Sustainability Science – The Greifswalder Theory of Strong Sustainability and its relevance for policy advice in Germany and the EU

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Abstract

The Greifswald approach was developed over many years in the co-operation of environmental philosophers and ecological economists. The theory combines normative arguments on our responsibilities for current and future generations (intra- and intergenerational justice), the conceptual debate on weak vs. strong sustainability, a new concept for natural capital with practical applications in three sectors: fisheries, agriculture and climate change policy. It was developed as an answer to the increasingly vague understanding of the sustainability concept in the political arena, which gives politicians the possibility of subsuming under it all sorts of different programs and strategies. A sharper definition of the concept is needed that offers a non-arbitrary orientation ground for action to end the further loss of essential parts of natural capital without becoming too rigid and exclusive of differences.

In this paper we give firstly a short overview about the philosophical background of the theory and about the conceptual debate on weak and strong sustainability. Secondly, we depict our concept of Natural Capital, which draws on Georgescu-Roegen's systematic framework of fund, stock, services, and flows and focuses on a central characteristic of nature: its (re)productivity. Accordingly, natural capital consists of living funds, non-living funds, and stocks. This differentiation offers a helpful ground for identifying specific preservation goals for the different parts of natural capital and can be successfully employed in the advice for policy makers (as it has been the case with the German Advisory Council for the Environment over a decade). Moreover, the outlined theory of funds avoids the main problems related to the standard definition of 'capital' according to capital and growth theory, which implies a homogenizing view and the necessity of monetary valuation.

In the final part we will then show how the Greifswalder approach can help to identify ways for a long term sustainable use of renewable resources for fisheries management in the European Union.

1. Introduction: towards a definition of sustainability

The complex idea of sustainability is the outcome of different intertwined threads running across history, societal movements, scientific research, and political aim-setting.

After the Rio-summit, which contributed to establishing worldwide the discourse and communication frame for a 'sustainable development', the term "sustainability" has been often used as a catch-phrase without specific meaning. Some scholars consider the famous definition of the Brundtland-report a bad compromise between the needs for nature conservation and the aspirations for economic growth. While a broad framing of the sustainability concept allows for a diversified and wide-ranged participation of stakeholders in the implementation of sustainability, this vagueness leaves it also open to being misused by power groups who want to press their business as usual into a new trendy setting.

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A sharper definition of the concept is needed that offers a non-arbitrary orientation ground for action without becoming too rigid and in this paper for the ISEE 2010 Conference we describe the Greifswald theory of strong sustainability as an approach to achieve that.

In the transdisciplinary field of the sustainability discourse the philosophical perspective can offer a multifaceted contribution. Crucial aspects of this contribution are:

- First, philosophy can play the role of a mediator or messenger by bridging among the different 'voices' participating in the process – it can be a semantic bridge not only among different disciplinary languages, but also (and even more peculiarly) between non-formalized knowledge, intuitions, daily assumptions and more formalized forms of knowledge (Muraca 2010). Moreover, philosophy can render accessible and subject to critique implicit intuitions about inter- and intragenerational justice, about duties towards the non-human world, about attributions of value emerging in different cultural and societal settings (economic, cultural valuation, livelihood values, preferences, spiritual and aesthetic valuation, etc.).

- Second, philosophy can play the role of the guardian at the boundary of the discourse, by continuously verifying who is admitted to talk, which voices have a stake and a place, which are excluded from the communicative process. Moreover, philosophy can play a critical role by making transparent which implicit presuppositions are assumed with no further questioning, which powerful and mainstream lines of thought lead to the silencing of alternative perspectives, as far as the latter are relevant for the question at stake (Muraca 2010).

- Furthermore, practical philosophy can act as a participant to the discourse rather than playing a observation role with regards to the different meanings, definitions, and attributions of sustainability that are factually and often strategically employed in communicative processes within society. In this function philosophy introduces its peculiar methodologies and theoretical framework into the communicative process.

This paper focuses specifically on this third role of practical philosophy. More precisely, practical philosophy can frame the theoretical setting of the sustainability discourse by developing a normative theory of sustainability and claim a clear stance in the scientific debate between weak and strong sustainability[2]. The theory of strong sustainability (TSS) presented in this paper does not take the pre-deliberative agreement on sustainability (as it has been establishing itself after Rio throughout societal, political, and scientific documents) as a mere given. This agreement combines some commitments to future generation with the so-called three-pillar-model by which economic, environmental, and societal objectives shall be (somehow) balanced. From a philosophical perspective, this is an insufficient foundation for a genuine discourse on sustainability. Going beyond this widespread agreement, TSS addresses critically the very core of the sustainability idea (inter- and intragenerational justice; diversified concept of Natural Capital etc.) in order to shape a normative comprehensive theory that can offer a well-founded orientation to the societal and political process of decision-making (Ott and Döring 2008; Grunwald 2009; Norton 2003).

[2] In the international discourse on sustainability there are but few approaches that aim at a philosophical and normative analysis from the point of view of inter- and intragenerational justice (see among others Dobson 2003 and Norton 2005). A thourough presentation of these approaches and a comparison with the Greifswalder theory would go beyong the scope of this paper.

Drawing on Habermas' discourse ethics the TSS assumes that a discourse is a peculiar form of communication, in which argumentation takes place (Habermas 1981).

The TSS therefore aims at:

- identifying criteria for distinguishing sustainable and non-sustainable paths on the ground of a wider consideration of arguments than the mere instruments of economics,
- specifying the proper scope of the discourse by setting up the frame of fields of action and application,
- delivering a ground for operationalization in policy and politics (see the role that TSS has played in policy advice activities – as it is the case for the German Advisory Council for the Environment),
- performing as a 'rational corrective' to clarify the diffuse discourse on sustainable development that takes place in society (Grunwald 2009).

By drawing on Lakatos' and Stegmüller's post-Popperian assumption that any theory is constituted by some core elements and a set of applications, some of which are paradigmatic, some other secure, and some contested, the TSS avoids the risk of transforming sustainability into a "theory about everything" without specific boundaries of application whatsoever.

Accordingly, the TSS consists of different 'levels' (see table below), which are not intended as a deductive hierarchy. The first two levels – the core elements of the theory – consist of a theoretical reflection that aims at framing the concept of sustainability as a regulative ideal. The last three levels open the field for a fruitful exchange with policymaking, praxis and socially participatory actions. The third level aims at bridging theory and practice.

1.Idea (intergenerational justice)

2.Concepts („strong" or „weak" sustainability, intermediate concepts)

3.Rules (constant natural capital rule, management rules)

4.Dimensions of policy making (climate change, fisheries, forestry, agriculture etc.)

5.Objectives (targets, time frames, set of instruments, indicators)

6.Implementation, Monitoring etc.

2. Sustainability as an ethical concept

The core of the idea of 'Sustainability' consists in the issue of intra- and intergenerational distributive justice and encompasses duties towards currently living generations and future generations regarding different goods (see Norton 2005), with a special focus on natural resources (Ott and Döring 2008). Obligations to posterity are to be combined with an assessment of consequences and side-effects of contemporary actions and institutions in order to identify how sustainable development should be established in policy making. The deontological assumptions must be made explicit. In terms of responsibility of justice towards future generations, at least the following questions have to be addressed:

- Are there any obligations to future generations at all?
- Should responsibility for the future be based on an egalitarian-comparative standard or on an absolute standard?
- What can be considered a "just" legacy?
- Are we permitted to discount future states of affairs?[3]

If ethical questions of intergenerational duties are discussed, it has to be justified first that duties towards future generations exist at all (for a thorough analysis and refutation of so-called "no obligation arguments", which deny these duties, see among others Ott 2004). Neither Parfits "Non-Identity-Problem" nor the argument claiming that future persons cannot have rights today are convincing (Parfit 1987); moreover, they seem to contradict basic intuitions of duties towards future generations that most people across cultures and centuries have been sharing. Parfit's Non-Identity-Problem obtains its moral relevance by confusing the terms individuality and personality (Partridge 1990; Grey 1996; Ott 2004). Against Parfit can be held that personality as a normative status is usually ascribed to human beings with specific cognitive capabilities. This status includes a system of rights. Individuality on the contrary refers to the concrete and contingent characteristics of a single human being resulting from a unique and non-interchangeable life story. Moral duties most of all apply to personality and less to individuality. Although the Non-Identity-Problem highlights the contingency that is involved on the level of individuality, its moral relevance regarding the justification of intergenerational duties is negligible. Accordingly, regardless of the specific individual identity that members of future generation will embody they will still be 'persons' in the sense proposed here and therefore subjects of rights. Moreover, as Unnerstall has argued at length, future rights can justify current duties (Unnerstall 1999). The anticipatable impact of future (moral or juridical) rights of persons is a necessary and sufficient condition for current intergenerational duties with regards to different goods.

According to the second question the ethical controversy centers on whether duties of justice towards future generations should be based on an absolute standard (access to anything that is required for a life of human dignity) or on a comparative one (no worse than current generations). The absolute standard ensures a "basic humane level" (in terms of basic capabilities, see below) whereas the comparative standard raises the issue of an appropriate "equivalence." While the former allows current generations to bequeath less to future ones than they have inherited (provided that this would be sufficient to lead a decent or dignified human life), the latter requires that future persons be not worse off than current ones (on average).

The TSS argues on the one hand for a strong and demanding absolute standard and suggest to replace the "(basic) need" approach by a culturally interpretable and context-sensitive list of capabilities, as compiled by Nussbaum (2001) in her "broad and vague conception of the good" (Ott and Döring 2008). Whereas according to the basic-need-approach all human beings are entitled to have merely what they need to survive the capability-approach sets the minimum standard at a much higher level to the inclusion of all necessary conditions to accomplish a good (rich, flourishing) life, i.e. a life worth of a human being. This approach encompasses capabilities such as "being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living," "being able to have attachments to things and people outside ourselves" and "being able to

[3] We are not able to explain that here. See for an overview the special issue of the Journal of Sustainable Development Vol 6, No. 1.

live with concern for and in relation to animals, plants and the world of nature." The list is based on ideas of the intrinsic richness of human existence and on the idea that a good human life lies in the exercise and performance of specific human capabilities.

While anti-egalitarians deny that equality has any intrinsic value and thus limit intergenerational duties to an absolute standard (Frankfurt 1987) according to the TSS also comparative aspects of justice above the absolute standard ought to be taken seriously into account. The comparative standard can be justified with the Rawlsian "veil of ignorance" (Rawls 1973). The veil of ignorance has to be designed in a way that the individuals behind it do not know to which generation they belong. By drawing on Rawls' idea of reciprocity, which suggests an equal distribution as the starting point, it is concluded that rational persons would probably choose a comparative standard as far as this is feasible within safe environmental limits.

The third core question leads to the next level of the theory, since it cannot be answered at the abstract level of theoretical moral justifications. It encompasses the widely debated issue about the fair bequest package that current generations owe to future ones.

3. What do we owe to future generations? Arguments in favor of Strong Sustainability

At the conceptual level, distinctions are made between weak, strong, and intermediate sustainability. The controversy among these concepts stems from different assumptions about substitutability between natural and man-made capital, about compensating future generations for losses, and about discounting future events (Neumayer 1999 w.f.r.).

The concept of weak sustainability is based on the obligation that present generations should bequeath future generations an undiminished stock of capital. In this concept, however, a far-reaching substitutability among types of capital is assumed; accordingly, natural capital may be prima facie substituted on a nearly unlimited basis as far as substitution is possible. This assumption goes back to Solow's "educated guess" (Solow 1974) that the degree of substitutability between artificial and natural capital is, in general, no less than one. Solow's guess implies a Cobb-Douglas-function. Thus, contemporary persons are entitled to "draw down the pool (optimally, of course!) so long as they add (optimally, of course!) to the stock of reproducible capital" (Solow 1974). Thus, the saving schedule can be measured by economic means. Most prominent is the genuine-savings-approach (Atkinson et al. 1997). The ideal portfolio manager considers possibilities of substitution by trying to maximise the net present value. From this point of view the preservation of natural resources is a meaningful/feasible goal only if it is proved to be more efficient if compared to other income types. However, for the sake of comparability natural resources have to be expressed in monetary terms. The deontological meaning of intergenerational duties can only be described in terms of a constraint imposed on maximization paths. The ethical idea is thus expressed as "non declining utility over time".

The concept of strong sustainability is based on the assumption that natural capital must be preserved on different scales (global, continental, national) out of moral respect for future generations. It is assumed that the range of substitutability between natural and man-made capital is limited. The loss of natural capital impoverishes the life prospects of future generations negatively. Some management rules and some policy suggestions (as, f. i., not to count the depletion of natural capital as income) are derived from this concept (Daly 1997). Strong sustainability has to justify the constant natural capital rule (CNCR). Because of the distinction between natural capital and cultivated natural capital a limited range of substitution is left under the CNCR. For Daly (1997) the assumption of complementarity is a sufficient argument to justify the rule of strong sustainability, according to which natural

capital should not decline over time (Constant Natural Capital Rule – CNCR). However, further arguments can be introduced to justify the CNCR. In fact, it is not only about whether or not and to what extend nature can be substituted in the production process, but also about whether "we" shall want the ongoing substitution of nature with regard to the capabilities approach, or, in other words, whether "we" can justify this substitution in the eyes of future generations.

The task of a philosophical scrutiny is to develop a well-founded judgment that can guide to a reasoned choice between the two concepts of sustainability. The judging process takes place in due consideration of ethical principles and in a situation that is practice-oriented but without any direct pressure to act. The key arguments are (Ott and Döring 2008; Ott 2009):

First argument: Weak sustainability is framed by neoclassical economics. In this frame, the general objective is to maximize the net present value. Rationality is defined as egoistic utility-maximization. Morality is either an external constraint or some altruistic preferences. Intergenerational obligations are reduced to altruistic preferences. Discounting is permitted (often at the rate of interest). Future ethics is transformed into efficient allocation across periods of time. On reflection, this theoretical frame contradicts a genuine future ethics. Many assumptions in economic models (Cobb-Douglas-function, Kaldor-Hicks-criterion, discounting, value of a statistical life) are repugnant for either epistemic or moral reasons.

Second argument: If we do not know the preferences and interests of members of future generation we are neither permitted to assume that these preferences will differ from ours' nor to assume that future persons like to live in artificial environments. It could be as well the case that their habits, beliefs, and interests will be more "greener" than contemporary ones. If uncertainty is taken serious, there is a reason to maintain options to live according to such habits and beliefs. If so, strong sustainability is more liberal by leaving more options and freedom of choice to future generations. Persons behind the Veil of Ignorance know that they have a specific concept of the good life but they do not know which one it might be. Thus, they do not know whether they will be nature-loving environmentalists or not. They know that many people place high value on "recreation in free nature", on "living lightly in nature", on wilderness experiences, and the like. If the persons behind the Veil of Ignorance would choose weak sustainability they might find themselves as naturalists being trapped in a "full world economy" where unspoiled nature has been lost. This situation would be uncomfortable, if not painful. If persons prefer to avoid such bad outcome, they should opt for a saving schedule which preserves natural capital on different spatial scales.

Third argument: Many people are searching for a personal environmental morality (as a source of self-esteem). Strong sustainability shows a better compatibility with the argumentative framework of environmental ethics, since it can pay greater respect to the manifold cultural, biophilic and spiritual values that people associate with the experience of nature and landscape. Arguments in environmental ethics entails instrumental values, eudaimonistic values, and (contested) conceptions of inherent moral values in nature. Since each argument can, in principle, be adopted or rejected, there is a plurality of reasonable interpretations of this universe of environmental discourse. Obviously, the concept of strong sustainability leaves more room to live according to different interpretations of this universe of discourse, whereas weak sustainability tends to leave room merely to instrumental values of nature (what is instrumentally valuable can be replaced by any equivalent, including money). People searching an environmental morality or even a "deep" ecosophy have strong reasons to adopt strong sustainability.

Fourth argument: If many ecological systems provide several kinds of functions, amenities, and services, adequate substitutes must be found for each and every single function. Weak

sustainability has to assume such findings or design the models accordingly. The substitutes must additionally be available now and not merely be a theoretical possibility. In reality, however, it is highly uncertain of whether such substitutes will be found. Multifunctionality in conjunction with uncertainty provides sound patterns of arguments in favor of CNCR.

Fifth argument: The case of the pacific island Nauru counts as counterexample against weak sustainability (Gowdy and McDaniel 1999). Nauru's inhabitants and its former colonial powers have destroyed Nauru's natural environment because of heavy mining. For some decades, Nauru's inhabitants afforded a high standard of living due to the interests of the accumulated capital. According to the measures of weak sustainability, Nauru had been the most sustainable place on earth. Quality of life on Nauru, however, has not increased because of widespread diseases and alcoholism. Meanwhile, a huge fraction of the economic capital has been lost in business affairs. If the measure of weak sustainability implies that countries with an impoverished state of the environment, poor health conditions, widespread addiction to alcohol, an risky and dependent economical base are to be ranked as highly sustainable, there is something at odds with the concept. If so, the Nauru-case counts as a refutation (some say: falsification) of weak sustainability.

Sixth argument: In many cases the relationship between man-made and natural capital is complementary. This has been Daly's main argument (Daly 1997) which has been backed by some examples (fisheries, forestry). Taken in isolation, Daly's argument is not sufficient for adopting the concept strong sustainability (Ott and Döring 2008). But if this line of reasoning is regarded as one pattern of argument in an overall judgment formation, the complementarity-argument counts in favor of strong sustainability.

Seventh argument: Precautionary principle, „minimax"-criterion, or safe minimum standard can be used in order to justify CNCR. Under conditions of uncertainty and in unique cases a prudent society should better err on the side of caution (and avoid "false positives" in a pay-off matrix). Risk-averse persons will agree to the precautionary principle behind the Veil of Ignorance but the argument is sound in practical discourse also.

These reasons can be held to be sufficient to justify the conception of strong sustainability in an envisaged counter-factual discourse with representatives of future generations. SRU (German Advisory Council on the Environment) argued that strong sustainability, the CNCR, and some management rules can be justified discursively (2002: 67). As consequence, programs of environmental policy making should be performed as being either preservation strategies or investment strategies related to natural capital. Such strategies, including objectives, indicators, and standards can't be conceived under the VOI. Having chosen the "best" available concept of sustainability either behind the Veil of Ignorance or in practical discourse, the persons now become real citizens which take an interest in environmental policy making. At the end of this line of reasoning, persons can't be conceived as private persons or consumers any more. If persons have adopted strong sustainability out of reason, they ipso facto have taken the roles of both moral persons and prudent citizens.

4. The Theory of Natural Capital in the Greifswalder Theory of Strong Sustainability

Some scholars oppose the term "natural capital" arguing that nature should not be designed as a form of capital (Biesecker and Hofmeister 2009). In fact, according to them the term capital tacitly implies transferring the understanding of utility yielding means of production, which is typical for man-made capital, to complex systems providing manifold ecological services, whose components are living and subject to evolutionary alterations. According to the TSS "capital" is used as a terminology at the intersection of economics and philosophy, being neutrally defined as stocks that yield a somewhat beneficial (useful) flow (Ott and Döring

2008). This concept of capital must be specified according to the specific features and benefits of different types of capital. Therefore, the TSS starts with the term natural capital in order to show in a subsequent step the "differentiae specificae" of natural capital as such, especially the autopoietic productivity of the living.

Natural capital is a totality concept that encompasses heterogenic entities. A homogenized understanding of natural capital contradicts the very meaning of the term. Natural capitals are multiple, heterogeneous, and internally connected. The CNCR refers to this net of critical stocks. The definition of the term natural capital in the TSS is as follows: natural capital consists of all components of the animate and non-animate nature, especially living and non-living funds, which can benefit human beings and highly developed animals in the exercise of their capabilities or which constitutes indirect functional or structural presuppositions for such beneficence in the broader sense.

In analyzing natural capital, it thus appears necessary to shift the accent from the universal (the genus proximum or capital) to the particular (the differentia specifica, which is nature). How the differentiae specificae of Natural Capital can be captured in a concept that allows for a more differentiated and adequate description of the term, in comparison to the conventional capital concept, remains a chief issue within Ecological Economics.

4.1 Following Georgescu-Roegen

In the TSS we draw on Georgescu-Roegen's differentiation among funds/services and stocks /flows, while developing this distinction further. Georgescu-Roegen criticizes that in the neoclassical growth theory economic processes are considered as being basically independent from the outside world. Necessary inputs are shoveled in and waste products come out of the economic process. Economics is caught in the dilemma of having to somehow represent in an analytical way non discrete processes and is therefore bound to ‚heroic simplifications (Georgescu-Roegen 1971). Accordingly, Georgescu-Roegen terms the method of neoclassical economics arhitmomorphic, since it divides a flow of partially overlapping durations into discrete unities (see Muraca 2010). Once we take such a perspective we can no longer analyze what happens within a process of production. However, in economic processes resources, material objects, labour etc. are used to produce goods and services, while waste and non-usable heat are outputs of the production process as well. Georgescu-Roegen‘s own attempt to consider economic processes adequately is his Flow-Fund-Model: „The factors of production can now be divided into two categories: the fund elements, which represent the agents of the process, and the flow elements, which are used or acted upon by the agents" (ebd. 230). Funds factors (or Capital factors) are considered the agents of production, since they transform the flow of natural resources into a flow of economically valuable products; Funds have to be kept at their constant specific efficiency so that the process can take place. Flow factors enter the economic process and are qualitatively changed/consumed through it. Flow factors are for example Inputs (resources) and Outputs (products and waste), but also so-called 'maintenance flows'. The latter are necessary in order to keep (maintain) funds factors in their condition of specific efficiency and furthermore to keep the process running. Similarly, when labourers go home in the evening to come back rested the next morning they are been kept in their constant efficiency by the maintenance flow in their families and houses. A machine needs maintenance and new parts at some point until its total renewal. Maintenance flows are all those factors that regenerate funds – they encompass all those assimilative or absorptive services, referred to as sink functions, that render economic processes possible in the long run (Gowdy and O'Hara 1997).

Funds are the classical three factors of production: Capital in a proper sense, Labor and Land: „But the most stringent example of this category is the Ricardian land which comes out in exactly the same amount and quality" (Georgescu-Roegen, 1971: 225). Land is the only net

which is able to collect solar energy source and convert it in usable products and services for the production process. While the flow of solar energy is infinite in size, but not at our disposal with respect to its rate of use, terrestrial stocks of low entropy (fossil fuels and mineral resources) are not infinite in size, yet their flow rate can be fixed at will according to our needs. Therefore, according to Georgescu-Roegen the assumption made by the neoclassical growth theory of endless growing goods and services does not hold because the capacity of the production factor land is limited according to its rate. Processes which depend on the production agent land take time to deliver their services and to regenerate; moreover, their potential overall services are not usable at once. Stocks delivering flows are consumed in processes. Theoretically, stocks can be all used up in a single moment. „These can be used with a speed and rhythm which, in principle, depends only on man's choice" (Georgescu-Roegen, 1969: 524).

4.2 A different understanding of natural capital

Following Georgescu-Roegen's differentiation of funds/services and stocks/flows it is now possible to define Natural Capital differently from other capital stocks (see also Faber and Manstetten 1998). While stocks (such as oil or coal) are inevitably consumed (e.g. destroyed) when used, funds as land (e.g. a field which is cultivated accordingly to its regeneration capacities) can be used over time without being consumed (Georgescu-Roegen 1971: 224-226). Moreover, we cannot use all the potential benefits resulting from a fund at a given time. If a field yields one ton of wheat every year, we are not able to harvest the potential 100 tons yield for the next 100 years today. The long term gains from the use of fields are not all beneficial today. Drawing on Georgescu-Roegen, we distinguish between services as the provision of benefits by funds and flows as the provision of benefits by stocks.

Furthermore, we distinguish between non-living funds, like the sun, air or water, and living funds. The fact that parts of nature are living beings, which are able to reproduce themselves, is the reason for an essential (and unique), qualitative feature of nature (Faber and Manstetten, 1998, Biesecker and Hofmeister, 2001, 2006). Living funds are therefore the active elements in nature that can regenerate Land in Georgescu-Roegen's term and carry out the role of ‚production agents'. Living funds, like animals or plants, besides providing direct services while being used are capable of regenerating other parts of nature: the non-living.[4]

From a human point of view living funds have an indefinite durability. Although the organisms that are parts of the funds die, the funds itself stays in a dynamic equilibrium by the reproduction of the individuals. In many cases we destroy these funds because we use them as stocks: As an example the living funds of deep sea fish species are being currently destroyed by fishing heavily in spite of the very slow reproduction rate of these species (this is significantly called 'mining the deep sea'). The only focus seems to be the present benefit. This is an obvious overexploitation of a fund that results in a reduction of the funds reproductive capacity. Instead of using the services that funds provide under the temporal condition of regeneration we overuse/consume them without taking time into account.

Figure 1 outlines the theory of funds in the Greifswald approach. We claim that Natural capital consists of stocks, of living and non-living funds. In case of funds, the ratio of the use of parts of the funds in comparison to its reproduction/regeneration rate is a main question. Since living funds regenerate themselves the use amounts should not exceed their reproduction rate.

[4] In this model solar radiation plays an exceptional role because it is the only non-living fund that originates from the outside of the earth system, that provides energy, and that is necessary for the survival of living funds.

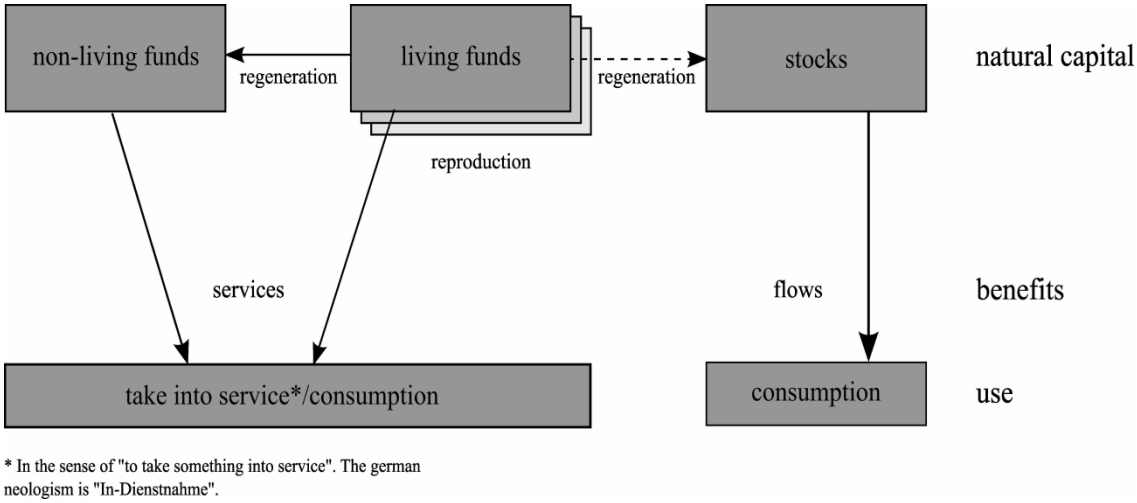

Fig. 1: Theory of funds (Ott and Döring 2008: 220)

By introducing a definition of Natural Capital based on the theory of funds, we can address the question for preservation of critical amounts of funds. If a living fund declines below a certain threshold, e.g. the size of a population of animals or plants species falls below a certain number, we pose a threat of the loss of both consumption and service possibilities because of the resulting lower regeneration rate of the fund. In case of non-living funds there is a threat of loss of service possibilities as well, this time due to the restriction of the funds functions.

4.3 Policy advice and the natural capital definition

Taking the above definition into account the preservation of natural capital shall be assured by the well-known “rules of management”. The German Advisory Council on the Environment formulates them as follows:

1) Renewable resources may only be used at the rate at which they regenerate normally.
2) Exhaustible raw materials and energy sources may only be consumed at the rate at which physically and functionally equivalent renewable substitutes are created.
3) Pollutant emissions may not exceed the absorption capacity of environmental substances and ecosystems, and emissions of non-biodegradable pollutants are to be minimised, whatever the extent to which unoccupied storage capacity remains available.

The rule of preservation is to be understood as a prohibition of degradation and the rule of investment as a mandate for improvement and creative planning.

The German Advisory Council on the Environment argues for a target oriented approach as a progress in environmental policy. In the Councils environmental and special reports over years he substantiated this approach for several areas of environmental policy (climate change, nature conservation, transport, agriculture and fisheries, biomass production, soil, water, oceans). In the advice for the German government the Council follows the TSS regarding the main policy areas. In the following chapter we draw on that conclusion and show how this may work for fisheries management.

5. Greifswald approach and long term fisheries management – identify ways forward

Fisheries management in the European Union is a centralized common policy for all member states. The Council of Ministers decides on all issues dealing with total allowable catches and technical measures (mesh sizes, fishing effort limitations etc.) for the European fisheries (outside the 3-nautical miles coastal waters).

The European Commission as principle manager of the resources relies on the advice of the International Council for the Exploration of the Sea (ICES) for proposals on catch limits. The most important issue is the amount of fish fishermen are allowed to take from the stock. In 2002 the environmental ministers decided at the Conference on Sustainable Development in Johannesburg to follow the MSY-approach (Maximum Sustainable Yield). This means for many stocks that they need to rebuild to such a level.

Until last year the precautionary approach was the background of the advice for catch possibilities. The main goal of the PA is to hold stocks within safe biological limits. For that fishery biologists define limits for stock biomass and fishing mortality.

B_{lim} Biomass limit: the biomass level below which the possibility of a total breakdown of the stock is very high and the reproductive capacity reduced; the fish stock size is so low that biologists cannot predict recovery over time.

B_{pa} Biomass precautionary limit: a stock size level such that a short-term reduction in fishing effort is expected to allow the stock to recover above this limit. Reproductive capacity is not yet reduced. Greater uncertainties regarding a species stock size cause B_{pa} to be set at higher levels and further apart from B_{lim}.

F_{lim} Mortality limit. The annual fishing level above which the risk of a total breakdown of the stock is extremely high.

F_{pa} Mortality precautionary limit: the annual fishing level above which the risk that the stock size falls below B_{pa} is high.

These reference limits can be translated into a decision matrix:

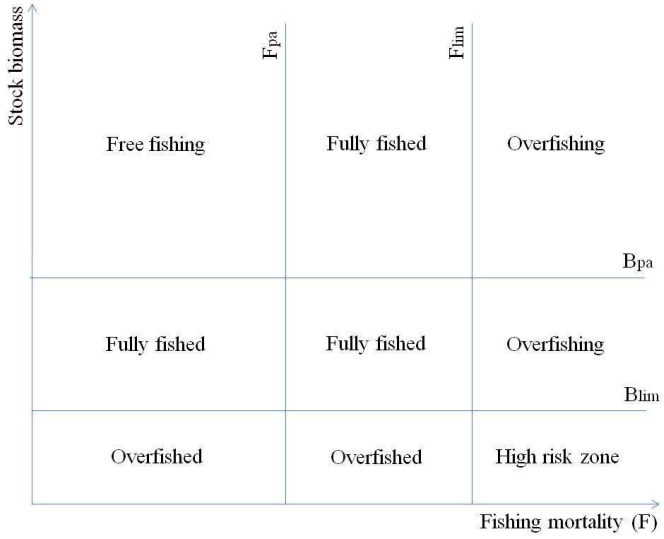

Fig. 2: Decision matrix and policy implications according to the precautionary approach in fisheries management (see Döring and Egelkraut 2008: 636)

The CFP has as one basic instrument multiannual management plans to move from a short term, one year quota system (decision in December on quotas for the following year) to a multiannual quota system. In the management plans the rules how the quotas have to be set is fixed for at least a three year period. The exact quotas are still unclear but in most plans a rule of maximum +/- 15% limits the fluctuations. Fishermen have, therefore, more security in long-term gains than before.

Setting long term targets and defining instruments how to reach those targets is a new approach in the multiannual plans. The Greifswald approach is demanding exactly this type of decision making process: setting of long-term targets and reaching of those targets efficiently. Therefore, this new policy approach fits very well as an application of our sustainability theory.

There is now some kind of automatism in the setting of TACs following the instruments in the management plans. This reduces the bargaining in the Council of Ministers on quotas for each country and makes decisions much more predictable for fishermen. This removes some of the uncertainties for future gains. After some plans are now in force for several years it is possible to draw first preliminary conclusions if the management plans work. We limit this analysis to two questions: are there signs of increasing stock sizes in the overfished stocks and are fishermen more willing to keep to the quota (lower unreported catches).

The basic question after the implementation of approximately 10 multi-annual plans now is whether the plans are successfully rebuilding the stocks. Every plan so far was a recovery plan. The following table 1 gives an overview on the plans, their targets and the situation in 2010.

Table 1: Success of multi-annual management plan in the EU fisheries policy

Stock	Targets	Target achievement (ICES assessment)	Comments
Baltic Sea cod			
western	F: 0,6	F: 0,83	Not achieved
eastern	F: 0,3	F: < 0,3	Achieved
North Sea cod	Stock size (Bpa)	Light increase	Not achieved
	F: 0,4	F: > 0,7	Not achieved
North Sea	Stock sizes	Increase (both)	Not yet fully achieved
plaice	F (plaice): 0,3,	F: 0,25	Achieved
sole	F(sole): 0,2	F: 0,34	Not achieved
Sole Bay of Biskay	Minimum stock size	Reached in 2007	Achieved
Sole western channel	F: 0,27	No Assessment	Unclear
Northern hake	F: 0,25	F: 0,25	Achieved
	Minimum stock size (Bpa)	> Bpa	Achieved
Herring west of Scotland	Stock size > 75.000 t	F < 0.25;	Achieved
	F dependent on stock size (between 0 and 0,25)	Stock size > 75.000 t	Achieved

Overall more than 50% of the targets are achieved or nearly achieved. Only North Sea cod and Sole western channel are showing only few signs of recovery. In the case of the Sole stock in the North Sea the F target is not achieved but overall the situation of the stock improved. We can draw at least the conclusion that in many cases the plans seem to work and the approach of setting targets which we have to achieve in the long run seems successful.

In the past in many fisheries official landings and the so-called ICES-landings which incorporate also known illegal/unreported landings are wide apart – meaning that ICES assumed high landings above quota. If there are signs now that fishermen aren't overshoot the quota anymore this would be a strong sign that they in favor of the management plan, his instruments and sure of a positive development if they keep the rules. The following table 2 gives an overview for 7 management plans.

Table 2: Comparison of TACs and landings in European fisheries under a LTMPS

Stock	Comment
Baltic Sea cod	Western stock ICES-landings below TAC 2006-8, above 2009 Eastern stock ICES-landings above TAC 2006-7, even 2008 and below 2009
Plaice North Sea	Before 2001 ICES-landings above TAC, afterwards even
Sole North Sea	ICES-landings above TAC nearly all years
Sole Bay of Biskay	After 2006 ICES-landings were under the TAC, discards decreased
Sole western channel	ICES-landings above TAC (catches reported for other areas)
North Sea cod	Official landings (no ICES-landings reported) under or near TAC in the North Sea and Skaggerak, no information on the eastern channel
Herring west of Scotland	ICES-landings under TAC in many years
Northern hake	ICES-landings above TAC before 2006, afterwards until 2008 below

In most of the fisheries under a management plan the ICES landings are now at the same level or under the TAC. This is a positive sign for the change in behavior of the fishermen.

6. Summary and Outlook

The TSS combines normative arguments regarding our responsibilities for current and future generations (intra- and intergenerational justice), the conceptual debate on weak vs. strong sustainability, a new concept for natural capital with practical implications. The increasingly vague understanding of the sustainability concept in the political arena makes it necessary to develop a sharper definition that offers a non-arbitrary orientation ground for action to end the future loss of essential parts of natural capital. The TSS is neither too rigid nor exclusive of differences.

In the meantime it is no longer disputable that we do have obligations to current and future generations. The main controversy is therefore about what a fair bequest package should look like, i.e. about weak vs. strong sustainability. Weak sustainability allows for the substitution of natural for man-made capital, strong sustainability argues in favor of the constant natural capital rule. We outlined the arguments for strong sustainability, which in our view are much more convincing than the arguments in favor of weak sustainability. In the meantime some proponents of weak sustainability are also accepting that we have to preserve critical stocks of natural capital. As Hediger (2009: 46) argues that weak sustainability " is flexible and open to

include additional issues and concerns, such as social dimensions of development as well as critical limits of natural capital, basic human needs, social cohesion, et cetera." However,Hediger's argument that strong sustainability is included in his concept of weak sustainability is not convincing. In fact, his understanding of strong sustainability is very much focused only on keeping limits for the use of natural capital and assumes nature as some kind of capital stock which is also the basis of the weak concept. INstead, our understanding of natural capital focuses on the specific differences in the basic capital concept in economics – stock that yields a flow of services. We argue for a different understanding of natural capital drawing on Georgescu-Roegen's funds, stocks and flows concept . In our understanding accepting limits leads to an argument in favour of strong sustainability. Hediger's position[5] is, therefore, a move away from the original weak sustainability concept to an intermediate position leaning towards strong sustainability (see also Ott & Döring 2008 for a discussion on intermediate concepts).

As the example of fisheries management policy in the EU showed we can argue that with clear targets (a certain fishing mortality), a clear strategy how to keep the targets (ways to set catching and effort limits) and the commitment of the participants in the fisheries (keeping to the rules) a change in policy to preserve natural capital is possible and the TSS gives a good ground for policy advice in the future.

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[5] Hediger widens the weak concept to include nearly everything and this seems the same problematic direction as in the sustainability discussion as a whole (becoming vaguer and vaguer).

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