Towards monitoring a socio-ecological transition

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1. Introduction

> *"Sustainable Development stands for meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs – in other words, a better quality of life for everyone, now and for generations to come. It offers a vision of progress that integrates immediate and longer-term objectives, local and global action, and regards social, economic and environmental issues as inseparable and interdependent components of human progress."* (European Commission[1])

Europe has not yet arrived at an economically, socially and environmentally sustainable development path which is envisaged with the EU's Europe 2020 strategy (European Commission, 2010) and the EU's sustainable development strategy (European Commission, 2001a). In order to get there a transition of the current system is required. The WWWforEurope project intends to lay the analytical foundation for this new development strategy. Within this framework, the main aim of this paper is providing a tool for monitoring the transition process. It is neither a primary objective to develop a new set of indicators nor to measure the progress of the transition itself.

We call this transition process socio-ecological transition since it focuses on required changes in the economic system considering the interactions with two complex dimensions, society and nature (Fischer-Kowalski & Haberl, 2007). The concept of socio-ecological transition shows similarities with the concept of sustainable development which – according to the famous Brundtland report (WCED, 1987) - is defined as aiming at meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (Council of the European Union, 2006). However, from our perspective it is helpful in the context of this paper to highlight the clear distinction between sustainable development on the one hand and sustainability on the other. Sustainability describes a system where the current status does not deteriorate over time. It aims at maintaining the capacity of the joint economy-environment system in order to continue to satisfy the needs and desires of humans for a long time into the future (Dimitrova et al., 2013; Common and Stagl, 2005). On the other hand, sustainable development refers to a system where the current status can be further improved while the achieved (future) status never deteriorates anymore. In other words, while sustainability focuses on the idea that the future will not be worse than the current status, sustainable development postulates that the current status might further improve but each of the achieved statuses will be sustainable themselves. Accordingly, not all developments (or development paths) starting from a sustainable status are sustainable. If a country's economic, social or environmental system is not yet sustainable, a shift in the development path (i.e. a transition) is needed to achieve sustainability.

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[1] http://ec.europa.eu/environment/eussd/

For this paper it is of particular importance to define the objectives of development. In other words, what should be improved while verifying sustainability? We define well-being as the main objective of societal development following conceptual considerations taken from a vision that has been developed within the WWWforEurope project: “By 2050 Europe will have become a role model for a dynamic, open and pluralistic economic area characterised by limited income differences, absolute decline of emissions and resource use and positive spillovers to neighbours and the world at large.” (Aiginger, Bayer, Kratena, Tichy, & Weiss, 2014). The envisaged system shall enable inter alia high levels of employment, social inclusion, gender equity and environmental sustainability. All of these elements are important to achieve individual and societal well-being.

Coming back to the main goal of this paper (i.e. monitoring the socio-ecological transition towards a sustainable development path) measurability is required. However, well-being itself is very difficult to measure. In particular, assessing whether the current level of well-being is sustainable is an even more complex issue to solve. The systemic changes occurring during the socio-ecological transition must comply with the principles of sustainable development considering the needs of future generations. We approach this issue by defining items that are relevant building blocks for the ultimate goal of improving well-being. The first step is the distinction in three dimensions (economic, social and environmental). If the settings in all three dimensions are favourable for well-being we can measure it indirectly.

Based on the aforementioned distinction between ‘static’ sustainability and ‘dynamic’ sustainable development in a second step we define both a static and a dynamic target for these three dimensions. Moreover, we argue that guaranteeing the dynamic target of staying on a sustainable development path is actually the ultimate objective even superior to the static target of achieving individual well-being. However, the dynamic characteristics complicate the measurement. For instance, GDP as a measure of economic performance can be measured easily but how can we measure its sustainability (or its sustainable development) for the future? We therefore identify in a third step relevant facets that are important preconditions for reaching the targets set within each dimension. Potential indicators are then assigned to the identified objectives and their preconditions.

From our perspective, our approach of breaking the complexity down into building blocks has the main advantage to allow us to highlight potential trade-offs and synergies between different aspects of the three dimensions. These trade-offs are very important for monitoring the socio-ecological transition. As long as the sustainable development path has not been achieved, some aspects of the three dimensions will have to deteriorate. Otherwise, the current system would already be sustainable. Highlighting the potential trade-offs allows identifying whether a deteriorating indicator is in line with the transition (since it allows another important aspect to improve) or whether it should be seen as alarming signal. On the other hand, knowing potential synergies between the three dimensions can help identifying leverages to achieve the sustainable development path. In some cases, adequate policy can convert a trade-off into a synergy. This monitoring approach makes a major contribution to promoting a sustainable development for Europe.

In the following we will discuss the different steps that are necessary to come up with a tool monitoring the socio-ecological transition. Chapter 2 introduces the main concepts relevant for measuring the progress or development of a society. Principally, this includes welfare, wealth, well-being which were put into context with a socio-ecological transition. The definition of these concepts is a prerequisite for understanding ongoing discussions about potential approaches to measure them. The concepts are different in their focus, but very often they are applied synonymously or at least in a similar meaning. In many cases, the notion of well-being is intended. This chapter also includes exemplarily work on well-being done within the WWWforEurope project. Based on the discussion of these concepts, we present the breakdown into the building blocks of sustainable well-being in the third chapter. The chapter will argue why which targets and preconditions have been selected. In the fourth chapter we will discuss potential indicators for the selected facets and how they relate to each other. Furthermore, we will focus the discussion on potential trade-offs and synergies. In Chapter 5, we discuss potential ways to measure the transition progress. We will also outline the main features of a monitoring tool which we propose for monitoring the progress in the socio-ecological transition. The main aim is monitoring whether the transition moves in the right direction, i.e. towards a sustainable development path. Unfortunately, we cannot present a completely filled-in monitoring tool. As will be discussed in the paper, further research (and sometimes normative decisions) would be required on some of the preconditions to complete the socio-ecological transition. For some of the indicators we do not exactly know the sustainability condition. We therefore focus on the main idea of the proposed tool and hope that it serves for further research to come up with a usable tool. Finally, chapter 6 will summarise our main findings.

2. Main concepts of human development and progress

Since the Club of Rome's publication “Limits to growth” in the 1970s, there is growing awareness that the traditional perception of development mainly focusing on economic production and income is inadequate for measuring people’s well-being and a shift in emphasis is required to tackle it adequately (Stiglitz, Sen, & Fitoussi, 2009). A lot of new concepts and indicators were developed based on neoclassical welfare economics and the System of National Accounts, trying to also include non-market commodities in order to obtain aggregated macro-indicators in monetary terms. Moreover, attempts have been made to also incorporate sustainability considerations (Dimitrova, et al., 2013). In this chapter, we try to give an overview about main concepts of measuring human development and progress and its linkages to the concepts of sustainability. Without a clear understanding of these concepts it is not possible to define and monitor the socio-ecological transition.

Measuring human progress (living standard, development of a society, welfare, etc.) has always been perceived as an important issue in politics and science. Earliest approaches focussed on the economic dimension and how the development of societies' welfare or wealth can be measured. However, both concepts are strongly linked to the economic dimension. The term **wealth** includes both material and immaterial aspects, but mainly the first aspect was considered by economists. For instance, Adam Smith, the first who made this distinction, defined wealth as the annual produce out of the land and labour of the society. In modern economics, the idea of wealth is based on a stock concept, while its returns (basically in the form of labour and capital income) are flows, a distinction which had not been made by Smith (Dimitrova, et al., 2013). The material wealth concept was recently augmented by immaterial or rather intangible assets (see for example Inclusive Wealth Report (UNEP, UNU-IHDP, 2012) or the comprehensive wealth approach by the World Bank (Ferreira & Hamilton, 2010)).

The neoclassical concept of **welfare** also contains a material facet since it is largely associated with the satisfaction of material human needs. Accordingly, welfare can be identified with consumption and thus – more broadly with human wealth. Increases in wealth or consumption respectively are perceived as a primary driver of welfare (Dimitrova, et al., 2013). More in detail, it can be differentiated between consumer/individual welfare and social welfare. Consumer welfare is defined through the individual benefits derived from the consumption of goods and services. Assuming that individuals have individual preferences, individual welfare might also differ across individuals consuming the same amount of goods and services. Individual welfare can therefore be described by ‘an individual’s own assessment of his/her satisfaction, given prices and income (OECD, 2002). Social welfare is obtained when summing up the welfare of all individuals in a society, which equals the overall welfare of the society. (Dimitrova, et al., 2013).

Although GDP is only a pure production indicator, it has been frequently applied as the most important measure of social welfare and human progress. In recent years criticism about its misleading significance arose. Originating from the system of national accounts, GDP only reflects a country’s economic activity (Kettner, Köppl, & Stagl, 2012). Since the Bretton Woods

Agreement GDP was often used as a benchmark for economic growth and living standards, and as such it has become the ultimate measure of a nation's success (Laurent & Le Cacheux, 2015). One major drawback of this measure is that it does not include the value created within the households (European Commission, 2015a). Furthermore, GDP does neither take into account an ecological nor a social perspective. For instance, neither natural resources nor income distribution are considered (Kettner, Kletzan-Slamanig, Köppl, & Köberl, 2012).

For identifying the real determinants of human prosperity it is therefore of vital importance to develop an alternative concept going beyond material conditions like national output and personal income (Laurent & Le Cacheux, 2015). This argument has given rise to focus more and more on **well-being** as it represents a multi-dimensional concept. In 1890, Alfred Marshall introduced the study of well-being into the science of economics. By defining economics in terms of "that part of individual and social action which is most closely connected with the attainment and with the use of material requisites of wellbeing" he still focussed on the material conditions of well-being (Dimitrova, et al., 2013). Later studies on well-being added findings from psychology and sociology. They have shown that also non-material aspects of people's life are relevant for well-being. These inter alia include social and family relations, work, leisure, health and the achievement of personal goals, as well as the feeling of meaning and purpose. Accordingly, the definition of well-being is very broad including material aspects on the one hand and a focus on psychological (immaterial) satisfaction on the other hand (Dimitrova, et al., 2013).

In general, there is a differentiation between objective and subjective well-being. The first concept is using a list of pre-selected objective indicators that are concerned with the satisfaction of physical and social human needs. The measurement of objective well-being is operationalised through quantifiable indices, generally consisting of social, economic and health indicators (e.g. Human Development Index). However this approach has three major weaknesses, namely the top-down decision of what constitutes a measure of well-being, the question of how to weight the different components of objective indicators and finally being paternalistic when applying the same set of indicators universally and not considering cultural and individual differences (Dimitrova, et al., 2013).

The concept of subjective well-being traditionally focuses on individuals' self-reported levels of happiness, satisfaction with life, positive feelings and the absence of negative feelings. The relevant data is gathered through surveys and interviews on life satisfaction allowing individuals to assess their own condition. Although the measurement of subjective well-being allows capturing aspects which had been omitted by objective measures, but which people perceive to be important in their lives, it can be criticized that the level of well-being can be affected by various factors (e.g. circumstances during the interview or formulation of questions). Moreover, cultural and language characteristics may influence the results of subjective studies, as well as genetic factors and personality traits (Dimitrova, et al., 2013). An important theoretical contribution to the measurement of subjective well-being was provided by the OECD (2013).

2.1 Examples for the measurement of well-being

In recent years, there has been increasing interest in establishing a broader array of indicators additionally to GDP in order to measure well-being. In the following we provide an overview on the most important contributions, including initiatives of the European Union as well as approaches from other institutions.

In 2001, the **EU Sustainable Development Strategy (EU SDS)** (European Commission, 2001a) was adopted by the European Council, followed by a renewal in 2006. Based on the standard definition of sustainable development[2] the EU SDS represents a framework for a long-term vision of sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting (European Commission, 2009a). The EU developed a set of sustainable development indicators (see Table 6 in the Annex) which is regularly improved in order to evaluate the agreed goals in the EU SDS. The EU SDS indicators cover the following ten dimensions: 1) socio-economic development, 2) sustainable consumption and production, 3) social inclusion, 4) demographic changes, 5) public health, 6) climate change and energy, 7) sustainable transport, 8) natural resources, 9) global partnership and 10) good governance. Headline indicators as well as operational, explanatory and contextual indicators are defined for each dimension. Reports monitoring the development of each dimension are provided by Eurostat biannually (Eurostat, 2015a).

Beyond GDP is in an initiative hosted by the European Commission, the European Parliament, the Club of Rome, the OECD and the WWF in 2007 (European Commission, 2007). It departs from the criticism that GDP was never designed to be a comprehensive measure of prosperity and well-being and that using GDP as a sole indicator is not addressing global challenges of the 21st century such as climate change, poverty, resource depletion, health and quality of life. Therefore the initiative aims at developing a set of indicators that is as clear and appealing as GDP, but includes more directly/obviously environmental and social aspects of progress (European Commission, 2015b). According to van den Bergh et al. (2014) the "Beyond GDP idea" is not replacing GDP but adding new, relevant indicators. The included social welfare concept is much different from the traditional theory of welfare economics. While the latter defines society as a sum of individuals most of the Beyond GDP indicators are not relevant for the single individual but rather for the society as a whole. Beside the traditional GDP, so-called enlarged GDP indicators are developed which start from GDP but adjust for some of its limitations to deliver a more comprehensive overview of a country's wealth or well-being. The next level includes social and environmental indicators. The first group gives insights into a broad range of social issues, concerns and trends, such as life expectancy, poverty rates, unemployment rates, disposable income, education levels etc. as well as into broader notions of social progress. The second group casts light over the state and development of issues such as natural resources, environmental pollution and waste, as well as related issues such as human health. The last dimension focuses on well-being. These indicators are used to broadly illustrate

[2] **Sustainable development** means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs." (Council of the European Union, 2006)

people's general satisfaction with life, or give a more nuanced picture of well-being in relation to their jobs, family life, health conditions, and standards of living. (European Commission, 2015c) For an overview of the Beyond GDP indicators see Table 7 in the Annex.

The **Europe 2020 Strategy** is a ten year growth strategy for the EU member states aiming at delivering high levels of employment, productivity and social cohesion, while reducing the impact on the natural environment. It explicitly acknowledges the need to focus on a broader array of indicators for measuring macroeconomic success and hence prioritizes smart, sustainable and inclusive growth. Five EU headline targets[3] in the areas of employment, R&D, climate change and energy, education as well as poverty and social inclusion, are currently measured by nine headline indicators and additional sub-indicators (Kettner et al., 2014 and Eurostat 2015b). For an overview of the Europe 2020 indicators see Table 8 in the Annex.

Being aware of the need to improve data and indicators to complement the concept of GDP the EU finances several research projects on new indicators reflecting wider public concerns than those currently covered by GDP (European Commission, 2009b). Examples are for instance, the Network for Green Economy indicators (NETGREEN, 2015) or Desire (new indicators for resource efficiency) (CORDIS, 2015).

In the last two decades many initiatives arose which tried to measure development and well-being with a set of comprehensive indicators capturing the environmental, social and economic dimension simultaneously. An important contribution to the development of an alternative measurement system beyond GDP was provided by the **"Commission on the Measurement of Economic Performance and Social Progress"** (Stiglitz et al., 2009). Initiated by the former French president Nicolas Sarkozy in 2008, the Commission was chaired by Joseph Stiglitz, advised by Amartya Sen and coordinated by Jean-Paul Fitoussi. The report highlighted that the time is ripe for shifting the traditional measurement system from economic production towards people's well-being. The shift in emphasis towards well-being is assessed as important because there appears to be an increasing gap between the information contained in aggregate GDP data and what counts for common people's well-being. Since indicators are influencing the political discourse, the decision on what shall be measured is highly significant. Hence, both having a good measurement system as well as a good understanding of such a system are important. Considering well-being as a multi-dimensional concept, Stiglitz et al. (2009) identified eight key dimensions that should be taken into account simultaneously, notably 1) material living standards (income, consumption and wealth), 2) health, 3) education, 4) personal activities including work, 5) political voice and governance, 6) social connections and relationships, 7) environment (present and future conditions), 8) insecurity, of an economic as well as a physical nature.

The **OECD Better Life Index** captures indicators (see Table 9 in the Annex) additional to GDP expanding the dimensions for measuring material living conditions and the quality of live. Within

[3] 1) 75% of the population aged 20-64 employed; 2) 20 million less people at risk of poverty; 3) 20/20/20 climate/energy targets; 4) 3% of the EU's GDP invested in R&D; 5) Less than 10% of early school leavers and 40% of the younger generation with a tertiary degree.

this approach well-being is explained in terms of quality of life as a first category and material conditions as a second one, including eleven dimensions altogether: health status, work-life balance, education and skills, social connections, civic engagement and governance, environmental quality, personal security as well as subjective well-being are assigned to the first category, income and wealth, jobs and earnings as well as housing are assigned to the second category (OECD, 2013a). The development of statistics capturing aspects of life which matter to people helps to understand what is driving the well-being of individuals and nations and what needs to be done to achieve greater progress. Additionally the Better Life Index allows comparing well-being across countries according to the importance given to the 11 dimensions by the user of the interactive web-based tool (OECD, 2015). Every two years the OECD provides the report "How's life? Measuring Well-being", which depicts the well-being of OECD countries and other major economies. The Guidelines for Measuring Subjective Well-being (2013b) are another important contribution of the OECD to address measurement gaps in dimensions such as life satisfaction.

2.2 Measuring human development and well-being within WWWforEurope

The WWWforEurope project does not only focus on economic development but also on social inclusion as well as on ecological sustainability. Hence, the project is also questioning GDP as a sole measure of human development and tries to capture a broader perspective when measuring social progress.

van den Bergh et al. (2014) offer a critical evaluation of the most important existing alternative indicators to GDP as a measure of welfare or human progress, namely the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI), sustainable and green(ed) GDP, genuine savings and composite indexes. The first two concept groups are based on corrections of GDP, while the second two concepts represent an alternative to GDP. After examining the advantages and disadvantages of the approaches under consideration the authors assessed the ISEW[4] and derived indicators (like GPI and Sustainable Net Benefit Index (SNBI)) as the most balanced alternative available right now, trying to repair multiple shortcomings of GDP and therefore being a clear improvement over GDP. Nevertheless, the applied calculation methods should be much improved, notably to undo the partiality and inconsistency of corrections. They conclude that an ideal indicator of social welfare is not available. As a strategy to arrive at a better approximation of social welfare they suggest to strive towards less misleading information and parallel to this, or subsequently, enlarge the amount of correct and useful information. This may lead to better choices in public decision-making and policy preparation.

[4] The Index of Sustainable Economic Welfare (ISEW) aims at "measuring the (consumption related) services that directly influence human welfare. This is accomplished by adding to GDP services that it omits, while deleting GDP categories that do not directly render services to consumers. The ISEW can thus be considered as a measure of the benefits of economic activity. In addition, the ISEW includes corrections to neutralize income inequality and the unsustainability of production and consumption." (van den Bergh & Antal, 2014, p. 4)

Kettner et al. (2012) examine already existing sets of 'wellbeing indicators' that were developed by a number of international institutions including the EU and the UN and provide a pool of available indicators and indicator systems that go beyond the narrow concepts of national economic accounts. Furthermore they structure the indicators and indices according to central areas of well-being (i.e. energy and emissions; environment and resources; equity; health; work, income, consumption; production; security; education; governance and civic engagement; life satisfaction). This results in a pool of indicators and indicator systems divided into three categories (indicator systems, composite indices as well as NAMEA (National Accounting Matrix including Environmental Accounts) and material flow accounts) which may help to go beyond the narrow concept of national economic accounts[5].

Based on the systematisation of already existing well-being indicators Kettner et al. (2014) suggest a list of possible socio-ecological indicators for four exemplary areas of well-being, i.e. shelter, food, mobility and social participation, aiming at accounting for key aspects to adapt for socio-ecological transitions. So far socio-ecological indicators lack a theoretical underpinning, therefore the authors review four approaches from sustainability science, ecological economics and new approaches of welfare economics, notably happiness economics, the capabilities approach, ecosystem services and energy services on which they build their indicators. One major contribution of this paper is the illustration how a stock-flow-service perspective for these four areas of well-being can be operationalised in an indicator system (see Table 10 in the Annex). Thus far, sustainability indicators did not systematically account for stocks and flows. Given that stocks of many resources are exhaustible, the authors consider it essential to account for the stocks as well as flows when aiming to support decision making for sustainability. In their paper the authors identify wellbeing-relevant services for each of the discussed approaches, which are the result of stock flow interactions. In order to overcome the lack of operationality they only suggest indicators for relevant stocks and flows for which data are available. In their database exemplary stock measures and the corresponding flow indicators are complied for each wellbeing-area and each approach. Finally the authors mention that this extended basis of socio-ecological indicators can be offered in such a way that it is conducive to integration in macroeconomic models.

In their paper, Aiginger et al. (2013) aim at redefining the term competitiveness as the ability of a country (i.e. region, location) to deliver the beyond-GDP goals for its citizens. This definition combines an evaluation of inputs or processes on the one hand with an assessment of output and goals on the other. They measure three pillars of outcome competitiveness[6]. The income pillar adds the indicators net national income (NNI), net disposable household income after taxes and social transfers (NDHI) as well as household final consumption expenditure (HFCE) to the traditional measure GDP per capita. The outcomes of countries' socio-economic systems

[5] For the list of identified already existing sets of wellbeing indicators see Annex in chapter 8.

[6] According to Aiginger et al. (2013) a typical definition of outcome competitiveness is offered by the European Commission (2001b): "the ability of an economy to provide its population with high and rising standards of living and high rates of employment on a sustainable basis". They further state that "fundamental outcomes thus began with GDP per capita as the main indicator of outcome competitiveness. Employment and unemployment indicators were then added to the analysis (p.13)."

in terms of poverty risk, income distribution and unemployment are considered in the social pillar. They include the following indicators: at-risk-of-poverty rates, impact of social transfers, Gini coefficient, S80/S20 income quintile share ratio, youth unemployment rate, long-term unemployment rate and employment gender gap. In the ecological pillar resource productivity, intensity of greenhouse gas emissions, energy intensity of production and share of electricity produced from renewable energy sources are evaluated. They construct a composite indicator for outcome competitiveness consisting of income, social and ecological pillars, following the beyond-GDP literature. In a subsequent step this measure is econometrically related to composite indicators of the three groups of input indicators: price competitiveness, economic structure, and capabilities.

Tichy (2013) studies the relation between subjective well-being and a socio-ecological transition more closely. He offers important insights on likely obstacles for enabling a dynamic socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. Subjective well-being includes cognitive aspects (i.e. life satisfaction) as well as emotional aspects (i.e. happiness). The cognitive aspect of life satisfaction is identified as relevant for analysing problems of trade-offs between goals and externalities, which drive a wedge between social and private objectives. More concretely, the paper uses the individual, economic and social determinants of self-reported life satisfaction to work out preferences of individuals and to confront these with the requirements and policy implications of a socio-ecological transition towards a sustainable development. The insights in the order of individuals' preferences provided by research on subjective well-being indicate serious sustainability problems, as it does when regarding politicians' orders of priorities. It is shown that citizens' desires and attitudes diverge substantially from what is required for sustainability. They rather prefer price stability, employment and growth, when asked directly.

Research on thinking of well-being has often emphasised the contribution of psychological and psychosocial factors over actual material circumstances (such as individual wealth), but the role of the environment or of ecological behaviour was not considered to a large extent. Hence, the author argues that policy directly based on opinion polls would turn out to be myopic and unsuitable to bringing about life satisfaction. This applies in particular to the long-run perspective of life satisfaction. A policy attempt to maximise people's (revealed actual) life satisfaction would necessarily neglect the externalities reducing life satisfaction in the long run, at least the life satisfaction of the next generation. It will be the task of policy makers to find ways to maximise life satisfaction under the restrictions of internalising externalities and taking proper account of sustainability, not life satisfaction per se.

2.3 Conceptualising well-being in the context of a socio-ecological transition

So far, in this chapter we have shown that the issue of measurability of human development has generated a broad range of ideas, concepts and approaches. These concepts are sometimes overlapping, sometimes they propose new elements. Overall, given the plenitude of used terms and considered (or not considered) elements, the literature appears partially confusing.

However, the various approaches have to be seen against the background of their origin. They have been developed to solve or answer diverse problems or questions and therefore follow various targets. The same also holds for this paper. We have to put the presented concepts in the context of monitoring the socio-ecological transition.

As has been discussed above, adequately capturing the multidimensional and complex idea of human progress is very difficult. In this paper we use the concept of well-being as the ultimate goal of human progress. The previous illustrations showed that well-being can be defined very broadly including material aspects on the one hand and a focus on psychological (immaterial) satisfaction on the other hand. For the purpose of our considerations we define well-being as a sentiment that is determined by a broad range of factors (material and immaterial) which are subjectively perceived by each individual. Using this definition, we consciously accept both that individuals have their own preferences (i.e. they can decide what makes their life worth living) and that the importance of the diverse impact factors for well-being might vary across individuals. Thereby, we consider cultural differences which we do not want to assess or contrast to each other (i.e. which perception of well-being is the right one or better than others). On the other hand, using this definition we have to accept that our concept of well-being is very difficult to measure and it is not trivial to statistically collect data on well-being that is directly comparable across individuals.

Our approach which will be discussed in detail in the next chapters, deals with this problem by detecting preconditions that enable an individual to achieve their personal well-being. If an individual has the opportunities and the freedom of choice to reach its life's goal, it is indirectly ensured that the ultimate objective of maximizing well-being is attainable. Our approach therefore circumvents the necessity of objectively measuring well-being by focusing on its preconditions.

However, the various concepts that have been discussed above are important preconditions for achieving individual well-being. (For an overview comparison of the concepts welfare, wealth and well-being see Table 1.) In particular, the concept of wealth covers the material (but in some recently developed conceptions also some immaterial) prerequisites of life. Income and wealth open up the opportunities required to consume what one most preferably desires for his/her well-being whereas these characteristics of consumption are covered by the notion of welfare presented above. However, from our perspective both concepts (wealth and welfare) are not a target per se and it is necessary to consider other preconditions for achieving the actual objective of well-being. Compared to wealth and welfare (which we classify as including mainly economic aspects) our perception of well-being considers social and environmental aspects as indispensable.

Focusing on the broader range of economic, social and environmental preconditions also allows us to circumvent the already mentioned issue that directly focusing policy on individual well-being is probably counterproductive for human development. As Tichy (2013) argues this focus would overemphasise the short-run while long-run sustainability is neglected. For our approach of monitoring a socio-ecological transition towards a sustainable development we need to define precisely the relation of well-being with sustainability. This connection was also examined by Laurent et al. (2015) as well as by Stiglitz et al. (2009) who discussed the main difference

between the concepts (or assessment) of (current) well-being and sustainability. They defined current well-being as a static concept being linked to economic resources (e.g. income) on the one hand and non-economic aspects of people's life (e.g. their activities or the social and natural environment they live in) on the other hand. Well-being itself could therefore be seen as a snapshot of a single point in time (or even of a single generation) and hence does not consider sustainability in the sense that it does not take up a long-term perspective. On the contrary, the concept of sustainability is a dynamic one accounting for development of well-being in the future by focusing on the pursuit and harmonisation of economic, social and environmental objectives. In the context of the WWWforEurope project the differentiation as well as the relation between (static) well-being and (dynamic) sustainable development is crucial.

Table 1 **Comparing the concepts of Wealth, Welfare and Well-being**

	Wealth	**Welfare**	**Well-being**
Considered dimension	economic (via material aspects), more recently social & environmental (via immaterial aspects)	economic, social	economic (material conditions), social & environmental (immaterial conditions)
Specific characteristics	• Focuses on different forms of capital • Including material (e.g. reproducible capital) and immaterial aspects (e.g. human capital, natural capital)	• Focusing on satisfaction of material human needs • Based on market efficiency principle	• Multi-dimensional concept (including material and immaterial aspects) • Subjective sense of live satisfaction among citizens
Differences within the concepts	• *Objective wealth* (i.e. notion of wealth as tangible goods) vs. *subjective wealth* (i.e. enjoyment derived from tangible goods) • Comprehensive wealth (World Bank) vs. inclusive wealth (United Nations) • National wealth vs. individual/household wealth	• *Consumer welfare* (i.e. individual benefits derived from consumption of goods and services) and *individual welfare* (i.e. an individual's own assessment of his/her satisfaction, given prices and income) • *Social welfare* (i.e. overall welfare of the society by summing up the welfare of all individuals in a society) & *human welfare*	• *Objective well-being* (using a list of pre-selected objective indicators concerned with the satisfaction of physical and human needs) vs. *subjective well-being* (focuses on individuals' self reported levels of happiness, satisfaction with life, positive feelings and the absence of negative feelings)
Connection to the other two concepts	Increases in wealth are a primary driver of welfare	Can be identified with wealth (consumption)	Well-being can be used as a measure for social welfare
Approaches	• GDP		• Happiness economics • Capabilities approach • Ecosystem services • Energy services

Sources: (Dimitrova, et al., 2013), (Kettner, Köppl, & Stagl, 2014), (Frey, 2008), (UNEP, UNU-IHDP, 2012), (Laurent & Le Cacheux, 2015), (Stiglitz, Sen, & Fitoussi, 2009)

3. Building blocks for sustainable well-being for Europe in 2050

In the WWWforEurope project, Europe is acknowledged as a long-run success model in both economic and social terms in the past. However, Europe faces difficulties for the future both in the short and medium run. Within the project, a vision for Europe has been developed for 2050 taking into account these difficulties: "*By 2050 Europe will have become a role model for a dynamic, open and pluralistic economic area characterised by limited income differences, absolute decline of emissions and resource use and positive spillovers to neighbours and the world at large.*" (For the full version of the WWWforEurope vision see Aiginger et al. (2014)).

Assuming that Europe has not yet reached a sustainable development path, in particular in ecological but also in economic and social terms, for reaching a sustainable trajectory in the year 2050 Europe is required to undergo a socio-ecological transition. This particularly involves adaptations in the environmental, the social and the economic system. In particular, taking into account the interactions and trade-offs between these dimensions is essential. Hence, a socio-ecological transition is necessary overcoming the short-sighted but still prevailing dominance of only one system – namely the economic one - to be considered in European policy. In order to spotlight the necessary socio-ecological transition in policy debates, but also to monitor progress towards a sustainable development path, the vision for Europe needs to be split into single objectives which are on the one hand comprehensible, tangible and simple enough to be easily understood, but which are also comprehensively covering the multidimensional characteristics of a socially, ecologically and economically sustainable development path.

So far, GDP was most often applied as an international standard for the measurement of human progress that was often defined by economic growth and or changes in living standard. Unfortunately, this indicator neglects a broad set of social and environmental aspects which are important to determine whether a system is sustainable in the medium and long run. The vision developed in the WWWforEurope project includes all three important dimensions, the economic, the environmental and the social one. A major contribution of the WWWforEurope project is its effort to address all three dimensions together taking into account potential trade-offs and synergies. This simultaneous approach is essential when striving for a socio-ecological transition towards high levels of well-being, including inter alia high levels of employment, social inclusion and gender equality while guaranteeing a sustainable development path for the European Union. The previous chapter has shown that well-being is a very complex idea and also the concepts used to describe it (incl. the wording and terminology used therefore) are heterogeneous.

The main precondition for this paper therefore is the definition of simple but comprehensive targets (for each of the relevant dimensions) which can be itemised into more detailed attributes covering the complex interaction of the multidimensional aspects. Defining an overall goal for each of the three dimensions includes both a 'static' and a 'dynamic' objective. The former aims at identifying the status that shall be reached (until the year 2050). Using mathematical wording, it is an optimisation problem maximising a single variable, e.g. maximising available income per

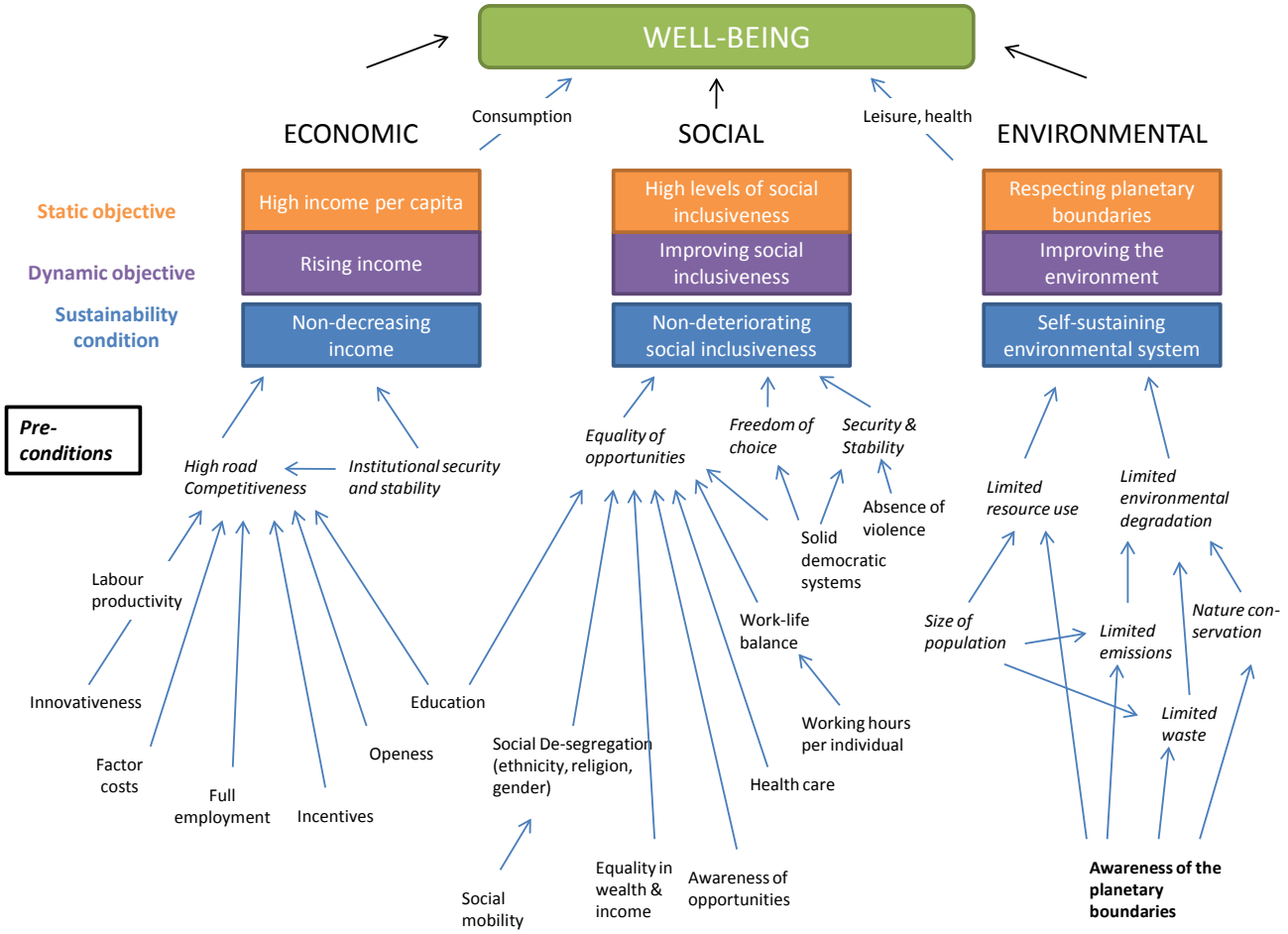
capita. The dynamic perspective aims at verifying sustainability. For instance, maximising available income per capita in the year 2050 might go hand in hand with decreasing income in the following years if the economic system has been overstrained. The dynamic objective shall therefore verify that the level reached in 2050 at least does not decrease again afterwards. In the best case, further progress is achievable. We therefore distinguish between dynamic objectives (i.e. achieving further improvements) and sustainability conditions (i.e. avoiding deterioration). If the latter are fulfilled for all three dimensions, a sustainable development path is reached.

Figure 1 illustrates the main approach of this paper. At the top of the figure, the main objective of achieving individual well-being is highlighted. For all three dimensions perceived as relevant for reaching this target, both a static and a dynamic objective are defined. They are based on the work carried out in the WWWforEurope project. In particular, they reflect the vision for Europe in 2050 and the targets derived thereof. These objectives of course come up short to completely cover the full range of relevant aspects within each dimension[7]. However, they subsume them if not perceived too narrow. In order to prevent a too narrow perception, Figure 1 also presents important preconditions to reach the targets. It has to be highlighted that these preconditions are not an objective by themselves although they are often understood as such[8]. For instance, limiting (or reducing) emissions as defined in the environmental dimension is one of the main targets discussed in the UN Climate Change Conferences. However, we argue that this is one of the means (or a precondition, but not a goal per se) to reach the environmental objective of respecting the planetary boundaries. On the other hand, if the static and dynamic objectives defined for each of the three dimensions as well as their sustainability conditions are reached, it is also ensured that the preconditions are fulfilled since otherwise the objective would not be met.

[7] The figure also does not show all possible interactions between the listed aspects. The focus is on highlighting the most relevant links and preconditions. We also do not consider all potential causal relationships between different preconditions within each dimension. Discussing all causal interplays would go far beyond the scope of this paper but in order to follow our approach we have to (implicitly) assume that there is a relevant causal relationship between the preconditions and the objectives defined.

[8] In principle, the same also holds for the objectives defined for all three dimensions. They can be seen as intermediate goals to reach the ultimate goal of a sustainable development path towards high levels of individual well-being.

Figure 1 **Building blocks of a sustainable development path for Europe in 2050**



Source: Own illustration based on the WWWforEurope Vision (Aiginger et al., 2014)

The figure therefore distinguishes between objectives and preconditions (we might also call them intermediate goals). Revisiting the mathematical wording used above, the Figure follows the idea of an optimisation problem (i.e. the objectives – dynamic, static and sustainability conditions - for each dimension) subject to constraints (i.e. the preconditions). We see the strength of our approach presented in Figure 1 in organising a very complex and multidimensional topic into a hierarchy highlighting the main targets in a comprehensible way but allowing to take into account its complexity. It allows breaking the complexity down and itemising core aspects of each dimension. This also facilitates the measurement whether the targets are reached (or the progress towards a sustainable development path). Not all of the objectives can be measured directly. For instance, it is impossible to find a single indicator measuring whether the planet's boundaries are respected. However, if we find adequate indicators for each of the preconditions required to respect the planetary boundaries, the objective can be measured indirectly[9]. If the indicators used show that all the preconditions of a complex objective are fulfilled, we can be sure that also the objective is fulfilled. In the following, we will therefore describe the breakdown of each dimension into items (static and dynamic objectives and preconditions). Examples for potential indicators for the single items are then presented in Chapter 4.

3.1 The social dimension

In our definition the overall objective within the social dimension is reaching high levels of social inclusiveness for all individuals which under the sustainability aspect can be further improved over time or at least does not deteriorate anymore. It implies that future generations shall not be face worse levels of social inclusiveness than the current generation. However, high levels of social inclusiveness are an important precondition when aiming at achieving individual well-being.

When looking at 'purely' social preconditions, we focus on those social aspects mainly relevant for verifying social inclusiveness. We argue that the *freedom of choice* in combination with the *equality of opportunities* are at heart for both social sustainability and maximising individual well-being when considering that preferences are heterogeneous across individuals. Concerning the latter, without having the opportunities to choose from and without having the freedom to choose what is preferred, well-being will always be constricted. If well-being is too unevenly distributed within a society, social sustainability is always endangered by social turmoil.

In order to verify both aspects – freedom of choice and equality of opportunities –, a *solid democratic system* is essential. However, a democratic system might still lack the ability to provide equal opportunities for all members of the society if other criteria are not fulfilled. For instance, when considering that ethnic minorities do not carry the option to enforce their rights social segregation can heavily affect the equality of opportunities. Of course other attributes than ethnicity can also restrict the equality of opportunities within a society (for instance gender

[9] If a precondition cannot be measured directly, our approach also allows measuring it indirectly using relevant impact factors for the precondition (i.e. "preconditions for the preconditions")

or religion). Furthermore, considering the social sustainability concept, *intergenerational de-segregation* is also very important. Social sustainability requires that future generations must have at least the same opportunities as the current generation and intergenerational improvements towards equal opportunities require high degrees of *social mobility* allowing previously underprivileged individuals to catch up.

Moreover, equality of opportunities depends on *education*[10]. If not all members of a society have equal access to education, opportunities in job careers, politics and social status are unevenly distributed. The same holds for *unevenly distributed wealth and income*. In particular, children of badly resourced families will lack at least some opportunities that rich descendants have. Furthermore, *health care* is an important precondition verifying equal opportunities across the society.

We would also like to highlight that the prevalence of extensive working hours restricts the time to inform oneself about possible opportunities. Thus an inadequate *work-life balance* has a negative influence on the equality of opportunities and consequently indirectly affects social inclusiveness and human well-being. In particular, taking into account the increasing number of burn-out affected employees and the existence of considerable overtime for many workers, from our point of view a reduction in the (actually provided) number of working hours per individual is preferable.

Taking together different aspects affecting the equality of opportunities might reveal potentially reinforcing patterns between these aspects. For instance, if income and wealth are unevenly distributed and those who are physically or mentally restricted are among the badly resourced, they might not be able to afford the health care required to compensate their disadvantage. Given the broad range of factors potentially deteriorating the equality of opportunities public intervention is most often well reasoned. Social mobility, low degrees of segregation, a well-established health care system and a solid democratic system are guaranteed through an efficient public sector.

Finally, *stability and security* in the society are an indispensable precondition for social inclusiveness and thus for individual well-being. Moreover, they are also required for setting the frame that each individual can freely chose from the given set of opportunities according to his or her preferences. The *absence of violence* as well as the existence of a well established democratic system is very important in order to verify security and stability in a modern society.

3.2 The economic dimension

In general, the economic system is very complex and includes a broad range of different micro- and macroeconomic activities mainly focusing on material aspects although besides goods economies also produce services which are not materialistic per se. However, the main issue for this paper is how to define a simple objective that subsumes all these different economic aspects but also serves as clear target for sustainable economic development.

[10] Education is also an important precondition for a high road competitiveness strategy and is therefore also relevant for the economic objective (see next section).

When comparing the economic dimension with either the social or environmental one, it can be easily shown that given the characteristics of the three dimensions it is least difficult to measure the former. Many economic activities can be measured numerically while it is often more challenging to operationalise social or environmental aspects. We argue that the relative simplicity of measuring economic aspects (e.g. using GDP as a measure of social welfare) strongly affects policy debates about societal goals. Economic concepts are far more easily described using tangible economic statistics than 'soft' social or environmental relationships. Economic targets therefore dominate the debates about human development. Considering the arguments raised in the discourse about the usability of GDP for measuring human development, we have argued above that the economic dimension should be seen as an important precondition (or intermediate objective) for maximising individual well-being. However, we would like to highlight again that the ultimate objective of human progress is not purely economic, but about maximising individual well-being.

The economic performance of a country of course has an important impact on the well-being of its inhabitants. Although there are also other economic aspects influencing well-being (for instance job satisfaction, work-life balance, etc.), we identify consumption of both goods and services as the most relevant channel how economic output feeds in well-being. We do not treat consumption as a purely economic activity (and therefore do not subsume consumption under the economic dimension, see Figure 1), because individuals perceive consumed goods and services differently. How they do that is also strongly determined by moral concepts and values which are strongly affected by the society. We therefore locate consumption at the interface between the economic and the overarching goal of achieving individual well-being. However, it is important to bear in mind that not the maximisation of consumption itself (i.e. the amount of goods and services consumed) increases human well-being but rather the maximisation of the benefits from consumption.

Hence, we decided to use *high income per capita* as a static target for the economic dimension. So far the income objective was mainly measured by GDP. The indicator has often been criticised for not taking into account important aspects of human development (see for example van den Bergh et al., 2014). However, following our model of splitting human development into the triangle of the economic, social and environmental dimension, the critique is less severe. Furthermore, higher income has other side effects on well-being, for instance it provides financial safety or access to position goods. The desire to improve one's relative status in society probably makes relative income (in comparison to others in the society) more important for well-being than absolute income (Tichy, 2013).

In order to account for a dynamic evolution over time the static economic objective is amended by the dynamic objective that is asking for rising income. Furthermore the achievement of the sustainability condition, non-decreasing income over time, implies that future generations will not face lower income levels than generations in the present or the past.

However, observing rising income (for instance growth in GDP) is not enough to be sure that income levels are economically sustainable. Considering the existence of economic crisis or bubbles, economic growth might also lead to disastrous collapses. Regarding the question about Europe's requirements in order to achieve a sustainable high level of income per capita in

2050, we therefore follow Aiginger, Bärenthaler-Sieber and Vogel (2013). They argue that given the framework of a competition-based worldwide market economy Europe's high-income countries have to focus on a *high road strategy with regard to competitiveness*, i.e. Europe should foster quality improving policies to overcome pure cost competition and to capitalise their comparative advantages. At heart of this strategy are country capabilities that enable change and sustainable future growth. In particular, these enablers include productivity enhancing elements such as *education* and *innovation*. In this context, the term productivity enhancing implies either more efficient production techniques or new or improved products. Both types can be the result of either formal research and innovation activities (e.g. in R&D laboratories) or of non-innovation activities (e.g. learning-by-doing, acquisition of advanced machinery, etc.). An innovation-enhancing framework and a well educated workforce are therefore key for a country's ability to base its competitiveness on quality instead of costs. Furthermore, *openness of the economy* (in order to reap the benefits of quality-based comparative advantage), *institutional security and stability* (including a *resilient financial system*), and an adequate framework fostering those *incentives* necessary for promoting both business activities as well as *full employment*[11] are important preconditions for high road competitiveness.

3.3 The environmental dimension

The environment is a complex system including many important components providing different services or functions for human individuals. It provides resources (stock[12] and flow[13] resources), life support services (i.e. services that make human life, and hence economic activity, possible) or amenity services[14] (e.g. nature-based recreational activity) and serves as a waste sink (Common & Stagl, 2005). The nature of the provided services and functions shows that the status of the natural environment strongly affects human well-being particularly in terms of health and leisure (see Figure 1). For instance, a contaminated environment concerning food or water is negatively affecting individuals' well-being. On the other hand, using environmental amenities by spending time in natural surroundings has positive effects on physical and mental health. Besides direct effects on leisure and health, the environment at least indirectly impacts a broad range of human activities also relevant for individual well-being. For instance, the availability of resources is a major precondition for most of the economic activities.

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[11] It is often argued that unemployment is a major risk for economic and social stability. High rates of unemployment can lead to poverty, social unrest and political and economic instability. We indirectly consider unemployment twice: First, in a market-based economic system the notion of full employment implies that everyone who wants to work is also able to get a job. Using this notion we implicitly consider unemployment in our set of relevant preconditions. Second, equality/inequality of income – the key issue of unemployment which might affect social stability – is also considered in both the economic and social dimension.

[12] **Stock resources:** "[...T]he amount used today does have implications for future availability. In the case of non-renewable resource, there is no rate of use that can be sustained forever. In the case of a renewable resource, there are rates of use that can be indefinitely maintained." (Common & Stagl, 2005, p. 94)

[13] **Flow resources:** "[...T]he amount used today has no implications for the amount that could be used in the future." (Common & Stagl, 2005, p. 94)

[14] **Examples for amenity services**: the purification of our air and water; the stabilization, and moderation, of the climate; nutrient cycling; the pollination of plants. (Common & Stagl, 2005, p. 110)

In the last decades the environmental system was getting more and more into a great distress implying also negative impacts for the economic system as well as individual well-being. Hence, from our perspective, *respecting the planetary boundaries*[15] is the main objective in order to reduce (and stop) the advanced degradation of the environmental system and the related negative consequences for economic and social activities. From a dynamic perspective, *improving the natural environment* should be targeted. We plead for more than just complying to an environmental sustainability condition – i.e. the environmental system is self-sustaining – since improvements can positively affect human well-being, may it be via more beautiful places to relax, more healthy breathing air or higher availability of natural resources to be used in the economic system. A *self-sustaining environmental system* would only imply that the current status is not deteriorating anymore. However, if biodiversity has already been lost or climate change has occurred, the environment can still achieve a self-sustaining status (but maybe at a lower level) again although the impact on humans' well-being is less beneficial than it has been before. Reversing losses in the environmental system should be targeted (at least – but not only – when looking at the environmental system only).

Respecting the planetary boundaries requires both limiting (or in the best case reversing) environmental degradation and *limiting (or reducing) resource use*. *Environmental degradation* includes pollution (for example the emission of greenhouse gases which are negatively affecting climate change) or the production of waste, but also deteriorating biodiversity or other encroachments of natural reserves. Moreover, environmental degradation also goes hand in hand with the availability of resources. For instance, pollution can reduce or even completely inhibit the usability of water, land areas etc. Losses in the biodiversity or a reduction in humus layers can inter alia reduce the productivity of farmland or confine returns of fishery[16]. Respecting the planetary boundaries and maintaining a self-sustaining environment is therefore a necessary precondition for both economic and social sustainability but as long as more resources are used by mankind than the natural environment can reproduce, the environmental system cannot be sustainable.

An important aspect relevant for both meeting the environmental objectives is the size of *human population*. The more people live on the planet, the more resources are required and the higher the encroachment and potentially also the degradation of the natural environment. The *public awareness of the planetary boundaries* then becomes even more important in order to politically enforce environmental sustainability, as a larger population probably more strongly restricts the freedom of choice. The more people live on the planet, the more severe the consequences of individual behaviour on aggregate. On the other hand, if individuals are aware of their benefits

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[15] Steffen et al. (2015) (revision of the famous Rockström article published in 2009) list nine boundaries defining a safe operating space for humanity based on intrinsic biophysical processes that regulate the stability of the Earth's natural system, notably biosphere integrity (functional/genetic diversity), biochemical flows represented through the nitrogen cycle and the phosphorus cycle, land system change, climate change, atmospheric aerosol loading, ocean acidification, stratospheric ozone depletion, freshwater use and novel entities. Concerning the genetic diversity of the biosphere integrity, and the nitrogen cycle, Steffen et al. (2015) argue that we have already left the safe operating space. A critical state is also reached regarding the phosphorus cycle, land-system change and climate change.

[16] Biodiversity and the productivity of farmland etc. are therefore also important (economic) resources.

of respecting the environment, their freedom of choice is not effectively affected since they would anyway try to avoid environmental harm when making their decisions. Individuals uprate environmentally choices if they are aware of the environmental sustainability problem. We therefore highlight public awareness of the planetary boundaries as important precondition for a sustaining environmental development.

4. Monitoring synergies and trade-offs between economic, environmental and social aspects relevant for sustainable human development

In this chapter we try to add detailed indicators to the objectives and preconditions we have systematised in chapter 3. Besides, the main aim of this chapter is to highlight potential synergies and trade-offs between the economic, social and environmental dimensions (and their aspects) while the indicators shall enable the measurement of a socio-ecological transition towards an economically, socially and environmentally sustainable development path. Since we cannot measure all relevant aspects and targets directly, we will also discuss potential caveats and limitations of measurability.

The discussion of potential synergies and trade-offs shall point out that the prioritisation of one objective can either positively or negatively affect the achievement of another objective. In other words, meeting the sustainability condition of one dimension can affect the achievement of the sustainability condition of another. For instance, fostering economic growth in order to ensure rising income potentially hampers environmental sustainability if it is based on higher levels of resource consumption. On the other hand, green innovations can increase the competitiveness of a country or region (and therefore foster economic development) while they also positively contribute to environmental improvements. Considering both synergies and trade-offs allows elaborating important linkages that have to be considered when monitoring a socio-ecological transition. Some examples for synergies and trade-offs between the three dimensions are described in the section below. In this way, by looking at the three dimensions in their entirety our approach adds additional value to the existing literature and takes into account the unique feature of the WWWforEurope project of jointly considering all relevant aspects.

We explicitly do not discuss the effects of severe deviations from economically, socially or environmentally sustainable development paths that might occur if the socio-ecological transition fails. For instance, in the worst case, environmental disasters (e.g. extreme weather events resulting from extreme global warming) might lead to extreme scarcity in available resources which might heavily affect the economic system or damage social and political stability. However, assuming that Europe (and the rest of the world) is able to manage the move towards a sustainable development path, we skip the discussion of worst case linkages between the three dimensions under investigation.

Table 2, Table 3 and Table 4 summarise objectives and preconditions discussed in chapter 3 for all three dimensions and assign adequate indicators to each of them (if available). The list of indicators is mainly based on joint work of the WWWforEurope project team[17]. It represents an exemplary list of indicators that might be used for monitoring the progress of a socio-ecological

[17] In particular, potential indicators for measuring a socio-ecological transition have been discussed at a consortium meeting in October 2014. The outcome of this brainstorming represents the main input for the indicator list elaborated here.

transition (towards a sustainable development path). However, the reader should keep in mind that there also exist other indicator sets that can be used for this purpose (see for example the discussion in chapter 2). Moreover, the tables list examples for synergies and trade-offs between the different dimensions[18]. In some cases, either synergies (in green) and/or trade-offs (in red) might occur. For instance, innovation can positively affect the environment if they are 'green' (e.g. the invention of solar cells). On the other hand, innovative products or production processes can also increase resource consumption or pollute the environment (e.g. combustion engines[19]). In these cases, whenever there can be either a positive or a negative effect, the linkage is listed in black font.

4.1 Measuring economic, social and environmental aspects of sustainable well-being

As mentioned in the previous chapter, measuring **economic aspects** is far easier compared to some of the social or environmental aspects. This is for instance demonstrated by the static economic objective of high income which can be directly measured either by GDP per capita or by disposable income per capita. While the first mainly measures market activities the second one enables to also capture material living standard by using household income and consumption[20]. However, when considering the dynamic perspective the resulting measurement of rising or at least non-deteriorating (and therefore sustainable) income becomes more complex.

The reason for this can be found in the nature of economic events. Since we are probably not able to adequately forecast, for instance, the evolvement of economic bubbles or economic crises, we might not ensure the maintenance of the dynamic target in the long-run. Hence, in order to be safe that the economic development is sustainable we have to take into account the preconditions for sustainable income growth that were mentioned in the previous chapter. For all the economic aspects we identified as relevant in order to (indirectly) measure economic sustainability we found useful indicators (see Table 2).

Turning now to the **social dimension**, the measurement of the key elements relevant for social sustainability reveals some difficulties. In particular, directly measuring the equality of opportunities and the freedom of choice is rather complicated given their multidimensional aspects. A heterogeneous range of population groups can face very unequal opportunities in different areas of life. While equality in income or in the access to education (for instance using Gini coefficients) and in particular extremes (e.g. poverty) is less difficult to measure, other

[18] We do not list any trade-offs or synergies within a dimension in order to shift the focus towards the interplay across dimensions. 'Within' synergies and trade-offs are therefore skipped although they provide also interesting insights. Moreover, not all potential trade-offs and synergies across dimensions are listed in detail. The main focus here is on summarising those that are most relevant for the socio-ecological transition. We therefore do not claim that the list is complete.

[19] In the case of combustion engines, technological improvements might also be labeled 'green' if they reduce emissions or resource use.

[20] The importance of emphasizing the household perspective when measuring income was already pointed out by Stiglitz et al. (2009).

facets are more or less intangible. This holds for instance for the awareness of opportunities. We assume that adequately measuring the awareness for all individuals in a country is almost impossible at least since catching the full set of (individual) opportunities is very difficult. However, we do not want to miss this aspect in our conceptual framework, since in our view it represents an important precondition for achieving equality of opportunities and consequently social inclusiveness.

From a different angle, it would be interesting to focus on potentially discriminated groups when measuring the identified preconditions for social sustainability. Purely focusing on the relevant preconditions without differentiating between these groups, the underlying heterogeneous pattern would probably be oversimplified. Therefore, it makes sense to look at differences between different ethnicities, generations (or age groups) or gender etc. which allows to elaborate differences in inter alia income levels, employment rates, career opportunities, access to health care etc. more accurately. In this context Hammer et al. (2014) examined the reallocation of resources across age and gender in a comparative European setting. The authors introduced the aggregate NTA (national transfer accounts) life cycle deficit as a concept of an economic dependency ratio allowing for flexible age limits and age-specific levels of economic dependency. Furthermore they move beyond the current NTA methodology and study gender differences in the generation of income and extend their analysis by unpaid household work. Other examples for indicators associated to the social dimension can be found in Table 3.

As far as the **environmental dimension** is concerned, the measurement of the public awareness of planetary boundaries is key for assessing the socio-ecological transition. It is a precondition for all consciously motivated shifts of human activities towards ecologically sustainability. Anyway, as already mentioned measuring awareness is not easy at all. Statistical data on public expenses for environmental protection, respective courses at schools, universities or other establishments for further education could be possibly used as proxy indicators. Although it is very difficult to measure, we argue that the awareness of planetary boundaries should not be missed in the list of indicators monitoring the socio-ecological transition (for an exemplary list of indicators for the environmental dimension see Table 4).

Another measurement problem regarding environmental sustainability reveals in its cross-border effects. The sustainability of a local environmental system strongly depends on the supra-regional or on the global system respectively as, for instance, also a country with low GHG emissions is affected by climate change. Global indicators are not able to draw attention to local problems, since local pollution is probably not significantly apparent in global aggregates. Accordingly, instead of only measuring the sustainability of the global environmental system, the contribution of a country or a region to attain environmental sustainability needs to be assessed. However, although the global environmental targets might be given, the target setting for local, regional or national contributions to global environmental protection is strongly influenced by political decision making or even by international negotiations and treaties. For instance, given different stages of economic or technological development, the stringency of environmental targets might therefore vary across countries. Regarding the monitoring of the socio-ecological transition, these cross-border effects strongly complicate the measurability of the transition at the country (or regional) level.

Table 2 **Indicators for the Economic Dimension**

	Dimensions and indicators	*Potential synergies and trade-offs*	
EC1.1 STATIC TARGET: High Income per capita			
	GDP per capita	Limited resource use, limited environmental degradation, poverty, freedom of choice	ENV, SOC
	Net disposable income per capita		
EC 1.2 DYNAMIC TARGET: Rising income per capita			
	Growth in GDP per capita	Limited resource use, limited environmental degradation, poverty, freedom of choice	ENV, SOC
	Growth in net disposable income per capita		
PRECONDITIONS			
EC2.1	High road competitiveness		
EC2.1.1	Factor Costs		
	Unit labour costs	Working hours per individual, poverty	SOC
	Energy prices	Energy consumption, limited resource use	ENV
EC2.1.2	Labour Productivity		
	Gross value added per hour worked	Reduced working hours per individual, health care	SOC
EC2.1.2.1	Innovativeness		
	Innovation Union Scoreboard Index (at national and regional level)	Limited resource use, limited emissions, limited energy consumption, health care system	ENV, SOC
	Gross domestic expenditure in R&D (GERD, % of GDP)		
	Number of researchers (in total employment)		
	Patents (citation weighted count)		
	Green patents (share of patents in green technology fields in total PCT (patent cooperation treaty) patent applications)		
EC2.1.2.2	Education		
	Tertiary Educational Attainment	Social mobility, solid democratic system, equality of opportunities, social (de-)segregation, awareness of planetary boundaries	SOC, ENV
	Secondary Educational Attainment		
	Illiteracy Rate		
EC2.1.3	Incentives		
EC2.1.3.1	Business Freedom		

	Dimensions and indicators	***Potential synergies and trade-offs***	
	Business Freedom Indicators	Limited emissions, limited waste, limited resource use	ENV
EC2.1.3.2	Income inequality	Income equality	
	Gini coefficient income	Equality in income and wealth, awareness of opportunities, Social (de-)segregation	SOC
EC2.1.4	Openness of the economy		
EC2.1.4.1	Market integration		
	Openness Index	Limited emissions	ENV
EC2.1.4.2	Labour market integration		
	Share of foreign-born in total employment	Limited emissions	ENV
EC2.1.5	Full employment		
	Employment rate (number of persons in employment as a share of total population)	Work-Life Balance, Security and Stability, Health Care	SOC
EC2.2	Institutional security and stability		
EC2.2.1	Political stability		
	Political stability and absence of violence	Solid democratic systems	SOC
EC2.2.2	Property rights		
	Property rights	Equality in wealth and income	SOC
EC2.2.3	Macroeconomic stability		
	Growth Business Cycle (GDP, IP)	Political stability	SOC
	Harmonized Index of Consumer Prices (HICP)		
	Current account imbalances		
	Real effective exchange rates		
	Fiscal sustainability indicators		
EC2.2.4	Interregional economic convergence		
	Absolute differences in GDP growth rates	Political stability	SOC

Table 3 **Indicators for the Social Dimension**

	Dimensions and indicators	***Potential synergies and trade-offs***	
S1.1 STATIC TARGET: High levels of social inclusiveness			
	-		
S1.2 DYNAMIC TARGET: Improving social inclusiveness			
	-		
PRECONDITIONS			
S2.1	Freedom of choice		
S2.1.1	Solid democratic systems		
	Politic stability and absence of violence	Competitiveness, openness, property rights, (marcoeconomic) stability	ECO
	Corruption Perceptions Index	Competitiveness, institutional stability	ECO
S2.2	Equality of opportunities		
S2.2.1	Equality in wealth and income		
	Gini coefficient wealth	Competitiveness, education, incentives, resource consumption, nature encroachment, limited waste, limited emissions	ECO, ENV
	Gini coefficient income		
S2.2.1.1	Poverty		
	People at risk of poverty and social exclusion (equivalised disposable income after social transfers is below poverty threshold, e.g. 60% of national median)	Education, awareness of planetary boundaries , political stability, limited waste, nature encroachment, resource consumption, limited emissions	ECO, ENV
	Severely materially deprived people		
S2.2.2	Education		
	Equality in educational attainment (Gini coefficients of educational attainment	Awareness of planetary boundaries, competitiveness, innovativeness, full employment	ENV, ECO
	NEETs (Share of 15-25 aged neither in employment, education nor training)		
S2.2.3	Awareness of opportunities		
	-	Incentives	
S2.2.4	Social de-segregation		
S2.2.4.1	Gender		
	aggregate national transfer accounts (NTA) life cycle deficit and surplus in percent of total labour income (by gender)	Competitiveness, education, innovation	ECO
	Employment rate (number of persons in employment as a share of total population, by gender)		

	Dimensions and indicators	***Potential synergies and trade-offs***	
S1.1 STATIC TARGET: High levels of social inclusiveness			
	Number of female researchers in total researchers		
	Number of women in lead positions		
	Accessibility of care facilities (by gender)		
	Gender wage gap		
S2.2.4.2	Ethnicity		
	Employment rate (number of persons in employment as a share of total population, by nationality or ethnicity)	Competitiveness, education, innovation, openness, solid democratic systems, political stability	ECO
	Number of researchers in total researchers (by nationality or ethnicity)		
	Number of persons in lead positions (by nationality or ethnicity)		
	Accessibility of care facilities (by nationality or ethnicity)		
	Wage gap (by nationality or ethnicity)		
	Employment rate (number of persons in employment as a share of total population, by nationality or ethnicity)		
	Social mobility indicators (Education, Income, Occupation)		
S2.2.4.3	Intergenerational		
	aggregate national transfer accounts (NTA) life cycle deficit and surplus in percent of total labour income (total)	Competitiveness, political stability, education	ECO
	Employment rate (number of persons in employment as a share of total population, by age groups)		
	Social mobility indicators (Education, Income, Occupation)		
S2.2.5	Health care system		
	Quality of health care system	Well-being, full employment	SOC, ECO
	Average life expectancy		
	Density of care facilities		
S.2.2.6	Work-life balance		
	Working hours per individual	Competitiveness, labour productivity, incentives	ECO
	Burnout affected persons in total employment		
	Employees working very long hours		
S2.3	Security and stability		

	Dimensions and indicators	*Potential synergies and trade-offs*	
S1.1 STATIC TARGET: High levels of social inclusiveness			
S2.3.1	Absence of violence		
	-		

Table 4 **Indicators for the Environmental Dimension**

	Dimensions and indicators	*Potential synergies and trade-offs*	
EN 1.1 STATIC TARGET: Respecting the planetary boundaries			
	-		
EN1.2 DYNAMIC TARGET: Self-sustaining environmental system			
	-		
PRECONDITONS			
EN2.1	Limited environmental degradation		
EN2.1.1	Limited emissions		
	Total GHG emissions (absolute & per capita)	Income, full employment, competitiveness, health care, labour productivity, business freedom	ECO, SOC
EN2.1.2	Limited waste		
	-	Full employment, competitiveness, health care, labour productivity, business freedom	ECO, SOC
EN2.1.3	Nature Conversation		
EN2.1.3.1	Nature encroachment		
	Forest & land (stocks)	Competitiveness, work-life balance , health care	ECO, SOC
	HANPP (pressure)		
EN2.1.3.2	Biodiversity		
	Species losses, Extinction rate (flow)	(Labour) productivity (agriculture)	ECO
	Habitats (stocks)		
EN2.1.3.3	Local green areas		
	Size of green spaces per inhabitant (at the city and regional level)	Work-life balance, health care	SOC
	Size of green spaces to other land use (industry, housing, traffic, etc.)		
	Share of green spaces with public access (in total green spaces)		
EN2.2.	Limited resource use		
EN2.2.1	Resource productivity		
	GDP per kg of domestic material consumption (DMC)	Competitiveness, factor costs	ECO
	Domestic resource consumption (DRC) (minus exports, plus imports) (per capita/per		

	Dimensions and indicators	***Potential synergies and trade-offs***	
	GDP)		
EN2.2.2	Resource consumption		
	Raw material consumption (RMC) (indirect effects, minus exports, plus imports) (per capita/per GDP)	Full employment	ECO
EN2.2.2.1	Water consumption/Freshwater Use		
	Fossil water extraction		
EN2.2.2.1.1.	Local water consumption		
	Total drinking water consumption per inhabitant (at the city and regional level)		
	Total drinking water consumption per sector (agriculture, households, industry, other) (at the city and regional level)		
EN2.2.2.2	Energy consumption		
	Total primary supply of energy	Energy prices, competitiveness	ECO
	Share of renewable energy		
EN2.3	Awareness of planetary boundaries		
	-	Innovativeness, competitiveness	ECO
EN2.4	Population Size		
	Number of inhabitants per km^2	Full employment, resource use, limited emissions, limited waste, nature conservation, awareness of planetary boundaries	ECO

The difficulties of the local/regional assignments can be exemplarily demonstrated for the measurement of GHG emissions, the oceans' acidification, etc. Indicators for green spaces, nature conservation as well as resource consumption and productivity can be more easily assigned to countries (or regions). However, there exist a number of suggestions for how to measure environmental aspects (see for example the System of Environmental-Economic Accounting, United Nations et al., 2014). Unfortunately, very often they are only able to measure an extract of a complex system (e.g. in the case of resources or biodiversity loss), since not all of the required data is available and a comprehensive coverage taking into account all indicators is probably confusing. The public awareness appears all the more important, since each individual is in charge to respect the planetary boundaries and activities of all individuals potentially affect inter alia resource use, the volume of waste and emissions etc.

4.2 Trade-offs and synergies between the economic, social and environmental dimensions

In this section we try to amend the list of indicators for each dimension with information on potential trade-offs and synergies across them. We start with an analysis of the relationship between the **environmental** and the **economic dimension**. The precise consideration of prevailing trade-offs and synergies is of outmost importance, since many environmental regulations and policy decisions that are necessary in order to achieve a socio-ecological transition have immediate impacts on the economic system. Therefore the direction of changes concerning economic indicators triggered by changes of environmental indicators and vice versa needs to be carefully studied.

A rather prominent example relates to increases in production which are often accompanied by rising pollution as well as higher energy and resource consumption. On the contrary, the limitation of resource use, emissions and environmental degradation which is absolutely necessary for achieving environmental sustainability restrictively affects economic growth. For example, the limitation of emissions can raise production costs and thus negatively impacts competitiveness resulting furthermore in an adverse effect for full employment and income. Moreover, in the case of abolishing environmentally doubtful production methods in order to reduce emissions or resource use a countries' productivity may be restricted. Such regulatory limitations potentially impede business freedom. But entrepreneurial activities are essential for remaining competitive, particularly in a creative, risk-taking and innovation-based context. The remarkable trade-off between incentives for being competitive and environmental sustainability is therefore obvious.

In contrast, a decrease in resource consumption due to the development of new technologies (i.e. an increase in resource productivity, more/same output per used resources) may positively influence competitiveness since factor costs are lower then. However, a basic awareness of the planetary boundaries is necessary for such a technical development in order to foster innovations which are also beneficial for the environment. In the best case, the awareness of

the planetary boundaries may support 'green' innovations[21] while having a positive influence on innovativeness and competitiveness. On the other hand, the prevention of innovations with a negative environmental impact may consequently restrict competitiveness. This implies the significant role of innovation, since depending on its design it can either support a synergy between the environmental and economic dimensions or it induces a trade-off. Anyway, new technologies might also lead to new demand for previously non-existing products which potentially increases resource use and causes a so-called rebound effect (see for example Sorrell, 2007).

In this context it is interesting to take a closer look on a country's competitiveness, since a competition-based economic system potentially runs the risk of systemically jeopardising environmental sustainability. If all economic agents have to be competitive to survive competition, some kind of prisoner's dilemma can occur where in the end all individuals are in a less favourable position. It becomes evident in the case of using cheap (non-priced) resources instead of recycled and thus more expensive resources which induces competitive advantages but altogether results in environmental degradation. A key issue here are energy prices. Holding all other components constant, energy prices are a decisive factor for competitiveness. For instance, if both the technology base (i.e. production technologies) and labour costs are completely the same in two competing countries, energy prices will determine whether the countries are competitive or not. Without any regulation, both countries will have incentives to make use of the cheapest energy sources. As long as the cheapest energy is not environmentally friendly (for instance nuclear or coal plants), competition will force the countries to either give up competitiveness or environmental sustainability. Furthermore, low energy prices might also result in higher resource and energy use. Anyway, moving towards an economically and environmentally sustainable development path will have to solve the trade-off between fostering competitiveness and reducing environmental degradation and resource use.

The limitation of **environmental** degradation (e.g. by reducing emissions and/or waste generation) also impacts the **social dimension** as it creates synergies with health care, or – reversely formulated – an increase in pollution and emission generation negatively impairs individual health. A similar effect can be found relating to the work-life balance. Locally available green areas as well as the possibility for recreation in a natural environment can increase individual performance or helps to better cope with the same workload. Consequently a better environment can again indirectly enhance the competitiveness of an economy.

Another example can be found when looking at the interaction between social equality and environmental sustainability as a higher level of equality concerning the distribution of income and wealth can have ambiguous effects on the environment. If less people live in poverty consumption normally increases which ceteris paribus results in an increase in the volume of waste and emissions. Furthermore this may constrain natural landscape, if for example each

[21] There exist numerous alternative definitions of green innovation. Following the OECD (2009), green innovation can be defined as 'the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives'.

family is able to afford a single-family-house. On the contrary, if higher inequality is socially accepted, i.e. if higher ranks in the society (based on wealth and income) are acknowledged, individuals have an incentive to demonstrate their social status. The use of status symbols can negatively affect the environment if the consumption of luxury goods is increased. Besides negative impacts of private jets, additional cars etc. mainly consumed by the richer ones, also the poorer ones consume status symbols in order to signal a higher status. We therefore argue that just the societal acknowledgement of social hierarchies based on inequality might have a negative impact on the environment. On the contrary, higher income offers opportunities to consume with greater awareness, for example by buying more durable (but also more expensive) products helping to reduce waste. This holds in particular for the poorest who have only limited scope to shift their consumption behavior. It is also not expedient to prescribe a non-wealthy person to dispense with certain products just to be able to purchase some expensive high quality products. In such a case the affinity towards environmental issues may not be distinctive for buying decisions. Therefore, if higher and more equally distributed income results in a conscious consumption the aforementioned trade-off may change into a synergy.

Another important variable that is influencing the objective of social inclusiveness as well as environmental sustainability is represented by the size of population although in some cases the direction of the relationship is not clear, for instance whether a high or small population is more inclusive or not. However, a high population causes more resource consumption, more waste and more emission generation and generally causes greater damage on the environment (e.g. through the expansion of inhabited and cultivated land). Moreover, it is often argued that full employment is more difficult to reach for a higher population size, at least temporarily if the population rose abruptly (e.g. through high birth rates or migration). If sufficient resources are available, in the long-term, production capacities should adapt to the size of population and rendering possible full employment. At the same time, however, resource bottlenecks may cause that not everybody can pursue a meaningful employment.

On the other hand, an oversized population could raise the awareness of the planetary boundaries. In a local context impacts on the environment manifest through, exemplarily, a reduction in natural space or a risen pollution, in a global context climate change can be mentioned as an example. If the population size is smaller, the repercussions of anthropogenic activities on nature might not be sufficiently recognizable or even negligible.

Regarding the **economic** and **social dimensions**, there can be also found some interesting linkages. For instance, the improvement of social stability and security can have strong positive synergies with both the economic and the environmental system. A stable democratic system without corruption does not only strengthen the freedom of choice and the equality of opportunities but also fosters economic development, allows to deal with environmental issues and serves as a conduit for high road competitiveness. Besides innovation, education is another key element for a successful high road competitiveness strategy. Improvements in the education system – in particular enhancing the general knowledge of people - have generally positive side effects, not only for economic development. For example, Crespo Cuaresma et al. (2013) show that countries which are able to improve the equality of educational attainment of young cohorts over time tend to have higher growth rates of income per capita. Besides positive

effects for competitiveness originating from improvements in research and innovation, better education can also positively contribute to social mobility and the maintenance of a solid democratic system and hence increases the equality of opportunities across different ethnicities (minorities, migrants etc.), age groups and gender. This case shows that positive sociopolitical effects go hand in hand with economic stability. Moreover, the educational system can make a significant contribution to raising the awareness of planetary boundaries if curricula also adequately cover environmental topics.

However, equality (e.g. in income) can also confine incentives and economic as well as innovation efforts. On the one hand a certain extent of income inequality is required in order to reward higher efforts. On the other hand, income inequalities might limit the equality of opportunities especially for descendents with different parental starting conditions. In any case, poverty and too unequal distribution of wealth may lead to social turmoil. Taken together, there is a clear trade-off between social and economic targets with regard to equality (or inequality).

The maintenance of competitiveness in order to survive in the economic system can also have strong effects on a society's cohesion. This can be illustrated by lower labour costs necessary for price competitiveness enforcing higher working hours in order to compensate the income loss. There might also be a need for working more to remain competitive in comparison to other countries which permanently exerts potential upward pressure on individual working hours. On the other hand an improvement of work-life balance (in terms of a less exhausting life and the prospects of leisure time) may have a negative impact on competitiveness. A reduction in working hours may result in increased associated wages or to a drop in production performance. Furthermore, full employment might lead to a reduction in working time per individual while producing the same volume. Full employment facilitates sharing the workload (but also inter alia the burden of financing the welfare system incl. pensions, health care etc.) which also positively contributes to political stability and individual well-being. If all individuals have the chance to individual self-fulfillment (in a job) social unrest and discontent are reduced.

5. Towards monitoring the socio-ecological transition

In the previous chapters we tried to give an overview about the dimensions of sustainability and their aspects relevant for a socio-ecological transition, and we listed potential indicators for their measurement. We argued that a sustainable development path – the final outcome of a successful transition – has to be sustainable in all three dimensions: the economic, the social and the environmental one. If sustainability in one of these dimensions is not reached, i.e. as long as key elements of one dimension deteriorate when others are improving, the transition has not been completed. In this chapter we discuss potential ways to measure the transition progress and outline the main features of a monitoring tool which we would propose for monitoring the progress in the socio-ecological transition.

We already discussed earlier that measuring the transition progress requires knowing the ultimate objective, i.e. the desired state. In chapter 3 we tried to break the social, economic and environmental triangle down into building blocks in order to tackle its complexity. However, target values for each of these building blocks would be required to compare the status quo with the target state. Unfortunately these target values are not known for all relevant facets. However, assuming that we knew them, different approaches might be conceivable regarding the measurement of the transition. For instance, composite indicators (like the Human Development Index[22]) are a tool for reducing a multidimensional complexity to a single number. The main advantage of this approach is the simplicity of the indicator finally derived. However, many assumptions have to be made to develop such an indicator. In particular, it is often not clear which weights to assign to the different elements or sub-indicators that are brought together. The problem becomes clear if we look at the economic dimension, i.e. cross country growth regressions. In these econometric analyses a very broad set of variables and indicators appear to have a significant effect on a country's growth performance. However, their importance varies across countries depending on their respective stage of economic development, their endowment with resources etc. It is therefore very difficult to come up with a meaningful weighting scheme which allows aggregating the different variables that might be relevant for growth to one single indicator measuring it. In many cases, the decision about the weighting scheme used for calculating a composite indicator is made arbitrarily. Furthermore, the larger the set of indicators combined, the less meaningful the resulting composite indicator and the less relevant it is for policy debates. A meaningful interpretation of a too broadly defined composite indicator is almost impossible.

Alternatively, Data Envelopment Analyses (DEA) might be a useful approach since they have been developed to analyse multidimensional problems. In this context an interesting approach was provided by Lábaj et al. (2014) who extended a DEA model with environmental and social

[22] The Human Development Index (HDI) was developed by the United Nations Development Programme and emphasises that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. It is a summary measure that aims at capturing human well-being in three major categories: life expectancy at birth, educational attainment, and GDP per capita (United Nations Development Programme, 2015).

indicators in order to measure so called eco-efficiency and to take social performance into account. Such an analysis could be used to compare the status quo with the target state. Using target values for each aspect as the 'envelope' and include it as an additional observation would allow calculating how far the current state is away from the target state. Nevertheless, the problem of unknown target values would also remain unsolved. In these cases, the best performing countries could serve as reference points. This way, using DEA would circumvent some of the arbitrary decisions required for defining a weighting scheme for composite indicators. Although DEA, unlike composite indicators, is able to account for trade-offs between inputs and output variables that are considered in the model, both approaches do not sufficiently allow to take into account the interrelations between different indicators. We therefore conclude that the usability of both alternatives – composite indicators and DEA – for measuring the socio-ecological transition is limited.

Given the difficulties described above, we argue that it is least difficult to monitor whether the transition moves into the right direction, i.e. towards the sustainable development path. If single indicators deviate from this direction, an adequate monitoring tool could strike alarm. However, given the complex interplay between the economic, social and environmental dimensions, monitoring the progress in the transition process is not trivial. So far, besides identifying the most relevant aspects (and adequate indicators) for a sustainable development path, our main aim was elaborating potential synergies and trade-offs between them. From our perspective, considering these trade-offs and synergies are key elements in order to adequately monitor the success of a transition. A key issue here is that sustainability in all three dimensions has to be achieved jointly. We have to keep in mind the potential negative side effects of one dimension on another one. For instance, economic sustainability might be reached (at least at the first glance) but the economic development path could inhibit environmental sustainability if the former is based on a resource depleting system. We therefore argue that the interdimensional trade-offs have to be considered in order to monitor the socio-ecological transition. In particular, during a transition process not all elements of the social, economic and environmental triangle can improve. Otherwise, by definition, a sustainable development path has already been reached and no transition is needed.

In the following, we suggest a tool which hopefully could be used for monitoring the socio-ecological transition. We will try to elaborate whether a deteriorating indicator value should be perceived alarming or whether it could be part of a necessary adjustment process towards a sustainable development path given potential trade-off-linkages. Given the broad set of relevant facets of the social, economic and environmental triangle (i.e. preconditions for a sustainable development path) and given that we do not know the exact target values for many of them[23], we only present the main idea of the proposed monitoring tool. Elaborating details of the tool

[23] For some of them the targets are easily set (or already have been set). For instance, in the case of GHG emissions zero emissions should be targeted. However, in many cases setting target values is a normative or at least political question if they cannot be based on unambiguous research. For instance, a high degree in equality in wealth and income might be seen important for verifying that all individuals have equal opportunities. On the other hand, higher inequality provides positive incentives for inter alia entrepreneurship and innovation. Identifying the optimal degree of equality or inequality is therefore anything but not trivial.

(i.e. filling in the tool) would require further research and also some normative decisions about the exact targets.

Table 5 provides an example how the tool might look like. In principle, the table shall list all indicators necessary to measure the sustainable development path in all three dimensions. In the example, we focus on real GDP per capita as we hope that this example is most easily understandable. The table compares the indicator values for a given country (in our case we have chosen Austria which had a real GDP per capita of €36.200 in 2013)[24] with those of the best performing country (Luxembourg, €75.400) and the target value. In the case of GDP, the objective value is set to "maximum" as the economic objective is maximizing income. Since in many cases we do not exactly know the real objective, comparing the country with the best performing country gives a hint how well the country performs. However, in the best of cases only the objective value is required.

[24] The table presents real GDP per capita data taken from Eurostat for Austria in 2013 since data for the best performing country (Luxembourg) are not available for 2014.

Table 5 **Proposing a tool for monitoring the socio-ecological transition**

	Dimensions and indicators	*Country*		*Objective (Level)*		*Goal met?*	*Potential trade-offs (highlighted in red if respective target is not met) (+/- indicates progress or regress in the respective target)*				*In line with trade-offs?*
		Level	*Change (over time, e.g. annual)*	*Best perf. Country*	*Objective*						
EC1.1 STATIC TARGET: High income per capita											
	Real GDP per capita (in €)	36,200€	-0.4%	75,400€	MAX	**NO**	**limited resource use (-)**	**limited environmental degradation (-)**	-	-	**NO**
	...	...		...	...		...	...	...	...	...
	...	...		...	...		...	...	...	...	...
	Total Green House Gas Emissions										

However, the absolute level is less important for sustainable development. It is more important that the current status does not deteriorate over time any more. We therefore added a column representing the indicator change over time (Austria's real GDP per capita decreased by 0.4 percent in 2013). If none of the indicators moves in an undesired direction anymore, the sustainability condition is met. Summarising the information about both the relative performance of the country under investigation with the objective (or at least the best performing country) and the change over time allows diagnosing whether the respective precondition for a sustainable development path is met. Given the negative annual growth rate and the gap to the best performing country in our example, neither the static goal of maximising income nor the corresponding sustainability condition is met.

Moreover, we propose to list all the relevant potential trade-offs that are linked to it. These columns indicate whether the sustainability of other dimensions is negatively affected. The table highlights those trade-off-links where the target is not met in red and also indicates whether progress or regress is made towards them. In the case of GDP, we list the trade-off-linkages to the environmental dimension. Both targets of limited resource use and limited environmental degradation are not yet reached (therefore highlighted in red) and we exemplarily state that Austria did not yet manage to make adequate progress yet (indicated by the "(-)")[25].

Considering potential trade-offs is also important for the assessment of whether the respective goal is met. In the previous paragraph we have argued that both the comparison with the best performing country (or in the best case the objective itself if known) and the change over time are relevant for this assessment. However, we would like to highlight that if we do not exactly know the target value a comparison with the best performing country might be misleading. The good performance might be based on a bad performance in other dimensions which would imply that this country also did not meet the sustainable development path yet. The comparison with the best performing country should therefore also take into account how well the country performs in the linked trade-off-dimensions. For instance, in the example Austria's income gap (with respect to Luxembourg) would hint at potential improvements if both environmental aspects are already at a sustainable development path too. As long as these targets are not fulfilled, i.e. if Austria still uses too many resources, it is not clear whether it should target further economic growth, at least if we aim at an economically, socially and environmentally sustainable development path. Considering potential trade-offs together with monitoring the performance in the respective indicators should than allow recognising whether a deteriorating performance should be seen as an alarm signal indicating that the transition does not make any progress (or moves into the wrong direction) or whether it is a necessary adjustment facilitating that sustainability is reached in another relevant dimension. For instance, economic de-growth could be seen less severe if the potential trade-offs can benefit thereof (which is not the case in our example).

[25] We do not claim that our assessment is correct but at least for reasons of illustration we have chosen to put a minus here.

Finally, we would like to resume our discussion of potential synergies we have identified in the previous chapter. From our perspective, they are less relevant for monitoring the progress of a socio-ecological transition. However, they might be key elements of a successful transition. For instance, adequate education policies can bring along positive effects for a country's competitiveness, its social inclusiveness as well as public awareness of the planetary boundaries. Therefore, it would contribute to moving towards social, economic as well as environmental sustainability. While focusing on those policies with positive synergies or side effects are meaningful elements of strategy towards a sustainable development path, it is not necessary to include the synergy linkages in a monitoring tool for the transition progress.

6. Summary

The main goal of the current paper was to demonstrate how a socio-ecological transition can be monitored. In order to define the concept of a socio-ecological transition a clear concept of the targeted situation (i.e. an economically, socially and environmentally sustainable development path) is needed. We therefore used a vision for Europe in 2050 defined in the WWWforEurope project and derived the objective of achieving individual well-being while guaranteeing a sustainable development path. We have tried to break this vision down into building blocks that could be measured by useful indicators. The main issue here is handling the multidimensionality and the diverse trade-offs across dimensions. However, the trade-offs could also become synergies if the respective strategies/policies are adequately defined.

Anyway, it is important to discuss the overall objectives of human progress in order to have a good basis for justifying the relevant building blocks. In chapter 2 we therefore summarized already existing concepts of measuring human progress with a special focus on well-being. We also included a summary of the WWWforEurope's work on well-being.

In chapter 3, we tried to identify and summarise the building blocks of the vision for Europe in 2050. There, we focused on the sustainability conditions, i.e. what is necessary that the economic, social and environmental system can become and remain sustainable. We tried to follow the main ideas of the WWWforEurope project (e.g. high road competitiveness as key strategy for economic sustainability). We argued why the diverse facets are relevant (at least from our perspective) but we do not claim completeness since we are aware that there exist a broad set of different opinions in the literature. Our selection focused on treating the three dimensions jointly while trying to maintain clarity.

In chapter 4 we added indicators to the building blocks identified in chapter 3. The main source for these indicators was a WWWforEurope consortium meeting. Our main aim in this chapter is highlighting synergies and trade-offs between our three dimensions which are very relevant to monitor the transition. In a transition process, not all indicators can improve. Some of them have to be adjusted in order to reach the sustainable development path. If it is possible that all indicators improve (or at least do not deteriorate) the sustainable development path has been reached and the transition would be completed. The discussion of potential synergies and trade-offs shall point out that the prioritisation of meeting the sustainability condition of one dimension can either positively or negatively affect the achievement of the sustainability condition of another. Identifying synergies shall allow identifying striking policy tools which especially help moving towards a sustainable development path. The trade-offs are relevant for a tool (described in chapter 5) which could be used to monitor whether the transition moves into the right direction. Deteriorating indicators could be seen as warning signal if there are no simultaneous positive effects for trade-off facets. We propose a tool in table form but we did not fill it in completely. This would require further research and in particular setting target values for all of the indicators would be required. Sometimes they are not (yet) known and therefore it would require normative decisions how to set them.

While designing a tool for monitoring a socio-ecological transition was the main aim of this paper, more research is needed to be able to fill in the tool. In particular, a more detailed elaboration of the synergies and trade-offs would improve the accuracy of the monitoring tool. This research has shown a first approach how the discussion can look like. A better refined list of indicators used for measuring the diverse facets of the economic, social and environmental system would also sharpen the tool. A next step could therefore be filling in an application of the monitoring for selected European countries. An interesting aspect thereby would be to consider already existing deadlines and target values of policy strategies in place (e.g. the Europe 2020 strategy) and monitoring the speed of change in order to assess whether it is enough for reaching the defined targets in time. If all indicators in one dimension hint at too little progress it would help highlighting the need for further efforts while also taking into account the potential trade-offs.

Furthermore, collecting data at the regional level would allow enhancing policies in cities and regions. The collected data should be at a lower, less aggregate level to improve policies. Éloi Laurent[26], for instance, emphasized the importance of looking at territorial/local well-being since looking at national averages does not say anything about well-being experienced by people. On average a country may be well off in terms of well-being, but when looking at a more detailed level it may get apparent that there are regional differences in the experience of well-being.

From our perspective, the main advantage of our approach is jointly taking into account the three relevant dimensions for a sustainable development path (i.e. the economic, social and environmental dimensions) while highlighting the trade-offs between them. This study may therefore serve as a first step towards a comprehensive and accurate monitoring tool and we hope that it represents a good starting point for being able to actually monitor the socio-ecological transition.

[26] WWWforEurope lecture on May 20th, 2015, Vienna

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8. Annex

List of wellbeing indicators by Kettner et al. (2012):

Indicator Systems:

- EU Sustainable Development Indicators (EU SDIs)
- UN Indicators for Sustainable Development (UN ISDs)
- OECD Better Life Indicators (BLIs)
- IEA/IAEA Indicators for Sustainable Energy Development (ISEDs)
- Indicators of the Environmental Performance Index (EPIs)
- Millenium Assessment Ecosystem Service Indicators (ESIs)
- PASHMINA Indicators

Composite Indices:

- Genuine Progress Indicator (GPI) / Index of Sustainable Economic Welfare (ISEW)
- Genuine Savings (GS)
- Human Development Index (HDI) (United Nations; complete neglect of environmental sustainability)

NAMEA and Material flow accounts:

- National Accounting Matrix including Environmental Accounts (NAMEA)
- Material flow accounts (MFA)

Examples for well-being indicators of the European Union as well as of other institutions

Table 6 **Indictors of the EU Sustainable Development Strategy[27]**

Dimension	***Headline Indicators***
Socio-economic development	*Real GDP per capita, growth rate and totals*
Sustainable consumption and production	*Resource productivity*
Social inclusion	*At-risk-of-poverty rate, by gender*
Demographic changes	*Employment rate of older workers*
Public health	*Healthy life years and life expectancy at birth, by gender*
Climate change and energy	*Greenhouse gas emissions (CO_2e)* *Share of renewable in gross inland energy consumption*
Sustainable transport	*Energy consumption of transport*
Natural resources	*Common bird index* *Fish catches taken from stocks outside safe biological limits*
Global partnership	*Official development assistance as share of gross national income*

Source: Kettner et al. (2012)

[27] For a more detailed illustration of the EU Sustainable Development Indicators (including sub-themes as well as further distinction between operational, explanatory and contextual indicators) see Kettner et al. (2012).

Table 7 **Beyond GDP (considering overlaps of dimensions)**

Dimension	***Indicators***
Traditional GDP (population's material well-being)	*GDP per capita*
Social indicators	*Corruption Perceptions Index*
Environmental Indicators	*Ecological Footprint* *EEA Core Set of Indicators* *Natural Capital Index Framework* *System of Environmental-Economic Accounting*
Enlarged GDP & Environmental indicators	*Environmentally Sustainable National Income*
Enlarged GDP & Environmental indicators & Social Indicators	*Adjusted Net Savings* *Canadian Index of Well-being*
Enlarged GDP & Environmental indicators & Social Indicators & Well-being indicators	*Genuine Progress Indicator* *Sustainable National Income*
Social indicators & Well-being indicators	*Capability Index* *Happy Life Years* *Human Development Index* *Index of Individual Living Conditions* *World Happiness Index* *National Accounts of Well-Being*
Environmental indicators & Social Indicators	*Comparing Welfare of Nations* *Index of Sustainable Economic Welfare* *Sustainable Society Index*
Environmental indicators & social indicators & well-being	*EU set of Sustainable Development Indicators* *European Benchmark Indicators* *Happy Planet Index* *JFS Sustainability Vision and Indicators* *MDG Dashboard of Sustainability* *Millennium Development Goals Index* *Time Distance Method of Analysing and Presenting Indicators*

Source: http://ec.europa.eu/environment/beyond_gdp/indicators_en.html [6.7.2015]

Table 8 **Europe 2020 Strategy**[28]

EU Headline targets	***Indicators***
Employment (75% of the population aged 20 – 64 employed)	*Employment rate (age group 20 – 64)*
R&D (3% of the EU's GDP invested in R&D)	*Gross domestic expenditure on R&D*
Climate change and energy (20/20/20 climate/energy targets[29])	*Greenhouse gas emissions* *Greenhouse gas emissions in non-ETS sectors* *Share of renewable energy in gross final energy consumption* *Primary energy consumption* *Final energy consumption*
Education (Less than 10% early school leavers and 40% of the younger generation with a tertiary degree)	*Early leaves from education and training* *Tertiary educational attainment*
Poverty and social inclusion (20 million less people at risk of poverty)	*People at risk of poverty or social exclusion, Sub-indicators:* *People living in households with very low work intensity* *People at risk of poverty after social transfers* *People severely materially deprived*

Source: http://ec.europa.eu/eurostat/web/europe-2020-indicators/europe-2020-strategy/headline-indicators-scoreboard [6.7.2015]

[28] For a more detailed illustration of the EU Sustainable Development Indicators (including sub-themes as well as further distinction between operational, explanatory and contextual indicators) see Kettner et al. (2012).

[29] GHG emission should be reduced by 20% compared to 1990; the share of renewable energy sources in final energy consumption should be increased to 20%; energy efficiency should be improved by 20%.

Table 9 **OECD Better Life Indicators**[30]

Dimension – Quality of life	***Headline Indicators***
Civic engagement	*Voter turnout* *Consultation on rule-making*
Social connections	*Social network (Quality of support network)*
Education	*Educational attainment* *Students' cognitive skills*
Environment	*Air pollution*
Health	*Life expectancy at birth* *Self-reported health*
Life satisfaction	*Life satisfaction* *Affect balance*
Personal security	*Homicide rate* *Assault rate*
Subjective well-being	*Employees working very long hours* *Time devoted to leisure and personal care* *Employment rate of mothers with children of compulsory school age*
Dimension – Material living conditions	***Headline Indicators***
Income and wealth	*Household disposable income* *Household financial wealth*
Jobs and Earnings	*Employment rate* *Long-term unemployment rate* *Personal earnings*
Housing	*Rooms per person* *Dwellings with basic facilities*

Source: (OECD, 2013a)

[30] For a more detailed illustration of the OECD Better Life Indicators (including secondary indicators) see Kettner et al. (2012).

Table 10 **Exemplary stock and flow indicators reflecting diverse approaches**

	Stocks				Flows			
Shelter		**Coverage**	**Years**	**Source**		**Coverage**	**Years**	**Source**
Happiness	Proportion of population living in households considering that they suffer from noise	EU27	2005-2001	Eurostat	Share of disposable income used for housing	EU27	2005-2011	Eurostat
	Share of populations that is satisfied with housing	EU27	2007	Gallup World Poll				
	Share of population living in poverty	EU27	2000-2011	Eurostat				
Capabilities	Dwellings	EU27	1990-2009	Odysee	Household investment dwellings	EU27	1990-2012	Eurostat
	Floor Area	EU27	1990-2009	Odysee	Maintenance costs dwellings	EU27	1990-2011	Eurostat
Ecosystem services	Vulnerability Index				Expenditures for flood protection			
					CO2-emissions households	EU27	1990-2010	IEA
Energy services	Buildings by construction period				Final energy consumption for space heating	EU27	1990-2009	Odyssee
	Efficiency of buildings by building type				Share of fossil fuels for space heating	EU27	1990-2009	Odyssee
Food		**Coverage**	**Years**	**Source**		**Coverage**	**Years**	**Source**
Happiness	Perceived health status	OECD	1990-2011	OECD	Share of household expenditures used for food (first quintile)	EU27	1994-2005	Eurostat
	Share of people satisfied with food							
	Share of population living in poverty	EU27	2000-2011	Eurostat				
Capabilities	Overweight and obesity	OECD	1990-2011	OECD	Total calories intake	OECD	1990-2009	OECD
Ecosystem services	Organic farmland	EU27	2000-2011	Eurostat	Share of organic food sales	EU27	2009-2010	FIBL
					GHG emissions agriculture	EU27	1990-2010	UNFCCC
					GHG emissions food industry	EU27	1990-2010	UNFCCC
Energy services	Capital stock food industry	EU27	1990-2007	FAO	Final energy consumption food industry	EU27	1990-2009	Odyssee
					Final energy consumption agriculture	EU27	1990-2009	Odyssee
Mobility		**Coverage**	**Years**	**Source**		**Coverage**	**Years**	**Source**
Happiness	Share of commuters	EU27	1999-2012	Eurostat	Commuting time	EU27	2000	How's life
Capabilities	Car stock	EU27	1990-2009	Odyssee	Passenger km travelled by cars			
	Bus stock	EU27	1990-2009	Odyssee				
	Motorcycle stock	EU27	1990-2009	Odyssee				
	Truck and light vehicles stock	EU27	1990-2009	Odyssee	Road freight transport in tonne km	EU27	1990-2009	Odyssee
Ecosystem services	Length of motorways	EU27	1990-2011	Eurostat	Transport gross investment spendings	EU27	1995-2011	OECD
	Length of other roads	EU27	1990-2011	Eurostat	CO2-Emissions transport	EU27	1990-2010	UNFCCC
Energy services	Car stock	EU27	1990-2009	Odyssee	Final energy consumption cars	EU27	1990-2009	Odyssee
	Bus stock	EU27	1990-2009	Odyssee	Final energy consumption bus	EU27	1990-2009	Odyssee
	Motorcycle stock	EU27	1990-2009	Odyssee	Final energy consumption motorcycle	EU27	1990-2009	Odyssee
	Truck and light vehicles stock	EU27	1990-2009	Odyssee	Final energy consumption trucks and light vehicles	EU27	1990-2009	Odyssee
					Share of expenditures for transport services	EU27	1995	Eurostat
Social inclusion		**Coverage**	**Years**	**Source**		**Coverage**	**Years**	**Source**
Happiness	Share of population with reliable helpers	EU27	2010	How's life	Weekly interactions with friends or family	EU27	2006	Eurostat
	Number of friends							
Capabilities	Share of population volunteering	EU27	2008		Time spent for volunteering (forthcoming)	EU27	2012	ESS
	Unemployment rate	EU27	2000-2012	Eurostat	Disposable household income	EU27	2000-2011	Eurostat
	Job quality				Years of education	EU27	2000-2011	Eurostat
Ecosystem services	Share of population without access to public green space	EU27	2000	Eurostat	Surface sealing	Austria	2008-2011	UBA
Energy services	Share of population with access to good public transport				Share of expenditures for public transport services	EU27	1990-2011	Eurostat

Source: Kettner et al. (2014)

Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs change. The financial crisis has exposed long-neglected deficiencies in the present growth path, most visibly in the areas of unemployment and public debt. At the same time, Europe has to cope with new challenges, ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundation for a new development strategy that will enable a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four-year research project within the 7th Framework Programme funded by the European Commission was launched in April 2012. The consortium brings together researchers from 34 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). The project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

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