Concepts and perceptions of land degradation and restoration

Book Section

CHAPTER **2**

CONCEPTS AND PERCEPTIONS OF LAND DEGRADATION AND RESTORATION

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EXECUTIVE SUMMARY

When dominant or mainstream perceptions and concepts have an undesired impact on nature and its contributions to people, promoting alternative perceptions and concepts may transform practices towards more desired impacts *(established but incomplete)*. Individual perceptions of the surrounding world are organized into concepts that vary depending on the knowledge, norms, values and beliefs of the community to which an individual belongs **(Figure 2.1)**. These perceptions and concepts influence the way a society builds its own reality and acts on it (*well established*) {2.1, 2.2.1.2}. The dominant worldviews of a given society or community can affect, positively or negatively, nature and nature's contributions to people {2.2.2, 2.2.3, 2.2.4}. To achieve Sustainable Development Goal 15.3 of a land degradation neutral world, a shift in worldviews in necessary: from one where land degradation is seen as collateral damage or an externality of desired development, to one where land degradation to achieve development is unacceptable {2.2.1.5, 2.3.3}.

Sustainable development is based on three pillars: social, environmental and economic. In its implementation, however, economic growth is often considered as the overarching driver of social and environmental progress *(well established)*. Land degradation is sometimes perceived as a result of underdevelopment, while the impacts of development on land degradation tend to be disregarded (e.g., public policies supporting export crops or huge infrastructures) **{Box 2.4}**. For example, in 2012, 26 out of 40 Agenda 21 targets were "far from being reached" and six were in recession {2.2.4}. Among the six were "fighting global climate change" and "changing consumption patterns" {2.2.4}. Development and economic activity can also cause negative externalities and degradation {2.2.1.5}. A successful example of creating disincentives for negative externalities is the "polluter pays principle" {2.2.1.5}. Widening the scope of this principle to make it more broadly applicable to land degradation might be considered.

People are often uninformed about the undesirable environmental impacts of goods and commodities *(well established)*. Raising awareness on how individual consumption choices can have unintended consequences in distant locations is a necessity (*well established*) {2.2.1.3}. Marketing disinformation about environmental impacts is a rule, not an exception {2.2.3.3, 2.3.2, 2.3.1.3, 2.3.1.4}. Trade competition externalizes social-environmental impacts to lower the prices {2.2.1.5, 2.2.3}. Internalizing the environmental costs of staple, clothes and other goods would raise public awareness, create a strong demand for low-impact products and promote more equity between people in developed and developing countries {2.2.1.5, 2.2.2.3}. Farmers and agribusiness corporations have a major role to play in inventing products and practices reflecting people's expectation for low footprint agriculture (2.2.3).

When land degradation affects cultural diversity and its associated biodiversity, not only are unique social-ecological systems threatened, but society also risks losing the local cultural knowledge that can inspire more sustainable practices *(well established)*. The pervasive absorption or loss of traditional knowledge and management systems, which have proven sustainable over decades or centuries, affects cultural, biological, agricultural diversity and ecosystem services {2.2.2.1}. Land and water degradation in or around traditional territories is mainly caused by external population pressure and development programmes such as dams or monoculture {2.2.2.3, 2.3.1.1}. The precarious situation of many indigenous and local people, and their knowledge systems, is an environmental as well as a social issue. Indigenous and local practices and values are embedded in worldviews and can provide alternatives to mainstream practices. For example, indigenous and local value that link the "good life" or "Buen Vivir" {2.2.2.1} to a fulfilling social life in a non-degraded environment point to more sustainable pathways through new worldviews, such as the expansion of traditional and/or agroecological practices along with new conscious consumption patterns. These have already been adopted by growing segments of civil society around the world and could be further promoted {2.3.1.2, 2.3.2.1}.

High and rising population numbers in many parts of the world pose profound challenges for environmental sustainability in both developed and developing countries *(well established)*. While human demography is predominantly seen as a matter of

poverty and underdevelopment to be dealt with by increasing food production, it is nonetheless a crucial but tabooed environmental issue *(unresolved)*. Successful closing of the transnational development gap and eradication of the difference in per capita consumption highlights the importance of the population size. Thus, the focus on reducing consumption might be extended to embrace an inclusive demographic policy. In 1972, the declaration of Stockholm acknowledged the environmental problems caused by overpopulation and stated that countries should control their demography without affecting basic human rights. Soon after Stockholm, however, the population problem was deemed a social and educational problem, and was addressed as an underdevelopment issue. Measures to curb population growth are available and can deliver significant and lasting environmental and social benefits. These include improved access to education, family planning and gender equality (*well established*), and improved access to social welfare to support ageing populations (*established but incomplete*). The role of subsidies that may be further stimulating population growth in more developed nations should also come under scrutiny as one of the measures to curb population growth {2.2.4.2, 2.3.1.4}.

The short-term financial costs of restoration are easy to quantify and may seem high, while the short-, medium-, and long-term effects of restoration on nature's contributions to people are less easy to perceive and value *(well established)*. The benefits of avoiding and reversing land degradation are undeniable and go beyond monetary valuation (*well established*). Raising awareness of the multiple benefits of both avoiding land degradation and restoring ecosystems might justify raising the resources to achieve restoration and land degradation neutrality targets. Moreover, a more holistic approach to nature's contributions to people could embrace and meet the expectations of a part of the civil society with knowledge systems that place social-ecological harmony above other considerations. While economic valuation of ecosystem services is common, many of the nature's contributions to people have no market prices {2.2.1.3, 2.2.1.5} and are therefore undervalued, if valued at all. This practice diminishes not only the economic, but also the multiple non-monetary and intrinsic values associated with nature and nature's contributions to people, be it spiritual, cultural or ethical {2.2.2.1, 2.3.1.2}. In addition, the concrete benefits of restoration might take longer to be achieved, while the costs of restoration are rather immediate {2.2.1.3, 2.3.1}. Costs and benefits of degrading or restoring can be defined in monetary terms {2.2.1.5}, but the question is multidimensional and includes the imperative to maintain biological and cultural diversity {2.2.2.1}. Benefits will be underestimated when the concept of "good quality of life" is limited to purchasing power (*well established*) {2.2.4.3, 2.3.2, 2.3.2.2}. These benefits would be easier to perceive if the dominant systems of value focused on the good quality of life with individuals having a fulfilling social life in a non-degraded environment {2.2.2.1, 2.3}.

The international community has recognized that a collapse of ecosystem functions would not be restrained by sovereign national borders. However, decisions to address urgent environmental problems are still guided by the incremental and discretionary jurisprudence of international conventions *(well established)*. Since the 1970s, international environmental law has been constantly developed and enriched to account for both the progress of science and environmental degradation. Nonetheless, global ecological deterioration, including climate change, is continuing (*well established*). Creating a proactive, new ground for international negotiation could be a first step to facilitate reversing land degradation, from which new jurisprudence could arise. This would include overcoming the old "environment versus development" dilemma and foster cooperation policies motivated by a common interest {2.2.4.1}. "Ecological solidarity" is a promising legal principle, which could renew the perception of the links between humans and their environment {2.2.4.3}. This principle embraces three dimensions: it recognizes the planetary interconnectedness of ecosystems and ecological process {2.2.1.3}; it may foster intergovernmental negotiations based on global and mutual solidarity; and it has a fundamental moral meaning emphasizing the common fate of humankind and all living beings {2.3.1.2}. If human progress was understood through these dimensions, efforts to prevent land degradation and to restore degraded land might be facilitated.

A global consensus on the definition and baseline for land degradation does not exist (well established), precluding sound scientific assessment of the extent and severity of global degradation, as well as the possibility of measuring success towards quantitative restoration targets such as Aichi Biodiversity Target 15 reinforced in Sustainable Development Goal 15 *(established but incomplete)*. Quantifying land degradation and its reversal through restoration requires assessment of the geographic extent and severity of damage at the current and restored state of the ecosystem, against a baseline (*well established*) {2.2.1.1}. Lack of consensus over baselines has led to debates over what constitutes degradation and subsequently to inconsistent estimates of the extent and severity of land degradation {2.2.1.2} **(Figure 2.5, Figure 2.7, Figure 2.8)**. This, in its turn, resulted in differing interpretations of the consequences of degradation for human well-being. To overcome this challenge, a shared global baseline could be adopted (*well established*) and a good candidate would be the natural state of ecosystems, deviation from which would be degradation {2.2.1.1} **(Figure 2.5)** (*established but incomplete*). Adopting natural state of ecosystems as the baseline against which to measure the extent and severity of degradation ensures a comparable assessment of land degradation in general, and a fair assessment of success in meeting the Aichi Biodiversity Targets across countries at different stages of economic and social development. Without this, more developed countries – that have transformed much of their environment centuries ago – are able, in practice, to assume much less ambitious restoration measures than less developed countries {2.2.1.1} **(Figure 2.5)**. For the aspiration to achieve land degradation neutrality by 2030, as agreed in SDG 15.3, the baseline for assessing success is different, namely the state of the ecosystems at 2030.

2.1 INTRODUCTION

Diverse perceptions, concepts and worldviews serve to shape one's affinity to the land. This affinity is generally shared by the society to which an individual belongs. Because societies are diverse, arriving at consensus about the state of land degradation and the need for restoration is never easy, especially when restoration does not create immediate economic profit. Summarizing the viewpoints of even a small range of stakeholders highlights the complexity of the perceptions and concepts that influence the practice of decision-making.

The purpose of Chapter 2 is to examine the concepts used by different stakeholders, assess how perceptions and concepts lead to degradation and suggest changes in policy that could help avoid degradation and facilitate restoration.

There are two ways to define concepts. The first is concepts as tools, to understand and organize the world. The second is concepts as social constructs, whose importance, validity and use vary across time and space. For instance, the concept of "race" was crucial in the nineteenth century to understand human variability, and led to scientific racism and colonization. Hence, the way a concept is understood and used can have a strong impact on social organization, geopolitics and environmental management.

This chapter, as other chapters in this assessment, was written by both natural and social scientists. Social sciences such as history, philosophy, legal or political science or anthropology do not obey the same regime of proof as natural sciences, such as ecology, biology or genetics. Many social facts and representations – including worldviews – cannot be quantified as "well established". Only a qualitative approach, then, can underline their importance and validity.

2.1.1 Organization of the chapter

Following the scoping document accepted by the Plenary of IPBES at its third session (IPBES-3) in January 2015, this chapter follows the structure as outlined in the scoping document (Annex VIII to decision IPBES-3/1) and consists of two main parts.

Section 2.2 is dedicated to perceptions, concepts and approaches to land degradation and restoration from different stakeholders' points of view. Cross-disciplinary concepts are explored throughout this section, such as the use of baseline as a tool to assess degradation and evaluate restoration success, and perceptions of these concepts by scientists, jurists, indigenous and local peoples, NGO managers, conventional farmers, agribusiness actors and decision-makers.

Section 2.3 explains why the impacts of land degradation on nature's contributions to people and human well-being are frequently difficult to perceive and how this can affect the decision-making process. We provide an overview of several obstacles to people's awareness, including "fuzzy concepts", but also underline people's collective reaction and eagerness to be involved in the development of environmental policing. We then examine how, in spite of these obstacles, awareness-raising may elicit public reactions, especially when policymakers' reaction appears to be too slow in the eyes of other stakeholders. The capacity of civil society (including NGOs) to propose alternative policies or practices is a powerful instrument to contribute to decisions at all political scales. It is also the main reason for being optimistic about our capacity, as citizens and human beings, to avoid and reverse environmental degradation.

2.1.2 What do we mean by perceptions, concepts, and worldviews?

In this section, we are not only dealing with facts, but also with cognitive (i.e., mental) processes that feed into worldviews, and specifically how these worldviews have affected and still affect current land degradation. Worldviews are reflected in practices and more generally in day-to-day attitudes and actions. Hence, a global effort to avoid or mitigate land degradation and to rehabilitate and restore degraded lands can be fostered by considering other worldviews and the related concepts and perceptions. We adopt a four-step explanation process to be as clear as possible in this chapter:

1. Presentation of definitions of reality, perceptions, concepts, worldviews and human well-being.
2. An illustration of cognitive processes as embedded in worldviews and reality **(Figure 2.1)**.

3. A practical illustration of these cognitive processes, through a very simple example of divergence among actors' perceptions **(Figure 2.2)**.
4. The IPBES Conceptual Framework and how this chapter is embedded into it **(Figure 2.3)**.

2.1.2.1 Definitions for the purpose of this chapter

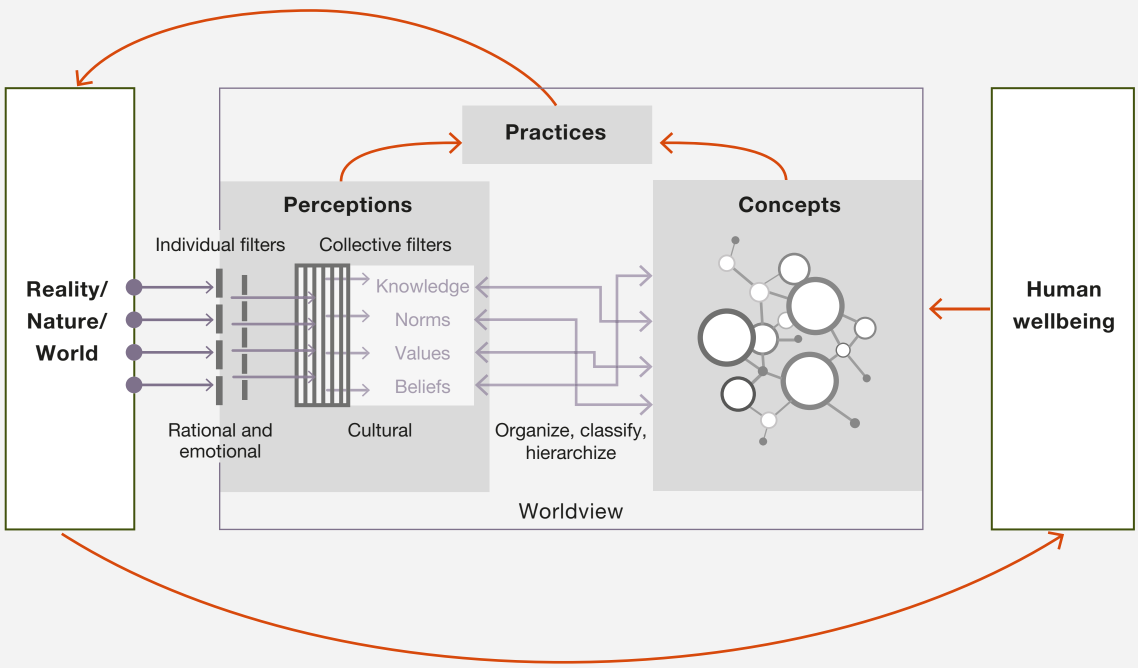
The cognitive processes synthesized in **Figure 2.1** are based on Damasio (1994), Laplane (2005), Norman (1988), and Pinker (1999). For the purpose of this chapter, the "reality" we refer to is the current state of biodiversity and ecosystem functions independent of human knowledge and perceptions and ecosystem services ("nature" in IPBES conceptual framework, **Figure 2.3**). Hereafter we will use "nature" as synonymous with this reality. Dealing with perceptions and concepts means that the focus is on what is perceived by humans about nature and nature's contributions to people. This human-centred view has been adopted at the second session of IPBES Plenary (IPBES-2).

Perceptions are the first stage of the human cognitive process. We can see a global picture of the reality, but we perceive what we focus on. What we see results from a neurological processing of the stimuli in our environment, while our perceptions are not neutral as they pass through rational and emotional filters which assess and interpret the relevance of what we see. These filters are conditioned by individual experience, education and by collective worldviews (Dickman *et al.*, 2013).

Concepts are defined as the second stage of the cognitive process. Perceptions are selected, organized, classified and hierarchized into concepts. This process is influenced by collective filters which are human systems of values, norms and beliefs. Concepts do not come alone, but as integrated networks. This is the reason why there is often a mismatch between environmental risk assessments, scientific alerts and pre-existing categories and beliefs in public opinion (Fischhoff *et al.*, 1992; Wallner *et al.*, 2003).

Worldviews are defined by the connections between networks of concepts and systems of knowledge, values, norms and beliefs. Individual worldviews are moulded by the community the person belongs to, which also applies to the scientific community. This is what we mean by a collective filter. To give a very simplified example, a Catholic will assign to a cross a symbolic dimension while a Siberian shaman will perceive it as a mere geometrical form. Practices are embedded in worldviews and are intrinsically part of them (e.g., through rituals, institutional regimes, social organization, but also in environmental policies, in development choices, etc.).

Figure 2 1 **A conceptual illustration about how perceptions and concepts are articulated and how they interact with reality ("world" or "nature").**



Human well-being (see Glossary) will be here considered in its relation with ecosystem services (Agarwala *et al.*, 2014). Land degradation and restoration have a direct and indirect influence on the quality of life and on human well-being. Once acknowledged, these impacts may modify perceptions, reorder concepts, change worldviews and thus foster new policies and practices.

Perceptions can be used as instruments to reorient policies by creating new concepts about land degradation and restoration and how they affect human well-being. Can we change priorities or increase awareness so that perceptions correspond to reality and evolve accordingly? The goal is to formulate different approaches to land degradation and restoration to minimize environmental impacts, which will have a more positive effect on human well-being for all members of society.

Figure 2 2 **Practical illustration of how seeing the same reality leads to different perceptions embedded in different sets of concepts.**

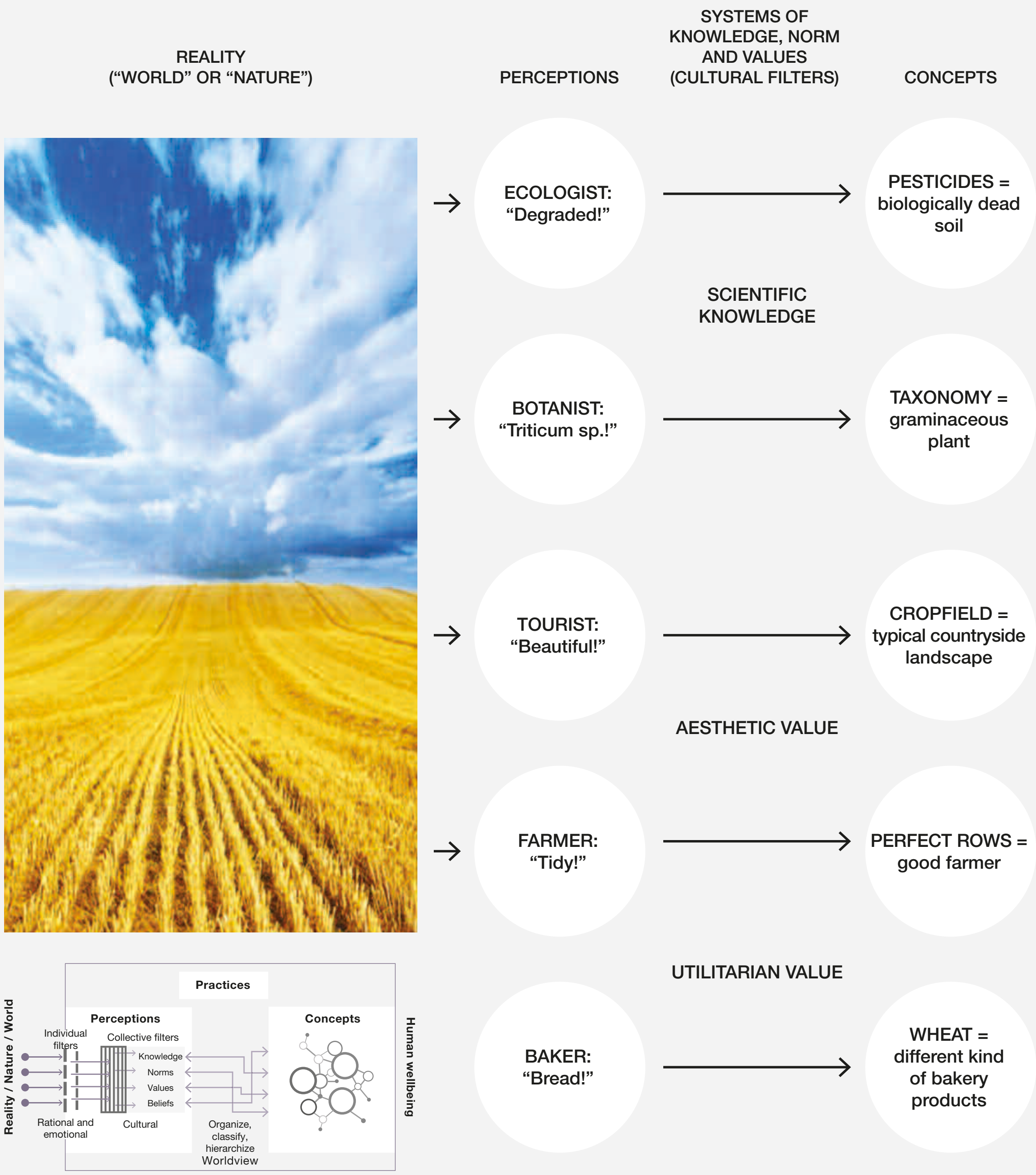
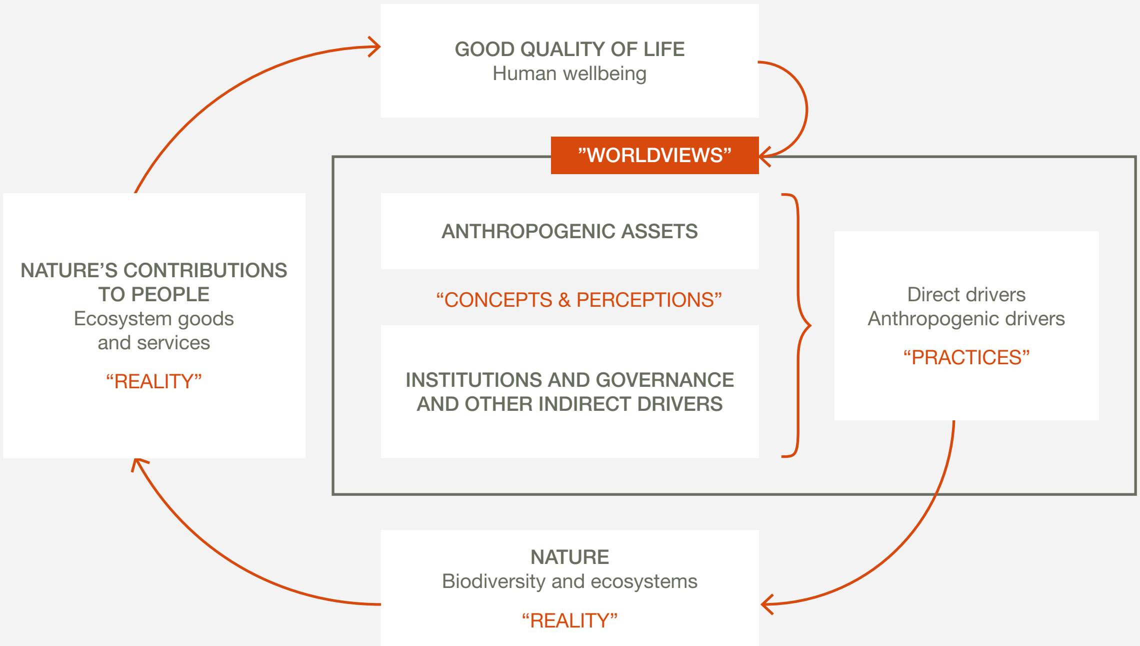


Figure 2 3 Chapter 2 (in red) as included in IPBES Conceptual Framework. Source: Modified from Díaz *et al.* (2015).



2.2 PERCEIVING AND CONCEPTUALIZING THE REALITY OF LAND DEGRADATION AND OPPORTUNITIES FOR RESTORATION

Vogt *et al.* (2011) identified several groups of actors that have different needs in terms of type and frequency of information related to land degradation and different capability for response: (i) the policymakers organized at different spatial scales (e.g., local, national, supra-national, global); (ii) land owners, users and managers (i.e., those interacting directly with the land and responding to the policies defined by the first group); (iii) the scientific community that both needs and produces information; (iv) the development community and NGOs, particularly in the case of desertification; (v) society at large, which relies on information for financial and public/political support; and (vi) the media, which translates and distributes the information to other groups. It is thus crucial to properly assess and understand the role and responsibilities of each of those different groups if deep changes in societal efforts – to avoid or mitigate land degradation and to rehabilitate and restore degraded lands – are to be successful (Vogt *et al.*, 2011).

This subchapter discusses the concepts and perceptions by grouping the six sets of actors above into four broader stakeholder groups: (i) scientists and jurists; (ii) indigenous groups and local populations; (iii) farmers and agribusiness companies; and (iv) decision makers, from national to international levels (civil society as a stakeholder and an actor will be considered in Section 2.3). In 2.2.1, we focus on the most important concepts developed by scientists to assess the status and responses of biodiversity and ecosystem functions and services to degradation and restoration processes. At the same time, Section 2.2.1 also attempts to show how the law and economics perceive and address these concepts by turning them into legal principles.

2.2.1 Ecological knowledge to assess degradation, facilitate restoration and inform legal and economical responses

The goal of the natural sciences is primarily to describe and understand the environment we live in and how people affect that environment, while the focus of humanities and social sciences is more on human societies, including their interactions with the environment (Sessions, 1987). The scientific approach, unlike others, is based on: observable, testable and measurable facts; evidence; transparency of the data and results; the peer-reviewed process; and is open to contradiction and further investigation, thanks to the accessibility of the data. In this section, we identify the most important concepts that natural scientists use to assess the status and responses of biodiversity and ecosystem functions and services. It should be noted that scientific concepts evolve with time, some of them appearing or disappearing according to the context and their practical value. For instance, "ecosystem services", which appeared in the 1980s, is widely used today (Chaudhary *et al.*, 2015). Science is a dynamic process and perpetually creates conceptual tools adapted to new or newly discovered realities (Kuhn, 1962).

We also consider how law and economics perceive these scientific concepts and discuss the most important additional concepts that these disciplines recognize and use. This is important because law and economics, among other social sciences, have offered central support to the analysis and formulation of land-use policies and instruments. Regarding their purposes, they can be a driver of land degradation (see Chapter 3) and a response to enhance restoration measures (see Chapter 6). This section attempts to demonstrate a gap between ecological concepts and their legal translation, which may lead to the perception that the land is not degraded.

2.2.1.1 The significance of baselines in assessing degradation and restoration

For the assessment at hand, the definitions of degraded land and restoration were provided by the IPBES Plenary (IPBES, 2015) and are fully described in Chapter 1 (based on Annex VIII to decision IPBES-3/1). Here we recap the essential sections of the definitions to aid understanding of the below discussion. "Degraded land" is defined as the state of land which results from the persistent decline or loss in biodiversity and ecosystem functions and services that cannot fully recover unaided within decadal time scales. "Restoration" is defined as any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state. "Rehabilitation" is used to refer to restoration activities that may fall short of fully restoring the biotic community to its pre-degradation state. Taken together these definitions mean that the concept of restoration refers to interventions whose intended outcome is full recovery of the ecosystem to its pre-degradation state, while rehabilitation has the intended outcome of partial recovery of the ecosystem. Inability to recover unaided is caused by: (i) crossing an ecological tipping point to a new state or regime, such that the ecosystem is unable to recover on its own within decadal time scales (see Chapter 4, Section 4.1.2); or (ii) business-as-usual land-use management that prevents an ecosystem from recovering unless aided by an alteration or cessation of the management.

Based on these definitions, any ecosystem that has experienced loss in biodiversity or ecosystem functions and services is considered degraded, provided it cannot fully recover unaided within decadal time scales. To understand if the "unaided" and "decadal" criteria can be met even from the perspective of biodiversity alone, a mechanistic understanding of succession and species community assembly processes is needed. There are only four mechanisms that can influence community composition as a result of community assembly processes: selection, drift, dispersal and speciation (Chase, 2010; Chase & Myers, 2011; Elo *et al.*, 2016; Gilbert & Lechowicz, 2004; Hubbell, 2001; Kahilainen *et al.*, 2014; Tuomisto *et al.*, 2003; Vellend, 2010). Unfortunately, assessing ecosystem degradation and recovery at the global scale, with a level of detail needed for the mechanistic understanding, is not feasible. Moreover, this only concerns biodiversity and community composition; the recovery of ecosystem functions or ecosystem services must be understood at the same level of detail (see also Skidmore & Pettorelli, 2015). Thus, degraded land might be better understood simply as land that has experienced a decline or loss of biodiversity and ecosystem functions and services – without a reference to the ability of the land to recover unaided (within decadal time scales). In this definition, the pre-degradation natural state can be understood as the state of land prior to the decline or loss of biodiversity or ecosystem functions and services. It is worth noting that regardless of the definition of degradation, one needs to be explicit regarding whether one is talking about degradation in terms of loss of biodiversity, loss of ecosystem function and/or loss of ecosystem services as there can be trade-offs amongst them (e.g. Bennett *et al.*, 2009; McShane *et al.*, 2011; Schröter *et al.*, 2014; Spake *et al.*, 2017).

Since the IPBES Plenary, at its third session (IPBES, 2015), adopted the use of pre-degradation state in the definitions of restoration and rehabilitation, the above definition of the pre-degradation state is an important guiding principle. In general, to obtain a genuine estimate of the magnitude of damage or recovery, the choice of a reference frame or a baseline is of critical importance (Bull *et al.*, 2014; Kotiaho *et al.*, 2016a, 2016b; McDonald-Madden *et al.*, 2009; Prince, 2016; UNEP, 2003) (See also Chapter 4, Section 4.1.2).

While in practice it appears to be difficult to reach an agreement on a perfect pre-degradation reference state or a baseline against which the degree of damage should be compared, in theory, we can come close to one (Kotiaho *et al.*, 2016a). The question of "how much damage has humankind caused on ecosystems?" contains an inherent, natural baseline, which is the state in which there was no damage caused by humankind (i.e., the pre-degradation state). This question should not be confused with the question about whether humans are part of nature or not (Haila *et al.*, 1997; Hunter, 1996), as we are one species among others. Rather, it is about our desire to restore the ecosystems we have damaged, as has been firmly established in a number of international conventions. The selected reference state or baseline will always influence the assessment of the magnitude of damage (see also Section 2.2.1.2) and this becomes vitally important when we set quantitative targets for restoration – such as the Aichi Biodiversity Target 15 that aims to restore at least 15% of degraded ecosystems globally, by 2020 (CBD, 2011; Kotiaho, 2015; Kotiaho *et al.*, 2016a, 2016b; Kotiaho & Moilanen, 2015).

When considering the quantitative restoration target it is worth noting that degradation has at least two dimensions: the extent of area that has been degraded and the magnitude or severity of degradation (or loss of condition) within that area (Kotiaho *et al.*, 2015; Kotiaho & Moilanen, 2015; Nkonya *et al.*, 2016). In addition, currently well over 50% of natural terrestrial ecosystems have been transformed to other ecosystems (Ellis *et al.*, 2010; Hooke & Martín-Duque, 2012; Houghton, 1994; Vitousek *et al.*, 1997). Transformation of natural ecosystems causes loss of ecosystem area and is degradation from the perspective of the original natural ecosystem **(Figure 2.4)**. The impact of degradation on biodiversity, ecosystem functions and nature's contributions to people are very different for ecosystems with little loss of condition compared with those where condition has severely declined or been transformed.

For the purpose of assessing anthropogenic ecosystem degradation, an obvious reference is the natural state without any human modification. Establishing the natural state for an ecosystem is challenging and some of the approaches are described in **Box 2.1**. Despite the challenges, when the goal is to estimate global and regional magnitudes of degradation, like in the current IPBES work programme, global geographic variation in the timing of economic and social development, and ecosystem degradation, makes a strong case for the adoption of the natural state baseline as a reference. To illustrate the point, let us consider the state of ecosystems in some recent past as a baseline. If we assess degradation against a recent time-bound baseline (e.g., 1950 in **Figure 2.5**), developed countries will show low degradation since they degraded much of their land before 1950. On the

Figure 2 4 **Land degradation can occur either through a loss of biodiversity, ecosystem functions or services, without a change in land cover class or use (1), or by the transformation to a derived ecosystem type such as the conversion of natural cover to a crop field (2), delivering a different spectrum of benefits, but also typically involving loss of biodiversity and reduction of some ecosystem functions and services.**

The transformed ecosystem can also be degraded with respect to the new societal expectations associated with that land use (3). Degraded natural ecosystems can also be transformed to another ecosystem (4), or restored towards their original natural state, either completely or partially ("rehabilitated") (5). Degraded transformed ecosystems can be rehabilitated towards a less degraded state, with respect to the expectation for a deliberately modified landscape (6). Both degraded and undegraded transformed lands can, under many circumstances, be restored or rehabilitated towards their original natural state (7 and 8). Success in achieving the aspirational goal of land degradation neutrality by 2030 in Sustainable Development Goal 15 may be measured based on whether biodiversity, ecosystem functions and services are stable or increasing in each of the focal ecosystems compared to their state in 2015.

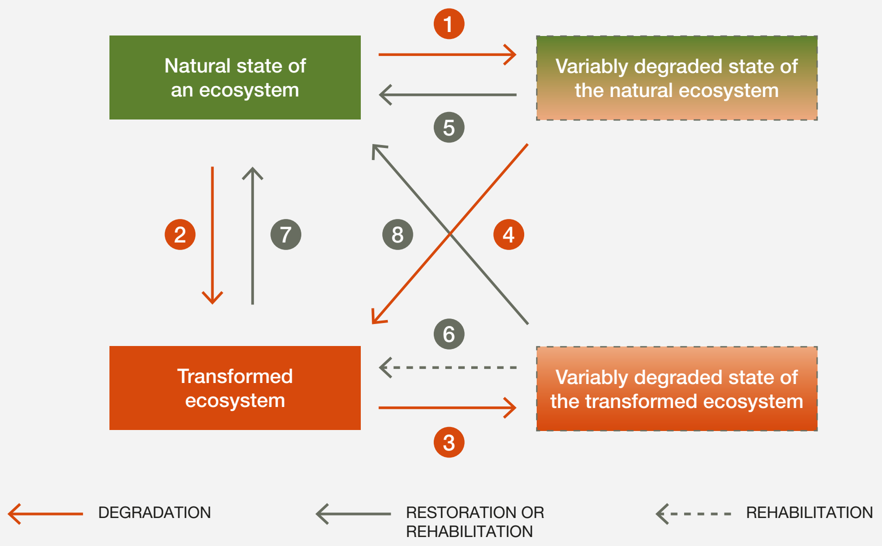
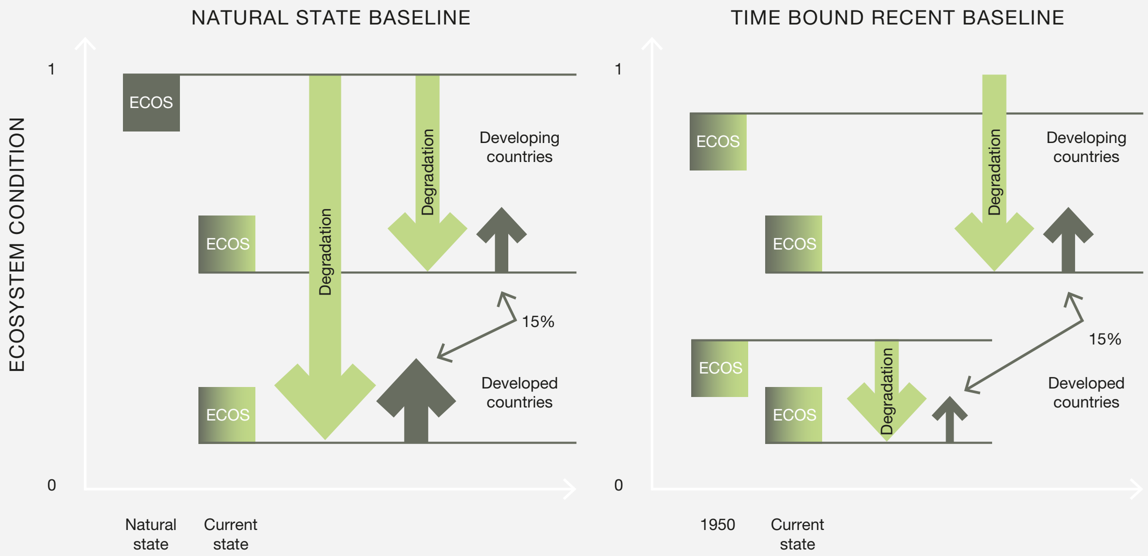


Figure 2 5 **How the choice of a baseline influences the effort required to reach the Aichi Biodiversity Target 15 of restoring 15% of degraded ecosystems in developing and developed countries.**

Magnitude of ecosystem degradation is the difference between the current state and the baseline (green downward arrows). On the left, the current state of ecosystems is compared to the natural state baseline and the magnitude of degradation and thus restoration effort (grey upward arrows) required from the developed countries is greater compared to the developing countries. On the right, a recent 1950 time-bound baseline is used. Due to different timing of development, and thus degradation, the restoration effort required from developed countries is less compared to the developing countries.



other hand, developing countries will show high degradation since they started to transform their environment more recently. In this case, the 15% restoration target for developed countries will require less restoration than the same target for developing countries, and thus is not equitable. By contrast, the concept of natural state baseline is independent from variations in the time of development of countries, and therefore it will provide a fair baseline for comparisons among countries at different stages of socio-economic development. When using natural state baseline, absolute degradation is reported to be greater in the most developed countries and smaller in the least developed countries, and the 15% restoration target for developed countries fairly involves more actual restoration than the same target for developing countries **(Figure 2.5)**. It is worth mentioning that to achieve land degradation neutrality by 2030 as aspired in SDG 15.3, the baseline for assessing success is different – namely, the state of the ecosystems at 2030.

Ecosystem services are not a biological phenomenon, but they are, by definition, the ecosystem attributes that humans value (MA, 2005b), and that trade-offs between them and biodiversity exist (McShane *et al.*, 2011; Schröter *et al.*, 2014; Spake *et al.*, 2017). Anthropogenic decrease or increase of the service may cause degradation of the ecosystem and therefore, while securing valuable ecosystem services, care must be taken to avoid levels of degradation which may compromise biodiversity, ecosystem functions or less valued ecosystem services (Bennett *et al.*, 2009).

Finally, the pre-degradation natural state baseline should not be confused with the goal or target of restoration or rehabilitation. A pre-degradation state baseline is necessary for assessing the magnitude of damage, and while the target should be directed towards the pre-degradation state baseline, the pre-degradation state itself need not be the target. In practice, the target will often be only partial rehabilitation towards the pre-degradation state (see also Kotiaho *et al.*, 2015, 2016a, 2016b).

It is worth noting however, that arguments have been put forward that interventions may aim at replacement of the natural state ecosystem with a different system (Bradshaw, 1984). Today replacements are called novel ecosystems (Hobbs *et al.*, 2006; Hobbs *et al.*, 2009, 2013). However, interventions that aim at replacement, or novel ecosystems, should not be regarded as restoration or rehabilitation *sensu* IPBES (IPBES, 2015). Instead, this debated concept (e.g. Hobbs *et al.*, 2014; Murcia *et al.*, 2014) should be referred to as maintaining, and sometimes fostering, of alterations which nevertheless have resulted in self-sustained ecosystems (Hobbs *et al.*, 2009; Perring *et al.*, 2013).

Box 2 1 Approaches to baselines and targets.

This Box enlarges on Box 1.1 in Chapter 1, and further information can also be found in Chapter 4, Section 4.1.2. A reference or baseline is essential to detect and assess the magnitude and direction of degradation (Prince, 2016; UNEP, 2003). Thus, an unambiguous implementation of the concepts of land degradation and restoration requires asking "degraded relative to what?" and "restored towards what?" Furthermore, both degradation and restoration refer to change over time and establishing the magnitude of change requires information at two or more times, or by inference, between two or more places thought to be initially the same (see Section 2.2.1.4).

There is no perfect reference state or baseline for all purposes, but allowing free selection of a reference state increases the possibility of deliberate bias and arguments. Nevertheless, for the purpose of assessing anthropogenic ecosystem degradation, an obvious reference is the natural state without any human modification. Establishing natural state for an ecosystem is challenging but there are at least two approaches that can be used, **time bound** and **counterfactual** natural state. Other reference states that have been used include various time bound **historical** baselines. Finally, while a reference is necessary for assessing the magnitude of degradation, it should not be confused with a **target**. Targets are always a matter of political choice – weighing societal, economic and ecological interests – and will vary case by case (Kotiaho *et al.*, 2016a). For further discussion about baselines and targets see main text in Section 2.2.1.1.

1. Time bound natural state baseline

Natural state can be understood as the ecosystem condition before degradation by human activities – that could be some time in the Holocene, ≤10,000 yr BP. This seems to be an obvious baseline from which to assess degradation and recovery, since it is before any human modification, but it is riddled with practical and theoretical issues. Practically, it is rare to find data from such distant past that includes all the variables needed to draw a comparison with current ecosystem conditions (Broothaerts *et al.*, 2014; Hoffmann, Erkens *et al.*, 2009; Vanacker *et al.*, 2014). There are also at least two conceptual challenges with the time bound natural state baseline. First, the climate and other biophysical environmental conditions have changed in the intervening time (from the baseline to present day) and it is difficult to disentangle the effect of anthropogenic degradation from natural environmental change (Bennion *et al.*, 2011). The second challenge arises from the fact that some degree of disturbance by humans is part of the evolutionary history of many current organisms, and such potentially cascading ecological changes are challenging to identify or take into account (Jackson & Hobbs, 2009).

2. Counterfactual natural state baseline

Another perhaps more operational approach for establishing the natural state baseline is the use of counterfactual thinking. In psychology, counterfactual thinking is a mental representation of alternatives to past events and it can be characterized by the phrase "what might have been" (Byrne, 2007; Epstude & Roese, 2008; Roese & Olson, 1997). Thinking about alternatives to our own pasts is central to human thinking and emotion (Epstude & Roese, 2008; Sanna *et al.*, 2003; Summerville & Roese, 2008; Wheeler & Miyake, 1992) and common across nations and cultures (Au, 1983; Gilovich *et al.*, 1985). Therefore, it may be a globally functional and understandable approach for establishing the natural state baseline for an assessment of the magnitude of degradation in a given ecosystem.

By asking what the environment would have looked like in the absence of the intervention or development, counterfactual thinking can be used and has been used in environmental impact scenario-modelling and in environmental impact evaluations for establishing references for the current state (Caplow *et al.*, 2011; Davis *et al.*, 2011; Ferraro, 2009). Although the approach has been rare in the environmental literature (Ferraro, 2009), the number of cases where it has been successfully applied to questions relevant to land degradation and restoration is increasing (e.g., Andam *et al.*, 2008; Joppa & Pfaff, 2011; Kotiaho *et al.*, 2016b; Robinson *et al.*, 2014; Urama, 2005). For example, Andam *et al.* (2008) estimated the effectiveness of conservation areas of Costa Rica, in preventing deforestation, by finding an answer to the question: how much more forest would have been cleared if the protected areas had not been established? In another example, Kotiaho *et al.* (2015, 2016b) assessed the magnitude of degradation across all terrestrial ecosystems of Finland by comparing the current state of the ecosystems to the state that would have existed had humans not disturbed the ecosystems. In the latter case, the counterfactual state is the natural state and functioned as the natural state baseline for measuring anthropogenic ecosystem degradation. The counterfactual natural state baseline does not suffer from the natural change challenge, but the availability of data or expertise can still be an issue. In addition, a method known as space-for-time substitution (Johnson & Miyanishi, 2008; Pickett *et al.*, 1998) or process-based modelling (Bowker *et al.*, 2006) can provide a reference approximating the time independent natural state (see Section 2.2.1.4).

3. Time bound historical baselines

Unlike a natural state baseline, time bound historical baselines may have suffered some degradation and thus provide underestimates of actual degradation. On the other hand, when the more recent past is chosen as the historical baseline, more data is available. Various historical baselines are used for trend studies (e.g. Bakker *et al.*, 1996; Keith *et al.*, 2013), however, they often suffer from arbitrary starting dates which makes comparisons difficult.

More recent historical baselines are useful for detecting contemporary past and future trends in biodiversity, ecosystem functions and nature's contributions to people – in particular, when we are interested in impacts of policy or management changes, such as the land degradation neutrality target of the

Sustainable Development Goal 15, for which the baseline will be the state of the ecosystems in 2030. Assessing deviations from the natural state would function equally well for this purpose, but as stated above, an estimated "natural state" can be more laborious to establish.

A distinct discontinuity exists in the degree and type of disturbance around the onset of the modern era, about two-three centuries ago around 1750-1850. This "pre-modern Holocene", before the "great acceleration" reference state, is not easily manipulated and many examples show it to be implementable, though not without its challenges (e.g. Bennion *et al.*, 2011; Jenkins *et al.*, 1990; Keith *et al.*, 2013; Naudts *et al.*, 2016). The same challenges as with the time bound natural state exist, but are generally not as problematic.

4. Target

A target is the desired state – in this case, for the purposes of restoration. A reference or baseline is needed to assess the magnitude of degradation and should ultimately be based on scientific research, while the target is based on a deliberate choice and is therefore context dependent. The target may change over time and will certainly vary from place to place. The target state need not be universal, unless so agreed. It is perhaps the most important of the states for policy purposes, since it represents the future and thus a state whose achievement can be influenced by policy.

A target state of an ecosystem can be derived from the perspective of biodiversity (as is most often the case in ecological restoration) or it can be considered from the perspective of nature's contributions to people or ecosystem services. Nature's contributions to people (or ecosystem services) are goods and services valued by human beings. They are a measure of human preference, which is similar to the "utilitarian" concept of the Millennium Ecosystem Assessment (MA, 2005a).

The concept of baseline in the law

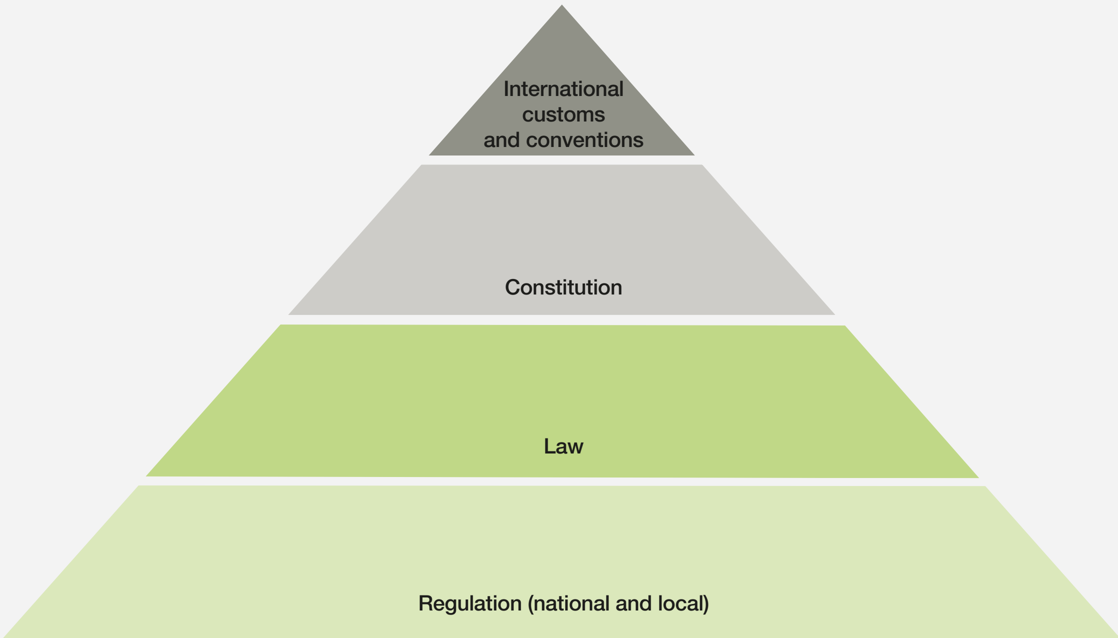
The concept of baseline is central also to the law, as impacts and damages are estimated relative to a reference state. Judges need a baseline to quantify the compensation measures and the law usually provides a definition of the baseline. This baseline can either converge or diverge from its ecological definition, even though ecological concepts are more and more integrated into environmental law (Naim-Gesbert, 1999) and tend to guide restoration and rehabilitation measures.

For example, in the European environmental liability regime, the "baseline condition" is the condition of the land immediately prior to the observed degradation, based on the best information available (Directive on Environmental Liability, 2004). In law, the baseline condition is often simultaneously the target of restoration after damage, which makes it different from the assessment and restoration of land degradation discussed above.

According to Kelsen (1960), a "hierarchy of norms" **(Figure 2.6)** organizes the legal order. It is designed by order of importance. Considering states' organization, the value of international law varies, but generally, international public law constitutes the supreme legal order insofar as the Constitution is modified to adapt to new international treaties. Consequently, if a definition of a baseline condition was given by an international convention, it could be ratified and integrated in national legal orders by the state parties.

Another interesting tool dealing with the concept of baseline is the Environmental Impact Assessment (EIA). It describes a "process that produces a written statement to be used to guide decision making" (Sands & Peel, 2012) and is meant to determine the state of ecosystems before plans, programmes or projects. In this context, unlike **Box 2.1**, the baseline will be the target of rehabilitation measures once the activity stops. In this chapter, we do not mention the several functions of Environmental Impact Assessment as a tool, but we question its ability to mitigate land degradation and facilitate restoration. Indeed, the written statements of Environmental Impact Assessment rely on the perception of their authors and on the control made by public authorities. Hence, the main question is "what is being assessed?". As many forms of land degradation are not perceived by the law as degradation *sensu stricto*, most of the impacts on land are not considered in these assessments. In other words, if the law does not perceive the land as degraded, there cannot be a legal obligation to restore (Boer & Hannam, 2004; Wyatt, 2008). Our point here is to demonstrate that a common understanding of land degradation in international environmental law, for national impacts and transboundary impacts, would guide the elaboration of Environmental Impact Assessment, acknowledging that it is also an international tool (e.g., Nordic Environmental Protection Convention of 1974), although many of the conventions that mention it are non-binding (e.g., Principle 17 of Rio Declaration of 1992) (Castillo & Bian, 2014). However, the definition of the concept of land degradation in an international convention would have to overcome a severe obstacle made by the International Court of Justice. In the Pulp Mills case (Argentina v. Uruguay, 2010) the Court stated that international law does not "specify the scope and content of an Environmental Impact Assessment and that it is for each state to determine in its domestic legislation or in the

Figure 2 6 **The hierarchy of norms in internal legal orders. Source: Kelsen (1960).**



authorization process for the project, the specific content of the Environmental Impact Assessment required in each case" (Johnstone, 2014).

With regards to waste management, industrial activities or polluted sites, legal frameworks and regulations aim to remediate (see glossary) contaminated or impacted land to levels where introduced contaminants do not impact the future use of the land in question (Layard, 2004; Carella & Chiappini, 1995; Jahiel, 1998; Mu *et al.*, 2014; Seerden & Deketelaere, 2000). This perspective is generally considered unambitious on its own as the objective is not ecological restoration (Billet, 2014; Brandon, 2013; Lambert, 2014; Zhao & Zhang, 2013). Furthermore, operation of controls by sworn agents on the exploitation sites needs to be enforced (Bryant & Akers, 1999; Cho, 1999; Mu *et al.*, 2014). Belgian law is particularly interesting in this aspect, because Wallonia, the Flemish Region, and Brussel's Region have separately adopted very detailed regulations that set standards of remediation. The remediation standards are the strictest for "green" forms of land use (e.g., nature and woodland) and the most tolerant for industrial uses of land (e.g., industrial area, area for waste disposal). However, for groundwater the law carries a harmonized remediation standard (see also Conference of the European Union Forum of Judges for the Environment, 2009).

Finally, the impacts which cannot be avoided or mitigated can, as a last resort, eventually be offset. The land degradation neutrality programme of the United Nations Convention to Combat Desertification (UNCCD) was set up to implement Sustainable Development Goal 15 (Target 15.3), namely to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". More specifically, it states: "by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world".

While the Sustainable Development Goal Target 15.3 is an international goal, the UNCCD's programme currently supports land degradation neutrality at national levels. Land degradation neutrality needs territorial boundaries or to be led by the concept of ecological equivalence to be fully efficient. In fact, it is worth noting that under the Land Degradation Neutrality Target Setting Programme (LDN TSP), an overarching Conceptual Framework has been established and neutrality indicators were introduced by the UNCCD and its Global Mechanism for baseline and target-setting, using a combination of land cover type, net primary productivity level and soil organic carbon level. Neutrality is a new concept to the law and no frame has been developed yet. Hence, neutrality should only be considered sufficient when the impacts on a degraded land are compensated by the restoration of an equivalent and close land. We suggest taking into consideration the French policy on compensation measures – eviter, réduire, compenser (i.e., avoid, reduce or eventually compensate for it). It is, in other words, the mitigation hierarchy (for further discussion on mitigation hierarchy, see Chapter 6).

2.2.1.2 Outcomes of using various definitions or reference frames to assess degradation

The magnitude of degradation can be perceived differently by different actors and/or stakeholders. One reason for varying perceptions is the "shifting baseline syndrome", which refers to changing human perceptions of an ecosystem over time (Pauly, 1995). Shifting baseline syndrome occurs when humans adjust their perception of the state of the environment unconsciously and whereby the abnormal easily becomes the new normal (Papworth *et al.*, 2009). It is worth noting that while the use of local ecological knowledge for regional and global assessments (such as the ones produced by IPBES) are becoming more common (Danielsen *et al.*, 2003; Jones *et al.*, 2008; van der Hoeven *et al.*, 2004), the shifting baseline syndromes does entail that such data should be used with caution (Papworth *et al.*, 2009).

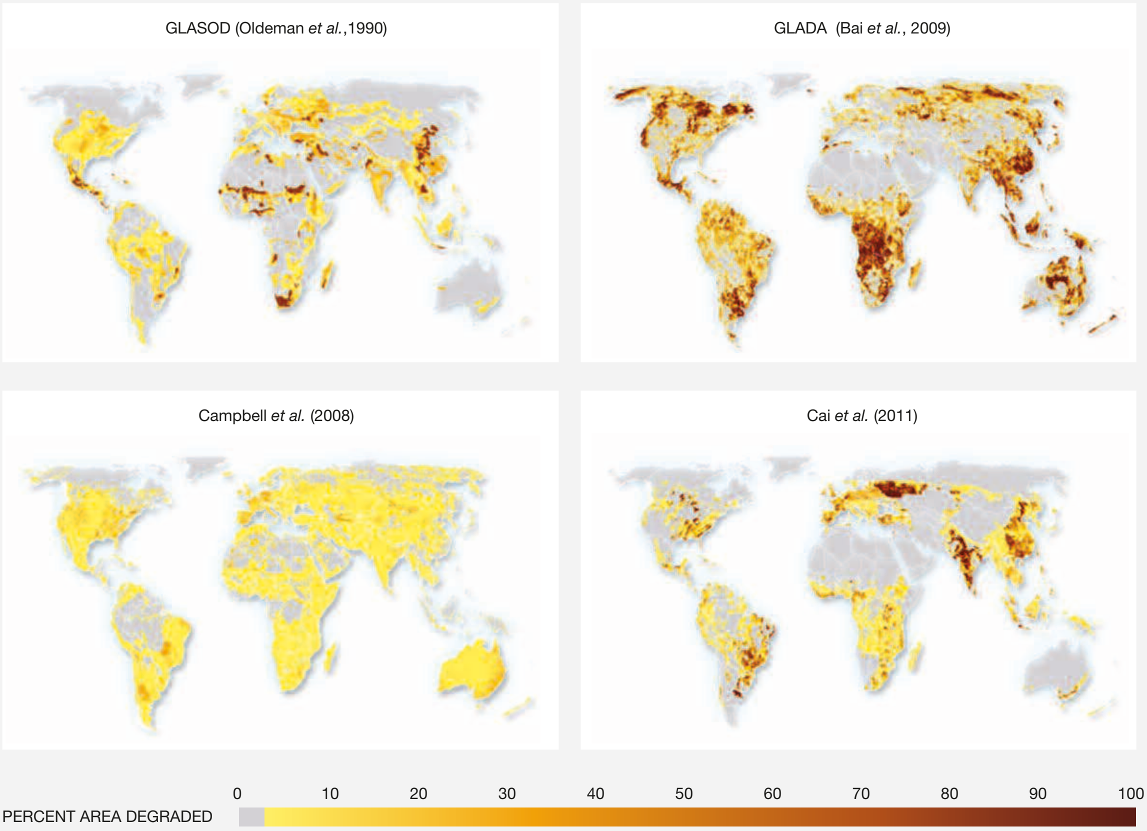
When assessing the current magnitude of degradation, there are concerns regarding the variability in definitions of concepts or principles which work towards deriving the pre-degradation reference frame (Hooke & Martín-Duque, 2012). Lack of consensus in the reference frame will cause the assessments of degradation and/or success in restoration to vary substantially (Gibbs & Salmon, 2015; Pereira *et al.*, 2014; Vogt *et al.*, 2011; van der Esch *et al.*, 2017). These estimates will often not agree with the one possible value of deviation from the natural state baseline for biodiversity and ecosystem functions. Furthermore, the lack of a common definition means that there will be different monitoring approaches, different indicators and different thresholds (e.g., Vogt *et al.*, 2011) which will considerably limit interoperability and integration across temporal and spatial scales for meaningful assessments. An additional source of variation between assessments can arise from the use of different methods. Gibbs and Salmon (2015) compared different approaches to assess degradation **(Table 2.1)**, namely expert opinion (e.g., Oldeman *et al.*, 1991), satellite- derived primary productivity (e.g., Bai *et al.*, 2008b), biophysical models, and the identification of abandoned or marginal cropland (Cai *et al.*, 2011; Campbell *et al.*, 2008). They found that there was more agreement between maps showing areas with little to no degradation than for areas with more degradation. Disagreement between different approaches was noted by Gibbs and Salmon (2015) who calculated an estimate global extent of degradation ranging between 470 million ha and 6.14 billion ha (see **Figure 2.7**). The disagreement was stronger in Asia (Gibbs & Salmon, 2015).

Table 2 1 **Benefits and limitations of major approaches used to map and quantify degraded lands (Gibbs & Salmon, 2015).**

Benefits and limitation refer to existing databases, not necessary the approaches as a whole, which could be improved to overcome limitations.

APPROACH	BENEFITS	LIMITATIONS
Expert opinion: Oldeman et al., 1991 Dregne & Chou, 1992 Bot *et al.*, 2000	• Captures degradation in the past • Measures actual and potential degradation • Can consider both soil and vegetation degradation	• Not globally consistent • Subjective and qualitative • Actual and potential degradation sometimes combined • The state and process of degradation often combined
Satellite-derived net primary productivity: Bai *et al.*, 2008	• Globally consistent • Qualitative • Readily repeatable • Measures actual rather than potential changes	• Neglects soil degradation • Only captures the process of degradation occuring following 1980, rather than complete status of land • Can be confounded by other biophysical conditions
Biophysical models: Cai *et al.*, 2011	• Globally consistent • Quantitative	• Limited to current croplands • Does not include vegetation degradation • Measures potential, rather than actual degradation
Abandoned cropland: Field *et al.*, 2008 Campbell *et al.*, 2008	• Globally consistend • Quantitative • Captures changes 1700 onward • Measures actual rather than potential changes	• Neglects land and soil degradation outside of abandonment • Includes lands not necessarily degraded

Figure 2 7 **Maps of land areas (percent of cell area) affected by degradation; each panel represents one of the methods described, all shown with common legend and 20 km grid. Source: Gibbs & Salmon (2015).**



This issue is further exemplified by looking at more approaches to assess degradation and the resulting estimates **(Figure 2.7, Figure 2.8)**. In the early 1990s, focusing on the status of soils, the UNEP Global Assessment of Human-Induced Soil Degradation (GLASOD) identified areas where "human intervention [had resulted] in a decreased current and/or future capacity of the soil to support life", based on expert opinion (Oldeman *et al.*, 1991). Two categories of degradation processes were identified: displacement of soil material (water and wind erosion) and deterioration (physical or chemical). Note that in this assessment, soils that are "actively managed" in "relatively stable agricultural systems" were not considered as degraded. Human-induced soil degradation was found to affect 1.964 million hectares worldwide (i.e., 15% of the terrestrial land), mainly due to water erosion (Oldeman *et al.*, 1991). In particular, 2% of the soils were considered extremely or strongly degraded.

More recently, efforts to assess the degree of land degradation globally have expanded their definitions, allowing the use of different methods and approaches **(Figure 2.7, Figure 2.8)**. For instance, the Global Assessment of Land Degradation and Improvement (GLADA) defined land degradation as "a long-term decline in ecosystem function and measured in terms of net primary productivity" (Bai *et al.*, 2008a). Technological improvement and the use of remote sensing also allowed for the use of the Normalized Difference Vegetation Index (NDVI) as a proxy to assess land degradation. However, the use of the index as a proxy for degradation, without considering land-use and land cover, has been criticized (Gibbs & Salmon, 2015; Vogt *et al.*, 2011). Biophysical models of agricultural productivity, combined with current land-use maps, are used to identify crops on land with marginal productivity, because these lands are prone to overutilization and subsequent degradation (Cai *et al.*, 2011; Gibbs & Salmon, 2015).

Wetlands are a further example of ecosystems for which a global assessment of degradation is particularly complex (see also Chapter 6, Section 6.3.2.5). Through rigorous assessment, Davidson (2014) recently confirmed the veracity of the longstanding estimate of wetland loss worldwide, namely 50% since the beginning of the 20th century. The first difficulty in devising a comprehensive estimate arises from a lack of knowledge on the distribution and extent of wetlands, with estimates ranging from 530 to 1280 Mha globally (Finlayson *et al.*, 1999; Lehner & Döll, 2004). Emerging technologies and better access to Earth observation products are promising advances to refine the global mapping of wetland (e.g. for peatlands see Dargie *et al.*, 2017; for global surface water see Pekel *et al.*, 2016). However, caution is advisable when defining a baseline for wetlands, because an increase in extent might be an artefact of technological improvement in measurement, rather than a result of conservation and restoration actions. Secondly, the assessment of wetland degradation is further complicated by the varying definitions of wetlands in use, in scientific publications and assessments. For instance, similar to the definition adopted for IPBES assessments, the Clean Water Act of the USA (EPA, 1990) considers wetlands to "generally include swamps, marshes, bogs and similar areas". Yet, the Ramsar Convention on Wetlands expands this definition to sites that "incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands" (Ramsar, 2013). In the Ecosystem Typology of the European Union, wetlands are represented by two categories: "inland wetlands" and "marine inlets and transitional waters" (EEA, 2015; Maes *et al.*, 2013). Analogous to the Living Planet Index , the Wetland Extent Trends index was recently proposed to overcome the incompleteness and heterogeneity of data on wetlands, and estimated a decline of 30% in the state of global wetlands between 1970 and 2008, particularly marked in Europe with a 50% decline (Dixon *et al.*, 2016). Using a current estimate of 900 Mha of wetlands globally (Lehner & Döll, 2004), this loss in wetlands represents the degradation of 3% of the ice-free land surface since 1970 **(Figure 2.8)**. While these estimates provide information on the area of wetland loss as a proxy for their degradation, they do not account for other forms of perturbation such as pollution and thus underestimate the magnitude of wetland degradation. For further discussion on wetlands and degradation of carbon stocks in wetlands, please refer to Chapter 4, Sections 4.2.3 and 4.2.5.

When looking at estimates of the global area under human pressures, considerably higher values for potential land degradation appear **(Figure 2.8.)**. Between 35 and 47% of the terrestrial ice-free habitats have been converted to cropland, pastures and tree plantations (Hooke & Martín-Duque, 2012; Pereira *et al.*, 2012) and a further 7% to human infrastructure (Hooke & Martín-Duque, 2012). More than 75% of the global land area has been transformed by humans and can be placed within an "anthrome" – an anthropogenic biome (Ellis *et al.*, 2010). The Temporal Human Pressure Index – based on changes in stable nightlights, human population and cropland area – estimated that human pressure increased in 64% of the terrestrial area between 1990 and 2010 (Geldmann *et al.*, 2014). Though the link between human pressure and degradation is limited by the scarcity of global and spatially-explicit data, identifying those areas altered by human activities can be a first step towards assessing degradation and potential restoration (Geldmann *et al.*, 2014). This type of assessment is all the more relevant considering the livelihoods of the human populations relying on land as a resource. It was for instance estimated that 1.33 billion people lived on "degrading agricultural land" in 2000 (Barbier & Hochard, 2016), 95% of which were in developing countries. The number of people living on this degraded land increased by 13% by 2012. Similarly, Bai *et al.* (2008b) estimated that over 1.5 billion people (i.e., 24% of the world population at the time of their study) were affected by land degradation. This further suggests that even though some developing countries might experience economic growth, the proportion of their population living in degraded rural areas, particularly in remote areas, might not benefit from it (Barbier & Hochard, 2016).

Estimates of land degradation can also show different results depending on the scale of the assessment (e.g., global versus national). By conducting a detailed assessment across all terrestrial ecosystem types in Finland, Kotiaho *et al.* (2015, 2016b) created a framework for assessing and reversing ecosystem degradation to support the national implementation of Aichi Biodiversity Target 15 and EU Biodiversity Strategy Target 2. Expert evaluations and all available data were utilized to construct pre-degradation natural state baselines for features important for biodiversity and for each ecosystem type, separately. In the assessment, "pre-degradation state for each feature" was defined as "the state of the feature in the ecosystems that would be existent in the absence of human intervention". This corresponds to the counterfactual natural state baseline explained in **Box 2.1**. Degradation percentages were shown to be relatively greater than those of previous global assessments **(Figure 2.8)**. The extent of degraded area across all terrestrial ecosystems was 84% of the area of Finland, while the overall average loss of ecosystem condition was 61%. A decade earlier and using a global assessment, only 8.2% of the terrestrial area of Finland were considered degraded (Bai *et al.*, 2008a) and nearly all of the country was considered part of the remaining global wilderness (Mittermeier *et al.*, 2003). This may suggest that many of the global-level assessments may not capture the true magnitude of damage that has been caused to biodiversity and ecosystem functions and services.

Assessing and mapping degradation can be a difficult task, even when the drivers of degradation are relatively well identified (see Chapter 3 for details discussion of drivers). This is illustrated by the ongoing European project RECARE (http://www.recare-project.eu), designed to develop a harmonized methodology to assess both the state of degradation of soil systems and its impact on functions and services. However, comprehensive knowledge on where, when and how known drivers affect the soil and methodologies for their assessments are often lacking (Stolte *et al.*, 2016). In some cases, the risk of, or susceptibility to, a given driver can be used as a proxy for the actual degree of degradation since they are easier to quantify and map.

Ultimately, the use of different models, input data and spatial and temporal resolutions can lead to heterogeneous assessments across countries, leading to an inability to capture the true nature of human-induced impacts on biodiversity and ecosystem functions and services. Regardless of the ecosystem, type of data or assessment methods used, uncertainty will be minimized with conformity to a singular consistent set of rules for deriving a baseline, evaluating the extent of degradation and assessing restoration success.

2.2.1.3 Difficult concepts that may impact land degradation and restoration: time lags, regime shifts, long-distance connections and scarcity

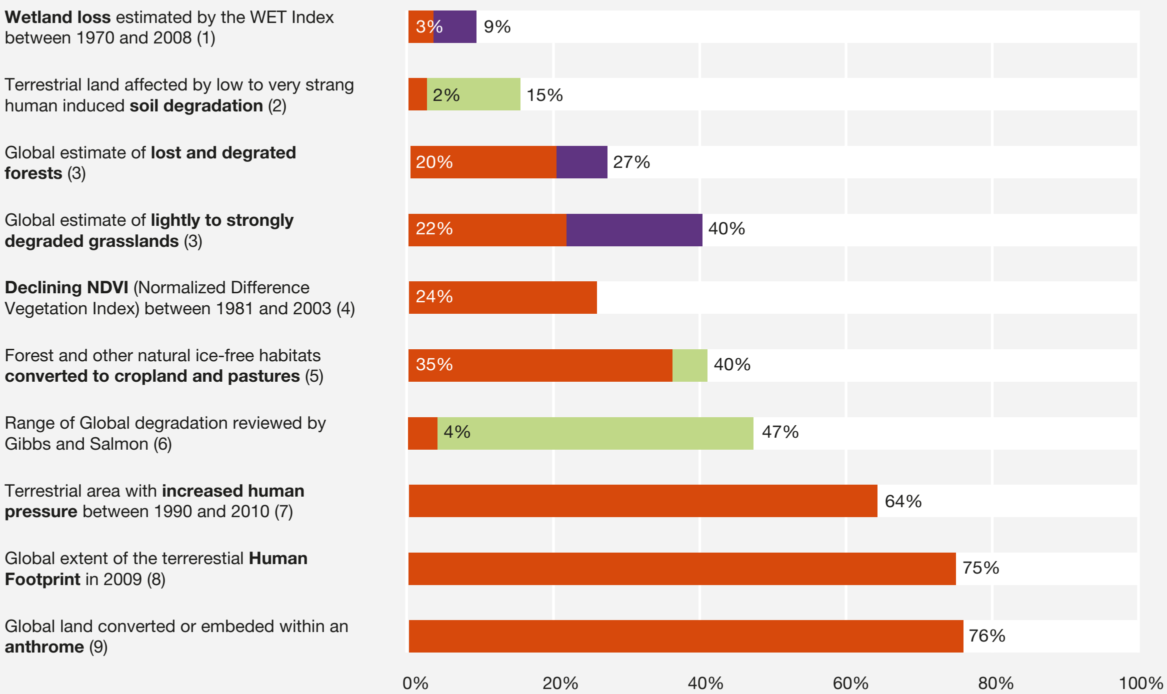
A few additional concepts are relevant for assessing the state and responses of biodiversity and ecosystem functions and services, but may be difficult to perceive as such. These concepts include time lags, resilience, regime shifts, irreversibility, long distance connections and land as a scarce resource. Difficulty arises from the fact that these concepts are often invisible at the local scale and can occur over long periods. Ignoring these concepts may lead to erroneous conclusions about the state and responses of biodiversity and ecosystem functions and services.

Time lags

Often, there is a time lag (or time delay) between the start of a degrading activity and its effect on the environment.

Figure 2 8 **Estimates of human pressure and degradation. Global estimates of the ice-free land surface affected by human pressure and/or assessed as degraded.**

Orange bars represent the percentage of terrestrial area affected by human pressure or degradation. Purple bars refer to the estimate of the proportion of the land surface covered by the ecosystem type (i.e., wetland, forests and grasslands). Green bars distinguish the upper from the lower estimates when both figures are provided in the study.
Sources: (1) Dixon *et al.* (2016); (2) Oldeman *et al.* (1991); (3) 3160 van Kolck *et al.* (2014); (4) Bai *et al.* (2008b); (5) Pereira *et al.* (2012); (6) Gibbs & Salmon (2015); (7) Geldmann *et al.* (2014); (8) Venter *et al.* (2016); (9) Ellis *et al.* (2010). [Adapted from Pereira *et al.*, 2014] Note that some of these estimates are dynamic and show an increase in degradation between two points in time (e.g., 4), while others are static and refer to the current percentage of a system being degraded (e.g., 3).
The estimate for wetland loss should be considered with caution, because we used an estimate of 900 Mha of wetlands globally (from Lehner & Döll, 2004) and applied a 30% increase backcasting to 1970 considering the Wetland Extent Trends index, from 1970 to 2008. The 900 Mha estimate is thus represented by the remaining 6% of ice-free land surface covered by wetlands in the figure.



For example, the IPBES Plenary (IPBES, 2015) adopted a definition of degraded land that had at its base the observed loss of biodiversity, but it should ideally have also incorporated time lags. Generally, the death and/or extinction of species in any given location does not follow immediately after the anthropogenic environmental change. In the ecological literature this phenomenon is known as extinction debt, and the time delay is called relaxation time (Jackson & Sax, 2010; Kuussaari *et al.*, 2009; Tillman *et al.*, 1994).

After the environmental change, the threshold condition for survival of some species may no longer be met, but these species are still extant because of the time delay in their response to the environmental change. For instance, using data on bird populations in a fragmented forest in Kenya, Brooks *et al.* (1999) estimated that 50 years after the isolation of forest fragments of 1000 ha, only half of the expected extinctions had already occurred. Even though our current understanding of the extent and time scale of extinction debt is limited (Essl *et al.*, 2015; Kuussaari *et al.*, 2009), it is expected to be greatest where large-scale habitat destruction has occurred recently (Hanski & Ovaskainen, 2002). Recently, the extinction debt concept was extended to include ecosystem services (Isbell *et al.*, 2015). Incorporating time lags, such as extinction debts, can lessen the impact of degradation by buying more time to land managers and conservation planners to improve the ecosystem conditions (via restoration or sufficient rehabilitation) before the projected extinctions occur (Brooks *et al.*, 1999).

Time lags are also present, and may be considerable, in the recovery of ecosystems after restoration and rehabilitation. In particular, in cases where species have gone locally extinct and restoration or rehabilitation is undertaken, ecological successions and natural recolonizations are also likely to happen with time lags (Hanski, 2000). For instance, a wildlife comeback is currently being observed in Europe (Chapron *et al.*, 2014; Deinet *et al.*, 2013). This comeback is partly due to conservation actions and changes in legislations (Deinet *et al.*, 2013), but was also facilitated by the abandonment of remote and marginal agricultural areas. This land abandonment created an opportunity for restoration via ecological rewilding: the passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing the human control of landscapes (Navarro & Pereira, 2012; Pereira & Navarro, 2015). The colonization of new suitable habitats may even be faster than the relaxation of the extinction debt if the change of the environment is slow enough (Svenning & Sandel, 2013).

Time lags presents a key question for environmental law as well, as it frames public actions. In many countries, public actions to repair a crime or a felony must be conducted within the time frame from one to thirty years. This rule is explained by the principle of legal certainty to protect citizens. However, when it comes to environmental law, these time frames are far from being widely adopted. Moreover, the statute of limitation that limits public actions commences after the event causing damage and not from the moment the damage is perceived. Therefore, if the damage appears or is perceived ten years or more after the damage was caused, the possibilities of a judicial action become void. The principle of legal certainty thus currently protects the polluters and does not account for ecological reality (Larson, 2005). Exceptions exist, such as in Alberta, Canada, where the law prescribes a 25-year liability for surface reclamation issues (topography, vegetation, soil texture, drainage and so on) and a lifetime liability for contamination associated with upstream oil and gas activities (Province of Alberta, 2016).

Resilience, regime shifts and irreversibility

The concept of resilience is common to both the natural and social sciences. In ecology, resilience refers to the ability of ecosystems to absorb disturbances while remaining in a stable state (Carpenter *et al.*, 2001; Holling, 1973; Kinzig *et al.*, 2006b; Scheffer *et al.*, 2015; Standish *et al.*, 2014a), while in social science, resilience is the capacity of human populations to adapt to new social-economic (development pressure, urbanization) or environmental contexts (climate change, deforestation, desertification). The main discrepancy between the definitions of resilience in the social and natural sciences is that social resilience can be defined as independent from the destruction or modification of the ecosystem, so long as human societies find subsistence alternatives (Adger, 2000).

Despite its growing popularity with policymakers and managers, some authors have recently pointed out the vagueness of the concept of resilience in ecology and its many definitions (Mumby *et al.*, 2014; Myers-Smith *et al.*, 2012; Standish *et al.*, 2014a). Nonetheless, resilience is particularly relevant to degradation and restoration (see also Chapter 4, Section 4.1.2.1 for further discussion on the role of ecological resilience in degradation processes). Ecological resilience highlights the level of disturbance that an ecosystem can sustain and can guide restoration. For instance, if a system is resilient to disturbance, its recovery to a pre-disturbance state can be passive and may not require human intervention other than cessation (Mumby *et al.*, 2014; Standish *et al.*, 2014a). Recovery time – the time required by an ecosystem to return to pre-disturbance state (Myers-Smith *et al.*, 2012; Standish *et al.*, 2014a) – is essential to consider, as ignoring it could lead to a premature assessment of impacts and thus underestimation of the potential success of restoration interventions (Haapalehto *et al.*, 2017).

Continuous and long-term pressure on ecosystems can lead to a loss of resilience and cause them to shift to an alternative stable state, a phenomenon called a "regime shift" (Barnosky *et al.*, 2012; Folke *et al.*, 2004; Kinzig *et al.*, 2006; Scheffer *et* *al.*, 2001, 2015; Scheffer & Carpenter, 2003). Examples of regime shifts are soil salinization, the transition from forests to savannas, fisheries collapse and the mangrove transition (Folke *et al.*, 2004; Leadley *et al.*, 2014; Rocha *et al.*, 2015). Disturbance thresholds are used to estimate the level of disturbance that a system can sustain before moving to an alternate state (Standish *et al.*, 2014a). Regime shifts can be rapid or more gradual (Walker & Meyers, 2004), the latter being potentially harder to identify and assess (Scheffer & Carpenter, 2003). Furthermore, the fact that the shift can be either smooth or abrupt, as is the case when the system reaches a tipping-point (Folke *et al.*, 2004; Leadley *et al.*, 2014), will have an impact on how the transition is perceived by different stakeholders.

The direct and indirect drivers of regime shifts were recently classified in five broad categories which also match to some extent the different drivers of land degradation discussed in Chapter 3 of this assessment: (i) habitat modification; (ii) food production; (iii) nutrients and pollutants; (iv) resource extraction; and (v) spill-over effects such as the indirect effect of human activities on natural processes (Rocha *et al.*, 2015). Those drivers can also be placed into networks of interaction within and across those categories, which highlights the risk of "cascading regime shifts," even more so when most of those drivers are linked to human activity (Kinzig *et al.*, 2006; Rocha *et al.*, 2015). Regime shifts can also be caused by the overexploitation or introduction of species (Leadley *et al.*, 2010). Invasive alien species have, for instance, changed biotic and abiotic conditions in island ecosystems (Burgiel, 2010) and caused shifts from submerged to floating plants in aquatic ecosystems (Nolzen *et al.*, 2017.). More generally, they can alter trophic cascades (Estes *et al.*, 2011) which can result in collapses in ecosystems (e.g., predator invasion in Downing *et al.*, 2012).

While the resilience of a system prevents it from crossing a threshold, the term "unhelpful resilience" was recently used to describe the fact that an ecosystem can be resilient in a degraded state, limiting the effectiveness of restoration (Standish *et al.*, 2014). Indeed, once in an alternative state, the process to reverse the system to its natural state might be too difficult or too costly (Folke *et al.*, 2004). Given our definition of degradation (see Section 2.2.1.1), a regime shift can often cause a system to remain degraded, even if the cause of the degradation is removed.

Many regime shifts are caused by climate change and other anthropogenic drivers, and have hence been extensively studied within socio-ecological systems. In those systems, the human impact is due to resource management – driven by local, regional and global socio-economic factors (e.g. Kinzig *et al.*, 2006) – while the state of the ecosystem will in turn impact the amount and quality of available resources. Regime shift can thus directly and indirectly affect the supply of ecosystem services and human well-being (Rocha *et al.*, 2015).

Thresholds in ecosystems are difficult and complex to observe and perceive, but can be assessed using observations of temporal data or experimentation (Mumby *et al.*, 2014; Scheffer *et al.*, 2015; Standish *et al.*, 2014; Laliberté *et al.*, 2010; Standish *et al.*, 2014). In addition, there are several databases and online resources to inform researchers and managers (e.g., http://www.resalliance.org/; http://www.regimeshifts.org/; and http://www.early-warning-signals.org) (Walker *et al.*, 2004; Rocha *et al.*, 2015).

Legal thresholds are the result of a social compromise defining what is acceptable and what is not. Hence, the change of status occurs when the degradation is no longer socially acceptable. Therefore, the legal perception of regime shifts is not in accordance with its ecological counterpart. Many judges lack environmental and ecological knowledge, which contributes to this effect and leads to the misunderstanding and subsequent discounting or dismissal of environmental impacts in legal proceedings (Lecuq & Maljean-Dubois, 2008). Nevertheless, creating specific environmental courts, like those created in India or Chile in 2012, might help remediate this shortcoming.

Timescales and the perception of land degradation and restoration

Humans and human activities have altered and/or degraded ecosystems since the late Pleistocene (Ellis *et al.*, 2013; Pereira *et al.*, 2012). In fact, relatively little of the Earth's land area can be considered natural or "wild" today (Mittermeier *et al.*, 2003; Sanderson *et al.*, 2002), while "intact landscapes" such as forest continue to decrease in extent (Potapov *et al.*, 2017). Yet, due to the timescale of such phenomena, even heavily-altered systems are not always perceived as degraded. For instance in Europe, some valued cultural landscapes – such as the Causses and Cevennes World Heritage site – or terraced farming are the products of intense and long-lasting alterations and use of ecosystems (Halada *et al.*, 2011; Navarro & Pereira, 2012). Their perception as "natural" and their acceptance as the "normal state of nature" (Vera, 2010) constitute an example of the shifting baseline syndrome (see 2.2.1.2).

Progressive or gradual degradation processes that occur during one's lifetime might also be difficult to perceive. Degradation, for example, due to overgrazing and non-sustainable agricultural practices (Leadley *et al.*, 2014; Scheffer *et al.*, 2001), can be a gradual process that can go unnoticed until a tipping-point or threshold is reached and the stakeholders start perceiving the intensity of degradation and its impact on their well-being (Folke *et al.*, 2004). This is also the case of the long-term degradation of the Amazonian forest which, in combination with climate change at the global scale, could lead to a sudden regime shift and a transition to a savannah-type ecosystem (Leadley *et al.*, 2014).

Other types of degradation that are easy to perceive are immediate catastrophic events. Those events are typically perceived and acknowledged by the public and demand concrete responses. A recent example is the breaking of the dam holding wastewater from Samarco mining Company that affected the Rio Doce in Minas Gerais, Brazil (see Box 5.8, Section 5.5.2) and was described by the Brazilian president as the “worst environmental disaster in the history of Brazil” (Escobar, 2015). The event was widely covered by the media internationally and triggered strong public outrage. The perception of emergency in the response to degradation is indeed a crucial point. A catastrophic event is more salient and might thus have more impact on policies and response (Jørgensen *et al.*, 2014). On the contrary, when degradation processes are slow, and their impact on human well-being are not immediately perceived or felt, the societies are less likely to stop the degradation process or initiate a restoration effort.

The slow recognition that desertification had to be internationally resolved is one such example. As pointed out by Corell (1999), the international community was mobilized several times on this topic before the United Nations Convention to Combat desertification (UNCCD) was signed in 1994. Severe environmental disasters had by then accelerated the process, such as the Sahelian drought (see Behnke & Mortimore (2015) for more on this discussion), and policymakers resorted to using a vocabulary of emergency (e.g., “disappearance of countries”) in order to accelerate actions. Still, it took fifteen years to sign UNCCD into force.

Likewise, the time for ecosystem recovery after restoration can vary greatly and should be systematically considered. Many ecosystems can recover assisted or in some cases, non-assisted, from disturbances but the time scale of such processes can span from decades to centuries (Jones & Schmitz, 2009; Kotiaho & Mönkkönen, 2017; Haapalehto, *et al.*, 2017). For instance, abandoned agricultural lands in Europe could take between several decades to over a century for ecological successions to occur and to naturally become forested (Verburg & Overmars, 2009). Active restoration must also be understood as a long-term process. We are only now starting to draw some conclusions from long-term and large-scale restoration programs, such as the restoration of the Mata Atlantica rainforest in Brazil (see Chapter 6, Box 6.4 and Section 6.3.1.2), one of the most endangered hotspots of biodiversity (Brancalion *et al.*, 2014; Melo *et al.*, 2013), or the Grain for Green program, a large-scale plan of restoration of set-aside land, initiated in 1999 in China to combat soil erosion and desertification (Cao *et al.*, 2009; Feng *et al.*, 2013).

By ignoring the potential time-lags between an action and the response of a system, a “short term” vision to assess the outcomes of conservation policies and restoration actions might also impact the capacity to observe and perceive successes (Tittensor *et al.*, 2014) or failures. Furthermore, the time-scale of restoration processes can become an issue when considering its mismatch with the duration of decision makers’ political mandates (Villalba, 2010), and during which tangible restoration results are often expected.

Global conservation targets are also typically time-bound. For example, Aichi Biodiversity Target 15 sets the target of restoring 15% of degraded land by 2020 (CBD, 2011). In contrast, having long-term perspectives could allow for the development of progressive approaches, where meeting the goals are reassessed through time, as the focal ecosystem is recovering (Chazdon, 2008). It was thus argued that restoration should be understood as an investment rather than a direct cost for society (de Groot *et al.*, 2013). It is important to allow the time needed to achieve restoration goals to avoid the premature perception of failure or non-achievability. Finally, it is important to recognize that human action targeted at specific species, ecosystems or ecosystem services – including through the degradation process or restoration and rehabilitation actions – can have an impact on the selective forces acting on biodiversity over long temporal scales (Sarrazin & Lecomte, 2016). Yet, those interactions are rarely accounted for. Hence, Sarrazin and Lecomte (2016) recently advocated for an “evocentric” (i.e., centred on evolution) approach to conservation, where strategies are developed to preserve both nature and future generations’ well-being, while considering processes acting at an evolutionary time-scale rather than opting for a “blind Anthropocene” in which any consideration for the conservation of the non-human is ignored (see also Kotiaho & Mönkkönen, 2017).

Long-distance impacts and their legal implications

There are often long-distance connections between land degradation and human well-being that are invisible to most stakeholders, but must be taken into account (see Chapter 5, Section 5.3.2.5). For example, consumption and pollution put major pressures on biodiversity and have shown worsening trends, both past and projected (Tittensor *et al.*, 2014). The global production and trading of goods to satisfy demand is also one of the main drivers of land degradation (Lambin & Meyfroidt, 2011a; Lenzen *et al.*, 2012). One clear example is the case of increasing meat consumption and soy production as drivers of deforestation (see **Figure 2.9**) (Marchand, 2009; Nepstad *et al.*, 2006). In particular, consumers in developed countries tend to have larger “biodiversity footprints” abroad than within their countries – contributing to significant negative impacts in developing countries (Lenzen *et al.*, 2012).

Figure 2 9 **An illustration of how long-distance connections are obstacles to full awareness of consumer choices.**

Increased demand for soy for animal feed, in Europe and Eastern Asia, encourages deforestation in South America, including the Cerrado savanna, Amazon forest and Pampa. Intensive pork breeding pollutes rivers and provokes the phenomenon of "green tides" on the seashores. Photo source: Creative Commons, licensed under CC BY-SA / Compiled by F. Kohler.

The consequences of local degradation processes can also have long-distance negative impacts on biodiversity and societies (Liu *et al.*, 2015). This is for instance the case with transboundary haze pollution in South East Asia – resulting from palm oil production and forest fires in Indonesia – which also raises the issue of perceived responsibility between countries (Forsyth, 2014). Furthermore, there are concerns that increasing EU demand for biofuels will increase indirect land-use change in countries where biofuels are produced (mostly in South America). In reaction, a directive on the promotion of the use of energy from renewable sources (European Commission, 2009) was adopted to provide a transnational legal framework for dealing with these issues (Farber, 2011). Failing to take into account these long-distance connections limits the ability of conventions and governments to design appropriate policies for mitigation, restoration and compensation. These considerations prompted the development of the "telecoupling framework" (i.e., socio-economic and environmental interactions over long distances), including assessments of its impact on land-use change globally (Liu *et al.*, 2013).

An additional long-distance connection of land-use change is caused by the transition of developed countries from net forest losses to net forest gains (Meyfroidt *et al.*, 2010), accompanied by urbanization and agricultural land abandonment. If and when the demand for agricultural and timber goods stagnates or increases, this transition might lead to the "outsourcing of degradation" (Meyfroidt & Lambin, 2011) – a process also known as land-use displacement. Similarly, there is a danger that strict conservation policies and the setting aside of land for conservation and/or restoration might become drivers of degradation elsewhere – a phenomenon known as "leakage of environmental impact" (Andam *et al.*, 2008; Armsworth *et al.*, 2006; Lambin & Meyfroidt, 2011b; Latawiec *et al.*, 2015; Lenzen *et al.*, 2012; Liu *et al.*, 2015). For instance, reforestation projects on productive land of the Mata Atlantica, in Brazil, could lead to the displacement of grazing pressures elsewhere (Latawiec *et al.*, 2015). Likewise, strong leakages were observed when Vietnam implemented a reforestation policy and increased its forest cover at the expense of neighbouring countries, where deforestation increased in order to satisfy the domestic demand in timber products (Meyfroidt & Lambin, 2009). Nonetheless, one positive form of long-distance connection occurs when the benefits of restoration are not only felt locally, at the spatial scale of the site being restored, but have downstream positive effects at a larger scale (de Groot *et al.*, 2013; Liu *et al.*, 2015).

Long-distance impacts caused by land degradation are hardly considered by national legal orders and even less by the international legal order. Thus, the legal concepts of land degradation and restoration are often constrained to local scales. This perception differs from the existing international legal order and its treaties and conventions for the protection of air and water quality, for example. Such a difference can be partially explained by the fact that land generally falls under state territory and national jurisdiction, despite its transnational characteristics. And despite the existence of general legal instruments, transboundary impacts caused by land degradation are often underestimated and not taken into account by the law (Convention on Environmental Impact Assessment in a Transboundary Context, 1991; European Commission, 2010; Gray, 2000; Johnstone, 2013). For example, select Member States have rejected the EU's proposal for a Soil Framework Directive – referring to the subsidiarity principle (Olazabal, 2007) and arguing that soil protection is a national matter and hence outside the scope of the EU.

Internationally, there is a lack of strong conceptual foundations for building effective international mechanisms. There are first and foremost conceptual and practical issues with the "sovereignty principle", because of the various hurdles it can create for an international organization or a country to investigate the state of land within national borders. Consequently, international conventions that focus on land have generally revolved around developing support approaches (Ramsar, 1971; Ninan, 2001; UNCCD, 1994) and are seldom legally binding (Friedrich, 2013; Revised European Soil Charter, 2003). Hence the current status of land prevents the development of alternative and legitimate (Bodansky, 1999) forms of ecological governance (Camanho, 2009; Angus, 2007; Woolley, 2015) based on the legal implementation of the concept of ecological solidarity, for example (Naim-Gesbert, 2014; Thompson *et al.*, 2011). Ecological solidarity (see Glossary) is a legal concept of French environmental law. It provides a step toward consolidating ecological and social interdependence in biodiversity policy. In the words of Thompson *et al.* (2011): "from ecology based on interactions to solidarity based on links between individuals united around a common goal and conscious of their common interests and their moral obligation and responsibility to help others, we define ecological solidarity as the reciprocal interdependence of living organisms amongst each other and with spatial and temporal variation in their physical environment". The idea is that in order to increase the efficiency of conservation measures, the surrounding landscape of the protected area must be integrated. In other words, ecological solidarity "could ensure the protection of the ecological and human dimensions of landscape functioning, where a multitude of (mostly undervalued) services are provided" (Thompson *et al.*, 2011) (see Section 2.2.3.3 for more detailed discussion about ecological solidarity).

Nonetheless, when countries share common concerns, the protection and sustainable management of land can become an international matter. The Alpine Convention (Dallinger, 1994), signed by the eight Alpine countries (Germany, Austria, France, Italy, Liechtenstein, Monaco, Slovenia and Switzerland) illustrates this idea. Its purpose is to create a common framework to manage and preserve the alpine environment. The convention is based on nine protocols and at least five of them are related to land issues: (i) mountain farming; (ii) mountain forest; (iii) spatial planning and sustainable development; (iv) conservation of nature and countryside; and (v) the most directly land-related soil conservation protocol of 1995. All alpine countries, except Switzerland, have ratified all of these protocols.

Although the whole mechanism of the Alpine Convention is facing governance and implementation issues, it nevertheless demonstrates that land (and more specifically soils) can be managed at a supranational level. Within this framework, parties have shared their knowledge to elaborate an appropriate text (Balsiger, 2007; Simon, 2011). For instance, the Soil Protocol conveys the definition of soil given by the European Soil Charter of the Council of Europe, by the European Commission and by the German Soil Protection Act (see also Chapter 6, Section 6.3.2.2). Moreover, this example illustrates that, as these alpine countries share a mountain area with specific threats and ecosystems, they have an accurate perception of the consequences caused by land degradation (Desrousseaux, 2014).

The progressive recognition of land as a scarce resource

Soil protection, in itself, is perceived as a national matter. Land and soil are two different legal objects and only specific threats or types of land are internationally preserved: the threat of desertification, high interest wetlands and natural and agricultural landscapes. Land, as a scarce resource (Lambin *et al.*, 2001; Lambin & Meyfroidt, 2011b), is largely unmanaged by international environmental law (Kiss & Shelton, 1991) except for the UNCCD.

International community, supported by soil specialists, have elaborated the concept of "soil security". It is described as an overarching concept of soil motivated by sustainable development and "concerned with the maintenance and improvement of the global soil resource to produce food, fibre and freshwater, contribute to energy and climate sustainability, and to maintain the biodiversity and the overall protection of the ecosystem. Security is used here for soil in the same sense that it is used widely for food and water" (Brauch & Spring, 2009; Keesstra *et al.*, 2016; Koch *et al.*, 2013). Traces of this concept are found in international working documents of the UNCCD. It refers to "existential threats for survival [of humankind] and requires extraordinary measures to face and cope with these concerns. Security concepts offer tools to analyse, interpret, and assess past actions and to request or legitimize present or future activities" (Brauch & Spring, 2009). As food or water are already considered security issues, the concept of soil security put soil issues at the same level of importance. For instance, while the right to water has been assigned a constitutional level of protection in most national legal orders (for the highest level possible, see **Figure 2.6**), such right has not been assigned for land (May *et al.*, 2015) – except where it concerns women or indigenous peoples in specific cases. Soil protection, therefore, needs to be developed at the international level (Boer & Hannam, 2004; Desrousseaux *et al.*, 2016). At this time, policymakers have access to non-binding instruments, such as the newly adopted Voluntary Guidelines for Sustainable Soil Management, which provides general technical and policy recommendations for soil preservation measures (FAO, 2017a).

Related to the concept of "soil" there is one further challenge for the law. Land and soil are frequently ambiguous in law, as they are not clearly separated or made distinguishable. On this matter, proposals have been made to adopt a Soil Protocol under the authority of the UNCCD (Boer & Hannam, 2015). Some institutions are aware of this situation and the European Commission, for instance, has expressively explained why soils should be differentiated from land. European Thematic Strategy for Soil Protection states that "while soil is the physical upper layer of what is usually referred to as 'land', the concept of 'land' is much wider and includes territorial and spatial dimensions. It is difficult to separate soil from its land context. However, this communication focuses on the need to protect the soil layer as such, due to its unique variety of functions vital to life" (2006).

At a national level, and due to their territorial specificities, some countries have an accurate perception of the scarcity of land and have thus built strong legal frameworks in order to prevent land degradation. For instance, Article 75 of the Federal Constitution of the Swiss Confederation, specifies that "the Confederation shall lay down principles on spatial planning. These principles are binding on the Cantons and serve to ensure the appropriate and economic use of the land and its properly ordered settlement" (1999). In other words, Switzerland has an accurate perception of the scarcity of its land and proactively attempts to limit its urbanization. Food safety is also one of its concerns. As a result, Switzerland is considered as one of the best performing countries of Europe to preserve land and associated food security (Dufourmantelle *et al.*, 2012; Karlaganis, 2001).

2.2.1.4 Approach to assess degradation and recovery of ecosystems

If assessment and monitoring of the negative effects (degradation) of management practices and development, or the positive effects of restoration and rehabilitation are to be done, they must be evidence-based (Block *et al.*, 2001). Measuring ecosystem degradation first requires determining a baseline, relative to which the current state of an ecosystem is compared. For the particular purpose of assessing anthropogenic ecosystem degradation, an obvious reference is the natural state without any human modification (see 2.2.1.1 and **Box 2.1**). Restoration success is in practical terms easier to assess and monitor than assessing degradation, because here the expected ecosystem changes are in the future and can be monitored. However, in order to do this rigorously and scientifically, there is a need for well-designed long-term monitoring programmes, following, for instance, the classical idea of the Before-After, Control-Impact design (Block *et al.*, 2001; Underwood, 1994) supplemented with replicates. First, one should establish replicated plots on independent ecosystems that are in a degraded state and on corresponding ecosystems that are in their pre-degradation state. The pre-degradation sites can be established by using the space-for-time substitution as a proxy (see below). The first inventory of the current state of all the plots should be conducted before any of the plots are restored. After the first inventory, half of the degraded plots should be restored and the other half left as controls. After the restoration measures have been completed there will be three different types of replicated plots: degraded plots, restored plots and plots in a pre-degradation state. The monitoring should be continued of all three of those plots. These replicated Before-After, Control-Impact designs allow the researcher to distinguish the true effects of restoration measures from natural succession and random changes in community composition, as well as other variables over time (see e.g. Elo *et al.*, 2016; Menberu c2017; Noreika *et al.*, 2016).

Space-for-time substitution, also known as a chronosequence (Blois *et al.*, 2013; Foster & Tilman, 2000; Haapalehto *et al.*, 2014; Johnson & Miyanishi, 2008), can be used to infer the magnitude of damage from a series of plots differing in terms of age since disturbance or restoration by humans. In this approach, pre-degradation state ecosystem plots that represent the same abiotic and biotic response attributes as the damaged target ecosystem (prior to degradation) are identified. Then, the attributes of the damaged and pre-degradation state plots are compared. This approach is commonly used in experimental ecology and in restoration ecology when assessing the success of restoration in reversing damage (e.g. Aide *et al.*, 2000; Kareksela *et al.*, 2015; White & Walker, 1997). In practice, some uncertainty exists regarding representativeness and the pre-degradation status of the chosen pre-degradation state ecosystem plots. In addition the assumption that all plots traced the same history in both abiotic and biotic attributes is unavoidable (Johnson *et al.*, 2008; Pickett, 1989).

2.2.1.5 Land-use change and externalities

There is no doubt that values play an important role in how societies treat nature, land and its ecosystem services, but there are also fundamental demographic and economic mechanisms leading to habitat loss and subsequent loss of biodiversity (Dasgupta, 2001; De Moor, 2008; Dietz, 2003; MEA, 2005b).

Biodiversity is something economists generally describe (in a largely anthropocentric approach) as displaying public-good characteristics. Public goods have non-excludable use by other potential users and are non-rivalrous in consumption (Kolstad, 2000). Ecosystem services are often rival non-excludable (common pool resource) or both non-rival non-excludable (public good). A market economy, based on private property and excludability, generates externalities (Kolstad, 2000; Pigou, 1920). Broadly speaking, the notion of an externality refers to a benefit or loss created by an individual's (or group of individuals') influence on production or consumptions possibilities for others, without any compensation or payment (Hanley *et al.*, 2007). Hence, externalities refer to economically important negative or positive impacts, not taken into account by markets.

Instruments to internalize negative externalities often revolve around attaching a cost (e.g., reflecting in the cost of commodities) to a negative impact (Kolstad, 2000; Pigou, 1920). Land-use changes can create biodiversity-related externalities by weakening life-supporting, regulating and cultural services, thereby inducing biodiversity loss. One way of addressing such negative environmental externalities is to develop policies for implementing compensation mechanisms (e.g., taxation). Examples of economic incentives to restrict negative externalities include taxes on emissions and pollutions, individual tradable quotas and quality standards. They directly target the rationale behind choices causing pollution and degradation, by internalizing the environmental cost into the price of a given good or service (e.g., industrial poultry or pork meat) under the "polluter-pays principle". Consequently prices of such products would rise, making abatement efforts and alternatives more economically appealing, thereby actively incentivising consumers to choose more environmentally-friendly products (Oosterhuis & ten Brink, 2014). Such an "ecotax" has been applied in Austria, Switzerland and Germany on heavy truck transportation and was quite effective in fostering local products or rail transportation (Sainteny, 2012). In some cases, removing "perverse subsidies" can be sufficient (Oosterhuis & ten Brink, 2014). Such subsidies are usually set up to support a given economic sector (e.g., agriculture), but in the process also contribute to increased negative externalities (e.g., nitrate pollution). By heavily subsidising agricultural production after World War II, the European Common Agricultural Policy is partially responsible for the overuse of fertilisers, leading to eutrophication since the 1970s (OECD, 2004). Instead of reducing such (perverse) subsidies for agricultural production, the EU decided to add new subsidies under a "second pillar" of the Common Agricultural Policy. These new subsidies pay for positive externalities of agriculture as well as reduction of negative externalities under the heading of "agri-environmental measures".

Incentives and restrictions are generally based on environmental impact assessments and cost-benefit analyses of the direct environmental and economic impacts of particular practices. For decision makers, cost-benefit analysis provides a feedback mechanism which confronts the problem of market demand for commodities and the lack of accounting for externalities with the same tools, measuring rod and language (i.e., value and costs). As such, exercises of valuation can play an important role in calling attention to the value of biodiversity and to intangible ecosystem services (Brondizio *et al.*, 2010). In turn, multi-criteria assessments (Munda, 2008; Verburg *et al.*, 2014) and deliberative approaches (Habermas, 1984; Raymond *et al.*, 2014; Vatn, 2009) go beyond the exclusive focus of environmental impact assessments on ecological structure and processes to consider the context-specific and often conflicting values held by human communities on the issues at stake (Langemeyer *et al.*, 2016).

Ecosystems have relevance for human well-being beyond the satisfaction of individual preferences for tangible goods and services. These intangible values of nature belong to the cognitive and emotional realm of human beings, and, as such, are hard to quantify (Kumar & Kumar, 2008; Wegner & Pascual, 2011) (see also Chapter 5). These psycho-cultural benefits of nature (see Chapter 5, Section 5.4.6) are increasingly recognized (Chan *et al.*, 2012) and their neglect in policy appraisal and interventions can produce undesired consequences (e.g., Fankhauser *et al.*, 2014; West *et al.*, 2006). Along these lines, some researchers have questioned the use of cost-benefit analysis and valuation. A recent survey showed that the academic literature gives little attention to the issue and rarely reports cases where ecosystem services economic valuation has been put in actual use (i.e., ex-post examples) (Laurans *et al.*, 2013). Nevertheless, a survey of U.S. decision makers has shown that they highly value economic information along with history and context studies to inform their decision-making process (Avey & Desch, 2014).

As property rights on environmental resources (such as clean air, water, biodiversity) are not well defined, the rights of use often go to the spoiler, which may result in the negative externality of long-term depletion of natural resources and a decrease in returns for all (Ostrom, 2010; Poteete *et al.*, 2010). One alternative to pricing instruments is to improve the allocation of property rights. Collectively devised and accepted resource-use rules have proven most effective in managing common pool resources and can generate long-term benefits for the group as a whole (De Moor, 2008; Duraiappah *et al.*, 2012; Mongin, 2003; Ostrom, 1990). For instance, a recent study of community managed conservancies bordering the north of the Maasai Mara National Reserve indicates that pastoral livelihoods currently do not constitute a source of habitat degradation and livestock grazing intensity has no impact on prey species and carnivore populations. Instead, the major threat to the survival of endangered predatory species, like the lion, are retaliatory killings due to livestock depredation. Here, household-level cash incentives from community-managed wildlife tourism act as an effective strategy to reduce the frequency and/or severity of reaction to livestock depredation, and enable the recovery of lion populations (Blackburn *et al.*, 2016). Setting land aside or reducing livestock densities was not necessary.

In an ecological compensation market, developers degrading the environment demand offsets that are provided by landowners, who in turn may invest in restoration of large land areas and sell offsets from these habitat banks. The trades are verified by an administrator (Coggan *et al.*, 2013). If no net loss is requested, the trading rules must make the ecological value of the destroyed and restored sites equivalent (McKenney & Kiesecker, 2010). Buying and selling offsets creates prices that reflect the costs of habitat restoration and the developers' need for offsets (Doyle & Yates, 2010). The restoration costs determine the supply of offsets: the rarer the habitat in question, the more expensive the offset. In an ideal offset market the desired biodiversity outcome, such as no net loss of biodiversity, can be achieved and that the costs of offsetting might inhibit harm caused by any development project (Conway *et al.*, 2013; Wissel & Wätzold, 2010).

Ecological compensations are considered to work only for ordinary habitats, because areas with threatened species and rare habitats may be irreplaceable (Pilgrim *et al.*, 2013), are under strict regulation and probably should not be included in the market exchange (McGillivray, 2012). Monitoring and verification is an important part of ecological competition. It has been argued that no net loss can only be achieved if current regulations pertaining to the avoidance and minimization steps of the mitigation hierarchy continue to be stringently enforced (Dickie *et al.*, 2010) and possibly reinforced (Conway *et al.*, 2013). However, as offsets can be mandatory or voluntary, they can be partial, instead of fully compensating (Moilanen & Laitila, 2016). Unfortunately, too often these ecological compensation guidelines have been neglected (Briggs *et al.*, 2009; Coggan *et al.*, 2013).

Currently, efforts to render ecological compensation initiatives more effective are being explored under the land degradation neutrality component of Sustainable Development Goal 15 (Caspari *et al.*, 2015; Dooley *et al.*, 2015; Minelli *et al.*, 2016; Welton, 2015). Land degradation neutrality is defined as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (UNCCD, 2015:4). Under this approach, the Science-Policy Interface of the UNCCD recommends that ecological compensation should be implemented by respecting the "mitigation hierarchy", as does IUCN (2016) and the Ramsar Convention through Resolution XI.9 (See Chapter 6, Section 6.2.1).

An important element to consider when predicting or assessing the effectiveness of economic incentive-based tools, is their interplay with the normative systems and motivations of targeted actors. The critics of ecological compensation are concerned that such schemes may create the false impression that any impact can be compensated for, whereas ecosystems' link to livelihood opportunities and psycho-cultural wellbeing (Brown *et al.*, 2013; Ryan *et al.*, 2010; Weimann *et al.*, 2015) are locally specific and therefore not fully replaceable (Escobar, 2008; Forest Peoples Programme, 2011; Quétier & Lavorel, 2011).

Nevertheless, common to many documents on ecological compensation is that, while they describe well the goals of ecological compensation or biodiversity offsetting including the mitigation hierarchy, they do not systematically cover the factors and decisions that effectively drive the outcome of offsetting. Recent work reviewed the concepts of offsetting and summarized the operational decisions that effectively determine how well ecological damage becomes compensated (Moilanen & Kotiaho, 2017, 2018). This document describes a framework allowing well-informed evaluation of biodiversity offsets. Factors treated in the document cover the three major axes of ecology, biodiversity, space and time as well as a host of additional factors, such as additionality, leakage, flexibility, connectivity, trading up, baseline trend assumptions and multipliers needed to account for various uncertainties. These should all be considered and addressed in the operationalization of any ecological compensation of biodiversity offsetting case.

2.2.2 Sense of place: indigenous and local peoples facing degradation and restoration

IPBES has, at its core, the integration of scientific, indigenous and local knowledge and practices so that degradation can be perceived and defined by different observers, and so that restoration can be achieved using both scientific and local expertise. Scientific knowledge tends to be specialized and deals with specific aspects of reality, while indigenous and local knowledge tend to be systemic (or holistic) (DeWalt, 1994; Lévi-Strauss, 1966; Pretty *et al.*, 2009; Roué & Nakashima, 2003). By systemic, we mean that indigenous and local knowledge and practices, in general, integrates both material and spiritual knowledge and practices (Nakashima *et al.*, 2012; Trosper & Parrotta, 2012).

Starting from the premise that indigenous and local knowledge and practices are integral to understanding the perceptions of land degradation and restoration, this subsection starts by reviewing the complexities of indigenous worldviews. This is followed by examples of indigenous and local classification systems related to soil degradation, showing how these different classifications may be useful for restoration projects. We then review obstacles, such as social inequities or discrimination, to the involvement of indigenous and local populations in conservation projects. We argue that the concept of "commons" is a useful tool for collective management, at the local scale (but also at international level, as explained in Section 2.2.3). Finally, we focus on NGOs and the dilemmas they can meet on the ground when trying to conciliate social and biodiversity conservation programmes.

There are two important challenges for "traditional" peoples. First, "being traditional" cannot be imposed on populations that might aspire to something else for themselves or their children (Kohler & Brondizio, 2017). "Being traditional" can be interpreted as being frozen in time, while in practice, being traditional means keeping a certain ethos, habitus (Bourdieu, 1977) or worldview even when adopting new practices and technologies. Many traditional populations are traditional exactly because they do not have access to full citizenship like basic public services. Keeping tradition alive should be a choice and not be imposed by conservation policies (Fukuyama, 2014), especially when access to benefit sharing is still to be enforced by national policies (Carrizosa, 2004; Stabinsky & Brush, 2007). The Nagoya Protocol paved the way by formalizing this access to benefit sharing (Bélair *et al.*, 2010).

Second, many public policies can sacrifice traditional practices to accelerate modernization (Roué & Molnár, 2016). Traditional populations are thus marginalized and forced to adapt to dominant market systems. Both challenges underscore the fact that traditional peoples need a legal forum to express their aspirations, while outsiders often view them as innate ecologists, supposed to compensate for environmental degradation brought on by development, or as obstacles to progress, requiring a quick assimilation (Chapin, 2004). In both cases, the interests of the environment and traditional peoples only partially coincide and environmental policies should not be limited to delegate environmental responsibilities to traditional peoples, because resolving environmental problems require a global rethinking of development trends.

For the purpose of this assessment, we will adopt the IPBES definition of indigenous and local people (which does not overlap exactly with the definition of the ILO, 1989), namely that indigenous and local people are those who rely on traditional cultural and subsistence practices and are at least partially dependent on local biodiversity and ecosystem services for their social reproduction (also see Glossary). Social reproduction here is understood as the phenomenon by which a society can perpetuate itself across time. For further discussion and definitions about indigenous and local knowledge and practices see Chapter 1.

Indigenous and local concepts and perceptions are embedded in worldviews deeply bonded to a specific territory, and some understanding of these worldviews is required to include them in this assessment. For example, concepts such as "taboo" (forbidden place, animal or action), "mana" (emanation of supernatural power) or "hau" (the spirit circulating through gifts) are seldom included in international assessments. The concept of "Mother Earth" used by IPBES, is specific to human groups (especially Andean), but was mentioned in the conceptual framework to signify the intimate relationship between human beings and their environment (Díaz *et al.*, 2015).

2.2.2.1 Nobody will survive the fall of the sky: spiritual knowledge against degradation

To understand the very specific link between indigenous and local peoples and their environment, we may have to rely, in many cases, on first-hand ethnography. **Box 2.2** gives an example of the complexity of the interpretive system of Yanomami people of South America, an example intended to illustrate the difficulty of generalizing indigenous and local concepts. However, in general, the link between indigenous and local practices and the environment is neither "human-centric" nor "eco-centric": human societies and the environment are perceived, not as separate entities, but as involved in a unique relationship (especially in totemic and animistic cosmologies - Descola, 2013). This relationship embraces also spiritual and symbolic values (Brondizio *et al.*, 2009; Díaz *et al.*, 2015).

For example, the concept of "mauri" among the Māori population of New Zealand is an expression of a balanced ecosystem and cosmic order (Harmsworth & Roskruge, 2014). A similar concept exists in Yanomami's cosmology (see **Box 2.2**) and in many other indigenous groups. It expresses the transcendence of a spiritual/physical principle according to which degraded land and soils are spiritually damaged, affecting the connectedness between humans and nature. Such a spiritual relation between humans and land and soils was vivid in Europe before the Enlightenment period (Patzel, 2010). A slight modification in land cover or species distribution also affects social balance and culturally significant places. In present days, in New Zealand, researchers, including Māori, have used indigenous memory and knowledge (mātauranga Māori) – for example understandings of traditional Māori concepts such as taonga, mauri and kaitiakitanga – alongside science to develop an integrated inclusive approach to wetland classification, restoration and management (Harmsworth, 2002).

As discussed above, indigenous and local knowledge and practices are not only about ecosystem management, but also about maintaining socio-ecological balance, often through spiritual principles **(Box 2.2)**. As shown by Kalkanbekov and Samakov (2016), the rules of behaviour on sacred sites leads to preservation of biota located in these areas. Many peasant communities around the world, who are not legally recognized as indigenous, maintain this spiritual relation through ethical practices. Respecting this spirituality through the concept of sacred sites is a powerful tool for biocultural diversity conservation. The example of Uluṟu-Kata Tjuṯa (Ayers Rock-Mount Olga), in Australia – at first a National Park (1958) then part of UNESCO cultural heritage (1994) – is one of many (Whittaker, 1994). Some countries went even further by considering that the environment should be defended as such, thus acknowledging its spiritual, but also intrinsic value. Such is the case of the New Zealand Parliament that adopted an Act stipulating that Te Urewera was no longer a National Park, but a legal entity with "all the rights, powers, duties, and liabilities of a legal person" (Section 11(1) of the Te Urewara Act, New Zealand Legislation, 2014). This Act was based on the recognition of the spiritual bond of Te Urewera ecosystems and Landscapes and Ngāi Tūhoe people, who endorsed the role of "guardians" of its integrity. On 5 August 2014, another Act was approved, giving the status of legal entity to Whanganui River in New Zealand (Ruruku Whakatupua, 2014). Under this Act, the Māori community and the government will each appoint a member to represent the river's interests.

These inclusive policies should not be conceived as creating open-air museums, but as responding to the necessity of reconnecting nature and people via immaterial links (Dudley *et al.*, 2009; see also Chapter 5, Section 5.4.6). Many sacred sites were purposely considered as sacred precisely because of their ecological and/or aesthetic interest (e.g., the Meteora monasteries in Greece or Mount Saint-Michel in France). Spirituality diffuses in a day-to-day life by creating long-lasting ethical principles, for which the Yanomamis' forest is an example (Kopenawa,

Box 2 2 Yanomami's perception of gold mining in the Amazon.

Yanomami's first contact with Brazilian pioneer fronts occurred in 1971 when the military regime decided to build a peripheral road in Northern Amazon. The situation got out of control in 1979 when the price of a gold ounce rose in the London Stock exchange, provoking a gold rush in Yanomami's traditional territory. The pressure from thousands of gold miners on game and other resources reduced Yanomami population from 20,000 to 7000. Yanomami were subjected to new diseases and starvation due to the disappearance of bushmeat, the use of mercury, as well as to massacres, rapes and slavery.

Anthropologist Bruce Albert (1993) documented the words of shaman and spokesperson Davi Kopenawa's about Yanomami's perceptions of the land degradation provoked by the gold rush. Yanomami perceive gold mining as "forest eating" and gold miners as "supernatural peccaries" rummaging through the soil, threatening cosmological order *(urihiri)*. In their worldview, Omamë, Yanomami's creator of the universe, destroyed the first world he created by provoking the fall of the Sky, which became the new Earth surface. The ancient world was buried, including gold and other metals, along with malevolent spirits. Buried metals are conceived as pathogenic agents *(shawara wakëshi)*, emanating a deadly smoke when extracted. That smoke affects and kills Yanomami. It affects also the "forest's breath", suffocating the trees and the living beings. Yanomamis now conceptualize all white men's activities through this lens and generalized the concept of *wakëshi* to embrace industrial pollution in a global perception of threatened sky and Earth. White men's greed is seen as a form of cannibalism, as it is contrary to Yanonami's worldview, according to which sociality is based on sharing food and goods. Thus, gold mining and wealth accumulation mean, not only ecological disaster, but also a perversion of human social order. Davi Kopenawa concludes: *"When we all have disappeared, when all our shamans will disappear, I think that the sky will fall again. […] The forest will be destroyed, the sky will darken. […] White people are smart, but they ignore the power of our shamans, and they are unable to hold the sky. […] Not only will the Yanomami die. White people will die also. Nobody will escape from this new fall of the sky."*

Based on Albert (1993).

2013). This mana (to use this generic indigenous concept for supernatural presence) challenges the limits between ecology, society and spirituality (Berkes, 2012). Sacred spaces that have spiritual significance create tangible opportunities for conservation of biodiversity and ecosystems (Bhagwat & Rutte, 2006), while preserving unique social-ecological systems, all of which are part of human cultural diversity. These considerations also raise the issue of the perception of restoration by indigenous and local populations in the case of sacred and symbolic sites. Although the ecological attributes of a degraded site can be, in theory, restored, one might question if the same can be said of its cultural value (Wild *et al.*, 2008).

This leads us to consider other ways of integrating indigenous and local concepts and perception not only in science, but also in industrial and post-industrial societies. An example of these alternative standards can be found in the Constitution of Ecuador (Constitution of Ecuador, 2008) and Bolivia (Constitution of Bolivia, 2009) which have integrated the concept of "Buen vivir" (or "Vivir bien") in order to recognize that individuals depend on nature (Acosta, 2008; Walsh, 2010). "Buen vivir" translates the Aymara concept of *Sumak Kawsay*, meaning "fulfilment". This ethics considers, for instance, that land is not only a means of production, but also a living territory with multiple, material and immaterial, dimensions (Borsatto & Carmo, 2013). Applied to nature, it leads to the restoration of land in accordance with a natural state baseline, a flourishing natural life. Applied to humans, it means that individuals should fulfil their lives through sociability, friendships and family ties, well-being, leisure, harmony with nature, and not just through work and material consumption. Amartya Sen (2001) proposes a similar concept, "capabilities", to describe the human potential to attain fulfilment. As a Constitutional principle, "Buen Vivir" refers to ancient and traditional Andean knowledge. Its concrete implementation in public policies, though, is still problematic (González & Vázquez, 2015; Gudynas, 2011; Villalba, 2013).

At an ideological level, "Buen vivir" entails an ethics that many rural social movements have adopted. This dimension of indigenous and local knowledge and practices transcends the limits of local projects: it constitutes a model of alternative connections between humans and their environment.

2.2.2.2 Withdrawing cash from the water bank: practical knowledge for restoration

Scientific assessments of land degradation and restoration are carried out using modern tools and technologies. However, it is important to recognise that the parameters by which indigenous and local people assess the indicators of land degradation and restoration are based on their traditional, long-term knowledge and have relevance to local resource management practices (Adams & Watson, 2003; Bollig & Schulte, 1999; Oba & Kotile, 2001; Talawar & Rhoades, 1998). The experiential and transgenerational knowledge of their surroundings, built on their close proximity and familiarity with their environment, is the key to the depth of indigenous and local perceptions of land degradation and restoration (Bennett, 2015) and their adaptive agrobiodiversity management (Jackson *et al.*, 2012). However, some of this knowledge may be subject to the shifting baseline syndrome discussed in 2.2.1.2. Nevertheless, studies have shown that, in many cases, indigenous and local people's soil classification systems are based on their in-depth knowledge of soils and often complements scientific assessments of soil properties aimed at determining the suitability of soils for agriculture (Adams & Watson, 2003; Cervantes-Gutierrez *et al.*, 2005; Critchley & Netshikovhela, 1998; Douangsavanh *et al.*, 2006; Peña-Venegas *et al.*, 2016; Pulido & Bocco, 2014).

Indigenous and local knowledge and practices about land management, and the causes and consequences of land degradation, can offer potential options for restoration. Thus, it is important to find "hybrid" solutions linking indigenous and local knowledge and scientific knowledge, as well as adopting interdisciplinary approaches to address these issues (Altieri, 2004; Andrade & Rhodes, 2012; DeWalt et al, 1999; DeWalt, 1994; Tengö et al, 2014). Today this complementarity is still problematic and different frameworks have been proposed for enabling successful collaboration between scientists and knowledge holders (Ens *et al.*, 2012; Trosper *et al.*, 2012).

The level of environmental knowledge of local and indigenous populations is today largely accepted and is unquestionable in its importance and relevance to conservation (Berkes & Davidson-Hunt, 2006; DeWalt, 1994; Tengö *et al.*, 2014). However, only recently has indigenous knowledge been welcomed and integrated into scientific knowledge in works on conservation issues (Reid *et al.*, 2009). This approach requires an equal partnership between scientists and local and indigenous peoples in every step of the research process. This integration is facilitated in in-situ conservation projects through a participatory approach (Borrini-Feyerabend *et al.*, 2000; Chambers, 1994), leading to community-based conservation programs (Berkes, 2004). The participation of local populations is not automatic, of course, and the efforts can be in vain because of the political context (McCormick, 2014). Nevertheless, there is reason to remain optimistic about this participatory process, as seen in **Box 2.3.**, describing how a successful restoration project is perceived by local population in Abraha Atsbeha, a village of Northern Ethiopia.

Box 2 3 **The case of Abraha Atsbeha: creating a "water bank" in Northern Ethiopia.**

Abraha Atsbeha is a village situated in Tigray, Northern Ethiopia, one of the driest parts of the country. By the end of the 1990s, after massive deforestation and overgrazing, the villagers relied almost exclusively on food aid. But, as Ato Gebremichael (main actor of the project and former chief of the village) put it: "for how long can you be a beggar for food?" In 1998, the Ethiopian Government, supported by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and other donors, proposed that the villagers adopt a new management plan, consisting of fencing the cattle and restoring springs using traditional practices. Such a plan was successful thanks to a strong collective capacity to achieve common objectives, a capacity translated into the concept of "social capital" (Brondizio *et al.*, 2009; Putnam, 1995). Now, almost twenty years after the beginning of the program, the villagers can harvest vegetables and fruits three times a year and can sell their surplus at local markets. The experience spread across the regions of Tigray, Oromia and Amhara, and inspired the program Africa RISING (The Africa Research in Sustainable Intensification for the Next Generation), created in 2012.

Locals perceive the restored springs as a bank account and irrigation as withdrawing cash from the "water bank". Ato Gebremichael describes it as: *"Allowing regeneration of vegetation on the upper part of the watershed is like putting your money in the bank. The only difference is that we are withdrawing the cheque not from where we deposit it, the upper part of the catchment, but from another place, the lower part of the catchment."*

Perceiving restoration as a metaphor for financial investment, and harvesting as an investment return, is an interesting way of reversing the unidimensional monetary evaluation, by considering nature's contributions to people as the money itself.

Based on: Lamond (2012); Shiferaw *et al.* (2012).

See also: "Ethiopia: The highlands turn green" on GIZ official website: https://www.giz.de/en

Many customary practices have a legal status within a tribe or even a state, if it recognizes customs as a source of law. Research in environmental law has demonstrated that many laws and decrees are based on customs, mostly regarding land management, fishing and hunting activities (Permingeat, 2009). Practical knowledge sometimes becomes a law regardless of its positive or negative impact on the environment. Nevertheless, this approach is fundamental to harnessing the solidarity between humans and their territory. Since the development of international environmental law, international and regional conventions have strived to preserve this knowledge. For instance, article VI of the African Convention on the Conservation of Nature and Natural Resources is dedicated to "land and soil" and calls for a sustainable management of land and its restoration. It explicitly mentions that local knowledge must be part of the management plans. In addition, article XVII of the Convention gives attention to the importance of respecting local farmers' rights and encourages their participation in decision-making processes (1968). However, the implementation of this Convention is still in process fifty years after it was signed (Ramutsindela, 2007) (see 2.2.3). Some countries specifically recognize indigenous rights, but international conventions are needed to protect traditional land tenure (e.g., Convention Concerning Indigenous and Tribal Peoples in Independent Countries, 1989) like the Voluntary Guidelines on Tenure (FAO, 2012). Protecting access to land has now become an urgent matter in the face of 'land grabbing' – when a foreign country buys arable land for its own supply (Borras Jr. & Francott, 2010; Freiburg, 2014; Locher *et al.*, 2012) – and the preservation of traditional knowledge is recognised as a major, albeit still poorly functioning, lever (see Section 2.2.3).

Furthermore, the question of fair and equitable benefit sharing is still an open one (Tvedt, 2006). The Nagoya Protocol the Convention on Biological Diversity (Buck & Hamilton, 2011) is meant to clarify this legal and moral issue both for genetic resources and for traditional knowledge associated with genetic resources (Buck & Hamilton, 2011). An adapted payment for ecosystem services, similar to the framework of European Union Common Agricultural Policy, is another path that needs exploring, as suggested by Ivașcu and Rakosy (2016) and Babai (2016) for Romania.

2.2.2.3 Social inequities versus "the tragedy of the commons"

The precarious situation of many indigenous and local people and their knowledge systems cannot be addressed by local participation in conservation projects alone, when existing development models continue to put pressure on their resources and livelihoods (Brandon, 1998) (see also **Box 2.4**, Section 2.2.4.3). For instance, some traditional farmers and/or traditional herders' conflicts in Sub-Saharan Africa are due to the expansion of monocultures reducing the extent of traditional grazing territories, leading to competition between traditional herders and small farmers, and to land degradation due to overgrazing (Tschopp et al, 2010; Turner, 2004). Facing the problem of overgrazing and erosion, or the overexploitation of undomesticated plants or animals, governments tend to impose restrictions that are hardly respected, as vulnerable communities have few alternatives (Mekuria et al, 2011; Wezel & Haigis, 2002). Sometimes, coercive legislation about uninhabited protected areas deeply affects people's relationships with their environment, leading to retaliatory actions such as burning protected forests (Agrawal, 2005a, 2005b) and intensive wood-trafficking (Kohler, 2008), or the loss of knowledge about how to coexist with predators such as wolves or bears (Benhammou, 2009).

Poverty and land scarcity is a major obstacle that can undermine conservation programmes, especially when it comes to tropical forests (Songoro, 2014). Local people are sometimes compelled to degrade forests when they cannot alleviate poverty, and therefore log and transform forests into pastures and croplands (Durand & Lazos, 2008). To face an uncertain future, these populations migrate (Reuveny, 2007) (see also Chapter 5, Section 5.6.2.1) or strategically invest in their children's education by overexploiting the remaining resources. However, these local issues should be considered, not as singular cases, but in part as the result of strict national policies (see Chapter 5, Section 5.2.2.2). Social inequity and the lack of adapted public policies cause or exacerbate many of these harmful practices (Adams & Hutton, 2007; Brockington *et al.*, 2006; Brockington & Wilkie, 2015; Sanderson, 2005; West *et al.*, 2006), especially in case of "land grabbing" (Anderson, 2013; Martiniello, 2013) and land concentration for export crops (Guibert & Sili, 2011).

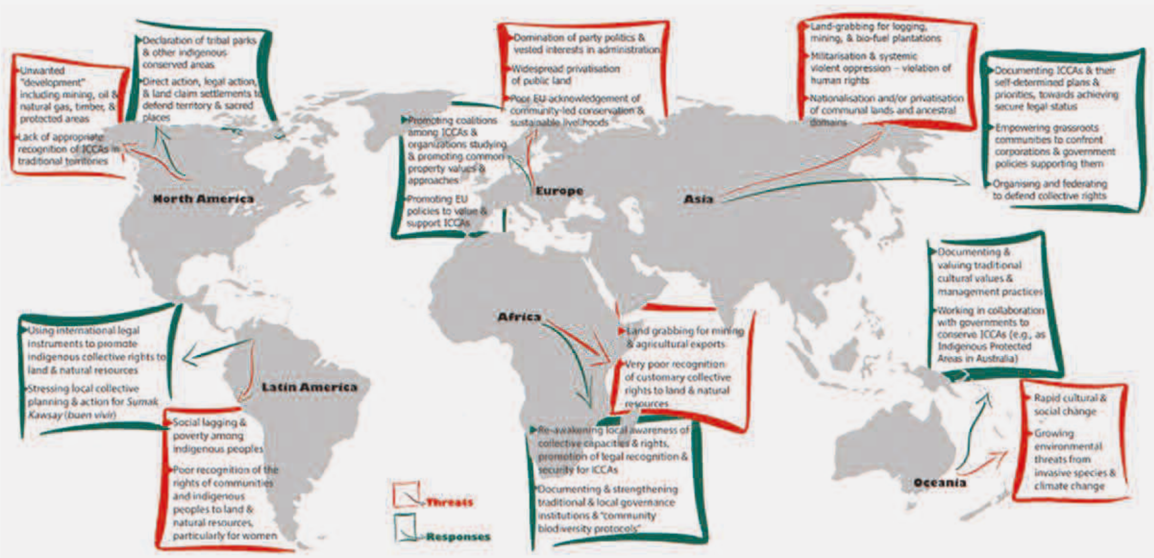
Many development projects occur in sparsely populated areas, which often coincide with traditional territories, such as hydroelectric dams (Rajagopal, 2014; World Commission on Dams, 2000). Pervasive deforestation in Africa (Kenrick & Lewis, 2001) and South-East Asia has led to the deterioration of "social ecosystems" in Indonesia (Anderson, 2013), Philippines (Eder, 1990; Zapico *et al.*, 2015) and many others (for an exhaustive list, see Survival International website: http://www.survivalinternational.org/). Indeed, negative environmental impacts can severely affect unique socioecological systems (i.e., human societies' reliance on the ecosystems they live in) and cultural diversity. In many instances, those most affected by these changes are also those most politically-marginalised (Kohler & Brondizio, 2017; Oyono, 2005). In such cases, especially, civil society can step in to stand for those segments of society that can hardly resolve these issues by themselves (Nonfodji, 2013). **Figure 2.10** show some of these conflicts and the solutions adopted.

Until recently, theories of human behaviour and common property contended that, left to its their own devices, individual pursuits and uses of common-pool resources inevitably lead to what was called by Hardin (Hardin, 1968) a "tragedy of the commons" (see also Chapter 5, Section 5.2.2.3). The underpinning rationale was as follows: under the shared management of common-pool resources, each individual engages in "free-riding" behaviour (Olson, 1965), whereby they hope to limit their own costs and maximize their own net benefits while benefitting from the conservation efforts of others. The predicted outcome is failure to cooperate and the unavoidable environmental degradation (Anderson & Hill, 1977; Demsetz, 1967; Hardin, 1968; North & Thomas, 1973).

In 1985, the National Research Council's Panel on Common Property Resource Management provided

Figure 2 10 **Example of threats to and responses by indigenous peoples and local communities.**

Source: The ICCA Consortium, Indigenous Peoples' and Community Conserved Territories and Areas (ICCAs), eaflet, Cenesta, Teheran (2013). http://www.iccaconsortium.org/



stimulus for an extensive number of case studies and meta-analyses on common property rights and collective action across the globe – an approach called Institutional Analysis for Development. These studies demonstrated that a “tragedy of the commons” was neither common nor inevitable (Berkes *et al.*, 1989; Bromley, 1991; Murphree, 1993; Ostrom, 1990). Throughout history there have been examples of socioecological systems in which the productivity of the land was low and human societies were unable to develop adequate collective institutions for internal regulation (e.g., the Polynesian Islands, the Easter Island) (Brander & Taylor, 1998; Caldararo, 2004). However, numerous case studies also demonstrated that self-organized collective institutions governed by stable communities that are buffered from outside forces have mostly sustained common-pool environmental goods and services successfully. Examples include collective rules for fisheries (e.g., Acheson, 2003; Davis, 1984), forests (e.g., Bray *et al.*, 2004; McKean, 1986) pastures (e.g., Campbell *et al.*, 2006; Netting, 1972), irrigation (e.g., Coward, 1977; Trawick, 2001), wild plants and animals (e.g., Dyson-Hudson & Smith, 1978; Eerkens, 1999) and production of landscapes (Bélair *et al.*, 2010). For a meta-analysis of the new commons and their implications for environmental management, see Duraiappah *et al.* (2014) and Lopez & Moran (2016).

Among the main concepts used to assess the efficiency of these systems are “human capital” and “social capital” (Brondizio *et al.*, 2009). Human capital represents all the knowledge, talents, skills, abilities, experience, intelligence, training, judgment and wisdom possessed individually and collectively by individuals in a population (Bourdieu, 1986). Social capital, as mentioned above, represents the capacity of a community (local or international) to gather and achieve common goals (Coleman, 1988; Putnam, 1995), sometimes by inventing new forms of governance, for example by empowering women (Banerjee & Duflo, 2012; Patel, 2012; Tripp, 2004).

Since the 1980s this new perspective on common property and collective action has given rise to community-based natural resources management policies and programmes that promote the collective ownership and management of common pool resources intended to deliver both conservation and community development outcomes (Ostrom, 2000; Poteete *et al.*, 2010; Roe *et al.*, 2009) (for a discussion of community-based natural resources management policies see Chapter 6). However, some critics observed that institutional analysis of development gave little space for ecological issues (Epstein *et al.*, 2013), including Ostrom herself (Ostrom & Cox, 2010). But lack of empowerment, land insecurity, resignation, poverty, social competition, lack of compensation, often inhibits a collective response if there is no international civil society support (Feldman & Geisler, 2012; Sanderson, 2005; Sanderson & Redford, 2004; Songoro, 2014) (see also Chapter 5, Section 5.2.3.3).

2.2.2.4 Facing human-wildlife conflict: NGOs’ dilemma

Since Rio 1992, the strategies between environmental (e.g., WWF, TNC, Greenpeace) and human rights NGOs (e.g., Survival International, Brazilian Instituto Socioambiental) began to converge, with environmental NGOs becoming a major ally of indigenous and local populations in their struggle for civil and territorial rights. This convergence came from an initiative of indigenous and local people, as expressed by the final declaration of the conference Two Agendas on Amazon Development, held by the Coordinating Body for the Indigenous’ Organisations of the Amazon Basin (2014: 81-93).

The main difference between major NGOs and governments is that the actions of the former are not limited by national borders, allowing them to have a global approach to problems that are often considered through the lens of sovereignty by governments. Major NGOs have the capacity to allocate funds where they are most needed. They can also cooperate with local groups to better target the desired objective, and thus, are major actors in channelling funds from developed to developing countries. This cooperation between international NGOs and local associations is crucial to avoid a standardized approach, disconnected from local realities. Instead, it can draw attention to the importance of listening to local populations as genuine stakeholders (Couix & Gonzalo-Turpin, 2015; Nastran, 2015), who must be given alternatives to meet their needs and social expectations (Sjögersten *et al.*, 2013).

This alliance between environmental and civil rights and/or humanitarian NGOs – and their commitment to local populations – can lead to positive results and achievements. Some well-thought and inclusive projects associate a broad range of stakeholders with diverging interests to promote common restoration projects – such as the restoration of the riverine forest of Xingu River, involving indigenous tribes, small farmers and soy producers (Arvor *et al.*, 2010; Campos-Filho et al, 2013; Schwartzman *et al.*, 2013) (see also Chapter 5, Box 5.5, Section 5.3.3.1 and Chapter 6, Box 6.5, Section 6.3.3.2).

However, these same alliances expose NGOs to a major dilemma provoked by land degradation – namely, the increased occurrence of “human-wildlife conflicts”, involving moral, political and ecological choices. Human-wildlife conflicts become more frequent and acute because of the shrinking of wild habitats (Dickman *et al.*, 2013), leading to extreme reactions such as culling (e.g., elephants) or poaching (mainly predators) (Distefano, 2005; Lamarque *et al.*, 2010; Löe & Röskaft, 2004; Woodroffe *et al.*, 2005). Emblematic apes (orangutans, chimpanzees and gorillas) are especially endangered by deforestation, leading them to feed on croplands. Furthermore, the increasing contacts between wild and domestic animals and human leads to the outbreak of zoonosis (Woodroffe *et al.*, 2005) such as aids, bird flu, bovine tuberculosis (which also affects baboons) (Sapolsky, 2002), swine fever, brucellosis, rabies or Ebola virus (see also Chapter 5, Box 5.7, Section 5.4.2). All of these diseases can mutate and affect humans as well as great apes, leading the latter to extinction (Ryan *et al.*, 2011). Human diseases (e.g., tuberculosis or yellow fever) can also affect great apes (Köndgen *et al.*, 2008; Wolf *et al.*, 2014) or New World monkeys (Crockett, 1998; Goenaga *et al.*, 2012; Mucci *et al.*, 2003). The Ebola outbreak in Gabon and Congo killed 5000 gorillas between 2002 and 2003 (Bermejo *et al.*, 2006). How can an NGO decide which species – endangered gorillas or humans – to deal with in the first place? An urgent situation should not prevent long-term programs, such as restoring deforested areas that create buffer zones to avoid future ethical dilemmas.

Much of the research on conservation conflict focuses on the adverse impacts that humans or wildlife have on one another (Conover, 2001), like the impact of predators on livestock (Marchini & Macdonald, 2012) or the impact of hunting on endangered species. A common response to these problems has been to scientifically quantify the impacts and then use legislative (e.g., bans and penalties), mitigation (e.g., financial compensation) and technical mechanisms (e.g., fencing livestock) to address¬ them (Gutiérrez *et al.*, 2016). However, adverse interactions between humans and wildlife are frequently a manifestation of underlying clashes of interests and values between opposing human groups (Marchini, 2014). Beneath the observable actions and impacts lies a complex web of contrasting worldviews and deteriorating trust between those who want to preserve wildlife and those whose livelihood and well-being are affected by it (Redpath *et al.*, 2015). Moreover, conservation conflicts often serve as proxies for conflicts between people over other social and psychological issues, including: struggles over group identity or ways of life; recognition; socio-economic status; fear of loss of control; and anger over historical grievances (Madden & McQuinn, 2015).

Different groups may have different views of what a conservation conflict is about, or whether there is a conflict at all (Redpath *et al.*, 2015; Young *et al.*, 2016). The effects of conflict on health and well-being of local people have been acknowledged (Barua *et al.*, 2013) and a great variety of local approaches to conflict resolution exist (Reed & Del Ceno, 2015). There is often a reluctance on the part of NGOs and government actors, including their respective scientific advisors, to acknowledge local perceptions of conflict, which can lead to increased frustration and lack of cooperation (Hulme & Infield, 2001; Young *et al.*, 2016). In many situations a top-down approach might ultimately be counter-productive, since the frustrated party (generally the locals) may develop a sense of grievance and the conflict may re-emerge elsewhere or several years after (Redpath *et al.*, 2015; Redpath *et al.*, 2013). Another counterproductive approach is to forbid practices based on social-ecological balance (see for example totemic and animistic worldviews described in 2.2.2) in which humans and predators maintain social relations (sometimes conflictual) based on beliefs or history (e.g., tigers and Mishmi people on the Sino-India border in Aiyadurai (2016)).

Confronted with the difficulty of solving these situations, scholars and practitioners (officers and/or employees from both NGOs and government agencies) have started to address conservation conflicts through better integration of knowledge and concepts in the ecological sciences with those in the social sciences that regularly engage with the underpinnings of human conflicts, such as psychology, sociology and peace studies (White & Ward, 2011). A review of 52 environmental conflicts indicates that mutual engagement of the parties can contribute to the development of equitable and effective agreements and improved relationships (Emerson *et al.*, 2009).

As existing legislation may sometimes be perceived as discriminatory, especially if it derives from international agreements imposed on national policies (Kohler, 2008; Mermet & Benhammou, 2005), NGO practitioners are generally better accepted at the national scale (Heydon *et al.*, 2010). However, complexity and uncertainties characterize any conflict management process, whereby conflicts can re-emerge unexpectedly; a long-term adaptive management approach is therefore required (Milner-Gulland & Rowcliffe, 2007). But another problem arises from the fact that NGOs are often accountable to their donors, above and beyond local populations or governments. This is a key issue in understanding how human-wildlife conflicts remain frequently unsolved. There are situations, for instance, where a specific program can come to an end, along with the means allocated for its implementation, even if the situation is far from being stabilized (Desmarais, 2007; Kohler, 2008).

What is certain is that NGOs cannot address human-wildlife conflicts on their own. Their actions have to be supported by strong political decisions. Examples include: limiting demographic pressure (see Section 2.2.4.2); developing payment for ecosystem services; enforcing legislation against long-distance wildlife trafficking; and avoiding the conversion of protected areas for activities such as transportation infrastructure, mining activities, oil extraction, export crops, dams and so on (see also Chapter 5, Section 5.3.2.1). In addition, endowing local populations with the ability to manage their commons – with a strong commitment to conservation issues – is generally effective.

2.2.3 Farmers and agribusiness: the conservation paradox

According to Graeub *et al.* (2016) the broad term "family farming" can be divided into at least three groups with differing needs: "those that are well-endowed and well-integrated into markets ('Group A'); those with significant assets and favourable conditions but lacking critical elements (like sufficient credit or effective collective action) and who may not qualify for social safety nets ('Group B'); and land-poor farmers, who are primarily characterized by family subsistence and/or non-market activities and who require significant investment in social safety nets ('Group C')".

The current subsection will focus on Group A as the main, but not only, representative of developed and emerging countries. Because of the territorial extension of agriculture and livestock farming, farmers are considered major actors in land-use conservation and environmental policies (Mattison & Norris, 2005). In 2005, agriculture covered 40% of terrestrial land (Foley *et al.*, 2005) (see **Figure 2.5**). Agriculture is a major driver of land cover change (Gibbs *et al.*, 2010; Lambin & Meyfroidt, 2011b; Southgate, 1990; Tilman *et al.*, 2002) (see also Chapter 4, Section 4.3.3.2). Trade-offs exist between the necessity to feed over 7 billion human beings and to conserve natural resources.

A number of sociological studies have addressed the underlying attitudes behind farmers' practices (Ahnström *et al.*, 2009; Karali *et al.*, 2014; Kohler *et al.*, 2014; Sullivan *et al.*, 1996). These attitudes are not exclusively grounded in economic rationality, let alone the social reproduction of the production unit (understood here as the will to transmit the farm to next family generation). They are oriented by social context (Bieling & Plieninger, 2003; Burton, 2004), family history (Ahnström *et al.*, 2009), differing sensitivities regarding the environment (Siebert, Toogood, & Knierim, 2006), and economic opportunities (Karali *et al.*, 2014). Most of these case studies highlight a strong commitment to life "in open air" and a sentiment of proximity to nature. The longer a family has been settled in a region, the deeper the attachment to the land (Ahnström *et al.*, 2009) – also called "sense of belonging". These studies have shown that organic farmers are less likely to chiefly view land as a means to an end (i.e., producing food) (Sullivan *et al.*, 1996). However, in general, their privileged relationship with nature makes farmers averse to the idea that their activities are degrading land or should be supervised by national or local authorities (Léger *et al.*, 2006). Nevertheless, as shown in the following subsection, social expectations about the many dimensions of food production (including symbolic) can re-orient perception and practices to be more in line with a growing environmental concern (Michel-Guillou & Moser, 2006).

2.2.3.1 The consequences of the Green Revolution on farmers' perception

During the 1930s and after World War II, agriculture was considered a strategic issue for national food security. Nation-states became major actors in orienting and improving agricultural policies to achieve self-sufficiency. The Green Revolution – a major change in agricultural practice and technology, which occurred between the 1930s and the late 1960s – resulted in a change of perception toward the physical landscape of the land, which had been for centuries a family patrimony, endowed with meaning and memory (Juntti & Wilson, 2005). Feeding the world as a mission assigned to farmers was one among the new watchwords of the agricultural policies, with Farmer Unions' support and the involvement of agronomic engineers. Standardized and patented seeds prevailed as a rule (Boy, 2008). Many traditional landscapes were now perceived as obstacles to new farm machinery (Kohler *et al.*, 2014). Food became disconnected from local consumption to enter global markets.

Despite the visible negative environmental impacts (erosion, toxic runoff, biodiversity loss) and the threats to human health, anthropological investigations showed that farmers have often interpreted their farming practices as cooperation with nature, affecting the way they perceive the negative environmental impacts of their practices (Novotny & Olem, 1994; Silvasti, 2003). High yields, regular rows and absence of weeds have become the elements that define "a good farmer" in the eyes of a peer (Burton, 2004; McGuire *et al.*, 2013; Silvasti, 2003). This concept of "good farming" has become so important that, in some cases, croplands along roadsides (i.e., the visible plots) are treated with more herbicides than the other croplands (Burton, 2004).

This generation of farmers embraced the Green Revolution as a liberation from misery and "backwardness" (farmers' expression, associated with the old status of a "peasant"). The new worldview and professional pride in producing food and domesticating nature ("turning the land productive" – farmers' expression) has led them to prioritize utilitarian approach when adopting new practices (Ahnström *et al.*, 2009).

New environmental laws – such as the European Union Common Agricultural Policy's turn to incentivising eco-friendly practices – are frequently perceived as a burden (Burton *et al.*, 2008). This perception of environmental issues as being secondary has been reinforced by the fact that fuel, water and chemical inputs are often highly subsidized by governments or federations, thus sending contradictory messages to farmers (Bazin, 2003; Kirsch *et al.*, 2014).

Competition among farmers at a national and international scale was further encouraged by the agreement following the Uruguay round (WTO, 1995). It laid the basis for an open access market (Part III, Article 4), by discarding domestic support to agriculture (Part IV, Articles 6 and 7, and Part V, Articles 9 and 10) and limiting national adjustments through specific custom duties (Part V, Article 8 and Annex 5, Section A). The global agricultural market would now be overseen by a supranational Committee on Agriculture, a subsidiary of the World Trade Organization (Part XI, Articles 17 &18) (WTO, 1995). Moreover, the agreement on intellectual property gave a major boost to biotechnologies, paving the way for corporations to be involved in the food production system (Lewontin, 1998; Desmarais, 2007). From then on, agriculture (which was until then a strategic national issue), became considered as a business like any other. In own words of the African Development Bank President: "agriculture is not a way of life. It is not a social sector or a development activity, despite what people may claim. Agriculture is a business. And the more we treat it as a business, as a way to create wealth, the more it will promote development and improve people's lives" (Adesina, 2016). Confronted to the necessity of producing more produce at low prices, farmers became encouraged to invest in productivity, sometimes leading to a spiral of debt.

While farmers have long minimized the environmental impacts of their practices when compared with the necessity of producing food (Tucker & Napier, 2001), they are more and more inclined to adopt environmental concerns. Not only in high-income countries, but also in middle-income countries (Karali *et al.*, 2014; Paolisso & Maloney, 2000), a shift is induced by the changing rural population and more generally by the pressure of public opinion, which results in emphasis on health and consumption concerns over production. The gap between conventional farming practices and people's awareness of the impact of the 'productivist' model on environment and food quality has been continuously increasing since the 1980s and the 1990s (Ward *et al.*, 1995). In other terms, the structuring concept of "good farmer" is now evolving to meet consumers' expectations.

Although conservation agriculture (González-Sánchez *et al.*, 2017) can have some negative aspects (e.g., increased labour when herbicides are not used or lower yields in the years following conversion) (Brouder & Gomez-Macpherson, 2014; Giller *et al.*, 2009), an increasing number of farmers are opting for new practices to meet consumers' willingness to pay for high-quality, low production footprint and locally-produced food, in developed as well as in emerging countries. In Sub-Saharan Africa and South Asia (Stevenson *et al.*, 2014), conversion to conservation agriculture is mostly meant to avoid land degradation and empower small farmers, when duly accompanied by private companies and investors (Jenkins *et al.*, 2004; Lambooy & Levashova, 2011), NGOs or government agencies. For higher income countries, provided they are correctly embedded in rural and/or urban social networks, farmers can escape from the spiral of debt and assume a more fulfilling social role (Knowler & Bradshaw, 2007; Padel, 2002; Strochlic & Sierra, 2007; Vogl *et al.*, 2015). Conversion to organic farming, adhesion to emerging social movements such as SlowFood (a grassroots movement in favour of locally and ecologically produced food) (for more details see http://www.slowfood.com/) or AMAP (French Association for the maintenance of a proximity agriculture, aiming at creating direct contact between producers and rural and/or urban consumers) (for more details see http://www.reseau-amap.org/), are potential pathways, as described in subsection 2.3.2.1.

Emerging concepts in agriculture, based on multifunctionality (Brouwer, 2004), are illustrative of this shift towards integrating environmental concerns in agricultural practices. The concept of "multifunctional agriculture" was adopted by the FAO (1999) and the EU Commission to foster an approach integrating landscape, biological connections and less environmentally-harmful practices. Traditional production practices that include these three aspects and contribute to the economy of the country already exist across Europe (e.g., olive gardens in Portugal, Greece, Italy and Spain) (Gu & Subramanian, 2014). Some developing countries also adopted this approach (Kriesemer *et al.*, 2016; Pham & Smith, 2013). Multifunctional agriculture is meant to integrate the economic, social and ecological aspects of land management. Two central concepts, those of land sparing and land sharing, have emerged and could be determinant (Hodgson *et al.*, 2010; Rey Benayas & Bullock, 2012).

Land sparing or "land separation" involves the agricultural intensification of existing land so that more land can be spared for wildlife conservation. It involves restoring or creating non-farmland habitat in agricultural landscapes at the expense of field-level agricultural production – for example, woodland, natural grassland, wetland and meadow on arable land. This approach does not necessarily imply high-yield farming of the non-restored, remaining agricultural land (Benayas & Bullock, 2012). See also 'Conservation agriculture' in Glossary.

High-yield farming requires less surface to produce the same quantity, or even more, assuming that modern technologies will continue to improve farming methods. Thus, arable land can be spared and restored to natural processes through fallows and afforestation. Land sparing is a trade-off between conventional methods, based on technological progress to overcome the limits imposed by the ecosystems, and the necessity to contain agricultural extension at the expense of natural processes (Adams & Mortimore, 1997; Bommarco *et al.*, 2013; Garnett *et al.*, 2013; Pender, 1998). Cultivation methods, in a context of land scarcity, could benefit from chemical and technological inputs (Brussaard *et al.*, 2010) – such as replacing bullocks and their manure by machinery (Gathorne-Hardy, 2016) – or could be used as an alternative for swidden fallow techniques in tropical contexts (Cardoso & Pinheiro, 2012; Ministério do Meio Ambiente, 2004). In other terms, intensification has the potential to simultaneously respond to farmers' demand for more productivity and competitiveness, while sparing land and preserving the environment (Barrett *et al.*, 2005; Foresight, 2011; The Royal Society, 2009; Rockström *et al.*, 2013; Roehrl, 2012; Smith *et al.*, 2010) (see also Chapter 7, Section 7.3.1). However, land sparing presents several limitations: it can spare ecological functions at the landscape level but not at the field level, and it tends to increase competition among farmers and make them even more dependent on off-farm resources (Benayas & Bullock, 2012).

Land sharing, on the other hand, is meant to restore ecological functions at the level of the field and to integrate agricultural production and natural processes. According to Benayas and Bullock (2012), five types of intervention follow the land sharing approach: "(i) adoption of biodiversity-based agricultural practices; (ii) learning from traditional practices; (iii) transformation of conventional agriculture into organic agriculture; (iv) transformation of 'simple' crops and pastures into agroforestry systems; and (v) restoring or creating specific elements to benefit wildlife and particular services without competition for agricultural land use." This approach enables crop production and wildlife conservation on the same land. There are several approaches to land sharing: organic farming, agroforestry, agroecology, biodynamic agriculture and permaculture – generally falling under the umbrella of "conservation agriculture" (see also Chapter 6, Sections 6.3.1.1 and 6.3.2.4).

Land sharing is a first step towards farming without agrochemicals, as it is meant to integrate natural processes into agricultural production. Examples include maintaining hedges and groves to fix the predators' guild and maintaining pollinators and using mixed crops to benefit from complementary processes (e.g., cereals and leguminous plants and/or fruit trees). The "Greening" shift of European Union's Common Agricultural Policy reform of 2013 is an innovation that makes the direct payments system more environment-friendly by subsidizing farmers who use farmland more sustainably and demonstrate care for natural resources (for more details, see https://ec.europa.eu/agriculture/direct-support/greening_en).

Both approaches have proven efficient for the restoration of degraded land and ecosystem services, but success has depended on the nature of landscape and varied from case to case (Barral *et al.*, 2015). What should be understood, however, is that from the biodiversity perspective, the best outcome may be the one where, at the landscape level, some areas are completely spared for biodiversity, some areas are shared with the emphasis on maintaining biodiversity and in some areas the production can be intensified (see e.g., Hanski, 2011; Kotiaho & Mönkkönen, 2017; Rybicki & Hanski, 2013) (see also Chapter 6, Section 6.3.1.2).

2.2.3.2 Agribusiness social and environmental policies: an asset for mitigation

According to the FAO, "agribusiness denotes the collective business activities that are performed from farm to table. It covers agricultural input suppliers, producers, agroprocessors, distributors, traders, exporters, retailers and consumers. Agro-industry refers to the establishment of linkages between enterprises and supply chains for developing, transforming and distributing specific inputs and products in the agriculture sector. Consequently, agro-industries are a subset of the agribusiness sector. Agribusiness and agro-industry both involve commercialization and value addition of agricultural and post-production enterprises, and the building of linkages among agricultural enterprises. The terms agribusiness and agro-industries are often associated with large-scale farming enterprises or enterprises involved in large-scale food production, processing, distribution and quality control of agricultural products" (FAO, 2013: 5-6).

A major change in agribusiness environmental policy was adopted after the Bhopal catastrophe (India, 1984) where an explosion in a pesticide plant belonging to a Union Carbide subsidiary officially killed 3828 (but Victims' Association count more than 20 000 collateral deaths). This catastrophe led the president of Union Carbide to declare at Davos, in 1991, that: "care for the planet has become a critical business issue – central to our jobs as senior managers" (Usunier & Lee, 2005:454).

Large corporations foster environmental consciousness by offering incentives to their suppliers. "For instance, responding to people's concerns about the destruction of rain forests and wetlands, multinational corporations such as Cargill and Unilever have invested in technology development and worked with farmers to develop sustainable practices in the cultivation of palm oil, soybeans, cacao and other agricultural commodities. This has resulted in techniques to improve crop yields and seed production" (Nidumolu *et al.*, 2009).

Many corporations respond to environmental concerns, especially when governments face stagnation of resources. On many occasions the private sector has been offered the opportunity to invest in market-based instrument and take a leading role in compensation, biodiversity offsets mechanisms (Jenkins *et al.*, 2012) and other schemes such as REDD+, ecotourism and/or sustainable forest and watershed management (Lambooy & Levashova, 2011). Lessening government involvement has led, in some areas, to the transfer of environmental management responsibilities to local or nongovernmental institutions, especially in Latin America (Liverman & Vilas, 2006).

The agribusiness sector responds mainly to social concerns by fostering programmes aiming at empowering small farmers to guarantee access to the global market. Five relevant concepts are highlighted in a report produced for the World Economic Forum, the New Vision for Agriculture's Partnership Model. This report underlined the necessity to provide solidarity and support to small farmers, especially in developing countries, through market-driven projects led by the private sector, rooted in viable business cases, integration of value chains that benefit all the stakeholders, and access to a globally connected market supported by an international network (World Economic Forum, 2016:3).

This initiative relies on multi-stakeholder conferences and workshops – associating farmers, rural outreach actors, policymakers and private sector leaders – and setting objectives for sustainable food production aligned with national objectives. For instance, at the May 2010 World Economic Forum on Africa, held in Tanzania, the multi-stakeholder taskforce was co-chaired by Tanzania's Minister of Agriculture and Unilever's Executive Vice-President. In 2011, to achieve Mexico's agriculture goals, the Minister of Agriculture proposed a partnership to private sector leaders, among which were Nestlé and PepsiCo. In Indonesia, the partners included Monsanto, Cargill and Syngenta.

One of the main drivers of such a collaboration is the food security issue; according to which feeding 9 billion people by 2050 requires developing new technologies for improved productivity in a context of land and water scarcity (Godfray *et al.*, 2010; The Royal Society, 2009). In this context, large corporations play a major role by investing in research and development while bringing greater benefits to farmers and rural communities for social equity. To achieve these goals, agribusiness defends the idea of agriculture (including small farming) as a market-driven activity connected to global markets, by providing small farmers seeds, inputs and guaranteed purchase. Bringing benefits to small farmers thanks to technology and access to the market leads major corporations to implement local programmes based on soy, corn, palm oil - both for human and animal food. **Box 2.4** (Section 2.2.4.3) gives the example of the Alliance for a Green Revolution in Africa, based on a public-private partnership. Developing and emerging countries are a promising market for GMO and agrochemicals, often presented by major corporations as "a technology for the poor" (Glover, 2010). Indeed, public opinion in developed countries (but not only) tends to be more and more reluctant to embrace biotechnologies and the use of agrochemicals, as shown by the "Monsanto Tribunal" held in The Hague on 15-16 October 2016 ("International Monsanto Tribunal," 2017) and a civil society initiative to promote the legal concept of "Ecocide" (or "crime against Nature"). This initiative was supported by 1200 organisations and signed by 90,000 petitioners (for further details, see http://en.monsantotribunal.org/signers-organisations).

2.2.3.3 Working towards transparency and ethical principles

The financial power of the research departments within agribusiness companies is quite enormous compared to public research funding in agronomy. The facts and data produced by researchers funded, directly or indirectly, by agribusiness companies (Simon, 2015) are in most cases legitimate, but generally focus on unidimensional evidence (e.g. restricted to nutrition facts without mentioning the environmental impacts and the risk of pesticide exposure in food) (e.g. Dangour *et al.*, 2009; Forman & Silverstein, 2012; Holzman, 2012). Moreover, by segmenting the studies, some companies do not disclose results about the "cocktail effect" of agrochemicals, nor do they conduct experiments based on public ordinary use, thus minimizing the level of exposure to pesticides and making it more arduous to identify more precisely the risks and impacts on human health (Damalas & Eleftherohorinos, 2011; Hernández *et al.*, 2013; Lee *et al.*, 2011).

Funding for public research generally glosses over areas where private research is perceived to be active. However, conflicts of interest have become an important theme in the scientific literature and community. A recent review of 672 scientific papers about genetically modified organisms (Guillemaud *et al.* 2016) showed that ties between researchers and the genetically modified crop industry were common, with 40% of the articles displaying conflicts of interest. The authors also found that the presence of conflict of interest was associated with a 50% higher frequency of outcomes favourable to the interests of the sponsoring company. Soon thereafter, another paper confirmed these conclusions (Krimsky *et al.*, 2017). For further discussion, see also Hicks (2017) and Wallack (2017).

Agribusiness specialized in chemical inputs and seeds also deploy a commercial strategy that considers farmers, not as primary producers, but as consumers (Diaz *et al.*, 2003). One of these strategies consists in offering packages of several products from the same brand, each tied to each other (UNCTAD, 2006), thus accentuating farmers' dependency on out-farm inputs and technical knowledge. It has been observed that this technical knowledge tends to disqualify local experiential knowledge, based on familiarity with soil and weather conditions (Desmarais, 2007; Marglin, 1996). Moreover, technical skills and understanding necessary for a proper use are extremely complex for farmers: studies conducted in Eastern Asia showed that farmers are not fully aware of the risks of using genetically modified seeds with high doses of pesticides on the development of secondary pests (for example on Bt cotton - see Ho *et al.* (2009) and Zhao *et al.* (2011)).

The dependency of farmers around the world is accentuated by the increasing concentration of the agricultural sector. According to the UN Conference on Trade and Development's report "Tracking the trend towards market concentration: the case of the agricultural input industry", less than ten major corporations (themselves results of mergers and acquisitions in the last 20 years) control more than half of the global seed market, with one corporation controlling 97% of the production of genetically modified seeds and three corporations controlling more than 50% of the global agrochemical industry (UNCTAD, 2006). The same report puts forward that the concentration of the sector sometimes leads to increased coordination and cooperation, such as contractual arrangements, alliances and collusive practices (UNCTAD, 2006). The report also states that the upstream production of seeds and agrochemicals is increasingly linked to the food processing industry: "it is also interesting to note vertical coordination upward and downward along the food chain, with the establishment of food chain clusters that combine agricultural inputs (agrochemicals, seeds and traits) with extensive handling, processing and marketing facilities" (UNCTAD, 2006).

These agrifood companies are generally reluctant to expose the ins and outs of the final products (Levin, 1999). A recent experiment with front-of-pack nutrition labels in France (Ducrot *et al.*, 2016) was met with strong opposition from major agrifood and distribution networks. Advertisements rarely mention actual facts: the information about production methods, socio-environmental impact, quality of ingredients, nutritional facts and types of additives is often incomplete or deficient. This tends to create a misperception of the origins and impacts of the food being consumed, thus hampering consumer awareness (e.g., the impact of meat consumption on climate change - Bailey *et al.*, 2014) (see also 2.2.1.3). Consumers in the lower economic classes are even less aware of the collateral effects of cheap and low quality food on weight, for instance (Cole *et al.*, 2000; Guignon, 2017).

When it comes to land degradation, agrochemical and biotechnology industries are partly responsible (see also Chapter 4, Section 4.2.4.2), and yet their efforts in restoring degraded lands are very uneven. Moreover, greater complications come from the fact that degradation induced by the agrochemical industry or other market forces can apply to different levels of biodiversity: the level of landscape and field (ecosystem diversity), the level of specific biodiversity or genetic diversity.

Ecosystem diversity is strongly affected by open-field monocultures based on mechanization and heavy chemical inputs. Intensive monoculture reduces habitats, pollutes soils and rivers, and reduces soils' capacity to regenerate, due to the disappearance of its microbiota and microfauna (Beketov *et al.*, 2013) (see also Chapter 4, Section 4.2.4.3). For instance, while using glyphosate in no-tillage agriculture is efficient against land degradation (see Section 1.3.4), the effects of this product on microbiota and aquatic ecosystems raises many concerns (Clearwater *et al.*, 2016). Regarding fertilizers, Reganold and Glover (2016) assert that soils in many regions across Sub-Saharan Africa are depleted to the extent that simply adding fertilizer will not improve soil health and may even make it worse (see also **Box 2.4**, Chapter 4, Section 4.2.9.5 and Chapter 5, Section 5.8.2.1).

Having a large share of the market gives corporations a potential leading role in reorienting practices and elaborating products less damaging to the environment and human health. Such a shift could be influenced by individual investors (by choosing ethical funds); by corporations (by negotiating between themselves a moral chart); or by governments, as suggested in 2012 UN Conference on Sustainable Development Declaration (point 47) (by creating a legal framework imposing transparency and fostering compensation, through restoration, and internalizing environmental costs in governmental taxes or in wholesale or retail prices). The liberalization of trade, in any of the cases, needs a high-level decision through international agreements.

Social and environmental concerns are now widely acknowledged by major corporations (WBCSD, 2008). However, remaining practices such as information retention – based on incomprehensive or loose legislations – tend to mislead consumers. This misinformation is further accentuated by the growing disconnect between food production, processing and consumption (Clapp, 2014; Henders & Ostwald, 2014).

2.2.4 Decision-making as a multifaceted (and endless) process

Decision makers at national or international levels have a major influence on the state of the planet, in matters of climate, degradation, overexploitation or sustainable use of natural resources.

This section begins with a summary of the concepts brought out in successive Earth Summits and the logic underlying international negotiations. Understanding what appears as political inertia (Brand & Görg, 2013) is central to shifting away from policies that aim to slow down degradation to implementing policies that seek to reverse it.

Another aspect explored in this section is the delay between scientific alerts and political decision (e.g. in Climate Change negotiations, 28 years - since 1988 - were necessary to take strongest but still non-coercive resolutions for its mitigation). The Alliance for a Green Revolution in Africa developed in **Box 2.4** (Section 2.2.4.3) gives a strong starting point to explore the various trade-offs between international assessments and high-level recommendations on environmental issues and development priorities. In Section 2.3.1.1, we build on the ideas of development, and more specifically "sustainable development," as the "fuzzy concepts". A fuzzy concept contains more ideology than reality, generating multiple understandings, which can lead to damaging decisions.

2.2.4.1 From Stockholm to Rio+20: the North-South tension

International negotiations on environment and climate have been shaped, since Stockholm 1972, by a North-South subjacent conflict and mutual distrust. This conflict is rooted in the first environmental report, *The Limits to Growth* (Meadows et al, 1972), published five to ten years after the independence of colonized countries, and in a period when a low oil price permitted accelerated growth in developing countries, such as "the Brazilian Miracle" (1968-1973). The conference was meant to raise global environmental concern and initiate a global eco-management strategy; and in practice, it catalysed an inflexion in environmental policies (White, 1982). It also introduced the idea of common but differentiated responsibilities.

The discussions in the Summit mostly revolved around development versus environment (Caldwell, 1972; Robinson, 1972; Rowland, 1973). The problems facing us today were already flagged in the preliminary debates and reports for Stockholm Conference (Hardin, 1968; Meadows *et al.*, 1972), and in the commentaries that followed its conclusion: demographic explosion, global climate change, collateral damages provoked by the Green Revolution (Joyner & Joyner, 1974).

Similar derivatives of the same discussion are ongoing almost half a century later and the problems policymakers have to solve today are still hampered by the same obstacles: difficulties in establishing effective supra-national environmental governance; a definition of sovereign rights that minimizes sovereign responsibilities (Caldwell, 1972; Coordinating Body for the Indigenous' Organisations of the Amazon Basin, 2014; Myers & Myers, 1982); and finally, guiding concepts based almost exclusively on economics (Robinson, 1972). In Stockholm, some developing countries strongly opposed environmental norms and taxes on the grounds that they could hamper socio-economic development (Robinson, 1972). For instance, José Augusto Araújo de Castro (1972), Brazilian Ambassador to the UN during the Summit, asserted that environmental issues concerned developed countries, while developing countries had no such problems. The necessities of achieving development was a priority to reduce poverty and reach Western standards of living (Castro, 1972) with a twofold ideological basis:

1. Environment was a matter of national priorities and developing countries' priority was development: "the implementation of any worldwide policy based on the realities of developed countries tends to perpetuate the existing gap in socioeconomic development […] and promote the freezing of the present international order. […] this permanent struggle between the two groups of countries persists in the present days and it is unlikely that it will cease in the near future" (Conca & Dabelko, 2015: 31).

2. Human beings stood above any environmental concern: "From the point of view of Man – and we have no other standpoint – Man […] is still more relevant than Nature" (cited in Conca & Dabelko, 2015:37). Hence, the idea that environmental concerns was a way for industrialized countries to impose restrictions on the development of other countries was deeply anchored (Head, 1977; Kennet, 1972; Kiss & Sicault, 1972).

By the time of the Rio Summit in 1992, developed countries had already accepted the idea of "common but differentiated responsibilities," according to which they should assume the financial burden of capacity building and technological transfer through the recently created Global Environment Facility (do Lago, 2009). The main achievement of this Summit, marked with optimism because of the end of the Cold War (Conca & Dabelko, 2010), were the United Nations Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD).

Genetic diversity did not become the financial manna expected and the collective intellectual property of indigenous and local communities has not yet been clearly conceptualized (Görg & Brand, 2006) nor defined in law. It is only 24 years after Rio Conference that Brazil approved Law No. 13,123 on May 20, 2015 and Decree No. 8.772 on May 11, 2016, regarding this topic. The reluctance of corporations to invest in and pay for indigenous or local knowledge about biodiversity is partially due to the complexity of negotiating rights to access and to benefit-sharing (Rosendal, 2011).

Coming just after the events of 09/11 in the U.S., the Johannesburg Summit in 2002 demonstrated that terrorism could affect the perception of environmental urgencies, just as the oil crisis of 1973 spoilt the advances of Stockholm Summit. Being held in South Africa, the host country insisted on prioritizing poverty issues as a leverage for international aid (Seyfang, 2003), by linking biocultural diversity to the eradication of poverty (Conca & Dabelko, 2010; UNESCO, 2002) as a return to old assistance policy (do Lago, 2009). Other developing countries (G77) disagreed with this orientation (Visentini & da Silva, 2010).

According to many observers, the UN Conference on Sustainable Development, held in Rio in 2012, provided continuity to the Johannesburg Conference concerns about poverty. The first and second sections of the final declaration "The Future We Want" (UN, 2012) consist of 41 points, out of a total 283, none of which mention the word "environment" alone, but rather always preceded by the necessity of reducing poverty and improving social development, gender equality and children fulfilment (Point 2, 4, 6, 10, 11, 19, 30). Point 11 is illustrative of the multiple priorities of the Summit: "we reaffirm the need to achieve economic stability, sustained economic growth, promotion of social equity and protection of the environment, while enhancing gender equality, women's empowerment and equal opportunities for all, and the protection, survival and development of children to their full potential, including through education." The definition of "Green Economy", a transversal concept widely used in the Declaration (point 26 and 58: b, g, h), insists on the necessary financial and technological support from developed to developing countries.

This last point strongly contrasts with the Stockholm principles, which asserted that sovereign rights came along with sovereign responsibilities. Another contrasting approach is about human demography: while Stockholm Declaration acknowledged the fact that demography was an environmental problem (see subsection 2.2.3.2 below), the Rio+20 declaration rejects all perspective of slowing down demographic growth, insisting on natality as a fundamental right (point 146), as well as universal access to assisted procreation (Point 145).

The focus on the human dimensions of sustainable development push us to think about different ways of conceptualizing socio-ecological relationship. As this chapter will further explore, we propose ecological solidarity (see Section 2.2.4.3 below) as an alternative paradigm. The next section revisits the demographic issue through the lens of environmental impact.

2.2.4.2 The taboo of demography as an environmental issue

Provided the average global fertility of humans declines to replacement level as projected, the human population will climb to 11.2 billion by 2100, from the current 7.5 billion. If fertility declines from what it is today, but remains half a child above the replacement level, human population will grow 120% and reach 16.6 billion by 2100 (United Nations, Department of Economic and Social Affairs, Population Division, 2015a, 2015b). This would lead, not only to an unsustainable demand in food and energy, but also to irreversibly transformed land through urban sprawl encroaching on croplands, thus threatening food security (Barbero-Sierra *et al.*, 2013; Doygun, 2009; Yeh & Li, 1999; Hasse & Lathrop, 2003; Jiang *et al.*, 2007; Johnson, 2001; Livanis *et al.*, 2006; Ministère de l'Environnement, 2017; Paül & Tonts, 2005; SAFER, 2013; Sheridan, 2007) (see also Chapter 4, Section 4.3.10).

How is human population size connected to degradation? For almost half a century, the growth of human populations has been blamed directly for environmental degradation (Diamond, 2005; Ehrlich, 1968; Hardin, 1968; Meyer & Turner, 1992; Robinson & Srinivasan, 1997). This led to years of discussion about the need to reduce population growth rates where they are high, often in developing countries. A UNEP report on the Economics of Land Degradation in Africa (ELD Initiative & UNEP, 2015), correlates land degradation and demographic growth: in 1962, each cultivated hectare supported 1.91 people; by 2009, one hectare supported 4.55 people (300% growth since 1962). Moreover, protected areas in poor countries tend to attract population for an easier access to natural resources, in the absence of better options (Joppa *et al.*, 2009; Struhsaker *et al.*, 2005; Wittemyer *et al.*, 2008), thus jeopardizing protection efforts (Liu *et al.*, 1999). Brashares *et al.* (2001) assert that where direct human influences put added pressure on species in remnant habitat patches, extinction rates are higher than those predicted by simple species and/or area models.

Many scholars objected to the focus on the number of people in developing countries. More attention is now given to how much each person consumes and how the Earth is used to support each person, especially in the context of growing meat consumption (Alexandratos & Bruinsma, 2012; Bailey *et al.*, 2014). If consumption per capita is important for degradation, then limiting consumption per person is also an appropriate goal (Ehrlich & Ehrlich, 2009; Ehrlich & Holdren, 2011). Both issues should be addressed in parallel, according to Ehrlich and Ehrlich (2009), along with the necessity of curbing economic growth by considering Earth's limits (Garcia, 2012; Meadows *et al.*, 1972). Both issues are equally complex as developing and emerging countries are striving to achieve Western standards of living and many developed countries are reluctant to change their way of life.

The declaration of Stockholm acknowledged the environmental problem caused by overpopulation in its 16th statement: countries should control their demography without affecting human basic rights. However, this matter was difficult to deal with, as the focus was mainly on developing countries' high natality rates. Once again, this approach was perceived as one more attempt from developed countries to interfere in developing countries' sovereign rights (Castro, 1972). The Stockholm Summit was followed by the World Conference on Population in Bucharest in 1974, where conflict led to the absence of a strong resolution (George, 1975). Soon after, the population problem was principally deemed a social and/or educational problem, excluding it from environmental discussions. A major step in this direction was the International Conference on Population and Development, held in Cairo in 1994. Its conclusion was that demography was a matter of education and empowerment of women, to be solved by international aid (Ashford, 2001; McIntosh & Finkle, 1995; Roseman & Reichenbach, 2010). "Since the use of family planning methods may prevent the prevalence of unplanned pregnancies, we call upon all national governments to reduce the need for abortion by providing universal access to family planning information and services" (UNPF, 1994, point 6). The Wall Chart developed by the Task Force on Basic Social Services for All (1997) focused on family planning, education, health care – addressing mainly the mother/child pairing and neglecting to address the connection between high birth rates, environmental degradation, migration flows and political instability.

Twenty years after Cairo, the International Conference on Population and Development (UNPF, 2014) published an assessment report on the Programme of Action adopted by the conferring parties. While the report acknowledged that a demographic transition occurred in many countries, it still highlighted that women's empowerment and gender equality were far from being achieved. A recent report by UNICEF (2014) dedicated to Africa, shows that the poorer the country and the social category, the less women have access to contraception – in Niger, for example, the number of women giving birth between 15 and 19 years old is 20,5%. According to the same report (2014:7): "in 2050, around 41% of the world's births, 40% of all under-fives, 37% of all children under 18 and 35% of all adolescents will be African – higher than previously projected." What is underlined is that family planning often fails to reach the most vulnerable fragments of the population and cannot fill the gap created by the lack of education combined with the lack of social inclusion. Hence, the question of human birth rate should be taken seriously – considering it both as a poverty issue and a high-priority environmental question (Crist *et al.*, 2017).

The main matter to discuss in developing countries is not only women's education or access to family planning, but the lack of retirement perspectives and, more specifically, the insecurity of people who fear to grow old without at least one child to support them. A solution, accordingly, could be to establish a universal retirement system, where pensions would be guaranteed even in case of political instability. Agenda 21 (5.56) also mentions the link between birth rate and lack of access to education and family planning, but it is mentioned in the social and economic section, and old age issue is mentioned as a separate problem: *"Proposals should be developed for local, national and international population/environment programmes in line with specific needs for achieving sustainability. Where appropriate, institutional changes must be implemented so that old-age security does not entirely depend on input from family members."*

On the other hand, FAO report "The Future of Food and Agriculture," mentions that "social protection combined with pro-poor growth will help meet the challenge of ending hunger and addressing the triple burden of malnutrition through healthier diets" (FAO, 2017b: xii).

Demographic issue is even more of a delicate matter in those countries where having many children is an element of social prestige for men, especially, but not only, in polygamist countries (Fargues, 1994; Goldstone, 2010). Such a system of value cannot be changed by policies alone, but should be accompanied, where appropriate, by awareness-raising of the environmental impacts.

Demographic issues also apply to developed countries, especially where extensive welfare policies exist. Even after the demographic transition, the population does not diminish, partly because immigration from overpopulated or conflict-ridden countries compensates for the birth deficit (e.g., one million migrants and refugees were reported in Germany in 2016), and partly because family allowances are ideologically-anchored in pro-natalist policies going back to the time of the word wars, especially in France (Palier, 2005; Prost, 1984). The ghost of an unbalanced rate between retired and active workers also looms on these policies (Murray, 2008; Van De Kaa, 2006) (see **Figure 2.11**), leading to what Joseph Chamie, former director of the United Nations Population Division, called a "Ponzi scheme" (https://www.theglobalist.com/is-population-growth-a-ponzi-scheme/).

Perhaps the key problem lies in the conception that birth limitation is invariably a violation of human rights. This perception is somewhat one-sided insofar as there is a

Figure 2 11 Pro-natalist campaign in Denmark.
Source: Spies Rejser (2014). https://www.spies.dk/do-it

distinction between controlling natality and not encouraging it. Family allowances are frequently proportionate to the number of children (Kalwij, 2010), hence discouraging natality would consist in limiting allowances to one or two children (Cochet, 2009). Not all birth limitation policies need to resemble the kind of totalitarian Malthusianism that is often assumed to accompany it, but rather can be stimulated through various socio-economic incentives and disincentives.

2.2.4.3 Towards new global concepts: ecological solidarity

For the purpose of this chapter, it is important to understand how a "common vision," as expressed in the Rio+20 Declaration can be based, forty years after Stockholm Summit, on reaffirming the necessity of economic growth to alleviate poverty, food production intensification thanks to agrochemicals and biotechnologies, liberalized global trade and other similar solutions. The Alliance for a Green Revolution in Africa programme, as discussed below **(Box 2.4.)** is an example of value-laden decision-making leading countries or economic federations to privilege one policy over others (i.e., a green revolution based on facilitated access to chemical inputs, mechanization, patented seeds and market-driven economy, as seen in Section 2.2.3.3).

Almost inconceivably, for the first time in human history, geophysical, climatic and biological changes are outrunning the time of political decision-making and are reaching the point of no return, as recently confirmed by an opinion paper signed by more than 15000 scientists (Ripple *et al.*, 2017). Markets and economic competition still govern international relations, which in turn, often ignore the impacts of land degradation, overexploitation of natural assets and climate change on quality of life and human well-being (Chan *et al.*, 2012). Indeed, from Stockholm to Rio+20, and even UNFCCC COP21 on Climate Change, negotiators had a tendency to privilege a geopolitical outlook over an ecological one. One of the main reason is the aforementioned North-South tension and divide. Some of the principles or issues that could have been considered as efficient instruments to build a common ground for negotiation were not adopted because of this tension. While embargos or sanctions have been applied for ideological, ethical or security reasons, such embargos or sanctions are unheard of for environmental reasons (for further discussion on this see UN 2012, Point 58).

To explain these consensual positions, the concept of "hegemony" is worth exploring. This concept underlies yet another one, that of "common sense". Both of these were coined in the 1930s by Italian philosopher and dissident Antonio Gramsci. As Karriem (2009:317) put it: "for Gramsci (1971), ruling class hegemony is not based on force alone, but on a combination of coercion and consent. That is, a hegemonic class rules by incorporating some of the interests of subordinate classes. Intellectual or ideological leadership is not merely imposed; instead, subaltern classes consent to or are persuaded to accept dominant ideas as 'common sense'."

This "common sense" helps us to understand why, beyond geopolitical disputes, international negotiations tend to privilege the same responses, based on a common

Box 2 4 Diverging perceptions about the Alliance for a Green Revolution in Africa (AGRA) program.

The Alliance for a Green Revolution in Africa launched in 2006, is mainly funded by the Rockefeller Foundation and the Bill and Melinda Gates Foundation. The current President of the African Development Bank declared, in 2016, that agriculture is a business and highlighted the importance of the Alliance for a Green Revolution in Africa for African food security (see http://www.afdb.org/en/news-and-events/article/agriculture-as-a-business-approaching-agriculture-as-an-investment-opportunity-15398/). The programme sets out to: encourage private investors in the agricultural sector; adopt hybrid varieties (e.g., maize and rice) tolerant to drought and pesticides; create local, African-owned seed companies that can multiply and distribute to retail shops locally; and adapt seeds and fertilizers to farmers, while training them in the use of these inputs. This view was expressed in a programmatic paper signed by two members of the Rockefeller Foundation and by the President of the African Bank of Development (Toenniessen *et al.*, 2008). The authors underlined that African farming systems were more diversified than in Southern Asia, where a Green Revolution occurred in the 1960s and 1970s, and led to a general improvement of farmers' condition and productivity (Pingali, 2012).

While the objective of an African Green Revolution is to ensure cereal self-sufficiency by 2050 (van Ittersum *et al.*, 2016) and integrate Sub-Saharan Africa into global markets as a competitive food producer, it is hard to find (ten years after the launch of the programme) openly positive assessments of the outcomes of this revolution. Most of the literature dealing with ex-post evaluation in several African countries (Ghana, Uganda, Tanzania and others) insist on the very context-specific successes or failures of this trend towards modernization and market-based policy (Dawson *et al.*, 2016; Moseley *et al.*, 2016; Moseley *et al.*, 2015). One of the inhibiting factors is the strongly anchored traditional seed exchange system, reluctant to adopt hybrid varieties (Louwaars & de Boef, 2012). Other authors underline the fact that AGRA should be accompanied by improvements in governance and democracy (Amanor, 2009; Markelova & Mwangi, 2010). A comparison between Asian and African Green Revolution shows that in the case of the former, the countries (especially India and Indonesia) were strongly supported and oriented by States, whereas Green Revolution in Africa relies more on markets for internal and external demand (Fischer, 2016). The same author asserts that African Green Revolution, contrarily to the Asian one, is not scale-neutral (i.e. of equal benefit to large-scale and small-scale farmers).

These structural problems – differing modes of production and social condition from one Sub-Saharan country to the other, along with generally poor environmental conditions – were acknowledged by the promotors of the project. Their anticipated response was that by increasing farmers' income thanks to a solid network of seed and fertilizer retailers and buyers, they would become economic actors in national and global markets while liberating workforce for industries (Toenniessen *et al.*, 2008), even in the absence of previous industrial revolution. Authors such as Frankema (2014) and Sheahan & Barrett (2017) are optimistic about the outcomes of today's improvements in technology, productivity and transportation, which could make an effective Green Revolution possible – able to improve farmers' condition along with the supply of a growing urban population.

On the other hand, the Alliance for a Green Revolution in Africa programme has been criticized by both scientists and international organizations. The same year Toenniessen *et al.* (2008) published their programmatic article, the International Assessment of Agricultural Knowledge, Science, and Technology for Development's Sub-Saharan Africa Summary for Decision Makers (Markwei et al, 2008) explicitly pointed at the danger of developing monocultures in Africa because of its social and environmental vulnerability, as did other researchers (Perfecto & Vandermeer, 2010; Scoones, 2009; Stigter, 2010). This assessment involved 400 researchers and dozens of national delegates (including those from Sub-Saharan Africa), who strongly recommended the adoption of agroecology as a sustainable practice.

The Alliance for a Green Revolution in Africa was also criticized by the special rapporteur on the Right to Food, in a statement submitted in 2009 to the Human Rights Council of the Office of the United Nations High Commissioner for Human Rights (Schutter, 2009). The conclusions of the Report on the Right to Food (Schutter, 2010) were identical. Finally, the International Panel of Experts on Sustainable Food Systems (IPES-Food, 2016) advocated for a paradigm shift from industrial agriculture to diversified agroecological systems (see also Chapter 6, Section 6.3.1.1). Many scholars also questioned such an orientation (Brown & Thomas, 1990; Holt-Giménez, 2008; Holt-Giménez & Altieri, 2006): small-scale farmers provide more than 70% of staple (FAO, 2014b) and are crucial for African food security (Altieri, 2009).

Indeed, a recent review showed that the cost of externalities provoked by pesticides is greater than the benefits of an increase in production (Bourguet & Guillemaud, 2016; Marcus & Simon, 2015; van Lexmond *et al.*, 2015). According to the Economics of Land Degradation report (ELD Initiative, 2015), the overuse and misuse of chemical fertilizer is a major cause of land degradation in Africa.

From a social point of view, some authors and institutions underline that the agroindustry leads to the displacement of rural populations to areas vulnerable to desertification and deforestation (Requier-Desjardins, 2008; Reuveny, 2007) – a situation worsened by climate change (FAO, 2008; IPCC, 2007) and by the absence of industrial jobs capable of receiving new workers. Land investment by multinational corporations can make the lives of small-scale farmers precarious because they are marginalized in the wider agricultural economy (Martiniello, 2013; Matondi *et al.*, 2011). It creates an underpaid rural class and also leads to rural exodus, increasing urban dwellers' economic insecurity, competition for subsistence and lack of options other than leaving agriculture all together (Bleibaum, 2010; Feintrenie *et al.*, 2014; Nonfodji, 2013; Richardson, 2010; Telenti, 2016) (see also Chapter 5, Box 5.4 and Section 5.3.2.5).

While the Alliance for a Green Revolution in Africa programme underlines that one of the major problems of African agriculture is crop losses, the FAO report on Food Wastage Footprint (FAO, 2013: 13) argues that the volume of food waste in agricultural production in Sub-Saharan Africa (35%) is equivalent to technologically-advanced European agriculture and less than Latin American agriculture. The main waste occurs in the phase of post-harvest handling and storage (35%), processing (12%) and distribution (12%). When the estimation is based on the number of calories, food loss in Sub-Saharan Africa goes up to 39%, while the main losses occur in the post-harvest handling phase (see **Figure 2.12**, Section 2.3.1.4). Food insecurity in Sub-Saharan Africa could (from these numbers) be considered a problem of conditioning and supply chain rather than one of production.

set of concepts, even if their efficiency is far from being constant or universal. New policy instruments could be used to facilitate international negotiations by fostering transnational and agreements. The concept of "ecological solidarity" (Naim-Gesbert, 2014; Thompson *et al.*, 2011) (see Glossary and Section 2.2.1.3, 2.2.4.3) would provide a useful framework for negotiating and implementing new and existing agreements (Pouzols *et al.*, 2014; Sarrazin & Lecomte, 2016).

"Ecological solidarity" is a French concept that needs further research. However, thanks to the revised law on National Parks of 2006 (Loi n° 2006-436), this concept already exists in the French legal order. Some studies have been made to explore the possibilities to extend it as a fundamental principle in environmental law and as a powerful tool for policymakers. Originally, ecological solidarity serves to guide the definition of ecological territories around protected areas, but it could convey a more global message based on the commonly shared idea that humans are part of their environment. It has an ecological, social and moral dimension, which allows it to be placed among the ecocentric concepts (i.e., between biocentrism and anthropocentrism). As explained by Thompson *et al.* (2011): "from ecology based on interactions to solidarity based on links between individuals united around a common goal and conscious of their common interests and their moral obligation and responsibility to help others, we define ecological solidarity as the reciprocal interdependence of living organisms amongst each other and with spatial and temporal variation in their physical environment" (also quoted in Section 2.2.1.3). This concept has two main elements (one factual, the other normative): (i) the dynamics of ecological processes and biodiversity in space and time; and (ii) the recognition that human beings are an integral part of ecosystem function. This concept is worthy of attention from a legal point of view and for land restoration, because it relies on the paradigm of a collective duty of humans towards the environment.

The origins of the meaning of "solidarity" comes with the idea of debt. According to Bourgeois (1896), solidarism is based on the principle of the existence of a debt among generations. Hence, the principle of ecological solidarity in the legal order could integrate the idea that the current generation owes to the future ones, requiring legislators, judges, and other actors of the law to take into account the long-term consequences of their actions on nature and future generations. Meanwhile, as we will see in Section 2.3.2, in almost all countries in the world, concerned people acknowledge the difficulty for decision-makers to adopt global solutions. This is the reason why, new solutions emerge, many times inspired by traditional knowledge and practices, based on ecological consciousness, social concern and global citizenship.

2.3 REALITY STRIKES BACK: IMPACT OF LAND DEGRADATION RAISES AWARENESS AND CAN MODIFY PERCEPTIONS

This section explores the main obstacles to the understanding of the reality of land degradation and the main reasons behind delays in decision-making. The section further explores how these delays can lead to informal social movements trying to adopt new practices and new forms of organization.

The first obstacle is that the temporal and spatial scales of land degradation sometimes make it difficult to perceive, as discussed in Section 2.2.1.3. As a result, inadequate understanding of land degradation and restoration – especially regarding timescales and long-distance connections – might cause policymakers and other stakeholders to create and support short-term and ultimately damaging policies.

The second obstacle is that concepts fundamental to land degradation or restoration are fuzzy (further discussion below in Section 2.3.1). This fuzziness can be worsened when private interests create uncertainty about the reality of environmental degradation, through lobbying or disinformation.

Finally, the incomplete understanding of land degradation and restoration may lead policymakers to perceive them exclusively from the perspective of food security. Indeed, global peace and political stability are threatened when basic needs of food and water are not adequately met due to land degradation (Barnosky *et al.*, 2012). Humans are thus posing a significant threat to themselves when they degrade the land. However, it is also important for policymakers to acknowledge that exclusive economic valuation of degradation and restoration may undervalue other dimensions important for a good quality of life (Wegner & Pascual, 2011a). The economic dimension is one among many dimensions of nature's contribution to people, which can be social, relational (Chan *et al.*, 2012), cultural (see Section 2.2.2), or intrinsic. This further emphasizes the importance and relevance of the multidimensional nature of human well-being (Jordan *et al.*, 2010).

In spite of these obstacles, information and awareness emerge and may elicit public reactions, especially when decision makers appear to be too cautious or risk averse (see Section 2.3.2.1). The capacity of civil society to organize and create alternatives can be a potent instrument to weigh on international decisions. However, many of these alternative solutions did not come to their full capacity as of yet.

2.3.1 Dealing with the multiple meanings of fuzzy concepts

This Chapter is about perceptions and how they gather into concepts. While many concepts intend to embrace the reality of human impacts on the environment, or to inform efficient tools for policy making, some can be misleading because they are 'fuzzy concepts' (Markusen, 1999). While they often facilitate consensual conclusions, this consensus is based on ambiguities and misunderstandings that can lead to future tensions. Examples are concepts like "sustainable development," "human progress," "precautionary principle" or "food security". These concepts are vague and can be interpreted in a multitude of ways, hampering any coordinated collective action.

2.3.1.1 Sustainable development

In the words of UN World Commission on Environment and Development (WCED, 1987), sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Today, however, sustainability is almost exclusively understood as having three dimensions: (i) economic development; (ii) social development; and (iii) environmental protection, as it was first captured by the United Nations in its Agenda for Development.

Sustainable development is perceived as a consensual issue, because nobody wants "unsustainable development." This, however, does not mean that this concept is clearly defined, by default (Mebratu, 1998; Redclift, 2002; Robinson, 2004). What exactly does "sustainable" mean? Slowing down the rate of degradation? Maintaining accelerated developmental dynamics while considering environmental issues? In the forestry sector, for example, the concept of sustainability is frequently used to refer to securing a regular long-term supply of wood products from the forest ecosystems (Kuhlman & Farrington 2010; Kotiaho & Mönkkönen, 2017).

Moreover, as seen in Section 2.2.4.1 the concept of Green Growth adopted during Rio+20 clearly affirmed that economic growth was a priority to reduce poverty. Therefore, invoking sustainable development is the opposite of considering "the limits to growth": an unlimited development will affect sustainability in all cases. Development generates losing natural capital, dwindling natural resources, increasing social conflicts and growing inequalities (Le Billon, 2015). The Earth and its ecosystems have ecological limits beyond which the whole life-supporting system may lose its equilibrium (Schramski *et al.*, 2015).

2.3.1.2 Human progress versus ethics

While sustainable development is conceived as a mainly economic issue, "human progress" is seen as synonymous with "technological advance". A human-centred perspective, placing humanity above all, has a tendency to oppose human progress to ecological issues, as expressed by Castro (1972). The problem with this humanistic vision of science and technology is that it does not include moral or ethical progress, which could compensate for this human self-centred (also called anthropocentric) vision of the planet (Rabhi, 2006, 2014). An alternative is "well-conceived humanism," a concept advocated by a French anthropologist Claude Lévi-Strauss (1985), which would leave space for other species by not destroying the planet. Considering the interests of non-humans and allowing them to evolve and adapt would be an important step in a more inclusive human ethics and a first step to acknowledge nature's intrinsic value (Burdon, 2011).

2.3.1.3 Precautionary principle versus "uncertainty principle"

The precautionary principle is a useful legal principle to enforce existing regulations when serious doubt exists. According to a common definition, the precautionary principle "enables rapid response in the face of a possible danger to human, animal or plant health, or to protect the environment" (Engle, 2008; EC, 2000). The precautionary principle is rooted in the idea that any decision that could affect the environment – and the services nature provides to humans – should be delayed until these impacts have been quantified. This applies mainly to new agrochemical molecules or genetically modified organisms that can have long-term consequences on the quality of soil and water, the trophic chains and/or pollinators (for past and current examples see the cases of DDT, chlordecone, neonicotinoids and even oceanic plastic particles).

The precautionary principle can be weakened, however, by over-emphasising "scientific uncertainty" and/or "lack of consensus" as a proof of internal contradictions (e.g., 97% of climatologists agree that climate change is anthropogenic, while the 3% who disagree are overrepresented in the media in the name of the "balanced" reporting). The invoked gaps in knowledge are often used as an argument to weaken the liability of industries when they cause damage (Mermet & Benhammou, 2005). This principle has been used by major companies or interest groups to discredit the scientific information against tobacco (Lee *et al.*, 2012), asbestos, junk food (Moodie *et al.*, 2013), neonicotinoids and, more recently, climate change. The uncertainty principle is efficient as it rests on the same elements as conspiracy theories: the best example is the "climategate" during Copenhagen COP 19 in 2009, when private e-mails were hacked and their meaning distorted.

Increasing knowledge through education is essential in solving environmental problems. However, it is important to keep in mind that while disinformation does not constitute knowledge, it nevertheless influences how people think about environmental issues. A good example comes from the International Panel on Climate Change (IPCC). The openness and massive IPCC scientific consensus about the causes of climate change struggles to counteract the large amount of attention the media gives to "sceptics", which yields significant influence on the social debate (Anderegg *et al.*, 2010; Antilla, 2005; Ehrlich & Ehrlich, 2009; Jacques *et al.*, 2008). Fuzzy concepts, disinformation and the "uncertainty principle," therefore, are dangerous as they can distort the urgency of situations and be used to avoid unpopular or costly decisions for the economy.

2.3.1.4 Feeding 9 billion people by 2050

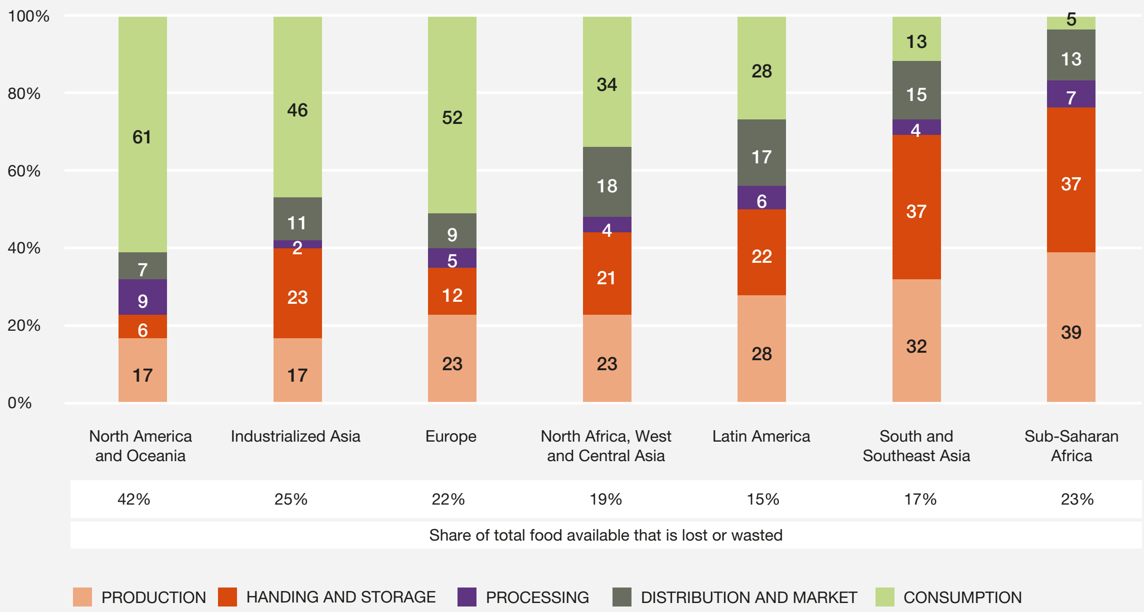
Feeding 9 to 10 billion people by 2050 is a recurring theme in agriculture and international policies (see Chapter 5, Section 5.3 for more details). While the core meaning of food security is "sufficient food for all at all time" (Beddington *et al.*, 2011), the concept of food security is often boiled down to a need for producing more ("sufficient food"), missing the distributional aspects across people, space and time ("for all at all time") implicit in the food security concept.

Highly technologized and intensified agriculture is unquestionably part of the solution that needs to be further investigated, and can draw from techniques and technologies from biotechnology, engineering and nanotechnology (Beddington, 2010). Crop improvement, smarter use of water and fertilizers, new pesticides and their effective management to avoid resistance problems, and the introduction of novel non-chemical approaches to crop protection will certainly contribute towards achieving the needed increase in food production.

Feeding 9-10 billion people in 2050 while relying only on market-driven agriculture and progresses in new technologies and techniques (as seen in Section 2.2.3.3), goes against recent reports speaking in favour of a variety of approaches (Beddington *et al.*, 2011). Making more food available can be achieved by several complementary measures including reducing food waste (food purchased but thrown away) and food losses (from the crop field to the market). This vision is finding its way among international organizations such as the FAO, focusing on the urgency to reduce food waste and losses at a planetary scale (Koh & Lee, 2012; Parfitt *et al.*, 2010). Food waste is a major problem in developed countries (Hall *et al.*, 2009; Papargyropoulou *et al.*, 2014; Venkat, 2011; WRAP, 2009) **(Figure 2.12)**. Hall *et al.* (2009) estimate food waste in the USA at 40%, with corresponding waste from associated production inputs such as energy and water. On the other hand, major problem in developing countries is not food waste, but food loss **(Figure 2.14)**, mainly because of deficient distribution networks (Aulakh & Regmi, 2013; Kurwijila & Boki, 2003; Liu *et al.*, 2013). Even partial reductions in food losses and food waste have the potential to ease the pressure on needed increases. Information represented in **Figure 2.12** can help public and private decision-makers target stages of the value chain where improvements could lead to the greatest reduction in food losses and waste.

Thus, among the fuzzy concepts, "food security" is certainly a powerful one, with ethical, moral and societal ramifications, especially when taken as a rationale for increasing production of food that will, in part, not even be consumed, while land and water are degraded to produce it. Food security is also frequently invoked by major actors of food production to

Figure 2 12 **Global food losses and food waste - extent, causes and prevention. WRI analysis based on FAO (2011). Source: From Lipinski *et al.* (2013).**



justify agricultural productivity growth, sometimes to the detriment of organic farming or agroecology – which are said to be unable to deliver enough food to feed the world on their own and which are relegated as niche production systems for upper middle-class consumers. Such a position can be found in scientific papers, such as one by Connor (2013) where it is asserted that: "it is exactly because the world now faces an inescapable requirement to increase crop production by 70% on essentially current agricultural land to adequately feed an expected population of 9.2 billion by 2050 that low yielding systems [such as organic farming or agroecology] cannot contribute to the solution". Advocating that agricultural production should be increased by 70% to meet the challenge of feeding a human population growth overlooks the fact that highly technologized and intensified agriculture can have environmental and health impacts, including land degradation, loss of biodiversity, reduction of nutritional quality of food, and cannot be considered as the only solution to the food security problem (Horlings & Marsden, 2011).

In the meantime, many reports and papers support conservation agriculture (see Glossary) as a credible solution (Muller *et al.*, 2017). Organic farming, permaculture, biodynamic agriculture or agroecology defend local productions and human-scale farming, while having a positive environmental impact (Badgley *et al.*, 2007; González-Sánchez *et al.*, 2016; Halweil, 2006; Parrott & Marsden, 2002; Pretty & Hine, 2001; Rundgren & Parrott, 2006). Recent studies tend to prove their potential not only in terms of productivity, but also in terms of farmers' income (e.g., in France - Dedieu *et al.*, 2017).

Today, environmental sustainability is commonly mentioned as a core component of successful business (Kareiva *et al.*, 2015), but the spread of disinformation is nevertheless still flourishing (Kareiva *et al.*, 2015; Lyon & Maxwell, 2011). Therefore, for the current assessment on land degradation and restoration, as well as for implementing measures to counteract degradation, it is important to recognize the threat of disinformation and find measures to overcome the disinformation through education and other appropriate measures.

2.3.2 Perception of policymakers' indecision and collective reactions

While conventional mainstream economics assumes that people act in their rational self-interest, recent studies from behavioural economics suggest that only 20-30% of humans are purely selfish, while the remaining three quarters of people are egalitarians and composed of conditional co-operators (50%) and very pro-social individuals (20-30%) (Meier, 2007). Members of these three quarters tend to evaluate self-interested individuals as evil individuals (Daly & Farley, 2011).

The emergence and empowerment of civil society is a major phenomenon since the 2000s (Schofer & Longhofer, 2011). This goes beyond being involved in an association or NGO. We call "civil society" the fraction of citizens who actively contribute to public debates (e.g., through demonstrations, new consumption patterns and life choices, blogging, petitions and so on). These concerned citizens realize that they could gain visibility and traction, not only by participating in demonstrations and social forums, but also through the internet (Ross, 2009). The example of Notre-Dame des Landes projected airport **(Figure 2.13)**, for instance, led hundreds of militants to occupy the area for years, opposing to the destruction of wetlands.

Contrarily to usual political parties, these movements are leaderless (Fletcher, 2010; Sutherland *et al.*, 2013). They privilege new ways of life opposed to consumerism, such as veganism or less-meat initiatives, neoruralism (Méndez, 2012; Pandolfi, 2014), or the "degrowth" movement (Fournier, 2008; Schneider *et al.*, 2010). "Degrowth" or "downscaling" is a modern political concept, popularized and developed by French economist Serge Latouche (2009), which initiated a political, economic and social movement based on ecological economics (Georgescu-Roegen, 1971) and anti-consumerism. Such a proposal, being recent, obviously contains inconsistencies (Cosme *et al.*, 2017). Nevertheless it proposes a new economic strategy as a response to the limit to growth (Assadourian, 2012; Demaria *et al.*, 2013; Kallis *et al.*, 2012; Weiss & Cattaneo, 2017). Degrowth is also a theoretical frame applied to agriculture, invoking the necessity of downscaling and re-localizing production (Boillat *et al.*, 2012; Sekulova *et al.*, 2013). While these precepts are often discarded or marginalized, they are based on a simple fact: the energy input to produce food in an intensive system is often greater than the calories contained in finished food products (Amate & de Molina, 2013). In traditional systems of mixed cropping, such as Mexican milpa (corn, pumpkins and beans planted together), the net calories produced are greater than those produced by the same area under monoculture, as it does not require external energy input (Altieri *et al.*, 2012; Altieri & Toledo, 2011). Finally, a recent study exploring tens of scenarios point at the potential of conservation agriculture to feed the world, provided food waste and meat consumption are reduced (Muller *et al.*, 2017).

Figure 2 13 **Zone à défendre (Area to protect) against the construction of Nantes' new airport, in Western France.**

Mega infrastructure projects find strong opposition by civil society, not only through petition and protests but through actual occupation. Photo credit: Creative Commons licensed under CC BY-NC.

2.3.2.1 Towards alternative paradigms: downscaling production and consumption

Global warming and ecosystem collapse are two concerns that transcend social classes and interest groups. The example of food security, which is being treated throughout this assessment, transcends almost all socio-environmental issues, as the way food is produced and distributed will condition the future of humankind. Against the predominant way of thinking of food security (through technology, intensification and global competition), another paradigm has emerged since the 1990s – the "food sovereignty paradigm" – defined by transnational social movements as "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems" (Forum for Food Sovereignty, 2007; Schiavoni, 2017). It received an important support from the United Nations Human Rights Council (Schutter, 2010), but also from the Food and Agriculture Organization (FAO, 2014a), and the International Panel of Experts on Sustainable Food Systems (IPES-Food, 2016). According to these reports, it would be necessary to reverse the productive trend adopted since World War II, maintain diversified systems of food production resilient to climate change, and try to shorten the distance from food to consumers, by revitalizing local food systems, particularly through agroecology (Altieri & Koohafkan, 2008) and agroforestry (see Chapter 5, Sections 5.3.3.1 and 5.5, and Chapter 6, Section 6.3.1.1).

"Agroecology" is a term used to describe the science of composition, function and structure of agroecosystems, the ideology of ecologically-friendly agriculture, the practices of farming that pay attention to conservation and the small-scale farmers' movements against industrialised modes of production in agriculture (Wezel & Haigis, 2002). Collectively, the science, ideology, practices and movements put forward an alternative worldview of how agriculture should be practised (Altieri & Toledo, 2011; Claeys, 2013; Rabhi, 2006; Schiavoni *et al.*, 2016). This alternative is primarily a reaction to the undesirable consequences of industrialised agriculture, including land degradation. In this context, a wide variety of terms have been used to describe these conservation agriculture alternatives: biodynamic, community based, ecoagriculture, ecological, environmentally sensitive, extensive, farm fresh, free range, low input, organic, permaculture, sustainable and wise use (Pretty, 2008). Until recently, these methods of sustainable agriculture were seen as alternatives rather than good practice principles in mainstream agriculture. Nevertheless, a recent trend in UN programs foster a generalization of sustainable and diversified practices (FAO, 2014b, 2017; IPES-Food, 2016). Further research is needed to understand its role in carbon sequestration (Govaerts *et al.*, 2009).

Alternative practices in agriculture also have an ideological dimension. They are now strongly supported by international small farmers organizations, such as La Via Campesina (created in 1993), including unions of developed as well as developing countries around an ideal of restoring traditional knowledge, gender equality and employment opportunities (also see Chapter 5, Section 5.2.3.2), virtuous environmental practices through agroecology (Perfecto & Vandermeer, 2010; Rabhi, 2006; Benayas & Bullock, 2012), and farmer empowerment (Altieri, 2009; Altieri & Toledo, 2011; Desmarais, 2010; Rosset & Torres, 2013). These movements try to create new community models, organized around the exchange of goods, food and services in moral (or social) economy (Edelman, 2005). La Via Campesina is an expression of collective and leaderless resistance; it associates indigenous and peasant movement, united in their claim for land and respect. Altieri and Toledo (2011) talk about a "new agrarian revolution" structured around agroecology. These new movements opt for a political resistance based on social practices, without directly confronting the neoliberal system. Williams (2008) defines this attitude as a "withdrawal from capitalism". The objective here is not the appropriation of the means of production, but the creation of a society with predominant values of solidarity, a non-materialistic approach to well-being based on sociability and respect for human and natural balance.

2.3.2.2 Creating active environmental subjects: the empowerment of civil society

At the global level, a new concept, "environmentality" (Agrawal, 2005a, 2005b) acknowledges the rise of "environmental subjects": people who no longer accept staying passive while the environment is threatened by global markets and unsustainable patterns of consumption (Fletcher, 2010).

Indeed, long supply chains (in kilometres or number of intermediaries) increase the profits of multinational corporations at the expense of producers, consumers and the environment (also see Chapter 5, Section 5.3.2.5). "Producing locally, consuming locally" is a new concept which is gaining influence in number of developed countries, including the USA, Canada, Germany, Italy, Spain and France (Deléage, 2011; Willer *et al.*, 2010) – although the contribution of food transportation on the carbon footprint remains relatively low compared to food production (Weber & Matthews, 2008), particularly for animal sources of proteins (Nijdam *et al.*, 2012). Raising ecological awareness is thus needed and could be achieved by making consumers aware of both their responsibility in environmental degradation and their power to solve the issue by adapting their behaviours (Peattie, 2010). In particular, the limitation of degradation, and accelerated restoration, can be addressed by either promoting sustainable practices by changing consumption behaviours, or a combination of approaches. Although progress was made in reducing the use of resources to produce goods, to date, the growing population has been increasing its consumption, thus limiting the positive impact of more efficient and sustainable production systems (Mont & Plepys, 2008).

Policymakers have a leading role in promoting new ideas and concepts about what would be our general interest, and enforcing them so that they become new realities (Fukuyama, 2014). This can be achieved through strong environmental policies. Some regulatory and economic instruments (e.g., taxes, products charges and standards) are meant to address both producers and consumers (Assadourian *et al.*, 2010; Mont & Plepys, 2008). Lenzen *et al.* (2012) argued that while international laws and regulations exist for the trade of endangered species, the same type of control could be applied on the trade of commodities whose production has a strong negative impact on biodiversity, including with policies targeting the consumers of products causing degradation. Wallner *et al.* (2003) show that ecological awareness might not change habits, but it does facilitate acceptance of more eco-friendly laws.

Promoting sustainable consumption is a major issue (UNEP, 2014). It requires revisiting some aspects of WTO agreements (see Section 2.2.3.1), especially when it comes to distorted competition. Several mechanism exist to promote sustainable or "green" consumption (Lebel & Lorek, 2008; Peattie, 2010). For instance, certifications and labels (e.g., FSC, Rainforest Alliance) aim to inform consumers, by raising ecological or environmental awareness and thus shifting purchasing behaviour towards products with reduced environmental impact (Lebel & Lorek, 2008). However, mechanisms for sustainable consumption appear most efficient when consumers are already sensitive to environmental issues (Rex & Baumann, 2007), otherwise the share of "green products" on the markets remains relatively low. Tukker *et al.* (2008) argued that sustainable production-consumption conflicts with the mainstream beliefs and paradigms about growth, markets and the institutions regulating them, and called for more evidence-based discussions.

This leads us to the major levers that policymakers could use: promoting new social norms, including through targeted taxes and an education, based on renewed ethical principles. People tend to adapt their behaviours to those perceived as common, normal, and/or morally and socially right (Goldstein *et al.*, 2008; Peattie, 2010; Schultz *et al.*, 2007). An education built upon ethical principles such as solidarity and cooperation would be a first step towards new perceptions. The current dominant model of social prestige is based ob raising the pattern of consumption to acquire expensive and/or rare products (e.g., expensive cars or clothes, ivory or rhino horn powder). An alternative model, based on a moral economy (Edelman, 2005), is emerging and growing with each year. This economy values social life, sobriety and solidarity, and is inspired by traditional populations and practices. Its aim is to consolidate social cohesion through community, mutual aid and production-consumption systems (Lebel & Lorek, 2008; Mont & Plepys, 2008; Tukker *et al.*, 2008). Education and awareness can contribute to transform passive citizens into environmental, proactive players, who feel concerned about their own impacts and responsibilities. Governments urgently need to take the lead in fostering an education system that values cooperation and solidarity, instead of competition and models based on high levels of consumption as a symbol of successful life.

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