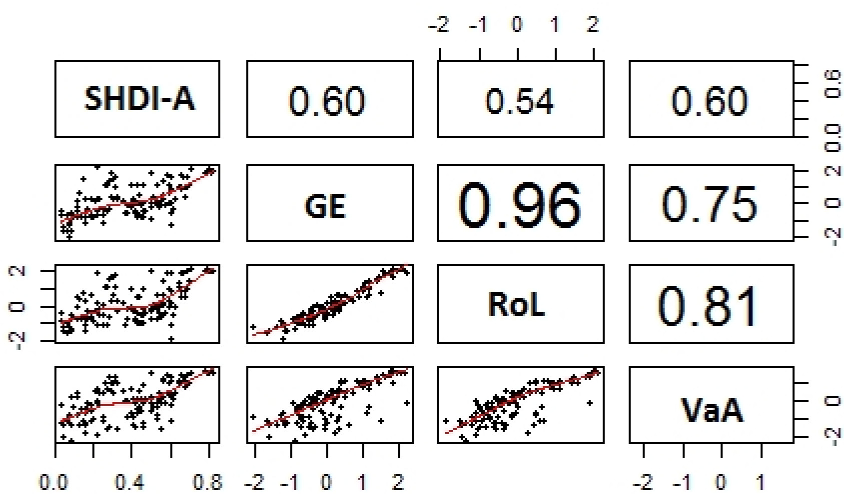


Figure 7. Correlation of SHDI-A with governance indicators

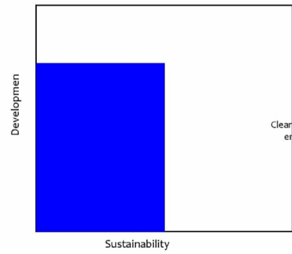
The method proposed (to track sustainability of the way development results have been achieved) is relevant also to the new SDG framework. Achieving the goals of sustainable development is critically important but doing that in a sustainable way is even more important. Applying the SHDI-A methodology to SDGs can help reach this goal.

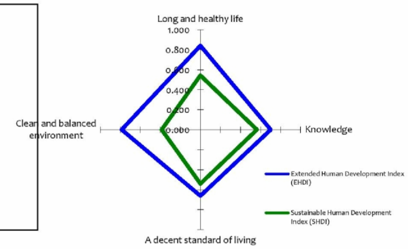
Apart from its information value, the proposed index has practical policy implications. Applied to country level, it sheds light on how the progress in individual areas has been achieved and what are the bottlenecks that the respective country might address. Figure 8 visualizes such “country sustainability” dashboard in the case of Armenia.

Figure 8. Country 'affordability' dashboard: Armenia

Armenia 2013

Human Development Index	0.730
Extended Human Development Index (EHDI)	0.744
Sustainable Human Development Index (SHDI)	0.503
% losses due to non-sustainability	24%
Human and Environmental Poverty Index	20.6





	Long and healthy life		Knowledge		A decent standard of living		Clean and balanced environment	
Status	Life expectancy index	0.839	Education index	0.702	GNI index	0.661	Environment Index	0.785
	Life expectancy at birth	74.6	Mean Years of Schooling	10.8	GNI per capita (USD PPP)	7,952	Improved water source (% of population with access)	99.9
			Expected Years of Schooling	12.3			PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	17.8
							Forest area (% of base year, 1990)	99.0
							Waste management, Improved sanitation facilities (% of population with access)	89.5
Sustainability	Health Sustainability	0.646	Education Sustainability	0.804	Standards of living Sustainability	0.817	Environmental Sustainability	0.492
	Healthy life expectancy at birth, years	62.0	Persistence to last grade of primary, total (% of cohort)	90.2	General government gross debt (% of GDP)	38.0	Water withdrawal - Annual freshwater withdrawals, total (% of internal resources)	42.9
					Energy use (kg of oil equivalent) per $1,000 GDP (constant 2011 PPP)	137	Terrestrial and marine protected areas (% of total territorial area)	8.1
							Share of energy from renewable sources	28.9
Context	Health expenditure, private (% of GDP)	2.6	Government expenditure on education as % of GDP (%)	2.3	HDI Loss due to inequality in income (%)	14.3	EFP Total Ecological Footprint (global ha per capita)	1.9
	Health expenditure, public (% of GDP)	1.9	HDI Loss due to inequality in education (%)	10.2	Income share held by lowest 20%	8.5	EFP Total Biocapacity (global ha per capita)	0.8
	Health expenditure, total (% of GDP)	4.5	Pupil-teacher ratio in primary education (headcount basis)	19.3	GINI index	31.3	EFP Biocapacity (Deficit) or Reserve (global ha per capita)	-1.0
	HDI Loss due to inequality in life expectancy (%)	12.7	Pupil-teacher ratio in secondary education (headcount basis)	..	Electric power transmission and distribution losses (% of output)	12.2	Bird species, threatened	15
	Physicians (per 1,000 people)	2.7	Internet users (per 100 people)	41.9	Informal payments to public officials (% of firms)	4.6	Mammal species, threatened	8
	Nurses and midwives (per 1,000 people)	4.8	Mobile cellular subscriptions (per 100 people)	112.4	Unemployment, total (% of total labor force)	16.2	Plant species (higher), threatened	71
	Hospital beds (per 1,000 people)	3.9	Firms offering formal training (% of firms)	16.2	Unemployment, youth total (% of total labor force ages 15-24) (modeled ILO estimate)	32.5		
	Improved water source (% of population with access)	99.9			Informal employment (% of total non-agricultural employment)	19.4		
	Improved sanitation facilities (% of population with access)	89.5			CO_2 emissions (metric tons per capita)	1.7		

4. Conclusions

The proposed index of affordable (or sustainable) human development is a novel approach combining high policy relevance, simplicity and statistical robustness. The index has a powerful appeal directly addressing one of the most fundamental human development challenges today – the unaffordability of the development path based on exponential increase of consumption as the major driver of growth. Unaffordability in that regard is broader than unsustainability usually understood primarily in environmental terms. The approach behind the proposed index addresses that.

A major novelty of the index is the integration of the **status** (*what* was achieved) and the **process** (*how* it was achieved) reflected in the two tiers of the index. This combination of status and process is what makes the index a policy relevant tool.

The incorporation of the third tier – the context indicators – is another novelty of the index. This tier serves as the "last mile" necessary for translating the globally comparable indicators into nationally-relevant implications, conclusions and policies. Tier C (which is not part of the index) provides the detailed national context of sustainable development (political, institutional) in which the challenges need to be addressed with real decisions.

In its entirety, the Sustainable Human Development Index within the affordable limits is a useful tool for diagnosing sustainability of the achieved human development level and thus flagging possible bottlenecks in the future and suggesting solutions. Moreover, the methodology tested in the SHDI-A for factoring in the possible 'unsustainability of the process' of human development can be applied also to the SDGs. An aggregated index for tracking progress in SDGs based on core outcome indicators weighted by the characteristics of the process (achieved in a sustainable or unsustainable way) would operationalize the entire SDG policy framework. Applying a rights-based framework and linking the SDGs to countries' legal commitments would bring the SDGs even closer to a working operational framework that would translate policy goals into sustainable outcomes.

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Annexes

Annex 1: Description of the indicators used for the fourth dimension proposed for the SHDI and the detailed computation formulas (Tier A)

Indicator	Description	Source
Water—Improved water source (% of population with access)	Access to an improved water source refers to the percentage of the population with reasonable access to an adequate amount of water from an improved source, such as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Unimproved sources include vendors, tanker trucks, and unprotected wells and springs. Reasonable access is defined as the availability of at least 20 liters a person a day from a source within one kilometer of the dwelling.	WB WDI WHO, UNICEF
Air—Air pollution PM2.5 (micrograms per cubic meter)	Population-weighted exposure to ambient PM2.5 pollution is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter, which are capable of penetrating deep into the respiratory tract and causing severe health damage. Exposure is calculated by weighting mean annual concentrations of PM2.5 by population in both urban and rural areas.	WB WDI
Forests—Forest area (% of base year, 1990)	Forest area is the land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use. Areas under reforestation that have not yet reached but are expected to reach a canopy cover of 10 percent and a tree height of 5 m are included, as are temporarily unstocked areas, resulting from human intervention or natural causes, which are expected to regenerate. Excludes: tree stands in agricultural production systems, for example in fruit plantations and agroforestry systems. The term also excludes trees in urban parks and gardens.	UNDP HDRO FAO

Habitat—Improved sanitation facilities (% of population with access)	Access to improved sanitation facilities refers to the percentage of the population with at least adequate access to excreta disposal facilities that can effectively prevent human, animal, and insect contact with excreta. Improved facilities range from simple but protected pit latrines to flush toilets with a sewerage connection. To be effective, facilities must be correctly constructed and properly maintained.	WB WDI WHO, UNICEF

Environment dimension index is calculated as geometric mean of indexed indicators

$$I_{Environment} = \sqrt[5]{Water \times Air \times Soils \times Forests \times Habitat}$$

Annex 2. Indicators deflating for unsustainable development path (Tier B)

Indicator	Description	Source
Health		
Adjusted Life Expectancy (HALE)	Healthy life expectancy (HALE) at birth adds up expectation of life for different health states, adjusted for severity distribution making it sensitive to changes over time or differences between countries in the severity distribution of health states.	WHO
Knowledge		
Persistence to last grade of primary, total (% of cohort)	Persistence to last grade of primary is the percentage of children enrolled in the first grade of primary school who eventually reach the last grade of primary education.	WB WDI UNESCO
Decent standards of living		
General government gross debt (% of GDP)	Gross debt consists of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future. This includes debt liabilities in the form of SDRs, currency and deposits, debt securities, loans, insurance, pensions and standardized guarantee schemes, and other accounts payable. Thus, all liabilities in the GFSM 2001 system are debt, except for equity and investment fund shares and financial derivatives and employee stock options.	IMF WEO
Energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP)	Energy use per PPP GDP is the kilogram of oil equivalent of energy use per constant PPP GDP. Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. PPP GDP is gross domestic product converted to 2005 constant international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as a U.S. dollar has in the United States.	WB WDI
Environment		

Water withdrawal - Annual freshwater withdrawals, total (% of internal resources)	Annual freshwater withdrawals refer to total water withdrawals, not counting evaporation losses from storage basins. Withdrawals also include water from desalination plants in countries where they are a significant source. Withdrawals can exceed 100 percent of total renewable resources where extraction from nonrenewable aquifers or desalination plants is considerable or where there is significant water reuse. Withdrawals for agriculture and industry are total withdrawals for irrigation and livestock production and for direct industrial use (including withdrawals for cooling thermoelectric plants). Withdrawals for domestic uses include drinking water, municipal use or supply, and use for public services, commercial establishments, and homes.	WB WDI
Terrestrial and marine protected areas (% of total territorial area)	Terrestrial protected areas are those officially documented by national authorities. Marine protected areas are areas of intertidal or subtidal terrain--and overlying water and associated flora and fauna and historical and cultural features--that have been reserved by law or other effective means to protect part or all of the enclosed environment.	WB WDI UNEP
Share of energy from renewable sources (% of total energy)	Electricity production from renewable sources, includes hydroelectric, geothermal, solar, tides, wind, biomass, and biofuels.	WB WDI

Penalty indexes (A_x) in Decent standards of living and Environment areas are calculated as geometric mean of indexed indicators. Sustainable Human Development Index within the affordable limits is calculated as geometric mean of deflated area indexes

$$AHDI = \sqrt[4]{(A_{Health} \times I_{Health}) \times (A_{Knowledge} \times I_{Knowledge}) \times (A_{Income} \times I_{Income}) \times (A_{Environment} \times I_{Environment})}$$

Relative losses due to non-affordability are calculated through comparison with EHDI:

$$\%Losses = \left(1 - \frac{AHDI}{EHDI}\right) \times 100\%$$

Annex 3. Results HDI, EHDI and SHDI-A values (2013)

	HDI	EHDI	SHDI-A	Losses	% loss
Europe and Central Asia					
Albania	0.716	0.738	0.546	-0.192	0.260
Armenia	0.730	0.744	0.503	-0.241	0.324
Azerbaijan	0.747	0.725	0.277	-0.447	0.617
Belarus	0.786	0.806	0.418	-0.388	0.482
Bosnia and Herzegovina	0.731	0.763	0.459	-0.304	0.399
Croatia	0.812	0.828	0.592	-0.237	0.286
Georgia	0.744	0.759	0.566	-0.193	0.254
Kazakhstan	0.757	0.777	0.461	-0.316	0.407
Kyrgyz Republic	0.628	0.639	0.446	-0.193	0.302
Macedonia	0.732	0.750	0.533	-0.217	0.289
Moldova	0.663	0.666	0.216	-0.450	0.676
Montenegro	0.789	0.805	0.565	-0.240	0.298
Russia	0.778	0.762	0.534	-0.227	0.298
Serbia	0.745	0.769	0.497	-0.272	0.354
Tajikistan	0.607	0.616	0.454	-0.162	0.262
Turkey	0.759	0.774	0.512	-0.262	0.338
Turkmenistan	0.698	0.413	0.078	-0.335	0.811
Ukraine	0.734	0.760	0.413	-0.347	0.457
Uzbekistan	0.661	0.647	0.221	-0.425	0.658
EU-28					
Austria	0.881	0.881	0.686	-0.195	0.221
Belgium	0.881	0.866	0.281	-0.584	0.675
Bulgaria	0.777	0.782	0.591	-0.191	0.245
Croatia	0.812	0.828	0.592	-0.237	0.286
Cyprus	0.845	0.848	0.256	-0.592	0.699
Czech Republic	0.861	0.859	0.649	-0.210	0.245
Denmark	0.900	0.907	0.794	-0.113	0.124
Estonia	0.840	0.864	0.646	-0.218	0.252
Finland	0.879	0.900	0.714	-0.187	0.207
France	0.884	0.885	0.558	-0.327	0.369
Germany	0.911	0.901	0.654	-0.247	0.274
Greece	0.853	0.857	0.294	-0.563	0.657
Hungary	0.818	0.828	0.441	-0.387	0.467
Iceland	0.895	0.913	0.543	-0.370	0.405
Ireland	0.899	0.902	0.311	-0.590	0.655
Italy	0.872	0.860	0.323	-0.537	0.625
Latvia	0.810	0.820	0.674	-0.147	0.179
Lithuania	0.834	0.836	0.657	-0.179	0.214
Luxembourg	0.881	0.879	0.693	-0.186	0.211
Netherlands	0.915	0.897	0.503	-0.393	0.438
Norway	0.944	0.952	0.818	-0.135	0.141
Poland	0.834	0.832	0.607	-0.225	0.270
Portugal	0.822	0.845	0.310	-0.536	0.634
Romania	0.785	0.774	0.607	-0.166	0.215
Slovak Republic	0.830	0.838	0.657	-0.181	0.215

	HDI	EHDI	SHDI-A	Losses	% loss
Slovenia	0.874	0.879	0.688	-0.191	0.218
Spain	0.869	0.883	0.595	-0.288	0.326
Sweden	0.898	0.916	0.787	-0.128	0.140
Switzerland	0.917	0.897	0.806	-0.091	0.102
United Kingdom	0.892	0.902	0.603	-0.299	0.331
Rest of the World					
Afghanistan	0.468	0.290	..	..	..
Algeria	0.717	0.709	0.378	-0.331	0.467
Andorra	0.830	0.859	..	..	..
Angola	0.526	0.294	0.037	-0.257	0.874
Antigua and Barbuda	0.774	0.779	..	..	..
Argentina	0.808	0.818	..	..	..
Australia	0.933	0.944	0.672	-0.271	0.287
Bahrain	0.815	0.557	0.129	-0.427	0.767
Bangladesh	0.558	0.367	0.152	-0.215	0.587
Barbados	0.776	0.792	..	..	..
Belize	0.732	0.767	..	..	..
Benin	0.476	0.307	0.083	-0.224	0.730
Bhutan	0.584	0.369	..	..	..
Bolivia	0.667	0.459	0.363	-0.096	0.209
Botswana	0.683	0.665	0.304	-0.361	0.542
Brazil	0.744	0.741	0.542	-0.199	0.269
Brunei	0.852	0.852	0.428	-0.424	0.498
Burkina Faso	0.388	0.245	..	..	..
Burundi	0.389	0.292	..	..	..
Cabo Verde	0.636	0.431	..	..	..
Cambodia	0.584	0.378	0.056	-0.321	0.851
Cameroon	0.504	0.340	0.201	-0.139	0.408
Canada	0.902	0.906	0.588	-0.318	0.351
Central African Republic	0.341	0.257	..	..	..
Chad	0.372	0.151	..	..	..
Chile	0.822	0.821	0.698	-0.122	0.149
China	0.719	0.480	0.325	-0.156	0.324
Colombia	0.711	0.719	0.576	-0.143	0.199
Comoros	0.488	0.362	..	..	..
Congo	0.564	0.394	0.252	-0.142	0.362
Costa Rica	0.763	0.798	0.680	-0.118	0.148
Côte d'Ivoire	0.452	0.328	0.187	-0.141	0.429
Cuba	0.815	0.829	0.555	-0.274	0.330
Dem. Rep. Congo	0.338	0.222	0.079	-0.143	0.645
Denmark	0.900	0.907	0.794	-0.113	0.124
Djibouti	0.467	0.308	..	..	..
Dominica	0.717	0.711	..	..	..
Dominican Republic	0.700	0.714	0.467	-0.247	0.346
Ecuador	0.711	0.711	0.604	-0.107	0.150
Egypt	0.682	0.483	0.151	-0.333	0.689
El Salvador	0.662	0.654	0.452	-0.202	0.309

	HDI	EHDI	SHDI-A	Losses	% loss
Equatorial Guinea	0.556	0.387	..	..	..
Eritrea	0.381	0.252	0.045	-0.207	0.823
Ethiopia	0.435	0.277	0.034	-0.242	0.876
Fiji	0.724	0.766	..	..	..
Gabon	0.674	0.470	0.252	-0.218	0.463
Ghana	0.573	0.371	0.251	-0.120	0.324
Greece	0.853	0.857	0.294	-0.563	0.657
Grenada	0.744	0.765	..	..	..
Guatemala	0.628	0.613	0.439	-0.174	0.284
Guinea	0.392	0.267	..	..	..
Guinea-Bissau	0.396	0.200	..	..	..
Guyana	0.638	0.686	..	..	..
Haiti	0.471	0.316	0.074	-0.242	0.765
Honduras	0.617	0.623	0.425	-0.198	0.318
India	0.586	0.280	0.112	-0.167	0.598
Indonesia	0.684	0.629	0.425	-0.204	0.324
Iran	0.749	0.513	0.269	-0.244	0.475
Iraq	0.642	0.447	0.068	-0.379	0.848
Ireland	0.899	0.902	0.311	-0.590	0.655
Israel	0.888	0.818	0.273	-0.545	0.667
Jamaica	0.715	0.735	0.207	-0.528	0.718
Japan	0.890	0.884	0.289	-0.595	0.673
Jordan	0.745	0.715	0.110	-0.605	0.846
Kenya	0.535	0.363	0.228	-0.135	0.372
Kiribati	0.607	0.415	..	..	..
Korea	0.891	0.694	0.399	-0.295	0.425
Kuwait	0.814	0.559	..	..	..
Lao PDR	0.569	0.508	..	..	..
Lebanon	0.765	0.728	0.164	-0.564	0.775
Lesotho	0.486	0.362	..	..	..
Liberia	0.412	0.291	..	..	..
Libya	0.784	0.676	0.061	-0.615	0.909
Macedonia	0.732	0.750	0.533	-0.217	0.289
Madagascar	0.498	0.247	..	..	..
Malawi	0.414	0.319	..	..	..
Malaysia	0.773	0.793	0.535	-0.258	0.325
Maldives	0.698	0.759	..	..	..
Mali	0.407	0.198	..	..	..
Malta	0.829	0.845	0.233	-0.612	0.725
Mauritania	0.487	0.205	..	..	..
Mauritius	0.771	0.799	0.461	-0.338	0.423
Mexico	0.756	0.768	0.552	-0.216	0.282
Micronesia	0.630	0.616	..	..	..
Mongolia	0.698	0.626	..	..	..
Montenegro	0.789	0.805	0.565	-0.240	0.298
Morocco	0.617	0.627	0.391	-0.236	0.376
Mozambique	0.393	0.244	0.026	-0.218	0.894

	HDI	EHDI	SHDI-A	Losses	% loss
Myanmar	0.524	0.462	..	..	..
Namibia	0.624	0.436	0.359	-0.077	0.177
Nepal	0.540	0.254	0.138	-0.116	0.456
New Zealand	0.910	0.920	0.826	-0.094	0.102
Nicaragua	0.614	0.611	0.094	-0.517	0.846
Niger	0.337	0.156	..	..	..
Nigeria	0.504	0.255	0.153	-0.102	0.400
Oman	0.783	0.533	0.191	-0.342	0.641
Pakistan	0.537	0.345	0.118	-0.227	0.658
Palau	0.775	0.826	..	..	..
Panama	0.765	0.766	0.627	-0.139	0.181
Papua New Guinea	0.491	0.247	..	..	..
Paraguay	0.676	0.686	0.499	-0.187	0.272
Peru	0.737	0.724	0.615	-0.110	0.152
Philippines	0.660	0.681	0.410	-0.271	0.398
Poland	0.834	0.832	0.607	-0.225	0.270
Qatar	0.851	..	..	..	..
Russia	0.778	0.762	0.534	-0.227	0.298
Rwanda	0.506	0.498	..	..	..
Samoa	0.694	0.746	..	..	..
São Tomé and Principe	0.558	0.414	..	..	..
Saudi Arabia	0.836	0.565	0.158	-0.408	0.721
Senegal	0.485	0.234	0.112	-0.121	0.519
Serbia	0.745	0.769	0.497	-0.272	0.354
Seychelles	0.756	0.802	..	..	..
Sierra Leone	0.374	0.257	..	..	..
Singapore	0.901	0.889	0.219	-0.670	0.754
Slovak Republic	0.830	0.838	0.657	-0.181	0.215
Slovenia	0.874	0.879	0.688	-0.191	0.218
Solomon Islands	0.491	0.367	..	..	..
South Africa	0.658	0.652	0.214	-0.438	0.672
Sri Lanka	0.750	0.755	0.528	-0.227	0.301
St. Kitts and Nevis	0.750	0.802	..	..	..
St. Lucia	0.714	0.732	..	..	..
St. Vincent and the Grenadines	0.719	0.744	..	..	..
Sudan	0.473	0.280	0.080	-0.200	0.713
Suriname	0.705	0.725	..	..	..
Swaziland	0.530	0.519	..	..	..
Sweden	0.898	0.916	0.787	-0.128	0.140
Syrian Arab Republic	0.658	0.658	..	..	..
Tanzania	0.488	0.321	0.184	-0.136	0.425
Thailand	0.722	0.718	0.406	-0.312	0.434
The Bahamas	0.789	0.813	..	..	..
The Gambia	0.441	0.311	..	..	..
Timor-Leste	0.620	0.416	..	..	..
Togo	0.473	0.213	0.070	-0.143	0.670
Tonga	0.705	0.755	..	..	..

	HDI	EHDI	SHDI-A	Losses	% loss
Trinidad and Tobago	0.766	0.792	0.234	-0.558	0.705
Tunisia	0.721	0.742	0.380	-0.362	0.488
Uganda	0.484	0.318	..	..	..
United Arab Emirates	0.827	0.561	0.147	-0.414	0.738
United States	0.914	0.918	0.297	-0.621	0.677
Uruguay	0.790	0.830	0.568	-0.262	0.315
Vanuatu	0.616	0.609	..	..	..
Venezuela	0.764	0.775	0.606	-0.169	0.218
Vietnam	0.638	0.610	0.410	-0.200	0.327
West Bank and Gaza	0.686	0.608	..	..	..
Yemen	0.500	0.251	0.039	-0.211	0.843
Zambia	0.561	0.378	0.171	-0.207	0.547
Zimbabwe	0.492	0.347	0.153	-0.195	0.561

HDI is available for 196 countries of the world

EHDI estimated for 195 countries of the world.

SHDI-A is available for 139 countries of the world.