Building the basis for sustainable land use –concepts and strategies for implementation in Germany and Japan

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Abstract

Sustainability has become a key term in many areas of science and policy. It is often applied to the way we should be using resources: with consideration of the full implications that our choices may have, so that future options are not limited by what we do today. Applying the sustainability concept in practice requires an understanding of the possible consequences of decisions made by politicians, business people and private consumers on social, economic and ecological systems. The complexity of these systems limits our ability to understand and predict their dynamics, but there is growing consensus that sustainable land management needs to address this challenge. The ecosystem service concept is becoming an important tool for this purpose. To operationalize this concept, political, legal and administrative aspects have to be matched with scientific understanding of synergies and trade-offs between different ecosystem services. Furthermore, the concept and its implications for everyday decision-making have to be communicated beyond academic circles. Different media including film are being used to make these complex issues accessible for non-experts. We discuss recent developments in these fields, using Germany and Japan as examples. We also highlight further research needs related to these topics and outline how they might be tackled through inter- and transdisciplinary projects.

Keywords: Sustainability, land use, satoyama, biodiversity, ecosystem services, scenarios

Sustainability concepts

Concepts of sustainability have developed in varied scientific, philosophical, social and political contexts, but they share a common background - their point of departure is generally a concern for long-term human well-being, and they are thus founded on ethical considerations. Maintaining conditions under which fulfilled lives are possible, i.e. physical, social and spiritual needs are met, is the overall aim of approaches to sustainable land and resource management. Debates on ethical behaviour have provided reference frameworks for the evaluation of choices that have to be made in the context of natural resource use, and the fundamentals of these debates show common patterns in Europe and Japan (Kant 1788, Watsuji 1952) in spite of differences concerning the relationship between the individual and the social groups with whom he or she interacts (Mayeda 2006).

Deterioration of ecological systems due to negative effects on their structure and functioning caused by human pressures have often been the primary focus of debates on sustainability, and the ensuing decrease of benefits – both material and immaterial - from ecosystems for humans has been the key problem for which solutions are sought (Komiyama and Takeuchi 2006, Ostrom 2009, Duraiappah et al. 2012). Although certain human activities may be judged as negative from an ecological perspective, they are often carried out with the explicit aim to improve living conditions for people and may thus be considered socially or economically sustainable, causing what has been termed 'the environmentalist's paradox' (Raudsepp-Hearne et al. 2010). This 'paradox' states that indicators of human well-being mostly have improved over the past decades while indicators for the state of the environment often have declined, which seems to contradict the notion that human well-being depends on favourable environmental conditions.

A basic approach to solving this apparent paradox is to take spatial and temporal separation of benefits and burdens in relation to resource use into account – those who consume resources and enjoy their benefits are often not or not immediately the ones who have to cope with negative consequences that this resource use may entail (Tallis et al. 2008). Another aspect is that technological development and the development of relatively efficient public and private institutions have facilitated increases in the availability of food and raw materials for many people, and that this increase is actually tangible, whereas losses in regulation functions and cultural services provided by ecosystems are not readily discernible (Raudsepp-Hearne et al. 2011).

Sustainability has been variously defined as an environmental, a social or an economic concept, but the term is increasingly being used in a holistic way, referring to the maintenance of the structural and functional integrity of all 'life supporting systems' (Walker et al. 2006). It then covers all three compartments, i.e. ecological, social and economic aspects (Fig. 1). At global scale, ecological systems encompass social and economic systems, and they provide the sources for all material goods that are used by humans in the social and economic system compartments. They also function as sinks for all emissions and waste. In addition, humans interact with ecological systems through cultural activities (arts, media, sports etc.), both individually and as groups. In spite of the obvious dependence of the anthropogenic system compartments on the ecological context, the perception of the relevance of the respective compartments for human well-being differs among different social groups, and this leads to differences in the prioritization of goals and measures for sustainability (Allenby 2006). An important issue in this context is the choice of indicators for various aspects of the feedback cycles in these coupled systems. Decisions on what to measure and how to quantify it can greatly affect the outcome of sustainability assessments (Grigoroudis et al. 2014, McNeill et al. 2014).

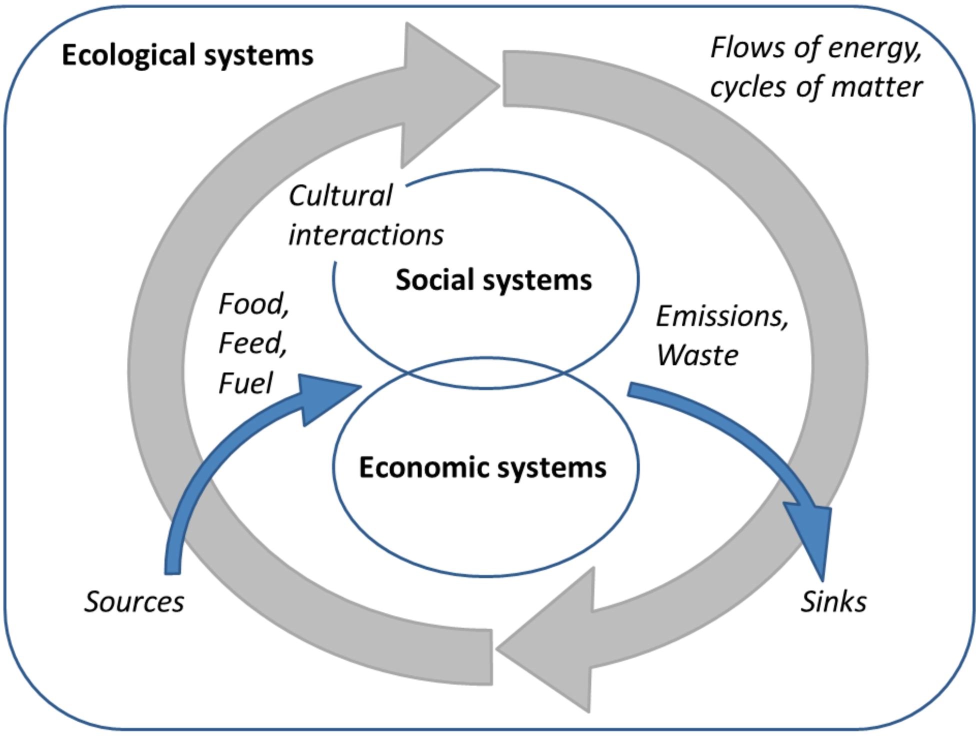

Fig. 1 Flows of energy, information and matter in nested ecological and socioeconomic systems. Long-term sustainability of social and economic systems depends on environmental sustainability. The use of ecosystem-based sources and sinks by humans must not exceed their respective capacities of providing resources and taking up emissions and waste.

Proponents of the view that economic or social concerns have to take precedence over environmental issues implicitly assume that either the capacity of ecosystems to provide goods and services for humanity is not (yet) limited, the reverberations of overexploitation of resources will not affect the group which they intend to favour, or technological development will enable us to cope with the consequences of any environmental change (Ascher 2006). All these assumptions are questioned by those who argue that there are limits to the capacity of the global ecosystem and to our social, economic and technical abilities to rectify any consequences of the rapid consumption of resources, especially when the system dynamics are non-linear and involve abrupt, large-scale changes (Meadows et al. 2004, Gerst et al. 2014).

If we assume that the links between ecological, social and economic systems are close, separating the compartments in policy development will likely miss relevant aspects of system dynamics. The preferred way forward to achieve comprehensive sustainability therefore should be to address the requirements for the prolonged functioning and the resilience of these coupled systems simultaneously (Liu et al. 2007, de Groot et al. 2010, Lang et al. 2012).

The philosophical foundation for sustainability thinking in European tradition is related to the 'Golden Rule' which calls for ethical behaviour on the grounds that 'one should do unto others as one would have others do unto oneself' (King 2008). It has parallels also in Japanese philosophical traditions that stress the connectedness between human beings and their physical environment (Mayeda 2006). Extending this approach to future generations requires consideration of the long-term consequences that decisions made today may have over considerable time spans (Jonas 1979, Allenby 2006). Because the actual development of complex systems like ecological, social and economic systems is largely unpredictable, estimating future effects of feedback cycles that are invariably set in motion by any decisions made today involves uncertainties (Gunderson and Holling 2001, Shiroyama et al. 2012). These uncertainties can diminish the influence of recommendations that are based on analyses of models designed to simulate the behaviour of ecological or socio-economic systems (Reuter et al. 2011, McNeill et al. 2014). Nevertheless, increasing amounts of evidence concerning the realized outcome of past decisions across political and economic sectors are becoming available, and these have been combined with improved techniques for scenario development and modelling to anticipate possible future trends (Henrichs et al. 2010, Britz et al. 2011, Harfoot et al. 2014).

Such approaches involving projections of future trends have been publicized in a number of reports on the relationship between humans and their natural environment over the past decades (Meadows et al. 1972, World Commission on Environment and Development (WCED) 1987, Millennium Ecosystem Assessment 2005, IPCC 2007, SCBD 2010, TEEB 2010, SCBD 2014). These reports have initiated debates on the use of land and natural resources, and they have resulted in scientific and political activities to identify the causes of environmental problems and to find options for mitigating them. Many commentaries, however, have been critical of the projections and of the conclusions drawn concerning necessary political action. The 1972 report on 'The Limits to Growth' (Meadows et al. 1972), for example, was criticized for having been too pessimistic in its projections of resource availability and resource consumption, mainly because technological progress has seemingly left the assumptions on which the projections were based invalid. However, the authors of 'The Limits to Growth' pointed out in their follow-up edition in 2004 that (a) the projections were not predictions of what would happen, but rather depictions of possible trajectories that are internally consistent under the limitations of the simplified system structures incorporated in the simulation model, (b) the projections of variables like world population and per capita grain production were remarkably accurate and (c) the main point of the study, to state and make accessible the idea of resource limitations and their implications for policies and governance systems, is still relevant (Meadows et al. 2004, Abdu et al. 2013). The debate following the publication of the reports has triggered the development of political agreements, institutions and legislation aiming to promote sustainability. The Multilateral Environmental Agreements of the United Nations – e.g. the Ramsar Convention, the Framework Convention on Climate Change and the Convention on Biological Diversity – now constitute an international framework for activities to improve sustainability at regional, national and local levels.

There have been calls to also consider the value and the rights of nature per se, as it has been customary in indigenous and local knowledge systems. However, the reasoning behind the sustainability approach has mostly centered on the need to maintain human well-being (Cronin and Kennedy 1997, Suzuki and McDonnell 1997, Thaman et al. 2013). Politically relevant sustainability concepts in Germany and in Japan are mostly anthropocentric, although discussions on intrinsic rights of 'nature' have taken place repeatedly, and the idea of a general responsibility of human societies for non-human life is an important motivation for the environmental movement in both countries (Kato and Nagao 1990). There have also been suggestions that perceptions of nature and the relationship between humans and nature differ between oriental and occidental cultures (Fukasawa 1989, Kuroda 1991, Ueda et al. 2012). These aspects will be picked up again in the discussion of the development of cultural landscapes in Germany and Japan.

Key components of anthropocentric sustainability concepts

Three fundamental aspects are necessary components of the idea of sustainability when analyzing it from an anthropocentric point of view: it requires (a) the assumption that essential resources for human existence may be limited, (b) the assumption that a particular range of states of environmental, social and economic conditions is preferable over others, and (c) the assumption that humans living now will be followed by other humans who will have equal rights to use resources. The first assumption implies that choices we make now concerning the use of resources will have an impact on resource availability in the future, and that this will determine to a certain extent the choices that humans will be able to make then. The second assumption implies that there is consensus about what is a desirable way of living, to be preferred over alternative options. This is often not the case, with expectations concerning the standard of living and the value systems concerning material and immaterial goods diverging widely among different groups within society (Shiroyama et al. 2012). The third assumption also has implications that may be controversial. Given that the future is uncertain, it is impossible to prove beyond doubt that humans will exist in the future, and that those living now have to take their potential needs into account (Jonas 1979). Sustainability concepts thus are always constructed based on assumptions that are not necessarily self-evident and are likely to be questioned. However, basic consensus about such concepts can usually be reached among people who accept that physical limits set boundaries to what can be achieved by technological development (Gerst et al. 2014). Furthermore, experience throughout human history shows that shortage of essential resources (food, clothing, shelter, social relationships) is common, and that shortages impose stress on individuals and groups (Diamond 1997, Beck and Sieber 2010). The conclusion then is usually that it is adequate to apply the precautionary principle and avoid actions that may aggravate resource shortages now or in the future (Jonas 1979, Ostrom et al. 1999, Bräuer 2003).

Sustainability concepts and land use

Consensus-building concerning anthropocentric sustainability concepts at abstract, theoretical levels is usually successful because trade-offs between different sustainability goals do not have to be addressed in detail. General agreement can often be reached on which dynamics of socio-ecological systems are desirable and which should be avoided. Applying these concepts at local scales where the majority of decisions by land managers and consumers are made adds the challenge of detailed trade-off analyses. In open socio-ecological systems where benefits and burdens related to particular choices can be decoupled, decision-makers can potentially be unaware of negative consequences of their actions, or they can deliberately ignore these externalities. If, in the interest of sustainable choices, decisions are to be based on comprehensive trade-off analyses, major efforts have to be made to establish the necessary knowledge base. It encompasses quantitative analyses of the impacts of resource consumption on land use and associated consequences for biodiversity (including genetic information, species and ecosystems) and ecosystem services.

To provide a starting point for the discussion of trade-offs and synergies among biodiversity components and ecosystem services in relation to land use decisions, we provide a brief overview of the development of cultural landscapes in Japan and Germany. We summarize recent trends that alter the structure and use of these landscapes, and we evaluate these trends from the viewpoint of sustainability. We further investigate how the implementation steps for the conservation and sustainable use of biodiversity required under the United Nations Convention on Biological Diversity (CBD) have been carried out in Germany and Japan. The CBD has the broadest thematic approach among the UN Multilateral Environmental Agreements and offers a unifying framework for policy development. We assume that fundamental human needs for food, shelter and social relationships are the same in both countries and discuss the way sustainability concepts are dealt with in relation to differences in the natural environment, philosophical traditions and social and political norms.

Cultural landscapes in Germany and Japan

The historic development of human influence on ecosystems shows similarities between Germany and Japan in spite of distinct climatic and topographical differences. Agricultural societies started developing during the Neolithic, which in Japan corresponds to the Jomon Period (ca. 14000 BP – 2300 BP), and typical patterns of land use were established that included settlements, arable fields, meadows and pastures, orchards and coppice woodlands as well as forests. Although there is debate over the timing of these developments, there is general consensus that subsistence agriculture had become the predominant food source by the Bronze Age in Europe and by the Yayoi Period (ca. 2300 – 1700 BP) in Japan (Crawford 2011, Bollongino et al. 2013). The most obvious difference between the cultural landscapes of Japan and Germany is rice cultivation that has provided the staple food for the Japanese population over two millennia in all regions where climatic conditions allow rice plants to grow (Fig. 2). Irrigation and drainage systems including reservoirs and channels are also standard elements of most of the Japanese rice production landscapes (Ichinose 2007). In many cases the topography of slopes was altered to create terraces so that the area of rice paddies could be extended (Fukasawa 1989, Washitani 2011). In marginal areas where summer temperatures were too low or geographical and soil conditions prevented the creation of paddy fields, buckwheat was a common crop (Shu et al. 2013). For this type of land use, parallels can be found in some areas in Germany as well, in particular on peat soils (Wieckowska et al. 2012). For such traditional rural landscapes the term 'satoyama' was coined in Japan, sometimes being used with a narrow meaning relating in particular to the coppice woodlands, and the term 'satochi' referring to the other landscape elements closer to the settlement (Takeuchi et al. 2003).

Nowadays, 'satoyama' is often used with a broader meaning, including all parts of the traditional rural landscape in Japan, and since 2010 the term has been popularized also outside Japan through the Satoyama Initiative (Ministry of the Environment Japan 2010, Washitani 2011). In order to explain the meaning of 'satoyama' in the context of the international Satoyama Initiative, the descriptive term 'socio-ecological production landscape' was created. A comparable term to 'satoyama' does not exist in the German language, but certain elements of traditional land use systems have particular names that are often restricted to certain geographical areas, e.g. 'Hauberg' for coppice woodlands or 'Streuwiese' for meadows that were mown not to obtain fodder for livestock but rather as litter to produce manure (Ellenberg 1996, Hotes 2008).

In Japan as in Germany, traditional cultural landscapes have received growing attention because of their rapid decline over the second half of the 20th century, driven by socio-economic trends leading either to abandonment or to land use intensification. As their original economic role largely disappeared, the former management regimes ceased, and the anthropogenic ecosystem types with their plant and animal communities were greatly reduced (Washitani 2001, Takeuchi et al. 2003). In marginal areas, the losses were mostly caused by abandonment and subsequent vegetation succession or afforestation, whereas agricultural intensification and conversion to urban land use types have been the main pressures in areas suitable for large-scale industrial farming or close to urban centers (Billeter et al. 2008, Maes et al. 2012, Yoshioka 2013). Agricultural intensification in Europe was also driven by policies for the international competitiveness of the agricultural sector, for low consumer prices and for food security (Temme and Verburg 2011). In Japan, postwar policies also aimed at productivity gains and mechanization of agriculture. The net effect of these trends has changed German and Japanese landscapes in similar ways, with urban and forest cover increasing, while the area of arable fields and grasslands tends to decline (Kadoya and Washitani 2011, Bieling et al. 2013). In addition to concerns over species conservation in relation to these trends, preventing the loss of traditional knowledge and culture is also a motivation for maintaining traditional rural landscapes (Watanabe and Washitani 2006).

Over the past few years, in particular since the sharp increase in prices for agricultural commodities in 2007/2008 and changes in energy policy including moves towards wider use of biofuels, intensification of land use has become a prominent issue both in agriculture and forestry (Smith et al. 2010, Britz and Delzeit 2013), although cessation of agricultural use and forest management is still a continuing trend in marginal areas. These trends are likely driven by the same external influences, i.e. global market forces, in Germany and Japan, without many direct links between the two countries. However, there are relevant factors where direct interactions between events and trends in one country exert influence on decisions made in the other. A recent example is the policy change in the German energy sector that accelerated due to the triple disaster in Japan with earthquake, tsunami and nuclear accident in March 2011. Links between Japan and Germany concerning environmental policies were also discussed in the 1980s, when technical measures to reduce pollution problems started yielding positive results in Japan, and it was suggested that German policy-makers might use some of the Japanese approaches as a blueprint for successful implementation of safeguards for environmental health (Tsuru and Weidner 1985). In relation to biodiversity-centered policies and administrative practice, German examples have been analyzed as potentially useful for developing the corresponding tools and methodologies in Japan (Ichinose et al. 2001). Because of the similarities e.g. in some economic characteristics, rates of technological innovation and demographic trends it seems likely that approaches to sustainable land management can profit from information exchange between Japan and Germany (Fig. 3).

Fig. 2 Cultural landscape in Japan (Toyooka City, Hyogo Prefecture, Honshu) with paddy fields in the valleys, surrounded by forested hills. This is a common land use pattern across the Japanese Archipelago, but land management practices have changed considerably over the past decades. Demographic and economic drivers are expected to keep putting pressure on traditional satoyama landscapes (photo: Stefan Hotes, October 2007).

The traditional land use systems that developed in Japan since the Yayoi Period have recently been re-evaluated from the perspective of sustainability, and they have been described as an exemplary approach to sustainable land and resource management. Namely the close functional coupling of different land use types within satoyama landscapes that were originally linked through water and nutrient management has been suggested as a basis for long-term sustainability (Watanabe 2011). The historical links between urban centers and surrounding rural landscapes in the context of waste management – in particular the trading systems for human faeces that were valued as fertilizer – have also received attention (Howell 2013).

Fig. 3 Production of plants for generating energy is becoming a prominent feature in German cultural landscapes. This involves risks and opportunities for biodiversity conservation and balancing trade-offs between provisioning, regulating and cultural ecosystem services. Japanese-German research group visiting a field with perennial herbaceous plants that are expected to improve the situation for wild fauna and flora as well as increase erosion control and soil carbon content compared to conventional maize production. Wetterau region, Hesse, central Germany (photo: Stefan Hotes, September 2013).

The triple disaster in 2011 with earthquake, tsunami and nuclear accident impacts has led to further debates over suitable responses to the forces of nature that regularly affect communities in Japan. Because engineering techniques that had been favoured over the past decades were insufficient to prevent widespread damage, stronger reliance on disaster prevention through the functions that natural ecosystems can perform has been called for (Washitani 2012), and the experiences gained with 'green infrastructure' in past centuries have been suggested as a valuable source of information that can support current planning needs for water management and flood protection in the reconstruction process (Ichinose 2012). Traditional land use systems in Germany are not commonly perceived in such a positive way or are discussed as a model for future sustainable land use, although there is a considerable movement towards the preservation of traditional landscapes both for species conservation and for the maintenance of regional cultural traditions (Blackbourn 2006, Hotes 2008, Bieling et al. 2010, Völkl et al. 2010).

Conceptual framework for sustainable use of cultural landscapes

Cultural landscapes fulfill multiple functions that can be synergistic, but often compete with one another or are even mutually exclusive (Waldhardt et al. 2010, Setälä et al. 2013). For example, maximization of agricultural yields using intensive tillage and high inputs of synthetic fertilizers and pesticides, often including alteration of landscape structures to facilitate mechanization of production techniques, regularly leads to biodiversity loss, reduction in soil fertility and loss of recreational values (de Vries et al. 2013, Hernandez-Morcillo et al. 2013). The conflict between profit maximization (or, from a farmer's perspective, rather the struggle to manage his business against natural and economic risks) and nature conservation has been an issue for a long time (Flade et al. 2003, Amano 2009, Kadoya et al. 2009). However, comprehensive assessments that address the full range of wanted and of undesirable effects of such land use systems have rarely been carried out, and knowledge about possible feedbacks between ecological dynamics and social or economic variables is still fragmentary (Stoate et al. 2009). Nevertheless, ecological knowledge about abiotic processes and biotic interactions in cultural landscapes has expanded, so that we are getting into a position to describe more general patterns that can be used to inform inter- and transdisciplinary analyses (Billeter et al. 2008, Amano et al. 2011, de Vries et al. 2013). Increasing demand for such analyses is coming from policy-makers and also businesses that are becoming aware of the need to take environmental risks into account when making decisions. The motivation for investigating socioeconomic effects of biodiversity change e.g. in connection with soil fertility or control of pests and pathogens is partly due to the expectation that ecological processes will become more relevant under scenarios of declining availability of fossil energy sources that have facilitated the extraordinary agricultural productivity increases in the second half of the 20th century (OECD/FAO 2012, van Vuuren et al. 2012). These feedbacks have not yet been integrated effectively in economic accounting both at farm and regional levels, but in order to achieve sustainable land use it is necessary to quantify them. To provide a unified framework for the analysis of the different landscape functions and to formulate options for sustainable land use that take their synergies and trade-offs into account, the concept of ecosystem services has been proposed (Millennium Ecosystem Assessment 2005, Daily and Matson 2008). This concept builds on the notion that the well-being of human societies ultimately depends on certain levels of ecosystem functioning (Fig. 4). The fundamental idea is to harness economic thinking and make decision-makers aware of the environmental and economic importance of ecosystems. To achieve this, costs of environmental degradation that have so far been externalized need to be integrated in the full economic balance. It is thus analogous to the 'polluter pays' principle that has been introduced primarily to control industrial emissions (Mauerhofer et al. 2013). Once a realistic picture of the full environmental costs is integrated in the price of products or in the evaluation of alternative plans for land use, construction projects etc., environmentally friendly products or plans should in theory get a competitive advantage over those that put a greater burden on ecosystems (TEEB 2010, Boisvert et al. 2013, Alvarado-Quesada et al. 2014). They should therefore succeed based on market mechanisms even without additional regulations or incentives (Köck 2010).

The ecosystem service concept has been criticized for being an anthropocentric approach that is basically utilitarian, ignoring the intrinsic value of nature and all its unique entities, be it individual organisms, species or ecosystems. The debate over ethical aspects and the real danger of missing the goal of sustainability if nature is subjected to economic valuation only is far from over, but there are strong initiatives promoting the basic idea of the ecosystem service concept while working on its weaknesses (Admiraal et al. 2013, Baker et al. 2013). A growing number of projects have applied the ecosystem service concept in environmental assessments, and it has been proven to be a useful tool to engage a wide range of stakeholders in discussions about sustainable use of natural resources (Seppelt et al. 2011, Seppelt et al. 2012). Whether it can deliver on the expectations of actually balancing human needs and wishes for material and immaterial fulfilment with the capacity of ecosystems to generate food, raw materials and energy sources, to regulate biogeochemical processes and biotic interactions, to be a place for recreation and to sustain the various capacities over time still needs to be assessed.

Similar to the definition of sustainability, the framework of ecosystem services is straightforward at a general, abstract level, but it is difficult to define and quantify in any given geographical and socio-economic setting. The reasons for this are both technical and philosophical. There is currently no widely accepted method for quantifying and valuing ecosystem services, which is due to different

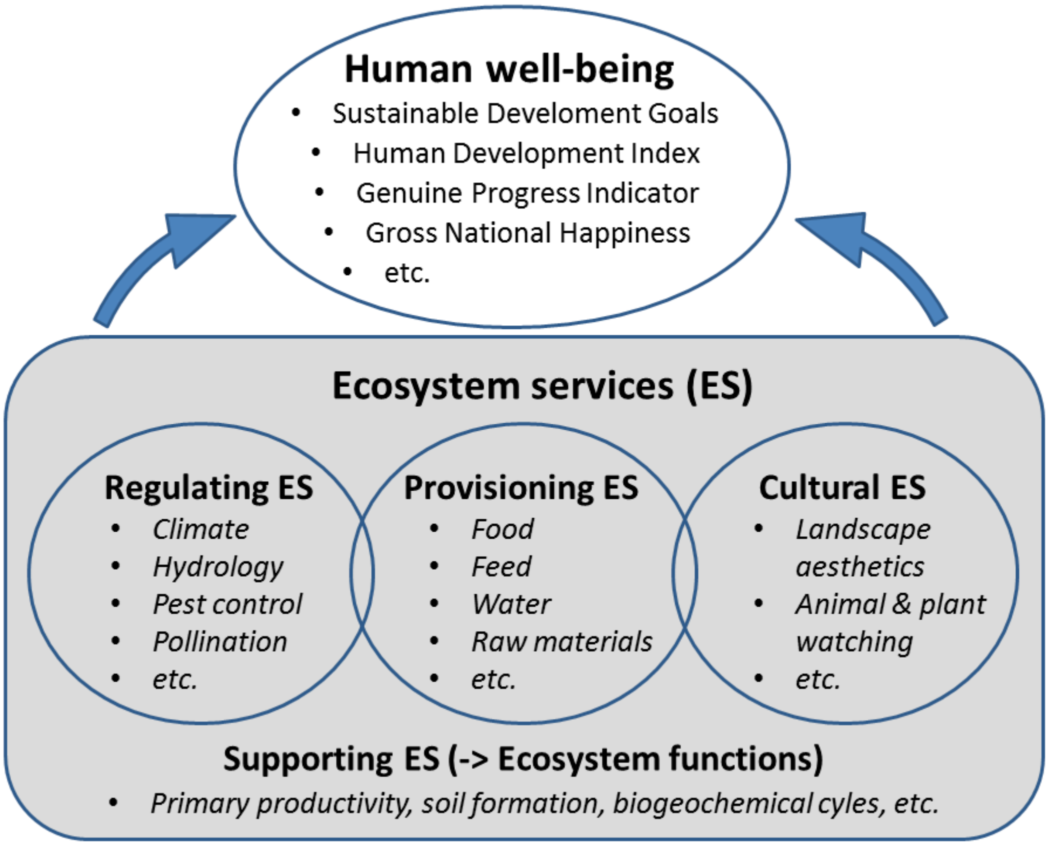

Fig. 4 Ecosystem services and human well-being. Ecosystem services include all processes occurring in and products/services provided by ecosystems that are considered beneficial for humans, irrespective of whether these ecosystems are managed or not. Supporting ecosystem services have also been termed 'intermediate ecosystem services' on the basis that they don't provide direct benefits for humans, but are a prerequisite for the other, 'final' ecosystem services. They are often separated from ecosystem services and classified as ecosystem functions. The latter are not interpreted in relation to benefits for humans.

perceptions of ecosystems and to different views on the position of humans in the context of socio-ecological systems (Chee 2004, Wallace 2007, Barrios et al. 2013). Critical technical problems are often a lack of data – comprehensive information on socio-economic variables as well as ecological characteristics is required for a comprehensive analysis, but it is rarely available –, insufficient knowledge about the quantitative relationships between different variables, and issues concerning the conversion of variables to units that make them comparable. This includes the conversion of biophysical measurement units (for regulating, provisioning and supporting ecosystem services) and of units for mental or emotional well-being (for cultural ecosystem services) to monetary values, in cases where monetary valuation is the goal (Kontogianni et al. 2010). For the evaluation of the sustainability of ecosystem service provision, projections into the future are necessary, but the complexity of the interlinked systems prevents reliable projections of many processes into the future (Henrichs et al. 2010).

Implementing sustainability concepts in land management and land use planning

Sustainability has been the underlying concept in all schemes developed for preventing or mitigating environmental degradation or for restoring degraded ecosystems. To implement the goal of sustainability, tools and mechanisms for adjusting the pathway of socio-ecological systems are needed. Such mechanisms can be based either on prohibition or prescription of certain actions through laws or administrative orders, or they can be based on incentive schemes or on disincentives (e.g. taxes). All these tools have been used in various ways both in Germany and Japan (Tsuru and Weidner 1985, Ichinose et al. 2001, Köck 2010, Miyamoto 2013). Early legislation for nature conservation in Germany and in Japan developed at the end of the 19th and the beginning of the 20th century when the concept of natural monuments ('Naturdenkmal' or '天然記念物', 'tennenkinenbutsu') was introduced (Kato 1984, Stiftung Naturschutzgeschichte 2003, Frohn and Schmoll 2006). Although considerable effort was put into using this concept for conservation, it was not always successful in the long term, and it was hard to apply in cases where ecosystems could not be maintained by just assigning legal protection, but rather required regular management or certain types of natural disturbance (Kankyocho Yaseiseibutsu Hogo Gyosei Kenkyukai 1993, Washitani 2012). Nature conservation laws followed in the years before the Second World War in both countries, but they had limited effects during post-war reconstruction and the following phase of rapid economic growth. Further categories of protected areas with different levels of strictness in the respective regulations were introduced, including national, prefectural and municipal parks. Scenic beauty and/or the occurrence of endangered species were key criteria for assigning protected area status. The functional relevance for ecosystem services was either unknown or not valued high.

To obtain systematic overviews of the state of threatened species, communities and habitats, surveys were conducted and red data books published. These trends also applied to Germany and Japan alike, although there was at that time no formal international framework to coordinate the efforts; similar approaches emerged in response to similar pressures (Hotes 1992, 2007).

An international policy framework for sustainable use of ecosystems and biodiversity has taken shape since the 1970s, when the Ramsar Convention on Wetlands (http://www.ramsar.org) was the first of the so-called Multilateral Environmental Agreements (MEAs) that have been developed at the level of the United Nations. At the Earth Summit 1992 in Rio de Janeiro, the Framework Convention on Climate Change (UNFCC; http://unfccc.int), the Convention on Biological Diversity (CBD; http://www.cbd.int/) and Convention to Combat Desertification (UNCCD; http://www.unccd.int) were adopted, significantly extending the range of activities concerning different, but interlinked topics in relation to sustainable land management. These international agreements induced a paradigm shift from traditional conservation approaches to broader, more inclusive approaches that explicitly place humans and their needs into the focus. UNFCC and CBD have taken on particularly prominent roles in the public debate on economic development and environmental management. Germany and Japan were among the first countries to ratify these Conventions, and both countries have played an active role in the development of the Convention agendas. Germany promoted e.g. the valuation of biodiversity and ecosystem services in the context of the CBD through the study 'The Economics of Ecosystems and Biodiversity' (TEEB 2010) and Japan brokered the Kyoto Protocol for the UNFCC and the Aichi Biodiversity Targets (Table 1) and the Nagoya Protocol for the CBD (Harrop 2011, Nicholson et al. 2012).

Table 1 Aichi Biodiversity Targets (http://www.cbd.int/sp/targets/)

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1 By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2 By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3 By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Target 4 By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Table 1 Aichi Biodiversity Targets continued

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use

Target 5 By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6 By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7 By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8 By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9 By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10 By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11 By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12 By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13 By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14 By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15 By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16 By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Table 1 Aichi Biodiversity Targets continued

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building

Target 17 By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18 By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19 By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20 By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Although the Conventions have no mechanism to enforce implementation at the level of member states, and there are no sanctions if targets are missed, committing to the political goals does create a certain pressure on governments to carry out appropriate actions. One of the commitments member states agreed to was to prepare national biodiversity strategies. Japan presented its first national biodiversity strategy as early as 1995 and has produced updates in 2002, 2007, 2010 and 2012 (Ministry of the Environment 2013). In Germany, it took until 2007 to develop the first version (Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU) 2007). The main reason for the long preparation time of the German strategy was reportedly the need for a joint decision-making process by all federal ministries together, which required extensive consultation and discussion. Another aspect is the subsidiarity principle linked to the federal organization of Germany which grants the right to regulate conservation issues primarily to federal states. The federal states therefore also needed to agree to the text of the national biodiversity strategy. By early 2013, six of the 16 federal states had developed their own biodiversity strategies based on the national strategy (Hotes et al. 2013), and as the seventh federal state Hesse also passed a strategy in August 2013.

In Japan, 23 biodiversity strategies existed at the prefectural level and 28 strategies at the municipal level in 2013 (Okuda 2013). Japan has a total of 47 prefectures and 1719 municipalities, indicating that the tool of 'strategies' is primarily used in a top-down manner, and that the local uptake of strategic long-term planning in combination with scenario analyses and biodiversity information is a slow process.

Biodiversity strategies do not have the power of laws or legally binding regulations, but they merely describe what political institutions agreed should happen in order to ensure conservation of biodiversity and its sustainable use. The strategies per se thus can only appeal to their readers to take an interest in sustainable use of biodiversity and ecosystems. To become effective, the provisions of the respective biodiversity strategies have to be considered in all relevant decision-making processes, as outlined in strategic goal A of the Aichi Biodiversity Targets. To achieve this, diverse governance tools are necessary. Takahashi et al. (2012) have summarized response mechanisms that are used to address management issues in cultural landscapes (satoyama) in Japan. The survey was conducted as part of the Japan Satoyama Satoumi Assessment (JSSA). They categorized the responses according to the basic 'Typology of Reponses by Nature of the Intervention' proposed in the Millennium Ecosystem Assessment into legal, economic, social and behavioural, technological and cognitive responses (Chambers et al. 2005). Not all of the lower categories in the MA were used in the Japanese study, and some further subunits not represented in the MA were distinguished; for the purpose of this paper, we extracted those responses that apply to land use (leaving out responses targeting oceans) and are organized at the national or sub-national levels (not counting international frameworks) (Fig. 5). A total of 77 responses were identified, the majority of which were classified as 'domestic environmental regulations' from the area of legal responses. Twenty-seven were not from the environmental sector, but were considered to be relevant for the maintenance of satoyama/satoumi areas (L7). Eighteen other responses belonged to the environmental sector (L6). A further nine responses were placed in the group of 'command-and-control interventions' (L9), giving a total of 54 legal responses. The remaining 23 responses were distributed across the economic, social, technological and knowledge categories.

The key question of how effective and efficient the different responses are in changing drivers of change or alleviating pressures on biodiversity and ecosystem services has been addressed in the Japan Satoyama-Satoumi Assessment, but suitable information or data for this purpose are hardly available (Takahashi et al. 2012). Quantitative assessments require extensive monitoring schemes, and running these professionally is costly. Data sources for biological information on species distribution and abundance often stem from citizen science initiatives, and solving issues of data quality control, spatial and temporal autocorrelation, and proper weighting of explanatory variables in analyses of such data requires special techniques (Aue et al. 2012).

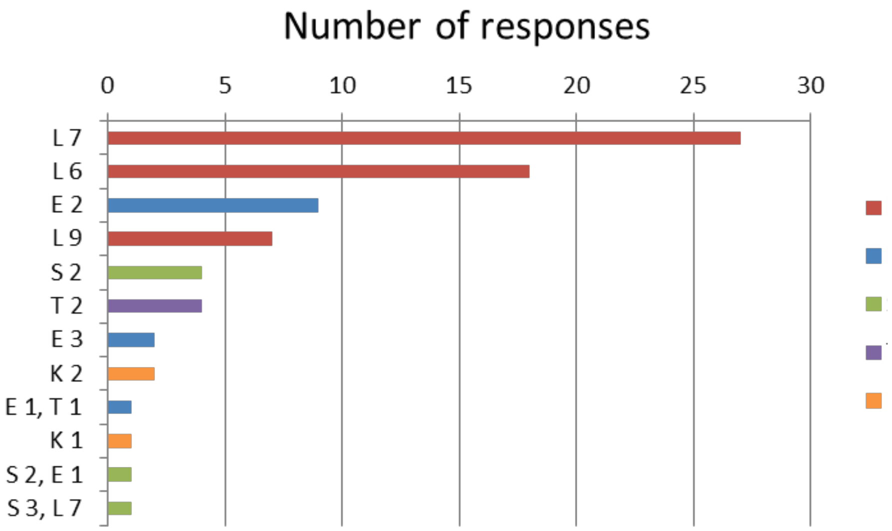

Fig. 5 Number of responses in different response categories to address biodiversity and ecosystem service issues identified in the Japan Satoyama Satoumi Assessment. International responses and responses in marine areas were excluded. L7 Domestic environmental regulations / administrative law not by environmental sector; L6 Domestic environmental regulations; E2 Voluntarism-based responses; L9 Command-and-control interventions; S2 Public education and awareness; T2 Recovery of ecosystem services; E3 Financial / monetary measures; K2 Knowledge acquisition and acceptance (scientific research); E1 Incentive based interventions; T1 Increasing crop yields; K1 Utilization of traditional knowledge; S3 Empowerment of local communities, women and youths (NGOs, NPOs).

Implementing sustainability concepts in decision-making at all relevant scales requires not only regulative measures including laws and ordinances or economic incentives like taxes or payments for ecosystem services, but at a much more basic level the necessity to consider sustainability issues at all needs to be established. Natural sciences aim to provide a quantitative basis for our understanding of sustainability, including the range of physical, chemical and biological conditions under which ecosystems remain in a state that is favourable for human well-being. Economics contribute an additional angle by investigating the efficiency of particular management measures that could be applied in order to keep a socio-ecological system within such a favourable state by comparing the outcome with the necessary input. However, decision-making concerning land and resource use is not solely based on rational considerations of ecosystem dynamics or the efficiency of the use of production factors, but such decisions are also influenced by emotional reactions and pre-existing values. The formation of such values itself depends partly on the information received through various media at different stages during the life of an individual, and the following section investigates how the depiction of traditional rural landscapes in Japanese and German popular culture may be an expression of beliefs about the relationship between humans and their natural environment. A term that was coined to describe the combined emotional, social and ecological relationships between humans and nature in the context of education is 'Ecoliteracy', and the link between this concept and sustainability is discussed.

Sustainability and Ecoliteracy

Ecological literacy, or Ecoliteracy, is a term that was developed in the 1990s to describe a holistic approach to education that expands earlier educational models which focus on the emotional and social intelligence to include ecological intelligence. They "posit emotional, social, and ecological intelligence as essential dimensions of our universal human intelligence that simply expand outward in their focus: from self, to others, to all living systems." They also see these "intelligences" as being "in a dynamic relationship with each other: Cultivate one, and you help to cultivate the others" (Goleman et al. 2012). In the study of visual culture, this involves studying texts (documentaries, films, and other media) to learn what they can teach us about cultural attitudes towards the environment. As a further step, popular texts can also be used not only to teach but to motivate and inspire young people to take a vested interest in green issues.

In Japanese popular culture, depictions of the environment range from the romantic to the post-apocalyptic. The former often exhibits itself as a nostalgia for idealized pre-modern Japanese landscapes (Robertson 1988, Wright 2005, Ono 2008), while the latter theme has deep roots in a country that has historically endured regular catastrophes (earthquakes, tsunami, fires, atomic bombs, -nuclear disaster, et al.) and anticipates more in the future (Napier 2005, Tsutsui and Ito 2006, Iles 2008). The depiction of sustainable landscapes, such as satoyama or satoumi, appeal to deeply rooted mythologies about Japanese national identity and are strongly tied to the indigenous Shintō religion. As such, their popular appeal can lead to the preservation of such landscapes.

One prominent example is the influential early 20th century writer and poet Kenji Miyazawa, Many of Miyazawa's short stories are set in a fictional land called Ihatov (イーハトーブ), which corresponds with real landscapes in Miyazawa's native prefecture of Iwate (Yonechi 1995). The cultural significance of these works, bolstered by their adaptions into popular animated films such as Gauche the Cellist (Isao Takahata, 1983) and Night on the Galactic Railroad (Gisaburo Sugii, 1985), led to Japan's Agency for Cultural Affairs designating several prominent landscapes (Mount Kurakake, Nanatsu Forest, Oi Forest, Tamabuchi Falls, England Coast, Gorin Pass, and Taneyama Plains) Places of Scenic Beauty in 2005.

Satoyama landscapes, in particular, appeal to "the collective nostalgia for an idealised 'pure heart' (magakoro) Japan" (Wright 2005). The most influential film in this regard is Hayao Miyazaki's My Neighbour Totoro (1988). Set in post-war Saitama Prefecture, this anime feature film tells the story of a University of Tokyo professor who moves with his two daughters, Mei and Satsuki, to the countryside while the girls' mother is convalescing in hospital. Their new home is in a typical satoyama landscape, with neighbours tending to their rice paddy fields on one side and forest nestled onto hills on the other. The sisters' fears about their mother's health are allayed by their contact with an imaginary creature called Totoro who lives at the base of a camphor tree, and can only be seen by children.   The relationship between the landscape and the people is depicted as a harmonious one, with great attention paid to realistic details, both visual and aural. While most critics describe the depiction of landscape in My Neighbour Totoro as "idyllic" (Hu 2010), the careful viewer can spot evidence of human impact on the environment, such as garbage in what is otherwise a pristine stream.

The connection that the people have with the land in My Neighbour Totoro takes on a spiritual quality because it is associated with the Shintō religion. When caught in the rain, the girls take shelter in an inari (fox spirit) shrine – common in rural areas because of the fox's association with fertility and a good harvest. The camphor tree where Mei first finds the large Totoro, has a rope. This rope, called shimenawa, indicates the sacredness of the tree in the Shintō religion. With these subtle references to Japan's indigenous religion, writer-director Hayao Miyazaki connects the relationship between Japanese and the satoyama landscape to Shintō spirituality. As Wright notes, in his early films Miyazaki is "concerned with articulating the possibility of a mystical connection between humans and the natural world." She goes on to remark that his "work displays a sense of nostalgia for a time when humans lived more in harmony with nature, but at the same time he refuses to deny the current reality of modernity and industrialisation" (2005).

The enduring popularity of My Neighbour Totoro can partly be attributed to the way in which the film fosters a sense of Heimat, the German term for love and attachment to one's homeland. The Heimat films (Heimatfilme) made in Germany, Austria, and Switzerland in the period between 1946 and 1965 connected happy family and community life to landscapes associated with "home" such as the Alps, the Black Forest, and the Lüneburg Heath (Hake 2002). Like My Neighbour Totoro, films like Grün ist die Heide (The Heath is Green, Hans Deppe, 1951) present idealised depictions of people living in harmony with the landscape and "affords the positive resolution of contemporary social and ideological concerns about territory and identity" (von Moltke 2005).

The satoyama landscape is tied to Heimat, which has parallels in Japanese notions of furusato and kokyō, in that it is tied to deep rooted ideas of home, nostalgia for an idealized past, and national identity. As Miyazaki himself describes in a 1997 interview: "Even though [the Japanese] have become a modern people, we still feel there is a place where we can find a forest full of beautiful greenery and pure running water that is like a dreamscape. And this kind of sensibility, I think, links us to our spirituality. . . Our ethnic character harbors the elemental power of the forest within a precious part of our spirit." As an artist, Miyazaki also recognizes the power of popular culture as a tool for education, explaining in a1998 panel discussion: "Animation is a way to convey the wonder and fascination of the forest to children and to those who do not have theoretical knowledge" (Miyazaki 2008).

In the case of My Neighbour Totoro, the popularity of the film has been channelled into the Totoro Forest Foundation (トトロのふるさと基金). This foundation's mission is to preserve the cultural assets of the Sayama Hills, the inspiration for the satoyama landscapes in the film, and their surrounding environs. Preservation of this area had already begun in the 1970s, but some of the habitat was badly affected by "urban and leisure facility development, destruction of the habitat, through deforestation and illegal dumping". In the 1990s, Hayao Miyazaki and 4 other contributors laid the foundations for the National Trust of Totoro no Furusato, and many fundraising efforts have included the support of artists, such as The Totoro Forest Project (http://totoroforestproject.org/) which featured more than 200 pieces of original art especially created by internationally acclaimed artists in the fields of animation, comic art, illustration, and the fine arts. The foundation has grown to cover an area of 2500 hectares of land in Tokyo and Saitama including woodlands and two reservoirs, Lake Sayama and Lake Tama. The foundation has recorded "1400 species of ferns and other vascular plants, 19 mammals, and over 200 different species of birds have been identified. In addition, 2500 species of insects, as well as frogs, snakes, and salamanders. . . call this satoyama home." (http://www.totoro.or.jp/english.html).

The educational aspect of popular media has in this case been used successfully to promote conservation of traditional cultural landscapes and to protect them from conversion to housing and industrial development, which is a continuing trend in areas close to urban centres (Tsunekawa 2003, Luo et al. 2014). However, maintenance of cultural landscapes requires continuous management, and preventing development is only a first step that needs to be followed by other appropriate measures for keeping characteristic land use patterns (Onodera et al. 2007). The last section summarizes some of the key points of discussion concerning the options for managing cultural landscapes under changing socio-economic and environmental conditions.

Overcoming the environmentalist's paradox

In Germany and in Japan, the dominant paradigm for societal progress and improvement of human well-being has been based on the idea of permanent economic growth, and this approach continues to the present day (Abdu et al. 2013, OECD 2013). According to standard indicators of prosperity and well-being like the Gross Domestic Product (GDP) or the Human Development Index (HDI), people in both countries have enjoyed favourable living conditions for several decades in spite of occasional economic downturns. Overcoming the 'environmentalist's paradox' in Germany and Japan thus requires that loss of biological diversity and ecosystem services are recognized as serious problems, and it requires that effective policy tools are developed to address them. As outlined above, recognition of the significance of biodiversity loss and the threat that environmental degradation poses to human well-being date back over decades or even centuries, and a number of responses have been developed. However, recent reports on status and trends of biodiversity have documented that the efforts have not yet been successful on a broad scale (Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (BMU) 2010, Duraiappah et al. 2012).

In their analysis of the Environmentalist's Paradox, Raudsepp-Hearne et al. (2010) conclude that the reason for the apparent discrepancy between ecological degradation and improvement of human well-being is not due to incorrect measurement of well-being. They suggest that three alternative explanations may be relevant: (1) human well-being is most closely linked to provisioning services, in particular food production, which has increased in general over the past decades; (2) technological development has decoupled human well-being from natural processes; (3) the current increase in well-being comes at a cost in the future, because time lags in the response of ecosystems to anthropogenic pressure mean that the levels of resource consumption can only be maintained for a certain period after which negative consequences occur.

Defining measures that can help achieve a holistic approach to sustainability (Fig. 1) will therefore involve methods to quantify regulating and cultural ecosystem services in addition to provisioning services, methods to estimate the full environmental implications of any type of technology and to take into account processes that occur over long time periods.

Initiatives using the ecosystem service concept, e.g. the study on 'The Economics of Ecosystems and Biodiversity' (TEEB 2010) or the new Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Hotes and Opgenoorth 2014) aim to make the 'value' of ecosystems and biodiversity visible, including regulating and cultural services. However, 'value' expressed in biophysical or monetary terms usually has considerable uncertainty attached to it, and the limitations of scenarios and models exacerbate the uncertainty of projections into the future. Application of the precautionary principle has been called for in order to achieve decisions that are likely to be sustainable under conditions of imperfect knowledge and stochastic behaviour of systems (Bräuer 2003, Matsuda et al. 2005). Furthermore, taking into account the observation that human decision-making is usually not entirely governed by rational, systematic consideration of advantages and disadvantages of certain choices, the emotional and intuitive level of human behaviour also needs to be addressed. Public perceptions of nature involving nostalgia, romanticism or realism as expressed in arts and media are an important aspect of this approach.

In order to coordinate the collection, processing and dissemination of relevant information on ecological, economic and social systems for the purpose of more sustainability-oriented decision-making, new types of institutions that catalyze such processes are necessary (Costanza 1996, Thomas et al. 2012). Their primary role will be to help identify opportunities for action that is likely to improve sustainability of socio-ecological systems. Because of the need to work across boundaries between scientific disciplines and to engage effectively with academic and non-academic stakeholders, such new institutions will have to be placed at the interface between these groups. At the level of the United Nations, the Intergovernmental Panel on Climate Change was established in 1988 as the first of these new institutions. Its reports have had considerable impact on public debates on human-induced climate change (Nakicenovic and Swart 2000, IPCC 2007, 2014). Following extensive debates in scientific and political circles, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established in 2012 to carry out similar tasks for the topics of biological diversity and the benefits that humans receive from nature (Larigauderie and Mooney 2010, Perrings et al. 2011). The IPBES is now taking preparatory steps for producing regional and sub-regional assessments of biodiversity and ecosystem services and to collate a global assessment based on these in 2018 (Hotes and Opgenoorth 2014). The challenges involved in this endeavour are likely to exceed those of the climate-related assessments, because the number of entities to be considered is much larger than in the case of greenhouse gases. Furthermore, different types of knowledge ranging from scientific to indigenous and local knowledge have to be brought together and assessed in a common framework, because the experience with certain land use options has to complement ideas derived from theoretical systems understanding. Considerations of temporal and spatial scales are also crucial in order to estimate the consequences of decisions for different stakeholders. The relevance and actual impact of policy advice that is based on integrated assessments will depend on how well the advice is received by the intended audiences, and this will depend on how tangible the output is for individuals at scales on which they operate personally (Mouri et al. 2013). It is encouraging to see that there are increasing efforts to translate the knowledge of socio-ecological systems into policies for sustainable land management that take biodiversity and ecosystem services into account (Furusawa et al. 2013, Nomura et al. 2013) and to integrate ecosystem services in a planning context. Continued research on the results of policies and management measures will be a prerequisite for adaptive land use schemes.

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