

Measuring what matters

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Inaugural lecture
Prof. Jan-Pieter Smits
January 26, 2018



/ Department of Industrial Engineering & Innovation Sciences

TU e Technische Universiteit
Eindhoven
University of Technology

Measuring what matters: a long-term view of sustainability

Where innovation starts

Inaugural lecture Prof. Jan-Pieter Smits

Measuring what matters: a long-term view of sustainability

Presented on January 26, 2018
at Eindhoven University of Technology

Introduction

Dear colleagues, beloved friends,

“I invest, he speculates, they gamble”. A chapter in *The Embarrassment of Riches*, Simon Schama’s seminal study of the Dutch Republic in the seventeenth century; the Golden Age when the Dutch “ruled the waves”.² In this chapter Schama highlights the shadow-side of that golden period: speculation in tulip bulbs leading to the collapse of that trade. Other parts of this book deal with the unease expressed by parts of society that questioned economic growth from a moral and ethical perspective. Natural disasters, such as the massive number of whales washing ashore, were seen as a sign from “above” that mankind, with its materialist tendencies, was moving in a wrong direction.

Schama’s description of the downside of economic growth may be applied to many historical periods, not least our own. His description of the Tulip Mania reminds us of the dot-com bubble, bitcoins and the financial crisis, which severely undermined economic growth in recent years. The ethical and moral critique on “economism” is also heard today. Voices from different parts of society warn us that the behavior of producers and consumers may end up undermining the possibility of life on this planet.

This moral and ethical appeal has great relevance. In the course of history, employers and employees were able to organize themselves in order to protect their interests. Nature does not have the capacity to do so. Only we, as human beings, can come to the aid of the natural environment. But this will only happen if we feel a moral obligation to do so.

In the first part of this lecture I will explain how sustainability can be operationalized and measured, and address three dimensions of sustainability (“here and now”, “later” and “elsewhere”). Next, I will focus on how these three dimensions can be quantified. How this can enrich the analysis of the effects of economic growth on human well-being and sustainability and how this information may help society to engineer a more sustainable future. The final part of the lecture focuses on the agenda for future research.

¹ I thank Harry Lintsen, Ruth Oldenziel, Erik van der Vleuten and Gerard Eding for giving feedback on earlier drafts, and Rita Gircour for language corrections.

² Schama, *The embarrassment*.

There is a growing awareness that the current economic developments do not necessarily promote higher levels of well-being. The crisis of 2008 has brought home the fact that economic growth has to be restructured in such a way that economic, social and ecological developments become more sustainable.³ Part of this reorientation concerns the measurements that society at large and policy makers in particular use. The perception is widespread that GDP (that is Gross Domestic Product, an indicator of aggregate output of the economy) does not give us comprehensive and adequate information about human well-being and the extent to which quality of life can be sustained over longer periods of time. Initiatives such as *GDP and Beyond* by the European Commission⁴ and the United Nations' *Sustainable Development Goals* (SDG's)⁵ are good examples of the attempt to look beyond the material aspects of life. This chair on *Quantification of Sustainability* reflects this trend. This research not only tries to identify which indicators can capture complex phenomena such as well-being and sustainable development, it also attempts to analyze to what extent economic growth has actually resulted in a more sustainable well-being in the long run. One may ask: Why this emphasis on quantification? Why the long-term perspective? And why should this research be carried out at a university of technology?

Why measurement? You cannot manage what you do not measure. Policy makers can only track progress in attaining their defined goals when they have the relevant indicators at their disposal. This is exactly why former UN Secretary-General Ban-ki-moon argued that a data revolution was needed to implement the SDG's.⁶ If society wants to move in a more sustainable direction, we need to monitor whether the sustainability criteria are met.

Why history? Sustainable development is an inter-generational phenomenon. After all, it is the behavior of the past generations that has resulted in the current sustainability problems. Historical analysis may help us understand the roots of these sustainability challenges, and to identify the technologies and institutional arrangements that may make the transition to a more sustainable society easier.

Why this research at a University of Technology? William Brian Arthur defined technology quite broadly, as "a means to fulfill a human purpose".⁷ This closely

³ OECD, *New Approaches to Economic Challenges* (NAEC). See: <http://www.oecd.org/naec/>.

⁴ European Commission, *GDP and Beyond*, see: http://ec.europa.eu/environment/beyond_gdp/index_en.html

⁵ United Nations, *Sustainable Development Goals* (SDGs), see: <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

⁶ <http://www.undatarevolution.org/>. Of course, this data revolution also concerns new ways of data collection, such as working with Big Data.

⁷ Brian Arthur, *The nature of technology*.

resembles the classical definition of economics as the science that focuses on how to meet human needs given scarce resources. Not only are these scarce resources needed to fulfill our present-day needs, but we must also preserve enough resources so that future generations can meet their needs. Technological innovation and diffusion are essential in making the most efficient use of resources.

From a sustainability perspective, technology is not necessarily good or bad. Historical research shows that certain technologies, which were used to solve “old” sustainability problems, created new challenges.⁸ It is therefore vital to know people’s preferences. What kind of life do we desire, and which technologies can be helpful to realize, to engineer that future?

Before moving to the analysis of data that inform us about long-term changes in human well-being and sustainable development, we first need to have an idea of how to operationalize and measure these complex phenomena. Well-being and sustainability are often used as container concepts, encompassing all that is good and beautiful for humanity, but often lacking a proper definition. Together with Rutger Hoekstra from Statistics Netherlands, I built a measurement system, which was refined in the work of the UNECE/Eurostat/OECD Taskforce for Measuring Sustainable Development. The final report of this group, the *CES Recommendations on Measuring Sustainable Development* has been endorsed by 65 countries.⁹ In May 2018, Statistics Netherlands will publish its first *Well-Being Monitor for the Netherlands*, based on this framework. It will be debated in parliament.¹⁰

The measurement framework takes the definition of the Brundtland Commission as its starting point:

Sustainable development is a development which meets the needs of the present generation without compromising the needs of later generations (here or elsewhere on the planet).¹¹

In other words, the measurement system focuses on three aspects: human well-being (or: quality of life) “here and now”, versus “later” and “elsewhere”. This well-being deals with the ecological, economic and social aspects of life.

⁸ See: Lintsen et al., Well-being sustainability and social development, introduction.

⁹ UNECE/OECD/Eurostat, CES Recommendations.

¹⁰ See: <https://www.cbs.nl/nl-nl/achtergrond/2016/16/cbs-nota-brede-welvaart-en-duurzaamheid>

¹¹ This definition was put forward in WCED, Our Common Future and slightly adapted in CBS, Sustainability Monitor 2014 (introduction).

In this lecture I will describe these three dimensions and investigate to what extent economic growth in the long-run has resulted in increases in well-being “here and now”, without depleting resources to such an extent that the well-being “later” or “elsewhere” was harmed. First of all, I will summarize some results of the monograph *Well-being, sustainability and social development: the Netherlands 1850-2050* that Harry Lintsen and Frank Veraart (TU Eindhoven), John Grin (University of Amsterdam) and I wrote.¹² Then I will present an agenda for future research.

¹² The Dutch version of this monograph, *De kwetsbare welvaart van Nederland 1850-2050*, will be published March 2018 by Prometheus.

Human well-being “here and now”

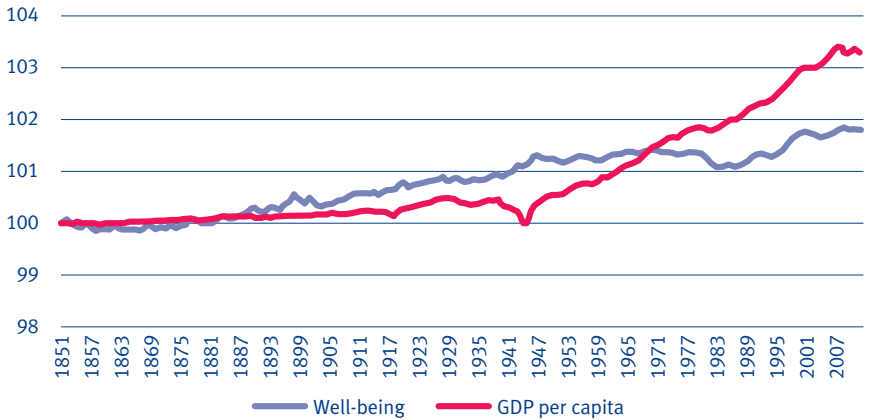
A key issue in the “GDP and Beyond” debate is to what extent all the economic growth that the Western world has witnessed has actually improved human well-being. In order to investigate this question, we first need to know what constitutes well-being. What determines quality of life? This is not an easy task, as society’s well-being depends on the extent to which its preferences are met. However, in conventional economic analysis these preferences are seen as “exogenous”, in other words they are not explained by the model. Tracing these preferences is a complex matter and subject to intense debate among economists.

The CES Recommendations opted for a pragmatic approach: a list of well-being themes and corresponding indicators was compiled.¹³ It was based on a literature review (including Maslow’s pyramid of human needs¹⁴) and on the analysis of datasets on well-being and sustainability from a large number of statistics agencies.

Graph 1 is taken from the study by Harry Lintsen, Frank Veraart, John Grin and myself. It compares trends in GDP per capita with an aggregate measure of human well-being. Of course, this graph gives only a rough approximation of the improvement in well-being, as the different aspects of quality of life such as education, health, air quality, material consumption etcetera, are all lumped together (with equal weights) in one composite indicator. The only reason to present this figure is to give a broad outline as to how, in the long run, GDP growth has, or has not, resulted in comparable improvements in human well-being.

¹³ UNECE/OECD/Eurostat, CES Recommendations, chapter 4.

¹⁴ Maslow, A theory of human motivation.



Graph 1

— Well-being — GDP per capita

Changes in GDP per capita compared with well-being, 1850-2011 (indices 1850=100).

Source: Lintsen et al., *Well-being, Sustainability and Social Development: the Netherlands, 1850-2050*.

This graph shows that, in the long run, both indicators show a clear upward trend until about 1960. It also indicates that well-being continued to rise even when the economy was in a slump, such as during the Great Depression between the two world wars. From the 1960s onwards, the relationship between the increases in GDP per capita and human well-being began to change. The economy continued to grow, whereas the trend on well-being stabilized. The graph suggests that from a well-being perspective there is an overshooting of GDP growth.

What happened? The growing environmental problems in this period are taken on board in the well-being index, but they are not part of the GDP measure. Moreover, the analysis of well-being shows that from the 1960s onwards people were less strongly embedded in society than before, and tended to trust political institutions less. This had a negative effect on well-being.

The challenges are not restricted to imperfect measurements. Also the coordination mechanisms that are used to regulate social and economic life need to be considered. During the nineteenth century a lot was left to the markets. However, markets may fail. In such cases a re-embedding of economic development is needed. In his study *The Great Transformation*, Polanyi indicated that economic growth during the nineteenth century resulted in serious disruptions.¹⁵ He argued that economic growth had to be re-embedded in society in such a way that it would benefit larger parts of that society. The state had to

¹⁵ Polanyi, *The great transformation*.

intervene to correct some of the undesired outcomes of the economic growth process.

Recent literature argues that new types of re-embedding are needed now.¹⁶ First of all, in the light of present-day ecological problems it is clear that the economy has to be re-embedded in nature. Potential ecological constraints on economic growth deserve more attention. Besides, a re-embedding of the economy in society is on the agenda, as some segments of society feel that their needs are neglected. Another striking conclusion that stems from our long-term analysis of sustainability is substantiated by recent findings in the work carried out by Statistics Netherlands for its *Monitor of Well-Being in the Netherlands*. The data reveal that even though well-being does not improve as fast as GDP grows, quality of life still increases in many domains. However, there is profound discontent with the way society develops.

This phenomenon is widespread throughout the Western world. In our study into long-term changes of well-being and sustainability, we coined this the well-being paradox.¹⁷ How is it possible that part of society is deeply dissatisfied with the state of affairs even though the indicators show stable or even upward trends in well-being? The historical analysis points to at least four possible factors that may explain this phenomenon:

Distribution of well-being: well-being may improve in society as a whole, but this does not necessarily mean that all social groups benefit from it. Some economists even argue that we cannot speak of an improvement in well-being if the gainers of change more than compensate the losers.¹⁸ This line of reasoning goes back to the work of Jeremy Bentham in the late eighteenth century, who said that the “greatest happiness of the greatest number of people” is the measure of right and wrong.¹⁹ The well-being paradox can be explained to some extent by the discontent of groups that do not fully benefit from society’s gains in well-being.

Insecurity and vulnerability: satisfaction with life is not always directly linked to current levels of well-being. Feelings of unease may stem from the fear of losing the quality of life that one has. In a more dynamic and complex globalizing world, growing numbers of people no longer have permanent jobs; they often get flexible contracts. Future income from pensions may also be a worry. Feelings of insecurity and vulnerability may lead to a greater dissatisfaction with life than the current indicators of well-being suggest.

¹⁶ Kemp et al., *The humanization of the economy*.

¹⁷ Lintsen et al., *Well-being, sustainability and social development, epilogue*.

¹⁸ Little, *A critique of welfare economics*.

¹⁹ Bentham, *A fragment on Government* (preface).

Changing preferences: to some extent social critique and dissatisfaction can be seen as positive phenomena. After all, they may lead to identifying problems and bottlenecks, which need to be solved. Furthermore, when old problems of well-being are solved, preferences may change, and aspects of life that were never seen as problematic may suddenly become problematized.

Ways to channel the societal debate: the ways in which the state and civil society interact are important for society's problem-solving potential. Until the 1960s, civil society in the Netherlands was organized around different religious or political belief systems. This is called the *pillarization* of society. However, the last quarter of the twentieth century saw the gradual evaporation of this system. A substantial part of the electorate no longer feels that politicians address their feelings and wishes. This partly explains the unease expressed in some segments of society. Of course, a successful channeling of society's preferences to the level of central government may make a successful transition to a more sustainable society more likely.

Questions about well-being always deal with trade-offs. The choice for one type may have a negative effect on other aspects. Often sustainability research deals with a macro level. It may, however, also be fruitful to focus on other levels of aggregation, such as cities. Here we can more easily identify consumer preferences. We can observe the impact of citizens' choices on their quality of life and see the trade-offs that are at stake.

Research into urban sustainable mobility, a program led by Ruth Oldenziel, provides a good opportunity to apply the measurement system of the CES recommendations at a local level and in a global context. The international program Sustainable Urban Mobility, initiated by researchers at this university and the Foundation for the History of Technology, explores possibilities for collaboration with the Dutch Ministry of Infrastructure and Water Management and looks at possibilities to include its activities in the Work Program of the European Commission.²⁰

This program uses a mixed-method approach involving both quantitative and qualitative approaches. Macro analyses are complemented by micro studies. The latter analyze the historical actors and the choices they made, as well as the determinants of their behavior. Moreover, important aspects of mobility, such as bicycling and walking, are taken into account. These have been overlooked in studies done at a macro level.

²⁰ <http://www.cyclingcities.info/research/>

Research on urban mobility is quite challenging, as it also implies a re-formulation of the measurement framework to the local level. Statistics Netherlands now cooperates with municipalities in enriching databases at the local level in the newly established Urban Data Centers (UDC's).²¹ This work at the urban level may be fruitful, as cities are important drivers in the various sustainability agendas that have been formulated.

²¹ For information on this initiative on Urban Data Centers, see: <https://www.cbs.nl/en-gb/dossier/regional-statistics/wegwijzer/cbs-urban-data-centres>; This work is also linked to work of the United Nations World Council on City Data: <http://www.dataforcities.org/>.

Human well-being “later”

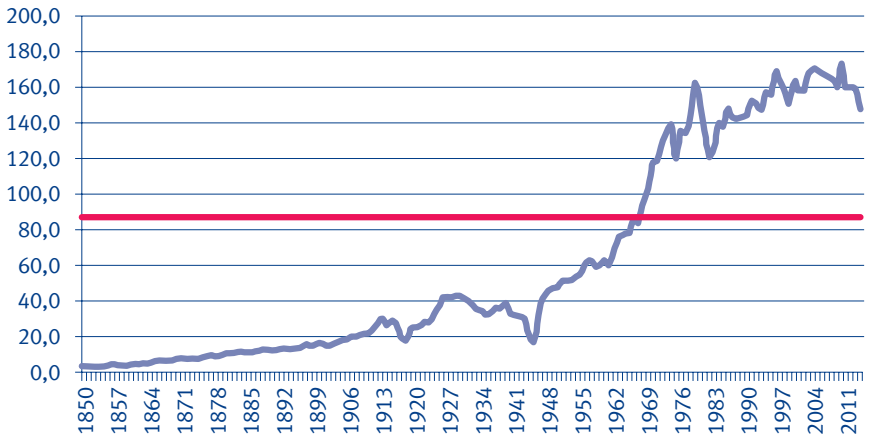
Debates on sustainable development largely address inter-generational issues. The inter-generational conditions of sustainability are met if future generations can at least enjoy levels of well-being comparable with those of the present generation. However, we have no crystal ball to look into the future, so it is impossible to know the preferences of future generations. One way to say something about future well-being is by focusing on the resources that are needed to generate well-being. The preconditions of inter-generational sustainability are met if the amount of resources per capita remains at least constant over time. Capital theory identifies the key resources that society has at its disposal.²² Apart from economic capital (machinery, equipment, infrastructure and knowledge), it considers human capital (the educational attainment and health of people) and social capital (the quality of inter-personal networks and institutions). Natural capital deserves special attention, as it is a form of critical capital. If natural resources fall below certain critical levels, the effects on the future of different life forms on this planet may be far-reaching.

Graph 2, which is taken from the study by Harry Lintsen, Frank Veraart, John Grin and myself, shows the development of CO₂ emissions over time.

This graph shows moderate growth until the 1950s and a rapid acceleration afterwards. The horizontal line depicts the level of emissions deemed to be sustainable, according to the Paris Treaty on climate change. It was only during the 1960s that CO₂ emissions surpassed the sustainability standards in their current definition. Society now faces high costs related to the high levels of CO₂ emissions that have accumulated since the 1960s.

The analysis presented in the monograph on the Netherlands 1850-2050 shows that the increase in material use and the emission of pollutants not only depend on the rapid rise in real income and the corresponding growth in consumption but that there are also cultural factors at stake such as the emergence of the mass consumer society. Besides, the circular economy of the nineteenth century has been replaced by a linear economy with increasing amounts of waste and emissions of pollutants. This all resulted in an economic development which no longer met the criteria of sustainable development.

²² For an extensive review on capital measurements, see: UNECE/OECD/Eurostat, CES Recommendations, chapter 5.



Graph 2

CO₂ emissions, 1850-2015 (in Kton; against sustainability norm). Source: Lintsen et al. *Well-being, Sustainability and Social Development: the Netherlands, 1850-2050*.

The costs of growth are not confined to natural capital. A proper analysis of inter-generational sustainability should take all capital forms into account. The World Bank applies a method to show the importance of different types of capital for a large set of countries.

A study of the World Bank, *The Changing Wealth of Nations*, revealed considerable international differences in total wealth per capita.²³ Total wealth is defined as the sum of all forms of capital (economic, human, social and natural capital; all expressed in monetary terms). In East Asia and the Pacific, South Asia and Sub-Saharan Africa the total wealth per capita is less than 5% of the level reached in the high-income OECD countries. The Middle-East & North Africa as well as Latin America achieved a level of 20 to 25%.

Table 1 shows the contribution of the several types of capital to total wealth. In other words, this table shows how important the different forms of capital are in various parts of the world. The category intangibles consists mainly of human and social capital.

The data indicate that the high levels of wealth in the high-income countries are largely explained by these intangibles. Another striking feature is the uneven distribution of natural capital. The natural assets amount to only 1.9% in the high-income OECD countries against 15 to 35% in other regions of the world.

²³ World Bank, *The changing wealth of nations*.

	Intangibles	Economic capital	Natural capital
East Asia & Pacific	50.3	28.4	21.3
Latin America	69.3	15.5	15.2
Middle East & North Africa	41.9	23.9	34.1
South Asia	57.3	17.5	25.3
Sub-Saharan Africa	59.7	13.8	28.0
High-Income OECD countries	81.2	16.9	1.9

Table 1

Structure of wealth 2005 (in % of total wealth). Source: Calculations based on World Bank, *The Changing Wealth of Nations*.

The international comparison also shows that the growth of wealth is driven by different types of capital in the various regions. The World Bank study shows that in the period 1995-2005 natural resources in South Asia and Sub-Saharan Africa were depleted. On the other hand, the growth of wealth in the high-income OECD countries was mainly driven by economic and knowledge capital. Here, the share of natural capital to the overall growth of wealth was negligible, simply because the high-income countries imported most natural resources from other countries. Even though we are quite well informed about long-term changes in well-being²⁴, a lot less is known about the evolution of the different types of capital in various parts of the world. Part of the research agenda on the “later” dimension concerns the construction of historical time-series for different types of capital for various regions of the world economy. This will enable us to chart whether or not economic growth and improvements of well-being in various parts of the world were based on a depletion of vital resources and which were the factors causing the various degrees of depletion.

²⁴ OECD, How was life? Global well-being since 1820. See: <http://www.oecd.org/statistics/how-was-life-9789264214262-en.htm>

Human well-being “elsewhere”

One of the major new ideas expressed by the Brundtland Commission, in its Report *Our Common Future*, is that the poverty problem in the Least Developed Countries (LDC's) is part and parcel of the sustainability challenge the Western world is facing. On the one hand, trade between the West and poorer regions of the world may generate income for the latter and, therefore, have a positive impact on their well-being. On the other hand, the huge exports of non-renewable natural resources by the sub-Saharan African countries in particular result in a depletion of their natural capital stocks.

Research by Hans Langenberg (from Statistics Netherlands) and myself showed that the Netherlands has been one of the largest per capita importers of natural resources in the EU throughout the last fifty years.²⁵ Interestingly, our analysis revealed that other former colonial powers also rank high in the trade in natural resources with LDC's. This raises questions about the historical roots of present-day trade specialization and the possibilities of path dependencies in trade relations.

We recently launched the project SUSTAIN here at TU Eindhoven, together with Erik van der Vleuten and Frank Veraart (TU Eindhoven), John Grin (University of Amsterdam) and Dirk-Jan Koch (Radboud University and Ministry of Foreign Affairs). Our aim is to investigate the historical distribution of sustainability gains and costs in raw material supply chains connecting the Netherlands, its former colonies and the Least Developed Countries in the period 1920-2050.

The first research question deals with how the costs and benefits of raw materials trade were distributed along the value chain. To what extent did trade partners in poorer regions of the world profit from that trade? Dutch colonial trade in the nineteenth century serves as a telling example. In the 1830s the *Cultuurstelsel* was introduced. This was a system of colonial exploitation in the Dutch East Indies. Indigenous planters worked for relatively low wages, but their produce was sold at quite high prices by the *Nederlandsche Handels Maatschappij* (Dutch Trading Company) on the Amsterdam market.²⁶ Detailed book-keeping records have allowed the costs and benefits of this type of trade to be traced in detail.

²⁵ Langenberg and Smits, “Invoer van grondstoffen”.

²⁶ Horlings, *The economic development*, chapter 4.

The trade in colonial products was quite substantial. In the 1850s colonial trade provided more than half of government income. However, the gains of trade were distributed rather unequally. In the 1830s only 8% of these proceeds went to the Dutch East Indies. During the 1850s and 1860s, when the living conditions of Indonesian planters became a concern, this share increased to about 40%.²⁷ Similar types of calculations can also be made for the trade value chains in later eras.

Secondly, the sustainability effects in the LDC's, or the former colonies, are assessed using the methods of the World Bank described in the previous section. These quantitative sustainability assessments will be supplemented with more qualitative evidence. In cooperation with scholars in Indonesia, Surinam, Ghana, Congo and Nigeria, qualitative historical research using ethnographic methods will reconstruct the development and governance of resource exploitation and assess the quality of life of those involved in this work. This research will enable us to get a deeper understanding about the impact the high-come countries have on the well-being and sustainability of the poorer regions in the world.

²⁷ Van Zanden and Van Riel, *Nederland 1780-1914*, chapter 5.

Measuring the non-measurable?

The measurement framework of the CES Recommendations is inspired by the neoclassical production function, which states that output (GDP) is a function of increases in labor and economic capital. The CES Recommendations use an augmented production function.²⁸ This explains changes in human well-being from a growth in labor and broadly defined capital, including economic, human, social and natural capital. Even though this approach is a step forward, it leaves a lot to be desired as it is firmly rooted in the paradigm of modernity. The last part of this lecture examines some of these modernist assumptions and potential shortcomings, and tries to define a research agenda for the longer term.

One of the shortcomings of conventional economic analysis is that it treats people's preferences as exogenous. Neoclassical economics, the dominant stream of economic thought in the twentieth century and an exponent of the modernist paradigm, argues that the preferences of citizens can be tracked down by looking at their consumer behavior. According to this approach, well-being equals the utility derived from consumption. In other words, our well-being only depends on what we consume. The question must be raised whether this approach tells us anything meaningful about human preferences. Do we really know and measure what is important to people?

The *GDP and Beyond* agenda also focuses strongly on capital, or the resources that are needed to generate well-being both now and in the future. The last few decades have seen huge advances in the measurement of capital. Still, there are some pressing issues that need to be addressed. First of all, there is the need for better measurements of financial sustainability. From the Tulip Mania in the Golden Age to the recent financial crisis and concerns about bitcoins; time and again “bubbles” are created that lead to a collapse of growth. The financial sector urgently requires “early warning” signals, in order to avoid severe disruptions such as we have seen after the crisis of 2008.

Another promising field of research concerns natural capital accounting. Statistics Netherlands recently started a project that attempts to assess the monetary value of ecosystems by looking at the services that they render to humanity.²⁹ However,

²⁸ UNECE/OECD/Eurostat, CES Recommendations, chapter 3.

²⁹ For recent work of Statistics Netherlands (CBS) on natural capital accounting, see:

<https://www.cbs.nl/en-gb/corporate/2017/35/value-of-forest-heath-and-built-up-areas-mapped-out>.

the consequence of this approach is that unexploited nature - which renders no services to humanity - has no value. From a strictly economic perspective, where nature is seen as an input in an economic process, this may be legitimate. However, seen from a broader sustainability perspective, it is hard to swallow that the ecosystems of Antarctica have no value at all. By putting a price on something, we may know its economic value. But does this mean that we really know how people *value* nature? If we are not careful, we end up in a situation where we know the price of everything, but the value of nothing.

This brings us to the topic of describing the value of nature beyond the more restricted forms of economic monetization. The well-being paradox already showed that objective developments and people's subjective appreciation may differ. One way in which statisticians try to overcome this problem is by measuring people's satisfaction with different aspects of life.³⁰ For example, to what extent are citizens satisfied with the natural environment. This approach is certainly a step forward, but it only gives a limited amount of information. First of all, satisfaction with life is measured as a score between 0-10. Most of these indicators have scores between 7 and 8, which hardly vary over time. Moreover, such indicators do not inform us *why* satisfaction is increasing or decreasing. They do not tell us how people actually *experience* certain aspects of life. In the modernist approach, observers describe a reality that is separate from them. Philosophers of science, however, propose alternative approaches. The French philosopher Merleau-Ponty stresses "sensing", instead of the more superficial "describing".³¹ Sensing assumes a relationship between object and subject, and tries to describe what the French so aptly call "le dedans des choses" (the inner meaning of things).

Deep mapping is a method with which this "inner meaning" of things can be revealed, and it can be applied to many aspects of life: the natural environment as well as the social context in which one lives.³² This method invites people to experience the connection with their environment. Delft University of Technology recently conducted an interesting experiment in the project Pin(k) a Place. People's perception of landscape was studied interactively by researchers who

³⁰ Veenhoven "Freedom and Happiness".

³¹ M. Merleau-Ponty, Phenomenology of perception.

³² The method of deep mapping was first explored by William Least Heat-Moon, *PrairieEarth*. The method of sensing, which is done by monitoring the interaction between people and their environment, is also relevant for the social and organizational context in which people operate. See for example: Scharmer's Theory U.

tried to record the “what, where and why” people feel most attracted to in a given natural environment.³³

Another project worth mentioning is GIFT-T! (Green Infrastructure for Tomorrow-Together!), carried out at Alterra (Wageningen University).³⁴ Its starting point is the notion that landscape mediates between nature and people. In the research of Alterra people are asked why nature is important to them. In an iterative process, they are asked about their preferences for certain ecosystem services, and also to what extent they prefer certain aspects of well-being. The outcomes can be summarized in statistical tables.³⁵ This research is one of the rare examples in which human preferences regarding the natural environment are studied. This work, as well as research based on “deep mapping”, gives us a better idea of how people experience nature. These data will not only enrich the monitoring of well-being and sustainability, they can also be quite helpful for policy makers and engineers in their attempts to re-shape the natural environment in line with people’s preferences. This may help to re-embed the economy in society and nature.

It is important in these redesigning processes to take on board the lessons that can be drawn from the past. In our study on two centuries of well-being and sustainability in the Netherlands, John Grin shows how historical knowledge can be used.³⁶ It provides a deeper understanding of the available options for moving toward a more sustainable future. In their handbook on the history of technology, Erik van der Vleuten, Ruth Oldenziel and Mila Davids maintain that we can only engineer the future if we understand our past.³⁷

Attempts to reveal people’s preferences concerning the natural environment are important, as they may enable us to *value* nature beyond the more limited economic approaches. Still, the question may be raised as to how fruitful it is to view nature and the environment as a form of capital which renders services, and which only has value because of the use that we humans make of it. Does nature not have an intrinsic value?

In the early nineteenth century, Jeremy Bentham already advocated fundamental animal rights, which can also be extended to other life forms. He tried to identify what he called the “insuperable line” which determines the extent to which humans should take the well-being of other life forms into consideration.

³³ <https://iopm2017.wordpress.com/project/>.

³⁴ See: <http://www.gift-t.eu/about/Alterra/alterra-wageningen> .

³⁵ Liu and Opdam, “Valuing ecosystem services”.

³⁶ Lintsen et al., Well-being, sustainability and social change, epilogue.

³⁷ Van der Vleuten et al., Engineering the future.

Bentham asked:

“What (else) is it that should trace the insuperable line? Is it the faculty of reason or perhaps the faculty of discourse? But a full-grown horse or dog, is beyond comparison a more rational, as well as a more conversable animal, than an infant of a day or a week or even a month, old. But suppose the case were otherwise, what would it avail? The question is not, can they *reason*? Nor, can they *talk*? But: can they *suffer*?”³⁸

Animal rights are increasingly placed on the political agenda. This is first small step toward attributing an intrinsic value to the environment, rather than considering it just a resource for human use. Recent research shows that “habitat provision” is mentioned by a relatively small number of people as the most important ecosystem service.³⁹ This shows that the intrinsic value of nature is not yet widely acknowledged.

As I mentioned in the introduction, a solution for some of the chronic environmental problems can only be found when humanity starts to value nature more than it has in the past centuries. After all, nature cannot solve issues of climate change and chronic biodiversity losses by itself. It needs human intervention to repair, or prevent even more damage. According to Matthijs Schouten, professor at Wageningen University, one should not speak of an environmental crisis but of an inner crisis of humanity that has caused the disruptions in the natural environment.⁴⁰

³⁸ Bentham, Introduction to the Principles of Morals, chapter 17.

³⁹ Liu and Opdam, Valuing ecosystem services.

⁴⁰ Schouten, De natuur.

Future research

The CES Recommendations on Measuring Sustainable Development open up new ways to measure and analyze human well-being and sustainable development. A couple of papers are planned not only on the methodology of this measurement framework, but also to describe the long-term development of well-being and sustainability in several regions of the world.

The study on long-term changes in well-being and sustainability in the Netherlands by Harry Lintsen, Frank Veraart and John Grin and myself shows how historical analysis can be enriched by taking on board the indicators of the CES framework, especially when using a mixed-method approach and linking these results to qualitative evidence.

Future research will be more of an international and comparative nature. It will be closely linked to work carried out by the Foundation for the History of Technology⁴¹, led by Jan Korsten and Erik van der Vleuten. This research will connect to the *Tensions of Europe* research⁴² as well as to the *Grand Challenges* project formulated by Erik van der Vleuten.

The proposed research can only be carried out if we have relevant and reliable statistical data at our disposal. Looking at the future work that needs to be done in the field of quantifying sustainability, there is a short-term agenda which deals with improving the indicators that are part of the framework of the CES Recommendations. It focuses most notably on strengthening the different capital accounts (particularly the natural capital accounts). Of course, there are serious limitations to treating nature as a form of capital, but at least by using the concept of natural capital, nature can become part of the social cost-and-benefit analyses on which policy makers base their decisions. It is important to speak the language of policy makers.

However, we must also formulate a more fundamental, long-term agenda. That research should focus on new ways to track human preferences. This information can also serve as a basis to re-design our environment. Here it is important to take into account the governance of technological innovation, the field of expertise of Floortje Alkemade (TUE). Besides, research carried out at the faculties

⁴¹ For more information on this Foundations, see: <https://www.histech.nl/en/>.

⁴² See: <https://www.tensionsofeurope.eu/>.

of Industrial Design and the Built Environment of this university demonstrates the key role engineers can play in re-shaping the environment.

The long-term agenda on tracking human preferences will not only improve the statistical monitoring of well-being and sustainability, it may also help to engineer a world with a better and more sustainable quality of life; a world where not only human life but all life forms matter.

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Curriculum Vitae

Prof. Jan-Pieter Smits was appointed part-time professor of Quantification of Sustainability in the Department of Industrial Engineering & Innovation Sciences at Eindhoven University of Technology (TU/e) on September 1, 2016.

Jan-Pieter Smits obtained his PhD degree in 1995 at the VU Amsterdam. He has worked at Utrecht University and the University of Groningen, where he published in the field of historical national accounting, long-term economic growth, and the effects of economic growth on well-being. He coordinated historical research in the Groningen Growth and Development Centre, and was a program coordinator in the N.W. Posthumus Institute, the post-graduate school of economic and social history. In 2007 Smits was appointed senior statistical researcher at Statistics Netherlands, where he became project leader of the Sustainability Monitor of the Netherlands. With Rutger Hoekstra he led the UNECE/Eurostat/OECD Taskforce for Measuring Sustainable Development. Smits has also represented Statistics Netherlands in the United Nations Inter-Agency Group for Measuring the Sustainable Development Goals. In September 2016, Smits was appointed part-time professor at Eindhoven University, a chair financed by Statistics Netherlands.

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