LEGAL ANALYSES AND AGRONOMIC INSIGHTS

ECOSYSTEM SERVICES & SOIL PROTECTION

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Ecosystem services and soil protection. Legal analyses and agronomic insights

Carole Hermon, Research supervisor

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Foreword

This book was written within the framework of the T2SEC Research Programme, *Tillage, Ecosystem Services and Offsetting, Agronomic and legal aspects*[1]. As the study relates to soil, an interdisciplinary approach was required, combining analysis from both agronomists and lawyers[2], but with the prime focus on the legal aspects. This predominantly legal focus was intended to address the dearth of research in the legal field compared with other disciplines, and its lack of visibility within the scientific community on questions of soil and ecosystem services.

To facilitate a collective approach to the research, the scope of the initial working hypothesis was narrowed considerably and reformulated as follows: some agricultural production systems, taking the example of those used in conservation agriculture, help maintain or restore soil functions and their associated ecosystem services. Incorporating these services in law could help promote such methods of production, and, in doing so, offer a new means of soil protection. The thinking has, therefore, focused on ecosystem functions and services, with the study of ecological offsetting being studied only as a secondary avenue for their recognition in law.
To this end, the agronomists involved reviewed the available literature, then supplemented this by field studies, in order to draw up an inventory of land ecosystem services that are conserved or enhanced by conservation agriculture. The legal consultants, faced with the less-than-advanced state of scientific knowledge, have developed a broader perspective (starting by identifying the standards that apply to soil protection), have identified the concept of ecosystem services in law, and have suggested how such services could be qualified. Following this, they analysed some of the instruments that can be used to integrate the concept of ecosystem services, and/or conservation agriculture practices: contracts, including rural leases, and contracts related to offsetting obligations, civil liability, government aid and public finance mechanisms. We were not able to consider other instruments, especially those related to combating climate change. This work does not, therefore, claim to be exhaustive.

As a joint, and interdisciplinary collective effort, the initial stage was devoted to pooling knowledge and developing a common culture. To this end, we produced a glossary (included here as an annex) whose sole purpose was to facilitate interdisciplinary dialogue; we also organised workshops with relevant researchers and lecturers[3]. The individual research work and writings, which followed the

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[1] Idex, ATS 2015, "Systèmes de gestion durable des ressources naturelles et de l'environnement [Sustainable Management Systems for Natural Resources and the Environment]", Université Toulouse 1 Capitole, IEJUC (EA 1919).

[2] The team brings together two laboratories (IEJUC, EA 1919, Université Toulouse 1 Capitole and UMR INRA/INP-ENSAT 1248 AGIR), and 13 researchers and lecturers in law and agronomy. *Cf.* List of authors below.

[3] Four workshops were organised between May 2016 and March 2017 on the concept of ecosystem services, the legal nature of ecosystem services, offsetting, and the commons. 13 people including researchers, lecturers and experts provided input in this way (*Cf. Infra* acknowledgements). We would again like to thank all those involved for their contributions to our collective appraisal.

preparatory stage, were then shared in a third stage, during which the team analysed and challenged it, as well as making proposals for how it could be refined. The result is this collective, interdisciplinary study, in which each individual's contribution has been enhanced to form a joint body of work that we hope is coherent and likely to stimulate additional research on a topic for which much remains to be done.

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INTRODUCTORY TEXT

Soil protection and ecosystem services
The need for an epistemological review

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The need to consider things from an epistemological perspective is an essential prerequisite for any academic study, but it appeared even more pertinent in writing this book.
This was, firstly, because it was a collective effort, and, secondly, because the research was interdisciplinary[1]. While preserving their own freedom of thought, the authors wanted to share their particular ideas, and then, by means of successive adjustments, achieve a common narrative, thereby avoiding a publication whose chapters suffered from irreparable contradictions. The team's objective was to present a coherent whole, rather than merely a collection of individual arguments. This epistemological approach thus offered an opportunity for those involved to draw on their own specialised knowledge in order to determine the areas that required clarification, both for their co-authors and for non-expert readers.

This decision to take an interdisciplinary approach, and the desire to decompartmentalise the processes of knowledge development have, therefore, moved us away from the conventional concept of science.
The most widely accepted conception of science, or at least the one that has most deeply affected our collective consciousness, is the Cartesian vision of knowledge, which aims to assimilate both science and truth. Scientists have adopted, in particular, two of Descartes's methodological recommendations, something that has had long-lasting effects on the way that academic research is carried out. Descartes's view was that the fields of knowledge and problem solving should be separated to enable them to be studied more effectively, and, then, that a "funnel" method should be used for problem solving, beginning with the simplest problem, and progressing through a series of increasingly specific questions[2]. This disciplinary specialisation was subsequently espoused by Kant[3], taken up by Comte[4] and applied to questions of law, in particular by Kelsen[5]. It has led to indisputable discoveries, and constitutes a solid basis for reasoning, but it is not infallible. In particular, the Cartesian

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[1] While a multidisciplinary perspective results in a juxtaposition of disciplines, and a transdisciplinary approach aims to remove the boundaries between disciplines–in order to generate an autonomous body of knowledge, an interdisciplinary approach consists of an « articulation of knowledge which leads, by successive, dialogue-like iterations to a partial reorganisation of the theoretical fields being considered", Ost F. and van de Kerchove M., 1987, *Jalons pour une théorie critique du droit* [*Milestones for a critical theory of law*], Brussels, Pub. des Facultés universitaires de Saint-Louis.
[2] Descartes R., 1637, *Discours de la Méthode* [*Discourse on the Method]*, p. 14.
[3] Atias C., 2002, *L'épistémologie juridique* [*The Epistemology of Law*], Dalloz, pp. 34 and following articles.
[4] Comte A., 1830-1842, *Cours de philosophie positive, Première et seconde leçons* [*Lessons in positive philosophy, First and Second lessons]*, http://classiques.uqac.ca/classiques/Count_auguste/cours_philo_positive/cours_philo_pos_1_2.pdf, spec. pp. 52 and following articles, and pp. 62 and following articles.
[5] Kelsen H, 1999, *Théorie pure du droit [Pure Theory of Law]*, Bruylant.

specialisation approach has led to an increasingly rapid fragmentation of knowledge[6], to the extent that, today, it is difficult to describe phenomena in their entirety. When applied to soil-related questions, a Cartesian concept of knowledge would result in separate biological and legal realities, reducing each, in turn, to separate, unconnected fields.
In contrast, the desire of the authors of the various chapters of this book was to adopt the "complexity" approach developed by Edgar Morin[7]. His central idea is that, to better understand a subject being studied, it must be examined in its entirety and in its context. The new knowledge that results from an investigation that encompasses a diverse set of data enables us to attain a coherent relationship between observations which, taken in isolation, would have appeared to be contradictory. "Adopting this paradigm of complexity, then, allows us to conceive as being linked what, prior to this, would have been viewed as being disjointed"[8]. The complexity approach is, of course, not perfect. An attempt to carry out "global" research, or research into "the whole", may come up against, in particular, the practical limitations that researchers have to contend with. In this work, we approach soil-related questions through the disciplines of law and agronomy, which certainly do not cover the subject "in its entirety". Nevertheless, the authors felt that the understanding gained by the small steps taken to embrace the concept of complexity were important ones, and that much would have been lost by abandoning such an approach.

While this perception of the scientific approach is now accepted in a number of disciplines, it remains relatively rare in law. Like the vast majority of law researchers, we see ourselves as positivists insofar as demonstrations always begin with an analysis of positive law. It is a question of studying existing standards and observable material[9]. However, among positivists, many writers hold to a normativist conception of law, and therefore our approach is different to theirs. Normativists consider that, in order to be valid, analysis must be limited to the observation of the standard, and they ignore the facts that are associated with it[10]. They know that the law is the result of political choices, which are themselves based to a large extent on justification, but, in the interests of accuracy[11], they choose not to include these considerations in their thinking. They subscribe, therefore, to a philosophy of specialisation of the type described above[12].
Our approach differs from numerous legal studies in another sense. They generally

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[6] Boyer R., « L'économie en crise : le prix de l'oubli de l'économie politique [The Economy in Crisis: the Cost of Forgetting Economics] » in *L'Economie politique*, 2010/3, no 47, p. 46.
[7] The approach is described in full in Morin E., 2008, *La Méthode [The Method]*, Éditions du Seuil.
[8] Ait Abdelmalek A., « Edgar Morin, sociologue et théoricien de la complexité [Edgar Morin, sociologist and complexity theorist] », *Sociétés*, 2004/4, no. 188, p. 115.
[9] Magnon X., 2008, *Théorie(s) du droit* [*Theory(ies) of Law*], Ellipses, p. 16.
[10] For those who hold to this approach, it is this characteristic that also makes research into law quite particular: « The autonomy of the legal discourse is manifest in relation to [...] sociology or political science insofar as the facts are removed from the field of study », Magnon X., « En quoi le positivism-normativisme-est-il diabologique? » ["What is positivism - normativism–is it diabolical?"], *RTD civ*., 2009, pp. 1 and following articles.
[11] Millard E, 2006, *Théorie générale du droit* [*General Theory of Law*], Dalloz, p. 29.
[12] It should be noted that, among positivists, jurists who hold to realist epistemologies accept the idea of incorporating facts into their work. However, in American and Scandinavian Realism, which are the two main schools of thought within realism, empiricism is based, above all, from the study of Praetorian decisions, Magnon X., « Théorie(s) du droit » [*Theory(ies) of Law]*, supra, p. 138. While the decisions of courts are to be dealt with in future work, the integration of facts will not be limited to this jurisprudential dimension.

see axiological neutrality as a non-negotiable requirement; without that, the area would no longer be objective, and science might introduce subjectivity or ideology into legal theory. However, the contributors to this work have set themselves the task of observing the prescriptive standards as objectively as possible, and also of identifying ways of improving soil protection. This work is therefore similar to a work of jurisprudence in the Aristotelian sense[13], in that it begins with a study of what is, in order to move towards what must be. While our complex and finalist approach remains a marginal one, it appears that it is becoming increasingly common[14]; perhaps even more so in environmental law[15].

[13] Aubenque P., *Jurisprudence in Aristote*, 2014, PUF.

[14] Daoust M.-K., « Repenser la neutralité axiologique, Objectivité, autonomie et délibération publique » [Rethinking Axiological Neutrality, Objectivity, Autonomy and Public Deliberation], *Revue européenne des sciences sociales*, 2015, n° 53-1, pp. 199-225.

[15] On the complex approach, see, for example, Gaillard E., « Pour une approche systémique, complexe et prospective des droits de l'homme [For a systemic, complex and forward-looking approach to human rights »], *in* « *Changements environnementaux globaux et droits de l'homme* » *[*« *Global environmental change and human rights »]*, Cournil C. and Colard-Fabregoule C (ed.), 2012, Bruylant, 648 pages, pp. 49-69. In terms of the finalist aspect, the links between environmental law and the theory of justice seem to be fundamental. They have existed since the first environmental studies in the United States in the early twentieth century, Torre-Schaub M., « Quelques apports à l'étude de la notion de justice environnementale [Some contributions to the study of the concept of environmental justice] », in *Changements environnementaux op. cit.*, pp. 71-87, esp. p. 73.

Soil protection in law

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Soil is a « blind spot » in law. While some relevant aspects are addressed, the area is not dealt with in its entirety, as a complex whole, covering a diverse set of functions[1].

It is in environmental law[2] that we might expect to find a coherent and comprehensive body of legislation relating to soil protection as a natural resource. In particular, this « soil law » could have been codified in Book II of the French Environmental Code, which is devoted to « physical environments »; it comprises two sections: one relating to « water, aquatic and marine environments » and the other to « air and the atmosphere ». This, however, is not the case and a third, soil-related section is conspicuous by its absence[3].

By comparison, water and air are subject to wide protection. This means that the law, while not presumably being exhaustive and without saying anything about its effectiveness, includes various criteria to define air and water quality, as well as prescribing protective measures, given that they constitute resources satisfying human needs, and provide an environment no matter what such resources are used for.

In terms of water, the quality required for human consumption is defined and protected by a set of rules[4]. The law also ensures that the volumes and flow rates of water available are sufficient to satisfy recreational, economic and food requirements, while also preserving the aquatic environment[5]. In addition, the

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[1] « The ecological functions of soils include the role they play in ecosystems such as : serving as a breeding ground for biodiversity ; contributing to the storage, the filtering and transformation of nutrients, substances and water, the recharge of groundwater; and carbon sequestration or regulation », Neyret L. et Martin G.-J., *Nomenclature des préjudices environnementaux*, LGDJ, 2012, p. 16.

[2] Environmental law is defined as « the law relating to the environment » (Prieur M. et al., *Droit de l'environnement*, Dalloz, 7e ed., 2016, n° 9) and, thus, where relevant, relating to soil, and/or as law whose « aim is to provide a framework for (the) protection (of the environment) » (Van Lang A., *Droit de l'environnement,* PUF, 4e ed., 2016, n° 64, Prieur M. et al. *Droit de l'environnement*, cited above, n° 9), which, therefore, includes the protection of soil.

[3] This absence is underlined in the following report, Bellec P., Lavarde P., Lefèbvre L. et Madignier M-L, *Propositions pour un cadre national de gestion durable des sols*, CGEDD-CGAAER, sep. 2015, p. 7 ; also relevant here are, « the contrast between the maturity of the law concerning the protection of water quality and aquatic environments, and the embryonic nature of that related to the protection of soil quality », Farinetti A., « La protection juridique de la qualité du sol au prisme du droit de l'eau », *Env. et DD*, 2013, n° 6, Etude 17, and « the neglect of soil protection in law », Billet P. « La prise en compte de la qualité des sols dans le droit français » in Bispo A., Guellier C., Martin E., Sapijanskas J., Soubelet H. et Chenu C. (coord.), *Les sols. Intégrer leur multifonctionnalité pour une gestion durable*, Quae, coll. Savoir Faire, 2016, p. 259.

[4] Potability criteria for water are defined (Art. R. 1321-2 and 3 CSP), prefectoral authorisation is required to produce and distribute water for human consumption (Art. L. 1321-7 CSP), and the associated testing regime is defined (Art. L. 1321-4 and 5 CSP). Water catchment zones are also protected by public utility easements (Art. L. 1321-2 CSP) as well as special catchment areas for drinking water supply (Art. L. 211-3-5° and 7° C. env.).

[5] Art. L. 211-1-II C. To this end, prior authorisations for drawing off water are required (Art. L. 214-1 and R. 214-1 C. env.) and crisis-management tools have been introduced to address situations where there is not enough water: water development and management plans (Art. L. 212-3 and L. 212-5-1-II-1° C. env.), specific authorisations and agencies for collective water management (Art. R. 211- 111 and following articles, and Art. R. 214-31-1 and following articles, C. env.) and drought orders (Art. R. 211-66 C. env.).

objective of « good quality » water, encompassing both good chemical[6] and ecological quality[7] is framed in European Union law and also reflected in national law, through water planning and management activities.[8]

The legislative framework relating to air is comparable. The body as a whole consists of a set of standards which lay down values that must be achieved, or not exceeded;[9] and, where it appears that there is non-compliance, or the potential for it, measures must be taken to reduce pollutant concentrations to their regulated levels[10]. The legislation is framed for the protection of health and the environment[11] in order that air quality does not affect human health thus respecting « everyone's right to breathe air that is not harmful to their health » (Art. L. 220-1 C. env.) but, also, air that has no adverse effects on vegetation and ecosystems[12].

There is no such provision for soils. The law does not lay down criteria for the quality[13] or condition of soils, and no (or very few[14]) limiting values that must not be exceeded in order to preserve their quality; there are no « objective values » to be achieved ; and, more specifically, it does not include criteria or values to be achieved with respect to the quality of agricultural soils. While not considering, at this point, the reasons for this lack of measures[15], their absence will now be set out and its extent assessed.

Even though soil quality and good functioning are not defined, it should not be assumed that the law does not provide, or encourage, soil protection. Soil is partially protected, in an indirect manner[16], by legislation whose aim is not to protect soil as such, but which, nevertheless, offers a degree of protection (§1). It is also protected by legislation aimed specifically at soil but this legislation, consisting of sporadic and one-off standards, only offers fragmentary soil protection (§2). Consequently, the issue of the construction of a « soil law » remains open (§3).

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[6] Concentrations of pollutants must not exceed certain thresholds.

[7] Quality is defined as being of good « quality in terms of the composition and functioning of aquatic ecosystems ».

[8] The Water Framework Directive 2000/60/EC of 23 October 2000 and Art. L. 212-1-IV C. env.

[9] Art. R. 221-1-II C. env.

[10] These measures affect the use of fuels or combustibles, vehicles, the use and operation of polluting installations, and the inspection of such installations (Art. L. 222-5 para. 3, Art. L. 226 C. env.); they also include, where necessary, emergency measures in the event of a peak in pollution (Art L. 223-1 C. env.).

[11] Cf. Art. L. 220-2, L. 221-1, L. 221-2, L. 221-6, Art. R. 221-1-II, R. 222-2 C. env.

[12] Cf. Art. 2 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone of 30 November 1999, and Art. 1 of Directives 2001/81/EC of 23 October 2001 and 2016/2284/EU of 14 December 2016 on national emission ceilings for certain atmospheric pollutants.

[13] In this respect, Desrousseaux M., *La protection juridique de la qualité des sols*, LGDJ, bibliothèque de droit de l'urbanisme et de l'environnement, t. 13, 2016, n° 25 : "There is no translation of (soil) quality into the legal sphere... neither in international, nor European, nor national law; while, in the eyes of the scientific establishment, this would 'appear to be the best method of implementing an effective policy for soil protection'".

[14] Legislation relating to the agricultural use of sewage sludge is an exception in this respect. Article 6 of Decree No 97-1133 of 8 December 1997, enacted for the transposition of EU Directive 86-278 of 12 June 1986, specifies that the application of sewage sludge must, in particular, not affect 'the quality of soil"; and, in this respect, it refers to a Ministerial Order of 8 January 1998 used to fix "the maximum levels of trace elements and organic compounds present in sludge" (Art. 15): an order laying down the technical requirements for the spreading of sludge on agricultural land, which is pursuant to Decree No. 97-1133 of 8 December 1997 relating to the spreading of sewage sludge.

[15] *Cf. infra* A. Chabert and J.-P. Sarthou « Agricultural soil, an essential yet neglected resource », Lionel Bosc « Property and soil protection. Reflections on civil law and the integration of soil quality ».

[16] According to Desrousseaux M., *La protection juridique de la qualité des sols*, cited above, n° 501.

1. The indirect protection of soil in law

There are numerous standards whose purpose is not soil protection, but which contribute to it[17] through the interactions between soil and other natural resources that nourish it: plants, animals and micro-organisms on the one hand, and human activities, especially agricultural activities, on the other. Thus, firstly, by protecting an area of the environment other than soil, or preserving a use supported by soil, some legal norms indirectly protect soil, even though this is not their purpose (1.1). Secondly, the soil is protected, not in its own right, but as a component of the environment (1.2).

1.1. The indirect protection of soil

The type of protection provided indirectly to the soil can be illustrated by various examples. We shall consider three here. On the one hand, to the extent that the functioning of soil is linked to water and the living organisms it supports, the legal protection offered to water (1.1.1), and to species and ecosystems (1.1.2), can benefit soil indirectly. On the other, the protection of areas assigned to agriculture against competing uses also protects soils against being rendered artificial as a result of developing urbanisation and the resulting impermeability (1.1.3).

1.1.1. Water law and soil

Water law provides an initial illustration of what indirect soil protection can include. The protection of water quality in general, and the quality of water intended for human consumption in particular, includes provisions designed to prevent the risks associated with runoff and the infiltration of polluting substances into water. Thus, soil protection may be required during periods where leaching is a risk, or provided through measures such as the establishment of grass strips alongside watercourses[18]. The supply of fertilisers and plant protection products, tillage and the management of intercropping can also be regulated[19]. In doing so, even though this is not the primary

[17] As such, the following review is not exhaustive but is based on examples that support this position.

[18] Since 2009, this has been made mandatory, except for regional variations, in all « vulnerable zones », i.e. areas affected by the nitrification or eutrophication of water due to the use of fertilisers on agricultural soils, Art. R. 211-75 and following articles, C. env.. *Cf.* Art. R. 211-81-7 ° and 8° C. env., amended Order of 19 December 2011 relating to the National Action Programme to be implemented in vulnerable zones in order to reduce water pollution by nitrates of agricultural origin, Annexes I-VII and VIII, adopted for the transposition of Directive 91/676 of 12 December 1991, concerning the protection of waters against nitrates from agricultural sources.

[19] The use of organic nitrogen is limited in all vulnerable zones (cf. previous note for the definition), Art. R. 211-81-5 ° C. env. Moreover, activities « likely to render water unfit for human consumption » are prohibited within local protection zones that cover intakes of water intended for human consumption, and regulated in those that might affect its quality as a resource (Art. R. 1321-13 al. 3 CSP), which may include inputs, tillage or intercropping management. Moreover, in drinking water catchment areas of particular importance (Art. L. 211-3-5 ° C. env), « areas subject to environmental regulation » may be defined, and within them, measures for land cover, tillage, management of inputs, diversification and rotation of crops may be required, or agreed upon by contract: (Art. R. 114-6 C. rural).

purpose of the legislation, water law provides measures beneficial to the quality and health of soils, preventing their contamination and limiting the loss of soil and organic matter through erosion.

1.1.2. Protection of ecosystems, species and soil

In a similar way, by protecting ecosystems and species, the law may include provisions that preserve the quality of soils and their proper functioning. Examples include Natura 2000 areas, which comprise natural habitats of special interest, those under threat, areas with rare or vulnerable species of flora or fauna, and particular sites visited by migrating birds, or used by birds for resting or mating (Art. L. 411-1 C. env.). In these areas, measures must be implemented to maintain the habitats in good condition and prevent their degradation, as well as damage to the species of fauna and flora they contain (Art. L. 411-1-V C.env.). To achieve this, contracts are signed with the owners and operators of land within the area[20] (Art. L. 414-3 C. env.) and, also, impact studies must be carried out for the majority of activities likely to significantly affect a Natura 2000 site, including those that, in principle, do not require any form of authorisation (Article L. 414-4 C. env.). Both of these measures offer protection to soils even though this is not their primary aim. Natura 2000 contracts may prohibit the use of fertilisers, plant protection products, and the turning over of meadowland, require the creation and maintenance of plant cover, the maintenance of hedges and copses, prescribe maximum or minimum limits to avoid over-grazing or under-grazing, etc. In terms of activities within the scope of impact studies and *ad hoc* authorisation, while they are outside the scope of ordinary law, the controls they provide, which go beyond the protection of habitats and species, definitely benefit soils, namely through measures concerning the spreading of sewage sludge, effluents, the turning over of meadowland or moorland and the removal of hedgerows (Article R. 414-27 C.env.).

In parallel, the protection of agricultural areas may allow some soils to be indirectly protected at least from one particular risk: that of urbanisation.

1.1.3. The protection of agricultural areas and soil

The law aims to address the ongoing issue of the loss of agricultural land from such areas as a result of urban sprawl. Following the SRU Act[21], French legislators have expressed the ambition[22] to « construire la ville sur la ville » (« build the city on the city » : the concept of preventing urban sprawl by reusing existing land) and, more specifically, by applying the Grenelle 2 Act[23]. Urban planning documents must now set objectives to protect agricultural areas and work against continuous

[20] These contracts, entered into by farmers, can take the form of a MAEC (an agri-environmental and climate measure).
[21] Act No. 2000-1208 of 13 Dec. 2000 concerning urban solidarity and renewal.
[22] It is widely accepted that this ambition has not been achieved *Cf.* in this respect, Desrousseaux M's conclusions in the thesis cited above, No. 367 : "The law remains too weak to work against the trend of increasing scarcity, which soil, as a natural resource, is now subject to".
[23] Act No. 2010-788 of 12 July 2010 on the national commitment to the environment.

urbanisation[24]. Among the various measures adopted in these acts, there is no objective to protect soil *per se*, but there is an intention to preserve agricultural areas, i.e. agricultural activity, in whatever form, by creating dedicated zones. However, by defining the limits for reclassifying agricultural areas[25] and severely restricting the scope for construction in them[26], urbanisation law protects soils from the resulting impermeability[27].

Soil may also be protected indirectly by laws that aim to address the environment in general.

1.2. The protection of soil as part of wider environmental protection

Environmental law includes overarching provisions designed to protect all aspects of the environment, which, therefore, include soil protection. This is the case for some environmental procedures (for example, those found in impact studies) and some regulations[28] for enforcing environmental protection (an example taken from classified-installations law).

1.2.1. Impact studies and soil

Mandatory impact studies, prior to carrying out works and development projects likely to damage the environment, were instituted by Act No. 76-629 of 10 July 1976 concerning the protection of nature. First, the study must enable the applicant to measure the effects of the project on the environment, and, having done that, to prevent, reduce, or offset them; and, second, to ensure that the project does not entail excessive damage to the environment. Therefore, the law requires that the impact study include a broad analysis of all the project's effects, both direct and indirect, on all aspects of the environment[29].
While the initial legislation did not include any specific reference to soil, Decree No. 93-245 of 25 February 1993, an amendment to the mandatory analysis required on the environmental effects of projects, added it to the list. Since then, the requirements for impact studies have been modified[30], but the obligation to analyse effects on soils

[24] These objectives must be set by SCOTs (territorial coherence plans) and PLUs (local urban plans) which cover land use planning and sustainable development (Art. L. 141-2 and L. 151-5 C. urb) ; they must also be quantified (Art. L. 141-6 and L. 151-5 C. urb.).
[25] Especially in municipalities not covered by a SCOT (see previous note for definition), where agricultural areas cannot be rezoned for urbanisation, Art. L. 142-4 C. urb.
[26] Only agricultural buildings and installations necessary for public or communal services, or agricultural use, are permitted in agricultural areas (Art. L. 111-4, L. 161-4 and R 151-23 C. urb.).
[27] Conversely, no planning rule can impose production methods on farmers, or ban them, for the reason that they might affect the quality or the health of soils.
[28] By « regulations », a term that implies an administrative function, we understand "the specific activity of prescribing measures to regulate private activities in order to maintain public order" ((Van Lang A., Gondouin G., Inserguet-Brisset V., *Dictionnaire de droit administratif*, Sirey, 5e ed, 2008) ; some regulations (which can be considered special regulations) may have a specific purpose – environmental protection – through the application of environmental regulations.
[29] Current legislation requires that impact studies focus on the following factors: « population, human health, biodiversity, land, soil, water, air, climate, physical assets, cultural heritage, including architectural and archaeological aspects, and the landscape », Art. R. 122-5-II-4 ° C. env.
[30] Decrees No. 2011-2019 of 29 December 2011 and No. 2016-1110 of 11 August 2016, codified under Art. R. 122-5 C. env.

has remained, and was further clarified by decree on August 11 2016[31].
Bound up as it is with other measures, we cannot be certain that, in practice, the analysis of soil-related effects will always be perfect, but the fact remains that, in law, the administrative judge can cancel an administrative authorisation that has been improperly issued due to a lack of analysis –or insufficient analysis–of the effects of a project on soil[32].

The law on classified installations[33], which tends to regulate the risks and inconveniences that these installations create for the environment, can, likewise, prevent or impose sanctions for damage to soils.

1.2.2. Classified-installations law and soil

The issue of soil pollution is central when classified installations are permanently decommissioned; their rehabilitation then becomes the express purpose of the law (cf. *infra* section 2.2). It is less significant at the stage where the licence to operate is issued.
Nevertheless, according to Article L. 181-12 of the French Environmental Code, authorisation may only be granted on a regular basis if it is accompanied by measures designed to prevent or reduce « significant adverse effects (of exploitation) on the environment and health», which certainly covers soil. In addition, the list of interests protected by the law relating to classified installations[34], which any authorisation must take account of, is sufficiently broad to encompass soil-related issues, even if they are not specifically addressed. Moreover, for some classified installations, taking account of the risk to soils is mandatory, namely for installations involving the largest storage or production volumes, which therefore fall under the IED Directive[35], and for special classified installations for which the

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[31] An impact study must include: « An estimate of the types and quantities of residues and emissions expected, such as those causing the pollution of water, air, and soil... » and an estimate of « factors likely to be affected by the project », including soil, Art. R. 122-5-II-2 ° C. env..
[32] Examples of this are : TA Nice 20 avril 1995 Chabas et autres c. Commune du Val, *RJE* 1996, p. 158 : the cancellation of an authorisation for a ZAC (a private-public urban renewal initiative covering a variety of mixed planning uses) that included a holiday village with a golf course, on the grounds that "the impact study does not include any analysis of the effects... of the project on soil and water"; TA Strasbourg 18 juillet 1997 ANEED c. Préfet de la Moselle, *RJE* 1999, p. 275 : the cancellation of the authorisation to operate an industrial waste storage facility on the grounds that "the impact study does not include any indication of the consequences of the project on soil, on the fauna and flora, on the landscape, on water supply and the population" ; CAA Paris 16 avril 1998 Société Sovetra, req. n° 96PA01543 : annulment of a decision approving the creation of another ZAC on the grounds that the impact study « does not demonstrate with any precision the consequences of this project on the environment, in particular with regard to its effects on water and soil ». These rulings, however, remain marginal compared with those on the inadequate analyses regarding water or biodiversity.
[33] A classified installation is defined as an industrial or agricultural installation that involves risks or inconveniences for the environment and/or nearby neighbourhoods, and is, as such, registered under a classification adopted by decree of the Council of State (the highest administrative court in France), annexed to the Article R. 511-9 of the French Environmental Code.
[34] Article L. 511-1 C. env. Lists : « the convenience for the neighbourhood, health, safety, public health, agriculture, the protection of nature, the environment and landscapes, the rational use of energy, and the conservation of sites and monuments, or items falling into the category of archaeological heritage ».
[35] Directive 2010/75/EU of 24 November 2010 concerning industrial emissions. According to Article R. 515-60 of the French Environmental Code, for these installations, « the authorisation shall set, at least,... (e) measures guaranteeing the protection of the soil, (f) measures concerning the periodic

ministerial decree sets out the general operating requirements including specific provisions for soils[36].

Ultimately, the benefits of legislation that protects soil, either indirectly (where soil protection is not its purpose), or by inclusion (where soil protection is one aim among others) cannot be ignored. The examples cited show that it helps prevent risks that threaten soils: erosion, loss of organic matter and biodiversity, pollution and impermeability. However, legislation that is not designed, or not particularly designed, to protect soil, cannot be expected to be as effective[37] as specific soil-protection legislation.
Such legislation exists. However, it remains incomplete today.

2. Laws dedicated to the protection of the soil: fragmentary protection

In law, there are some standards whose aim is to protect soil and effectively establish a degree of soil protection. Firstly, we can distinguish provisions whose aim is to prevent or limit the degradation of soils, and, more specifically, the degradation of agricultural soils (2.1). Secondly, there is sometimes a requirement to repair or restore degraded soils, although there are no specific provisions here with respect to agricultural soils (2.2). But juxtaposing these scattered texts reveals only a partial protection of the soil.

2.1. Preventing damage to soil

While the « proliferation of regulations » and « ever-increasing red tape »[38] are often bemoaned, when it comes to preventing the degradation of the soils, or limiting their degradation, we can only note the lack of such legislation. Apart from the provisions adopted under the Common Agricultural Policy (CAP), which, therefore, constitute the main part of the normative approach (2.1.5), we found only four sets of regulations, the first relating to soil erosion (2.1.1), the second to rezoning of land for biofuel production (2.2.2), the third to the application of sewage sludge to land (2.2.3), and the fourth to soil protection in the Alps (2.2.4). This simple tally reveals the seemingly anecdotal nature of the law dedicated to preventing damage to soil.

2.1.1. Protection against erosion

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monitoring of the soil (where the activity involves the use, production or release of hazardous substances or mixtures) ».

[36] For example, the Decree of 27 December 2013, laying down general requirements for cattle, poultry and pig farming (the authorisation regime) stipulates measures against land degradation by free-range pigs and open-air poultry runs (Art. 20 and 21), restrictions on the spreading of effluents (Art. 27-1) and rules for the storage of livestock waste (Art. 34). It should be noted, however, that similar requirements for soil are rare.

[37] A standard is considered to be « effective » if it has the intended effect, « the effects it is designed to produce », de Béchillon D., *Qu'est-ce qu'une règle de droit ?*, O. Jacob, 1997, p. 10.

[38] *Cf.* in particular Conseil d'Etat, Rapport public 1991, *De la sécurité juridique*, Rapport public 2006, *Sécurité juridique et complexité du droit*, *Rapport de la mission de lutte contre l'inflation normative*, Lambert A., Boulard J.-C., rapport au Premier ministre, 26 mars 2013.

Soil erosion began to be addressed in the early twentieth century in forestry law, for the purpose of controlling natural hazards: the risks of floods, landslides and avalanches[39] ; it was expanded in 2003[40].

On the one hand, the prevention of erosion is one of the objectives of French agricultural policy[41]. On the other, a new chapter has been introduced into the rural code; it is entitled: « specific agricultural areas subject to environmental constraints », these areas being made up of zones known as « erosion zones »[42]. « Programmes of action » are undertaken, including a set of measures[43] likely to limit erosion.

However, the scope of this new tool is limited for two reasons. Erosion zones must first be delimited by an administrative authority[44] and parliamentary proceedings indicate that these are not intended to cover all French land that is vulnerable to erosion. The objective of the delimitation of the erosion zones, and the subsequent classification of such zones, confirms the restrictive determination to create zones subject to environmental measures. The overriding concern is the prevention of flooding: soil erosion must be prevented, or limited, because it increases the risk of flooding. As a result, the erosion zones « cover the parts of the country where... agricultural practices have promoted soil erosion and accelerated runoff, which has resulted, or is likely to result, in downstream damage »[45]. The objective of protecting soil against erosion was later extended to include water quality[46]. To achieve this, the definition of erosion zones was modified to include areas where: «...diffuse erosion of agricultural soils (is) likely to compromise the achievement of objectives for good water quality, or, where relevant, the potential for good environmental quality »[47]. However, the loss of substrate, or damage to biodiversity, induced by erosion are not included in this definition and do not constitute, at present, explicit grounds for delimiting erosion zones.

Secondly, erosion zones have the particular characteristic of being subject to both incentives and constraints. The programme of action « to reduce soil erosion in these

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[39] Cf. Desrousseaux M., thesis cited above, n° 520 et ss., Fèvre M. « Les services écologiques et le droit. Une approche juridique des systèmes complexes », thesis, University Côte d'Azur, 2016, pp. 77-80

[40] Act No. 2003-699 of 30 July 2003 concerning the reduction of technological and natural risks and the repair of damage.

[41] Complement to Article 1 of Act No. 99-574 of 9 July 1999 on agricultural policy : « Agricultural policy... has, as one of its objectives,:.. the prevention... of soil erosion ».

[42] Art. L. 114-1 C. rural.

[43] The programme of action « defines the measures [as being]... among the following : 1° Plant cover, permanent or temporary ; 2° tillage, management of crop residues, input of organic matter that promotes water infiltration and limits runoff; 3° management of inputs..., 4°. diversification of crops...; 5° maintenance or creation of hedges, banks and low walls..., 6° restoration or maintenance of specific plant cover; 7° restoration or maintenance of ponds, lakes or wetlands », Art. R 114-6 C. rural.

[44] Such delimitation is under prefectoral jurisdiction.

[45] Art.1 Decree No. 2005-117 of 7 February 2005, concerning the prevention of erosion, codified under Art. R. 114-1 of the French Rural Code.

[46] Art. 8 Act No. 2012-1460 of 27 December 2012, amending Article L. 211-3-II of the French Environmental Code : programmes of action may also be implemented in areas where erosion of agricultural soil « is likely to compromise the achievement of objectives for good water quality, or, where relevant, the potential for good quality » of the water.

[47] Decree No 2007-882 of 14 May 2007, concerning specific zones subject to environmental measures, codified under Article. R. 114-2 C. rural.

areas » includes practices « to be promoted »[48] and practices that « may be made compulsory » (Art. L. 114-1 C. rural). If, « at the end of a period of three years following the publication of the programme of action », it has not been suitably implemented, prefects may « decide that some of the measures recommended by the programme, subject to the timescales and conditions that they decide », (Art. R 114-8 C. rural) shall be mandatory. But they are not obliged to do this.
In the end, then, it is the long-standing legislation for the protection of forests, introduced in 1922[49] « to preserve the integrity of forests, that play a key role in soil maintenance and erosion control »[50], that turns out to be the most restrictive. Protected forests may include, for example, « woodland and forest whose preservation is recognised as being necessary for the maintenance of land on mountains and slopes » and for defence against erosion[51] ; in 2011, these represented a surface area of just over 63,000 hectares. In such areas, « any change of use or occupation likely to compromise the conservation or protection of forests » is prohibited[52]. Exploitation of such forests, as well as water resources and pasture land, is subject to restrictive conditions[53]. Beyond this, the French Forestry Code also requires the protection of soils in mountain forests, even if they are not classified under Article L. 141-1, with regard to the gradient-related erosion risks[54]. As a minimum measure, municipalities must regulate the use of communal pastures (Art. L. 142-5 C. for.). The prefect may also decide to prohibit grazing on certain areas and pasture lands « belonging to any owner whatsoever »[55]. And if « the maintenance and the protection of land » requires it, restoration work and reforestation can be declared to be in the public interest (Art. L. 142-7 C. for.).

2.1.2. Protecting soils against the production of biofuels

With the potential development of biofuels [56] and bioliquids[57] to be used to meet national greenhouse gas reduction targets, and those defined in EU law to promote the use of biofuels[58], the risk of over-cultivation of soils used to produce the raw materials for these biofuels and bioliquids was rapidly identified, as well as natural

[48] In support of the incentive measures, aid may be introduced « where additional costs or loss of income might be incurred » (Art. L. 114-1 C. rural).
[49] Act of 28 April 1922, on protective forests, OJ, 4 May 1922, p. 4606.
[50] Liagre J. « Bois et forêts. Protection des bois et forêts », *JCl. Env. et DD.*, fasc. 3720, n° 138, voir également, Fèvre M., thesis cited above, pp. 124-126.
[51] Art. L. 141-1 C. for..
[52] Art. L. 141-2 C. for.. In particular, « no clearing, no excavation, no extraction of materials, no public or private infrastructure for rights of way, and no raising of soil levels or deposits may be carried out », Art. R 141-14 C. for ..
[53] Art. L. 141-5 C. for..
[54] *Cf.* Desrousseaux M., thesis cited above, n° 510, Fèvre M., thesis cited above, pp. 119-122.
[55] The period of restrictions cannot, however, exceed ten years; if it does, the owners are entitled to compensation, Art. L. 142-1 and 2 C. for ..
[56] Biofuel means « a fuel ... used for transport and produced from the biomass defined in Art. L. 211-2, namely, the biodegradable part of products, waste and residues from agriculture ... as well as the biodegradable part of industrial and household waste », Art. L. 661-1 C. énergie.
[57] Bioliquid means « a liquid fuel intended for energy uses other than transport... and produced from biomass », Art. L. 661-1 C. energie.
[58] Directive 2003/30/EC of 8 May 2003 sets targets for the incorporation of biofuels and other renewable fuels; these increase from 2% at 31 December 2005, to 5.75% at 31 December 2010; Art. 3 Directive 2003/30/EC concerning the promotion of the use of biofuels or other renewable fuels in transport.

soils being tilled for such production[59]. The tension between soil protection and biofuel production was addressed by the European Parliament in a resolution of 29 September 2011: « Soil is a scarce resource » and the Parliament calls for « concrete action, effective measures and monitoring, especially as regards the production of biofuels »[60].
In addition, « sustainability » criteria for soil production, and criteria for protecting biodiversity and carbon storage in soils have been established[61]. Only the following are taken into account to meet the objectives for the development of renewable energies (Art. L. 661-2 al. 1 C. energy) : biofuels and bioliquids bound by these sustainability criteria. Tax advantages and other public aids for biofuels are also subject to compliance with these criteria (Art. L. 661-2 para. 2 C. energy). In addition, a new directive has modified previous legislation limiting rezoning of land, including indirect changes[62], for the purpose of biofuel production[63].

2.1.3. The protection of soil from pollution by sludge from sewage treatment plants.

The spreading of residues from the treatment of waste water, known as « sewage sludge », is a less expensive solution than incineration. And, because such sludge can be of agronomic value, its use in agriculture has been encouraged[64]. However, because its application may pollute soil, the agricultural community has demanded safeguards, in the form of regulations, about how it is spread. Incidentally, as M. Desrousseaux notes[65], this is the first time that the European Commission has tackled the issue of soil[66].
The fundamental principle laid down is: « Sludge can only be spread if it is in the interest of the soil or for fertilising crops and plantations. Its spreading is not

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[59] This is known as the ILUC (Indirect Land Use Change) effect. *cf.* Desrousseaux M., *La protection juridique de la qualité des sols*, thesis cited above, p. 360

[60] European Parliament Resolution of 29 September 2011, on developing a common EU position in preparation for the United Nations Conference on Sustainable Development (Rio+20), P7_TA (2011) 0430, §52.

[61] Directives 2009/28/EC and 2009/30/EC of 23 April 2009 (Art. 17 and 7b, respectively) ; according to Article L. 661-5 of the French Energy Code, « biofuels and bioliquids must not be produced from raw materials that come from : 1° Land of high value in terms of biodiversity; 2° Land with a significant carbon sink ; 3° Peatlands », which, in turn, constitute significant ecological reservoirs and an important source of carbon storage.

[62] Directive 2015/1513 of 9 September 2015; according to Recital 9 of the Directive, « Where pasture or agricultural land previously destined for food and feed markets is diverted to biofuel production, the non-fuel demand will still need to be satisfied either through intensification of current production or by bringing non-agricultural land into production elsewhere. The latter case constitutes an indirect change in land use, and when it involves the conversion of land with a high carbon sink it can lead to significant greenhouse gas emissions. »

[63] In particular, the proportion of biofuels produced from cereals, sugar and oilseed crops, or plants, grown mainly for energy production purposes is limited (Recitals. 17-22, Art. 2).

[64] In this respect also, Recital 7 of Directive 86-278 of 12 June 1986, on the protection of the environment, and in particular soil, when sewage sludge is used in agricultural applications, contains the following provisions: « Sludge can have valuable agronomic properties and it is therefore justified to encourage its use in agriculture ».

[65] Thesis cited above, No. 164.

[66] As the text itself highlights, « this Directive also aims at establishing certain initial Community measures in connection with soil protection », Recital 6.

permitted simply as a means of disposal »[67]. *A fortiori*, such spreading should not affect the quality of soil[68] and the risk of contamination by heavy metals found in sewage sludge must be prevented. To achieve this, sludge spreading is subject to a prior administrative authorisation or declaration[69]; there are requirements for treatment before spreading; and technical characteristics and spreading methods are also regulated[70].

2.1.4. The protection of soil in the Alps

The provisions contained in the Alpine Convention on soil protection[71], adopted on 16 October 1998, are both ambitious and not very restrictive, because the measures to be adopted by the signatory states were not set out in a precise manner.
The protocol is ambitious in its objectives and the perspective it takes. The protocol aims to prevent all types of soil damage, « quantitative and qualitative soil impairments», erosion, impermeabilisation, pollution, deterioration of the soil structure ; it states that the « restoration of [soils] natural functions in impaired locations are matters of general interest » and that « economic interests must be reconciled with ecological requirements ». However, the provisions of the protocol only commit signatory countries to adopting the measures necessary for its implementation, and the terminology used reveals how flexible the requirements of the text are[72]. As a « vast list of good intentions », most of the provisions of the protocol cannot, therefore, be applied directly[73].

In conclusion, by combining incentives and restrictions, obligations to do certain things and not do others, the law aims to prevent the occurrence of damage to soil. But, the list of these standards reveals that their scope remains marginal, confined to particular purposes and/or geographical areas. It is, therefore, the common agricultural policy (CAP), and the associated aid, that includes the most ambitious provisions for soil protection; but, by definition, they only apply to farmers, and, more specifically, to farmers entitled to aid under the CAP.

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[67] Art. 6 al. 2 Decree No. 97-1133 of 8 December 1997 on the spreading of sewage sludge.
[68] Art. 6 al. 1 Decree No. 97-1133.
[69] Art. R. 214-1 C. env., Section 2.1.3.0.
[70] Order of 8 January 1998 laying down the technical requirements applicable to the spreading of sewage sludge on agricultural land, adopted pursuant to Decree No. 97-1133 of 8 December 1997 on the spreading of sewage sludge.
[71] Cf. Decree No. 2006-125 of 31 January 2006 on the publication of the protocol on the implementation of the Alpine Convention of 1991 with respect to soil conservation.
[72] Thus, "the restoration of the natural characteristics of damaged soils should be encouraged" (Art.1.2), and "the protective aspects shall, as a matter of principle, be given priority over use aspects" (Art. 2.2), and "Contracting Parties shall explore the possibilities of supporting, through fiscal and/or financial measures, the actions for soil conservation in the Alpine region targeted by this Protocol. Measures compatible with soil conservation and with the objectives of a prudent and environmentally sound use of soils should be given special support."(Art. 2.3), "Areas damaged by soil erosion and landslides shall be rehabilitated in as far as this is necessary for the protection of human beings and material goods."(Art. 11.2), etc.
[73] This means that a plaintiff would have no grounds to claim violation of its provisions in a dispute in terms of the direct applicability of an international standard, CE Ass. 11 avril 2012, Gisti, req. n° 322326.

2.1.5. The CAP and soil

In the common agricultural policy, environmental protection is incorporated in support based on three conditions[74] : firstly, the payment of the aid is subject to compliance with certain environmental requirements[75] ; secondly, aid is offered in return for agri-environmental commitments [76] ; and, lastly, farmers can only benefit from the entirety of the direct payments, under the first condition[77], if they incorporate certain agronomic practices, that are beneficial to the environment and climate, into their production systems[78]. Soil protection is one of the environmental issues identified by the CAP.

In order to prevent soil erosion and maintain a certain level of organic matter in soils, « Good agricultural and environmental conditions »[79] for being entitled to aid, prohibit : 1 - the tilling of waterlogged or flooded soil (Art. D. 615-51 C. rural.), 2 - the ploughing of plots (other than in a direction perpendicular to the slope) with a gradient greater than 10% between 1 December and 15 February[80], 3 - the burning of crop residues (Art. D. 615-47 C. C. rural). Moreover, the obligation to ensure a minimum level of soil cover (Art. D. 615-50 C. C. rural) also contributes to their protection, even if the primary aim of the measure is stated as carbon storage.

Under the second condition for CAP support, agri-environmental contracts may be used to encourage the adoption of practices that protect soil quality. Thus, an « agri-environmental crop-rotation measure » was proposed to farmers from 2007 to 2010[81]. Above all, a measure for the « conversion to direct seeding on land with plant cover » has just been introduced by the Ministry of Agriculture. According to the ministry's information sheet, dated 21 April 2017, « the measure meets the needs for sustainable management of agricultural soils by fighting erosion, providing organic matter, promoting biological activity and preventing the compacting of soils. ...[it] encourages farmers to limit their tillage as much as possible, ensure plant cover throughout the year, and diversify crop rotations on arable land. The mechanical working of soils is replaced by the work of soil organisms [biological work] and the root systems of plants ... [It] promotes the practice of direct seeding on soil covered by plants » without prior tillage. Under a five-year contract, farmers undertake to convert at least 40% of their assisted areas to conservation agriculture in the first year, at least 60% in the second year, at least 80% in the third year ; and, after that, the entire surface area[82]. The « field crop systems » agri-environmental measure also

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[74] For more detail, *cf.* Hermon C. « Agriculture et environnement. Un nouveau projet pour la PAC ? », *Revue de l'Union Européenne*, janvier 2014, n° 574, p. 52

[75] In accordance with the principle known as aid conditionality.

[76] Elements of the second condition for support under the CAP.

[77] Made up of market-support measures and supplemental income for farmers.

[78] Art. D. 615-31 and following articles, C. rural.

[79] Such « good agricultural and environmental conditions », defined in part by Member States, complement the European regulatory requirements in order to set out the conditionality rules. Art. 93 Regulation No 1306/2013 of 17 December 2013 on the financing, management and monitoring of the Common Agricultural Policy.

[80] Unless a permanent vegetation strip of at least 5m is established at the bottom of the plot of land, Art. D. 615-51 C. rural.

[81] PDRH (The French rural development programme) 2012 Annual Implementation Report, p.53

[82] The level of aid is €163.79/ha a year. Farmers must convert at least half of the area of their farms, and the area committed must not be less than 10ha. In addition, over the whole area, including unconverted land, the farmer must remain within set limits (according to the IFT – an application frequency index set for the area – for herbicides and other products); and, on areas of land benefiting from aid, they must meet a number of requirements: soil analysis, the recording of practices, humic

supports practices that are beneficial to soil quality. In addition to the mandatory reduction of herbicides and introduction of pulses, the measure makes aid conditional on the introduction of crop diversification and rotation.
Lastly, the new environmental conditions, specified under the first condition for CAP support, strengthen the system by introducing simple requirements. To benefit from the supplement to the basic payment, farmers must : diversify their crops[83], conserve permanent grasslands and maintain or create « areas of ecological interest », such as hedges, trees, grass strips, fallow land, areas of agroforestry, etc.

The entire aid package certainly provides a lever for farmers to better address the quality and health of their soils. The conditions for qualifying for the aid, and the supplement to the basic payment, encourage farmers, fearing that the aid will be reduced, to adopt basic practices with respect to soils, and the new agri-environmental measures, referred to above, may lead to a transition to production techniques that are (more[84]) beneficial to soil. But, in law, there is, of course, no obligation on the farmer to apply for the MAEC aid (the French system of agri-environment measures), or to meet the conditions for full payment of such aid[85]. Moreover, while the various reforms have led to greater consideration of the environment, the CAP has not instigated an ecological revolution, and its priority objective remains agricultural production[86].

While there is an absence of measures to prevent soil degradation, the law does include obligations to restore it. However, it is only applied today to former industrial sites, when they are modified for a different purpose.

2.2. Soil restoration

In law, soil restoration measures can be imposed on the basis of the Environmental Liability Directive[87] (2.1) or the law relating to classified installations (2.2). In addition, Act No. 2014-366 of 24 March 2014 adds a new chapter to the French Environmental Code entitled « polluted sites and soils » ; questions remain about whether these provisions actually create new obligations with respect to soil restoration (2.3) or not. The law on classified installations, and Act No. 2014-366, concern rehabilitation for the urbanisation of former industrial sites whose operation has resulted in soil pollution. As for the Environmental Liability Directive: it has never been implemented; this does not preclude its future implementation, but underlines the fact that its conditions for application, and the regime it imposes, constitute obstacles to its deployment[88]. Thus, the scope of soil restoration in law is

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balances, monitoring of earthworm indicators, agricultural observation of biodiversity, and diversification and rotation of crops.

[83] At least two crops when the exploitable area exceeds 10ha, and at least three when it exceeds 30ha.

[84] The « field crop systems » measure is not primarily aimed at soils, but biodiversity and water quality; However, it should help to limit the impact of these cropping systems by reducing pollutant transfers and improving nitrogen fixation.

[85] On the other hand, a reduction in aid, could be economically difficult to bear.

[86] For more detail, *cf.* Hermon C. « Agriculture et environnement. Un nouveau projet pour la PAC ? », cited above.

[87] Directive 2004/35/EC of 21 April 2004 on environmental liability with regard to the prevention and repair of environmental damage.

[88] Cf. Hermon C. « La réparation du dommage écologique. Les perspectives ouvertes par la directive du 21 avril 2004 », *AJDA* 2004, p. 1792, Kromarek P. et Jacqueau M. « Réflexions autour de la

narrow, framed, on the one hand, by whether or not there is pollution, and, on the other, by the goal of urbanisation; to a large extent, then, the likelihood of such legislation being used for the restoration of degraded agricultural soils[89] is low.

2.2.1. The Environmental Liability Directive and the restoration of damaged soils

The Environmental Liability Directive (ELD)[90] places a responsibility on the operators of installations to repair some types of ecological damage that had not been previously addressed in law. However, the directive's lack of application, to date, means that there is relatively little to say about it.
At first reading, it appears that the ELD could offer a solution to the issue of soil degradation. Not all types of environmental damage are covered by the directive, but damage to land is covered explicitly (Art. 2.1)[91]. Moreover, the damage is understood as damage to a resource or a service rendered (Art. 2.2)[92]. However, a closer reading reveals that the definition of damage is very limited as it only considers repairable damage to soil as: « land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms ». As a result, the remediation measures address this health issue alone: « The necessary measures shall be taken to ensure, as a minimum, that the relevant contaminants are removed, controlled, contained or diminished so that the contaminated land, taking account of its current use or planned future use at the time of the damage, no longer poses any significant risk of adversely affecting human health. » (Annex II.2). The approach is therefore extremely limited. In the end, it turns out to be close to that already in force under classified-installations law.

2.2.2. Classified-installations law and the restoration of polluted soils

Classified-installations law obliges the last operator of an installation that has ceased activity to restore the site to a condition that poses no danger or inconvenience to residents and the environment. This may require the dismantling of buildings, removal of hazardous substances, and the decontamination of polluted soils. The scope of the remediation required is specified: the site must be restored to a state that allows future use of the site, as determined jointly with the relevant municipality's

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transposition de la directive sur la responsabilité environnementale en droit français », *Env. et DD* nov. 2004, n° 11, Etude 18.

[89] For example, by prescribing the establishment of hedges to fight soil erosion, or the establishment of intermediate crops to absorb excess nitrates.

[90] Directive 2004/35/EC of 21 April 2004 transposed by Act No. 2008-757 of 1 August 2008 and codified in Articles L. 162-1 and the following articles of the French Environmental Code.

[91] However, diffuse pollution is excluded, which greatly limits the scope of application of the directive to address soil damage, « unless a causal link between the damage or threat and the activities of the different operators is established » Art. L. 161-2-7 ° C. env.

[92] Damage is defined as a « measurable negative change in a natural resource or a measurable deterioration of a service related to natural resources, which may occur directly or indirectly ». For an analysis of this broadening of the scope of damage affecting services cf. I. Doussan « *Les services écologiques : un nouveau concept pour le droit de l'environnement [*Ecological services: a new concept in environmental law*]* », in Cans C. (dir.), *La responsabilité environnementale [*Environmental Responsibility*]*, Dalloz, 2009, p. 125.

mayor, or president of the EPCI[93] responsible for planning, and the owner of the site, if the owner is not the operator[94]. The remediation of polluted soils, thus considered in the context of the future use of the site, especially in terms of its potential for residential use;[95] in a context where the « *construire la ville sur la ville* » [build the city on the city] approach 5discussed above° is being taken, intends to reuse brownfield sites. The scope does not include, the more general objective of restoring the quality or health of contaminated soils[96].
However, we can cite the special regime for the rehabilitation of quarries [97] which specifically addresses soils: « The backfilling of the quarries must be managed in such a way as to ensure the physical stability of the backfilled land. It must not affect the quality of the soil... »[98].

2.2.3. The ALUR Act and the rehabilitation of polluted soils

Article 173 of the ALUR Act[99] adds a new article to the French Environmental Code under a chapter entitled « Polluted Sites and Soils ». The context of this provision and the intention of legislators « to create access to housing and a renewed urban environment » are the same as those described above : to make use of brownfield sites where there is a lack of land for urban development. But if we consider the specific provisions of the law, its scope is more difficult to measure : is it, in fact, just a straightforward clarification of who is obliged to finance remediation actions or is it more progressive in terms of rehabilitation obligations?
According to Art. L. 556-3-I of the code, « in the event of soil pollution, or the risk of soil pollution, presenting risks to health, safety, public health or the environment, and with the use having been taken into account, the authority, with power to enforce the law, may, after giving formal notice to that effect, require any necessary works to be carried out at the expense of the responsible person ». In terms of the law of classified installations, this provision does not create new obligations, unless it is applicable even though activity has not ceased. The text does not address such cases, and it is for the judge to decide, either by assuming an analogy with classified-installations law, or by opting for a literal reading of the text, according to which rehabilitation is required « in the event of soil pollution... involving risks » with respect to land use, even though there is to be no change of use or cessation of activity.

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[93] A body under which several French communes exercise powers jointly.
[94] Art. L. 512-6-1 and L. 512-7-6 C. env.
[95] In the absence of agreement between the operator, the owner and the municipality's mayor (or the president of the EPCI), the rehabilitation, prescribed by the prefect, must allow at least "a future use of the site comparable to that during the last period of operation of the decommissioned facility." But "in cases where [such] rehabilitation ... is clearly incompatible with the future use of the area ... the prefect may set ... more restrictive rehabilitation requirements, allowing a use of the site consistent with urban planning documents" (Art. L. 512-6-1 and L. 512-7-6 C. env.).
[96] Because the restoration of polluted soils is considered, in law, in terms of toxicity thresholds and uses of the site, without any obligation to restore the quality of the soil
[97] It should be noted that quarries constitute classified installations, when a certain area of exploitation, or quantity of materials to be extracted, is exceeded, *cf.* Desrousseaux M., thesis cited above, n° 622 et 663 et ss..
[98] Art. 12.3 of the Order of 22 September 1994 relating to quarry operations and primary processing facilities for quarry materials, amended by the Order of 5 May 2010, *Cf.* Desrousseaux M., thesis cited above, n° 688-689.
[99] Act No 2014-366 of 24 March 2014 concerning access to housing and a renewed urban policy.

In addition, the scope of Art. L. 556-3-I of the French Environmental Code exceeds that of classified installations. Moreover, Paragraph II of Art. L. 556-3 lists the persons required to rehabilitate soils polluted by waste, whatever its origin, including, therefore, those not associated with classified installations. However, while the rehabilitation of polluted soils was initially required, on the basis of waste law, with the polluted soils treated as waste,[100] this has not been the case since the entry into force of Directive 2008/98/EC of 19 November 2008 concerning waste[101]. Therefore, Article L. 556-3-I of the French Environmental Code appears to constitute a development in terms of obligations to restore soils polluted by waste, which are not covered by the law in its present form. In this sense, we could envisage that, in particular, the obligation to rehabilitate agricultural soils polluted by fertiliser residues[102], which are considered as waste,[103] could be ordered by the authorities[104]. This same logic could be used for soil polluted by residues from plant protection products[105] which have not been consumed for their intended purpose and, therefore, constitute waste[106]. If the legal texts were to be read in this sense, then the law's scope in terms of the restoration of agricultural soils would be considerable, always assuming that those with an interest in applying such law take it up and demand that it be used in this way.

Ultimately, while positive law is not void of soil protection provisions, the juxtaposition of all these measures certainly does not guarantee the complete protection of the soil in general, and agricultural soils in particular: their scope and purpose are too limited. In this respect, in two successive communications, the European Commission concluded that "despite the delivery of some soil protection through several existing policy areas, a comprehensive Community approach to soil protection does not exist. Soil protection is more the result of the crosscutting nature of soil [which benefit from legislation that does not directly address them] than the outcome of an explicit intention to tackle soil problems[107]. This analysis resulted in a proposal for a directive creating a framework for soil protection that was "aimed at filling this gap" [108], and which could have been the basis of a "soil law" had the

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[100] CJCE 7/09/2004 SA Texaco Belgium, CAA Versailles 10/05/2007, req. n° 05VE01492.

[101] The scope of the Directive excludes '*in situ* soils, including unexcavated, polluted soils'.

[102] For more detail, *cf.* Bellec P., Lavarde P., Lefèbvre L. et Madignier M.-L., *Propositions pour un cadre national de gestion durable des sols*, cited above, pp. 45-47.

[103] According to Article L. 541-1-1 of the French Environmental Code, « within the meaning of this chapter [Prevention and Management of Waste], the terms are defined as follows: Waste: any substance or object, or more generally any movable property, which the holder discards or which he/she intends to, or is obliged to, discard ». For more detail, cf. Langlais A., « Le droit face à la gestion des effluents et des émissions d'azote », in *Les flux d'azote liés aux élevages. Réduire les pertes, rétablir les* équilibres, Expertise collective, rapport, INRA, 2012, p. 429 et ss..

[104] This restoration could be ordered : of the producer of the waste, or of the farmer – as the keeper of the material – if he/she has committed a fault, or, failing that, of the owner of the land « if he/she has been negligent or (if) he/she is aware of the pollution. » (Article L. 556-3-II C. env.).

[105] *Cf.* Bellec P., Lavarde P., Lefèbvre L. et Madignier M.-L., *Propositions pour un cadre national de gestion durable des sols*, cited above, p. 45.

[106] The farmer would also be responsible here as the producer of waste.

[107] Communications Commission européenne : *Vers une stratégie thématique pour la protection des sols*, 16/04/2002, COM(2002)179final

[108] Recitals, draft proposal for a text. In the recitals to the proposal for a directive, the Commission noted: « However, due to their different objectives and scopes, and to the fact that they often aim to safeguard other natural environments, existing provisions, even if fully implemented, offer only a fragmented and incomplete protection to soil, as they do not cover all soils and all soil threats identified. Hence, soil degradation still continues ».

proposal had been carried through.

3. Towards the construction of a "soil law"?

The proposal for a directive, tabled by the Commission in 2006, has not been adopted (3.1). Nevertheless, there was common agreement : an analysis of soil degradation was drawn up[109] and linked to the inadequacies of the legal framework, and a demand for legal protection was made, based on the functions of the soil and the services provided by it (3.2).

3.1. The proposal for a directive on soils

The proposal for a directive defining a framework for soil protection[110] was remarkable in three ways: it clearly identified the objective of the protection[111], which included the functions of the soil and the resulting services[112], and it took a comprehensive approach to these functions and services.
According to the recitals of the draft text, « The proposed legislation, which aims at protecting soil and the preservation of the capacity of soil to perform its environmental, economic, social and cultural functions ». The following was stated in Article 1 of the proposal: 1. This directive establishes a framework for the protection of soil and the preservation of its capacity to perform any of the following environmental, economic, social and cultural functions : (a) biomass production, including in agriculture and forestry ; (b) storing, filtering and transforming nutrients, substances and water ; (c) providing a biodiversity pool, such as habitats, species and genes ; (d) providing a physical and cultural environment for humans and human activities ; (e) being a source of raw materials ; (f) acting as a carbon sink ; (g) being an archive of geological and archaeological heritage.

This systemic approach, including soil functions and services, was the text's essential contribution[113]. The rest of the article stems from the above, « To that end, it lays down measures for the prevention of soil degradation processes, both occurring naturally and caused by a wide range of human activities, which undermine the capacity of a soil to perform those functions » (Art. 1). To this end, the proposal included an obligation to assess the impacts on soils of the application of certain

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[109] Bellec P., Lavarde P., Lefèbvre L. et Madignier M.-L., *Propositions pour un cadre national de gestion durable des sols*, cited above, p. 30 et ss, FAO and ITPS, *Status of the World's Soil Resources (SWSR)- Technical Summary*, Rome, 2015, Bispo A., Guellier C., Martin E., Sapijanskas J., Soubelet H. et Chenu C. (coord.) *Les sols. Intégrer leur multifonctionnalité pour une gestion durable*, cited above, pp. 32 et ss..

[110] Proposal for a directive establishing a framework for soil protection and amending Directive 2004/35/EC, 22 Sep 2006, COM(2006)232final.

[111] In this respect, it addressed Desrousseaux M's observations, thesis cited above, no. 610 : « There is no doubt that the weaknesses of law in effectively tackling soil degradation... are a consequence of the difficulties the law has in identifying the real object to be protected ».

[112] The proposed directive confuses function and services; it only refers, specifically, to the « functions » of the soil, without distinguishing the functions (of carbon sequestration, providing a pool of biodiversity, and storage of water and nutrients), from the services, cultural services and production services of the raw materials for agriculture and forestry that are referred to in the text.

[113] On the change of methodological approach, which assumes an understanding in terms of functions and services, *cf.* Fèvre M. « 'Ecosystem services', a functional concept », *infra*.

sectoral policies[114] and to identify « areas in their national territory, at the appropriate level, where there is decisive evidence, or legitimate grounds for suspicion, that one or more of the following soil degradation processes [erosion, reduction of organic matter contents, compacting, salinisation, landslides] has occurred or is likely to occur in the near future. » (Art. 6) In addition, the Member States had to adopt objectives to reduce the risk of damage to the soil (though the draft directive did not lay down the quality standards) as well as the programmes of measures to achieve these objectives[115], including specific measures that would "contribute to the prevention and reduction of the introduction of dangerous substances into soil to avoid soil contamination and to preserve soil functions." (Recital 20, Art. 9). Finally, Member States had to require land users to take « precautionary measures when their use of the soil can be expected to significantly hamper soil functions »[116].
The proposal for a directive, submitted on the basis of Article 175(1) of the EC Treaty,[117] would have had to obtain a qualified majority in the Council. It failed as a result of the reluctance of Member States, who were concerned by what they saw as important industrial-policy issues (raised by the draft directive) relating to agricultural activity[118], as well as the cost of implementing the measures envisaged, particularly those needed to address soil contamination[119]. The proposal was therefore abandoned in 2014. It could have returned to the legislative agenda though. A European Citizens' Initiative was launched in September 2016, pursuant to Article 11.4 of the Treaty on European Union, calling for the adoption of « specific legislation on soil protection »[120]. But the initiative did not collect the number of signatures required for the Commission to take it up[121]. Having said that, such an initiative is not unusual: there have been numerous calls for a soil law to be enacted.

3.2. Calls for the adoption of a soil law

Calls for the protection of soil are long-standing and recurrent. Since 1972, the Council of Europe had been calling for the adoption of « appropriate legislation to

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[114] « In the development of sectoral policies likely to exacerbate or limit soil degradation processes, Member States shall identify, describe and assess the impacts of such policies on these processes, in particular in the areas of... agriculture... climate change, environment, nature and landscape » Art. 3.
[115] Art. 8.1, Programmes of measures to combat erosion, organic matter decline, compaction, salinisation and landslides. For the purposes of preserving the soil functions... Member States shall in respect of the risk areas identified...draw up, at the appropriate level, a programme of measures including at least risk reduction targets, the appropriate measures for reaching those targets, a timetable for the implementation of those measures and an estimate of the allocation of private or public financing of those measures."
[116] Recital 12; and in this sense also, Art. 4.
[117] « The Council... shall decide what action is to be taken by the Community in order to achieve the objectives referred to in Article 174 » relating to the environment.
[118] P. Raoult, French Senate Report, on behalf of the Committee on Economic Affairs, on the motion for a resolution... on the proposal for a directive, doc. French Senate, No. 290, 17 April, 2007, p.7.
[119] In this respect also, Delegation for the European Union, French Senate, 9 Nov. 2006 : « The French Senate's Delegation for the European Union... asks the European Commission to ensure the proportionality of the measures envisaged, and, in particular, to justify that the cost of each of them is reasonable in view of the expected benefits ».
[120] https://www.people4soil.eu.fr
[121] According to Regulation No 211/2011 of 16 February 2011 on the citizens' initiative, the petition would have needed to collect one million signatures, from the citizens of seven Member States within one year, for the Commission to act on it while still remaining free to respond in whatever way it saw fit.

protect the soil and, if necessary, restore it, noting in particular, in the case of agricultural soils, the destruction of organic soil (and its structure) by inadequate agricultural practices and the misuse of heavy machinery, as well as soil pollution by the indiscriminate use of some chemical fertilisers and pesticides »[122]. From a strictly food-related perspective, in 1981, the FAO also adopted a « World Soil Charter » in which it urged Member States to « incorporate principles of rational land use, and management and conservation of soil resources, into appropriate resource legislation ».

Today, the UN is urging the international community to adopt an additional protocol to the Convention to Combat Desertification, based on the concept of soil security, which goes beyond the single question of desertification[123], and among its sustainable development goals, retains the principle of land-degradation neutrality (LDN)[124]. In 2010, the FAO Committee on Agriculture again took up the issue of soils and urged the UN agency to renew its attention to soil matters, non-renewable resources and suppliers of vital ecosystem services[125]. This resulted in a « Revised World Soil Charter », adopted in June 2015, which broadened the perspective to the functions of water regulation and concentration of greenhouse gases in the atmosphere (§5), their qualities in terms of essential reservoirs of global biodiversity, micro-organisms, flora and fauna (§8), and related services. Reports, communications and opinions on soils from international, European and national bodies are multiplying. The convergence of these texts is striking: on the one hand they appeal to the law – for the adoption of specific legislation – and on the other, they refer heavily to the functions and services rendered by the soil in order to justify the need for a renewed degree of protection[126]. It is no surprise, then, that references to functions and services are now a regular occurrence[127].

Further work has developed the academic thinking on the subject. So, according to Maylis Desrousseaux : « In order to emphasise preservation, the quality of soils *through* services can enable the recognition and protection of their environmental value », « the concept of soil quality, which would cover all the services that soils

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[122] European Soil Charter, EJN 1976, No. 3-4, p. 421.

[123] Concept developed during the World Day to Combat Desertification in 2009; for more detail, cf. Desrousseaux M., thesis cited above, No. 566 and following articles.

[124] General Assembly Resolution « Transforming Our World : The 2030 Agenda for Sustainable Development », 25 Sep. 2015, A/RES/70/1, Sustainable Development Goal 15, Target 15.3 : « By 2030, combat desertification, restore degraded land and soil... and strive to achieve a land degradation-neutral world ». 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 », *cf.* « Land Degradation Neutrality Target Setting Programme (LDN TSP) », UNCCD, 2016.

[125] FAO, Committee on Agriculture, *Soil for Food Security and Climate Change Adaptation and Mitigation*, 22nd Session, 16-19 June 2010, COAG/2010/4.

[126] In this sense also, European Commission Communications, « *Towards a Thematic Strategy for Soil Protection*, *Thematic Strategy for Soil Protection* », cited previously, which refer, respectively, to soils' "wide range of vital functions", and "all the different functions that soils can perform", in order to emphasise the need to ensure soil protection ; Courtoux A. et Claveirole C. « La bonne gestion des sols agricoles : un enjeu de société », Avis du Conseil économique, social et environnemental, mai 2015 : the EESC has called for soil protection, describing it as largely non-existent yet sheltering the most important part of the planet's biodiversity, and stating that the ecosystem services it performs are vital; the report cites the functions and services provided by the soil whose general interest is widely recognised, in calling for the implementation of a national soil strategy (given the absence of relevant law) and a strengthening of the coherence of sectoral legislation and policies.

[127] *Cf. infra* I. Doussan, « A brief history of the incorporation of the concept of ecosystem services in law », Fèvre M., thesis cited above.

perform... could prove relevant in developing a principle of soil protection »[128].
The ideas of functions and services would therefore make it possible to identify more clearly which object should be protected, while renewing the approach to it[129], and then justifying such protection and making it acceptable[130]. But, beyond this identifying and legitimising function, it is important to judge whether an explicit approach[131] using services can, in law, establish a degree of soil protection that did not previously exist.
The amendment of Article L. 110-1 of the French Environmental Code by the 2016 "Biodiversity" Act, and the subsequent integration of ecosystem services within areas of general interest[132], justifies the introduction of protection, including by restricting the rights of owners or operators. According to settled case law, the right to hold property or the freedom to conduct business may be overridden, for reasons of public interest, provided that they are not disproportionate. Now, environmental protection is one of the reasons that can justify infringement of the right to hold property or the freedom to conduct business[133]. In the future, more specifically, it is possible that the protection of ecosystem services, in the general interest, may also be invoked[134]. This service-based approach will, therefore, make it possible, where appropriate, to put in place a range of protective measures, including expropriation, public easements classified as being in the public interest, prior authorisation, operating conditions, etc., with respect to the particular services provided by such environmental components[135]. Having said that, even without considering the socio-economic obstacles[136], all types of services will certainly not be protected, given that

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[128] No. 62 and introduction, respectively ; M. Desrousseaux's thesis focuses on the quality of soils, and not on the services performed by them; but it is based on the idea of services in order to construct the concept of quality that it defends. See also, Langlais A. « L'appréhension juridique de la qualité des sols agricoles par le prisme des services écosystémiques », *Dr. rural*, n° 435, août 2015, Etude 20 : "In view of the urgent need to consider soils, the use of the particularly high-profile concept of ecosystem services (ES) may be justified in itself, but it can also be used strategically in order to draw attention to the need to conserve and recover quality soils".

[129] *Cf. infra* M. Fèvre « 'Ecosystem services', a functional concept ».

[130] *Cf.* in this sense also, Fèvre M., thesis cited above, p.18 : « Ecosystem services ... [reveal] that beyond the loss in itself due to the degradation of a natural resource, significant consequences for the economy and human development ensue », Bellec P., Lavarde P Lefèbvre L. and Madignier M.-L., report cited above, p.4 : « When the idea of 'the common heritage' is debated, the general interest of ecosystem services rendered by soil is recognised ».

[131] Fèvre M., thesis cited above, p. 70 : « The concept of "services" leads us to see how functional and systemic approaches are already at work, but in an unstructured, dispersed fashion, in legislation that is concerned with clearly-identified elements of the environment ». The first part of the document is devoted to identifying « ecological services... already taken up in law ».

[132] According to Article L. 110-II of the Code, amended by Act No. 2016-1087 of 8 August 2016 aimed at recovering biodiversity, nature and landscapes, « the safeguarding of services [provided by the spaces, resources and natural marine and land environments, sites, diurnal and nocturnal landscapes, air quality, living organisms and biodiversity, is] of general interest ».

[133] *Cf.* for ex. CAA Nantes 31 décembre 2009, Mme Marie Scoarnec, *RJE* 1-2011, p. 127, concl. S. Degommier, Cons. Constit. 11 octobre 2013, n° 2013-346 QPC, CE 17 juillet 2017, req. n° 410989. Pour plus de développements, cf. Tomadini A., *La liberté d'entreprendre et la protection de l'environnement. Contribution à l'étude des mécanismes de conciliation*, LGDJ, 2016.

[134] Services provided by soils are not specifically covered by Article L. 110-II (cf. *supra* footnote 132). However, we do not see any obstacle to the protection of these services under the general interest insofar as the link between soils and the environments and resources listed in the article is expressly referred to in the following paragraph: «...soils... contribute to the common heritage of the nation », which is, itself, made up of all the environmental elements set out in Article L. 110-II.

[135] *Cf. infra* G. Beaussonie « The legal definition of ecosystem services ».

[136] Resistance, particularly in the agricultural sector, would be strong. We would cite, in this sense too, the position repeated in the aforementioned report. « While highlighting the positive environmental

the requirement for proportionality, as understood in case law, is set against it. Also, the approach based on attributing value to services, and the incentives to preserve them, appeared to be a fruitful one to us, justifying the developments that centre on these financial[137] and contractual[138] methods of valuation. And, despite its failure to fully convince, the inclusion of damage to ecosystem services at the head of the list of damages that may require legal compensation now makes it possible to rectify that which had not been possible until now[139].

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impact of their practices, the most committed farmers still want to maintain control of their "soil capital"... In general, farmers fear the implementation of specific constraints in terms of agricultural land uses, especially those applied using uniform measures, which can stem from a desire to regulate their activity in the interests of maintaining ecosystem services while questions of the recognition of environmental services and that of their economic value are put to one side », p. 61.

The financial tools developed for emissions-trading markets, and linked to public policy aimed at combating climate change, cannot, on the other hand, be addressed here. We leave this question for works of a more general nature on the subject.

[138] *Cf. infra* M. Poumarede « Ecosystem services and contracts. What environmental obligations exist in contract law ? », B. Alidor « Offsetting and ecosystem services », D. Krajeski « Tillage, ecosystem services and rural leases», L. Icher « Public spending in the Environmental Field : the Case of Soil Protection ».

[139] *Cf. infra* S. Jean « The effect of ecosystem services on civil liability law ».

Agricultural soil, an essential yet neglected resource

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Soil and the necessity of its protection are underrepresented in the law, one reason for which may be the neglect of these concerns within agronomy[1].
Soil is closely bound with food production, agricultural heritage and regional identity. In an agricultural country such as France, it might be expected that soil be considered, by agronomists at the least, a major resource.
It is indeed in agriculture that the majority of soil actors can be found. If soil state is regarded as existing upon a continuum, from highly human-transformed soil, such as urban ground, to the preserved natural soil of a protected natural area, agricultural soil occupies an in-between position; it cannot be considered to be completely isolated from either side of the spectrum. Furthermore, due to the close relationship between "the earth" and food production, agricultural soil likely furnishes the best example of how vital this resource is to humanity.
Modern agriculture is a result of scientific and industrial developments which have weakened the bond between farmers and the soil upon which they rely for the growing of crops. Concurrently, soil damage has long been ignored, and its magnitude and consequences remain mostly unknown. Ultimately, it is only recently that scientists, and practitioners linked to policy-making and civil society organisations, have become aware that soil is a fragile resource much more critical than was believed until the last century. Scientific knowledge regarding soils is still largely incomplete, and the scope of national and international issues related to soil conservation is only beginning to become evident.

1. The evolving perception of agricultural soil

The close bond between humans and soil goes back as far as the beginnings of agriculture. However, the evolution of science and industry, especially post-war, has fundamentally changed our relationship to soil. Nevertheless, growing awareness of the environmental damage due to human activity gave rise, at the end of the last century, to the notion of soil-habitat, which notion is today the basis of a paradigm shift in the growing consideration of soil health in agriculture.

1.1. From antiquity to the twentieth century: the marked shift caused by science and industrialisation

Since ancient times, Roman agronomists have been laying the foundations of an understanding of the abundance and quality of crops as in relation to landscape and soil. In antiquity, evaluation criteria of the latter were mainly related to texture (composition and proportion of clay, silts and sands), but also colour, smell and taste[2]. These criteria have since

1 On the invocation of science by the law, cf. Naim-Gesbert E., 1999. *Les dimensions scientifiques du droit de l'environnement. Contribution à l'étude des rapports de la science et du droit [The Scientific Dimensions of Environmental Law. A Contribution to the Study of the Connections Between Science and the Law]*, Bruxelles, Bruylant.

2 Camizuli E., Petit C., Bernigaud N., Reddé M., 2016. Principes méthodologiques pour caractériser des agrosystèmes antiques [Principle Methods for the Characterisation of Agroecosystems in Antiquity]. *Les Nouvelles de l'archéologie [Archaeology News]*, 142, 20-26.

formed the basis upon which to evaluate what is now called the fertility of a soil, as well as the basic rules for the improvement and maintenance of same. A more pragmatic approach saw what was known as the "quality of a field" as the ratio between the effort needed to cultivate the land and the crop production achieved. This perception of field quality made it possible to ascribe an economic value to agricultural plots and thus facilitated land trades. For centuries, the concept of fertility did not exist as such, and the emphasis was simply upon what was needed to "cultivate well." The eventual recognition of the notion of land fertility, having first allowed large increases in surface productivity and labour, then gave rise to the agronomic revolutions of the Middle Ages and the Renaissance, which were based as much upon machinery as on a better use of cultivated biodiversity.

It was in the 19th century that the notion of soil fertility became truly tangible and would be for decades associated with soil chemical properties. The work of the German chemist Justus von Liebig (1803-1873) revolutionised agriculture by identifying the fundamentals of the mineral diet of plants. Liebig's work was in contrast to the dominant theories of the time, mainly based on the importance of humus, with his new insight on plant nutrition, the identification of essential elements for the growth of plants (nitrogen, phosphorus and potassium) and the notion of mineral limiting factor[3]. Although Liebig's discoveries were subsequently criticised, challenged and amended – including by himself – they formed the basis of the industrialisation of agriculture of almost 180 years ago. Liebig particularly defended the idea that soil was not the source of all the elements needed for plant growth[4]. Developments in agriculture following this discovery led to an increase in crop yield; farmers forced to cultivate on "bad soils" could now find the chemical means to overcome this constraint. But this technical upheaval in crop production led to agriculture's increased dependence upon chemical industrial inputs[5]. It also had the more insidious consequence of hastening the erosion of arable land and changing the way in which soil was perceived. Soil was no longer considered to be an essential resource for the development of plants, since it was now possible, by adding inputs, to compensate for soil's failures.

Soil was perceived by the later generations of farmers, particularly by those who lived through the industrial revolution after the Second World War, as a mere support for the growth of plants, recognised only in terms of its proclivity, or otherwise, to bear crops. It was valued for its intrinsic properties, which were considered to be its structure and capacity to retain the water and minerals which plants need. These are the basic properties still referred to as soil fertility. This definition of fertility, representing all the physicochemical properties of a soil and the resulting constraints and benefits for the farmer, was measured according to a battery of indicators, still in use today, including amount and availability of nutrients, depth, texture and stoniness. Thus, soil which was easy to cultivate was "good," or fertile, as opposed to "bad" soils, which, were good yields to be achieved, needed external input, such as fertilisers, tillage or water. Accordingly, during the second half of the twentieth century and the beginning of the twenty-first, soil was perceived as a support, the physical and chemical properties of which could be improved for better crop development by means of often labour- and energy-consuming interventions (ploughing and other soil tillage, drainage, fertilisation, organic and calcium amendments, etc.).

In the 1980s, perception of agriculture and natural resource management significantly changed due to the growing world population, the limitation of resources, social instabilities

[3] A deficit in one mineral element limits the growth of the plant.

[4] Brock W.H., 1997. *Justus von Liebig: the chemical gatekeeper*, Cambridge University Press, Cambridge, 396 p.

[5] Pfeiffer D.A., 2006. *Eating Fossil Fuels : Oil, Food and the Coming Crisis in Agriculture*, New Society Publishers, Gabiola Island, Canada, 144 p.

and damage to vital natural processes[6]. Ecosystem health became a global concern[7], and agricultural soil was no exception, particularly with the discovery that soils hitherto deemed "good" seemed to be steadily losing their fertility. Mechanical destructuring and compaction of soil resulted in the tractive force required to pull a plough increasing from 30 to 80 horsepower. At the same time, the amount of nitrogen required for the same level of yield was continuously increasing, rising from 60-75 units of wheat produced per unit of synthetic nitrogen at the beginning of the 1960s, to just 20-30 in the early 2000s[8]. These facts highlighted the limitations of the industrialisation of agriculture and encouraged agricultural actors to redesign their vision of the soil.

1.2. The twenty-first century: the emergence of the concept of soil-habitat

Productivity capping or losses observed despite increasing mineral fertilisation are mainly attributable to a decline in soil's ability to provide some of a plant's nitrogen supply through the process of humus mineralisation[9]. This decline is the consequence of a decrease in soil humus content, caused by rapid humus destruction (through mineralisation) insufficiently balanced by its formation (humification); this in turn is mainly due to inadequate organic matter management, but also the accelerated mineralisation brought about by excessive tillage.
In light of such losses, intensive practices based on industrial inputs were soon questioned. The importance of soil organisms was brought into consideration, especially their role in the structure and fertility of soil[10] and the impact of cropping management upon them and their functions. However, the lack of scientific knowledge at the time prevented the elaboration of a definitive theory of the relationship between agricultural practices and soil fauna[11]. At this time, the notion of soil quality took precedence over that of fertility. Soil quality was, and continues to be, defined as, "*the capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health*"[12]. Soil was thus fully recognised as its own living system, and a possible explanation for fertility losses could be found in the alteration of both the soil organisms' activity and the biological processes in which they participate. Soil was perceived as a habitat for the first time, and has since been viewed in terms of both its abiotic and biotic (either inert or living) components. The quality of soil therefore depends not only upon its inherent physical and chemical properties, but also upon its biological component and the functions which this provides, since these functions contribute significantly to the physiochemical characteristics upon which plant growth depends[13].

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[6] Costanza R., Norton B.G., Haskell B.D., 1992. *Ecosystem Health: New Goals for Environmental Management*, Island Press, Washington, 269 p.
[7] Mermut A.R., Eswaran H., 1997. Opportunities for soil science in a milieu of reduced funds. *Canadian Journal of Soil Science*, 77, 1-7.
[8] Tilman D., Cassman K.G., Matson P.A., Naylor R., Polasky S., 2002. Agricultural sustainability and intensive production practices. *Nature*, 418, 671-677.
9 Humus mineralisation is a physical, chemical and biological process leading to the transformation of organic constituents into mineral constituents (Gobat *et al.*, 2013).
[10] Dick R.P., 1992. A review: long-term effects of agricultural systems on soil biochemical and microbial parameters. *Agriculture, Ecosystems and Environment*, 40, 25-36.
[11] Lee K.E., Pankhurst C.E., 1992. Soil organisms and sustainable productivity. *Australian Journal of Soil Research*, 30, 855-892.
[12] Doran J.W., Sarrantonio M., Liebig M., 1996. Soil health and sustainability. *In: Advances in Agronomy* (D.L. Sparks, ed.), Academic Press, San Diego, 1-54.
[13] Bender S.F., Cameron Wagg C., van der Heijden M.G.A., 2016. An underground revolution: biodiversity and

1.3. Soil health, a new paradigm

The concept of soil health emerged concurrently with that of soil quality. The former refers, among other things, to the stability of the soil ecosystem due to its resilience to stress, to its biological diversity and to the level of internal nutrients recycling[14]. The scientific community has not yet reached consensus upon the definition of soil health, however, and some consider it to be a component of soil quality, relevant only to soil ecology[15]. Generally, health and quality are considered synonymous[16], although the notion of health is often preferred because it maintains a more "living" and dynamic vision of soil, and implies a holistic approach to the subject.

Nonetheless, the term "soil health" is not to be discounted. To recognise that soil has its own health is to recognise that its condition can be altered. The observed loss of soil fertility which led to the emergence of these terms proved that this loss can be brought about by the pressure of human activity[17]. Furthermore, the recent spread of conservation agriculture, which considers the soil to be a fundamental resource, has also shown that human activity is able to preserve and restore the fertility of a soil – to "heal" it. Some agricultural practices are now well recognised as contributing to healthy soil management. Among these, non-tillage, diversification of crops and intercrops (with the inclusion of legumes), the use of plant cover and organic amendments are recognised to particularly contribute to an active and diverse soil microbial community, an important source of ecosystem services[18]. However, although scientific knowledge is steadily advancing, little is known of the actual interactions between agricultural practices and soil health. Notably, it is currently impossible to extend a definite scientific proposal of the types of practices which might maximise the sociological, economic and ecological benefits linked to soil and its productivity.

In the field, by contrast, such healthy soil management practices first appeared in the 1970s and their uptake has rapidly increased over the past 20 years. While cover crops are still seldom used, the reduction of tillage and the lengthening of rotations are increasingly applied worldwide to improve the natural fertility of agricultural soils[19].

2. The lack of recognition of the importance of soil loss

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soil ecological engineering for agricultural sustainability. *Trends in Ecology and Evolution*, 31, 440-452.

[14] Elliott L.F., Lynch J.M., 1994. Biodiversity and soil resilience. *In: Soil Resilience and Sustainable Land Use* (D.J. Greenland, I. Szabolcs, eds), CAB International, Wallingford, UK, 353-364.

[15] Karlen D.L., Mausbach M.J., Doran J.W., Cline R.G., Harris R.F., Schuman G.E., 1997. Soil quality: a concept, definition, and framework for evaluation (a guest editorial). *Soil Science Society of America Journal*, 61, 4-10.

Van Bruggen A.H.C., Semenov A.M., 2000. In search of biological indicators for soil health and disease suppression. *Applied Soil Ecology*, 15, 13-24.

[16] Doran J.W., 2002. Soil health and global sustainability: translating science into practice. *Agriculture, Ecosystems and Environment*, 88, 119-127.

[17] Mason J., 2003. *Sustainable Agriculture*, 2nd edition, Landlinks Press, 205 p.

[18] Larkin R.P., 2015. Soil health paradigms and implications for disease management. *Annual Review of Phytopathology*, 53, 199-221.

[19] Florentín M.A., Peñalva M., Calegari A., Derpsch R., 2010. Green manure/cover crops and crop rotation in Conservation Agriculture on small farms. *Integrated Crop Management*, 12, 1-109.

Larkin R.P., 2015. Soil health paradigms and implications for disease management. *Annual Review of Phytopathology*, 53, 199-221.

To this slow acceptance of soil as a habitat essential for crop production, and as a resource to be conserved, is added an overall underestimation of the risks which it faces.
Like the climate, soil has a double temporality: 0.017 to 0.036 mm of soil is formed per year[20], and millennia (between 8,300 and 17,600 years!) are necessary for the formation of the 30 cm-thick arable layer, while irreparable soil damage can be suffered in only a few decades, or even a few years. Erosion, particularly by water, is among the most severe threats to soil, alongside artificialisation and waterproofing, the three considered by the Global Soil Partnership to be the main threats in Europe. Other threats include contamination, compaction, loss of organic matter, loss of biodiversity, landslides and acidification[21].
Although it is estimated that in France the current rate of soil destruction is 40 times faster than that of its creation, the importance of erosion has long been underestimated by farmers and agricultural stakeholders, due to the insidious nature of this phenomenon. Despite the fact that increasingly whitening hillsides testify to the loss of soil as calcareous bedrock approaches the surface, erosion itself is observed but rarely: during fierce storms, when ditches fill with soil and streams are laden with silt and clay. Once crops are established, soil degradation is effectively no longer directly visible. In the large European cereal production areas, where the landscape is relatively flat, soil is deep and erosion slower (but nonetheless present) than in hillside growing areas. Disappearance of the soil is imperceptible, and regular cleaning of ditches usually recovers the lost earth. Thus, the erosion phenomenon remained, until recently, largely unnoticed.
The realisation that these soil losses result in a loss of fertility – and therefore of profit – has brought erosion in particular, and physical and chemical alterations to soils in general, to the attention of agricultural actors. Yield losses directly due to erosion alone are estimated at around 0.3%[22]. In addition, erosion entails fertiliser run-off, which is not only a net loss for farmers, but also impairs water quality and endangers aquatic ecosystems. Yield losses and additional production costs represented by other physical and chemical alterations in agricultural soils are not, to the authors' knowledge, quantified, but it is reasonable to assume that they represent a significant economic impact.

3. The limits of current scientific knowledge

[20] Reicosky D.C., 2015. Conservation tillage is not conservation agriculture. *Journal of Soil and Water Conservation*, 70, 103A-108A.
[21] Chenu C., Bispo A., Martin E., Sapijanskas J., Soubelet H., 2016. Sols et société : enjeux actuels [Soils and Society : Current Issues]. *In : Les sols. Intégrer leur multifonctionnalité pour une gestion durable [Soils. Integration of Their Multifunctionality for Sustainable Management]* (A. Bispo, C. Guellier, E. Martin, J. Sapijanskas, H. Soubelet, C. Chenu, coord.), Éditions Quæ, Versailles, coll. Savoir-faire, 15-53.
FAO/ITPS, 2015. Status of the World's Soil Resources – Main Report, Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, 650 p.
Jones A., Panagos P., Barcelo S., Bouraoui F., Bosco C., Dewitte O., Gardi C., Erhard M., Hervas J., Hierderer R., Jeffery S., Lükewille A., Marmo L., Montanarella L., Olazabal C., Petersen J.-E., Penizek V., Strassburger T., Toth G., Van den Eeckhaut M., Van Liedekerke M., Verheijen F., Viestova E., Yigini Y., 2012. The state of soil in Europe: a contribution of the JRC to the European Environment Agency's environment state and outlook report, SOER 2010, Reference report, Luxembourg, 72 p.
[22] den Biggelaar C., Lal R., Eswaran H., Breneman V., Reich P., 2003. Crop yield losses to soil erosion at regional and global scales: Evidence from plot-level and GIS data. *In: Land Quality, Agricultural Productivity, and Food Security: Biophysical Processes and Economic Choices Al Local, Regional, and Global Levels* (K. Wiebe, ed.), Edward Elgar Publishing, Cheltenham, UK, 262-279.
Scherr S.J., 2003. Productivity-related economic impacts of soil degradation in developing countries: an evaluation of regional experience. *In: Land Quality, Agricultural Productivity, and Food Security: Biophysical Processes and Economic Choices Al Local, Regional, and Global Levels* (K. Wiebe, Ed.), Edward Elgar Publishing, Cheltenham, UK, 231-261.

Our understanding of soil remains incomplete; although beneath our very feet, this ecosystem is difficult to study and observe. Very little is yet known, the situation compounded by the fact that the scientific research on soil, although expanding, is recent and continues to lack tools, including soil health indicators.

3.1. Soil : the third biotic frontier

After the ocean floor and tropical forest canopies, soil is considered to be the third biotic frontier: one of the rich habitats the secrets of which have not yet been fully explored because of their complexity, inaccessibility and impressive diversity. Soil is believed to be home to 25% of all described species[23] and likely an even greater proportion of undescribed species. For comparison, in a pasture averaging three livestock units per hectare[24], the biomass of earthworms in the same field is almost equal to that of the cattle[25], yet earthworms are one of the least abundant groups of soil fauna, counting in the tens or hundreds per square meter as opposed to the thousands or millions of nematodes, mites and springtails, and billions of fungi and bacteria. However, beyond the extraordinary diversity of life forms which it contains, the biodiversity of soil remains largely unknown, both taxonomically and ecologically (notably in terms of the structure of food webs), as the structural and functional approach towards the study of biodiversity in general, and that of soil biodiversity in particular, is still in its infancy. This reflects the low level of scientific interest in soil biodiversity, especially agricultural, in recent decades, which is likely due to ignorance of the functional benefits (primarily water and nutrient supply and protection against plant bioagressors) which it can offer to crops.

3.2. Inventory and multifunctionality of soils: a recent scientific community

In 1972, the European Soil Charter had already proposed that the multifunctionality of soils be explored, but in practice soil fertility was still the main concern of agronomists. In France, the Gessol program, started in 1998, established a structured scientific community around the subject of the multifunctionality of soils. In the 2000s, the program undertook the identification and quantification of the physical, chemical and biological degradations suffered by soil and the impact of these upon its functions[26]. Concluded in 2015, this program greatly contributed to the development of soil-related knowledge, particularly as regards changes in use and management in response to issues of food security, climate change, health and biodiversity. These data must now be synthesised, compared and shared to improve soil management and allow for better protection. In addition, despite this significant body of knowledge acquired over the last 20 years, gaps persist in the scientific knowledge of soils, particularly in the field of agronomy. As primary research challenges for the coming years, the Gessol program identified the understanding of the role of soils in maintaining agricultural

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[23] Decaëns T., Jimenez J.J., Gioia C., Measey J., Lavelle P., 2006. The values of soil animals for conservation biology. *European Journal of Soil Biology*, 42, S23-S38.

24 One standard livestock unit (LU) is equivalent to a standard dairy cow of 600 kg. One sheep, for example, represents 0.15 LU.

25 1,000 to 1,500 kg / ha of earthworms for 1,800 kg / ha of cattle. Gobat J.-M., Aragno M., Matthey W., 2013. *Le sol vivant. Bases de pédologie - Biologie des sols [The Living Soil. Foundations of Pedology – Soil Biology]*, 3e éd., Presses polytechniques romandes, coll. Science et ingénierie de l'environnement, 820 p.

[26] Bispo A., Guellier C., Martin E., Sapijanskas J., Soubelet H., Chenu C., 2016. *Les sols. Intégrer leur multifonctionnalité pour une gestion durable [Soils. Integration of Their Multifunctionality for Sustainable Management]*, Éditions Quæ, Versailles, coll. Savoir-faire, 384 p.

Citeau L., Bispo A., Bardy M., King D., coord., 2008. *Gestion durable des sols [Sustainable Soil Management]*, Éditions Quæ, Versailles, coll. Savoir-faire, 320 p.

production, mitigating climate change and adapting production systems to the latter, as well as the identification of healthy soil management practices and their implementation[27].
Also deserving of mention among French initiatives is the scientific interest group Sol (GIS Sol[28]), who has, since 2001, been designing, directing and coordinating the geographical inventory of soils in France, the monitoring of their properties and changing quality. At international level, the first global assessment of the soil resource and the threats which it faces was published in 2015[29]. Estimating the extent of damage on a global scale is still considered a difficult exercise[30].
Finally, with the rise of the concept of "One World, One Health", first proposed by the Wildlife Conservation Society[31] in 2004 and taken up by major international organisations such as the FAO and UNICEF[32] in 2008, the question of the relationship between human health, animal health and environmental health has become an emerging area of multidisciplinary research. However, the integration of soil health into this holistic approach, wherein it is considered only indirectly through types of land use and its role as a pathogen reservoir[33], has met with difficulties. Its importance was acknowledged only very recently by the scientific community, where some authors are going so far as to suggest the acknowledgement of the soil as the main link between the concepts of ecosystem services and "One Health"[34], particularly because a majority of approaches to ecosystem services do not systematically integrate the link to human health[35]. However, although the relationships between agricultural practices, soil health and plant health are becoming clearer, those between soil health, the nutritional value of food and human health remain poorly understood and little studied[36].

3.3. Looking for relevant indicators

The holistic vision of soil which has gained traction over the past 15 years has necessitated the development of new indicators with which to assess not only soil fertility, but also soil quality, and, to a greater extent, soil health. At first, scientific research was thus mostly directed toward the search for such biological indicators[37] as would allow the promotion of

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[27] Bispo A., Guellier C., Martin E., Sapijanskas J., Soubelet H., Chenu C., 2016. *Les sols. Intégrer leur multifonctionnalité pour une gestion durable [Soils. Integration of Their Multifunctionality for Sustainable Management]*, Éditions Quæ, Versailles, coll. Savoir-faire, 384 p.
28 http://www.gissol.fr.
[29] Food and Agriculture Organization of the United Nations (FAO) and Intergovernmental Technical Panel on Soils (ITPS), 2015, Status of the World's Soil Resources - Main Report, 607p.
[30] Gibbs H.K., Salmon J.M., 2015. Mapping the world's degraded lands. *Applied Geography*, 57, 12-21.
[31] WCS, 2004. One World, One Health: Building Interdisciplinary Bridges to Health in a Globalized World. Symposium organized by the Wildlife Conservation Society, 29th September at the Rockefeller University, New York City.
[32] FAO, OIE, WHO, UN System Influenza Coordination, Unicef, BANK W., 2008. Contributing to One World, One Health. A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface, Consultation Document, 67 p.
[33] Rabinowitz P., Conti L., 2013. Links among human health, animal health, and ecosystem health. *Annual Review of Public Health*, 34, 189-204.
[34] Keith A.M., Schmidt O., McMahon B.J., 2016. Soil stewardship as a nexus between Ecosystem Services and One Health. *Ecosystem Services*, 17, 40-42.
[35] Ford A.E.S., Graham H., White P.C.L., 2015. Integrating human and ecosystem health through ecosystem services frameworks. *Ecohealth*, 12, 660-671.
[36] Reeve J.R., Hoagland L.A., Villalba J.J., Carr P.M., Atucha A., Cambardella C., Davis D.R., Delate K., 2016. Organic farming, soil health, and food quality: considering possible links. *Advances in Agronomy*, 137, 319-368.
[37] de Paul Obade V., Lal R., 2016. Towards a standard technique for soil quality assessment. *Geoderma*, 265, 96-102.
Doran J.W., Zeiss M.R., 2000. Soil health and sustainability: managing the biotic component of soil quality.

agricultural systems which preserve soil while maximising farmer profit, by optimising the use of industrial inputs (fuels, fertilisers, irrigation water, pesticides and specific machinery). Toolboxes of indicators and protocols were proposed in response to the growing demand from stakeholders willing to better manage soil health, notably through assessment of the effect of agricultural practices[38]. However, the concept of soil health being intrinsically complex, as it covers all properties and functions of soil, its evaluation remains difficult, subject to debate and varies according to context and type of soil. Each year, research explores new avenues for the assessment of soil health, through advances in molecular biology[39], new physicochemical indicators relative to organic matter[40] or investigation of indicators hitherto deemed irrelevant to soil, such as the oxidation-reduction potential[41].

Applied Soil Ecology, 15, 3-11.
Pankhurst C.E., Hawke B.G., McDonald H.J., Kirkby C.A., Buckerfield J.C., Michelsen P., O'Brien K.A., Gupta V.V.S.R., Doube B.M., 1995. Evaluation of soil biological properties as potential bioindicators of soil health. *Australian Journal of Experimental Agriculture*, 35, 1015-1028.

[38] Stockdale E.A., Watson C.A., 2009. Biological indicators of soil quality in organic farming systems. *Renewable Agriculture and Food Systems*, 24, 308-318.

[39] Arias M.E., Gonzalez-Pérez J.A., Gonzalez-Vila F.J., Ball A.S., 2005. Soil health: a new challenge for microbiologists and chemists. *International Microbiology*, 8, 13-21.

[40] Morrow J.G., Huggins D.R., Carpenter-Boggs L.A., Reganold J.P., 2016. Evaluating measures to assess soil health in long-term agroecosystem trials. *Soil Science Society of America Journal*, 80, 450-462.

[41] Husson O., 2013. Redox potential (Eh) and pH as drivers of soil/plant/microorganism systems: a transdisciplinary overview pointing to integrative opportunities for agronomy. *Plant and Soil*, 362, 389-417.
Husson O., Husson B., Brunet A., Babre D., Alary K., Sarthou J.P., Charpentier H., Durand M., Benada J., Henry M., 2016. Practical improvements in soil redox potential (Eh) measurement for characterisation of soil properties. Application for comparison of conventional and conservation agriculture cropping systems. *Analytica Chimica Acta*, 906, 98-109.

Property and soil protection
Reflections on civil law and the integration of soil quality

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"The history of the law of property is one of the major subjects for philosophical and academic study [.]; a scholarly analysis is still needed to put into perspective as part of a much wider body of law, the action of humanity on real property (land) and the effect of (its) alienation on the formation and gradual development of societies."[1] Property and land have a deep and ancient relationship, which is nevertheless poorly known, whereas it would appear that more studies have been made of water and air[2]. Now in legal terms there is a fundamental difference between, on the one hand, water and air, and, on the other, land - and the ground and soil that comprise it. Water and air are considered to be Commons[3] which cannot thus be alienated (bought or sold) particularly since they lack a specific utility whereby they could be considered to be objects that can be owned. Since they are not generally rare, it follows that it appears to be unnecessary to reserve them[4]. *A contrario*, ground (henceforth in this document we shall consider that ground includes soil but will refer specifically to soil whenever the quality of the ground is in question) is without doubt the first true object covered by the law of property. As such, it is considered in terms of Article 518 of the French Civil Code, to be "naturally unmovable"; the "real estate", which "includes the surface of the ground and the soil in it"[5], "is [indeed] the epitome of unmovable property"[6]. However, the legal definition of ground would appear to be inadequate, particularly in civil law. While some academic proposals have been made[7], particularly due to the necessity of protecting the environment, it should be noted that the French Civil Code, while structured around property[8], has, surprisingly, very little to say about its main subject, namely 'ground'. The French Civil Code effectively deals with ground less as a legal object, than through the legal regime of property itself.

Property is, however, constructed mainly around buildings which initially had the most value. It is, for example, ownership of the ground which enables a person, through

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[1] Giraud C.-J.-B., *Recherches sur le droit de propriété chez les romains, sous la République et sous l'Empire*, éd. Aubin, 1838, p. 13.

[2] For ex. Joachim C., *Le partage des compétences en matière de protection de la qualité des eaux douces au Canada et dans l'Union européenne*, Th. Toulouse 1, 2014 ; Barbara J., *Les normes relatives à la réduction de la pollution de l'air et la sanction des faits de pollution*, Th. Grenoble II, 1997 ; Directive n° 2008/50/CE du 21/05/08 concernant la qualité de l'air ambiant et un air pur pour l'Europe ; Directive 2000/60/CE du Parlement européen et du Conseil du 23 octobre 2000 établissant un cadre pour une politique communautaire dans le domaine de l'eau.

[3] Art. 714 C. civ. : « Il est des choses qui n'appartiennent à personne et dont l'usage est commun à tous ». Sur la question, V. Chardeaux M.-A., *Les choses communes*, L.G.D.J., 2006.

[4] « Le droit considère qu'il n'est pas légitime ou utile d'en réserver leur usage à une seule personne et qu'elles doivent être destinées à l'usage commun » : Rochfeld J., *Les grandes notions de droit privé*, PUF, Paris, 4e éd., spéc. p. 215.

[5] Terré F. et Simler Ph., *Les biens*, Précis, D., 9e éd. 2014, n° 33, p. 40.

[6] *Idem*.

[7] For ex. Neyret L. et Martin G. J., (dir.), *Nomenclature des préjudices environnementaux*, L.G.D.J., 2012, spéc. p.16.

[8] Zenati-Castaing F., *La propriété, mécanisme fondamental du droit*, *RTD Civ.* 2006, p. 445.

acquisition (see Article 546 of the French Civil Code)[9], to claim constructions built on the plot of ground owned It is thus obvious that property is not limited to the ground itself. Quite on the contrary, the first item of Article 552 of the French Civil Code specifies that "ownership of the ground includes ownership of what is above and below". It should be noted here that there are a few exceptions: the French Civil Code includes waivers for treasure[10], and also for mineral resources or quarries[11], mainly in relation to sovereignty[12]. Nevertheless, while Article 552 enables one to presume ownership of what is above and what is below the ground, even though this presumption may be reversed or inverted, the presumption is nevertheless subject, in terms of the French Civil Code, to prior ownership of the ground. Ultimately, it would appear that ownership of the ground is not dealt with directly by the code. Continuing along these lines, Article 552 of the French Civil Code only presumes ownership of its principal object, the ground, in order to determine ownership of the soil in it (and what is above the ground), and indirectly, as we shall see, its quality or qualities. It nevertheless remains true that ownership of the ground is the true foundation of ownership itself.

The principal and decisive condition in law, had already been for centuries the ownership of "land". Property is indeed largely constructed by Roman law which considered "property as such"[13], it being understood that "law is developed by contemplating reality, which essentially consists of people and things"[14]; whereas we now tend to "see property through the eyes of people under the influence of the individualistic philosophy of subjective rights"[15]. Thus property symbolised "from the time of the *Ancien Régime* (feudal order), control of the ground, for peasant farmers and more wealthy citizens"[16]. Thus, real estate, which initially had a vital link to the ground, was the "true" property. *A contrario*, movable property or goods, structured mainly around freedom of trade, appeared to be less significant, as indicated by the saying *res mobilis, res vilis* (movable property has less value than immovable property)[17]. Now, if the property of a thing is defined by "the quality of belonging to a person"[18], in other words "the right to benefit from not only certain services [...] but from *all services* which are free"[19], then it appears that the quality of the soil (as a

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[9] Art. 546 c. civ. : « La propriété d'une chose soit mobilière, soit immobilière, donne droit sur tout ce qu'elle produit, et sur ce qui s'y unit accessoirement soit naturellement, soit artificiellement. Ce droit s'appelle "droit d'accession". »

[10] Art. 716 c. civ. V. sur le sujet, Berchon P., *Trésor*, Rép. civ. Dalloz, janv. 2009.

[11] Code minier ; On the definition of mines and quarries, V. Art. L 100-1 du Code minier :
« L'assujettissement d'un gîte contenant des substances minérales ou fossiles soit au régime légal des mines, soit à celui des carrières est déterminé par la seule nature des substances qu'il contient, sous réserve de dispositions contraires prévues par le présent code ».

[12] Loi du 21 avril 1810 concernant les mines, les minières et les carrières.

[13] Zenati-Castaing F. et Revet T., *Les biens*, PUF, Paris, 2008, 3e éd., n° 2, p. 24.

[13] Beaussonie G., "The legal definition of ecosystem services", *supra*.

[14] *Idem*.

[15] *Idem*.

[16] Sicard G., Le droit de propriété avant l'article 17 de la déclaration des droits de l'homme et du citoyen, *in Propriété et Révolution*, éd. CNRS, Toulouse 1, 1990, p. 20.

[17] « *Chose mobilière, chose vile* »

[18] Zenati-Castaing F. et Revet T., *Les biens*, *op. cit.* n° 2, p. 24.

[19] De Vareilles-Sommieres, La définition et la notion juridique de la propriété, *RTD civ.*, 1905, p. 443 : author uses the terms "service" and "utility" indiscriminately.

component of the ground) is only one of its utilities among others[20]. It follows that the quality or qualities of the soil, since they are part of the nature of the thing - a legal object - namely the ground, cannot be distinguished from the thing itself[21]. Consequently, when dealing with ground ownership, we are already dealing with ownership of its qualities, and inversely.

Without saying any more or drawing hasty conclusions, it would appear that the relationship between ownership and ground are practically indivisible. Indeed, a reading of the French Civil Code leads us to believe that the ground and, consequently, the quality of the soil, is essentially considered either to be the supporting medium (the basis) for working the land (i.e. the soil), in an agrarian society[22], or to be the supporting medium (i.e. the ground) for constructions, in particular, dwellings. Given this, it is not surprising that soil quality is hardly taken into account in law, even though some qualities may already have been used as arguments for not alienating some spaces, such as regularly flooded zones, which consequently exclude all buildings, or excessively stony ground, which is often unfertile. Now, this is where a major paradox arises: even though ground appears to be the privileged object of property, it also appears to be considered only as a supporting medium for it, and thus its properties are not acknowledged. Accordingly, we shall be considering how soil quality can be protected by ownership. We shall, therefore, have to investigate not only the possibility that property protects the quality of soils (2) but also, initially, how ground fits into the legal definition of property as an object, without considering its qualities (1), since this is the basis on which quality is taken into account by the French law of property.

1. Soil quality neglected by property

We have briefly reviewed the relationship between land and property, but it is worth analysing it more thoroughly. It does seem that ground is undoubtedly the historical medium on which property is based (1.1), to the extent that it is also the medium which structures the property (1.2).

1.1. Ground, the historical medium from which property emerged

There has been widespread debate about the origins of property as a social phenomenon by, among others, anthropologists [23], jurists[24] and philosophers[25].

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[20] Beaussonie G., "The legal definition of ecosystem services", *supra*.

[21] *Idem*.

[22] The French Civil Code was promulgated in 1804, well before the Industrial Revolution; furthermore, this code is largely based on Roman law, established in a much more agrarian society, if indeed it was.

[23] Le Roy E., *La terre de l'autre. Une anthropologie des régimes d'appropriation foncière*, L.G.D.J., Paris, 2011 ; Testart A., Propriété et non-propriété de la Terre, *Études rurales*, 165-166, 2003, 209-242 ; Testart A., Propriété et non-propriété de la terre, *Études rurales*, 169-170, 2004, 149-178 ; Godelier M., Aux sources de l'anthropologie économique, *Socio-anthropologie*, 7, 2000, http://socio-anthropologie.revues.org/98 ; spéc. n°13 ; Müller B., Anthropologie de la propriété et du pouvoir : des utopies alternatives au néolibéralisme 2, *Annuaire de l'EHESS*, 2010, 606-607.

However, there is broad consensus about the profound links between the emergence of property and that of agriculture, in the sense of primary cultivation of ground; in other words the emerging domestication of plants and the associated farming of land, even though there is still a debate about the causal relationships. "Part of the harvest had to be set aside as seeds for sowing for the following season while ensuring that nobody ate the reserves. The first crops must have been sown around homes. But then [people] looked for other more suitable places: clearings or the alluvial banks of streams, and rivers which spilled over each year. It then became necessary to impose property rights concerning harvesting in the natural environment, in places where previously everybody had had the right to gather food or other natural resources. There where previously everybody had the right to gather food or other natural resources. What must have been the most difficult to create, was not the agriculture itself but the society it engendered"[26]. Property thus emerged through the domestication of plants as a result of need: the transition of human societies, based on hunting and gathering, to societies where the uncertainty of subsistence was gradually reduced by cultivating plants, in other words in a pragmatic way, by cultivating ground. Land would thus be alienated (become property) through one's work: "Work is an expression of freedom; property is the consequence of work. Thus, property rights are an inherent part of freedom itself"[27].

In order to clarify the relationship between ground and property we have to understand what we have just discussed: the French Civil Code, almost entirely dominated by property[28], paradoxically considers ground only indirectly; at best, dealing with it indirectly, it treats it as an assumed object in Article 552, in which, for example it, more generally, describes the consequences of its alienation[29]. Likewise, Article 553 of the French Civil Code[30] considers property as that which is found "above" without referring to the "ground" but to the "land": in this case ground ownership is assumed without ever being explicitly referred to. It is thus only the consequences of its alienation which are dealt with. However, when referring to ownership of an estate, it is indeed the ownership of ground which is intended. For example, the ownership of a

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[24] Carbonnier J., *Flexible droit, Pour une sociologie du droit sans rigueur*, L.G.D.J., 10e éd., 2014 ; Xifaras M., *La propriété, étude de philosophie du droit*, PUF, 2004 ; Simler Ph., Qu'est-ce que la propriété, in *Qu'en est-il de la propriété ? L'appropriation en débat*, Les Travaux de l'IFR, Mutation des normes juridiques n° 5, PUT, 2006, p. 251 et s. ; Zénati F., *La nature juridique de la propriété, contribution à la théorie du droit subjectif*, th. Lyon III, 1981 ; Lévy J.-P., *Histoire de la propriété*, par, coll. « Que sais-je? », PUF, 1972.

[25] Proudhon P.J., *Qu'est-ce que la propriété ?*, Les classiques de la Philosophie, LGF, 2009 ; Proudhon P.J., *Théorie de la propriété*, Les introuvables, L'Harmattan, 1997 ; Engels F., *L'origine de la famille, de la propriété privée et de l'Etat,* Le temps des cerises, 2012, préf. Darmangeat C.; Rousseau J.J., *Discours sur l'origine et le fondement des inégalités parmi les hommes*, Flammarion, 2011 ; Tocqueville A., *De la démocratie en Amérique*, Gallimard, 1986 ; Dagognet F., *Philosophie de la propriété, l'avoir*, PUF, 1992 ; Mounier E., *De la propriété capitaliste à la propriété humaine*, Desclée de Brouwer, Paris, 1936.

[26] Mazoyer M., Pelt J.-M, Monod T., Girardon J., *La plus belle histoire des plantes*, éd. Points, 2002.

[27] Projet de déclaration soumis au bureau de l'Assemblée par le député Pison de Galland, in *La déclaration des droits de l'homme et du citoyen*, S. Rials, Paris, Hachette, 1988.

[28] For ex. Zenati-Castaing F., *La propriété, mécanisme fondamental du droit*, RTD Civ. 2006, p. 445.

[29] Art. 554, 624, 660 et 661, 1245-2, 1601-3, 1792 et 1793 C. civ.

[30] Art. 553 du c. civ. : « Toutes constructions, plantations et ouvrages sur un terrain ou dans l'intérieur sont présumés faits par le propriétaire à ses frais et lui appartenir, si le contraire n'est prouvé ; sans préjudice de la propriété qu'un tiers pourrait avoir acquise ou pourrait acquérir par prescription soit d'un souterrain sous le bâtiment d'autrui, soit de toute autre partie du bâtiment ».

house in legal terms is determined much more by the ownership of the ground on which it is built than by ownership of the house itself. It is because the land has first been alienated that the house is as well. "Claiming that property rights, the true foundations of civil society, only concern the surface of the land, is to misunderstand their nature; is it to profess the doctrine of tyrants"[31], because "misnaming an object adds to the misfortune in the world"[32]. It appears, moreover, that ground is not just *any* legal object but the main and major object of the law of property as defined in the French Civil Code of 1804, in which it forms the original framework for property. The ground is indeed the central medium for expression of ownership. The French Civil Code, which is built around the power inherent in property, contains innumerable references to "ground". Even so, as we have said, the code does not explicitly refer to ground *per se* as a central element affirmed as such, despite the ownership of ground being its main illustration.

1.2. The ground a medium that structures the property

"Ground" does not appear to be referred to in the French Civil Code as the expression of a pre-existing property. Whether it be the accession[33] mentioned in Article 554, in which ownership of the ground "adds to" that of the constructions that are above it the concept of adjoining property covered in Articles 660 and 661 which lay the legal basis for a construction separating two estates distinguished by the plot of ground, or again Article1601-3 concerning the destiny of a future construction, assuming that the ground is already owned (or again for Articles 1792 and 1793, the question here being one of responsibility), and finally Article 1245-2 which indirectly mentions the ground when referring to "products of the ground", this still appears to be the case. In each of these cases, the French Civil Code describes the ground because it assumes that the property exists : it is thus in these cases the consequences of the ownership of the ground which are dealt with and nothing more. From this we may then draw one of two possible conclusions: either the French Civil Code intends to govern property by structuring real estate as ownership of the ground, or, inversely, property, as conceived of by those who wrote the code, must be regarded as a universal framework for which the object remains as being of no consequence. The solution must lie somewhere between the two: while the primary importance of property was most certainly that of ownership of land, property as a legal concept has to be analysed as a way of structuring the law, for which ground was the principal medium, without it being the only medium.

The writers of the code directly raised the question of the relationship between ownership of the ground and property, to such an extent that they defined it as being related to freedom: "True property is born from the division of land which takes place when people are bound together by a social agreement which provides the foundation

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[31] A.P. XXIV, discours de Heurtault-Lamerville, député du Cher, p. 240 ; discours de Saint-Martin, p. 237 : cité par Poumarède J., De la difficulté de penser la propriété (1789-1793), *in Propriété et Révolution*, éd. CNRS, Toulouse 1, 1990, p. 33.

[32] Camus A., *Œuvres complètes*, T. I, La Pléiade, p. 908.

[33] Accession is understood to be the consequence of the property which enables the owner to acquire accessories that his/her thing produces or which join it or are incorporated into it.

of a society"[34]. Ownership of the ground thus became the very foundation of society. Is this not what Rousseau meant when he wrote that the first person who, having fenced off a piece of land, then said: "This is mine," and found people who were foolish enough to believe him, was the true founder of civil society. How many crimes, wars, murders, how much misery and how many horrors could humanity have been spared by the person who, pulling out the stakes or filling the ditches cried out to his fellows : "Don't listen to this imposter; you will lose everything if you forget that the fruits are for all and that land belongs to nobody"[35]? "In the game of philosophical discourse, the concept of property was understood as a value attached to humans, their creative activities and subsequently, his work"[36]. The idea would remain that: "the right of ownership is that which belongs to every citizen to enjoy, as he wishes, his property and his income, the fruit of his labour and his industry"[37]. This is how the cultivation of ground justified its ownership. However, owning the fruits of the ground could also have sufficed, as was suggested in his time by Pierre Joseph Proudhon[38].

But this explanation does not suffice. Or, more precisely, it no longer suffices to explain the extent of ownership of the ground. Perhaps we should then consider the quality of the soil, which is the purpose of our work, but not its inherent quality since the real issue is the quality which has been conferred to it. The ownership of ground, in fact, makes it possible to maintain, on its surface, a sort of perenniality due to its perpetual nature[39]. It thus makes it possible, through the object to which it applies, not only to claim ownership of the fruits which come from it (a classical claim) but also, through the perenniality that it engenders in law; to claim ownership of the quality of the soil due to the regular work done on it (a more modern type of property). In other words, quality is defined legally just as much from a subjective point of view; in other words as the consequence of a subject claiming ownership of the ground, as from an objective point of view, i.e. due to the biological components and processes. The quality of the soil thus remains an accessory of the ground as an ownership object, but, and this is what makes it so particular, it remains, on the one hand, "transformed" by the work of its owner, and, on the other, subjected to the owner's absolute will. In other words, it becomes a property object in its own right.

2. Protection of soil quality by property

If property is an absolute right[40], it consequently appears to be one of the most effective protective mechanisms, since it derives from absolute power but, this absolute quality cuts both ways when considering the quality of soil : it is the reason why soil quality is absorbed by ownership of the ground (2.1) but could also be a way of protecting soil quality, by making the object autonomous (2.2).

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[34] Poumarède J., *De la difficulté de penser la propriété* (1789-1793), *op. cit.*

[35] Rousseau J.J., *Discours sur l'origine et les fondements de l'inégalité parmi les hommes*, Deuxième partie, 1754.

[36] Koubi G., *De l'article 2 à l'article 17 de la Déclaration de 1789 : la brèche dans le discours révolutionnaire*, *in Propriété et Révolution, op. cit*., p. 74.

[37] Jaurès J., *Histoire socialiste de la Révolution*, rééd. Soboul, T. 2, p. 469.

[38] Proudhon P.J., *Qu'est-ce que la propriété ?*, *op. cit.* ; Proudhon P.J., *Théorie de la propriété*, *op. cit.*

[39] Art. 2227 du code civil : « Le droit de propriété est imprescriptible ».

[40] V. art. 544 c. civ.

2.1. Quality absorbed by ownership of the ground

"The legal protection of soil quality is not capable of playing the vital role required of it. This situation would depend on the particular status of the resource. While it was possible to tackle without difficulty the protection of other natural resources such as air, water or biodiversity, current law is largely inadequate for taking into account damage to soil. This is hardly surprising. Air and water are protected, since they can legally be used by everyone, whereas the ground, being immovable, is a property object ; its protection therefore only concerns its owner"[41]. In other words, since the ground is protected via the intermediary of its owner, civil law does not make provision for any general protection of soil quality. It nevertheless remains true that there are some specific provisions for soil quality. Accordingly, Article L. 411-27 of the Rural and Marine Fisheries Code, which stipulates that "the fact that the lessee employs practices on the land he/she has leased for the purpose of preserving [...] the quality of soil", is not without interest[42]. But these provisions for particular situations have a very limited, not to say, isolated, scope. It is thus clear that there are no general provisions made for protecting soil quality in the French Civil Code.

This gap in the French Civil Code should not surprise us, for at least two different types of reason. On the one hand, soil quality is only, as we have seen, an attribute of the owned property, nothing more. Given that, it is simply part of the utility, as M. Beaussonie has demonstrated[43]. For example, poor soil quality will not encourage anyone to claim the ground, due to its lack of usefulness[44]. However, this hypothesis is less and less likely these days, because real estate is more and more in demand[45]. Furthermore, property belongs to a sphere of power based on claiming land. Soil quality is involved here, in its own right, because it is only a consequence of this sphere of appropriation. The quality of the soil may well have been the reason why the property was appropriated. But it then becomes, in a way that cannot be distinguished, and is thus not obvious, the owner's thing (property), just like the ground itself. In this case the quality of the soil would be considered to be the result of a fruit-bearing thing - the ground - and it would be up to the owner to decide whether to keep it or not.

It is a classic hypothesis which can easily be illustrated: the owner of a forest may just as well decide to collect various elements produced by the fruit-bearing thing, as he may decide to cut it down in order to recover the wood[46]. The logic is no different

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[41] Collard Dutilleul F. (dir.), *Dictionnaire juridique de la sécurité alimentaire dans le monde*, Larcier, 2013, rubrique Sols, P. Steichen.

[42] Hermon C., "Soil protection in law", *supra*, et Krajeski D., "Tillage, ecosystem services and rural leases", *infra*.

[43] Beaussonie G., *op. cit.*, *supra*.

[44] For a while this was the case for deserts in particular, whose lack of usefulness meant there was little reason to appropriate them. This is still partially the case for Commons, namely water and air.

[45] Cavailhes J., Mesrine A., Rouquette C., Le foncier agricole : une ressource sous tensions, *Economie et Statistique*, n° 444-445, 2011.

[46] Subject to certain administrative authorizations and possible replenishment obligations, relating to the size of the forest in question and its possible classification. V. not. Règlement du 20 octobre 2010, n° 995/2010, de l'Union Européenne *établissant les obligations des opérateurs qui mettent du bois et des produits dérivés sur le marché* vient encadrer la coupe du bois et sa commercialisation ; complété

when applied to the ground: ownership of the soil gives its owner the right to either confer or maintain its quality or to consume it. In this sense, the owner of a piece of ground might decide to exploit, and possibly maintain, the quality of its soil, just as he might decide to exhaust it. Thus he might destroy the quality of the soil through intensive farming, just as he might maintain it or even increase the quality of the soil, while carrying out the same agricultural activity but with different practices[47].

"*A priori,* no ecological particularity is required for distributing ownership of the ground, which is only its abstract medium"[48]. If ownership of the ground annexes its soil quality, it is perhaps also because, as we have said, the ground is only perceived as a means; in other words, the ground appears to be only, in this case, the means whereby ownership is expressed. In other words, it is because ownership of the ground enables long-term ownership of what is above it (particularly the constructions on it) to be established that it first has to be owned. In this sense, the ground is only the means for "becoming an owner", and consequently the property concerns less the ground *per se* - and even less its quality - than the appropriation of its surface; in other words, as a medium for bearing what is above the ground. If this is the case, since one is not really interested in the ground, why should one be interested in the quality of the soil ?

Indeed, "the right of public or private ownership is based on ownership of the ground"[49], and not on the quality of the soil. However, it remains true that the quality of the soil, at least publicly, affects the desire to appropriate the ground. For example, a person wishing to acquire land in order to build on it would be more concerned with its geographic location than the quality of the soil ; *a contrario*, if the objective is to farm the land, then obviously the owner would be more concerned with the potential quality of the soil, even though this quality might also depend on his work. Soil quality cannot be appropriated as a legal object. The only legal object involved here remains the ground, since it's quality is only relevant as the essence of the property and *a minima* as an accessory in the form of the property below it. Thus, as far as urban planning law is concerned, the quality of the soil may sometimes be taken into account but only in that it lends itself to a general classification, enabling or excluding particular uses of ground[50]. Making a distinction between ground and its quality would appear to be practically impossible given that they are, by their very nature, inexorably linked. However, M. Desrousseaux has noted that "the law of property recognises two types of ground: one made up of living organisms (soil) and the other (ground) serving as a base for structures but governed by a single legal regime"[51]. While there is no

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par le Règlement Délégué de la Commission Européenne n° 363/2012 du 23 février 2012 *relatif aux règles de procédure concernant la reconnaissance et le retrait de la reconnaissance des organisations de contrôle conformément au règlement*, et le Règlement d'exécution de la Commission n° 607/2012 du 6 juillet 2012 *sur les modalités d'application relatives au système de diligence, ainsi qu'à la fréquence et à la nature des contrôles à effectuer auprès des organisations de contrôle conformément au règlement.*

[47] *Cf.* Chabert A., *Expression combinée des services écosystémiques en systèmes de production agricole conventionnels et innovants : étude des déterminants agroécologiques de gestion du sol, des intrants et du paysage*, Th. Toulouse, INPT, 2017.

[48] Desrousseaux M., *La protection juridique de la qualité des sols*, LGDJ, Biblio. de Dr. de l'Urba**.** et de l'Env., T. 13, 2016, n° 28, p. 11.

[49] *Idem*.

[50] The urban planning code distinguishes, for example, agricultural and natural peri-urban spaces (art L. 143-1 to L. 143-6) from wooded areas (art L. 130-1 to L. 130-6) urban, whose local planning plans are responsible for specifying the assignments (articles L. 123-1 to L. 123-20).

[51] Desrousseaux M., *La protection juridique de la qualité des sols*, *op. cit.*, n° 27, p. 11.

doubt about them falling under a single legal regime, this unity is justified in our opinion by them being part of the same concept: there is only one, unique property. The arguments put forward by this author are nevertheless insightful, since jurists are recommending particular protection for living organisms[52], and since these proposals have been taken into account somewhat by legislators with respect to animals[53].

2.2. Is soil quality an autonomous property object?

While our conception of property would appear not to include, or at least limit, any protection of soil quality, unless it were done by its owner, it is nevertheless true that jurists are now making proposals for such protection. Following this line of thought, did not Dean Duguit suggest, at the beginning of the 20th century, that the social function of property be affirmed[54]? After observing that the legal system tends to be based on an "essentially socialist conception"[55] - by which he meant the socialisation of law[56] - as well as on a "metaphysical conception of subjective law"[57], Duguit postulated that the idea of an "isolated and independent human being is pure fiction [...]. People are social beings; they can only live in society; they have always lived in society"[58]. Consequently "people have no rights; nor does the collectivity have more. But any individual in society has a certain role to play, certain tasks to perform"[59]. Illustrating his argument by property, he affirmed that "property is not a right, it is a social function"[60] in other words if the owner "does not fulfil the function or fulfils it poorly, […] then the authorities may legitimately intervene to compel him to do so[61]. While this proposal is attractive, particularly in that it could oblige landowners to guarantee a certain level of soil quality in order to fulfil the social function of the property, it is nevertheless not in line with the contemporary interpretation of property which subjects most of the other rights to the property, rather than subjecting the property to constraints[62]. More recently, M. Ost developed the idea of

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[52] Neyret L., *Atteintes au vivant et responsabilité civile*, LGDJ, Biblio. de dr. priv., T.468, 2006.

[53] Art. 515-14 c. civ. (L. 16 févr. 2015 n° 2015-177) : « Les animaux sont des êtres vivants doués de sensibilité. Sous réserve des lois qui les protègent, les animaux sont soumis au régime des biens ».

[54] Duguit L., *Les transformations générales du droit privé depuis le Code Napoléon*, Paris, Libr. Félix Alcan, 1912. V. ég. : Duguit L., *Le droit social, le droit individuel et la transformation de l'Etat*, Paris, Libr. Félix Alcan, 2e éd. 1911. Sur la doctrine de Duguit L.: V. not. Boccon-Gibod T., Duguit, et après ? Droit, propriété et rapports sociaux, *RIDE*, 2014, p. 285 et s ; Melleray F. (Dir.), *Autour de Léon Duguit*, Bruxelles, Bruylant, 2011. Pour une autre approche : Renard G. et Trotabas L., *La fonction sociale de la propriété*, Paris, S., 1930. V. ég. Millet L., *Contribution à l'étude des fonctions sociale et écologique du droit de propriété : enquête sur le caractère sacré de ce droit énoncé dans la Déclaration des droits de l'homme et du citoyen du 26 août 1789*, Th. Paris I, 2015 ; Fabre-Magnan M., Propriété, patrimoine et lien social, *RTD civ.*, 1997, p. 583.

[55] Duguit L., *Les transformations générales du droit privé depuis le Code Napoléon*, *op. cit*., p. 8.

[56] Duguit L. refers to not. : Charmont J., *La socialisation du droit*, Revue de métaphysique et de morale, 1903, p. 403 ; et A. Mater, *Le socialisme juridique*, Revue socialiste, XL, 1904, p. 9 et s.

[57] Duguit L., *Les transformations générales du droit privé depuis le Code Napoléon*, *op. cit*., p. 9.

[58] *Ibid*. p. 18.

[59] *Ibid*. p. 19.

[60] *Ibid*. p. 21.

[61] *Idem*.

[62] *Cf*. art. 545 C. civ.

"transpropriation"[63] with a view to considering that the common heritage of humanity implies cohabitation of several owners for a given legal object: on the one hand there would be an owner as normally understood, being the "owner" of the thing; on the other hand some utilities would be detached from the owner for the benefit of the collective group: "The result would be that the master and owner of the space or resource would not hold the same sway over each of the aspects of his/her property; some uses would remain sovereign (including up to the right to destroy), while others would henceforth be controlled or prohibited"[64]. When applied to soil, transpropriation would tend to consider soil quality as falling under the common heritage of the nation, for example, while leaving ownership of the ground to its current owner. The recent act governing biodiversity[65] follows this line of thought by recognising that "protection of the soil is in the general interest", and integrating it into the common heritage of the nation in the French Environmental Code". Here again, the model proposed appears to be if interest, but it would imply that a true legal regime would first have to be defined in order to effectively apply the concept of common heritage which for the moment is considered to be simply a formal statement of intent[66]. Finally, a recent academic trend aims to affirm the existence of Commons[67]which implies a "legal revolution"[68] involving the proclamation of common property. All of these proposals however, would either limit property or affirm another property object.

But some provisions might turn out to offer useful solutions. As mentioned earlier, the French Rural Code covers the eventual integration of soil quality[69]. This provision, applied to rural leases, would make it possible to integrate protection of soil quality in a legal framework. Indeed, Article L. 411-69 of the same code[70] stipulates that: at the end of the rural lease, the lessee must hand back the estate in the state in which he/she found it[71], the initial state having been determined jointly, by the lessor and lessee, at the time the lease was signed[72]. When determining the level of soil quality, when the lease expires, we might easily imagine[73] an obligation to return the estate with the

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[63] Ost F., *La nature hors la loi, L'écologie à l'épreuve du droit*, éd. La découverte, 2003, spéc. p. 338.
[64] *Ibid*. p. 339.
[65] Loi n° 2016-1087 du 8 août 2016 pour la reconquête de la biodiversité, de la nature et des paysages.
[66] V. Savarit I., Le patrimoine commun de la nation, déclaration de principe ou notion juridique à part entière ?, *RFDA*, 1998, p. 305 ; Groulier C., *Quelle effectivité juridique pour le concept de patrimoine commun ?, AJDA*, 2005, p. 1034 ; Del Rey M.-J., La notion controversée de patrimoine commun, *D.* 2006, p. 388.
[67] Ostrom E., *Gouvernance des biens communs, Pour une nouvelle approche des ressources naturelles*, éd. De Boeck, Bruxelles, 2010, 1e éd. ; Parance B.et de Saint Victor J. (dir.), *Repenser les biens communs*, CNRS éd., Paris, 2014 ; Coriat B., *Le retour des communs, La crise de l'idéologie propriétaire*, éd. Les liens Qui Libèrent, 2015.
[68] Parance B. et de Saint Victor J. (dir.), *Repenser les biens communs*, op. cit., p. 9.
[69] Art. L. 411-27 C. rur.
[70] Art. L. 411-69 C. rur. : « Le preneur qui a, par son travail ou par ses investissements, apporté des améliorations au fonds loué a droit, à l'expiration du bail, à une indemnité due par le bailleur, quelle que soit la cause qui a mis fin au bail ».
[71] Krajeski D., *Droit rural*, 2e éd., Lextenso Ed., 2016, spéc. n°187, p. 183.
[72] Art. 1730 C. civ. : « S'il a été fait un état des lieux entre le bailleur et le preneur, celui-ci doit rendre la chose telle qu'il l'a reçue, suivant cet état, excepté ce qui a péri ou a été dégradé par vétusté ou force majeure ». Nous soulignons que cette disposition est applicable aux baux ruraux mais aussi aux « baux des maisons ».
[73] It would certainly be useful to consider whether this obligation, which initially would appear to benefit the owner, might not also benefit the estate itself.

same level of quality, which considered objectively, would be advantageous to the estate itself[74].

The same might be true for a lease under the French Civil Code : the lessee being obliged, at the end of the lease, to hand back "the thing in the condition in which it was received"[75]. This provision obviously intends to protect the owner of the thing leased in that the lessee respects the destination of the leased thing, but also in that he/she hands it back in the state in which it was taken; if this is not the case, the lessee could be held liable[76]. Without going overboard, one could easily consider that the soil quality of the thing leased, for example, the garden of a house, could be subject to such provisions. In this case, it would be appropriate to determine, as part of the lease, the level of soil quality when the lease entered into force. However, one might still wonder who or what would be protected : would it be the owner or the object itself? We believe that the owner would be protected rather than the object. Indeed, such a clause, even though it would benefit both the soil and its owner, would nevertheless be subject only to the owner's will, both for its insertion in the lease and for enforcement of the protection offered, once the lease has expired. Legislation would be the only way of perpetuating the spirit of such a clause[77].

"Ownership of land, mother of all"[78]as Montesquieu might have written. It would be difficult to affirm the contrary, since property seems to be structured in relation to land. It would also be difficult to distinguish the ground from its quality, since both are linked by their very nature, as demonstrated by the property regime[79]. In this sense, ground as the basis for property, is the legal object which contains its quality. We consequently believe that property cannot impede the legal integration of soil quality, in the sense that, as we have seen, the latter cannot be distinguished from the ground; the soil is just as much a legal object as the ground itself. There are thus only two solutions: either make soil quality a legal object in its own right, in other words define "soil utility" so that it can be property in its own right[80] ; or limit the property by an easement which protects some characteristics of soil, as is already the case for minerals or aqueducts[81]. By default, it makes no sense, in civil law at least, to refer to "soil quality.

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[74] Krajeski D., "Tillage, ecosystem services and rural leases", *infra*.

[75] Art. 1730 C. civ. : « S'il a été fait un état des lieux entre le bailleur et le preneur, celui-ci doit rendre la chose telle qu'il l'a reçue, suivant cet état, excepté ce qui a péri ou a été dégradé par vétusté ou force majeure ».

[76] Art. 1732 C. civ. : « Il répond des dégradations ou des pertes qui arrivent pendant sa jouissance, à moins qu'il ne prouve qu'elles ont eu lieu sans sa faute ».

[77] Cons. const., 16 janv. 1982, n° 81-132 DC*, D.* 1983. 169, note Hamon L., *JCP* 1982. II. 19788, note Nguyen Vinh et Franck, *Gaz. Pal.* 1982. 1. 67, note Piédelièvre et Dupichot, Rev. crit. DIP 1982. 349, note Bischoff ; *contra* Cons. const., 7 déc. 2000, n° 2000-436 DC, *AJDA* 2001. 18, note Schoettl J.-E.; D. 2001. 1840, obs. Favoreu L.

[78] Montesquieu, *Pensées*, n°1839.

[79] *Cf.* art. 552 C. civ.

[80] For ex. to numbers credit card : Crim., 14 nov. 2000, n° 99-84522.

[81] Art. L. 152-17 C. rur.

THE INTEGRATION OF THE CONCEPT OF ECOSYSTEM SERVICES INTO LAW

A brief history of the incorporation of the concept of ecosystem services in law

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Introduction : the scientific origins of ecosystem services and their institutionalisation

From the 1970s onwards, and particularly during the preparations for the UN conference held in Stockholm in 1972, research work carried out by American ecologists emerged promoting the concept of ecosystem services. Yet, it was really in the 1980s that this idea began to develop and became the subject of an increasing number of publications. From the very beginning, the idea was marked by a dual context : on one hand, there was the integration of the systemic and dynamic aspects of ecological processes into the environmental sciences, and, on the other, the desire among some scientists to warn of "the possibility of reaching the limit of the planet's capacities"[1] due to increasing human activity. As a result, the idea emerged, that defining the "services provided by nature" could strengthen public awareness about the importance of properly functioning ecosystems to people's lives. In this same vein, economists also produced work providing an economic analysis of the ecological functions considered essential for human well-being, as well as research based on the idea of "natural capital" as a contributory factor in the development of human societies. One landmark article, in particular, by Costansa *et al.*, published in 1997 in the journal, Nature, saw a team of researchers produce a financial evaluation of ecosystem services and natural capital at the global scale[2].

Then, there are the reports published by international NGOs, which continued this work, and the approach of discussing nature through ecosystem services, which eventually penetrated the political sphere. "This approach works towards a clearly identified objective: going beyond the sectoral classification of problems as a result of the existence of international conventions on issues like biodiversity, desertification, climate change etc., and proposing a global and "ecosystemic" vision of environmental issues[3]."

A determining event for the institutionalisation of ecosystem services was, without doubt, the publication of the 2005 Millennium Ecosystem Assessment (MEA), a far-reaching study undertaken by the UN and supported by several large international organisations[4]. The study, which involved in excess of a thousand researchers over more than three years, had an extensive reach. According to the UN's own

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[1] Mongruel R., Méral P., Doussan I., Levrel H., 2016, L'institutionnalisation de l'approche par les services écosystémiques : dimensions scientifiques, politiques et juridiques. *In : Valeurs de la biodiversité et services écosystémiques. Perspectives interdisciplinaires* (Roche P., Geijzendorffer I., Levrel H., Maris V., eds), collection Up date Sciences technologies, éditions Quae, Versailles, 191-216, p. 192

[2] Costanza R., d'Arge R., De Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., R.O'neill, Paruelo J., Raskin R-G., Sutton P., Van den Belt M., 1997, The value of the world's ecosystem services and natural capital, *Nature*, 387, 253-260.

[3] Mongruel R., Méral P., Doussan I., Levrel H., 2016, L'institutionnalisation de l'approche par les services écosystémiques : dimensions scientifiques, politiques et juridiques, précité, p. 195.

[4] http://www.millenniumassessment.org/fr/

commentary on the report, "the focus of this assessment on ecosystem services and their link to human well-being and development needs is unique. By examining the environment through the framework of ecosystem services, it becomes much easier to identify how changes in ecosystems influence human well-being and to provide information in a form that decision-makers can weigh alongside other social and economic information." The MEA, therefore, proposed an analytical framework and ecosystem-services typology based on four main categories[5]. While the typology would later be completed, criticised, and amended by numerous other works, this report unquestionably contributed to establishing an approach based on ecosystem services and warning about their degradation. "Beyond being a mere assessment of the state of global biodiversity, this international expert study has, above all, enabled the articulation and communication of the concept of ecosystem services and provided a generally applicable methodology to quantify the consequences of changes in biodiversity on ecosystems and on different aspects of human well-being. Since then, this work has stimulated a large amount of research on ecological services, whether on developments to the methodology, case studies for systems within individual services (such as pollination), new progress in understanding the mechanisms involved in the relationships between biodiversity and ecological services, or the mechanisms for the socio-economic evaluation of biodiversity and environmental services"[6]. We, therefore, observe that "the increase in the power of the concept of ecosystem services (...) is the result of a co-construction between science and politics at an international level (...), and that the institutionalisation of this approach has, therefore, not been a separate process from its scientific construction[7]."

As a result, and no doubt due to this co-construction, ecosystem services have entered the spheres of public policy and law, without necessarily being scientifically mature, something that has led to a renewed approach being taken towards the environment.

1. The entry of ecosystem services into the fields of public policy and law

It was following the MEA that ecosystem services formally entered the fields of environmental policy and law. The concept does not appear, for example, in the convention on biodiversity adopted at the Earth Summit in Rio de Janeiro in 1992. In terms of European Union texts, it is absent from the 1998 publication, "Biodiversity

[5] Namely: 1- Provisioning services: these are the products provided by ecosystems such as genetic resources, food, fibre, as well as fresh water. 2- Regulating services: these are the benefits enjoyed from the regulating processes provided by ecosystems such as the regulation of climate, water, and certain human diseases. 3- Cultural services: these are the non-material benefits provided by ecosystems through spiritual enrichment, cognitive development, reflection, leisure, and aesthetic experience, such as knowledge systems, social relationships, or aesthetic values. 4- Supporting services: these are the necessary services for the production of all other services provided by ecosystems. They include the production of biomass, the production of atmospheric oxygen, the creation and retention of soil, the nutrient cycle, the water cycle and the provision of different habitats.

[6] Le Roux X., Barbault R., Baudry J., Burel F., Doussan I., Garnier E., Herzog F., Lavorel S., Lifran R., Roger-Estrade J., Sarthou J-P., Trommetter M.(eds), 2008. Agriculture et biodiversité. Valoriser les synergies.Expertise scientifique collective, INRA, France, 116 p.

[7] Mongruel R., Méral P., Doussan I., Levrel H., 2016, L'institutionnalisation de l'approche par les services écosystémiques : dimensions scientifiques, politiques et juridiques, précité, p. 197.

Action Plan"[8] and is barely implicit in the 2001 publication, "Biodiversity Action Plan for Agriculture"[9]. However, it is at the heart of two publications produced in 2006 and 2007. One, "Halting Biodiversity Loss by 2010 – and Beyond : Sustaining ecosystem services for human well-being"[10], focuses on biodiversity ; the other involved the mid-term evaluation of the Sixth Environment Action Programme[11]. As for those EU texts that are legally binding on Member States, it can be noted that in Directive 2000/60, known as the Water Framework Directive[12], the idea of ecosystem services for aquatic species does not appear. However, in the directive of 21April 2004 on environmental liability[13] it is specifically referred to as an element for defining environmental damage by employing the term "ecosystem services". Taking into account the objective of the MEA, which was to highlight damage affecting ecosystem services, it is, without doubt, no coincidence that it first appeared in law as part of a reparations system for environmental damage.

Next, we can see that sector specific texts rely on ecosystem services to establish protection systems for some resources. This can clearly be seen in 2006 in the proposal for a soils directive defining a framework for the protection of soils and the preservation of their capacity to perform environmental, economic, social and cultural functions, (Art.1)[14]. Services are also at the heart of the Marine Strategy Framework Directive of 17 June 2008[15], and then in the Regulation of 22 October 2014 on the prevention and management of invasive alien species[16].

In French law, the term "ecosystem services" has been little used for a long time, even if this type of approach has made unquestionable progress (See below: M. Fèvre "Ecosystem services, a functional concept"). In 2008, the law for the transposition of the Environmental Liability Directive incorporated environmental services into a very specific administrative policy. Included in Article L.161-1 I 4° of the environmental code, ecological services are defined as functions provided by the soil, water, and protected species and habitats, that benefit one of these natural resources or the public. Defining them in this way seems to allow them to be considered as ecosystem services. It is, however, ecosystem services that were explicitly addressed in 2014 by the act on the future of agriculture, food and forestry[17] covering "systems of agro-environmental production, including the method of biological production, which combine economic, social (...) environmental and health aspects. These systems (...) are based on biological interactions, the use of

[8] COM (1998)42, non publié.
[9] COM (2001)162 final.
[10] COM (2006)216 final.
[11] COM (2007)225 final.
[12] Directive 2000/60 of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
[13] Directive 2004/35/CE of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage
[14] The definition of these functions is based more on that of "services" thus leading to a degree of semantic confusion in the legal field, also noticeable in French law.
[15] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy.
[16] Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species Article 4.3 c): "Invasive alien species [...] are, based on available scientific evidence, likely to have a significant adverse impact on biodiversity or the related ecosystem services [...] ".
[17] Act No. 2014-1170 of 13 October 2014

ecosystem services and the potential offered by natural resources (…)"[18]. It is these systems of agricultural production that "public policy addresses in order to promote them and make them sustainable"[19].

But it is, undoubtedly, the law to recover biodiversity, nature and the countryside of 8 August 2016 that gave the greatest space to ecosystem services. As soon as the motives for drafting the legislation were revealed, it was indicated that biodiversity, "an economic strength of France (...) assures services that contribute to human activities, known as ecosystem services." In the act itself, "the conservation of services" provided by "the spaces, resources, natural land and sea habitats, sites, daytime and night-time landscapes, air quality, living beings and biodiversity" were declared to be "of general public interest"[20]. The principle of preventative and corrective action, as a priority at source, was further integrated into law and, in future, involved "avoiding damage to biodiversity and the services it provides".[21] Finally, then, services were introduced into the French Civil Code by this 2016 act. Article 1247 of the code, recognises ecological damage and defines it as "a non-negligible breach of the components or functions of ecosystems or the collective benefits enjoyed by people from the environment". This last expression unquestionably relates to ecosystem services. Lastly, we can add the new principle of complementarity between the environment and agriculture, which refers not only to ecosystem services but also "environmental services" that can contribute to agricultural, aquaculture and forestry activities using "the ecological functions of an ecosystem to restore, maintain or create biodiversity."[22]

The act of 8 August 2016 is, however, too recent for its effects to be measured; yet it is reasonable to suggest that the integration of ecosystem services into law is likely to result in a renewed legal understanding of the environment.

2. Ecosystem services and the legal understanding of the environment

The possible effects of the concept of ecosystem services on the legal understanding of the environment should be looked for as much in the term "services" as in the word "ecosystem". It would seem that the first term has been of greater interest to authors. The main criticisms made against ecosystem services are reproaches to the utilitarian and anthropocentric approach to the environment that it results in[23].

Yet, in law, we see that natural resources have been, and still are, understood and protected in terms of their utility to humans. This is the case, particularly, for water where "balanced management must allow, as a priority, health, public sanitation, civil security, and the population's drinking water supply needs to be met."[24] We may also consider that green spaces, plant and animal species, as well as

[18] Art.L.1.II of the French Rural and Marine Fisheries Code
[19] Art.L.1.II of the French Rural and Marine Fisheries Code
[20] L.110-1-II of the Environmental Code.
[21] L.110-1-II 2° of the Environmental Code.
[22] L.110-1-II 8° of the Environmental Code.
[23] Cf., Maris V., 2014. *Nature à vendre. Les limites des services écosystémiques*, ed. Quae, coll. Sciences en questions.
[24] Art. L.211-1 II of the Environmental Code.

"remarkable" or "heritage" biodiversity are protected under law due to the cultural services that they offer.

From this point of view, ecosystem services don't appear to be something able to significantly change the legal approach to the natural environment. They may even serve to reinforce the protections granted under law, thus strengthening its legitimacy. In fact, they express the strong dependency of societies on ecosystems and on their good functioning. This was recognised in the French constitution, according to which "the future, and the existence of humanity itself, is inseparable from its natural environment."[25] This dependence is so strong that to protect ecosystems and their services, is to protect human societies and their activities. While "this dependence was, for a long time, considered as an obstacle to be overcome, with scientific and technological progress being the guarantors of human domination of the natural world"[26], the concept of ecosystem services tends to show that such dependence is, for the most part, unavoidable, and even inherent to life on earth.

Yet, we also know that the law recognises, often implicitly, the intrinsic value of nature, independently of its utility to humans. In this way, environmental law leads unquestionably to a broadening of the interests that are legally protected: humans are not the only ones to require the protection of the law. The environment exists as an object of protection in itself, and an "area of focus"[27] that is not solely human. Here we can cite the UN's World Charter for Nature, adopted by its General Assembly on 28 October 1982, the preamble of which declares that "Every form of life is unique, warranting respect regardless of its worth to man." Ten years later, in the preamble to its Biodiversity Convention, Member States declared that they were "conscious of the intrinsic value of biodiversity". Consequently, while in law, the environment is protected by virtue of its utility to man, it is also protected in its own right.

The risk maybe that the success and applied nature of the ecosystem-services concept "steamrollers" through the field of law "crushing" elements of the environment considered as being "useless". What is more, we might fear the narrowing of environmental thought around a reductive conceptual framework, from which it could become impossible to question, and eventually rethink, our relationship with the living world. The concept of ecosystem services, developed to raise societies' awareness about the necessity of preserving ecosystems, could make them blind to a more nuanced and complex approach to the environment[28]. The risk may be greater

[25] Constitutional Act No. 2005-205 of 1 March 2005 on the Environmental Charter.
[26] Maris V., op-cit., p. 23.
[27] Farjat G., 2002, Entre les personnes et les choses, les centres d'intérêts. Prolégomènes pour une recherche, *RTDCiv*., 221-236.
[28] Norgaard R-B., 2010, Ecosystem services: From eye-opening metaphor to complexity blinder, *Ecological Economics,* 69, 1219-1227 : "What started as a humble metaphor to help us think about our relation to nature has become integral to how we are addressing the future of humanity and the course of biological evolution. The metaphor of nature as a stock that provides a flow of services is insufficient for the difficulties we are in or the task ahead. Indeed, combined with the mistaken presumption that we can analyze a global problem within a partial equilibrium economic framework and reach a new economy project-by-project without major institutional change, the simplicity of the stock-flow framework blinds us to the complexity of the human predicament. The ecosystem services approach can be a part of a larger solution, but its dominance in our characterization of our situation and the solution is blinding us to the ecological, economic, and political complexities of the challenges we actually face".

still because even if the law is able to establish the complex reality of the relationships between humans and non-humans[29], legal categories and qualifications often find their roots in a dualistic and utilitarian vision of the world.

What is more, the concept of ecosystem services fits perfectly into a neo-liberal ideology, which thinks of nature in terms of "capital", "flows", and "natural agents", and proposes a dematerialised approach that easily lends itself to monetisation. For certain authors, ecosystem services "represent the archetypical imaginary good, whose sole goal is to be traded, as if the concept had been created just for that"[30]. We can observe that the mechanism for environmental compensation, is part of the same trend, especially since the amendments to the Act of 8 August 2016 that introduced "units of compensation", destined to fulfil the role of "liability" incurred by those pursuing projects that damage the environment.

But the concept of ecosystems can also result in a renewed approach to environmental law.
In fact, ecosystem services also bring a systematic and dynamic approach to the environment. While, in chronological terms, the adoption of a systematic legal approach preceded the use of the term ecosystem services, they may represent the engine, or fuel that was missing[31]. As a result, ecosystem services can contribute to pushing, or breaking down, the borders and the compartments that the law uses. For example, the protection of natural spaces today takes into account the functions, and ecological networks that are linked to them, including certain ecosystem services provided (for example, water treatment, the regulation of parasites, and cultural service), by wetland areas, green or blue belts, and the Natura 2000 network[32]. Evaluating the impacts of an activity or a development project is also likely to be modified, and made more complex, by taking into account the functions and services of the ecosystems affected. We can also assume that the concept of ecosystem services brings with it new actors. We now not only consider the beneficiaries of these services, but also the environmental "producers" or "service providers", and have adapted the role of existing actors (such as public powers, NGOs, and companies) leading, as a result, to consequences in terms of environmental "governance". Some of these basic shifts, created, strengthened and accelerated by the diffusion of ecosystem services in the field of law are already perceptible[33]. More specialised legal analysis needs to be carried out to better categorise these services, their effect on contract law, and, in particular, their effect on land leases, civil liability, and public spending. This will help determine whether ecosystem services can be viewed as a new legal object and a means of creating new legal relationships, and if they are able to effect significant changes to existing legal categories and

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[29] Coutellec L., Doussan I., 2012, Legal and ethical apprehensions regarding a relational object. The case of the genetically modified fish, *Journal of Agricultural and Environmental Ethics*, 25 (6), 861–875.
[30] Boisvert V., 2015, Les services écosystémiques : un nouveau concept ?. *In : Le pouvoir de la biodiversité. Néolibéralisation de la nature dans les pays émergents*, (Thomas F., Boisvert V., eds), collection Objectifs Suds, éditions Quae, 215-229, p. 227.
[31] Fèvre M., 2016, *Les services écosystémiques et le droit. Une approche juridique des systèmes complexes*, thèse de doctorat en droit, Université Côte d'Azur, 712 p.
[32] *Cf. infra* Fèvre M. « Ecosystem services, a functional concept ».
[33] Cf. for instance Fèvre M., 2016, op. cit ; A. Langlais (ed.), à paraître, *L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?,* Presses universitaires de Rennes.

systems. It is very much in the interests of the contributions that follow to explore these avenues and seek to provide answers to them.

« Ecosystem services », a functional concept

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Introduction

In the early 2000s, the authors of the United Nations report on the *Millennium Ecosystem Assessment (MEA)* postulated that humans were dependent on the healthy state of ecosystems through the benefits they derived in terms of well-being and the satisfaction of basic needs. Since then, use of the « ecosystem services » concept has increased dramatically. The common international classification (CICES) breaks down such services into a typology, which makes a distinction between supply, regulatory and cultural services.

From the outset, the concept of « ecosystem services » has had a strongly informative dimension. On the one hand, it allows collaboration and dialogue between different disciplines on most environmental issues, including the fight against erosion of soils and the loss of biodiversity[1]. On the other, it highlights the consequences linked to decoupling aspects of socio-economic governance from ecosystem constraints, and alerts decision makers about the costs this entails[2]. The concept then rapidly feeds into public policies and nature-protection strategies, to the extent that issues of ecosystem services are, almost systematically, intrinsically linked to those of biodiversity.

Although constructed outside the sphere of law, ecosystem services are also increasing in importance as a legal concept. In fact, they are associated with a range of remediation, management and prevention schemes[3]. However, the legal definition of ecosystem services is open to criticism. A literal interpretation of Article L.161-1-I-4° of the French Environmental Code[4] leads, in one sense, to a fairly typical form of confusion between functions and services. The reference to functions benefiting « natural resources » remains faithful to an eco-centred approach, which considers ecosystem functions as being useful for biodiversity, not simply for humans. Yet, a function takes the form of a service only when it contributes to the satisfaction of a human need[5]. The text of the article also limits repairable services to services provided by water, soil, and protected species and habitats. The reference to soils evokes a very broad and vague sphere of application which makes it more difficult to understand which functions or services fall into this category. Conversely, the reference to protected species and habitats concerns the lists established by the 1979 Birds Directive

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[1] Boisvert V., 2015, Les services écosystémiques : un nouveau concept ?, *In : Le pouvoir de la biodiversité. Néolibéralisation de la nature dans les pays émergents*, (Boisvert V., Thomas F.), IRD Editions, 1ère édition, coll. Objectifs Suds, QUAE, Marseille, p. 137.

[2] Pushpam K. (dir.), 2012, *The Economics of Ecosystems and Biodiversity : Ecological and Economic Foundations*, Ed. Earthscan Ltd, Washington, p. 25.

[3] Doussan I « A brief history of the incorporation of the concept of ecosystem services in law », *supra.*

[4] "Ecological services" are defined as "the functions provided by soils, waters, and species and habitats... for the benefit of one of these natural resources or the public, to the exclusion of services rendered to the public by improvements made by the operator or the owner."

[5] Boyd J., Banzhaf S., 2007, What are Ecosystem Services ? The Need for Standardized Environmental Accounting Units, *Ecological Economics,* 63, p. 621.

(Annex I) and the 1992 Habitats Directive (Annexes II, IV and I, respectively), which constitute only a narrow view of biological diversity.

Faced with a confusing legal definition, ecological science remains of limited help, as there are still difficulties in accurately defining the relations between species, the functioning of an ecosystem and ecosystem services[6]. Yet, despite these limitations, several authors cite their integration as a legal innovation, an undeniable step forward, or a significant example of legal enshrinement[7]. Thus, the concept of « ecosystem services » may not be separated from its beneficial effects. In other words, if we go back to Professor Vedel's analysis, the concept of ecosystem services could be perceived as a « functional concept », namely a legal concept characterised by a vague and unsound definition that becomes coherent only through its function[8].

We can immediately see the functional character of ecosystem services from the point of view of public policy because the concept offers an economic metric that makes the preservation of biodiversity « attractive ». However, what role can it play in terms of law applicable to the protection and management of nature? And how does it contribute to its development and renewal?

Ecosystem services do not depend directly on natural resources, but on the integrity and diversity of the functions provided by ecological systems[9]. As such, researchers define certain ecological functions by referring to the services they underpin[10]. An ecosystem service can therefore only be understood if we consider its underlying functionality[11]. Also, some authors note that « thanks to the 'ecological-services' approach, the conservation of biodiversity, which originally focused on the protection of species and sites of special interest, increasingly takes into account the functionality of ecosystems »[12].

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[6] *Cf.* Barnaud C., Antona M. et al., 2011, Vers une mise en débat des incertitudes associées à la notion de service écosystémique, *VertigO- la revue électronique en sciences de l'environnement*, 11 (1), http://vertigo.revues.org/.

[7] Desrousseaux M., 2014, *La protection juridique de la qualité des sols*, Thèse de doctorat, spécialité Droit, Université Jean-Moulin – Lyon III, p. 449 ; Fuchs O., 2008, Le régime de prévention et de réparation des atteintes environnementales issu de la loi du 1er août 2008, *A.J.D.A.,* 38, p. 2110, Hédary D., 2008, La loi du 1er août 2008 sur la responsabilité environnementale : quel progrès pour l'environnement ?, *Dr. Env.,* 163, p. 29.

[8] Vedel G., 1950, La juridiction compétente pour prévenir, faire cesser ou réparer la voie de fait administrative, *JCP*, 1950 (I), 851, p. 425.

[9] Wallis C., Blancher Ph., Séon-Massin N., Martini F., Schouppe M., 2011, *Mise en œuvre de la directive-cadre sur l'eau. Quand les services écosystémiques entrent en jeu,* 2ème séminaire « Quand les sciences de l'eau rencontrent les politiques publiques », 29 et 30 sept. 2011, Bruxelles, Les rencontres de l'ONEMA, p. 27 ; Barbault R., 2011, La biodiversité, une façon écologique de comprendre notre monde, *In : Quelle(s) valeur(s) pour la biodiversité ?, ECOREV*, *Revue critique d'écologie politique*, 38, p. 11.

[10] « *The capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly* », De Groot R.-S., Wilson M.-A., Boumans R., 2002, A typology for the classification, description and valuation of ecosystem functions, goods and services, *Ecological Economics*, 41, p. 394 ; « […] *the functions represent the potential that ecosystems have to deliver a service* » ; Pushpam K. (dir.), *op. cit.,* p. 18 ; « les fonctions d'un écosystème sont les emboîtements nécessaires au niveau des écosystèmes, pour que la fourniture du service s'opère », Aronson J., 2012, Regard d'un écologue sur la proposition de Nomenclature des préjudices environnementaux, *In : Nomenclature des préjudices environnementaux*, (Neyret L., Martin G.-J.), coll. Droit des Affaires, L.G.D.J. Lextenso, Paris, p. 54.

[11] Mission Économie De La Biodiversité, 2014, *Les paiements pour Préservation des Services Ecosystémiques comme outil de conservation de la biodiversité. Cadres conceptuels et défis opérationnels pour l'action*, CDC Biodiversité, Les Cahiers Biodiv'2050 : Comprendre, 1, p. 12.

[12] Delangue J., 2015, Services écologiques : de quoi parle-t-on ?, *Espaces Naturels,* 52, p. 25 ; Longeot J.-F., Dantec M., 2017, *Rapport fait au nom de la commission d'enquête sur la réalité des mesures de compensation*

In 2008, Jean Untermaier saw, in the consideration of ecological functions, a new objective for the law applicable to nature conservation[13], given that their erosion is directly related to losses in biodiversity. However, this approach, based on functions, is struggling to find its way into law[14]. Soil provides a clear illustration of this. The 2002 European Commission paper « Towards a Thematic Strategy for Soil Protection », but also the European Charter for the Protection and Sustainable Management of Soil, recognise its capacity to fulfil a multitude of functions essential to life[15]. However, the 25 September 2006 proposal for a European directive on soil protection[16] remains at the draft stage[17].

In addition, because ecosystem services reflect the close ties between the ecological and social spheres, their management, in areas such as the prevention and repair of damage, means that reciprocity in relations between humans and nature has to be considered. While there is full awareness within the environmental sciences[18] of the importance of these interactions, the law has often considered them as broken or non-existent, such that the protection of nature has long operated outside of the field of human development. As it gains ground, however, the concept of « ecosystem services » is driving legislators to understand their inseparable nature.

The recognition of ecosystem services therefore has a role to play in the fight against ecosystem degradation, by playing its part in the renewal of the way that the law understands aspects of nature (1), and in the structuring of relations between society and nature.

1. A renewed approach to the environment in law

The sole legal definition of « ecological services » refers to the functions performed by the physical and biological aspects of nature. In fact, the concept « reflects the idea that in biodiversity [...] interactions between species are more important than their quantitative value »[19]. This is already a significant development for environmental law, which, historically, has been confined to the consideration of different aspects of nature as separated from each other. Such an approach, using functions, is not unknown in law, but remains peripheral and piecemeal. The use of ecological services tends to reverse this trend and to make it more systematic (1.1). The taking into account of ecological functions also requires an understanding of the conditions under which they operate. Also, the introduction of

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des atteintes à la biodiversité engagées sur des grands projets d'infrastructures, intégrant les mesures d'anticipation, les études préalables, les conditions de réalisation et leur suivi, Sénat, 517, p. 21.

[13] Untermaier J., 2008, « Biodiversité et droit de la biodiversité », *R.J.E.*, NS, p. 21.

[14] Decision No.1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 "Living well, within the limits of our planet".

[15] Revised European Charter for the Protection and Sustainable Management of Soil, adopted by the Committee of Ministers on 28 May 2003 at the 840th meeting of Ministers' Deputies, Annex 28, paragraph 9.1.

[16] European Commission, *Proposal for a Directive of the European Parliament and of the Council establishing a framework for the protection of soil and amending Directive 2004/35/EC,* COM/2006/0232 final,Brussels, 25 September 2006.

[17] Voir Hermon C., « Soil protection in law », *supra*., et Doussan I., A brief history of the incorporation of the concept of ecosystem services in law, *supra.*

[18] Tatoni Th., Cramer W., Piégay H., Galop D., 2013, Pour une écologie globale, *In : Prospective de l'Institut écologie et environnement du CNRS*, (Thiébault S., Hadi H. (coord.)), compte-rendu des journées des 23 et 25 octobre 2012, Avignon, Les Cahiers prospectives, HS, pp. 219-224.

[19] Martin G.-J., 2009, Les effets de la responsabilité environnementale : de la réparation primaire à la réparation compensatoire, *Dr. env.,* 6, repère 6.

ecosystem services into the legal field demonstrates the importance of addressing ecological systems as a whole (1.2).

1.1. The integration of environmental functions in law

Before the concept of « ecosystem services » was integrated into law, it already covered some functions performed by soils (1.1.1). On closer examination, most of these functions appear to be more like services, a sign that the idea of socially useful functions had already influenced the legal field. Recent reforms also show how they have gradually been introduced in various legal regimes, a sign that services continue to exert this influence (1.1.2).

1.1.1. Environmental functions incorporated into law before the emergence of the "ecosystem services" concept[20]

From the beginning of the 2000s, the French Forestry Code recognised the multifunctional nature of forests, i.e. the interdependence of their economic, ecological and social functions. Recognised benefits of forest cover, which legislators have taken measures to safeguard, include soil fixation in areas with high natural hazards, acting as a facility that can be used for public leisure in areas close to cities, but also the protection of biological balances. Closely linked to the economic functions of forests, the recognition of ecological and social functions, given their specific character, raises the issues of management and the maintenance of their equilibrium[21]. The principle of « sustainable management » thus makes it possible to preserve functions, by varying legislative measures in the light of local interests, geographical contexts and communities' priorities. The « protective forests »[22] instrument, for example, preserves forest cover, helping control steep gradients in mountainous areas, and also dune mobility in coastal areas subject to the risk of subsidence[23].

It is, moreover, this natural ability of forests to provide ecosystem functions and services that justified their early framing in law. It is also the belated recognition of the functions and services provided by wetlands that has now led legislators to introduce measures to protect them, despite having, for a long time, encouraged their draining.

The Water Act of 3 January 1992[24] incorporates the protection of wetlands into Article L.211-1-I-1 ° of the French Environmental Code. The text of the article justifies this new provision in terms of the support such areas provide to the general objective of rational water-resource management. Thus, in 1995, wetlands were recognised in public policy as « natural infrastructures » because of « the many functions they provide to communities »[25]. Yet, there

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[20] Such developments, among others, would be limited to the examples of forest soils and moist soils.

[21] CGAAER, 2014, Trop exploitées, les forêts disparaissent, *In : Controverse documentée à propos de quelques idées reçues sur l'agriculture, l'alimentation et la forêt. Ministère de l'agriculture, de l'agroalimentaire et de la forêt,* mission n°13083, ép. n°4, p. 12.

[22] Tools considered as public easements provided for in Article L.141-1, New French Forestry Code.

[23] Art. L. 143-2 New French Forestry Code.

[24] Act No. 92-3 of 3 January 1992.

[25] Bazin P., Mermet L., 1999, L'évaluation des politiques « zones humides » de 1994 : son origine, son déroulement, ses résultats, *Les annales des Mines,* p. 89.

is no mention of « services », which is, again, what is actually being discussed here[26]. Also, legislators saw, in the purification and regulation functions provided by wetlands[27], a qualitative and quantitative management tool for water resources. This is evidenced in the key principles of the first Water Development and Management Master Plans (SDAGEs), which aimed to maintain these functions on the grounds that they « play a valuable role for society which should be recognised by local communities »[28]. It should be noted that, while acts and decrees do not refer to « services », most of the SDAGEs prepared for the period 2009-2015[29] and, then, for 2016-2021[30], now use the concept to define the functions of wetlands that are useful to society in their objectives and measures[31]. Thus, the Rhône-Méditerranée SDAGE stresses that « the preservation of the proper functioning of the environment is needed for biodiversity and useful for society »; it makes particular note of essential wetland services, including their role in the prevention of natural hazards and the preservation of fluvial dynamics[32].

The DTR (*développement des territoires ruraux* - Development of Rural Areas) Act of February 23, 2005[33] reaffirmed the importance of wetlands, recognising their preservation and management as being in the general interest[34]. As a result, legislators have adopted measures to protect their « useful » functions. Article L.211-3-II 4 ° a) of the French Environmental Code thus gives prefectoral authorities the option to define new areas subject to environmental regulation (ZSCEs)[35], for which action programmes, aimed at protecting the greater general interest, are to be established. Thus, wetlands of particular environmental interest (ZHIEPs) are areas whose maintenance or restoration are an efficient way of ensuring the regulation of watercourse flows, a self-purification function, a habitat for species, or peak reduction during floods[36]. In addition, Water Development and Management Plans (SAGEs) can define Strategic Water Management Zones (ZSGEs), for which public easements are

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[26] Indeed, for some authors, talk of "natural infrastructures" led to a recognition of "the importance of these systems for society because of the services they provide".

[27] Flood protection and elimination of dissolved substances are some examples ; Barnaud G., Mermet L., 1998, Leçons à tirer de la procédure de délimitation des zones humides aux États-Unis, *In : Zoner les espaces naturels ? Objectifs, Méthodes et Perspectives*, (Maurin H., Le Lay G., De Feraudy E.), Synthèse du séminaire tenu à Paris le 2 décembre 1996, MNHN, p. 62.

[28] Rhône-Méditerranée SDAGE, 1996, *Protection et gestion des milieux aquatiques et des zones humides*[Protection and management of aquatic environments and wetlands], 20/12 (2), pp. 2 and 29.

[29] The Seine-Normandie SDAGE discusses the "wetland environmental services" (2010-2015 SDAGE for the Seine Basin and Normandy coastal inlets, Key Principles, Order of 20 November 2009, page 86*)*, the Rhine-Meuse SDAGE discusses "services provided" by aquatic environments and wetlands (Rhine-Meuse SDAGE *,* Key Principles, Order of 27 November 2009, pp. 27, 59 and 89), the Rhône-Méditerranée SDAGE also discusses "services provided by aquatic environments" as well as "services resulting from the management of wetlands" (Rhone-Mediterranean SDAGE *,* Towards healthy aquatic environments : Objectives and programmes of measures, Order of 20 November 2009, pp. 68 and 94), the Adour-Garonne SDAGE discusses "services rendered by aquatic environments" (Adour-Garonne SDAGE, Key Principles, *OJ*, 1 December 2009, p. 11).

[30] Provisions that "aim at ensuring the physical equilibrium and self-purification capacity of aquatic environments, and support the essential functions and services provided by wetlands", Rhône-Méditerranée SDAGE, 20 November 2015, version presented to the Catchment Committee, p. 51, Adour-Garonne SDAGE, January 2016, p. 82

[31] Lucas M., 2014, La compensation écologique des zones humides en France : vers une intégration des services écosystémiques ?, *Dr. Env.*, 219, p. 21.

[32] Rhône-Méditerranée SDAGE, Key Principle No. 1, « Prioritising prevention and interventions-at-source for greater effectiveness », Key Principle No. 2, « Effectively implement the non-degradation of aquatic environments principle », pp. 42, 50 and 503.

[33] Act No. 2005-157 of February 23, 2005.

[34] Art. L. 211-1-1 C. env.

[35] The regime is provided for in Articles R.114-1 to R.114-10, C. rural.

[36] Circular DGFAR/SDER/C2008-5030 of May 30, 2008, *op. cit.*, pp. 5 and 19.

established, on the sole assumption that these wetlands play a significant role in protecting water resources.

ZHIEPs and ZSGEs can therefore only apply to areas in which society recognises the provision of ecological, social or hydrological functions. Legislators have thus created protective tools, not for the environment in its own right, but for the functions it provides. The linking of ZHIEPs and ZSGEs also testifies to the way in which the law has prioritised such functions, by enabling a particularly powerful instrument that is employed to preserve hydrological functions.

In-depth analysis of the examples discussed, leads to the observation that it is rather the regulatory and cultural services provided that the law preserves, even if it uses the term « functions »[37]. It must be said that the reluctance of parliamentarians and the government is still palpable when it comes to handling the concept of "ecosystem services"[38]. Whatever the reality, there has been a noticeable increase in legal protection of functionalities since the concept appeared.

1.1.2. Environmental functions incorporated into law following the emergence of the « ecosystem services » concept

As the « ecosystem services » concept becomes more widespread, we observe an increasing integration of ecological functions in law.

This change is first evident in the framing of measures for damage remediation[39]. The reference to ecological services in the definition of repairable accidental damage in Article L.161-1-I-4 ° of the French Environmental Code requires that such restoration encompass ecological functions[40]. This approach corrects previous legal practice which legal doctrine had, much earlier, rejected. In 1989, Martine Rémond-Gouilloud pointed out, with respect to environmental damage, that « ...taking into account each specimen separately, in isolation from the whole, leads people to forget that its intrinsic value is inseparable from its environmental value : often, what counts, is not the individual element but its function; the role it plays within its ecosystem »[41]. This is exactly what the restoration of ecological services encourages : that both the damaged elements, and the functions they fulfil, be restored[42]. Legislators have, moreover, *a priori*, provided themselves with the means to fulfil such ambitions, by defining « a multi-faceted restoration regime »[43]. Thus, independently of primary and complementary restoration measures, the law has introduced a so-called

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[37] Fèvre M., 2016, *Les services écologiques et le droit. Une approche juridique des systèmes complexes*, Thèse de doctorat, spécialité Droit, Université Côte d'Azur, Nice, partie I.
[38] *Ibid*., p. 370.
[39] *Cf. infra* S. Jean « The effect of ecosystem services on civil liability law ».
[40] Camproux-Duffrène M.-P., 2009, Les modalités de réparation du dommage ; apports de la « responsabilité environnementale, *In : La responsabilité environnementale, prévention, imputation, réparation,* (Cans Ch. (dir.)), Coll. Thèmes et commentaires, Dalloz, p. 116.
[41] Rémond-Gouilloud M., 1989, *Du droit de détruire - Essai sur le droit de l'environnement*, P.U.F., Paris, pp. 224-225.
[42] Martin G.-J., 2010, La responsabilité environnementale, *In : L'efficacité du droit de l'environnement*, (Boskovic O.), coll. Thèmes et Commentaires, Dalloz, Paris, p. 6.
[43] Jarlie-Clément C., Gautier-Sicari M.-A., 2004, La directive sur la responsabilité environnementale, originalités et incohérences d'un régime juridique novateur, *B.D.E.I.,* 4, p. 13.

« offsetting » remedy, which aims to deal systematically with transient losses in ecological functionalities that have occurred between the time when the damage occurred and the moment when the first measures began to take effect. Although it does not apply this threefold approach, functions are also core to the definition of ecological damage[44] in the act on restoration of biodiversity, nature and landscapes (the RBNP Act)[45]

In the same way, the act has extended this new requirement to the functions damaged by development projects. Article L.110-1-II-2° of the French Environmental Code thus states that the principle of preventative action « implies avoiding damage to biodiversity and the services it provides ; and, failing this, reducing its scope, or, as a last resort, offsetting damage that cannot be avoided or mitigated in terms of the species, natural habitats and ecological functions affected ». According to the Senate Committee of Inquiry's report, this new article considers biodiversity as being inseparable from the services it provides when applying the principle of preventative action. This extension of the scope to cover ecological services will necessarily affect the way in which environmental assessments are carried out for example, the implementation of avoidance, reduction and offsetting measures will no longer be able to ignore the associated environmental functions[46].

Lastly, new functions have recently been incorporated into the protection objectives of forestry law. Since 1985, in France, the Forestry Code has recognised the soil protection function of forests. Conversely, the water protection and air purification functions of forests had to wait for subsequent legislation – the Act of 13 October 2014[47] on agriculture, food and forests – before gaining recognition. In creating these new provisions, legislators have recognised the general interest in conserving the regulatory functions of forest cover[48]. Here too, it is really the issue of « services » that is at play, as the parties to the Oslo Ministerial Conference recognised explicitly as early as 2011[49].

As scientific knowledge and social needs evolve, and the concept of « ecosystem services » has gained in popularity legislators' attention is increasingly focusing on ecological functions. In fact, legal recognition of the functions performed by forests and wetland ecosystems was already in place through the idea of preserving the functions useful for the protection of people and property : namely, services.

However, this approach based on functions, has long been limited to these two areas only. The concept of « ecosystem services » provides a more forceful argument than that of « functions » ; it is attractive in that it enables a move beyond this purely piecemeal approach. To make the protection of environmental services an objective of environmental law requires that the ecological functions that underpin them, and therefore the conditions under which they operate, be given a more general definition when developing and applying rules on environmental protection.

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[44] Art. 1247 C. Civ., ecological harm consists of "a significant impairment of the elements or functions of ecosystems or the collective benefits derived by society from the environment".
[45] Act No. 2016-1087 of 8 August 2016.
[46] Fèvre M., 2016, *op. cit*., pp. 454 et s.
[47] Act No. 2014-1170 of 13 October 2014
[48] Art. L.112-1-4 ° C. forestier.
[49] Forest cover « helps the environment mitigate and adapt to climate change », and provides « protection of water and soil and other ecosystem services while protecting society and its infrastructure from natural hazards », Ministerial Conference on Forest Protection in Europe, FOREST EUROPE, Oslo, Norway, 14-16 June 2011, Recital 7.

1.2. The incorporation of ecological systems into law

Understanding the ecological functions that underpin services implies no longer viewing things as a single structure, but as complex systems that call for a methodological approach that reflects them, rather than one based on static and individual components. These specific requirements for ecological services inevitably lead to a renewal in the way that the law encompasses ecosystems, and imply a focus on protection as well as exploitation. While legislators tend to simplify ecological complexities, the influence of services reintroduces them, in turn highlighting the importance of adopting a new approach to the natural environment (1.2.1). The recent incorporation of new environmental objects into law bears witness to this fact (1.2.2).

1.2.1. A new approach to nature

From a scientific point of view, ecological functions are the result of processes and interrelationships that occur within a complex ecological whole[50]. It is, then, by considering the system as a whole, that the functions, interactions and intermediate processes involved in the production of services can be understood. This is the value of taking a systemic approach.

The Natura 2000 network is the best example of the law taking such an approach to the environment. The 1992 Habitats Directive and the 1979 Birds Directive are, in fact, based on the idea of protecting species by protecting spaces[51]. The network thus aims to protect the habitat function for species of special interest, as well as more generic functions through the protection of « natural habitats », which are, in fact, ecosystems. But what is particularly interesting in the Natura 2000 approach is that these functions are preserved on the scale of a European network. While compartmentalising the law "scotches any possibility of global and systemic management of areas and their associated environments"[52], the network approach, which is particular to Natura 2000, designates each site in terms of ecological coherence, functions and connectivity between ecosystems. This organisation into functional networks leads, indirectly, to ecological services being protected[53]. In 2010, the Natura 2000 network contributed considerably to the regulatory control of natural hazards, the development of recreational activities, water purification, and the maintenance of agriculture and fishing[54]. This state of affairs led European institutions to recognise not only the importance of the

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[50] Mission Économie De La Biodiversité, 2014, *op. cit*., p. 12.

[51] Le Corre L., 2012, Réseau Natura 2000. Constitution. Régime de protection*, JCL Environnement et Développement durable*, fasc. 3820, repère 4.

[52] Le Louarn P., 1999, *Les zones humides et le droit,* CNFTP, SFDE, p. 35.

[53] Brahic E., Terreaux J.-Ph., 2009, *Évaluation économique de la biodiversité - Méthodes et exemples pour les forêts tempérées,* QUAE, p. 23 ; Steichen P., 2004, Quels statuts juridiques pour les sites Natura 2000 ?, *Études foncières*, A.D.E.F, 18, p. 7.

[54] Ten Brink P. Badura T., Bassi S., Daly E., Dickie H., Gantolier S., Gerdes H., Kettunen M., Lago M., Lang S., Markandya A., Nunes PALD, Pieterse M., Rayment M., Tinch R., 2011, *Estimating the Overall Economic Value of the Benefits provided by the Natura 2000 Network*, Final report to the European Commission, Institute For European Environmental Policy, Brussels.

Natura 2000 environmental policy to the sustainability of ecosystem services[55], but also, and in particular, the value of a systemic approach to protecting them[56].

There appears to be an almost unbreakable link between systemic models and the maintenance of ecological services[57]. While this seems obvious within the ecological sciences, it is not the case in law, where such a model and approach are still uncommon[58]. Yet, beyond the mere production of services, the whole sphere of environmental conservation could be made more effective by policies based on a systemic approach[59]; this would then result in a more uniform legal approach, consistent with ecological structures[60]. The introduction of the concept of « ecosystem services » thus renews the importance of this systemic approach, which remains largely piecemeal. It moves environmental law into a state of flux towards a new protection model that requires the incorporation of new concepts.

1.2.2. New areas of protection

The scientific definition of ecological services is based on the concept of « ecosystems », but also on that of « processes »[61] (1.2.2.1). Contrary to the legal definition, it does not make a distinction between the quality of the natural elements that are at its root, to the extent that so-called « common » biodiversity has tended to enter the arcane world of law (1.2.2.2).

1.2.2.1. Ecological processes

Ecological processes are at the root of ecological functions. Several authors have argued for their recognition in law[62], and for them to be regulated « in their complexity and irreducibility »[63]. Described as « urgent » in 1996[64], the protection and management of

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[55] Commission Européenne, 2011, Natura 2000 : les défis financiers du futur, *L'Environnement pour les Européens, Magazine de la direction générale de l'environnement*, 44, p. 3 ; Commission Européenne, *Infrastructures vertes - Renforcer le capital naturel de l'Europe*, COM(2013) 249 final, 06/05/2013, Bruxelles, p. 9.

[56] Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 "Living well, within the limits of our planet", Point 22.

[57] Maresca B., Mordret X., Ughetto A.-L., Blancher Ph., 2011, Évaluation des services rendus par les écosystèmes en France, *Développement durable et territoires,* [en ligne], 2(3), http:// developpementdurable.revues.org/9053, (consulté le 14 juin 2017) ; Ranganathan J. et al., 1998, *Services d'écosystèmes. Guide à l'attention des décideurs,* World Resources Institute (WRI), p. 2.

[58] De Roany C., 2004, L'approche par écosystème pour la gestion des pêcheries – un concept en quête de définition, *Dr. Env.* 116, p. 45 ; Billet Ph., 2015, Le sens des équilibres, *op. cit.,* p. 183.

[59] Dubois G., 2009, *Écologie des coléoptères saproxyliques : Biologie des populations et conservation d'Osmoderma eremita (Coleoptera : Cetoniidae*), Thèse de doctorat, Spécialité Biologie, Université de Rennes 1, p. 5.

[60] Doumbé-Billé S., 1998, L'apport du droit international à la protection de la nature : la convention des Nations-Unies sur la conservation de la diversité biologique, *In : 20 ans de protection de la nature*, Colloque de la SFDE, 28-29 novembre 1996, P.U.L.I.M., Limoges, p. 198.

[61] According to Gretchen Daily, ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life », Daily G.

[62] De Klemm C., 1998, Les législations de protection de la nature : les enseignements du droit comparé, *In : 20 ans de protection de la nature*, *op. cit*., pp. 232 et 237.

[63] Naim-Gesbert É., 1997, *Les dimensions scientifiques du droit de l'environnement,* Bruylant et Vubpress, Bruxelles, p. 409.

[64] *Ibid.,* p. 234.

ecological processes have not yet been reflected in European law[65]. However, it is fairly easy to see that the loss of some of these processes is creating risks for society. In fact, Cyrille de Klemm warned that « once impaired, processes become unable to provide the services needed for flora, fauna and ecosystems »[66] and often lead to « ecological disasters and considerable economic loss »[67]. This is the case with most soil processes threatened by artificial practices such as recycling, decomposition, humidification, the modification of cycles and nutrients, detoxification or bioremediation.

Some processes that are of use to society are specifically protected by law. Some examples are processes that fight the potential for steep soil gradients to suffer erosion, but also sedimentation processes that assist water purification and the maintenance of the banks[68]. Others are currently being recognised, such as wild pollination processes[69]. In many ways, these processes are similar to what we might call a regulatory service[70].

The generic concept of « biological processes » is now favoured by legislators. Incorporated as such into the legislation on the general principles of environmental law, ecological processes are now an integral part of France's common heritage[71]. The effect of the RBNP Act shows that the integration of this scientific concept, as an « innovation », into the French Environmental Code introduces « the idea of biodiversity in continual interaction with its various components (substrates, taxa, and ecosystems), and that it must be understood in a dynamic way »[72]. More specifically, it should be seen as a new way of taking regulatory services into account[73]. Everything, then, comes down to terminology, but, nevertheless, it is by viewing nature through the lens of services that ecological processes have now been more clearly integrated into law. The same thing could be said of so-called « ordinary » species.

1.2.2.2. Ordinary biodiversity

Soils are home to a wide variety of species[74], about most of which there is still scant knowledge. However invisible they may be, such species play a vital role in the functioning of the global ecosystem and are at the root of various ecological processes, which, themselves, underpin functions and services. They include microorganisms (such as bacteria and fungi), macrofauna (such as ants and earthworms), microfauna (such as nematodes), mesofauna (such as collembolans), macrovertebrates (such as moles), biotic regulators, and plant litter

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[65] *Ibid.,* p. 235 ; De Sadeleer N., 2009, La protection de la nature et de la biodiversité, *In : Droit et politiques de l'environnement,* Les Notices, La documentation française, Paris, p. 194.
[66] De Klemm C., 1989, Les éléments de l'environnement, *In : L'Écologie et la loi : le statut juridique de l'environnement : réflexions sur le droit de l'environnement,* (Kiss A. (dir.), Carbiener R., Doumbé-Billé S., Fromageau J., Guttinger Ph.), coll. Environnement, L'Harmattan, Paris, p. 23.
[67] *Ibid.*
[68] See Article L. 214-17 of the French Environmental Code on the preservation of the ecological continuity of rivers by the operators of hydraulic installations.
[69] Fèvre M., *op. cit*., p. 439.
[70] On the subject of forestry law, which closely regulates the hazard-preventing ecological functions of forests, Eric Naim-Gesbert underlines the fact that such legislation does indeed protect "ecological processes".
[71] Art. L. 110-1-I al. 2 C. env.
[72] Gaillard G., 2014, *Rapport fait au nom de la commission du développement durable et de l'aménagement du territoire sur le projet de loi relatif à la biodiversité*, Assemblée Nationale, 26 juin, p. 54.
[73] Delangue J., 2015, *op. cit*., p. 24.
[74] Matthieu C., Lozet L., 2011, *Dictionnaire encyclopédique de science du sol,* Tec & Doc, Lavoisier, p. 79.

engineers[75]. In contrast to biodiversity that is rare, endangered, or of particular scientific interest, these common species do not feature in the various legal codes. It seems, however, that they may have a value as a result of the services they perform[76]. At the normative level, focusing on the regulatory services requires, more than for any other type of service, one that no longer concentrates on remarkable nature itself[77].

Starting from the idea that Article L. 110-1 of the French Environmental Code recognises the general interest of safeguarding ecosystem services, new objectives can then be set for conservation[78] . In particular, this leads to extending the scope of protection by focusing on such common species, and, as a result, reviewing the rights pertaining to them. This recognition of the importance of ordinary biodiversity in the production of services will, in particular, play a role in the assessment by competent authorities of the acceptability of development projects subject to an environmental assessment[79].

Beyond breaking down the boundaries between species and spaces, a second advantage of the services approach is that it highlights the interrelationship between ecosystems and social groups[80]. Use of the concept also results in a renewed legal approach to relations between humans and nature.

2. A renewed legal approach to relations between humans and nature

An ecosystem service is characterised by the linking of a function and a benefit derived by humans. It is the systemic approach that enables moving beyond ecological variables to encompass humans and their place in the system. As ecosystem services become more important, a redefinition of relations between humans and nature tends to emerge in law. It is reflected, in particular, in the appearance of new productive models (2.1) and new general principles (2.2).

2.1. New productive models

The 2008 Marine Strategy Framework Directive was the first text to explicitly base the exploitation of natural resources on an ecosystem approach, with the aim of safeguarding marine services. The ecosystem approach is a type of systemic approach that considers

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[75] Voir notamment Desrousseaux M., *op. cit.,* p. 17.

[76] Chevassus-Au-Louis B. et al., 2009, *L'approche économique de la biodiversité et des services lies aux écosystèmes – Contribution à la décision publique,* rapport, Centre d'Analyse Stratégique (CAS), p. 265 ; Mouysset L., 2015, *Repenser le défi de la biodiversité. L'économie écologique,* coll. Sciences durables, Rue d'Ulm, Paris, p. 55.

[77] Couvet D., contribution orale à l'École thématique du CNRS, *La notion de services écosystémiques et ses applications. Examen critique et interdisciplinaire*, Montpellier, 10-14 juin 2013.

[78] Untermaier J., 2008, *op. cit.*, p. 31.

[79] *Cf.* « le raffermissement de la valeur de la nature *via* les services écologiques », Fèvre M., 2016, *op. cit.,* p. 533 et s.

[80] Mathevet R., Ritan C., Tatoni Th., 2015, Biodiversités et solidarités : au-delà des aires protégées, dessiner des « territoires capables, *h&b, La revue d'humanité et de biodiversité,* 2, pp. 86-94.

humans as an integral part of ecosystems. As such, they both influence it and benefit from the services. However, it is not only in the exploitation of marine resources that links exist between services performed and a systemic approach to environments (2.1.1). Rural law has also recently incorporated the concept of agro-ecology, which is based on the same model (2.2.2).

2.1.1. The systemic approach at work in the exploitation of marine resources

Article L. 219-7 of the French Environmental Code transposes Article 1.3 of the Framework Directive. It states that the protection and management of marine environments intend to apply an ecosystem-based approach to the management of human activities that ensures "the sustainable use of marine goods and services by present and future generations". Degradation of ecosystems, then, can now be measured in terms of services lost[81]. Thus, the article encourages the preservation of ecological functionality for the sole purpose of providing services related to maritime and coastal activities.

This ecosystem approach is at the heart of the Maritime Spatial Planning Directive of 23 July 2014[82]. Starting from the observation that healthy marine ecosystems provide multiple services, their integration into planning decisions maximises the benefits derived by society[83] by mediating conflicts between opposing uses. When applied to planning, the ecosystem approach allows for interactions between present and future activities and uses, but also the synergistic interactions between these activities and uses, and with the marine environment[84].

Supply services are particularly affected by the degradation of ecosystems. Following the entry into force of the new Common Fisheries Policy on 1 January 2014[85], the RNPB Act introduced Article L. 911-2-1° into the French Rural and Marine Fisheries Code. In domestic law, policies on sea fishing, marine aquaculture and other sea harvesting activities are therefore encouraged to operate « within a framework that uses the ecosystem approach in order to minimise environmental damage »[86].

These new provisions demonstrate that the least bad way of reconciling human activities with environmental protection is not only to maintain and restore the environmental elements that constitute the resource, but also to ensure the proper functioning of the associated ecosystem[87]. The objective of conserving marine food supplies and recreational services is now encouraging those working in fishery and aquaculture to maintain the healthy state of ecological functions and their corresponding interactions with marine ecosystems.

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[81] Gambardella S., 2017, La(es) valeur(s) de la biodiversité marine à travers le prisme des quotas de pêche, *In : Quelle(s) valeur(s) pour la biodiversité ?* (Hautereau-Boutonnet M. Truilhé-Marengo E.), mare&martin, p. 279.
[82] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning.
[83] Recital 13, Directive 2014/89/EU.
[84] Article 8-2 and 6-2(a), Directive 2014/89/EU.
[85] Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy, Article 4.1(7).
[86] Voir Curtil O., 2014, La réforme de la politique commune de la pêche, *RD rur.,* 424, dossier 15, repère 3.
[87] Martin Ph., *Projet de loi relatif à la biodiversité,* Assemblée nationale, n° 1847, 26 mars 2014, p. 37.

The systemic approach is being applied in a very clear way in the general management of marine environments. It has also moved beyond purely maritime issues, and is now being adopted in the agricultural sphere.

2.1.2. The systemic approach at work in the exploitation of agricultural resources

The Act on the future of agriculture, food and forestry of 13 October 2014 introduced a preliminary book into the French Rural and Marine Fisheries Code. It comprises two articles, intended to define the purposes of rural law. Paragraph II, Article L.1 states that « public policies aim at promoting and sustaining agro-ecological production systems ». It goes on to say that these systems are « based on biological interactions and the use of ecosystem services... ». Indeed, as Carole Hermon points out, agro-ecology « draws on services provided *by* the environment, and, in turn, provides services *to* the environment »[88]. Because the concept of « services » is central here, agro-ecology places rural law within « a systemic dynamic »[89], and cultivated systems in a much wider context, in which interactions and complementarities have to be determined and taken into account[90].

The concept of « services » plays a remarkable role in expressing this strong interdependence, which still relies, too much, on unconsciously linking society to functional ecological systems. While conventional agriculture gives the illusion of being able to overcome this interdependence by the addition of inputs, it is the concept of "services" alone that reminds us that the collateral effects of plant protection products (in particular the decline of pollinators and the populations of species that control pests) are a genuinely limiting factor on yields. On the other hand, the use of services provided by the environment, through agro-ecology, allows the creation of a further service: the supply, and the preservation of other services, such as regulatory services. In this way, the agro-ecological model goes further, in the consideration of ecological complexities, than the multifunctional approaches used in forestry law and rural law.

Today, we still have cause to doubt the function and operability of the objectives set out in the preliminary book of the French Rural and Marine Fisheries Code. However, to further encourage these types of sustainable practices, based on the use and production of services, new principles emerged with the RNBP Act.

2.2. New general principles

The RBNP Act largely reworked Article L. 110-1 of the French Environmental Code. Among the changes made, it is worth noting the addition of two new principles, each of which aims to

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[88] Hermon C., 2015, L'agroécologie en droit : état et perspective, *R.J.E.*, 3, p. 420.

[89] Trébulle F.-G., 2015, « Propos conclusifs », colloque sur « L'intégration du concept d'agroécologie en droit : état des lieux et perspectives, 22 mai 2014, *Dr. Env.*, 230, p. 27, Hermon C., 2015, *op. cit.,* p. 420.
« L'agroécologie adopte un point de vue systémique, prend en compte les interdépendances et complémentarités des activités et des élément composants les écosystèmes », Hermon C., 2016, Plaidoyer pour une simplification du droit relatif à la protection de l'environnement dans le secteur agricole, *In : Les futurs du droit de l'environnement : simplification, modernisation, régression ?* (Doussan I.), Colloque annuel de la SFDE, 20 et 21 novembre 2014, Bruylant, Bruxelles, p. 243.

[90] "Agro-ecology, in effect, requires taking into account complex interrelations between crops, the associated herbivores and ecological systems, and even the landscapes they are part of."

reorganise relations between humans and the environment, as well as relations within society. Thus, the principle of complementarity between the environment and human activity recognises the farmer's role in conserving the environment and providing ecological services (2.2.1). As for the principle of ecological solidarity, which is already founded in law, this requires a consideration of the interactions between geographical areas when making public decisions, and an approach that distributes costs and benefits beyond purely administrative boundaries (2.2.2).

2.2.1. The principle of complementarity between the environment and human activities

The role of the farmer or landowner in maintaining natural areas had already been recognised in some parts of rural and forestry law. Today it is enshrined in the RBNP Act and integrated into the general principles of environmental law. Article 8(2) of the act introduces the principle of complementarity between the environment, agriculture, aquaculture and sustainable forest management, aiming, in particular, to guarantee "environmental services that use the ecological functions of an ecosystem to restore, maintain or create biodiversity". The question of the extent to which this principle is normative has been debated at length by parliamentarians[91]. While it is easy to doubt its initially prescriptive character, the complementarity principle constitutes an « interpretative guide » to be used by judges, in legal doctrine, and by authorities defining public policy[92]. Despite being formulated in a way that leaves room for confusion on the guidelines and the respective roles of those involved[93], it is clear from this new article that there is a desire to value socio-ecosystem interactions on the basis of ecological functions. In this sense, the principle of complementarity recognises that the healthy state of ecosystems does not exclude human activities, but, moreover, that some such activities can have a beneficial effect on ecological functioning and thus contribute to conserving biodiversity and its associated services. By recognising the ability of operators to provide environmental services, legislators assign a new role to them, thus opening the way for mechanisms that will encourage these players to aid environmental protection. Here again, the reference to « services » seems to make the protection of biodiversity and ecological functions socially acceptable.

However, there is often a disconnect between the areas that produce ecosystem services and those that benefit from them, which raises the issue of ecological solidarity[94].

2.2.2. The principle of ecological solidarity

In environmental law, ecological solidarity encompasses both ecosystem relations, and relations between society and nature (2.2.2.1). Applied to ecological services, it quite

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[91] Doussan I., 2017, Vive la complémentarité de l'agriculture et de l'environnement !, *In : Loi Biodiversité. Ce qui change en pratique*, (Cans Ch., Cizel O. (dir.)), Éditions législatives, pp. 77-81.
[92] Voir Champeil-Desplats V., 2007, N'est pas normatif qui peut. L'exigence de normativité dans la jurisprudence du Conseil Constitutionnel, *Cahiers du Conseil Constitutionnel*, 21.
[93] Doussan I., 2017, *op. cit.*
[94] Chevassus-au-Louis B., 2011, Les services écologiques des forêts : définition des concepts, origines et typologies, *Revue forestière française,* LXIII (5), p. 222.

naturally introduces the question of sharing the costs and benefits of protecting and managing them (2.2.2.2).

2.2.2.1. From ecosystem solidarity to mutual responsibility between humans and nature

The Act of 14 August 2006[95] introduced the principle of ecological solidarity within the very specific context of national parks. Article L.331-1 of the French Environmental Code thus allows the interactions, between a park's core area and the peripheral municipalities that have elected to be part of it, to be taken into account in order to allow relevant flows, processes and essential functions to be defined. Article 2.3° of the RBNP Act has added a sixth clause to the general principles of Article L. 110-1 of the French Environmental Code. From now on, the protection, enhancement and management of aspects of the environment must also apply the principle of ecological solidarity, "which calls for the taking into account of interactions between ecosystems, living organisms, and natural or managed environments, in any public policy decision that has an environmental impact." The RBNP Act is, therefore, also concerned with interface phenomena, the difference being that it includes human activities through reference to the overarching idea of « living organisms ». These interactions can then easily be measured in terms of services provided. Thus, legislators recognise that when an ecosystem is disturbed, there are repercussions on other ecosystems, and that conserving ecosystem services implies considering the likely effects of development or an activity, on these interrelations, especially in terms of costs and benefits.

2.2.2.2. Sharing the benefits and costs of maintaining ecological services on a regional scale

The most recent SDAGEs have encouraged the consideration of mutual interdependence between the upstream and downstream parts of water catchments, in terms of the regulatory services provided by the first to the second for example water purification[96]. During parliamentary debates on the RBNP Act, Geneviève Gaillard MEP presented an amendment proposing the principle of ecological solidarity between geographical areas, which would apply only to public authorities. This involved considering the geographical dimension of mutual responsibility, according to which, while it has a cost to a community in terms of its conservation and maintenance, an ecosystem (a complex ecological environment with obvious functions) often provides a benefit to a neighbouring, or other, geographical area[97]. Thus, any public decision can have an impact beyond the boundaries of a community, just as is the case for catchments. As such, the decision in question must be able to take into account interactions between geographical areas. The solidarity principle implies sharing the financial burdens related to maintaining ecosystems in good order, with the geographical areas that benefit from them[98]. The benefits derived from the functioning of ecosystems are, in fact, ecosystem services. The enshrinement of ecosystem services in law thus leads to the promotion of the old, piecemeal principles, now raised to the status of new guiding principles.

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[95] Act No. 2006-436 of 14 April 2006 relating to national parks, the marine natural parks and regional natural parks.
[96] Lucas M., 2014, *op. cit.,* p. 24.
[97] Gaillard G., 2015, Assemblée nationale, XIVe législature, Session ordinaire de 2014-2015, Compte rendu intégral, première séance du lundi 16 mars 2015.
[98] *Cf.* Icher L., Public spending on the environment: the example of soil protection and services, *infra,* concerning the Act, of 28 December 2016, relating to mountainous areas.

Ecological science has a role to play here in terms of "documenting the dependencies between the socio-ecosystems providing ecosystem services and the beneficiary socio-ecosystems"[99].

The visibility of the concept of « services » therefore opens the way to a new, geographically-based approach to environmental issues and to a shared approach to management, focused on overall balances. Ecosystem services may be a first key in moving towards legislation that goes beyond legal categories and territorial boundaries, in order to better incorporate ecological dynamics.

Conclusion

Ultimately, ecological services outweigh functions in their potential for use in law. The richness and functionality of the concept of « ecological services » lies in its potential to influence the transformation currently in progress, which affects the very foundations of law. The purpose here is not to claim that ecological services are solely responsible for these developments, which began before the concept appeared, driven by ideas of « biodiversity » and « sustainable development ». On the other hand, the concept is being increasingly integrated in law, and it helps consolidate these necessary changes, bringing with it the application of new models, tools and concepts, encouraging an approach that recognises and takes into account the complexity of the socio-ecological systems. Considering its role in developing standards that are more in line with ecological requirements, the concept of « ecosystem services » is, in our view, a functional concept. While we strongly believe this, care must be taken not to cloud the concept of a « function », or open the way to the domination of law that is focused merely on species and « useful » spaces[100].

[99] Bosi S., Euzen A., 2015, *Prospective droit, écologie et économie de la biodiversité,* Les Cahiers Prospectives, CNRS, p. 12.
[100] Doussan I., « A brief histoty of the incorporation of the concept of ecosystem services in law », *supra.*

The legal definition of ecosystem services

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As part of the French evaluation of ecosystems and ecosystem services (the national EFESE programme), "ecosystem goods and services" are defined as "socio-economic advantages derived by humans from sustainable use of the ecological functions of ecosystems"[1]. As controversial as it may be[2], this name "ecosystem goods and services" and the proposed definition, evokes a true concept, in other words it designates a reality which can be perceived in at least two ways : firstly, it involves perceiving an ecosystem as providing practical advantages for people, which is easily conceivable; then, almost conversely, it involves perceiving humans as being capable of adding value to, or at least of preserving, an ecosystem, which is just as easy to understand.

In this context, the role of Law seems to be perfectly natural: the advantage, the protection and the value attributed to an object, *lato sensu* (i.e. in the broad sense), no matter what they may be, rarely occur *ipso facto* (i.e. as an inevitable result). And even if that were the case, which is not entirely inconceivable, we should at least have to foresee, or even prevent, any possible conflict concerning the possession, in its original meaning, of that object, and even more so in that it is partly due to nature, which is usually considered to belong to nobody. So we need Law. For this, Law has to incorporate ecosystem services in its own reality, in other words it has to define them.

Law, during its construction, is ready to deal with facts. It names them abstractly, by means of concepts, with the association of different concepts enabling the rule of law to be implemented. Before a rule based on a fact can be applied, that fact must have been tied to a legal concept. More precisely, the fact will fall into a pre-existing legal category, so that the corresponding legal regime, in other words the rules, may be applied. That incorporation is known as legal definition.

Things are simple when there is a suitable label, in other words when the Law either creates, or explicitly consecrates, the concept which it endows with a complete legal regime. For a long time, that was not the case for ecosystem services, whose definition can thus only be borrowed from other concepts, which had already been incorporated into Law. Nowadays, there is a definition, particularly in the French Environmental Code, but not only; however apart from the fact that it lacks clarity, it only invokes part of the regime under which ecosystem services might fall.

Thus, we may read, as of Article L. 110-1 of the aforementioned code, that the "common heritage of the nation [...] generates ecosystem services and customary use", that protecting these services is "in the public interest", that they "contribute to the objective of sustainable development" and thus constitute one of the five commitments listed at the end of this inaugural text. To this end, one of the principles affirmed by the legislators is that of "avoiding damage to biodiversity and to the services it provides; if this is not possible then we should at least reduce the impact;

[1] Refer to the glossary of this book.
[2] Doussan I., A brief history of the incorporation of the concept of ecosystem services in law, *supra.*

finally there should be compensation for impacts which it was not possible to avoid or reduce, while taking into account the species, natural habitats and ecological functions affected"[3]. It is moreover on this subject alone, that, in this respect, the French Environmental Code goes precisely beyond the standard petition, with the assignment of "ecological" services, which appear to be, rather awkwardly, just another name for "ecosystem" services[4], being perceived as damage caused to the environment, which as such, may and should be foreseen and repaired according to the rules stipulated in Articles L. 160-1 and following. In this respect, the ecological services are even defined as "functions carried out by soils, water and the species and habitats protected for the benefit of one of these natural resources or for the benefit of the public, to the exclusion of services rendered to the public by improvements made by the farmer or the owner", in other words "environmental" services. In the most recent, Article 1247 of the French Civil Code, concerning compensation for ecological prejudice, this prejudice is defined in an even more modern fashion as "a non-negligible damage to ecosystem elements or functions of ecosystems or to the collective advantages drawn by humans from the environment".

Ultimately, in spite of their much wider calling, which is clear both from their positive definition and the ambitious goals described in their respect in Article L.110-1, ecosystem services, or ecological services, are thus only mobilised negatively, as possible grounds for repairing damage. This is not surprising, given the extent to which environmental law is above all constructed to be protective, rather than to enhance value[5]. But this is not sufficient, since what is protected is, most of the time, protected for its value, value which is revealed through a utility, whose removal would effectively entitle a plaintiff to compensation. The essence would therefore appear to lie in this value of ecosystem services, which makes them useful as such and which, when the value is affected, would lead to it being restored for the beneficiaries. It then becomes necessary to tie these objects to the legal definition that best expresses this essence.

In Law, a fundamental distinction is made between subjects, in other words people, who benefit from legal rules, and objects, in other words things to which the rules in question are applied.

Ecosystem services may be considered to be things in the wider sense of the word or, if one prefers not to go that far, may be linked to things such as soils, water, species etc. The things represent all the objects, physical or abstract, that a person is likely to own : a car, a castle, but also pond, cow or, again, information. As such these things constitute, because in many ways they are useful to people, the objective and subject of all the legal relations between people. They (people) exchange them and through their mediation, guarantee all their commitments.

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[3] These affirmations are recent; they effectively derive from Act No. 2016-1087 of 8 August 2016 concerning restoration of biodiversity, nature and landscapes.

[4] Similarly: - This vocabulary has not yet been stabilised, no doubt for the previously mentioned reason: that legal inclusion of the aforementioned services is still in its early stages.

[5] Cf. Hermon C., « Plaidoyer pour une simplification du droit relatif à la protection de l'environnement dans le secteur agricole », *in Les futurs du droit de l'environnement. Simplification, modernisation, régression* (dir. Doussan I.), Bruylant, 2016, p. 235.

Whether ecosystem services are thus the utilities of a thing or whether they are the reification of these utilities, the main questions concerning them remain those of the advantage of the utilities and any possible damage to them. In other words, the first question to be asked in law is that of the benefit derived from ecosystem services, i.e. determining who can or may claim to be entitled to benefit from their utilities or to be entitled to compensation for those that have been lost.

In parallel, ecosystem services are things or are linked to things, that due to their link with the environment, are not used carelessly. This raises the question of a legal framework for benefiting from ecosystem services in short of regulating their use.
At this stage when we are mainly trying to determine to whom the ecosystem services should be connected and what they can do with them in other words finding out who will be able to take advantage of them and use them in accordance with the laws and regulations; obviously we are referring to property here. Ecosystem services are thus, first of all, objects that can be owned, in other words goods, or elements of such an object, i.e. utilities.

Following the previous discussion, we should nevertheless not jump to the conclusion that the legal definition of ecosystem services has been entirely settled. There are in fact many objects that are owned. Carbonnier jokingly pointed out that they might be "*un œuf ou un bœuf, mais aussi les usines Renault, un billet de 100 F, l'étang de Ville d'Avray"* (an egg or an ox, but also the Renault factories, a 100F banknote, the marsh of the City of Avray)[6], whose specific legal natures would lead to each of them falling into a different legal regime, beyond the common regime to which they all belong. This first means that there is nothing to prevent ecosystem services from being effectively perceived as goods or at least, as elements of one or more goods[7]. These services would then merely be inscribed as part of these new goods that evolving human societies have consecrated[8]: information, various kinds of rights, etc.

However, this situation then implies that these original objects, ecosystem services, give rise, within the law of property itself, to new questions that only a more precise legal definition, along with the corresponding regime, appears to be likely to resolve. Should the law of property be forced to evolve given the obvious inadequacy of its current rules, thus creating a new definition, or, on the contrary, is the law as it stands already able to accommodate these modern goods, by mobilising a pre-existing definition?

The answer may at first be found by determining how property is defined in law and more precisely the definition of its purpose, the particularity of ecosystem services, since they have their own characteristics which make them a particular case in the category of owned objects (1). Acting on this basis it then becomes possible to compare the object thus determined with existing qualifications : in fact ecosystem services have many characteristics that are the same as other owned objects (2).

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[6] Carbonnier J., *Les biens*, Quadrige, PUF, 2004, 19e éd., n° 707.

[7] A lot has already been written about such a hypothesis, which seems to be the main one envisaged. Cf. Martin G.-J., « Les biens-environnements, une approche par les catégories juridiques », *RIDE*, 2015/2, p. 139.

[8] Revet T., « Les nouveaux biens », Rapport français, *in Travaux de l'Association H. Capitant*, t. 53, *La propriété*, 2003, n° 19, p. 285.

1. The specific characteristics of ecosystem services as owned objects

Ecosystem services are useful to humans; there is no doubt about this, because this is why they have been consecrated and incorporated into law. In so doing has not Law simply reaffirmed what ecology and the economy have already revealed ?[9] Nevertheless, once this has been noted things become more complicated, because on the one hand, these services either demonstrate how ecosystems are more useful for humans than they are for themselves or are in fact the ecosystems themselves. In other words their usefulness is an intrinsic characteristic (1.1). Moreover, ecosystem services are, more precisely, useful to humans, to humanity in general or at least to a group rather than to one person in particular. In this sense, their usefulness is common to all (1.2).

1.1. An intrinsic usefulness

"Goods are things whose usefulness justifies their being alienated (sold or bought)"[10]. The usefulness is less consubstantial with the concept of property, in other words, with a property object. And this is doubly the case since only things that are useful, but also whose reservation for a single owner, appears to be useful, are alienated. This is one of the reasons why certain things belong to everybody, since their abundance means that there is not yet a need to appropriate them, in spite of their undeniably intrinsic usefulness : air, natural light, flowing water, etc. However, in a world in which everything is possible due to scientific breakthroughs, it may especially be useful to avoid these things belonging to somebody. There are in other words things that one cannot appropriate and things that we do not wish to be appropriated. All are commonly shared things.

In any case, in order for a thing to become a property, in other words to be appropriated, what is important is its usefulness for one or more people. This means that this usefulness is only taken into account when considering potential owners, in short in an extrinsic and subjective way. This explains the difficulty of circumscribing the concept of goods/property.

The only thing we can be certain of is that in the contemporary French legal system is that the useful thing and consequently the appropriated thing belongs completely to its owner. Once it has become property, the thing keeps its intrinsic usefulness, which will then, in a monopolistic way, benefit a single person : the owner. A contemporary interpretation has thus chosen property as the only way of inscribing in law the set of utilities of the thing that it defines. Fairly often this involves assimilating the reason which led a person to appropriate a thing, the extrinsic usefulness, and the qualities of the thing appropriated, its intrinsic usefulness, which is present before and after the appropriation but only benefits the owner, and even goes beyond what he/she wanted to do with the thing[11].

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[9] Cf., in this book, Doussan I., « A brief history of the incorporation of the concept of ecosystem services in law"

[10] Zenati-Castaing F., Revet Th., *Les biens*, PUF, 2008, 3e éd., n° 2.

[11] See our study with regard to this : « Bien(s) et utilité(s) », *in Mélanges Grégoire Forest*, Dalloz, 2014, p. 39.

In some situations, evolving techniques have made it possible to make one of the intrinsic utilities of a property, autonomous. For example, the criminal chamber of the Court of Appeals, in a famous judgement handed down on 14 November 2000[12], considered that the number of a credit-card could be property in the same way as the card itself. Even though it comes from the latter, the credit card number nevertheless has its own usefulness and the comparison between the two objects described in this way thus appears to be very enlightening.

The card and its number do have a similar usefulness, but not in common, enabling the person who deposits funds to then use them by presenting the card or its number. Consequently, one might well imagine, as did the criminal chamber of the Court of Appeals in this case, that one might respectively and independently submit them and use them fraudulently[13]. The usefulness of the credit card number thus ended up becoming an autonomous thing, which due to its usefulness, became property.

From this point of view, it is possible to envisage that ecosystem services, at least when they are specifically couched in law with respect to the ecosystem they are part of, are utilities that can be legally dealt with as autonomous objects. But in fact there still remain two major difficulties, particularly in comparison with the credit card number.

The first difficulty is the lack of physical separation between the ecosystem services and the ecosystems. Indeed, while a credit card number can exist perfectly well independently of the card itself, this would not appear to be the case for ecosystem services, which can only be considered abstractly to be autonomous with respect to the ecosystems of which they are a part[14]. However this objection is debatable, given that the services provided appear to be perceptible independently of the property that generates them. Moreover, this is why they have been taken into account, particularly by Law. The real problem, then, lies in their fleeting existence, and hence in peoples' perception of them.

The second difficulty is indeed, the ephemeral nature of ecosystem services. While the credit card number survives its use, ecosystem services, ontologically speaking, are consumable. They only exist while they are being provided, which makes it difficult to grasp them, in legal or other terms. In this respect, they are more comparable with services, in terms of the Law, for which the regime appears to be adapted to their evanescence than with that of property in the strict sense of the term, something that implies a lengthy existence[15].

However, some ecosystem services appear in fact, in spite of their evanescence, to be as long-lasting as the property which generates them. For example, the carbon sequestration service provided by a meadow only disappears when the meadow does.

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[12] *Bull. crim*., n° 338.

[13] Cf. Cass. crim., 19 May 2004, *Bull. crim.*, n° 125: sanction, this time, of fraudulent use of the credit card itself. Although it was obviously handed in with the card, the number was not used by the author of the fraud. Classically, the author of the fraud only used (then abused) the card and its PIN code (which is different to its number!).

[14] See the intervention of Mme Vanuxem S., La nature des services écosystémiques en droit privé, [The nature of ecosystem services in private law] IDEX, T2SEC, IEJUC, Toulouse, 26 May 2016.

[15] See the intervention of M. Revet Th.,, La nature des services écosystémiques en droit privé, [The nature of ecosystem services in private law] IDEX, T2SEC, IEJUC, Toulouse, 26 May 2016.

The credit card number is property, but what about ecosystem services ? In the light of the previous discussion, it is still difficult to say, since the autonomy and stability that characterise the concept are still controversial for such services. This is even truer in that these services are common utilities (i.e. belonging to everybody) and are thus a particular case for the law of property.

1.2. The utility of Commons

The grouping of utilities in the same property, which characterises modern property, has a corollary which is, in fact, rather more the cause : the exclusivity of their benefit for the owner. This being the case, each of the utilities of a property, whether they be real or virtual, is only destined to benefit one person : the owner. In this sense the concept of Commons, which is nevertheless appealing, appears to be a contradiction, at least to the classical jurist, for whom Commons can only be "things", in other words inalienable or at least unalienated. Their definition and incorporation in a body of law are, moreover, precisely covered in Article 714 of the French Civil Code[16].

However, ecosystem services have beneficiaries, which even if not universal, are in any case several. They benefit, in particular, people rather than a single person. In the sense, apart from the fact that the owners of ecosystem supports from which ecosystem services derive, are not always in a position to stop other people from using them, it is conceivable, since this is the condition for using these services, that the owners be subject to positive obligations[17].

Nevertheless there are different situations in which owners already have to accept that others will benefit from part of the utilities of their property, either because they or the previous owner have committed to this or because they are obliged by law.

The most well-known case, without a doubt, is that of the right to reproduce property, which the Court of Appeals, in accordance with the logic of Article 544 of the French Civil Code, initially refused to withdraw from the owner's monopoly, before later obliging the owner to share it, given the impossibility of preventing people from photographing buildings in the street, unless the owner is able to demonstrate that this use creates an abnormal issue for him/her[18].

The comparison with ecosystem services appears to be relevant in that the image of the property seems to be as inseparable from the latter as are the services of the property which supports an ecosystem. But it also has limits: the image survives its reproduction whereas services sometimes disappear when they are consumed. Having said that, many of them appear in fact, as consubstantial to the property which generates them as might be the image of a property (e.g. flood control service or a carbon sequestration service).

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[16] "There are things which belong to nobody and which can be used by all (item 1). The way in which they can be used is regulated by law (Item 2)". Jurists are increasingly less bothered by this idea:
[17] See the intervention of M. Revet Th.,, La nature des services écosystémiques en droit privé, [The nature of ecosystem services in private law] op.cit.
[18] Cf. Cass. civ. 1ère, 10 May 1999, *Bull. civ.* I, n° 87, then Cass. ass. plén., 7 May 2004, *Bull. A. P.*, n° 10.

No matter what this difference may be, there is no reason why the utilities of a property cannot be shared between the owner and others, on condition, nevertheless, that all the utilities, or even most of them, are not taken away from owners otherwise they would no longer be the owner of an object, which consequently, would no longer be a property. The thing would be classified as part of the Commons. In this respect, a Commons utility should not totally exclude private utilities, otherwise property itself would be in jeopardy[19].

Ecosystem services do not prevent the owners of property supporting ecosystems that generate them from using them. They (the ecosystem services) should at least not limit this use too substantially, as this would infringe owners' rights. Should one not, then, plan some kind of payment for this utility flow, which has not been included in any texts up to now? This is all the more conceivable since, on this point, as on others, ecosystem services ultimately resemble other property objects into which it might consequently be possible to assimilate them

2. Characteristics that are common to ecosystem services and other property objects

As autonomous legal entities, since the law singles out the property they are derived from, ecosystem services are things *lato sensu* (in the broad sense); in short things coming from other things. As we have already said, "thing" is a word which, in French law, refers to everything that exists - even if it does not have any physical substance (with the exception of legal persons) and that as a thing, is destined to become the object of a right to which the legal persons will be entitled. Nevertheless for this to be the case, ecosystem services would have to be truly autonomous, whereas we have seen that the issue of whether or not they are separated from the property from which they are derived, is a matter of some controversy. Consequently there are two hypotheses to be envisaged: on the one hand, perceiving an ecosystem service as the usefulness of a thing (A) ; and, on the other, perceiving such a service as a utility which has become a thing (B).

2.1. A utility of a thing

Since modern property is as we have said, one and indivisible, the hypothesis of the service which would not constitute property, but would simply be one of its utilities, is the most reassuring. Two elements must then be combined to determine what ecosystem services are in legal terms: firstly, the link with the thing from which they are derived, and secondly, their common usefulness.

From such a combination one may infer several possible qualifications: common fruits, administrative easements, environmental regulation enforcement or easement obligations pertaining to the property in question.

[19] This would be contrary to, in particular, the Constitution : See for example, Déc. n° 81-132 DC of 16 Jan. 1982 and all the decisions which followed it.

First, Madame Vanuxem, starting from the observation that ecosystem services are, as gifts from nature, things that are generated regularly by other things without altering the substance of the latter, suggested qualifying them as natural fruits, in the sense given to this idea by the classic interpretation of Article 583 of the French Civil Code, which defines them as "those which are the spontaneous product of the Earth"[20]. She then specifies that this is on condition that the ecosystem services be perceived as separated from the property from which they are derived, which is conceivable, at least intellectually and also on the condition that these new fruits not be perceived as property, but as a new form of Commons.

There may however be two objections to this proposal, in spite of the virtue of it emphasising the link between ecosystem services and the property which supports the ecosystems from which they are derived. First of all, does the concept of fruit really include an interest which is thus separated from its major objective, which is to designate its owner? This owner in fact owns the property which generates the fruit. Then, might one truly imagine that a Commons thing could flourish as part of a thing which is alienated, in other words owned[21] Private property and Commons are contradictory, which appears to be difficult to justify logically.

Since one of the characteristics of ecosystem services may be to impose, for the common good, obligations on owners of property which generate them, the classification of administrative "easement" would appear to be the most suitable[22]. As an existing onus, in other words the obligation incumbent on an estate to be subject to a restriction which is intended to place this utility in the service of someone other than the owner, administrative easement appears to correspond to the mechanics of an ecosystem service. Administrative easement is effectively based on general usefulness, such that its beneficiary is inevitably an unspecified public. In short, there is a servient estate but not really a dominant estate.

Since ecosystem services may be supported by an estate for the general interest, they consequently limit, for the same reasons as we have seen, the prerogatives of the estate's owner. We can thus see that the forms of administrative easement are relevant. Moreover, there are already numerous easements based on environmental preoccupations, the fight against pollution and technological risks, the protection of architectural and urban heritage, or, again, on enhancing the value of landscapes.

On condition that ecosystem services not be perceived as existing onuses, it is still possible to consider that the protection obligations inherent in them could lead to environmental-regulation enforcement. However, in this case, if there are obligations, they are in fact due, if not by the estate, in any case through the estate. Thenceforth, since they are without a doubt, onuses, the hypothesis of environmental regulations enforcement must thus be discarded at least for the moment (the owner is not obliged, as yet, to request permission to use the services), because such an

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[20] Intervention of Mme Vanuxem S., La nature des services écosystémiques en droit privé, préc. [The nature of ecosystem services in private law, *op.cit.*]

[21] Objection put forward by M. Revet Th., La nature des services écosystémiques en droit privé, préc. [The nature of ecosystem services in private law, op.cit.]

[22] This proposal and the following ones are those of M. Revet Th., La nature des services écosystémiques en droit privé, préc. [The nature of ecosystem services in private law, op.cit.] In this case it is not an easement in the sense of civil law, since the service due "by the estate" is not proffered for the benefit of other estates, as this notion nevertheless implies (see Art. 637 C. civ.).

obligation to request permission might be an effective way of preventing any risk of these services being affected negatively.
Ecosystem services may, finally, be perceived as easement obligations that, because they are inherent in a thing, without which they could not manifest themselves, are transmitted from owner to owner. This approach to the problem seems to be even more relevant given that the "environmental easement obligation pertaining to the estate" has recently been written into law[23]. Indeed, Article L. 132-3 of the French Environmental Code stipulates henceforth that "the owners of real estate may sign a contract with a public authority, a public establishment or a legal person in private law, which is working to protect the environment, for the purpose of creating such obligations as they may consider necessary, which will also be passed on to future owners of the property, on condition that the aim of such obligations is to maintain, conserve, manage or restore biodiversity elements or ecological functions".

Ecosystem services may thus be understood as obligations for the successive owners of property supporting ecosystems to allow all or some of the others to benefit from their contribution to the ecosystems in question. These obligations are real in that they are effectively based on services provided by a property. However, the limit of such an analysis is immediately evident: unlike the actual environmental obligation, for which the beneficiary is perhaps universal, but the debtor's obligation is limitation, without a doubt, to the designated co-contractor - a public authority, etc. -, the ecosystem service sometimes has a debtor which is just as universal (shouldn't everyone allow ecosystems to produce their contribution to the common good?) - as is his/her beneficiary. Thenceforth it seems to be difficult to conceive of an actual obligation relationship, because, since an obligation, in the strict legal sense of the term, cannot be due to everyone - the well-known universal passive obligation of Planiol – nor can it be owed by everybody. All of this has of course to be relativised according to the services concerned.

From the moment owners of a property supporting an ecosystem have to suffer the use of services provided by it for the benefit of all, should they not be compensated, by a payment, for this deficit of utility for them, in other words demand "payments for ecosystem services" ? Even though this possibility (which for the moment is more a hypothesis than a fact) is interesting, in spite of the fact that one can already identify some positive obligations incumbent on the owners of property offering such services[24], it concerns more situations in which human intervention proves necessary, in other words environmental services rather than ecosystem services. Even though the ecosystem services could be provided without actively involving the owner, the distribution of utilities is not sufficient to warrant payment, particularly since the owner would not in any case be able to prevent it. The situation will perhaps be different when the owners of property supporting ecosystems are subject to actual positive obligations.

When the source of a common good is a property, the obligation to share it with everyone is a burden for the owner. It is from this point of view that it would appear possible to qualify ecosystem services as a sort of environmental easement imposed on the owners of property supporting ecosystems.

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[23] *Cf. infra* Alidor B., « Offsetting and ecosystem services »

[24] Cf. in this book Poumarède M., « Ecosystem services and contracts. What environmental obligations exist in contract law ? »,

However there is another way to explore the definition of ecosystem services from the opposite point of view, that of its beneficiaries. From their point of view, does not the utility thus conferred become a property, or at least, a thing ?

2.2. A utility which has become a thing

As we have already mentioned, it sometimes happens, in spite of the indivisible nature of modern property, that a utility is separated from a property and becomes, as an autonomous entity, a new property. Furthermore, it is then conceivable that this utility be attributed to another other than the owner of the property which generated it. This is true, in particular, for certain property recognised by case law from the European Human Rights Tribunal based on Article 1 of Protocol No. 1, in terms of which all people "are entitled to have their property respected", and, more particularly, by the judgement of *Öneryildiz versus Turkey,* handed down on 30 November 2004[25].

The decision made on this basis, led to the protection of a person who was illegally occupying a slum dwelling, for which, in principle he should not have been recognised as being the owner. The European Court nevertheless considered that "the authorities had *de facto* acknowledged that the claimant and his family were entitled to a heritage pertaining to their dwelling", and that this entitlement was "sufficiently important and recognized to constitute a substantial interest, hence a "property" in the sense of the norm expressed in the first sentence Article 1 of Protocol No. 1"[26]. Henceforth, even though the legitimacy of the alienation of the property could be questioned according to the traditional foundations of the law of property, its utility for the claimant, could not be brought into question. Furthermore, it was found that the interest of the thing thus determined, went beyond mere usefulness, but was in fact a need, which once identified, led to the confirmation of a highly ethereal "property".

To speak more plainly, since a person had an interest in his dwelling being perceived as his property, even thought it was founded on nothing other than the interest itself, in short on its utility the European Court confirmed that this was the case.

Does it not follow then that ecosystem services, beyond their usefulness, are needs for humanity ? In this sense, are they not then property belonging to all ?
The previous conception runs up against the logic of French law, which only authorises a common good on condition, inversely, that the thing concerned not be alienated. It is precisely for this reason that it is not alienated. Article 714 of the French Civil Code stipulates that "there are things which belong to nobody that can be used by all". This would be the case for ecosystem services, on condition that they be detached from their source, when they would become Commons.

However, as mentioned previously, we should then have to admit that the property, the estate containing the ecosystems, is able to produce the Commons, the ecosystem services. In other words, that the property would become inalienable from the moment the ecosystem services are separated from their base. The comparison made

[25] Req. n° 48939/99.
[26] §§ 127-129. §§ 127-129.

by Madame Vanuxem with the fruits[27] can then be envisaged, with the fruits becoming the property of the one who possesses them rather than of the owner.

But there are limits to this point of view: apart from the fact that for the fruits, this only involves naming another owner and not denying his/her existence as for Commons, the other owner is an owner because he/she has a relationship with the principal thing : he/she owns it, which means having the right to use it and is thus being entitled to assign the fruits to his/her upkeep. This is not at all the case for ecosystem services, which simply 'escape' their owner and the property from which they derived.

Is it then useful to make them into autonomous things ? Would it not be better to simply perceive them as mere common utilities of a property which remains the estate of a single person ?

Advancing carefully, given the necessity to respect the concept of property, which is the technique French legislators appear to have chosen for integrating ecosystem services in law, just as for any object for which one wishes to establish a legal subject/object relationship, it would be better to perceive these services as parts of a property rather than as property in their own right. In this sense, they represent a utility whose particularity is that they benefit several or all people, way beyond their single owner, who is not entitled, most of the time, to prevent them from being used. The body of law which governs them, in other words their current legal framework, appears effectively to depend on this characteristic.

[27] Intervention of Mme Vanuxem S., La nature des services écosystémiques en droit privé, préc. [The nature of ecosystem services in private law, *op.cit.*]

ECOSYSTEM SERVICES DELIVERED BY SOILS, FROM AN AGRONOMIC PERSPECTIVE : THE CASE OF CONSERVATION AGRICULTURE

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Agroecosystems form interfaces between humans, our practices and knowledge, and natural resources. Contrary to natural ecosystems, agroecosytems are markedly production-orientated, their biological and physicochemical parameters deliberately manipulated by humans in order to secure high-quantity and high-quality agricultural production, by means of, notably, irrigation, fertilisation and management of bioaggressors (weeds, diseases and pests). They are nonetheless ecosystems, being not only sites of material flow and biological interactions, but equally providers of habitats and services. Modern agriculture, founded upon an industrial paradigm, is now known to impact upon natural capital[1], and soils in particular[2]. Today, the limitations of these agricultural systems are becoming evident, particularly in light of the negative feedback loop created by their impact upon the environment (pollution and increasing scarcity of natural resources, emission of greenhouse gases, increased resistance of bioaggressors to crop protection agents, etc.). They are less resilient than they once were, and their sustainability is uncertain, particularly in the context of global changes.

If it is to be sustainable, the agriculture of the future must be less dependent upon non-renewable inputs, integrate biological and ecological processes, involve local stakeholders and promote collective action[3]. Today, these agroecological concerns are prompting an increasing number of farmers to reinvent their systems, in order to make them simultaneously profitable, resilient and consistent with their environment. This ecosystem approach to agriculture has thus given rise to a range of alternatives – such as organic farming, agroforestry, permaculture and soil conservation agriculture – to what are known as "conventional" systems, but also the integration of such practices as cover cropping, mixed cropping, integrated crop protection and conservation biological control. These agricultural systems are now institutionalised or recognised at various levels, and are together the key to the agroecological transition which it is necessary to begin.

Within this work reflecting upon the subject of soil protection, the authors have chosen to focus upon ecosystem services in soil conservation agriculture; this not due to an assumption of the greater agroecological efficiency of this form of agriculture as opposed to others – certain of which, such as organic farming, are well known for the biodiversity which they support – but because the paradigm of conservation agriculture is centred around the issue of soils. The authors will therefore evaluate the services provided by this agricultural system.

Soil conservation is a particularly interesting theme for the transition towards an agroecological commitment. Relegated by industrial agriculture to the role of an "inert" supporting medium[4] which may even be discarded (in soilless cultures), soil is nonetheless a full-blown ecosystem which accommodates vital ecological processes (see insert)[5].

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[1] Pretty J.N., Brett C., Gee D., Hine R.E., Mason C.F., Morison J.I.L., Raven H., Rayment M.D., Van Der Bijl G., 2000. An assessment of the total external costs of UK agriculture. *Agricultural Systems*, 65, 113-136.

2 See Chabert A. and Sarthou J.-P., "Agricultural soil, an essential yet neglected resource," above.

[3] Pretty J., 2008. Agricultural sustainability: concepts, principles and evidence. *Philosophical Transactions of the Royal Society B*, 363, 447-465.

4 In an interesting parallel, soil is also relegated to the position of "supporting medium" in civil law. See Bosc L., "Reflections on civil law and the integration of soil quality," above.

[5] Lemanceau P., Maron P.A., Mazurier S., Mougel C., Pivato B., Plassart P., Ranjard L., Revellin C., Tardy V., Wipf D., 2015. Understanding and managing soil biodiversity: a major challenge in agroecology. *Agronomy for Sustainable Development*, 35, 67-81.

Ecological processes in the context of soil

- Primary productivity: the capacity of a soil, natural or cultivated, to produce plant biomass for ultimate human use (such as human and animal food, textiles and fuel).
- Water purification and regulation: the capacity of a soil to extract toxic compounds from the water which it contains, and to take up, store and restore water for future human use, in a manner which prevents erosion and prolonged periods of drought or flooding.
- Carbon sequestration and regulation: the capacity of a soil to reduce the negative impacts upon the climate of an increase in greenhouse gas emissions into the atmosphere (for example, CO_2, CH_4 and N_2O).
- Provision of functional and inherent biodiversity: the multitude of organisms and ecological processes of a soil in interaction with all soil components, constituting a functionally crucial element of the natural capital of soil, and providing society with a wide range of cultural and other, as yet uncategorised, services.
- Provision and recycling of nutrients: the capacity of a soil to take up nutrients in the form of by-products; to provide nutrients, including its own inherent resources; to acquire nutrients from air and water; and to transfer these nutrients to plant foodstuffs.

These ecological processes, carried out simultaneously but at varying levels which differ according to the type of production system, are thus the foundation of diverse ecosystem services, and also inform the judgement of soil quality.

Tillage in order to loosen the soil, prepare the seedbed, manage weeds, increase fertility, etc., is an ancestral practice, dating back to some 3,000 years BC[6] and forming the basis of numerous agricultural systems. However, this systematic disturbance of the soil ecosystem was brought into question in the United States at the end of the 1930s, following the severe erosion and catastrophic climate events of that decade (the Dust Bowl), when the risks of erosion engendered by ploughing were highlighted for the first time[7]. It was thus that an alternative agricultural system, soil conservation agriculture, was developed in the United States, in order to combat soil erosion associated with drought and wind action, and, equally, to deal with growing economic pressure due to the rise in oil prices[8].

This new form of agriculture, built upon the paradigm of maintaining the natural cohesion of soil aggregates, hinges upon three themes which encompass a body of practices: maximum reduction of soil tillage (until the point of complete eradication), diversification of the species grown in crop rotation and permanent soil cover by cover crops or crop residues (fig. 1). The three are together intended to secure the protection and reinforcement, as much physical as biological, of soil health[9].

[6] Hobbs P., Sayre K., Gupta R., 2008. The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society B*, 363, 543-555.
[7] Faulkner E.H., 1943. *Plowman's Folly*, Michael Joseph Ltd, London, 175 p.
[8] Friedrich T., Derpsch R., Kassam A., 2012. Overview of the global spread of conservation agriculture. *Field Actions Science Reports. The Journal of Field Actions*, Special Issue 6, 0-7.
[9] Farooq M., Siddique K.H.M., 2015a. Conservation agriculture: concepts, brief history, and impacts on

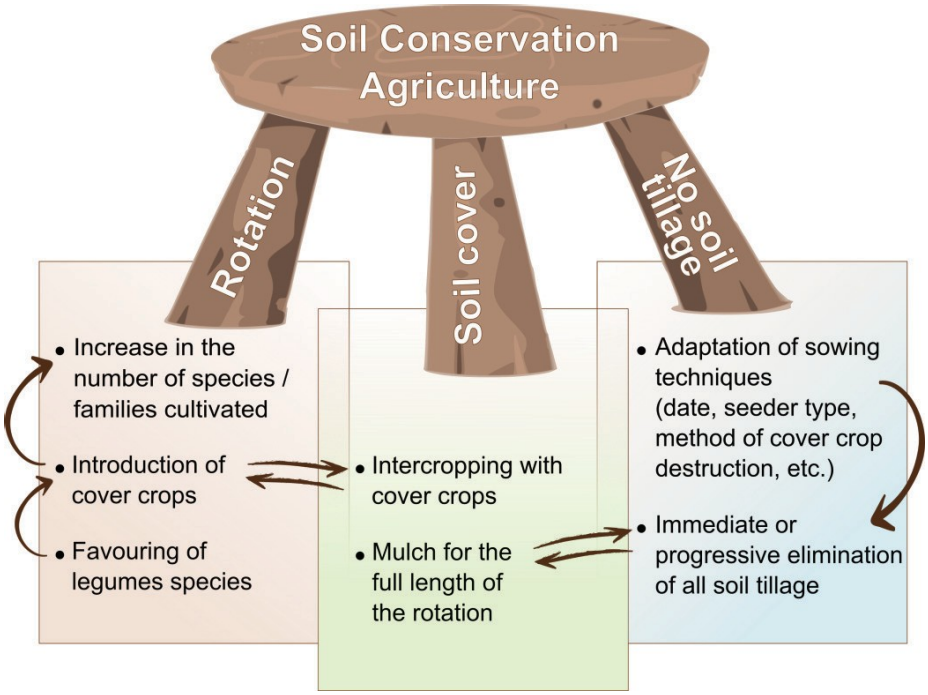

Figure 1. Features of conservation agriculture practice.

Although this alternative agricultural system currently benefits from neither institutional framework nor consumer recognition, it is undergoing notable development worldwide in very varied soil, and socio-economic, conditions [10] . Soil conservation agriculture is nevertheless almost entirely unknown to the wider public, and is poorly supported in France and in Europe, where its rate of adoption by farmers, while increasing, remains low.

However, the significant development of soil conservation agriculture in the past 40 years (notably in South America, North America and Australia[11]), as well as the recent scientific interest in this agricultural system, today gives us an overview of the associated benefits (also referred to as "positive externalities") for soil and beyond.

A copious scientific literature now supports the claim that promoting agricultural practices which respect soil health, such as those employed in soil conservation agriculture, has a positive effect not only upon soil ecosystem services, but also further afield, including in terms of productivity. Although the literature on soil conservation agriculture in France remains scarce, its potential is demonstrated – and the importance of developing better soil protection further underlined – by the recent results of a French study of the effects of this system upon different ecosystem services.

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agricultural systems. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds.), Springer International Publishing, Switzerland, 3-17; FAO, 2008. *Investing in Sustainable Agricultural Intensification. The Role of Conservation Agriculture*, A framework for action, Food and Agriculture Organization of the United Nations, Rome, 24 p.

[10] Derpsch R., Friedrich T., 2009. Development and current status of no-till adoption in the world. *In: Proceedings of the 18th Triennial Conference of the International Soil Tillage Research Organization (ISTRO)*, 15th-19th June, Izmir, Turkey.

[11] Kassam A., Friedrich T., Derpsch R., Kienzle J., 2015. Overview of the worldwide spread of conservation agriculture. *Facts Reports*, 8, 3-11.

1. Soil conservation agriculture and soil protection

Soil conservation agriculture is linked to soil health on at least three levels: by its reduction of soil susceptibility to erosion, by its transformation of soil communities and by carbon storage.

1.1. Reducing soil loss and risk of erosion

Having been the catalyst for the initial development of soil conservation agriculture, protection against soil erosion remains the chief objective of this form of agriculture. Beyond the basic limitation of soil loss from agricultural plots, reducing erosion has positive impacts upon water quality and soil fertility, as well as indirect and wide-ranging effects, such as upon climate change.

Although reduced soil tillage is often considered to be the cornerstone of soil conservation agriculture and is credited with the generation of various services, these are in fact assured by the implementation of the system's three principles in combination. The modification of soil organic matter (SOM) distribution is one of the principal impacts of this combination upon the soil: while SOM is distributed more or less evenly throughout the soil in conventional systems, from the surface layer to the plough-line, it is particularly concentrated in the surface layer in soil conservation agriculture, the resulting distribution bearing a stronger resemblance to that of a natural grassland or a forest than to that of a worked plot. This is largely due to the reduction of soil tillage, notably the absence of ploughing[12], while permanent soil cover represents the main source of increased SOM in the surface layer, often added to by the more substantial organic amendments applied in soil conservation agriculture in comparison to more conventional systems.

SOM accounts for less than 10% of soil components, yet is vital to its functioning; maintaining, notably, soil cohesion as soil particles are more strongly bound to one another in soils with a higher proportion of humus (dead, decomposed, stable SOM). Modification of SOM distribution within the soil profile and its increase in the surface layer thus improve soil structural stability, reduce the risk of erosion and increase bearing capacity[13]. In addition to its contribution of organic matter, the use of permanent soil cover in soil conservation agriculture positively affects erosion [14] by offering physical protection against the destructuration – mainly due to raindrop impact – of surface soil aggregates. The consequent soil stability limits the formation of surface seals (compaction of the first few millimetres of surface soil), which are at the root of erosive runoff in periods of rainfall. These positive effects are particularly manifest when direct seeding is implemented: this practice maximally

[12] Ploughing is a method of soil tillage, often the deepest (between 20 and 30 cm in France), consisting of the turning over and mixing of the entire arable layer, in order to loosen it, destroy weeds and bury crop residues. In Europe, this is used as an initial process which is then followed by more superficial interventions which refine soil structure and prepare the seedbed.

[13] Soane B.D., Ball B.C., Arvidsson J., Basch G., Moreno F., Roger-Estrade J., 2012. No-till in northern, western and south-western Europe: a review of problems and opportunities for crop production and the environment. *Soil Tillage Research*, 118, 66-87.

[14] Labreuche J., Le Souder C., Castilon P., Ouvry J.F., Real B., Germon J.C., De Tourdonnet S., 2007. *Évaluation des impacts environnementaux des Techniques culturales sans labour en France [Evaluation of the environmental impacts of no-plough cultivation techniques in France]*, Ademe-Arvalis-Institut du végétal-Inra-APCA-AREAS-ITB-Cetiom-IFVV, 400 p.; Soane B.D., Ball B.C., Arvidsson J., Basch G., Moreno F., Roger-Estrade J., 2012. No-till in northern, western and south-western Europe: a review of problems and opportunities for crop production and the environment. *Soil Tillage Research*, 118, 66-87.

reduces soil disturbance[15] and allows soil to evolve more rapidly[16] than it does in reduced - tillage farming[17]. Moreover, the elimination of ploughing in soil conservation agriculture allows not only the saving of energy (necessary traction power being reduced) but also increases working across slopes – equally successfully in reduced tillage farming as in direct seeding (depending on tool type, particularly of seeders) – thus further reducing ploughing erosion in hillside plots, where runoff is already a problem.

Nevertheless, the efficacy of soil conservation techniques in terms of erosion reduction varies greatly in relation to soil texture, being most conclusively effective upon clay soils[18] and appearing to be less so upon sandy soils[19]; results in loam soils are highly variable and dependant largely upon other parameters, such as which crops are included in rotation.

Reduced soil tillage in soil conservation agriculture is also the cause of profound transformations in soil structure. Physical soil quality is improved by the formation of biological porosity of surface soil, which assures better infiltration and thus improves crop recovery of rainwater and mineral elements (particularly phosphorous)[20]. These phenomena are slow to develop, and there is sometimes an increase in apparent density of the first 20-25 centimetres of soil in the first years following a switch to soil conservation agriculture. This is particularly the case in poorly managed systems, and translates to reduced aeration of the surface soil horizon and a consequent slowing of soil warming in spring, as well as increased surface hydromorphy. Together, these delay spring sowing. Porosity generally takes several years to re-establish, evidence of its biological, rather than mechanical, nature within these systems, where it is no longer created by the passage of tools (which creates fissuring and vertical macroporosity) but principally by the biological activity, notably of earthworms, promoted by soil conservation agriculture (creating interconnected macroporosity and microporosity). In soils containing more than 15-20% clay, climatic variation (alternating humidification/desiccation and/or freezing/thawing) also acts upon the soil structure by means of changing its volume, creating fissures and thus soil aggregate porosity. The result is

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[15] Direct seeding is a practice which consists of dispensing with, on a one-off or permanent basis, any form of soil preparation prior to sowing. The only mechanical soil disturbance is that generated by the seeder (of which there are models specific to this type of practice), to a depth of a few centimetres, during the opening and closing of the seed furrow. Direct seeding is considered to be the flagship practice of soil conservation agriculture, yet relies upon the implementation of the two other principles of soil conservation agriculture: permanent soil cover by chosen plants and their residues, and longer-term rotations.

[16] West T.O., Post W.M., 2002. Soil organic carbon sequestration rates by tillage and crop rotation: a global data analysis. *Soil Science Society of America Journal*, 66, 1930-1946.

[17] Reduced tillage techniques are cultivation methods based upon the reduction of any physical soil disturbance in order to prepare seedbeds or combat weeds. They therefore necessarily preclude ploughing (the turning over of soil by means of a plough), but also deep tillage in general, even if this does not involve the turning over of earth.

[18] Chichester F.W., Richardson C.W., 1992. Sediment and nutrient loss from clay soils as affected by tillage. *Journal of Environmental Quality*, 21, 587-590; Labreuche J., Le Souder C., Castilon P., Ouvry J.F., Real B., Germon J.C., De Tourdonnet S., 2007. *Évaluation des impacts environnementaux des Techniques culturales sans labour en France [Evaluation of the environmental impacts of no-plough cultivation techniques in France]*, Ademe-Arvalis-Institut du végétal-Inra-APCA-AREAS-ITB-Cetiom-IFVV, 400 p; Rhoton F.E., Shipitalo M.J., Lindbo D.L., 2002. Runoff and soil loss from midwestern and southeastern US silt loam soils as affected by tillage practice and soil organic matter content. *Soil Tillage Research*, 66, 1-11; Tebrügge F., Düring R.-A., 1999. Reducing tillage intensity: a review of results from a long-term study in Germany. *Soil Tillage Research*, 53, 15-28.

[19] Quinton J.N., Catt J.A., 2004. The effects of minimal tillage and contour cultivation on surface runoff, soil loss and crop yield in the long-term Woburn Erosion Reference Experiment on sandy soil at Woburn, England. *Soil Use and Management*, 20, 343-349.

[20] Soane B.D., Ball B.C., Arvidsson J., Basch G., Moreno F., Roger-Estrade J., 2012. No-till in northern, western and south-western Europe: a review of problems and opportunities for crop production and the environment. *Soil Tillage Research*, 118, 66-87.

that biological porosity is characterised, in relation to mechanical porosity, by its different architecture, and notably by a more significant interconnection between macropores and micropores. Porosity created by anecic earthworms (large worms which create winding but generally vertical paths between the soil surface and its deep horizons, situated more than one metre deep) is associated with a highly connected network of microporosity, promotes water drainage and increases the water reserve easily available to plants, as well as vertical (with the deep horizons) and horizontal hydraulic conductivity[21]. Soil also becomes less susceptible to the compaction caused by agricultural machinery, unless in very wet conditions, owing to its greater load bearing capacity, this in turn due to greater soil aggregate cohesion[22].

The physicochemical upheaval of soils in soil conservation agriculture is thus closely linked to the development of the biological communities which inhabit it. Indeed, the profound modification of the soil habitat causes a significant, yet still poorly understood, reorganisation of the communities dependent upon it (soil life), themselves partly responsible for the development of soil structure and for nutrient availability.

1.2. Promoting soil biodiversity and its ecological functions

Essentially, soil conservation agriculture modifies the composition and structures of soil communities, particularly at the interface between a soil and any crop residues left upon its surface[23]. This system changes soil habitats, spatially redistributing resources and, more directly, protecting certain organisms from the immediate risks of soil tillage (mechanical destruction, desiccation on the soil surface and exposure to predators). These modifications in turn influence the entire food chain of an agroecosystem – in terms of abundance or diversity of species, distribution and activity – thus affecting numerous ecosystem services, such as plant nutrition, soil structuring, control of bioaggressors, carbon storage and greenhouse gas emissions.[24]

Overall, soil conservation agriculture increases biological activity in surface soil, but may reduce it at greater depths, due to the fact that the burial of organic matter residues is not practised within this system. Numerous studies have been, and continue to be, carried out upon the impact of soil conservation agriculture upon soil life, and generally support the positive effect of its practices, despite substantial disparities which can be observed according to organism size[25]: macrofauna are significantly favoured by soil conservation agriculture, as compared to mesofauna and microfauna[26]. Large organisms are effectively more harshly

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[21] Soane B.D., Ball B.C., Arvidsson J., Basch G., Moreno F., Roger-Estrade J., 2012. No-till in northern, western and south-western Europe: a review of problems and opportunities for crop production and the environment. *Soil Tillage Research*, 118, 66-87.

[22] Labreuche J., Le Souder C., Castilon P., Ouvry J.F., Real B., Germon J.C., De Tourdonnet S., 2007. *Évaluation des impacts environnementaux des Techniques culturales sans labour en France [Evaluation of the environmental impacts of no-plough cultivation techniques in France]*, Ademe-Arvalis-Institut du végétal-Inra-APCA-AREAS-ITB-Cetiom-IFVV, 400 p.

[23] Tebrügge F., Düring R.-A., 1999. Reducing tillage intensity: a review of results from a long-term study in Germany. *Soil Tillage Research*, 53, 15-28.

[24] Vieublé L., 2015. Valoriser la composante biologique pour entretenir et améliorer la fertilité chimique et physique des sols. [Recognising the biological component in order to maintain and improve physicochemical soil fertility.] Continuing education at AgroParisTech Maroc, Paris.

[25] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76; Van Capelle C., Schrader S., Brunotte J., 2012. Tillage-induced changes in the functional diversity of soil biota: A review with a focus on German data. *European Journal of Soil Biology*, 50, 165-181; Wardle D.A., 1995. Impacts of disturbance on detritus food webs in agro-ecosystems of contrasting tillage and weed management practices. *Advances in Ecological Research*, 26, 105-185.

[26] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76; Wardle D.A., 1995.

impacted (death of individuals, exposure to predators, etc.) by the mechanical soil disturbance found in conventional systems, and benefit from the redistribution of resources and habitats of soil conservation agriculture. In particular, soil conservation agriculture has a proven positive impact upon earthworms, the veritable architects of soil, indispensable to its natural structuring. Absence of mechanical soil disturbance and an increase in the proportion of SOM in the surface soil modify the distribution of resources within the soil profile, and the habitat conditions (air and water flow) of soil life. Mulch, consisting of crop residues and contributing to this surface SOM, provides shelter and a food source for surface fauna. Mulch also slows the drying out of soil at the end of spring and delays the end-of-autumn freeze, thus allowing gentler transitions, favourable to earthworm development, between seasons. Worms can thus feed and reproduce for longer and likely better acclimatise to the changing of the seasons. Numerous studies and field observations further confirm that the number of earthworms in an agricultural plot increases with a reduction in the intensity of soil tillage[27]. Epigeic and anecic worms, both of which feed on the surface, are particularly supported by practices which keep crop residues on the soil surface. Incidentally, it is not uncommon for recording in conventional systems to list no epigeic worms (already rare in agroecosystems) or anecic worms. Species such as *Lumbricus terrestris*, an anecic worm common in Europe, can disappear completely after numerous years of ploughing, due to their very low rate of reproduction and high sensitivity to soil disturbance and the burying of crop residues. Given that earthworms recolonise a plot from the surrounding area, their reappearance is far from guaranteed in regions which have been very intensively farmed for many years, even after a switch to soil conservation agriculture[28].

Microfauna and microflora, however, are not systematically encouraged in all their diversity by soil conservation agriculture. Nevertheless, changes in soil physicochemical properties in soil conservation agriculture significantly influence the distribution of species and the balance between bacteria and fungi, as compared to ploughed systems[29]. These organisms being closely linked to soil fertility, plant capacity to extract the elements necessary for their development and plant-health risks, these equilibriums are of utmost importance to production stability[30].

In comparison with a more homogeneous distribution throughout the depth of a ploughed soil, direct seeding results in a marked stratification of soil micro-organisms (in terms of both quantity and activity) which follows the distribution of SOM[31]: fungi dominate from 0-5 cm, a layer monopolised by bacteria in ploughed systems[32], and biomass and microbial activity in the layer from 0-10 cm are both significantly higher than in ploughed systems, but lower or comparable in subsequent layers[33]. This has repercussions upon the speed at which carbon and nitrogen are mineralised, and thus upon their availability to plants. While the rate of

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Impacts of disturbance on detritus food webs in agro-ecosystems of contrasting tillage and weed management practices. *Advances in Ecological Research*, 26, 105-185.

[27] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76.

[28] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76.

[29] Doran J.W., 1980. Soil microbial and biochemical changes associated with reduced tillage. *Soil Science Society of America Journal*, 44, 765-771; Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76.

[30] Ishaq S.L., 2017. Plant-microbial interactions in agriculture and the use of farming systems to improve diversity and productivity. *AIMS Microbiology*, 3, 335-353.

[31] Andrade D.S., Colozzi-filho A., Giller K.E., 2003. The soil microbial community and soil tillage. *In: Soil Tillage in Agroecosystems* (A. El Titi, ed.), CRC Press, 51-81.

[32] Frey S.D., Elliott E.T., Paustian K., 1999. Bacterial and fungal abundance and biomass in conventional and no-tillage agroecosystems along two climatic gradients. *Soil Biology and Biochemistry*, 31, 573-585.

[33] Wright A.L., Hons F.M., Matocha J.E., 2005. Tillage impacts on microbial biomass and soil carbon and nitrogen dynamics of corn and cotton rotations. *Applied Soil Ecology*, 29, 85-92.

mineralisation is higher in surface soil layers in this system, owing to higher microbial activity, the opposite is true in deep layers (below 10 or 15 cm), meaning that the overall speed of mineralisation of carbon and nitrogen is appreciably inferior to that of ploughed systems[34]. To this is added an overall evolution of the bacteria and fungi community towards species better adapted to the new quality and distribution of SOM. Soil conservation agriculture encourages the growth of copiotrophic actinomycetes (a Eubacteria adapted to high concentrations of nutrients, particularly of carbon), which develop slowly and are involved in the gradual deterioration of fresh organic matter. It also stimulates growth of *Azotobacter* and *Nitrospira* bacteria, all heavily involved in the nitrogen cycle [35] and indicators of a stable environment. Although bacteria predominate and present a more significant genetic variety overall in ploughed and intensively tilled systems[36], nitrifying and anaerobic bacteria are more diverse in direct seeding[37], thus allowing the provision of mineral nitrogen within humified SOM, which can be found even in those soil horizons or compartments with poor or no oxygen supply. Owing to the greater humidity of soil beneath mulch and the lack of mechanical disturbance[38], ascomycete fungi (which break down less recalcitrant fresh organic matter[39]) and mycorrhizal fungi[40] are particularly encouraged in the first centimetres of soil under soil conservation agriculture. The extent of mycorrhizal colonisation of plant roots is therefore greater in direct seeding[41], which supports root exploration, and therefore root capacity to capture water and nutrients, while reinforcing plants' natural defences [42] . In ploughed or intensively tilled systems, however, it is basidiomycete fungi, capable of breaking down recalcitrant organic matter, which are encouraged. This brings into question the sustainability of such systems, as, by breaking down this more stable SOM – fresh SOM being rapidly consumed by the bacteria which are more numerous in these systems – these fungi gradually diminish the SOM responsible for better soil structure and long-term soil carbon storage. Overall, the bacterial and fungal communities encouraged under soil conservation agriculture allow the slower degradation of SOM and a more gradual supply of mineral elements to plants throughout the duration of their development. Furthermore, the 1:1 ratio of fungi to bacteria found in ploughed plots becomes 3:1 in a plot under soil conservation agriculture[43], thus approaching that of natural ecosystems, where the domination of fungi can reach 100:1 in forest soils. Numerous fungal

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[34] Grigera M.S., Drijber R.A., Wienhold B.J., 2007. Redistribution of crop residues during row cultivation creates a biologically enhanced environment for soil microorganisms. *Soil Tillage Research*, 94, 550-554; Pekrun C., Kaul H.P., Claupein W., 2003. Soil tillage for sustainable nutrient management. *In: Soil Tillage in Agroecosystems* (A. El Titi, ed.), CRC Press LLC, Boca Raton, 83-113.

[35] *Azotobacter* convert atmospheric nitrogen into organic molecules and *Nitrospira* transform nitrite ions into nitrate ions.

[36] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76.

[37] Drijber R.A., Doran J.W., Parkhurst A.M., Lyon D.J., 2000. Changes in soil microbial community structure with tillage under long-term wheat-fallow management. *Soil Biology and Biochemistry*, 32, 1419-1430; Ibekwe A.M., Kennedy A.C., Frohne P.S., Papiernik S.K., Yang C.H., Crowley D.E., 2002. Microbial diversity along a transect of agronomic zones. *FEMS Microbiology Ecology*, 39, 183-191.

[38] Spedding T.A., Hamel C., Mehuys G.R., Madramootoo C.A., 2004. Soil microbial dynamics in maize-growing soil under different tillage and residue management systems. *Soil Biology and Biochemistry*, 36, 499-512.

39 Recalcitrant organic matter is the very stable part of a soil, rich in complex sugars such as lignin and tannins, which improves its physical properties and stores carbon long-term (the "carbon sink" of soils).

[40] Drijber R.A., Doran J.W., Parkhurst A.M., Lyon D.J., 2000. Changes in soil microbial community structure with tillage under long-term wheat-fallow management. *Soil Biology and Biochemistry*, 32, 1419-1430.

[41] McGonigle T.P., Miller M.H., Young D., 1999. Mycorrhizae, crop growth, and crop phosphorus nutrition in maize-soybean rotations given various tillage treatments. *Plant Soil*, 210, 33-42.

[42] Selosse M.A., Baudoin E., Vandenkoornhuyse P., 2004. Symbiotic microorganisms, a key for ecological success and protection of plants. *Comptes Rendus Biologies [Biologies Reports]*, 327, 639-648.

[43] Brady N.C., Weil R.R., 2008. *The Nature and Properties of Soils*, Pearson Prentice Hall, New Jersey, 621 p.

species develop in the form of filament networks (mycelium) which are particularly damaged by mechanical soil tillage, thus significantly reducing the quantity and diversity of this type of fungi in conventional systems. These mycelium networks play a key role in soil structural stability[44] and notably in long-term carbon storage[45].

As for the mesofauna (insects, nematodes, springtails, etc.), the effects of various practices, and the consequences upon associated processes and thus ecosystem services, remain difficult to judge for this group of soil life. In 1995, David A. Wardle[46] compiled the results of 106 previously conducted studies and underlined the significant variations, particularly regarding these fauna of intermediate size, which could be observed from study to study, according to intensity of soil tillage and residue burial, time of year, crop studied, and soil and climate conditions. In addition, he highlighted the importance of practices linked to the reduction of soil tillage, but could not clearly identify farms truly practising soil conservation agriculture in keeping with its three principles, due to the definition of soil conservation agriculture at that time (to an extent, this remains an issue today). More recent studies conducted in the last decade continue to support David Wardle's conclusions. Christine Van Capelle *et al.*[47], who compiled the German studies on the subject in 2012, have concluded that impacts, particularly long-term, upon soil biodiversity remain little understood, notably the interplay between practices, soil texture and crop type,

1.3. Carbon storage in soil conservation agriculture

Agriculture is in part responsible (as are the majority of human activities) for greenhouse gas emissions, and thus for the release of fossil carbon[48] into the atmosphere, where the carbon accumulates in its mineral form (CO_2, carbon dioxide), intensifying pollution and global warming[49]. Soils can lose up to 75% of their organic carbon through intensive agriculture[50], which loss must be compensated by exogenous contributions, sometimes costly, in order to maintain productivity. And yet, in their natural state, soils are an indispensable carbon sink; it is currently estimated that appropriate soil management within agroecosystems could allow the recapture of between 1.2 and 3.1 billion tonnes of carbon per year[51]. Storage is primarily in the surface horizon, but is now known to also occur in deeper zones, below 30 cm[52]. The

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[44] Guggenberger G., Frey S.D., Six J., Paustian K., Elliott E.T., 1999. Bacterial and fungal cell-wall residues in conventional and no-tillage agroecosystems. *Soil Science Society of America Journal*, 63, 1188-1198.

[45] Bailey V.L., Smith J.L., Bolton H.J., 2002. Fungal-to-bacterial ratios in soils investigated for enhanced C sequestration. *Soil Biology and Biochemistry*, 34, 997-1007.

[46] Wardle D.A., 1995. Impacts of disturbance on detritus food webs in agro-ecosystems of contrasting tillage and weed management practices. *Advances in Ecological Research*, 26, 105-185.

[47] Van Capelle C., Schrader S., Brunotte J., 2012. Tillage-induced changes in the functional diversity of soil biota: A review with a focus on German data. *European Journal of Soil Biology*, 50, 165-181.

[48] Stable carbon which is gradually stored in the subsoil over the span of geological eras.

[49] IPCC, 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution du 2nd groupe travail au 5e rapport d'évaluation du Giec (Intergovernmental Panel on Climate Change) [Contribution to the fifth evaluation report of Giec (Intergovernmental Panel on Climate Change) by the second working group], United Kingdom and New York, 1132 p.

[50] Lal R., 2011. Sequestering carbon in soils of agro-ecosystems. *Food Policy*, 36, S33-S39.

[51] Lal R., 2011. Sequestering carbon in soils of agro-ecosystems. *Food Policy*, 36, S33-S39; Paustian K., Lehmann J., Ogle S., Reay D., Robertson P., Smith P., 2016. Climate-smart soils. *Nature*, 532, 49-57.

[52] De Moraes Sa J.C., Lal R., 2009. Stratification ratio of soil organic matter pools as an indicator of carbon sequestration in a tillage chronosequence on a Brazilian Oxisol. *Soil Tillage Research*, 103, 46-56; Mulder V.L., Lacoste M., Richer-de-Forges A.C., Martina M.P., Arrouays D., 2016. National *versus* global modelling the 3D distribution of soil organic carbon in mainland France. *Geoderma*, 263, 16-34; Plaza-Bonilla D., Nolot J.M., Passot S., Raffaillac D., Justes E., 2016. Grain legume-based rotations managed under conventional tillage need cover crops to mitigate soil organic matter losses. *Soil Tillage Research*, 156, 33-43.

contribution of organic matter, via amendments, crop residues or cover crops, is the main vehicle of this storage, allowing the storage of between 0.3 and 0.5 tonnes of carbon per hectare per year, with or without soil tillage[53], and up to 0.5-0.9 tonnes when all three principles of soil conservation agriculture are applied[54]. John M. Baker *et al.*[55] thus estimated in 2007 that 25 billion tonnes of carbon could be recaptured in 50 years if all arable land were converted to soil conservation agriculture.

It should be particularly noted that it is the synergy of the three pillars of soil conservation agriculture which allows this storage[56]. Indeed, non-tillage, although important for the preservation of soil aggregate structure, exerts an only marginally positive effect upon carbon storage[57] if not practised in conjunction with cover cropping, the restitution of crop residues and well-planned rotation. For example, the inclusion in a rotation of varieties or species with a significant root mass allows carbon to be deposited at a deeper level within the soil profile, where element turnover is lower, thus supporting long-term carbon storage[58]. Year-long carbon sequestration is assured by cover crops providing an avenue of carbon storage during periods of intercropping; with well-chosen species, these also allow synergy with the nitrogen cycle[59].

In addition to being conducive to the reduction of greenhouse gases, carbon storage in agricultural soils contributes to the qualitative and quantitative improvement of the water cycle; to the restoration of soils, ecosystems and their associated biodiversity; and to global food security. Indeed, an increase in soil organic carbon is instrumental in soil quality and, as such, in the production of foodstuffs: in developing countries, a gain of one tonne of carbon per hectare per year would be accompanied by an average gain of 32 million tonnes of cereals per year[60].

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[53] Dimassi B., Mary B., Wylleman R., Labreuche J., Couture D., Piraux F., Cohan J.P., 2014. Long-term effect of contrasted tillage and crop management on soil carbon dynamics during 41 years. *Agriculture, Ecosystems and Environment*, 188, 134-146; Lal R., 2015a. Soil carbon sequestration and aggregation by cover cropping. *Journal of Soil and Water Conservation*, 70, 329-339.

[54] Olson K., Ebelhar S.A., Lang J.M., 2014. Long-term effects of cover crops on crop yields, soil organic carbon stocks and sequestration. *Open Journal of Soil Science*, 4, 284-292; Powlson D.S., Stirling C.M., Thierfelder C., White R.P., Jat M.L., 2016. Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems? *Agriculture, Ecosystems and Environment*, 220, 164-174.

[55] Baker J.M., Ochsner T.E., Venterea R.T., Griffis T.J., 2007. Tillage and soil carbon sequestration. What do we really know? *Agriculture, Ecosystems and Environment*, 118, 1-5.

[56] Lal R., 2015b. A system approach to conservation agriculture. *Journal of Soil and Water Conservation*, 70, 82A-88A; Pisante M., Stagnari F., Acutis M., Bindi M., Brilli L., Di Stefano V., Carozzi M., 2015. Conservation agriculture and climate change. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 579-620.

[57] De Moraes Sa J.C., Lal R., 2009. Stratification ratio of soil organic matter pools as an indicator of carbon sequestration in a tillage chronosequence on a Brazilian Oxisol. *Soil Tillage Research*, 103, 46-56; Powlson D.S., Stirling C.M., Jat M.L., Gerard B.G., Palm C.A., Sanchez P.A., Cassman, K.G., 2014. Limited potential of no-till agriculture for climate change mitigation. *Nature Climate Change*, 4, 678-683.

[58] Kell D.B., 2012. Large-scale sequestration of atmospheric carbon *via* plant roots in natural and agricultural ecosystems: why and how. *Philosophical Transactions of the Royal Society B,* 367, 1589-1597; Paustian K., Lehmann J., Ogle S., Reay D., Robertson P., Smith P., 2016. Climate-smart soils. *Nature*, 532, 49-57.

[59] Lal R., 2015c. Cover cropping and the "4 per Thousand" proposal. *Journal of Soil and Water Conservation*, 70, 141A-141A.

[60] Lal R., 2011. Sequestering carbon in soils of agro-ecosystems. *Food Policy*, 36, S33-S39.

2. Soil conservation agriculture and conservation of services beyond soil

While the positive effects of soil conservation agriculture practices upon soil health are to be expected, the indirect impacts of soil preservation practices are equally significant, thus rendering the system a factor in the response to issues linked to climate change, the combating of crop bioaggressors and the maintenance of agricultural productivity.

2.1. A lever in the face of climate change

In light of the impact of our activities upon the climate, humanity is currently faced with two imperatives: the mitigation of this impact and our adaptation to the changes which we have engendered. By way of its modification of crop phenology, physiology and productivity and its complication of water management, climate change has significant repercussions for agriculture. Soil conservation agriculture, largely owing to its effects upon soil, is conducive not only to adaptation to climate change but also to its mitigation[61].

As discussed above, soil conservation agriculture has great potential as a means of storing atmospheric carbon and thus for reducing the global warming risks associated with greenhouse gases such as CO_2. To this can be added the system's reductions in fossil fuel consumption and greenhouse gas emissions as a result of fewer tillage passes and more integrated fertiliser management (owing to organic matter management and particularly to leguminous cover crops)[62]. Fuel consumption in soil conservation agriculture is reduced in this way by 60% in comparison to conventional systems[63], and a reduction in emissions of N_2O and CH_4 (other greenhouse gases) also occurs after several years of well-managed soil conservation agriculture[64], primarily due to the development of soil bacterial activity.

Soil conservation agriculture is itself more resilient in the face of climate change, in view of the reliability of its productivity in contexts of hydric stress[65]. Changes in physical, chemical and biological soil properties associated with this system allow an improvement in water supply and stabilise production by mitigating the effects of drought or severe weather conditions [66] , both likely to become more frequent in future. This resilience can be

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[61] Pisante M., Stagnari F., Acutis M., Bindi M., Brilli L., Di Stefano V., Carozzi M., 2015. Conservation agriculture and climate change. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 579-620.

[62] Holland J.M., 2004. The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agriculture, Ecosystems and Environment*, 103, 1-25.

[63] SoCo Project Team, 2009. Final report on the project Sustainable Agriculture and Soil Conservation (SoCo), European Commission, Scientific and Technical Research series, 172 p.

[64] Dendooven L., Gutiérrez-Oliva V.F., Patiño-Zúñiga L., Ramírez-Villanueva D.A., Verhulst N., Luna-Guido M., Marsch R., Montes-Molina J., Gutiérrez-Miceli F.A., Vásquez-Murrieta S., Govaerts B., 2012. Greenhouse gas emissions under conservation agriculture compared to traditional cultivation of maize in the central highlands of Mexico. *Science of the Total Environment*, 431, 237-244; Palm C., Blanco-Canqui H., DeClerck F., Gatere L., Grace P., 2014. Conservation agriculture and ecosystem services: an overview. *Agriculture, Ecosystems and Environment*, 187, 87-105; Six J., Ogle S.M., Breidt J., Conant R.T., Mosier A.R., Paustian K., 2004. The potential to mitigate global warming with no-tillage management is only realized when practised in the long term. *Global Change Biology*, 10, 155-160.

[65] Pittelkow C.M., Liang X., Linquist B.A., van Groenigen K.J., Lee J., Lundy M.E., van Gestel N., Six J., Venterea R.T., van Kessel C., 2014. Productivity limits and potentials of the principles of conservation agriculture. *Nature*, 517, 365-368.

[66] Holland J.M., 2004. The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agriculture, Ecosystems and Environment*, 103, 1-25.

particularly attributed to the benefits gained from the contribution of organic matter to soil[67]; to the stability of surface soil aggregates, which prevents soil sealing during periods of heavy rainfall; to the crop residues which improve water storage and slow runoff and to biological microporosity and mesoporosity, which maximise water retention for use during drought[68].

2.2. Biological regulations

Numerous services referred to as "regulating"[69] or "regulation" services form the basis of agricultural production. The value of global food production reliant upon animal pollination, for example, was estimated to be EUR 153 billion in 2005[70], insect pollinators being responsible for the reproduction of 84% of plants cultivated for human consumption in Europe and 65-70% globally[71], constituting 35% of total global food production[72]. Likewise, biocontrol of pests by their natural enemies is one of the most important input services[73] of agroecosystems[74]. These beneficial organisms – predators and parasitoids – are responsible for 50% of pest control worldwide, in contrast to 40% by genetic factors and only 10% by pesticides[75]; on a global scale, they alone reduce pest-associated losses by USD 100 billion per year[76].

The use of insecticides and, to a lesser degree, fungicides is detrimental to beneficial insects such as pollinators or the natural enemies of crop pests[77]. Within the framework of integrated crop protection and biological control by conservation, the use of these inputs is therefore the primary practice to be avoided in order to promote the abundance and diversity of natural

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[67] Song Z., Gao H., Zhu P., Peng C., Deng A., Zheng C., Mannaf M.A., Islam M.N., Zhang W., 2015. Organic amendments increase corn yield by enhancing soil resilience to climate change. *The Crop Journal*, 3, 110-117.

[68] Pisante M., Stagnari F., Acutis M., Bindi M., Brilli L., Di Stefano V., Carozzi M., 2015. Conservation agriculture and climate change. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 579-620.

[69] As used in MEA, 2005. *Ecosystems and Human Well-being: Biodiversity Synthesis*, Millennium Ecosystem Assessment, World Resources Institute, Washington, DC, 100 p.

[70] Gallai N., Salles J.-M., Settele J., Vaissière B.E., 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics*, 68, 810-821; Klein A.-M., Vaissière B.E., Cane J.H., Steffan-Dewenter I., Cunningham S.A., Kremen C., Tscharntke T., 2007. Importance of pollinators in changing landscapes for world crops. *Philosophical Transactions of the Royal Society B*, 274, 303-313.

[71] Williams I.H., 1994. The dependences of crop production within the European Union on pollination by honey bees. *Agricultural Zoology Reviews*, 6, 229-257.

[72] Klein A.-M., Vaissière B.E., Cane J.H., Steffan-Dewenter I., Cunningham S.A., Kremen C., Tscharntke T., 2007. Importance of pollinators in changing landscapes for world crops. *Philosophical Transactions of the Royal Society B*, 274, 303-313.

[73] See Glossary.

[74] Fiedler A.K., Landis D.A., Wratten S.D., 2008. Maximizing ecosystem services from conservation biological control: the role of habitat management. *Biological Control*, 45, 254-271; Gurr G.M., Wratten S.D., Luna J.M., 2003. Multi-function agricultural biodiversity: pest management and other benefits. *Basic and Applied Ecology*, 4, 107-116; Wilby A., Thomas M.B., 2002. Natural enemy diversity and pest control: patterns of pest emergence with agricultural intensification. *Ecological Letters*, 5, 353-360.

[75] Pimentel D., Burgess M., 2014. Environmental and economic costs of the application of pesticides primarily in the United States. *In: Integrated Pest Management* (D. Pimentel, R. Peshin, eds), Springer, 47-71.

[76] Pimentel D., Wilson C., McCullum C., Huang R., Dwen P., Flack J., Tran Q., Saltman T., Cliff B., 1997. Economic and environmental benefits of biodiversity. *Bioscience*, 47, 747-757.

[77] Lavorel S., Sarthou J.-P., 2008. Intérêts de la biodiversité pour les services rendus par les écosystèmes. [The relevance of biodiversity to services delivered by ecosystems] *In: Agriculture et biodiversité : des synergies à valoriser [Agriculture and biodiversity: synergies to promote]* (X. Le Roux, R. Barbault, J. Baudry, F. Burel, I. Doussan, E. Garnier, F. Herzog, S. Lavorel, R. Lifran, J. Roger-Estrade, J.-P. Sarthou, M. Trommetter, eds), Expertise scientifique collective, rapport Inra [INRA collective scientific expert report], Paris, 738 p.; Oerke E.-C., 2006. Crop losses to pests. *Journal of Agricultural Science*, 144, 31-43.

enemies within crop systems[78], and the biological pest control which they provide[79]. The positive impact of organic farming (which prohibits the use of synthetic biocidal products) upon these organisms is now incontrovertible[80].

However, much less understood or studied is the potential advantage of the preservation of soils by soil conservation agriculture as regards the biological regulations taking place within them. Nonetheless, the negative effects of intense soil tillage, particularly ploughing (i.e., soil inversion), upon soil arthropods are well-documented[81], and this method has actually been used for centuries to control field pests in general and soil pests in particular. In the case of beneficial insects, several studies have shown a greater diversity of predators, notably carabid beetles and spiders, in direct seeding or reduced tillage plots than in those subjected to regular ploughing [82] , species of large size again being those most affected by soil tillage [83] . Concurrently, surface crop residues and permanent cover crops offer a more complex environment (to the benefit of spiders[84]), shelter and a buffered microclimate favourable to the development of numerous arthropods at different stages of their life cycle and times of year[85]. To this is added alternative prey, encouraged by increased SOM, crop residues and unburied weed seeds[86].

There is little research concerning the effects of soil management on aerial natural enemies, and still less in the case of pollinators. However, similar beneficial effects of reduced tillage have been shown in the case of a species of wild bee which pollinates squashes[87], as well as for ladybirds[88], parasitoid wasps of the Trichogrammatidae family[89], flying beetles, hoverfly

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[78] Ehler L.E., 2006. Integrated pest management (IPM): definition, historical development and implementation, and the other IPM. *Pest Management Science*, 62, 787-789.

[79] Howarth F.G., 2000. Non-target effects of biological control agents. *In: Biological Control: Measures of Success* (G. Gurr, S.D. Wratten, eds), Kluwer Academic Publishers, Dordrecht, The Netherlands, 369-403; Jonsson M., Wratten S.D., Landis D.A., Gurr G.M., 2008. Recent advances in conservation biological control of arthropods by arthropods. *Biological Control*, 45, 172-175.

[80] Winqvist C., Ahnstrom J., Bengtsson J., 2012. Effects of organic farming on biodiversity and ecosystem services: taking landscape complexity into account. *Annals of the New York Academy of Science*, 1249, 191-203.

[81] Kladivko E.J., 2001. Tillage systems and soil ecology. *Soil Tillage Research*, 61, 61-76; Legrand A., Gaucherel C., Baudry J., Meynard J.M., 2011. Long-term effects of organic, conventional, and integrated crop systems on Carabids. *Agronomy for Sustainable Development*, 31, 515-524; Shearin A.F., Reberg-Horton S.C., Gallandt E., 2007. Direct effects of tillage on the activity density of ground beetle (Coleoptera: Cababidae) weed seed predators. *Environmental Entomology*, 36, 1140-1146; Witmer J.E., Hough-Goldstein J.A., Pesek J.D., 2003. Ground-dwelling and foliar arthropods in four cropping systems. *Environmental Entomology*, 32, 366-376.

[82] Holland J.M., Luff M.L., 2000. The effects of agricultural practices on Carabidae in temperate agroecosystems. *Integrated Pest Management Reviews*, 5, 109-129; Kosewska A., Skalski T., Nietupski M., 2014. Effects of conventional and non-inversion tillage systems on the abundance and some life history traits of carabid beetles (Coleoptera: Carabidae) in winter triticale fields. *European Journal of Entomology*, 111, 669-676; Marti O.G., Olson D.M., 2007. Effect of tillage on cotton aphids (Homoptera: Aphididae), pathogenic fungi, and predators in South Central Georgia cotton fields. *Journal of Entomological Science*, 42, 354-367.

[83] Hatten T.D., Bosque-Pérez N.A., Labonte J.R., Guy S.O., Eigenbrode S.D., 2007. Effects of tillage on the activity density and biological diversity of Carabid beetles in spring and winter crops. *Environmental Entomology*, 36, 356-368.

[84] Rypstra A.L., Carter P.E., Balfour R.A., Marshall S.D., 1999. Architectural features of agricultural habitats and their impact on the spider inhabitants. *The Journal of Arachnology*, 27, 371-377.

[85] Roger-Estrade J., Anger C., Bertrand M., Richard G., 2010. Tillage and soil ecology: partners for sustainable agriculture. *Soil Tillage Research*, 111, 33-40.

[86] Holland J.M., 2004. The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agriculture, Ecosystems and Environment*, 103, 1-25.

[87] Shuler R.E., Roulston T.H., Farris G.E., 2005. Farming practices influence wild pollinator populations on squash and pumpkin. *Journal of Economical Entomology*, 98, 790-795.

[88] Marti O.G., Olson D.M., 2007. Effect of tillage on cotton aphids (Homoptera: Aphididae), pathogenic fungi, and predators in South Central Georgia cotton fields. *Journal of Entomological Science*, 42, 354-367.

[89] Sharley D.J., Hoffmann A.A., Thomson L.J., 2008. The effects of soil tillage on beneficial invertebrates

larvae and lacewings[90]. Certain of these species, while not directly dependent upon the soil in principle, benefit from changes to the agroecosystem under soil conservation agriculture. Indeed, certain species of bee or hoverfly, within the Diptera and Syrphidae, which nest or hibernate in the soil (sometimes even in the very centre of agricultural plots)[91] benefit from the absence of soil disturbance. Others profit more indirectly from a switch to soil conservation agriculture, through habitat creation, greater weed diversity (weeds being more common and tolerated in soil conservation agriculture), or physiological alterations in host plants, which, having grown in a soil rich in biodiversity – particularly in nitrogen-fixing bacteria and mycorrhizae – have reinforced natural defences or, notably, modified attractiveness to pollinators[92].

As for the efficiency of biological control of crop pests and the impact of the latter upon crops, it has been observed that these are, respectively, better[93] and equivalent or less[94] in soil conservation agriculture as compared to a conventional growing method. Many studies of the effects of soil tillage or lack thereof do not account for the interactions of this practice with the other elements of soil conservation agriculture, but the control of bioaggressors in this type of system, especially of diseases[95], relies particularly upon well-used rotation. In this sense, the three pillars of soil conservation agriculture are inseparable as regards the maintenance, or indeed the improvement, of regulation services[96]. Certain cases remain nonetheless problematic, such as that of slugs, widely recognised and well-documented as being difficult to manage without soil tillage, particularly in the first years of such a system.

2.3. Agronomic and economic performance of soil conservation agriculture

It is estimated that, across all climates and crops worldwide, soil conservation agriculture delivers a yield loss of approximately 2.5% in comparison to conventional agriculture[97].

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within the vineyard. *Agricultural and Forest Entomology*, 10, 233-243.

[90] Tamburini G., De Simone S., Sigura M., Boscutti F., Marini L., 2016. Conservation tillage mitigates the negative effect of landscape simplification on biological control. *Journal of Applied Ecology*, 53, 233-241.

[91] Raymond L., Sarthou J.P., Plantegenest M., Gauffre B., Ladet S., Vialatte A., 2014. Immature hoverflies overwinter in cultivated fields and may significantly control aphid populations in autumn. *Agriculture, Ecosystems and Environment*, 185, 99-105.

[92] Barber N.A., Gorden N.L.S., 2015. How do belowground organisms influence plant-pollinator interactions? *Journal of Plant Ecology*, 8, 1-11.

[93] Tamburini G., De Simone S., Sigura M., Boscutti F., Marini L., 2016. Conservation tillage mitigates the negative effect of landscape simplification on biological control. *Journal of Applied Ecology*, 53, 233-241.

[94] Basch G., Friedrich T., Kassam A., Gonzalez-Sanchez E., 2015. Conservation agriculture in Europe. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 357-388; Kesavan P.C., Malarvannan S., 2010. Green to evergreen revolution: ecological and evolutionary perspectives in pest management. *Current Science*, 99, 908-914; Kutcher H.R., Johnston A.M., Bailey K.L., Malhi S.S., 2011. Managing crop losses from plant diseases with foliar fungicides, rotation and tillage on a Black Chernozem in Saskatchewan, Canada. *Field Crops Research*, 124, 205-212.

[95] Leake A.R., 2003. Integrated pest management for conservation agriculture. *In: Conservation Agriculture: Environment, Farmers Experiences, Innovations, Socio-Economy, Policy* (L. García-Torres, J. Benites, A. Martínez-Vilela, A. Holgado-Cabrera, eds), Springer Netherlands, Dordrecht, 271-279.

[96] Roger-Estrade J., Anger C., Bertrand M., Richard G., 2010. Tillage and soil ecology: partners for sustainable agriculture. *Soil Tillage Research*, 111, 33-40.

[97] Pittelkow C.M., Liang X., Linquist B.A., van Groenigen K.J., Lee J., Lundy M.E., van Gestel N., Six J., Venterea R.T., van Kessel C., 2014. Productivity limits and potentials of the principles of conservation agriculture. *Nature*, 517, 365-368. Following the publication of this study, a protest movement sprang up among North American farmers, who criticised the assessments of research organisations and technical institutes, who, according to the farmers, underestimate the performance of soil conservation agriculture. "29 reasons why many growers are harvesting higher no-till yields in their fields than some university scientists find in research plots" http://www.no-tillfarmer.com/articles/4038.

Conversely, in a context of hydric stress, observed yields in soil conservation agriculture are, on average, higher than in conventional agriculture[98]: in dry climates, a yield increase on the order of between 50 and 100% has been observed by Oihane Fernández-Ugalde *et al.*[99], and between 20 and 120% by Amir Kassam *et al.*[100], in relation to conventional agriculture.

At a European level, notable differences can be observed between countries, yields being poorer overall in soil conservation agriculture in the north of the continent, falling by 6.9%, while increasing by approximately 13%, relative to conventional agriculture, in the south (including France)[101]. It should be noted that measured yield levels in soil conservation agriculture are particularly dependent upon the age of the system, and tend to increase over time[102].

Beyond yield, various authors acknowledge that economic profit in soil conservation agriculture is higher[103] than that of a more conventional mode of production, due to a reduction of 50 to 75%[104] in labour costs, of 60% in fuel costs[105] and of 80% in equipment maintenance costs[106]. The improvement of soil organic carbon content and the incorporation of legumes in rotation add the possibility of reducing the costs of nitrogen fertiliser after some years[107]. These factors combine to lower the profitability threshold (yield level) after which the operation becomes economically viable. In Portugal, for a farm of 500 hectares, this profitability threshold (calculated based upon net margin) has thus been estimated at 14.3 quintals per ploughed hectare, compared to 11.3 in soil conservation agriculture[108].

However, the main barrier to elimination or significant reduction of soil tillage remains: that it would deprive farmers of their principal means of weed control. The use of soil tillage – for

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[98] Pittelkow C.M., Liang X., Linquist B.A., van Groenigen K.J., Lee J., Lundy M.E., van Gestel N., Six J., Venterea R.T., van Kessel C., 2014. Productivity limits and potentials of the principles of conservation agriculture. *Nature*, 517, 365-368.

[99] Fernández-Ugalde O., Virto I., Bescansa P., Imaz M.J., Enrique A., Karlen D.L., 2009. No-tillage improvement of soil physical quality in calcareous, degradation-prone, semiarid soils. *Soil Tillage Research*, 106, 29-35.

[100] Kassam A., Friedrich T., Derpsch R., Lahmar R., Mrabet R., Basch G., González-Sánchez E.J., Serraj R., 2012. Conservation agriculture in the dry Mediterranean climate. *Field Crops Research*, 132, 7-17.

[101] Basch G., Friedrich T., Kassam A., Gonzalez-Sanchez E., 2015. Conservation agriculture in Europe. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 357-388.

[102] Pittelkow C.M., Liang X., Linquist B.A., van Groenigen K.J., Lee J., Lundy M.E., van Gestel N., Six J., Venterea R.T., van Kessel C., 2014. Productivity limits and potentials of the principles of conservation agriculture. *Nature*, 517, 365-368.

[103] Sturny W.G., Chervet A., 2015. Oberacker a fêté ses 20 ans : bilans et perspectives. [The Oberacker study celebrates its twentieth birthday: outcomes and prospects] *TCS Magazine*, 85, 6-25; Tebrügge F., Böhrnsen A., 1997. Crop yields and economic aspects of no-tillage compared to plough tillage: Results of long-term soil tillage field experiments in Germany. *In: Experience with the Applicability of No-Tillage Crop Production in the West-European Countries.* Proceedings of the EC Workshop-IV, Langgöns, Germany, 25-43.

[104] SoCo Project Team, 2009. Final report on the project Sustainable Agriculture and Soil Conservation (SoCo), European Commission, Scientific and Technical Research series, 172 p.

[105] SoCo Project Team, 2009. Final report on the project Sustainable Agriculture and Soil Conservation (SoCo), European Commission, Scientific and Technical Research series, 172 p.

[106] Freixial R., Carvalho M., 2010. Aspectos prácticos fundamentales en la implantación de la agricultura de conservación/siembra directa en el sur de Portugal. *In: Proceedings of the European Congress on Conservation Agriculture,* Madrid, 361-370.

[107] Carvalho M., Basch G., Calado J.M.G., Barros J.F.C., 2012. Long term effect of tillage system and crop residue management on soil carbon content of a Luvisol under rainfed Mediterranean conditions. *Agrociencia*, 16, 183-187.

[108] Marques F., Basch G., 2002. Comparação da viabilidade económica de quatro sistemas de mobilização do solo. *In: I Congresso Nacional de Mobilização de Conservação Do Solo*. Universidade de Évora, Evora, Portugal, 283-298.

the mechanical destruction of weeds or for the false seedbed technique, for example – is indeed the chief alternative, often preferred for its efficacy and lower cost, to the use of herbicides. Additionally, in the absence of soil tillage, seeds are more likely to remain on the surface and permanent mulch modifies germination conditions, favourable to certain species but limiting to the germination of most of those species which undergo light-dependent germination. Some seeds left on the surface are also consumed or damaged by the biological community, often more diverse in soil conservation agriculture. Certain weeds are disadvantaged by these particular conditions, such that a selection of weed groups different to those which would be selected in conventional systems is found in soil conservation agriculture[109]. Currently, chemical weed control remains the most effective option in the absence of soil tillage, and thus the most widespread.

A switch to soil conservation agriculture thus necessitates a radical paradigm shift concerning weed management. However, the human resources, tools and even strategies of weed control in soil conservation agriculture remain insufficient to support conversion[110]. In current practice, a switch to soil conservation agriculture is accompanied by an intensification in herbicide use during the first years: a transition period as the farmer learns and the system matures (particularly in terms of biotic and abiotic changes in its soil). However, after some years under well-managed soil conservation agriculture, the adoption of an integrated weed management approach combining chemical and non-chemical methods (chiefly mechanical destruction, prolonged rotation and cover cropping during intercropping) results in a reduction in weed emergence after sowing[111] and a drop in herbicide use, the latter becoming equivalent or inferior to that of conventional systems[112]. Farooq et Siddique[113] therefore underline the importance of this question for soil conservation agriculture systems by adding weed control as the "fourth pillar" of the system in their book *Conservation Agriculture*. Skilful use of cover cropping is a particularly important lever in weed management under soil conservation agriculture, but expertise on cover crops among both farmers and advisers remains scarce and little adapted to variations in local conditions.

3. A French example: conclusions of the observation network Seracc (Services écosystémiques en agriculture conventionnelle et de conservation) [Ecosystem services in conventional agriculture and conservation agriculture]

Between 2013 and 2016, INRA Toulouse, in collaboration with a network of approximately

[109] Holland J.M., 2004. The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. *Agriculture, Ecosystems and Environment*, 103, 1-25.
[110] Singh V.P., Barman K.K., Singh R., Sharma A.R., 2015. Weed management in conservation agriculture systems. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 39-77.
[111] Gupta R., Seth A., 2007. A review of resource conserving technologies for sustainable management of the rice-wheat cropping systems of the Indo-Gangetic plains (IGP). *Crop Protection*, 26, 436-447; Singh V.P., Barman K.K., Singh R., Sharma A.R., 2015. Weed management in conservation agriculture systems. *In: Conservation Agriculture* (M. Farooq, K.H.M. Siddique, eds), Springer International Publishing, Switzerland, 39-77.
[112] Sturny W.G., Chervet A., 2015. Oberacker a fêté ses 20 ans : bilans et perspectives. [The Oberacker study celebrates its twentieth birthday: outcomes and prospects] *TCS Magazine*, 85, 6-25.
[113] Farooq M., Siddique K.H.M., 2015b. *Conservation Agriculture*, Springer International Publishing, Switzerland, 665 p.

50 farmers in three departments surrounding Toulouse, conducted a study which simultaneously compared the expression of 17 ecosystem services (see fig. 2) in soil conservation agriculture to that in organic farming and conventional agriculture (with varying intensities of soil tillage)[114].

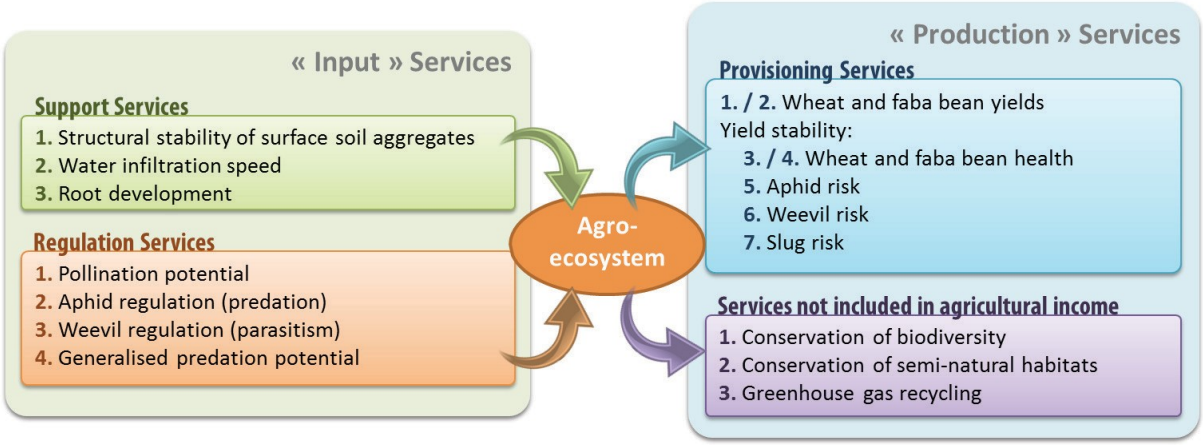

Figure 2. The 17 services studied within a Seracc framework. Seven "input" services ("regulation and maintenance services" according to the CICES definition[115]), four of which are regulation services and three of which are support services; seven production services which contribute to agricultural income ("provisioning services" according to the CICES definition) and three production services not included in direct agricultural income ("regulation and maintenance services" or "cultural services" according to the CICES definition).

This French study, carried out over two crop years and for two winter crops (winter wheat and winter faba bean), allowed the confirmation of some of the current knowledge concerning the relationship between soil conservation agriculture and ecosystem services by contextualising them locally.

In this hillside region of limestone-clay, sometimes loamy, soils, the positive effects of soil conservation agriculture – particularly of direct seeding – upon the structural stability of soil aggregates could be confirmed. During violent winter rainfall, raindrops tore away no or very few surface soil particles in direct seeding plots, contrary to ploughed soils, although reduced tillage techniques provided very variable results, underlining the fact that outcomes of these intermediary practices are dependent upon soil type. Nevertheless, the fact that soils can better retain water under soil conservation agriculture means that they are more thoroughly saturated in winter, and these soils demonstrated a limited rainwater infiltration capacity, potentially a source of more significant runoff in winter and spring than in ploughed systems. It can nonetheless be posited that the enormous difference in structural stability between a ploughed soil and a soil in direct seeding, the presence of a cover crop or a mulch and the irregularities of a non-tilled soil (which does not form the usual deep and regular furrows following the direction of the slope) combine to greatly lessen runoff impact in soil conservation agriculture as compared to more conventional systems, owing to reduced runoff speed and smaller soil losses.

[114] Chabert A.M.-H., 2017. Expression combinée des services écosystémiques en systèmes de production agricole conventionnels et innovants : étude des déterminants agroécologiques de gestion du sol, des intrants et du paysage. [The combined expression of ecosystem services in conventional and innovative agricultural production systems: a study of the agroecological determinants of soil management, inputs and landscape.] Doctoral thesis in the field of Agroecosystems, Ecosystems and Environment; National Polytechnic Institute of Toulouse; 248 p.

[115] Common International Classification of Ecosystem Services. See Glossary.

Analysis of the agro-environmental performances of Seracc network farms also confirmed the potential of soil conservation agriculture to reduce agricultural contributions to carbon emissions, through the reduction of fuel consumption, a more reasoned use of inputs (particularly fertilisers) and agroecological infrastructures; certain farms practising direct seeding or reduced tillage techniques in organic farming show the potential to recapture up to the equivalent of 200% of their emissions.

Regarding biological regulations, observations in the Seracc network mirrored the international literature in being highly variable; of the three cases of regulation studied, only that of the grain aphid showed a significant positive impact of soil conservation agriculture. Nevertheless, the levels of regulation observed in soil conservation agriculture were comparable to those in organic farming. In this region, soil conservation agriculture thus offers a potential method of improving these services to the same degree as is currently provided by organic farming, acknowledged for the superiority of its biological regulations as compared to conventional systems. The Seracc network has additionally allowed the importance of field margins, forest edges, grass strips and hedges for the hibernation of numerous natural enemies to be brought to the fore. It was found that those organic farming operations within the network which also applied the principles of soil conservation agriculture (with only superficial soil tillage) systematically showed a more significant diversity of agroecological infrastructures. These farmers, engaged in a holistic agroecological approach (via the elimination of synthetic inputs, reduction of soil tillage and diversification), included non-productive areas in their diversification as a matter of course. These habitats can support diverse natural enemies, thereby surrounding plots by an area of increased regulation potential. As was demonstrated in the case of weevil regulation, however, some natural enemies can be disadvantaged by this diversification.

Despite the potential increase in the number of pests such as slugs or weevils, productivity in soil conservation agriculture remained similar, on average, to that of conventional agriculture, with an average difference of -0.5 quintals per hectare of wheat and +5 quintals per hectare of faba beans. In addition, no particular susceptibility to cryptogrammic diseases could be demonstrated. However, a great deal of variation was observed in soil conservation agriculture and the systems were unequal in terms of productivity: both the highest and lowest yields of the network were observed in soil conservation agriculture. While it is not yet possible to conclusively state the causes of this variability, it nevertheless appears that farmer mastery of the system and its maturity are the principal determinants, both responsible for the recovery and maintenance of soil health.

A further advantage of the Seracc research network was the opportunity which it provided to compare soil conservation agriculture not only with more conventional agriculture but also with organic farming, another form of agroecological system. Organic farming is recognised as reducing pollutant transfer to water and soils, encouraging carbon storage by SOM, improving physicochemical and biological soil quality, emitting less CO_2 and fostering bird, plant and insect biodiversity, particularly of predators[116]. It is sometimes criticised, however, for the production losses for certain crops which can be provoked by the elimination of mineral nitrogen fertilisers and synthetic crop protection agents; observations made within the Seracc network tended to confirm this assessment. Overall, conservation of biodiversity and semi-natural habitats was superior in organic farming, as in soil conservation agriculture,

[116] Bengtsson J., Ahnstrom J., Weibull A.C., 2005. The effects of organic agriculture on biodiversity and abundance: a meta-analysis. *Journal of Applied Ecology*, 42, 261-269; Gomiero T., Pimentel D., Paoletti M.G., 2011. Environmental impact of different agricultural management practices: conventional *vs.* organic agriculture. *Critical Reviews in Plant Science*, 30, 95-124.

in comparison with conventional agriculture. However, organic farming systems were discovered to be much more susceptible to erosion than those in soil conservation agriculture, to the same degree as in conventional agriculture. In addition, while faba bean yields were little affected in organic farming, wheat yields were notably inferior (-13.8 quintals per hectare on average, as compared to conventional agriculture). Significantly, the farms which saw the lowest yields were those which applied the principles of both soil conservation agriculture and organic farming; while the combination of these two approaches is not without virtue from an ecological point of view, its productivity remains too unpredictable for its sustainability to be assured.

Overall, this study furnishes a detailed illustration of the potential of soil conservation agriculture to overcome the apparent incompatibility of productivity and environmental performance. The study also revealed a high degree of variability in expression of ecosystem services under soil conservation agriculture, which can be primarily attributed to system immaturity in terms of ecological balance and farmer expertise, this type of agriculture continuing to suffer a significant lack of technical support.

PROPOSALS FOR SOIL PROTECTION IN LAW.

CAN THE CONCEPT OF ECOSYSTEM SERVICES PROVIDE THE BASIS FOR A NEW PROTECTIVE REGIME ?

ECOSYSTEM SERVICES AND PUBLIC FUNDING

Public Spending in the Environmental Field : the Case of Soil Protection

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The following contribution will study how the French State and its local governments[1] can protect the soils through public spending. Since there are no regulations to preserve them[2], public powers can use money to fill this lack. They opt for financial incentive instead of legal constraint.

Given the extent of this issue, it could not be treated in the one chapter. Therefore, the study needed to be delimitated. If a sectorial approach had been chosen, the farming activity would have been the most interesting one to examine since "*the agricultural ecosystems are by far the largest structured ecosystems in the world*" [3] and the link between this work and the ecosystem services is legally acknowledged[4]. However, some very exhaustive research has already been led[5]. It occurred that it would be more innovative to delve into the financial tools public administrations can employ to improve the preservation of soils (including agricultural ones). Still, too many options of public spending exist so to reduce further the scope of the contribution the following methodological procedure has been adopted: two ways for public persons to fund the protection of soils that are diametrically opposed have been selected and will be compared[6]. On the one hand, the State and the local governments can sign "Payments for Environmental Services" (PES) with persons paid to preserve soils[7]. On the other hand, they could create green accounting standards integrating the value of the soils to encourage their protection. The main features of these two solutions have to be described in order to understand how different they are.

Preserving nature with PES requires a human intervention. One party to the contract[8] acts so that ecosystems can function correctly. In exchange, the other party, who believes that this task is valuable (here, the State or a local government[9]), pays for the provision of this service.

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[1] Public spending refers to expenditures of public administrations, including the Social security. However, the latter is excluded from the reasoning since protecting the soils does not belong to its missions (even though the degradation of the environment might induce health costs, see article L. 110-1 II of the Environmental code (CE).

[2] *Cf. supra* Hermon C. « Soil protection in law ».

[3] FAO, 2007, *La situation mondiale de l'alimentation et de l'agriculture*, p. 2.

[4] See article 2-8° of the law n° 2016-1087 pour la reconquête de la biodiversité, de la nature et des paysages (RBNP; also called « biodiversity law »).

[5] See Langlais A, « Les paiements pour services environnementaux, une nouvelle forme d'équité environnementale pour les agriculteurs ? Réflexions juridiques », *Droit rural*, n° 413, mai 2013, étude 7 et *L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?*, A. Langlais (dir.), Presses universitaires de Rennes, 2017, A paraître.

[6] Environmental taxes are excluded from this study, see: F. Bin et C. Viessant « Précis de fiscalité de l'environnement », LexisNexis, under publication, S. Caudal « La fiscalité de l'environnement », LGDJ, 2014 and N. Caruana « La fiscalité environnementale. Entre impératifs fiscaux et objectifs environnementaux, une approche conceptuelle de la fiscalité environnementale », L'Harmattan, 2015.

[7] On the possibility for public persons to sign contracts, see Hastings-Marchadier A., « Les contrats de droit privé des personnes publiques et la liberté contractuelle », *AJDA,* 1998, pp. 683-693 and Pontier J.-M., « La liberté contractuelle des personnes publiques », *AJDA* 2013, pp. 837-839.

[8] Knowing that PES are not only contracts, *cf. infra* M. Poumarède,. « Ecosystem services and contracts. What environmental obligations exist in contract law ? »

[9] Langlais A, *op. cit*., §12. Since the biodiversity law, the article L. 312-3 of the CE explicitly provides that PES can be concluded by public persons.

The aim for the service seeker is to make the exploitation of a natural resource financially less attractive than its safeguarding. In other words, PESs does not follow the "polluter-pays" logic but, on the contrary, a "protector-receiver" logic[10]. This is perfectly coherent with the current orientation of environmental law that tends to favour consensualism and incentives[11] rather than the use of public interventions traditionally employed[12]. On top of that, PESs are seen as growth drivers as they should induce investments and hence, job creations[13]. Therefore, this tool could be an interesting way to compensate the shortcomings of positive law[14], here, the absence of a legal regime protecting soils. This method could even be more effective that the issuance of general scope norms because PESs are negotiated and can be adjusted to specific needs of a given ecosystem, on a given territory.

Otherwise, instead of acting directly by initiating spending, administrations could protect the soils by adopting a green accounting system. To fully understand this suggestion, some reminders might be necessary. General accounting gathers a set of rules – called a "standard" – that enables a "fair view"[15] of the assets and liabilities to a private legal person[16]. But, accounting is more complex when applied to the State or the local governments as they have to seize the specificities of public decisions[17]. Thus, "national accounting" tracks the assets and liabilities of the administrations but also collects statistical data on the French economy. As a consequence, it provides general indicators[18] such as the Gross Domestic Product (GDP), which is the annual wealth creation of the Nation (including public persons, private legal entities and households). This wide accounting standard is used as a base for taking political measures but does not integrate the value of natural elements, notably soils. One solution to encourage ecological policies is to add those components to calculate a green GDP[19]. The opponents to this option explain that the elaboration of a green standard is too complex to be satisfactorily realised, to be used as an operational instrument and to become compulsory.

Comparing PESs and green accounting, which one of these two public spending models seems to be more useful to the protection of soils? PESs appear to be simpler, enables immediate action and targets precisely soils. Yet, when they are concluded by public persons, these agreements generate numerous legal difficulties that make them less attractive (1). On the opposite view, creating an environmental accounting standard is highly technical – and might seem both theoretical and off-putting[20] – but offers interesting perspectives. Although it would have only indirect consequences on public spending, it could be worth the intellectual effort (2).

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[10] Sutterlin O., « Le principe pollueur-payeur », *J.-Cl. Env. et DD*, fasc. 2024, §11.
[11] Sutterlin O., « Le principe pollueur-payeur », *J.-Cl. Env. et DD*, fasc. 2024, §11.
[12] Langlais A., *op. cit*., §12.
[13] De Perthuis C. et Jouvet P.-A, *op. cit.*, p. 126.
[14] Sutterlin O., *op. cit*., §11.
[15] This phrase is the official one, it has been chosen since accounting cannot depict the exact picture of the legal entity concerned but should allow people who read a balance sheet to have an idea of its financial situation.
[16] This accounting standard applies to private compagnies but widely influenced the rules dedicated to administrations, see Collet M., *Finances publiques*, LGDJ, 2016,, p. 108. Since 2008, the "fair view" requirement is inscribed in the French Constitution (article 47-2), Kott S. (dir.), *Droit et comptabilité, La spécificité des comptes publics*, Economica, 2017, p. 4.
[17] Milot J.-P., « L'information financière sur les finances publiques : périmètre, utilité et portée », *RFFP*, n° 122, avril 2013, p. 137.
[18] Milot J.-P., *op. cit*..
[19] *Cf.* Angel M., *La nature a-t-elle un prix ? Critique de l'évaluation des biens environnementaux*, Les presses Ecole des Mines de Paris, 1998, p. 3.
[20] Collet M., *op.cit.*, p. 491.

1. PESs : the Limitations of Current Public Spending

The safeguarding of soils through PESs generates costs for administrations as they have to pay their co-contractors. At the same time, these legal obligations are, in the best-case scenario, poorly efficient in terms of soil preservation (1.1). Worse, they might be risky as they are a source of legal uncertainties when they involve public persons (1.2). Indeed, specific problems emerge then because distinctive norms are enforced to avoid distortion of competition. These rules would not apply to the same extent if concluded by private entities[21].

1.1. PESs : the Questionable Efficiency of Public Spending

PESs might be a peripheral way to protect the environment, notably the soils. The following limitations apply for all of them but bear distinctive consequences when the State or a local authority is involved. Indeed, the administration have to ensure the "sound use of public money"[22].

The consensual nature of PESs is presented as an advantage but can be considered a weakness: without the consent of the provider, environmental services are not protected. In order to obtain this agreement, the buyer might tone down the demands – in particular in terms of length of the commitment[23] – and thereby reduce the level of soil protection. As underlined by the doctrine, this is probably the reason why most PESs do not compel the service provider to achieve a result but simply include a best-effort term[24], an obligation to do or not to do something to the best possible standard. Hence, the terminology used is not appropriate: the payment is not due because of the provision of an environmental service but because of a practise; this is also true for agri-environmental measures (AEM) of the second pillar of the Common Agricultural Policy (CAP)[25].

Moreover, to convince the service provider, a payment is offered. Here again, the PESs are limited by their own characteristics: if the main motivation of providers is financial, they will develop strategies to benefit as much as possible from public money. PESs may cause a dead-weight effect: some people could simply be volunteers because they have already adopted the encouraged behaviours without being asked for it. This is even more likely that, as explained, the terms do not require precise and demanding results. In those circumstances, the public expenditure would be useless since the State or the local government would pay to maintain a *status quo*. Once the service will be finished, the provider could raise the financial claims to

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[21] *Cf. infra* Poumarède M.. « Ecosystem services and contracts. What environmental obligations exist in contract law ? »

[22] This is not just a political or financial argument as the "sound use of public money" belongs to positive law. Even though, it has no accurate definition, it is both a contitutionnal requirement (Cons. Constit., 26 juin 2003, n° 2003-473 DC, *AJDA*, 2003, p. 1404, note E. Fatôme) and a tool used by the administrative judge, Boiteux D., « Le bon usage des deniers publics », *RDP*, n°5, sep. 2011, pp. 1099-1135.

[23] Etrillard C., « Paiements pour services environnementaux : nouveaux instruments de politique publique environnementale », *Développement durable et territoires*, vol. 7 n°1, p. 6.

[24] Out of honesty, other factors explain the fact that obligations of means a predominant. Given the complexity of the functioning of ecosystems, it might be difficult to require results. It is much easier to pay and control human actions, either doing or not doing, Doussan I. et Martin G.-J., « Les PSE à la lumière de la théorie générale des contrats », *in L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?*, Langlais A. (dir.), 2017, under publication, pp. 1-13.

[25] Doussan I. et Martin G.-J., « Les PSE à la lumière de la théorie générale des contrats », *op. cit.*, p. 5.

accept to continue the environmental efforts (even if the action was not initially an effort). This trap is partly defeated in the agricultural field. Indeed, to receive agri-environmental aids of the second pillar, the professionals need to fulfil a minimum set of regulations. PESs can be signed only to ask for more than these obligations require[26]. The additional charges of the farmers are compensated by the public person.

Not only PESs do not appear to produce high "environmental returns on investment", they could induce legal risks for the administrations.

1.2. PESs : the legal weaknesses of public spending

Besides the issue of efficiency, PESs might bear important legal risks, both in national (1.2.1) and European (1.2.2) law, when the paying party is a public person and the agreement does not involve a farmer.

1.2.1. PESs' qualification in National Law

In domestic law, the identification of a PES raises difficulties. Concluding such an agreement does not fulfil a need of the public person but helps to realign the activity of the private sector with the general interest[27].

If the service provider is the one to solicit the State or the local government, the PES becomes an "objectives and means convention" as explained by the highest French administrative Court in the "Commune d'Aix-en-Provence" case[28], then by the circular of January the 18th 2010[29]. Then, the payment is qualified as a subsidy[30].

If the administration initiates the PES – which seems to be the most plausible hypothesis if these contracts are employed as a political instrument to protect soils – the payment will not be a subsidy anymore but it will be analysed as a price[31]. Henceforth, the PES is no longer an "objectives and means convention" but a public procurement contract by which the public party remunerates a private party for a service[32]. This shift bears great consequences. The procedures gathered on the Public Procurement Code (PPC) have to be respected if the price reaches the thresholds defined in decrees[33]. They require accurate definitions of the demands of the administration in order to compare the projects of competitors. A vague description could engage the public person's responsibility towards rejected candidates[34]. Yet, the complexity of the functioning of ecosystems might make this task complicated for the

[26] Langlais A.,, *op. cit*., §15.
[27] Nicinski S., « Besoins », *Droit des marchés publics & Contrats publics spéciaux*, Le Moniteur, coll. Moniteur Références, T. 1, II.410, mise à jour n° 71, juill. 2012, p. 4.
[28] CE sect., 6 avril 2007, Commune d'Aix-en-Provence, *JCP A* 2007, n°2111, note Karpenschif M..
[29] Circulaire du 18 janvier 2010 relative aux relations entre les pouvoirs publics et les associations : conventions d'objectifs et simplification des démarches relatives aux procédures d'agrément.
[30] If the subsidy is higher than 23000 euros a year, the convention has to mention the purpose, the amount, the means of payment and the use of the money, article 10, law n° 2000-321 du 12 avr. 2000 relative aux droits des citoyens dans leurs relations avec les administrations. But all of these elements are written in PESs anyway.
[31] Article 4 b, circular du 18 janvier 2010, *op. cit*..
[32] If the service provider is paid regularly, the PES could be another type of public procurement contract, a public service delegation.
[33] There a several thresholds for public procurement and public service delegation contracts.
[34] Nicinski S., *Le droit public des affaires*, *op. cit*., p. 591.

contract writers. Once this phase is completed, the public procurement procedures count several other steps matched with delays to comply with not paying a fine or risking the annulment of the administrative decision authorising the conclusion of the convention. Moreover, if the PES is a public procurement contract and there is a litigation, the administrative judge can base the decision on the "sound use of public money" as this principle is stated in the very first article of the PPC. Thus, the efficiency of public spending that was mentioned earlier, could become a major issue during disputes. On top of these difficulties, the violation of public procurement procedures could induce criminal prosecutions against natural persons for the offences of favouritism[35], corruption or influence peddling[36].

Hence, the potential qualification of public procurement contract would make PESs both time consuming and costly.

1.2.2. PESs' qualification in the European Union (EU) law

In the EU law, PESs could be understood as State aids, automatically illegal[37]. Indeed, according to the article 107 § 1 of the Treaty on the Functioning of the European Union (TFEU) "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market". Regarding PESs, if they do not fulfil a need of the administration, the payment given to the service provider is perceived as a support that the latter would have obtained in normal market conditions[38]. Still, this principle is lessened both by general derogations and derogations that could apply specifically to AEMs.

There are three types of general derogations. The first one is to be found in the second paragraph of the article 107 of the TFEU[39]: some payments are not considered like State aids, they are therefore compatible with the internal market. But, financial measures dedicated to the protection of the environment do not belong to this list[40]. Then, the third paragraph of the same provision announces that, when a Members States notifies a public support, the Commission can decide to treat it as compatible, thus authorised, aid. Some of the categories listed are wide enough to include the preservation of nature, notably of soils, such as: "(b) aid to promote the execution of an important project of common European interest or to remedy a

[35] Article 432-14 of the Criminal Code (C. pén.).
[36] Article 432-11 C. pén..
[37] State aids include all sorts of financial support such as subsidies, tax exonerations, loan guarantees, answer to a written question, published in the Official Journal of the European Communities (OJEC) C 125, 17 August 1963.
[38] Caylet S., « Contrats publics et paiements pour services environnementaux », *in L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?*, under publication.
[39] If all conditions of the article 107 § 1 were not fulfilled, the amounts received by the service providers would not be considered like State aids.
[40] These are the only situation where the derogation applies: "(a) aid having a social character, granted to individual consumers, provided that such aid is granted without discrimination related to the origin of the products concerned; (b) aid to make good the damage caused by natural disasters or exceptional occurrences; (c) aid granted to the economy of certain areas of the Federal Republic of Germany affected by the division of Germany, in so far as such aid is required in order to compensate for the economic disadvantages caused by that division".

serious disturbance in the economy of a Member State"[41], "(c) aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest" and "(e) such other categories of aid as may be specified by decision of the Council on a proposal from the Commission". Despite the theoretical possibility to fit pro-soil protection PESs in these exceptions, the interpretation of this provision is very restrictive[42] so it probably would not apply. Finally, the Commission regulation of June the 17th 2014[43] allows Member States not to declare certain financial supports. This could be useful but would only apply to a very precise type of PESs that preserve soils: States and local authorities may grant up to 20 million euros to a company or a project with no previous European authorisation if these investments serve the purpose of "repairing environmental damage by remediating contaminated sites" [44]. Even then, aids would have to be transparent, attractive and published. Unlike the general derogations that would be difficult to apply to PESs protection the soils, all the exceptions related to the agricultural activity are regularly used. According to the article 42 of the TFEU, the prescriptions of the article 107 and the following ones are not automatically applicable to the CAP aids; they are "only to the extent determined by the European Parliament and the Council". Consequently, most of the grants are ruled by specific[45] norms including *de minimis* thresholds[46], guidelines[47] and a waiver regime[48]. From the combination of these texts, it appears that the aids provided for by the second pillar of the CAP[49] can participate in the protection of soils. The 2014 regulation states that investments can be compensated by public grants if they pursue the goals listed at the article 3 of the same text, notably the agro-environmental and climate objectives[50]. Thus, the agricultural PESs can contribute to preserving the soils[51].

On top of these general and specific textual exceptions to the public aid ban, financial supports are permitted by the European judges when they are considered as Services of General Economic Interest (SGEI). This qualification does not prevent the application of competition law but authorises the just compensation of extra-costs generated by public service obligations. Since the "Altmark"[52] case, these payments are allowed if four conditions are cumulatively met: the recipient undertaking the task must actually have public service

[41] In 2011, the EU launched the "Europe 2020 Strategy" that aims at encouraging economic growth, notably through environmental actions. See,http://www.construireleurope.org/pprod/wp-content/uploads/2014/02/FT-EU2020.pdf

[42] Vade-mecum on State aids, 2016, p. 67.

[43] Commission regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty.

[44] Article 45 of Commission regulation (EU) No 651/2014, *op. cit*., while the common *de minimis* threshold is set at 200.000 euros on three fiscal years. article 3.2 of the Commission regulation (EU) n° 1407/2013 of the 18 december 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to *de minimis* aid.

[45] If an agricultural aid is not provided for in specific texts and contains environmental measures, the environmental norms – when they exist – shall take over, Vade-mecum on State aids, 2016, p. 211.

[46] Commission regulation (EU) n° 1408/2013 of 18 December 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to *de minimis* aid in the agriculture.

[47] European Union guidelines on State aids in the agricultural and forestry sectors and in rural areas, 2014-2020, 2014/C 204/01.

[48] Commission regulation (EU) n° 702/2014 of 25 June 2014 declaring certain categories of aid in the agricultural and forestry sectors and in rural areas compatible with the internal market in application of Articles 107 and 108 of the Treaty on the Functioning of the European Union.

[49] See the point 207 and the following ones of the guidelines.

[50] Article 14.3.d of the regulation n° 702/2014, *op. cit*..

[51] *Cf. supra* C. Hermon, « Soil protection in law »

[52] CJCE, 24 juill. 2003, aff. C-280/00, *Dr. adm*. 2003, n° 186.

obligations to discharge and those obligations must be clearly defined; the parameters on the basis of which the compensation is calculated must be established both in advance and in an objective and transparent manner; the compensation cannot exceed what is necessary to cover all or part of the costs incurred in the discharge of the public service obligations, taking into account the relevant receipts and a reasonable profit; where the undertaking is not chosen in a public procurement procedure, the level of compensation must be determined by a comparison with an analysis of the costs that a typical transport undertaking would incur (taking into account the receipts and a reasonable profit from discharging the obligations)[53]. These criteria call for two remarks to be made. Firstly, the "reasonable profit" reduces the financial incentive for environmental services providers if PESs are recognised as SGEI. Secondly, more fundamentally, it is not certain that the safeguarding of soils would be interpreted as public services, thus, that PESs protected them could be conceived as SGEI. The list of these services is not exhaustive but it traditionally includes post, transports, telecommunications and energy. It should expend but the dynamic is long so one must remain cautious. For the moment, it is not possible to determine whether the judges would perceive the protection of the environment as part of the general economic interest or not[54].

From the previous developments, it appears that PESs could become, not only costly and poorly efficient, but dangerous for the administrations. It is a way to protection the environment that has been conceived for the private sector and might be interesting within this framework[55], but that cannot be used on a large scale to launch a soil protection policy. In contrast, green accounting could have a greater impact on the public spending aiming at preserving the soils.

2. Environmental Accounting : the Potential of a Prospective Public Spending

Adding natural elements to national accounting could be a promising middle path, neither a unilateral public intervention, nor a consensual financial incentive created for the private sector.

The creation of a green accounting constitutes a wide approach as it incorporates all natural elements, including soils and their services. Despite the persisting political resistance, the potential of this option has been identified both by the academics who initiated this pondering and international and European institutions which are currently working on a standard (2.1). Such accounting fundamentally reconsiders public finances to reorient public spending in a more ecological direction. Some concrete examples in French public finances tend to show that this dynamic is underway (2.2).

2.1. Environmental Accounting : the Premises of a Green Standard to Correct the Gaps of Traditional National Accounting

[53] AEMs' and SGEIs' definitions are very close as both compensate a service provider for additional services.
[54] Peiffert O., *op. cit.*, p. 119.
[55] *cf. infra* M. Poumarède.« Ecosystem services and contracts. What environmental obligations exist in contract law ? »

Allocating a monetary value to elements that are not part of trade might seem artificial. Yet, a convention (as a standard accepted by a given community[56]), even abstract, enables the creation of landmarks. This information might be imperfect as it is not backed on observable transactions and it is based on political choices which are partially arbitrary[57], but if it is known and acknowledged by all, it becomes a base to impulse concrete actions[58]. National accounting produces data used by the public persons to make political choices[59]. A green GDP would measure the natural capital of a Nation as well as its fluctuations. It would increase the legitimacy of pro-environmental policies. Thus, despite the existing criticism (2.1.1), green standards are being drafted (2.1.2).

2.1.1. Environmental Accounting : the Oppositions

This way to protect the environment provokes intense reactions that originate both from environmental campaigners and defenders of economic liberalism. Their arguments do not seem to be justified. All of the green accounting opponents explain that the creation of such a standard is too complex[60] because all the natural elements have not been classified and when they have been, their estimation is inaccurate and their evolutions and interactions are not known well enough[61]. These difficulties exist but are not necessarily paralysing: despite the risk of an unprecise valuation, the incorporation of natural data would give a fairer image of the wealth per inhabitant than not doing it[62]. Besides the technical point, both groups of opponents develop distinctive arguments against green accounting.

In a nutshell, the environmental campaigners believe that the valuation of nature is the first step towards its commercialisation that would encourage the exploitation of resources. Yet, counting does not mean trading[63]. Plus, the environment has already been valued, just not systematically. Indeed, in France, law provides for two types of valuation: a compensatory valuation when a degradation of the environment is not possible to avoid or to reduce; a contentious valuation when a dispute is referred to a judge[64]. Only a "tutelary" valuation lacks to guide policy-makers[65]; here, green accounting would be useful.

Just as briefly, liberals believe that the intervention of administrations is detrimental to the market equilibrium so it should be limited. Therefore, they fight all arguments that increases the legitimacy of public action. But, it could be replied that the creation of an environmental accounting would also benefit the private sector. Households, but more importantly

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[56] http://www.cnrtl.fr/definition/convention

[57] What is the value of the Eiffel tower? The wealth of a Nation is an opinion, Henochsberg M., « Oui, nous sommes solvables ! », *Revue Banque*, juin 2012, supplément, pp. 21 s.

[58] Centre d'analyse stratégique, Chevassus-Au-Louis *et al*., *op. cit.,* p. 7.

[59] Greffe X., *Gestion publique*, Dalloz, 1999, p. 376.

[60] Commission sur la mesure des performances économiques et du progrès social, Stiglitz J., Sen A., Fitoussi J.-P. et *al*., 2009, p. 68.

[61] Hein L. et *al*., "An Introduction to Ecosystem Accounting", *in Routledge Handbook of Ecosystem Services*, Potschin M. et *al.* (dir.), Routledge, 2016, p. 218.

[62] For example, the American GDP increases since the 1980s as well as the national environmental costs, De PEerthuis (C.) et Jouvet (P.-A.), *op. cit.,* p. 75.

[63] See Martin G.-J., « Les "biens-environnements" », *op. cit.,* p. 149 and Centre d'analyse stratégique, Chevassus-Au-Louis *et al*., *op. cit.,* p. 7.

[64] *Cf. infra* B. Alidor and S. Jean.

[65] Martin G.-J., « Les "biens-environnements" », *op. cit.,* p. 140.

companies[66], are more and more often asked to contribute to the protection of nature[67]. They too, would need conventional landmarks to fully benefit from existing legal apparatus such as the PESs. From this point of view, it would have been more coherent to start with the elaboration of a green standard.

Despite the remaining oppositions, environmental accounting systems have been created and are currently being tested.

2.2.2. Environmental Accounting : the Existing Proposals

The methods employed vary from one project to the other but the approach is always the same: one starts with a physical inventory then the listed natural elements are turned into monetary data. Natural capital is a part of the stock of the capital used to produce, just like equipment, technology and knowledge. It fluctuates with the incoming and outgoing flows, i.e. the investments and the depreciations[68]. The most sophisticated versions of green standards have been produced at the international and European levels.

As early as 1987, the United Nations (UN) ordered the Brundtland report, inspired by the academic paper of Nordhaus and Tobin[69]. This document demonstrated that the contemporary accounting standards were uncomplete since they did not include the resources of water, sea and earth[70]. Five years later, at the Rio Earth Summit, the UN already encouraged the States to incorporate natural elements to their national accounting[71]. Right after, the UN started to reflect on its own standard, the System of Environmental-Economic Accounts (SEEA), to help them in this complex task. Its first version was issued in 1993 and their work got more and more precise. The later one, released in 2003, valued ecosystems[72] including soils[73] and their services. This work has been used by the EU as a basis for reflection.

In 2011, the Union launched the "Europe 2020 Strategy" that is a list of actions to achieve before that year, notably the instauration of a green accounting standard[74], including the soils

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[66] Since the 1992 Rio Earth Summit, the application of green accounting to compagnies was recommended, Trébulle F.-G., *op. cit*., §40. This evolution has already started. Compagnies listed on the French market have to give environmental information since the law "Grenelle 2" (2010). Moreover, some businesses employ voluntarily green standards such as the United Nations (UN) System of Environmental-Economic Accounting (SEEA), Teller M., « Développement durable et comptabilité », *Cahiers de droit de l'entreprise,* n° 3, Mai 2010, dossier 15.

[67] Commission des comptes et de l'économie de l'environnement, *Les comptes de l'environnement en 2013*, déc. 2015, p. 15, p. 16 et p. 18.

[68] De Perthuis C. et Jouvet P.-A., *op. cit.*, p. 68.

[69] Since 1970, these authors suggested to compute *Measure of Economic Welfare* (MEW) to incorporate leisure, domestic work as well as negative externalities like pollution in the GDP, Nordhaus W. D. and Tobin J., « The Measurement of Economic and Social Performance », *in Is Growth Obsolete?*, NBER, 1973, pp. 509-564.

[70] UN report, Brundtland *et al*., *Our Common Future*, 1987, p. 47. This piece of work underlines that biodiversity should be valued, *ibid*., pp. 125- 135.

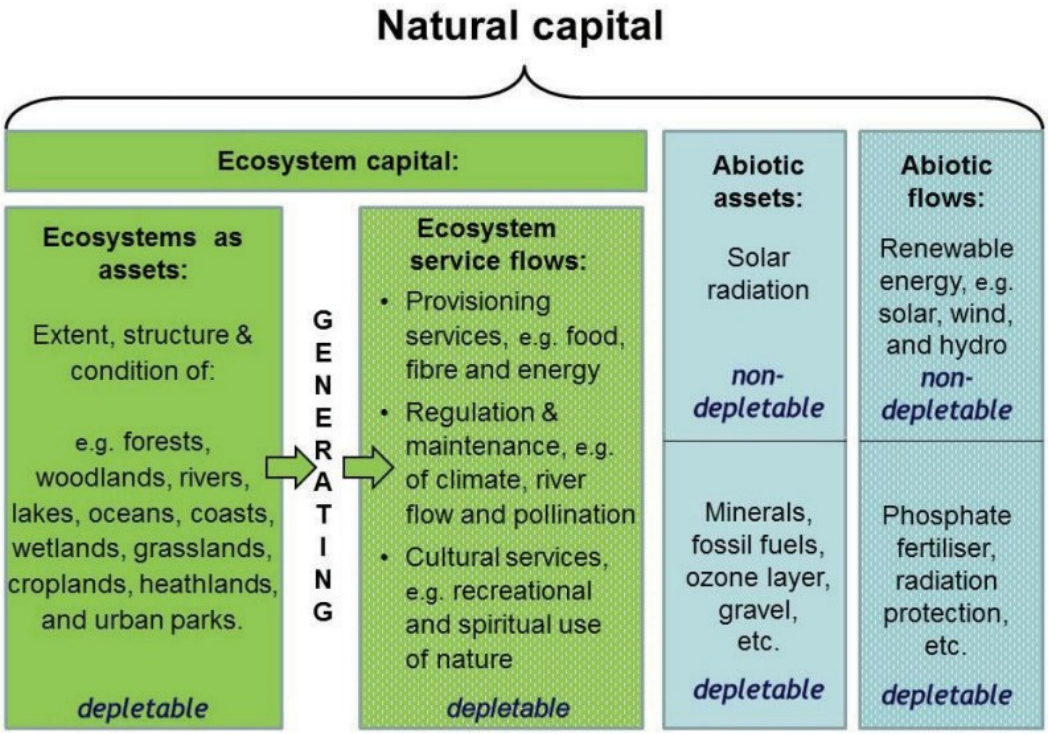
[71] Trébulle F.-G., « Droit du développement durable », *J.-Cl. Env. et DD*, fasc. 2400, §40.

[72] UN, *System of Environmental-Economic Accounting 2012, Experimental Ecosystem Accounting*, CO-edited with the European Commission, the Organisation for Economic Co-operation and Development and the World Bank, 2013.

[73] Fauna, flora, soil, water and carbon of each ecosystem unit are valued, UN, *System of Environmental-Economic Accounting 2012, op. cit.,* p. 50.

[74] EU reference document on Natural Capital Accounting, *op. cit*., p. 7.

and their services[75]. Eurostat is currently consolidating a set of rules named "KIP-INCA" for Knowledge Innovation Project - Integrated system for Natural Capital and ecosystem services Accounting. To finalise this task by 2020, it uses all the possible synergies, all the work already realised by other European agencies and projects. For the inventory, the institute employed the natural elements maps available[76]. For the monetary valuation step, Eurostat made use of the UN SEEA[77]. Just like the international standard, KIP-INCA adopts a wide conception of natural capital comprising: the ecosystems such as forests and rivers; all the categories of ecosystem services; the abiotic assets and flows as the figure below shows[78]. This template is still a work in progress that is perfectible[79].



EU reference document on Natural Capital Accounting, *Prepared as part of the EU MAES process*, January 2015, figure 2.1, p. 11.

[75] European commission, *Knowledge innovation project (KIP) on Accounting for natural capital and ecosystem services, Scoping paper*, June 2015, p. 3.

[76] For instance, Eurostat collaborated with the European Environment Agency (AAE), the Enhancing ecoSysteM sERvices mApping for poLicy and Decision mAking (ESMERALDA) and the Mapping and Assessment of Ecosystems and their Services (MAES) responsible for mapping the ecosystems on the continental territory. It also worked with the Operational Potential of Ecosystem Research Applications (OPERAs) that propose solutions to turn academic research into concrete action and the Land Use and land Cover Survey (LUCAS) specialised in the study of the soils, European commission, *Knowledge innovation project (KIP) on Accounting for natural capital and ecosystem services, Scoping paper*, *op.cit*., p. 1.

[77] *Ibid*., p. 2. Then, KIP-INCA is supposed to inspire national environmental accounting. France is currently working on its « Stratégie Nationale pour la Biodiversité » (SNB) that also includes the mission of preparing such a standard. However, the French version is not yet as developed as the European one.

[78] Eurostat, *Compilation of comments on draft Natural Capital reference document*, Feb. 2015, p. 11.

[79] For example, the agronomists who worked on this book pointed that: oceans are over-exploited but the mass of water should increase in the future so it is not depletable; the same reasoning can be applied to the ozone; on the contrary, the atmosphere should appear in the template.

Despite its flaws, a green accounting system is adapted to the needs of soil protection. First, the vision of nature is large enough to include all the elements contained in this milieu, all the functions and services, whether they require human action or not. Second, thinking of a standard does not demand the prior adoption of a legal norm: the successive fails to pass regulations to safeguard soils[80] are not an obstacle for the issuance of accounting rules. This type of work could even stimulate the policy-makers, make them vote such compelling texts. Realising an environmental accounting standard is a huge workload because of the complexity of the functioning of the environment and the absence of trade to indicate the value of nature. However, the potential gains might be worth the intellectual effort.

2.2. Environmental Accounting : Budgetary Advantages and "Greening" of Public Spending

The adoption of a green accounting system seems particularly suited to the protection of the environment, notably of soils. It would be useful for public persons who could then evaluate their natural wealth and spend correctly public money to preserve it. In order to establish a standard that would concretely influence policies, these would be the steps to follow: work on new rules, like the UN and the EU are doing, then incorporate them in national accounting. Indeed, within the Union, the latter standard has gained biding force: Members States have accepted to respect these norms and to forward the data coming out of it to the European institutions. Thus, each year, France computes its GDP, public debt and public deficit[81] then the Commission controls the compliance with budgetary discipline texts. Several limitations exist but the two most famous ones concern the public debt that shall not exceed 60% of the national GDP and the public deficit that should not represent more than 3% of the same indicator[82]. Hence, mechanically, the introduction of natural elements in the GDP's equation would lower the budgetary discipline *ratios*. In 2016, France's indebtedness reached 96% of its GDP and its deficit reached 3,4%[83]. Knowing that this State has a very rich natural heritage thanks to its continental location[84] and its overseas territories[85], such a measure would permit not only to respect the European limitations, but also to implement an ambitious environmental policy[86]. Here again, the artificial dimension of an accounting convention appears clearly but a standard has practical consequences. Changing accounting rules is definitely a political choice that modifies the perception of reality and generates some other political decisions.

On top of alleviating pressure on public spending, debt and deficit, an environmental accounting system would allow administrations to revaluate their fiscal policies. On the one hand, it enables to target – legal – subsidies that are detrimental to the environment. The EU urges the Member States to eradicate them. To do so, France ordered a report in 2010. Amongst the main recommendations, one suggested to list damaging aids which requires to

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[80] *Cf. supra* Hermon C., . « Soil protection in law ».
[81] Appendix B of the regulation (EU) n° 549/2013 of the European Parliament and the Council of 21 May 2013 on the European system of national and regional accounts in the European Union.
[82] Maastricht Treaty, article 1 of the protocol n°12 on the Excessive Deficit Procedure (EDP).
[83] https://www.insee.fr/fr/statistiques/2669747
[84] Centre d'analyse stratégique, Chevassus-Au-Louis B. et *al*., *op. cit.,* p. 44.
[85] Office National de la Biodiversité (ONB), *Bilan 2016 de l'état de la biodiversité en France : une nature française sous tension*, mai 2016, p. 1.
[86] Moreover, the elaboration of a green standard is relatively cheap as it induces only personnel costs, Chevassus-Au-Louis B. et *al*., *op. cit*., p. 265.

"progress in terms of accounting"[87]. On the other hand, the green accounting would help the policy-makers to reorient their taxes in a more ecological direction. This would be particularly helpful as current tax law affects soils in two ways. Firstly, local taxes that local governments receive are based on constructions and infrastructures so they encourage the artificialisation of the soil[88]. Secondly, inheritance taxation promotes capital mobility since it targets long and safe investments and unproductive goods. This means that taxpayers are motivated to seek high short term returns while soils would need to be less exploited.

Progressively, maybe because the French State starts realising the mentioned opportunities, national public finances are getting greener. Several illustrations could have been chosen but two of them seemed particularly enlightening. Even if they do not go as far as an environmental accounting standard would, they show that public spending is now more frequently used to protect the environment, notably soils and their services.

Although the GDP still does not include natural elements, the State borrows to fund green expenses. It has recently created a green sovereign bond, the "*Obligation Assimilable du Trésor (OAT) verte*"[89]. Buyers know that they are funding the protection of the environment when they purchase this financial product. These amounts will serve the fight against climate change, pollution and biodiversity loss[90]. When the first issuance was announced, in 2017, the *OAT vertes* were presented in such a way to attract more investors. Indeed, it interested them as they were willing to lend 23 billion of euros while only 7 billion were issued. The buyers accepted a 1,75% interest rate and the loan will last 22 years[91].

The second example concerns local finances. The article 4 of the so-called "mountain law" of December 2016[92] states that equalisation apparatus will take into account natural resources, including environmental services, and the expenses that mountainous areas trigger for some local authorities[93]. This provision organises both a vertical and horizontal equalisation to help the administrations which spend the more to preserve these territories[94] because this mission provides services for the whole Nation[95]. Although this system incorporates the value of environmental services, the parliamentary reports insist on the expenditures because mountainous territories are often the poorest. Indeed, their populations are smaller so are their

[87] Centre d'analyse stratégique, *Les aides publiques dommageables à la biodiversité*, Sainteny G. (dir.), La Documentation française, 2010, pp. 35 s..
[88] Sainteny G., *Plaidoyer pour l'écofiscalité*, Buchet Chastel, 2012, p. 100.
[89] This creation was decided in 2015, during the UN climate change conference organised in Paris.
[90] République française, *Document-cadre de l'OAT verte*, 10 janvier 2017.
[91] http://www.aft.gouv.fr/articles/lancement-de-l-oat-verte-1-75-25-juin-2039_12865.html
[92] Law n° 2016-1888 du 28 décembre 2016 de modernisation, de développement et de protection des territoires de montagne.
[93] This provision was added after a senatorial amendment.
[94] According to the article 72-2 al.4 of the French Constitution, the law provides for equalisation to promote equality between local governments. When it is vertical, money comes from the State and goes to the weaker local administrations; when it is horizontal, the wealthiest local governments help.
[95] Actu environnement, rapport rédigé par Mmes A. Genevard et B. Laclais, *Un acte II de la loi montagne pour un pacte renouvelé de la Nation avec les territoires de montagne*, juillet 2015, p. 73.

fiscal revenues[96]. This principal has been voted but we still do not know how this apparatus will work in practise[97].

Those two instances of the greening of French public finances might result from the weaknesses of the argumentations developed by opponents to environmental accounting and the advantages thereof. Indeed, unlike the PESs solution, such a standard is not limited by consent of private persons, enables a global valuation of nature and extends the protection of soils beyond the only agricultural activity. Therefore, this path seems relevant.

[96] In these areas, expenditures are on average 29% higher for municipalities counting less than 1000 inhabitant. On top of that, these small villages are more numerous in mountainous territories, *Pour la montagne*, n°277, Décembre 2016, p. 2. These problems had already been pointed out by the French Court of Audit, Cour des comptes, *Concours financiers de l'Etat et disparités de dépenses des communes et de leurs regroupements*, octobre 2016, par exemple p. 62.

[97] The available schedule of implementing decrees does not indicate if or when a text on the article 4 will be published.

ECOSYSTEM SERVICES AND CONTRACT LAW

Ecosystem services and contracts

What environmental obligations exist in contract law?

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Understanding the way in which contracts in private law can cover ecosystem services requires, in the first instance, determining whether they can be the subject of an obligation, i.e. whether they can be defined as "services" in the sense of Article 1163 of the French Civil Code. In other words, is there a contract for the provision of an ecosystem service: a contract whereby a promisor (for example, the owner or farmer of the estate) could commit to providing an ecosystem service to a creditor? The answer to this question assumes that the ecosystem service has been previously defined in law.

In testing a number of legal definitions, Guillaume Beaussonie[1] has put forward the following hypothesis : an ecosystem service could be defined as a utility provided by a real property. Such a definition would allow the protection of the environment, both in its own right and in the interests of society, to be taken into account. This deserves to be tested against the entire set of ecosystem services which are notoriously diverse, despite attempts at categorisation. In particular, while it might be appropriate for regulatory and maintenance services, its suitability to supply services should be tested[2], although a definition of natural fruits (Art. 583 C. Civ. and following articles[3].), or even of products, would seem a better description.

Whatever the case, if ecosystem services are then treated as utilities, could they be subject to contractual obligations? Article 1163 of the French Civil Code, which states that "an obligation has as its object a service, present or future", does not, at first sight, appear to preclude this: such a service could be interpreted as including

[1] Beaussonie G., « The legal definition of ecosystem services », *supra*.
[2] Langlais A., « L'appréhension juridique de la qualité des sols agricoles par le prisme des services écosystémiques », *Dr. rural* 2015, Etude 20.
[3] S. Vanuxem S., « La nature des services écosystémiques en droit privé », IDEX T2SEC, IEJUC, Toulouse, 26 mai 2016.

ecosystem services[4]. Nevertheless, when considering definitions, Guillaume Beaussonie, after having shown that a service is the utility of a real property, immediately goes on to say that such utility would be of a communal nature[5]. As such, it would provide a benefit to all, not just to the owner of the property, nor, undoubtedly to a single, identified creditor or group of creditors[6]. Consequently, creating a contractual obligation between the single owner of a real property and another party, whether a private or public person, remains a difficult challenge[7].

Beyond this, the definition of an ecosystem service (naturally) ties in with this legal definition put forward by Guillaume Beaussonie, in contrast to the concept of an environmental service. The first of the two, an ecosystem service, is a "socio-economic advantage derived by humans through the sustainable use of ecological functions of ecosystems"[8], or, put another way, a "service rendered by an ecosystem"[9].

In other words, no legal person seems to be able to act as a promisor for an ecosystem service[10] at least if we accept that the legal persons neither produce nor co-produce ecosystem services. After all, since farming favours pollination, for example, we might consider that the relevant legal person is the co-producer. This seems even more obvious with regard to supply services: is the natural fruit here not "co-produced" by the ecosystem and the legal person? However, including in this last hypothesis – that of supply services, we note that the service remains ecosystemic, in the sense that while the legal persons are demonstrably involved in the functioning of the ecosystem, and while they can facilitate it, they do not provide, and therefore cannot be, directly, promisors or co-promisors. Nevertheless, before continuing, it should be noted that, if we were to accept that legal persons can co-

[4] Chantepie G. et Latina M., *La réforme du droit des obligations*, Dalloz, 2016, art. 1163.
[5] Beaussonie G., ibid
[6] Maris V., *Nature à vendre, Les limites des services écosystémiques*, Quae éd., 2014, p. 60 ; Deffairi M., *La patrimonialisation en droit de l'environnement*, IRJS éd., 2015, p. 639.
[7] Langlais A., « Les paiements pour services environnementaux comme nouveau contrat environnemental », in Boutonnet M. (dir.), *Le contrat et l'environnement, Etude de droit interne, international et européen*, PUAM, 2014, p. 185, sp. p. 191.
[8] See Glossary, *infra*
[9] Langlais, A., sp. p. 186
[10] Langlais A., « Les paiements pour services environnementaux, une nouvelle forme d'équité environnementale pour les agriculteurs ? Réflexions juridiques », *Dr. rural* 2013, Etude 7

produce services, some of the solutions developed below should be partly reconsidered.

Similarly, and correlatively, it would appear that an (identified) legal person cannot be a creditor, in the legal sense, of an ecosystem service. Even though one may still question the hypothesis, it would appear that the benefits of ecosystem services to legal persons must be based on a fact. That people derive a "benefit" is certain, even if this underlines an anthropocentric approach to the environment. But such a benefit may not constitute a debt owed to an identified legal person. For example, if a given ecosystem service (the pollination of crops, pest control, etc.) potentially benefited a "neighbour" more, as a result of the service provided, a person cannot be considered a creditor given that there is no promisor. They would merely benefit – as well as the rest of humanity.

As a product of the ecosystem, the ecosystem service benefits a community, or even people in general, which is a long way from a contractual relationship between a promisor (the owner) and a creditor (the beneficiary). Consequently, there is less fear of nature becoming a mere commodity, but at the same time the disadvantage is that the possibility of obliging a person to provide an ecosystem service becomes less likely. It cannot, then, be the subject of a contractual obligation. Perhaps this is the legislators' intention, even if the meaning of terms remains open to interpretation[11], which means that a prudent approach is best. In fact, "ecosystem services" are virtually absent when it comes to offsetting relating to "damage that cannot be avoided or mitigated in terms of the species, natural habitats and ecological functions affected" (Art. L. 110-1 C. Env.), and in terms of actual environmental obligations whose purpose is "to maintain, conserve, manage or restore biodiversity elements or ecological functions" (Art. L. 132-3 C. Env.).

If an ecosystem service cannot be subject to a contractual obligation, i.e. a service, does this mean that contracts cannot be used in other ways to address such services? Such a conclusion would be surprising given that contracts are already "used as a

[11] Hermon C., « Les travaux préalables de la Commission européenne et les textes portant réforme de la PAC », in « Agriculture et environnement. Un nouveau projet pour la PAC ? », *Revue de l'Union Européenne* 2014, p. 52.

means of environmental protection, alongside the more traditional methods used by the law"[12]. And, more to the point, we observe that legal persons, the owners of real property, lessees and, more generally, farmers, may be capable of having an effect on the quantity or quality of ecosystem services. In fact, it is quite clear that humans can render services to nature. By preserving or improving the environment, they support ecosystems[13] and their ability to provide services[14]. This is the point of environmental services, "services that actors (…) render to society as a whole (…) and which are intended to reduce the pressure on ecosystems or which enhance their functioning": in other words, "services rendered by humans to nature"[15]. As a preventative, or restorative, measure, legal persons can thus render an environmental service that improves the functioning of an ecosystem, by favouring services and products.

So, it seems that the environmental service, is better fitted than the ecosystem service to be subject to a duty or obligation, provided a creditor (beneficiary) can be identified. Environmental services are primarily services rendered to society as a whole which justifies, at least, an institutional approach, with the institution representing the common interest. Now, when a promisor can be identified, environmental services can be governed by a contract. This is a question of contractualising agricultural practices or production systems that offer environmental benefits[16]. Environmental services, then, represent "services" in a legal sense[17], i.e. they are subject to contractual obligations (Art. 1163 C. Civ.) which contribute to preserving or improving an ecosystem and, therefore, the associated ecosystem services. A legal person, usually an owner but also a lessee (and more generally a farmer), as Didier Krajeski demonstrates[18], is then the promisor of this

[12] Langlais A., préc., p. 199 ; Giraudel C., « Un phénomène nouveau, le développement des conventions et des partenariats privés », *in la protection conventionnelle des espaces naturels*, PULIM, 2000, p. 13. Adde Monteillet V., *La contractualisation du droit de l'environnement*, Dalloz, coll. Bibliothèque des thèses, 2017.

[13] See Glossary: "Dynamic complex of plants, animals and micro-organisms and non-living environments, which, by their interaction, form a functional unit".

[14] Langlais A., « Les paiements pour services environnementaux comme nouveau contrat environnemental », cited above.

[15] Langlais A., cited above.

[16] *Contra* Doussan I. et Martin G. J., « Les PSE à la lumière de la théorie générale des contrats », *in* Langlais A. (dir.), *L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?*, Presses universitaires de Rennes, 2018.

[17] See Labous K. et Gruger H., cited above.

[18] Krajeski D., « Tillage, ecosystem services and rural leases», cited above.

"environmental service" (the service to be provided) on behalf of a creditor (beneficiary), a private or public legal person identified in the contract. The objective of this environmental service will then be, in particular, to preserve or restore an ecosystem and, therefore, ultimately, an ecosystem service. Consequently, while the ecosystem service cannot be subject to an obligation, it is the objective of the contract (Art. 1162 C. Civ.). By "objective" of the contract, it should be understood that the ecosystem service is the subjective cause of the contract (Anc. Art. 1133 C. Civ.), about which the parties are contracting. For example, the object of the primary obligation in a pollination agreement[19] is the provision of hives and colonies of bees (the environmental service) and their maintenance: it is therefore a question of using real property for agricultural and/or environmental purposes in order to maintain or improve the state of the property. In fact, the pollination service, an ecosystem service, is the subjective cause of this service; or the "goal", as we must now call it (Art. 1162 C. Civ.). It is not the object of the obligation, and cannot be, given that it provides a common benefit.

It is by considering that the environmental service is the "service", i.e. that which is the object of to the principal or accessory obligation, while the ecosystem service is the "goal" or objective of the contract, that we can see how a contract for the delivery of an environmental service can be used (1), and its content specified such that it favours the associated ecosystem services (2).

1. Contracting for environmental services

To ensure that contracts can actually be used for environmental services (1.2), one first has to determine, in advance, the many and various legal instruments that are being used for ecosystem services (1.1).

1.1. From payments for environmental services (PESs) to contracts for the provision of environmental services

[19] Billet Ph., « La convention de pollinisation », *in* M. Boutonnet (dir.), cited above, p. 269.

As a result of its economic approach[20], the well-known, but generic, definition of "Payments for Environmental Services" [21], disregards the contractual nature (or not) of the activity involved in preserving or restoring an ecosystem[22]. Since this, above all, is about "paying farmers for environmental services"[23], the general term PES is used to classify contracts whose primary or accessory obligation (such as an environmental clause in a rural lease) has as its subject an "environmental service" and/or various paracontractual elements triggering a "benefit" (aid, compensation, etc.) for the implementation of environmentally-friendly practices[24]. From a legal point of view, the category of PES covers a range of different services: it is simply a question of describing the various processes required to preserve the ecosystem and, beyond that, to protect the environment, regardless of the nature of the legal instruments employed; the law and regulations then sit quite naturally alongside the contract.

Even when the boundaries are somewhat blurred, the contract remains particular. While a member of the PES family, it is particular in that the objective of the parties contracting for the provision of environmental services is not simply regulatory compliance: it is not a question of complying with the law or regulations, even when some kind of advantage is envisaged. The parties' aim is to commit the promisor, most often in return for payment agreed upon with the creditor, to perform an "environmental obligation", which takes the form, in this case, of an environmental service[25]. Yet, this environmental service, the subject of the principal, or accessory, obligation must not be confused with the mere application of laws and regulations. It is not a question of the promisor committing himself to the creditor to respect the legal and regulatory norms. In fact, it would be reasonable to suppose that, if this were the case, the obligation would be devoid of a subject. Article 1107 of the French Civil Code says as much, on the subject of contracts for good and valuable

[20] Langlais A., « Les paiements pour services environnementaux, une nouvelle forme d'équité environnementale pour les agriculteurs ? Réflexions juridiques », cited above.
[21] V. Doussan I. et Martin G. J., « Les PSE à la lumière de la théorie générale des contrat »s, cited above.
[22] Comp. Doussan I. et Martin G. J., cited above
[23] Rapport FAO, *The state of food and agriculture. Paying farmers for environmental services*, 2007.
[24] See Aznar O. et alii, « Mesures agro-environnementales et paiements pour services environnementaux », in Ph. Méral, D. Pesche (coord.), *Les services écosystémiques, Repenser les relations nature et société*, Quae éd.2016, p. 201.
[25] Langlais A., « Les paiements pour services environnementaux comme nouveau contrat environnemental », cited above,

consideration: “A contract is said to be for good and valuable consideration when each of the parties receives a benefit from the other in return for what they provide”. It does not seem possible to interpret mere compliance with the law and regulations as a benefit : this represents an “illusory consideration (…)” in the sense of Article 1169 of the French Civil Code. For the obligation to have a subject, the commitments made, which necessarily comply with relevant laws and regulations, must be distinguished from them, either because they are different from them (because the law and regulations do not provide for them), or because they are more demanding in terms of environmental protection. Without exception then, environmental *contractual* obligations cannot be those provided for in laws and regulations.

Beyond this, we might consider associated areas : can an activity that conforms to traditional, good agricultural practice be contractualised and, possibly, remunerated ? The answer to this question involves, firstly, identifying what good agricultural practice is, which the Common Agricultural Policy, in particular, refers to as “rules of the art”. In addition, we should consider whether such an obligation to respect good agricultural practice, has a subject in the sense of Article 1163 of the French Civil Code ; i.e. does observing good agricultural practice constitute a “benefit” in the sense of Article 1107, despite the fact that is has to be imposed on farmers? Is this, again, simply an “illusory consideration (…)”(Art. 1169 C. Civ.) ? The answer to this series of questions is essential, in that it will help identify what constitutes an environmental service, thus telling us when a contract for the provision of environmental services can be used for good and valuable consideration. Either, all good agricultural practices that favour the environment can be defined as “benefits”, even if the farmer commits a breach by not adopting them. In this case, they may be the subject of an obligation, and, in this sense, remuneration for their use constitutes a real consideration. Or, like legal and regulatory compliance, obligations to comply with agricultural good practices (if they can be identified) have no subject and, in the eyes of the creditor, constitute an “illusory consideration (…)”. Therefore, such a contract would be considered null and void (Art. 1169 C. Civ.)[26].

[26] Comp. Labous K. et Gruger H., « Produire de la biodiversité : un avenir pour les agriculteurs », *Dr. Env.* 2017, 291

Contracts, then, do not lend themselves to addressing all kinds of agricultural practices favourable to the environment. Given that good agricultural practices do not constitute "benefits" in the sense of Article 1107 of the French Civil Code, legal and regulatory requirements are excluded from its scope ; but also, to the extent to which they can be defined, must not be subject to environmental obligations (in the sense of good and valuable consideration) with which farmers must comply : this would also be an "illusory (…) consideration" likely to result in the nullity of a contract for the provision of environmental services. In other words, contracts can only be validly used for practices that are more favourable to the environment: those that do not simply entail mere compliance with laws and regulations or a reference to "good agricultural practice".

1.2. Contracts for environmental services : the environmental obligation

Contracting for environmental services involves the creation of an environmental obligation on the part of a promisor. Usually this takes the form of an accessory obligation in a contract such as a rural lease (1.2.1). The environmental clause, then, is a commonly used term. But, without changing their nature, environmental obligations may also be principal ones (1.2.2), finding their way into a contract for the provision of environmental services, in the strict sense of the term.

1.2.1. Accessory environmental obligations: the environmental clause

This type of environmental obligation can certainly be an accessory to a contract in the sense that it is not the promisor's (who may also be a lessee or farmer) main obligation. It could, for example, be an environmental clause precluding the use of GMOs in a contract for the supply of agricultural produce. This applies, similarly, to rural environmental leases, i.e. those that contain "clauses aimed at compliance by the lessee with practices whose objective is the preservation of water resources, biodiversity, landscapes, product quality, soil and air, the prevention of natural hazards and the fight against erosion, including obligations to maintain a minimum level of maintenance of ecological infrastructures" (Art. L. 411-27 C. rural). Despite the legal difficulties of implementation, which reduce the scope for their application,

as Didier Krajeski shows elsewhere[27], rural leases oblige the lessee to turn to agricultural practices that favour the development of ecosystem services on the basis of the 15 clauses in Article R.411-9-11-1 of the French Rural and Marine Fisheries Code, which lessors will use to draft the lease's environmental clauses[28].

In these and other options, such as an agreement setting out the conditions for temporary occupation, we find, as an accessory to a principal obligation, an environmental obligation whose purpose is an environmental service. The subject, extent and intensity of these vary: an absence of the use of inputs, the preservation of wetlands, types of fertilizers to be used, and/or limitations on plant protection products, the maintenance of grasslands, harvesting schedules and techniques, tillage techniques, protection of water resources, diversification of crop rotations, etc.

Sometimes it involves a prohibition: the promisor must refrain from using plant protection products on a given plot of land, from cultivating another, from applying mineral fertilization, practicing stubble burning, etc. But, equally, it can involve prescriptions, such as the maintenance of all man-made features on a plot of land (dry-stone walls, hedges, etc.) or isolated trees. Above all, it will also oblige the promisor to take actions such as the commitment to maintain permanent plant cover and maintain specific areas of cover that have an environmental benefit (wildflower meadows, grassy strips, etc.), etc.[29]. These prohibitions and prescriptions, which are subject to accessory obligations, will therefore be adapted, and possibly specified, by the contracting parties, according to the layout of the site and the objectives the parties envisage, bearing in mind that neither legal nor regulatory requirements, nor good agricultural practices, can be subject to an environmental obligation, whether it be principal or accessory.

1.2.2. Principal environmental obligations

[27] Krajeski D., cited above.
[28] Boutonnet M., « Les obligations environnementales et le contrat de bail », in M. Boutonnet (dir.), *Le contrat et l'environnement, Etude de droit interne, international et européen*, PUAM, 2014, p. 57.
[29] CEREMA, Direction territoriale Méditerranée, *Le bail rural à clause environnementales et le paysage « agro-environnemental »*, juin 2015, http://www.mediterranee.cerema.fr/IMG/pdf/BRE_Document_Juin_2015.pdf

Environmental services can be subject to a principal obligation. Here, the environmental obligation is the promisor's principal contractual obligation, whether he be the owner, tenant or, more generally, any farmer cultivating the plot of land: this involves a contract for the provision of environmental services, most often framed as a contract for good and valuable consideration[30]. While this type of environmental contract[31], aimed at the preservation and restoration of the environment, is undoubtedly less frequent, there are nevertheless a number of examples of it, notwithstanding the risk of them being requalified as rural leases (C. rural, s. L. 411-1). Some have become well known, such as the example of Vittel, which has been the subject of countless studies[32]. The company has entered into environmental contracts with farmers with the aim of being able to continue using its mineral water source in compliance with regulations. But, beyond such agreements, there are numerous contracts whose main purpose is the provision of an environmental service: these are classified as "stewardship agreements", "leases", etc. Some are very specific, such as agreements about pollination[33]. Others are part of a suite of agreements. As Bastien Alidor points out, legal obligations to compensate damage to biodiversity generate contracts[34]. Yet, nothing prevents the primary obligation of such a contract being an environmental service, provided it is consistent with the compensatory measures already defined in the official authorisation. Unless, for example, the contracting authority takes "direct" responsibility for the compensatory measures (Art. L163-1 II C. Env.), after, for example, having acquired the necessary real estate (even though in this case, he could sign an environmental rural lease) in most cases it is necessary to resort to a contract. Such is the case when, "as a non-expert in ecological matters"[35], an "offsetting operator" is engaged : a "public or private person required, by a person subject to an obligation, to implement measures to offset damage to biodiversity, who implements them on behalf of this person, and coordinates them over the long-term" (Art L.163-1 III C. env.). But, as the contractor is acting directly, or through an offsetting operator, Article L. 163-2 of

[30] See Civil code, 1165.
[31] About environmental contract, see Boutonnet M., « Le contrat environnemental », *D*. 2015, 217.
[32] Pomade A., « Les paiements pour services environnementaux contribuent-ils à l'émergence d'un « gradient de juridicité » ? », *VertigO - la revue électronique en sciences de l'environnement*, Volume 16 Numéro 1, mai 2016.
[33] Billet Ph., cited above.
[34] Alidor B., « Offsetting and ecosystem services », *infra*.
[35] Lucas M., « Le contrat au service de la compensation écologique », EEI, 2017, Dossier 11.

the French Environmental Code underlines the fact that use of a contract is essential. In fact, it stipulates that "when measures to offset damage to biodiversity are implemented on land not belonging to the person subject to the obligation to implement these measures, nor to its designated offsetting operator, a contract between the owner and, where appropriate, the lessee or farmer, must define the nature of the offsetting measures, how they will be implemented, and their duration". Possibly then, the purpose of such a contract's primary obligation is an environmental service or services, with the owner, lessee or farmer committing to conserve, restore, rehabilitate, create, or improve practices.

2. The content of contracts for the provision of environmental services

Whether principal or accessory, environmental obligations usually relate to persons (2.1) ; however, the creation and development of a real obligation (2.2) could provide an appropriate way of tying numerous environmental services to the estate in question.

2.1. Personal environmental obligations

A personal environmental obligation is simply a right to a benefit (2.1.1) ; nevertheless, it has some particular features that have repercussions for its execution (2.1.2).

2.1.1. The substance of personal environmental obligations

Regardless of the context in which a contract for environmental services is signed, there is the question of the type of commitment to be made by the promisor: usually the owner, farmer, or rural lessee. As we have seen, the promisor usually undertakes, above all, to provide a service, a generic term used to describe the subject of an obligation (Art. 1163 C. Civ.). Thus, in practical terms, the promisor is committed to doing something, with the contract or contractual clauses then prescribing or prohibiting a particular activity. Until recently, this commitment was defined in the

French Civil Code as an obligation to do something, or, if the contract contains prohibitions, to not do something (former Art. 1101 C. Civ.). Although these definitions are no longer used in the French Civil Code, which aims to define only a "service", without providing further details of what this involves, we do not believe that this constitutes a change : the provision of environmental services provided by a promisor can still comprise both an obligation to do, or not do, something. For example, the obligation to maintain hedges and shrubs between 15 August and 30 November would be considered an obligation to do something, while the prohibiting of the filling of ponds and ditches is an obligation to not do something; yet both constitute a "service" in the sense of Article 1163 of the French Civil Code.

Lastly, the essential element is, therefore, no longer present. It lies in the creation, by means of a contract, of a contractual obligation to provide an environmental service. Consequently, it is the definition of an "obligation", nevertheless still absent from the French Civil Code, that is important. An obligation is, in effect, a legal relationship between two people, a creditor and a promisor, under which one (the creditor) has the right to require a service from the other (the promisor)[36]. Thus defined, it appears that an obligation is therefore a personal commitment: it leads to the provision of the service by the promisor who, the obligation assumes, will behave in a certain way, by, as already discussed, doing or not doing something. The promisor is therefore required to provide an environmental service (the subject of the principal or accessory obligation in the contract, Art. 1163 C. Civ.) with the aim of preserving or restoring an ecosystem and therefore, ultimately, an ecosystem service (the objective of the contract, Art. 1162 C. Civ.). Let us be clear though, ecosystem services, which provide a common benefit, cannot be subject to an obligation; at most, they are the objective of a contract, or, putting it another way, its subjective cause.

This observation allows us to put aside a source of confusion on the subject that is found in the literature; sometimes the view is put forward that the promisor of an environmental service only has an obligation of means, and not one to achieve a given result, on the grounds that "specifications generally impose a set of practices on farmers, without any provisions to monitor the environmental results achieved (an

[36] Poumarède M., *Droit des obligations*, LGDJ 2014, n^{os} 1 et s

increase in biodiversity, improvements in the fertility of soils, etc.). Conversely, a duty to achieve results (*sic*), would compensate farmers if, and only if, the intended environmental outcomes were achieved and verified"[37]. What is then advocated is an "approach to payment linked to the result in terms of their production or restoration of the ecosystem service" on the grounds that it would be a "more direct approach which empowers, and professionalises, farmers in their contribution to the restoration/preservation of ecosystem services". Such an analysis is, however, deceptive ; considering that the promisor would have a duty to achieve a given result and that this result is the restoration of the ecosystem service, this would be tantamount to making the promisor the provider of an ecosystem service. However, we know that this cannot be the case, because ecosystem services are assets that provide a common benefit. This does not mean, however, that a promisor of an environmental service would be subject only to an obligation of means[38]. On the contrary, the provision of an environmental service is usually an obligation to achieve a given result, in that it takes the form of an agricultural practice or an agricultural production system. Identifying which environmental services provided by the promisor will have a positive effect on the ecosystem is, undoubtedly, a real challenge. But this does not affect the environmental services which the promisor is committed to providing, in the sense that it does not alter the intensity of activity: the links between the promisor's practices and the expected environmental results (improvements to the ecosystem) must be assessed prior to the contract being signed (or during its execution, if the parties have agreed to do so), but they are not of a nature that affects the intensity of the promisor's obligations, which are the means or to a result, to be achieved. In fact, as in all contracts, the pre-contractual negotiations will have enabled the parties to define the objectives to be achieved and plan the associated obligations, including any inspections during the course of the contract, and any corresponding penalties in the case of a breach. In fact, contracts for the provision of environmental services are designed to last for considerable periods of time, but they must also be adaptable during this period.

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[37] Duval L., Binet T., Dupraz P., Leplay S., Etrillard C., Pech M., Deniel E., Laustriat M., 2016, *Paiements pour services environnementaux et méthodes d'évaluation économique. Enseignements pour les mesures agro-environnementales de la politique agricole commune.* Etude réalisée pour le ministère en charge de l'agriculture. Rapport final. Egalement Labous K. et Gruger H, préc.

[38] Comp. Doussan I., et Martin G. J., préc.

2.1.2. The execution of personal environmental obligations

The service provided by the promisor does not involve any special features, as such; as we have discussed, it involves an obligation to do something (or not do something), with the promisor committing to provide an environmental service. This obligation will be to achieve a given result or to deploy certain means, according to what the parties have agreed upon. From a contractual point of view, then, the particularity is to be found elsewhere. It is twofold.

On the one hand, the necessarily long-duration contract must be combined with a degree of flexibility, possibly enabling the service provided by the promisor to be adapted during the course of the contract's execution.

Achieving the environmental result (ecosystem services) – the subjective cause of the environmental clause – certainly implies a considerable duration : the obligations must be long-term. The French Civil Code now provides a stronger framework for long-term contracts (Art. 1210 and following articles, C. Civ.) such as contracts for the provision of environmental services. In fact, it can be assumed that such a service is sometimes repeated periodically, and sometimes maintained for the contract's duration, which supposes that its execution is monitored. Whether the environmental service is being properly provided then, according to the contract, will be evaluated from an initial baseline (the condition of fauna, flora, etc.) ; this evaluation may be visual (an inspection by the beneficiary), based on the promisor recording his agricultural practices (through logs, etc.), or on a scientific assessment by a third party, etc.

But, addressing the real difficulties in correlating environmental services with the environmental value added, the maintenance or development of the ecosystem and its services sought by the beneficiary, requires a certain flexibility[39]. The commitment to the environmental dynamics can be adapted in different ways: first, by the use of a relatively short-term contract with an option to renew; second, by the use of a "trial" period to allow agricultural practices to be tested, in order to get the promisor to make a long-term commitment ; or, third, by the use of adaptation clauses, allowing

[39] Lucas M., « Le contrat au service de la compensation écologique », préc.

the environmental services to be adapted, to some extent, in terms of effectiveness, in order to achieve the desired results.

Nevertheless, these contractual processes, which can be used to ensure the continued provision of the environmental service, will be of little use unless the contract is tied to the land it concerns.

The second particularity of contracts for the provision of environmental services is this : if the environmental service can be linked to the person, the promisor, it may also be linked to the real estate concerned. Often, an environmental service is of no interest unless it is linked to an estate; this, then, supposes an estate[40] related to the contract's duration. For instance, the production cycle of an oak forest can be more than a hundred years! Therefore, the linking of the environmental service to real estate often becomes a question of paramount importance, in order to ensure the stable and long-term provision of environmental services. While this poses few problems for an accessory environmental clause, when it applies for the duration of the principal contract (for example, in a rural lease) the difficulties increase if the environmental service is the subject of a principal personal obligation attached to the person of the promisor, not to the real estate concerned. In practical terms, if the ownership of the land is transferred or the promisor disappears (as a result of death, liquidation of a business, etc.), a contract for the provision of environmental services could lose all effectiveness, or even lapse, if there is no plan for the transfer of obligations, in part, or in their entirety, to those to whom the title of the land has been transferred. This is why some are trying to stress the constitution of real rights in the interests of the environment: this would involve tying the environmental service to the property, and not just to the person, by creating a real responsibility, linked to the associated estate, which, as such, would be binding on its successive owners. While it seems that most agreements involve personal obligations on the part of a promisor (the owner, lessee, farmer, etc.), a number of options, which are less than perfect but seek to put in place long-term and stable arrangements, have also been explored ; some of these have been taken up in legal doctrine, legal practice or case law. It is in this sense that other contracts have been considered, and sometimes used, alongside

[40] Lucas M., « Le contrat au service de la compensation écologique », préc.

contracts for the provision of environmental services: contracts incorporating rights of use or usufruct, environmental easements[41], the creation of real rights of special enjoyment[42], long leases and the creation of environmental real estate trusts[43]. At the same time, a real environmental obligation has appeared. This, enshrined in Act No. 2016-1087 of 8 August 2016, could be, under certain conditions, the principal obligation in a contract for the provision of environmental services.

2.2. Substantive environmental obligations

A real environmental obligation has appeared in Article L. 132-3 of the French Environmental Code[44] under which "the owners of property may contract with a local or regional authority, a public institution or a legal person governed by private law and acting to protect the environment, with a view to placing a responsibility on them, as well as subsequent owners of the property, such real obligations as they see fit, and whose purpose is the maintenance, conservation, management or restoration of elements of biodiversity or ecological functions." If the main lines of such contracts have not yet been clearly defined, despite real environmental obligations being a known concept with a known regime, it seems that nothing prevents this real obligation to provide an environmental service, even if the very strict conditions (in terms of the degree of formality, the quality of parties, purposes, etc.) and precautions taken (the rights of lessees and third parties) in such contracts do not allow them to be used generally, including with respect to offsetting. Be that as it may, we have understood that such a mechanism allows, on the one hand, a promisor, a physical or legal person, to be subject to obligations to do or not do

[41] See Boutonnet M, « Servitude environnementale conventionnelle ou contrat constitutif d'obligation réelle environnementale », in Boutonnet M. (dir.), *Le contrat et l'environnement, Etude de droit interne, international et européen*, PUAM, 2014, p. 271 ; Sarlat J.-J. et Olivier A., « La servitude conventionnelle environnementale », *Env. et DD* 2011, Etude 7

[42] Civ. 3e, 31 oct. 2012, n° 11-16.304, *D*. 2012. 2596, obs. A. Tadros ; *D.* 2013. 53, note L. d'Avout et B. Mallet-Bricout , et 2123, obs. N. Reboul-Maupin ; *AJDI* 2013. 540, obs. F. Cohet-Cordey ; *RDI* 2013. 80, obs. J.-L. Bergel ; *RTD civ.* 2013. 141, obs. W. Dross ; Civ. 3e, 28 janv. 2015, n° 14-10.013, *D.* 2015. 599, note B. Mallet-Bricout, 988, chron. A.-L. Méano, et 1863, obs. N. Reboul-Maupin ; *AJDI* 2015. 304, obs. N. Le Rudulier ; *RDI* 2015. 175, obs. J.-L. Bergel ; *RTD civ.* 2015. 413, obs. W. Dross, et 619, obs. H. Barbier ; *JCP* 2015. 148, veille S. Milleville ; *JCP N* 2015. 1083, note J. Dubarry et M. Julienne ; *JCP* 2015. 252 note T. Revet.

[43] See *Droits réels au profit de la biodiversité : comment le droit peut-il contribuer à la mise en œuvre des paiements pour services environnementaux ?* Rapport de la mission économie de la biodiversité, Fondation Nicolas Hulot pour la nature et l'homme, 2013.

[44] Martin G. J., « Les potentialités de l'obligation réelle environnementale », *Dr. Env.*, oct. 2016, p. 334 et s.

something, and, on the other, to tie these obligations, in a way, to land, which increases their duration and stability. In fact, for a contract that could remain valid for up to 99 years, the successive owners of the estate, specific devisees and/or legatees, will be bound by the obligations (recorded in the land registry) to do, or not do, under the contract for the provision of environmental services : a legal obligation where the real environmental obligation, in effect, binds the owner of the estate who, as such, will therefore have to provide the environmental service.

In conclusion, contracts fail, in terms of our initial intention, to address ecosystem services : as the common utilities of an asset, they cannot be the subject to a contractual obligation in which the owner of an estate, or a farmer, could be the promisor. In doing so, this analysis, which also reflects the idea stressed here that the owner (or farmer) does not co-produce ecosystem services, leaves such services outside the realm of commerce.

But, a contract may, nevertheless, favour them: it is a question of contractualising the services that humans can render to nature – "environmental services" – which, in particular, take the form of agricultural practices or systems of agricultural production that are more favourable to the environment than mere compliance with laws and regulations and the application of good agricultural practices.

As the subject of principal or accessory obligations, environmental services tend to favour ecosystems, and, as a consequence, ecosystem services, which appear as "objectives" of contracts for the provision of environmental services.

Offsetting and ecosystem services

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The mechanism of offsetting - which is already well-known, and which has been reinforced - was recently introduced to further contribute to protecting soils and the ecosystem services they produce. However, a brief look at the perspectives provided by the use of contracts will enable us to qualify the actual contribution.

The mechanism is already well known, since it is by no means new. Since the introduction of the Acts of 10 July 1976 and 2 February 1995 (known as the "Barnier Act")[1], offsetting has been presented in impact studies, representing the first form of upstream consideration of the impacts of human activities. It was then applied in different forms in various sectors of environmental law: in terms of land clearing (Art. L. 341-6 C. for.) or in terms of achieving the conservation objectives of a Natura 2000 site (Art. L. 414-4 VII C. env.).

The mechanism was reinforced by Act No. 2016-1087 of 8 August 2016 concerning the protection of biodiversity, nature and landscapes, known as the "Biodiversity" Act[2], which establishes the principle of offsetting in Article L. 110-1 of the French Environmental Code, discarding the sector-based approach which had previously existed, and introducing the mechanism of offsetting as a general principle in environmental law. The principle of preventative action, which is one of these general principles, is now supplemented (Art. L110-1-II 2 *in fine* C. env.) by the integration of the "ERC" sequence (French "*éviter, réduire, compenser*" [i.e.: avoid, reduce, offset]) which states that "as a last resort", if avoiding or reducing cannot be achieved, then "the impacts must be offset (...) by taking into account the species, natural habitats and ecological functions affected; the principle must aim to achieve a zero net loss in terms of biodiversity, or indeed aim to enhance it." This form of offsetting is therefore integrated beforehand[3]. Despite some harsh criticism, it incorporates the principle of prevention[4]: this point is important because it also underlines the exceptional nature of the offsetting measure, which is only ranked as a

[1] Act No. 76-629 of July 1976 concerning the protection of nature and Act No. 95-101 of 2 February 1995 concerning the reinforcement of environmental protection. Article 2.4 of the Implementing Decree No. 77-1141 of 12 October 1977 specified that the impact study must present "the measures proposed by the contracting authority or the petitioner to remove, reduce and if possible offset the adverse consequences of the project on the environment."

[2] Van Lang A., « La loi Biodiversité du 8 août 2016 : une ambivalence assumée », AJDA 2016, p. 2381

[3] Combe M., « Le régime juridique de l'obligation de compensation écologique », EEI, n° 6, Juin 2017, dossier 8 : « (...) *la compensation* ex ante *désigne l'ensemble des actions mises en œuvre pour contrebalancer les dommages prévus – mais non encore réalisés – par un projet, plan ou programme sur l'environnement qui n'ont pas pu être suffisamment évités ou réduits* »

[4] *Contra* Lucas M., 2015, *Étude juridique de la compensation écologique*, préf. J.-M. Staub et M.-P. Camproux-Duffrène, LGDJ, T. 11, p. 67 n° 77

secondary alternative to reduction and comes far behind avoidance measures[5]. If the coupling of prevention and offsetting in the general principles does not go far enough, the second paragraph of Article L. 161-1-I of the French Environmental Code makes it clear that offsetting measures "cannot substitute avoidance and reduction measures".

As regards the general framework of the new act, the objective expressed by the minister of the environment when presenting the bill concerning biodiversity was to establish a legal framework "for biodiversity as a whole: from the genes to the most important level of ecosystem organisation, namely landscapes and seascapes"[6]. The minister's words express a particularly ambitious goal which resulted in the establishment of certain major innovation that we will not explore in this document, but which are worth highlighting (the French Biodiversity Act includes many innovations that profoundly alter the legal landscape[7]). We shall note that the new law attaches a "use value" (the term is used in the text of the Act) and an exchange value to biodiversity, placing it fully within the field of private contract law, which forms the basis of economic exchanges. The presentation of the reasoning of the draft bill in this regard underlines that "biodiversity is an economic force for France since it provides "ecosystem services" for which the "cost of [their] disappearance" cannot yet be established.[8]. The spirit of the Act is therefore to give economic players, who have not been able to avoid or reduce their impact on biodiversity, the opportunity to create a balance between adverse impacts and offsetting measures in order to achieve a sort of ecological "neutrality"[9], or even "gain"[10]. In this regard, the use of contracts as a vector for protection or offsetting is not new and this has been developed to a limited degree. In fact, each area has a specific protection : contracts concerning rivers have been established in the field of "water law", "rural law" uses leases that include an environmental clause[11], and the "law governing classified installations" has specifically established a duty of information[12] in real-estate sales and uses environmental liability clauses. Indeed, it has become difficult to establish an exhaustive list of the types of contacts that might include provisions concerning the environment. However, there is no doubt that "contracts have become a component of environmental law"[13].

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[5] Jégouzo Y., « De certaines obligations environnementales : prévention, précaution et responsabilité », AJDA 2005, p. 1164 ; *adde* STEICHEN P., « Le principe de compensation : un nouveau principe du droit de l'environnement ? », *in* C. CANS (dir.), *La responsabilité environnementale. Prévention, imputation, réparation*, coll. « Thèmes et commentaires », Dalloz 2009, p. 143

[6] Draft bill on biodiversity n° 1847 du 26 mars 2014.

[7] Ch. CANS, O. CIZEL, *Loi Biodiversité, ce qui change en pratique*, Éditions Législatives, 2017, spéc. p. 62 et s.

[8] Faure M., *L'analyse économique du droit de l'environnement*, Bruylant, 2007.

[9] Billet Ph., « La « neutralité environnementale » : esquisses juridiques », in *Mélanges en l'honneur de François Collart-Dutilleul*, Dalloz, 2017, p. 103 et s.

[10] Lucas M., *Étude juridique de la compensation écologique*, *th. préc*., p. 358, n° 430 et s.

[11] Etrillard C., « La compensation écologique : une opportunité pour les agriculteurs », Dr. rur. n° 441, Mars 2016, étude 10

[12] Art. L. 514-20 C. env. ; Asscher J., « L'article L514-20 du Code de l'environnement : une obligation d'information tronquée », *Gaz. Pal*. nov-déc. 2007, p. 3941.

[13] Monteillet V., 2017, *La contractualisation du droit de l'environnement*, Dalloz, Nouvelle Bibl. de Thèses, vol. 168

As regards offsetting, contracting authorities can fulfil their obligations in several ways. Three of these methods use contracts as a means of organizing offsetting measures. The first type of contract aims at collaboration with the "offsetting operator", a public or private person/entity responsible for implementing the measures and coordinating them in the long term (Art. L. 163-1-III, C. env. ; this concerns a business contract in the sense of civil law). The second method refers to the acquisition of offsetting units which suggests a dematerialised approach to offsetting (using a sales contract). In this case, the contracting authority is allowed to buy units produced on "nature offsetting sites" (Art. L. 163-3 C. env.). The last solution, through Article L. 132-3 of the French Environmental Code, gives the owner the opportunity to create a real contractual environmental obligation whose purpose is to maintain, preserve, manage or restore components of biodiversity.

The flexibility of the contract makes it possible to provide a coherent response to the administrative offsetting recommendation, adapted to the soil qualities of the environments undergoing a loss of biodiversity. However, there is a major limit linked to the long-term viability of the measures. On site offsetting will not always be possible and the place where the measures are implemented will therefore depend on the availability of land. Marthe Lucas pointed out the probable consequences of scattering offsetting sites : "Increase in edge effects, loss of ecological coherence, difficulties in monitoring and evaluating the overall results, and an increase in the number of partners and contracts."[14]

In this context, the economic approach to offsetting (which aims to replace a loss by a gain) gives lawyers the feeling it is illusory. Does the framework proposed effectively protect the soil and the services they provide to society? On a more general level, does it protect the natural assets that "generate ecosystem services and use values" (new Article L. 110-1-I C. env.) ? Asked in this way, these questions provoke the following remark: is the damage to an ecosystem or an ecological function not inseparable from the services it provides for human activities? Upstream offsetting does not however refer to the latter. If this were really the case, we would suddenly see a paradigm reversal: the purely economic vision linked to the notion of ecosystem services would give way to the imperative need to preserve the natural environment, without taking into account human interests. Nevertheless, the articles of the act relating to offsetting are written in an accounting-type style which seems to go hand in hand with the increasingly anthropocentric vision of environmental law. Thus, we must inevitably ask ourselves if the notion of ecosystem services can contribute something to the various methods of offsetting.

We will first try to study these methods while noting the new offsetting mechanisms and the monitoring they are subjected to (1). Then, we will study the new law that establishes the notion of "ecosystem services", and look at it through the prism of offsetting in order to see if it acts as a catalyst for the mechanism or if it hinders it (2).

[14] Lucas M., « Le contrat au service de la compensation écologique », EEI n° 6, Juin 2017, dossier 11

1. Offsetting in the Biodiversity Act

Offsetting implies a "protecting land" (this is the vocabulary used by the players involved in offsetting). In other words, the use of new available land to implement offsetting schemes will pose a problem. Since this availability is not guaranteed, several offsetting methods were agreed upon. We will first look at the different mechanisms (1.1) before looking at how offsetting is monitored (1.2).

1.1. Offsetting mechanisms

The contracting authority bound by the legal obligation may "directly" take charge of the offsetting measure (Art. L. 163-1-II c. env.). Nevertheless, if the contracting authority does not wish to handle the offsetting itself, it has the option of using two types of contracts, involving either the use of "an offsetting operator" (Art. L. 163-1 III C. env.), or the "acquisition of offsetting units" (Art. L. 161-3 C. env.). These two mechanisms are supplemented by a real environmental obligation that can also be a legal offsetting tool[15].

In the first case, where the person/entity legally responsible for the offsetting (the contracting authority) establishes a contract with an operator, the contractual relationship has no standing in the eyes of the administrative authority. This clearly means that only the contracting authority will be liable in the eyes of the administrative authority. The operator may implement the offsetting measure on a plot of land belonging to him, or on land belonging to a third party. It is only specified that it concerns "legal or private persons". Moreover, it is surprising to note that, during a certain period, the parliamentary study considered implementing certification for operators, before finally abandoning the idea. The lack of precision concerning the status of this new player in the field of biodiversity raises questions, particularly since the operator is supposed to manage the offsetting for the contracting authority, who is solely liable for its performance.

In the second case, the purchase of offsetting units clearly suggests a dematerialised approach to soil protection. The general idea is to avoid a "net loss" in terms of biodiversity by counter-balancing a technically impossible offsetting situation through the production of offsetting units. This enables the legislator to establish an offsetting obligation based on results. It is of little importance that demand-based offsetting [16] may be impossible, the developer can always consider purchasing units (supply-based offsetting): the strength of the obligation intended by the law must therefore be relative to the implementation of the offsetting operation. If the obligation of results was aimed at ensuring the effectiveness of the measure (which the text might mislead us to believe), it would be logically impossible to sell units from sites whose ecological results have not yet been achieved... To manage this emerging market, legislators decided that nature offsetting sites must be certified[17] ; the criteria for obtaining certification include the fact the person who implements the

[15] Monteillet V., *La contractualisation du droit de l'environnement*, th. préc., p. 85, n° 109 et s.

[16] Leray G., « La responsabilité environnementale de l'entreprise à l'épreuve de la compensation », RLDA n° 128, 1er juillet 2017

[17] Decree No. 2017-265 of 28 February 2017 concerning the certification of nature offsetting sites.

measure must have the "technical and financial capacities required(...)" which gives the administrative authority sufficient latitude in terms of judging the quality of the operators and the sites on which the measures will be carried out.

Finally, offsetting can also be implemented by using new "real environmental obligations"[18]. This involves giving the owner of a building the possibility of attaching a "long-term environmental obligation to the asset which is automatically transmitted to his/her successors"[19]. According to the terms of the initial version of the draft bill, this point had two objectives : "To facilitate the development of sustainable actions that will stop the erosion of biodiversity", and "to enable an owner to put in place a simple contractual obligation on his/her property"[20]. A contractual solution for protecting the land associated with the property needed to be found. However, the real obligation is "a tool proposed to a private owner who wishes his/her asset to be managed in a manner that is consistent with protecting nature, by using contractual freedom to adapt the obligations agreed upon to achieve the objective pursued, taking into account the specific characteristics of the site and the specific protection need"[21]. Under the terms of the new Article L. 132-3 of the French Environmental Code, "the owners of real estate assets may establish a contract with a public authority, a public institution or a legal person under private law acting for the protection of the environment, with a view to making them, and the subsequent owners of the property, responsible for the real obligations that they deem fit, as long as the obligations are intended to maintain, conserve, manage or restore biodiversity elements or ecological functions". The mechanism, which exists abroad[22], is similar to that of servitude. It has given rise to a debate, which will certainly continue, on the legal nature of the scheme, which is half way between property law and contract law[23]. This is not a personal obligation as in the case of an environmental lease, nor a servitude which presumes there is a relation between dominant and servient estates[24] (at least concerning servitude in private law). The mechanism corresponds more generally to an obligation *propter rem* (i.e. linked to a thing and which is attached to the owner of the thing) which has the dual advantage of providing both a certain freedom in establishing its content (in reality we speak of contractual freedom, now provided for by Article 1102 of the Civil Code) while remaining enforceable *erga omnes* (to all) since it is not linked to a person but to an asset. This is the philosophy that Professor G.-J. Martin wanted to convey through the establishment of the "real obligation" by giving operators "a tool that provided flexibility, contractual freedom, and independent will."[25] The contract containing the

[18] Herrnberger O., « L'obligation réelle environnementale, le point de vue de la pratique », EEI n° 6, Juin 2017, dossier 17.

[20] Ass. Nat. (French Parliament) No. 1847, 26 March 2014, draft bill on biodiversity.

[21] Martin G.-J., « Les potentialités de l'obligation réelle environnementale », Dr. de l'env. n° 249, 2016, p. 334, spéc. p. 335

[22] Mekki M., « Les *conservation easements* en droit américain », in *Le contrat et l'environnement, Étude de droit comparé*, M. Hautereau-Boutonnet (dir.), Bruylant, 2015, p. 115, spéc. p. 123

[23] Denizot A., « L'obligation réelle environnementale ou droit réel de conservation environnementale ? Brève comparaison franco-chilienne de deux lois estivales », RTD civ. 2016, p. 949

[24] Art. 686 C. civ.

[25] Martin, G.-J. « La servitude environnementale de droit privé », in *Les servitudes environnementales*, N. Huten, J.-F. Struillou (dir.), Cah. GRIDAUH 2015, n° 28, p. 61

real obligation will take the form of an authentic deed whose content will be determined by the parties. The owner can thus assign the utility of the building to ecological purposes. He/she may do so to protect the ecological assets of his land/soil or to promote a resource, but the process is based on ecological altruism since no real incentive is provided for in the text. Private persons will not go down this avenue unless they are entirely sure that their desire to protect one of more resources on their land can be satisfied. On the other hand, the real obligation can also be used to give the person responsible for an offsetting measure (Art. L132-3 al. 2 C. env.) power over his/her "offsetting debt". This can be done in two different ways. In a first case, the developer who calls on an operator remains solely responsible as regards the administration of the performance of the offsetting measure. By attaching a real obligation to his asset, he/she brings what some have called a "third party guarantee"[26] into the relationship, to ensure the proper performance of the measure, in place of the contracting authority. In the second case, the owner can produce his/her own offsetting units by seeking the certification of the asset to which he has attached a real obligation. In this case, the land owner, or the operator if he/she so agrees, can position themselves in the offsetting market by offering biodiversity units. This supply-based offsetting model is well known in the United States[27] and will invariably raise questions as regards monitoring and the regulatory framework.

These same perspectives are found in the "real entitlements of special tenure" (*droits réels de jouissance spéciale)*, recently recognised by the Court of Appeal[28]. This recognition aims to allow the owner to assign the benefit of a real entitlement on his asset to a third party, giving that person a special tenure (enjoyment of the asset)[29]. Unlike the latter, the act of 2016 nonetheless provided two incentives concerning the real obligation: firstly, the contract establishing such an obligation is not subject to registration fees and land advertising tax[30]; secondly, since 1 January 2017, municipalities can exempt property that has no buildings upon it and to which the owners have attached a real environmental obligation from land tax. Nonetheless, in spite of the many proposals[31] that had already been made as regards the recognition of the real obligation, it was the Court of Appeal which first opened the door to a new means of protecting the ecological use of a building *via* the creation of a "real

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[26] Doussan I., « Compensation écologique : le droit des biens aux services de la création de valeurs écologiques et après ? », in *Repenser la propriété, un essai de politique écologique*, Guibet-Lafaye C., Vanuxem S. (dir.), PUAM, 2015, p. 99, spéc. pp. 108 et 109

[27] Géniaux G., « Le Mitigation Banking : un mécanisme décentralisé au service des politiques de « No net loss » », in *Les difficultés de mise en œuvre de la Directive Habitat 2000*, INRA, n° 19, 2002, p. 57

[28] Cass. civ. 3e, october, 31, 2012, n° 11-16.304, RTD civ., 2013, p. 141, obs. W. DROSS, RDC 2013, p. 584, note R. LIBCHABER ; Cass. civ. 3e, january, 28, 2015, n° 14-10.013, , D. 2015, p. 599, note B. Mallet-Bricout, RTD civ. 2015, p. 413, note W. Dross, *Defrénois* 2015, p. 419, note L. Andreu, N. Thomassin, Cass. civ. 3e, sept., 8, 2016, n° 14-26.953, RDI, 2016, p. 598, obs. J.-L. Bergel, RTD civ. 2016, p. 894, obs. W. Dross, voy. également L. D'Avout, B. Mallet-Bricout, « De l'autonomie, de la durée et des causes d'extinction des droits réels de jouissance spéciale », D. 2017, p. 134

[29] Reboul-Maupin N., Grimonprez B., « Les obligations réelles environnementales : chronique d'une naissance annoncée », D. 2016, p. 2074

[30] Art. 662 and ss. CGI.

[31] Martin G.-J., « Pour l'introduction en droit français d'une servitude conventionnelle ou d'une obligation *propter rem* de protection de l'environnement », RJE 2008, n° spécial, p. 123 ; Avant-projet de réforme du droit des biens, Périnet-Marquet (dir.), v° art. 608

entitlement of special tenure"[32]. Finally, the effectiveness of this new real obligation needs to be tempered, since it will generally be dependent on agreement from the person who takes up the rural lease, and at the moment, it is difficult to explain to the interested parties the direct opportunity provided by the framework[33]. Equally, the implementation of the obligation will be limited by the preservation of "rights related to hunting" and "those related to hunting reserves". Hunting therefore prevents the constitution of offsetting measures through the constitution of a real obligation.
Offsetting and the real environmental obligation are promising systems, with great potential yet certain limits, some of which are highlighted through the monitoring of offsetting.

1.2. The monitoring of offsetting

So that the obligation of offsetting does not remain a simple "good wish", a real monitoring process must be established. This implies monitoring the use of the ERC (avoid, reduce, offset) strategy implemented by the contracting authorities, involving local authorities in the identification of areas with high ecological-gain potential, locating priority offsetting measures in the areas that are coherent with the "*Trame verte et bleue*" (ecological conservation network), tracking the local deployment of offsetting measures[34], and proposing a standardised framework of tracking methods, etc.

In addition, it is naive to believe that offsetting will be effective if sanctions are not applied when all or part of the measures are not executed. With this in mind, Articles L. 163-4 and L. 171-8 of the French Environmental Code set out a range of measures that are traditionally found in other parts of environmental law: the first step is to give formal notice within a time-frame determined by the competent administrative authority (the prefect, through associated jurisdiction); the second step, if the person responsible for the offsetting obligation does not act upon the notice, is the performance of the measure, carried out either by an operator (nothing is mentioned about the deficiency of the contracting authority who might not be able to call on an operator), or through the purchase of offsetting units. In all cases, the administrative authority "may" authorise the establishment of "financial guarantees" intended to ensure, in one way or another, the offsetting. A failure to fulfil one of these obligations may also lead to a reporting procedure, an administrative fine and/or criminal sanctions.

In addition, even if the offsetting is carried out correctly, the act does not solve the problem of monitoring. The purchase of units, for example, makes it difficult to assess the overall effects of the measure and certainly leads to a loss of ecological coherence. Putting a time limit on offsetting contracts is not always compatible with

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[32] Mekki M., « Les virtualités environnementales du droit réel de jouissance spéciale », RDC n° 1, p. 105

[33] *Comp*. Van Lang A., « La loi biodiversité du 8 août 2016 : une ambivalence assumée », AJDA 2016, p. 2381

[34] See the Senate Report No. 517 (2016-17) by R. Dantec, Commission of Inquiry into measures for offsetting damage to biodiversity in major infrastructure projects. The report suggests creating regional agencies for biodiversity.

the sustainability of offsetting measures. If the offsetting operator must deal with a change of ownership that contradicts the ecological assignment of a site, can the administration order the contracting authority to start the offsetting process again? Monitoring these offsetting measures therefore raises many problems that could be accentuated by the inclusion of ecosystem services in offsetting.

2. The relevance of offsetting ecosystem services

Offsetting in itself does not include ecosystem services directly. It is reduced to functions (2.1) according to the letter of the law. Nonetheless there is a link between the two that we will try to understand. We will then look at the critical perspectives of this link (2.2) which create a certain degree of ambiguity between the concepts of function and service.

2.1. Reducing offsetting to the scope of ecological functions

The law concerning upstream offsetting only concerns damage to the environment. The first versions of the draft bill concerning the rewriting of Article L. 110-1 2° of the French Environmental Code referred to the "ecosystem services and functions affected"[35], before offsetting was confined to "damages that could not be avoided or reduced, by taking into account the species, natural habitats and ecological functions affected". Mélodie Fèvre sees this deletion in the text as "a kind of malaise in the face of the manipulation"[36] of the concept of ecosystem services which creates confusion between the notion of function and service. However, the two ideas are quite distinct : when talking about functions, we are concerned with protecting biodiversity, whereas when talking about services we are concerned with a particular utility, notably benefiting human activity, which is therefore subjective. As such, we understand why it would be difficult to directly offset damage to ecosystem services: the cost of the service depends on the benefit it produces, which varies according to the utility obtained by the beneficiaries. Having said that, concerning downstream offsetting this time, the definition of ecological damage still includes the notion of "ecological service", which makes it a little more complicated to make a clear distinction. Article L. 161-1 4 of the French Environmental Code states that "the meaning of environmental damage within the framework of this law refers to direct or indirect measurable environmental damage to ecological services, i.e. the functions performed by soils (...)".

In the same way, the real environmental obligation's only purpose is to "maintain, conserve, manage or restore biodiversity elements or ecological functions". Ecosystem services are not mentioned. However, we believe that the recognition of

[35] French National Assembly, draft bill on biodiversity (first reading) ; text from the Sustainable Development and the Territorial Development Commission, No. 2064, Annex to the report of 26 June 2014, p. 4

[36] Fèvre M., 2016, *Les services écologiques et le droit, Une approche juridique des systèmes complexes*, Université Côté d'Azur, p. 411 et s

other mechanisms would enable offsetting to take services into account indirectly. This would be the case if we took the principle of solidarity into consideration.

Now regarded as a principle, solidarity "(...) involves taking into account - in any public decision-making process that has a significant impact on the environment of the areas concerned - the interactions between ecosystems, living beings and natural or man-made environments" (Art. L. 110-1-II 6° C. env.). When applying this principle to the field of offsetting, it is logical to suppose that the person who implements the measure must take the interdependence of ecological functions between several areas into account. Moreover, the person responsible for the offsetting should take account of the "interactions between ecosystems", "living beings" and "natural and man-made environments". For example, it would be logical to suppose that a local authority in an area with rich biodiversity and which must bear the cost of such a measure, might ask a neighbouring community which benefits from ecosystem services generated by this biodiversity to participate in its conservation. More generally, the neighbouring land that would benefit from an offsetting measure through the improvement of an ecosystem service could be asked to participate financially by the developer. Since its introduction for National Parks the "principle" of solidarity has not been, to our knowledge, the subject of any case law. So, we must wait to see how a judge might use this new tool. While the regulatory content of this new principle is still very uncertain, it nonetheless provides a dynamic vision of biodiversity enabling ecosystem services to be taken into account in the implementation of the offsetting measures.

Among the general principles of environmental law, the principle of complementarity could also bring offsetting and ecosystem services closer together. Article L110-1 II 8° of the French Environmental Code notes that economic players take into account the "ecosystem interactions that guaranteeing both the conservation of ecological continuities and the environmental services that use the ecological functions of an ecosystem to restore, maintain or create biodiversity". Leaving aside the absence of standards within the provision[37], we can note the beneficial consequences that certain agricultural activities provide. If we take a forward-looking approach, we should ask ourselves about the place of the farmers as biodiversity producers[38]. Could offsetting methods not include the practices of conservationist agriculture or at least organic agriculture ? If in the future, the answer to this question were "yes", then this would enable us to completely reconsider the role of farmers in implementing offsetting measures and in protecting the land they exploit. This would also promote the protection of the ecosystem services that the farmers obtain. One of the beneficial consequences would be to reduce the pressure on land when implementing offsetting measures, as mentioned earlier.

2.2. Critical perspectives of eco-centred offsetting

[37] Champeil-Desplats V., « N'est pas normatif qui peut. L'exigence de normativité dans la jurisprudence du Conseil Constitutionnel », *Cahiers du Conseil Constitutionnel*, n° 21, janv. 2007 ; du même auteur, *Méthodologies du droit et des sciences du droit*, Dalloz, 2014, p. 262, n° 422 et s. spéc. n° 431.

[38] Zenati Fr., Revet Th., *Les biens*, PUF, 3e éd., §152

As regards the implementation of the new framework, the Biodiversity Act took a long time to draft and it includes 174 articles, and establishes many mechanisms that might influence each other; it is therefore impossible to study the scope of the impact for the moment. The period of interpretation will progressively give way to a the period of litigation and it is at this point that many of the questions will be answered. From a technical point of view, the vocabulary used in the new act conveys an essentially accounting-style approach to environmental law, since the offsetting measures must, at the very least, aim to achieve a "zero net loss", or "a gain in biodiversity" (Art. L. 110-1-II 2° C. env.). The idea concerning the nature offsetting sites is therefore to replace a biodiversity unit with another. But that implies, in law, a certain fungibility[39] that is difficult to conceive in practice. Ms. Desrousseaux notes that "Land is a transferable, appropriable and available asset but its quality, i.e. the ecological services that are linked to it, cannot be detached in such a way as to make it possible to destroy them in one place and offset them in another, without losing their substance."[40]. Beyond this aspect linked to the notion of fungibility, as regards offsetting performed on a different site, we can even note a contradiction with the principle of ecological solidarity aimed at taking into account the interdependence between ecosystems, which inevitably has a territorial dimension. Legislators noted this inconsistency and requests that the offsetting is performed "as a priority" on the "damaged site", or "at least", "nearby". This characteristic of offsetting has led thinking on the subject to be strongly critical, as for example Mrs. Camproux-Duffrène for whom "offsetting by anticipation means ignoring how ecosystems function and the specific nature of each ecosystem. Offsetting is not about returning to the previous balance, since it still exists, but about organising future destruction and providing compensation."[41] The acquisition of "units" reinforces this idea and appears to completely deny and ignore the specific bio-physico-chemical nature of each area of land[42] which will subject to offsetting. The entire matter rests on the question of whether the "compensations" are relevant and effective[43].

Ultimately, there will be three main difficulties. First of all, there are two types of reasoning, which stand in opposition, and concern the ontology of environmental law: are we protecting the soil/land itself or the services provided? More specifically, by assigning a use value to an ecological function, have legislators not introduced a bias between function and service? Indeed, it would be difficult to imagine the fungibility of a function that you can convert into a biodiversity unit without thinking that ecosystem services could not also be one[44]. The act is not clear on this subject: it incorporates the concept of service into natural heritage but excludes it when it

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[39] Desrousseaux M., 2016, *La protection juridique de la qualité des sols*, préf. Ph. Billet, LGDJ, t. 13, p. 309

[40] Camproux-Duffrène M.-P., « Le marché d'unités de biodiversité : questions de principe », RJE 2008, p. 87 ; *adde* Van Lang A., « La compensation des atteintes à la biodiversité : de l'utilité technique d'un dispositif éthiquement contestable », RDI 2016, p. 586

[41] Berthet E., *Concevoir l'écosystème, un nouveau défi pour l'agriculture*, Paris, Presses des MINES, 2014

[42] Maris V., *Nature à vendre, Les limites des services écosystémiques*, Quae, 2014, spéc. p. 58 et s.

[43] Martin G.-J., « Les « biens-environnements ». Une approche par les catégories juridiques », RIDE 2/2015, t. XXIX, p. 139

[44] Regnery B., 2013, *Les mesures compensatoires pour la biodiversité. Conception et perspectives d'application*, thesis, University Pierre et Marie Curie

comes to offsetting. However, it seems difficult to separate the two when carrying out the measures.

Moreover, in the act and its implementing decrees, there is a lack of detail concerning the implementation and monitoring of offsetting measures. This is due to the very nature of soil/land and its associated services; the specific nature of a specific piece of land is difficult to enclose within the general framework of the law. The complexity and particular nature of each piece of land would almost require a particular offsetting system that the general and impersonal character of the law has difficulty protecting for the moment. In addition, there is a lack of indicators which means it is not possible to quantify and qualify the gains in biodiversity in relation to the losses. Legislators seem to have delivered the law without the instruction manual. To have a common framework for reading and understanding the law, it will most certainly be necessary to use public-policy budgeting tools.
Finally, when considering the ins and outs of offsetting, we enter into a new field of ideas and concepts which for the moment have not yet undergone the test of time. Equivalence, service, function, additionality, solidarity, proximity, gain, net loss etc. : these are all tools that lawyers will have to use to protect the land more effectively while ensuring the sustainability of the services they provide to those who exploit it.

Tillage, ecosystem services and rural leases

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Introduction : The rural lease, a farming contract

The lending or leasing of the land and buildings required for farming by an owner, to a person likely to exploit them, has been covered by different legal instruments over time. Since the end of the Second World War, French legislators have decided that this type of farming, based on indirect title, should be covered by a legal contract which limits the respective freedom of the parties, namely the 'rural lease'[1]. This kind of lease is now a very widespread framework for exploiting farming land. Consequently, when considering the issue of tillage and ecosystem services from the perspective of farming activities, it is necessary to include the question of rural leases, since they cover farming activities for a substantial part of France.

It is obvious that such a contractual agreement, in that it is widely used, cannot be ignored when public authorities want agriculture to contribute to environmental protection. Acts which regularly reform agriculture in general, and rural leases in particular, have thus gradually integrated arrangements to take this preoccupation into account in rural leases, even though environmental protection is not the main purpose of such a lease, which is and always has been, the satisfactory exploitation of the property leased. Thus, Act No. 99-574 of 9 July 1999, directly placed in opposition the satisfactory exploitation of land and property, on the one hand, and environmental protection on the other, by limiting the right of the lessor to request an annulment of the lease, on the grounds that the lessee[2], has violated his/her customary obligations, due to the development by the lessee of "practices whose purpose is to preserve water resources, biodiversity, landscapes, the quality of products, soils and air, the prevention of natural hazards and the fight against erosion"[3]. Taking it a bit further, Act No. 2006-11 gave the lessor the possibility of imposing on the lessee, practices "whose purpose is to preserve water resources, biodiversity, landscapes, the quality of products, soils and air, the prevention of natural hazards and the fight against erosion, including obligations to ensure a minimum level of maintenance of ecological infrastructures". In other words, the rural lease may include environmental clauses. Inserted into Article L.411-27, the text, after having reaffirmed the lessee's ecological initiative, then reaffirms the lessor's ecological initiative. We shall see however that this latter initiative is very strictly circumscribed. Act No. 2014-1170 of 13 October 2014 modified the text but did not manage to generalise this possibility. Act No. 2010-874 of 10 July 2010, by integrating, under certain conditions, methanisation products in the list of farming activities, automatically extended the scope of the rural lease to include this activity. The Act of 13 October 2014 took this extension into account in the arrangements for

[1] Art. L. 411-1 and ss. rural code.

[2] These obligations are found in the French Civil Code, in Articles 1766 and subsequent articles, referred to in Article L. 411-27. The substance of the texts, as far as farming is concerned, is that they oblige lessees to not abandon cultivation of the land, to not change the usage of the property leased, to respect the lease clauses, and to reasonably exploit the property leased.

[3] Art. L. 411-27 rural code, the text is quoted in its version modified by Act No. 2006-11 of 5 January 2006.

compensating lessees for improvements[4]. Finally, we may refer to Act No. 2016-1087 of 8 August 2016 which links the actual new environmental obligations pertaining to the property in question, to the rural lease[5].

In this set of standards linking rural leases and protection of the environment, we may wonder what the consequences are of integrating reflection on the relationship between humanity and nature from the point of view of ecosystem services. In this work, they are defined as the "socio-economic advantages derived by humans from sustainable use of the ecological functions of ecosystems"[6]. Several authors working on this topic, across a range of specialisations, have expressed their reservations as to whether the concept and proposals that may arise from it are really innovative[7]. One may wonder in particular whether it will lead to the implementation of new and practical actions. In spite of these reservations, it would appear, however, that this is the case. Agricultural research on ecosystem services seems in particular to lead to precise recommendations concerning the techniques developed by farmers. These techniques might make it possible to develop the potential of services provided by an ecosystem, not only to the farmer or the owner of the property being exploited, but also to third parties. This is the case for example for conservation farming. This is developing around three inter-dependent principles[8]: prolonged and diversified crop rotation, permanent organic cover on soils and minimum disturbance of soil. It offers advantages to the farmer, who produces and uses fewer inputs. It is also advantageous to the owner, whose soil is restored or has its productive capacity increased. Finally, it is of benefit to third parties, if only because the products cost less.

We note from the example of conservation agriculture that the advantages derived from ecosystem services require changing agricultural practices and adopting new methods of production, in other words farmers must play an active role through the way they produce. It directly calls into question the way in which rural leases organise the farming of the property leased: can lessees simply do what suits them ? Can the lessor force lessees to change their practices ? Can a profit or at least a compensation, be drawn from these practices, independently of the person who was directly involved ?

It should be remembered here that the rural lease, as conceived after the Second World War, is not restricted by the customary relationship between parties, traces of which can still be found in the French Civil Code : a lease characterised by the desire to protect the owner's property has been replaced by a lease that emphasises stability for the lessee and the freedom to exploit the property[9]. While lessees may be sanctioned, in particular for not having correctly exploited the property leased[10], they

[4] Art. L. 411-73, 2 rural code
[5] Art. L. 132-3 C. env. on the issue
[6] Refer to the glossary for this point
[7] Fèvre M., 2016. *Les services écologiques et le droit*, Thèse, Université Côte d'Azur, p. 15 s. – Doussan I., supra.
[8] Cf. *supra* Chabert A. and Sarthou J.-P. « Ecosystem services delivered by soils, from an agronomic perspective : te case of conservation agriculture ».
[9] Dupeyron C., 1994. *Droit agraire*, Economica, n° 543 s. –Krajeski D., 2016. *Droit rural*, Defrénois, n° 147.
[10] Art. L. 411-31-I, 2 C. rur. the lessee has to have been responsible for compromising satisfactory exploitation of the property, and the lessor has to prove this.

must be compensated for any improvements they may have made[11]. Let there be no mistake, the regulatory preoccupation governing the status of rural leases is still 'the necessity to exploit the property leased, in particular the land, in a way that protects its capacity to produce'[12]. What has changed between the French Civil Code and the French Rural and Marine Fisheries Code is the increase in the lessee's prerogatives and the correlative decrease in those of the lessor, for determining what happens to the property while it is being leased.

Any practices that contribute to the development of ecosystem services have to be considered in relation to those principles which make the rural lease a particular case. They should also deal with two questions, in a logical order, the first is how to integrate these practices into the contractual relationship defined by the rural lease ? The second question is "what are the consequences of integrating these practices" ?

1. The possibility of integrating the use of agricultural practices that contribute to the development of ecosystem services into the contractual relationship.

The gradual integration of ecological preoccupations in rural leases has revealed several elements which may prove crucial. The issue has to be considered from the point of view of each of the parties. This is because, while the possibility of a lessee using these practices was taken into account, so was the right of the lessor to impose this kind of practice on the lessee. Next, what makes these practices, which favour ecosystem services, so particular is the fact that they combine in an inseparable way, farming methods and actions that favour the environment. It is not simply a way of producing with an eye to the environment which is being envisaged, but a new way of associating the ecosystem with agricultural production. These different elements necessarily affect the way in which the practices in question are integrated in the rural lease.

1.1. The scope for the lessee to use agricultural practices that contribute to the development of ecosystem services.

When one considers the possibility for a lessee to use farming practices that encourage the use of ecosystem services, one immediately has to deal with the dual nature of these practices (i.e. protection of the environment and the agricultural production method). While Article L. 411-27 of the French Rural and Marine Fisheries Code would appear to be the obvious point of entry in the contract, a more careful reading would appear to contradict that idea. *A priori*, the practices in questions could easily fall within the wide (and enlarged) scope of the text (preservation of water resources, biodiversity, landscapes, product quality, soils and air, the prevention of natural hazards and the fight against erosion). It should be remembered that this text only attempts to protect the lessee against a penalty (i.e. annulment of the lease). It does not prejudge the way in which lessees might have recourse to these practices during the lease especially when they modify their way of farming, which is the case for the practices we are referring to.

[11] Art. L. 411-69, 2 C. rur.
[12] Derrousseau M., 2016. *La protection juridique de la qualité des sols*, LGDJ, n° 76 s.

When the way in which lessees produce and the extent of their freedom to do so is being considered, it would appear to be more natural to refer to Article L. 411-29 of the French Rural and Marine Fisheries Code which has the advantage of dealing directly with the question of changing cropping practices. This leads to a clear answer to the question of determining whether the lessee may adopt the practices under consideration and if necessary, in spite of the lessor's opposition. For many authors, this text characterises lessees's freedom to farm as they wish. The point that interests us is that it gives lessees the possibility of changing their production practices.

The procedure follows logic which is fairly common in rural law and to put it simply, reasonable. The text first emphasises the agreement of the parties and makes provision for later arbitration in the event of disagreement. The provision focuses on the cropping resources implemented by lessees more than on the extent to which their projects protect the environment, which is not referred to. This is a reminder that the rural lease is above all a farming contract. What is taken into consideration here is the capacity of new production methods to improve farming conditions. The lessee has to be able to prove this. From this point of view, the possibility of evaluating such practices could determine the way they are implemented in rural leases. The lessee may, in fact, have to discuss this at an agricultural rent tribunal if the lessor, having been informed of the modifications to be implemented, takes the matter to the court because he/she believes that it will lead to a deterioration of the land. It would therefore appear to be difficult for the lessee to attempt to implement any practices that have not already proven satisfactory.

It would also appear that lessees of rural leases may have recourse to the practices in question to the extent that they can demonstrate their effectiveness. Can the lessor impose such practices?

1.2. The scope for the lessor to impose agricultural practices which contribute to the development of ecosystem services.

Due to the close link between these practices and the farming methods, it would appear that the issue is no different to that of determining whether the lessor may impose a certain way of farming on the lessee. Developments related to the lessee's freedom to farm as he/she wishes, are likely to clarify this issue : lessors are not (or areno longer[13]) the ones who decides how the property will be exploited. They can no longer impose particular production methods on the lessee. However, the dual nature of the practices in question, would appear to limit that claim. In other words, the issue of whether these practices protect the environment, could make it easier for the lessor to impose them. If such were the case, it would be no small paradox. We shall see, however, that in the light of existing texts, the possibilities are fairly limited. The lessor may in fact, theoretically used two instruments to integrate environmentally friendly practices into a rural lease: the environmental clauses and

[13] This is what is implied by Article L. 411-29 of the French Rural and Marine Fisheries Code when it refers to Article 1766 of the French Civil Code to exclude the application of the latter. The latter article stipulates obligations for the lessee, which we have already mentioned, under the old concept of the rural lease.

the actual environmental obligations pertaining to the property in question.

We have emphasised that the insertion of environmental clauses in a rural lease is done in a restrictive framework. The opening statement in Article L. 411-27 initially appears to have a wide scope, in this sense it echoes the measure adopted in favour of the lessee in the same text: "Clauses aimed at compliance by the lessee with practices aimed at the preservation of water resources, biodiversity, landscapes, product quality, soil and air, the prevention of natural hazards and the fight against erosion, including obligations to maintain a minimum level of maintenance of ecological infrastructures, may be included in the leases". However, restrictions quickly come into play.

Firstly, this insertion is only possible in three cases that are specifically stipulated in the text[14]. This insertion can then only cover practices which are listed in Article R. 411-9-11-1 of the French Rural and Marine Fisheries Code[15]. The practices that lessors expect to be developed, which may be a combination of various possibilities, shall be added to this list if they wish to impose them on the lessees with whom they are to sign a rural lease. This does not raise any difficulties for conservation agriculture.

Whereas the intention had been to generalise the use of environmental leases during the vote on the Bill of 13 October 2014, the idea was abandoned due to the inconsistencies that might result from disorderly multiplication of practices. The regulation took this risk into account. Article R. 411-9-11-3 thus stipulates that even if practices are implemented due to the location of plots, they must comply with the official management document for the protected space in question. On the hypothesis that recourse to environmental clauses is possible due to the standing of the lessor, then practices which meet the environmental issues relevant to the area of the property leased, should be chosen.

While recourse to the environmental lease appears to be a little disappointing due to the likelihood of it not being widely adopted, recourse to the actual environmental obligations pertaining to the property in question, is even more so. According to Act No. 2016-1087 of 8 August 2016, this involves giving the owners of real estate the possibility of "signing a contract with a public authority, a public establishment or a

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[14] Namely : - to guarantee maintenance of these practices or infrastructures on the plot or plotsleased; - where the lessor is a legal person under public law, an accredited environmental protection association, a legal person, whose accreditation is subject to compliance with a certain number of conditions specified in the French Labour Code, a recognised public interest foundation or an endowment fund; - for plots located in certain spaces mentioned in Article L. 411-27.

[15] Namely : The non-tilling of grasslands; creating and maintaining grass cover and management arrangements; harvesting arrangements; clearing an area of shrub growth and maintaining a cleared area threatened by encroachment of vegetation; deferred grazing on plots or parts of plots; limiting or prohibiting fertiliser input; limiting or prohibiting plant protection products; periodical or permanent plant cover of land for annual or perennial crops; introducing, maintaining specific covers for environmental purposes and the associated maintenance arrangements; prohibition of irrigation, drainage and all forms of sanitation; arrangements for submerging plots and managing water levels; diversification of crop rotation; creating, maintaining along with the associated arrangements for maintaining, hedges, banks, copses, isolated trees, aligned trees, buffer strips along streams or rivers or along forests, ponds, ditches, terraces, low walls; tillage techniques; cultivation or livestock production complying with specifications for organic farming; practices combining agriculture and forestry, and in particular agroforestry.

legal person under private law acting to protect the environment, for the purpose of making them and also the subsequent owners of the property, responsible for the actual obligations pertaining to the property in question, as they see them, whenever such obligations are intended to maintain, conserve, manage or restore biodiversity elements or ecological functions"[16]. As we can see, under the conditions stipulated in the text and with a scope that does not explicitly integrate the development of ecosystem services, this means that the owners themselves take on the responsibility and oblige their successors to do the same. This does not mean imposing the responsibility created on the farmer directly. Furthermore, the text includes protection for the current lessee; the owner cannot implement the actual environmental obligation without the prior agreement of the lessee. If the lessee does not respond within two months, he/she is considered to have accepted the obligation and any refusal has to be substantiated. Whatever the case, even if it is accepted, the lessee is not legally bound, only the owner. In a rural lease[17], the only way of imposing the behaviour that it implies, would be to introduce environmental clauses into the lease, in other words to return to the mechanism we have just referred to and which appears to be the only truly effective tool in this respect. However, the commitment made by the owner would have to be included in the list we have referred to and the hypothetical situation would have two be one in which such clauses could be stipulated. If a rural lease is signed following the commitment to the actual environmental obligation, the same solution (if in fact it is one), will be used, since the difficulty is the same : the obligation is only binding, due to its existence, on the owner of the property to which it applies.

Given the current state of the text, it is not surprising to note that the lessee could fairly easily adopt practices that promote the development of ecosystem services, even if there is a disagreement with the lessor. The difficulty for the lessee would appear to be having to prove the efficiency of these practices with respect to the farming conditions. It would be difficult for the lessor to oblige the lessee to adopt these practices. In any event, the question remains as to what the consequences of integrating these practices into the rural lease might be.

2. The consequences of integrating practices promoting the development of ecosystem services in the contractual relationship

Independently of the advantages procured by ecosystem services, we are trying here to determine the consequences that the integration of new practices could have on the contractual relationship. These consequences vary according to the person, lessee or lessor, who has taken the initiative to change the practices

2.1. The consequences of a change of practices initiated by the lessee.

In the relationship binding the lessee to the lessor, the change in production methods must be taken into account for any settlements to be made at the end of a lease. This is because they would undoubtedly improve the leased property, thus entitling the lessee to compensation.

[16] Art. L. 132-3 environnmental code.
[17] For an external solution: Reboul-Maupin N. et Grimonprez B., op. cit.

With respect to rural leases, compensation is only admitted for improvements when the lease is terminated, for whatever reason. The compensation procedure for these improvements is very carefully regulated. In principle, only improvements that are obviously useful for the farm, and which have been regularly made, can be compensated. This means that the lessee has complied with the procedures stipulated in Article L. 411-73 of the French Rural and Marine Fisheries Code. However, with respect to compensation for improvements that we have referred to, their origin has to be taken into account. Indeed, the adoption of these practices falls under Article L.411-29. Yet, according to this text, lessees who modify the cropping methods on this basis are not entitled, unless they have the lessor's agreement, to compensation for improvements made to the leased property.

Moreover, this agreement by the lessor does not mean that the parties can freely set the amount of the compensation due to the lessee. In principle, the texts specifying the calculation of the improvement compensation are applicable to all without exception[18], but case law would appear to influence this principle, at least when it leads to a result that is favourable to the lessee[19]. It would appear that the conversion to conservation agriculture has to be integrated, fairly naturally, into practices whose purpose is to improve the productivity of soils. Article L. 411-73, 3, stipulates that "with respect to transforming soil for cultivation, or a change of crop which would increase the productive potential of the land by more than 20%, or to cropping improvements as well as the land improvements mentioned in Article L. 411-28, the compensation is equal to the cost of the work done by the lessee at the time of expiry of the lease and whose effect is likely to continue after his/her departure, after deducting amortisation for a period no longer than 18 years The amount of compensation may be determined by comparing the state of a property when lessees began exploiting it and the state when they leave or by means of an audit by an expert. In this case, the expert may use any method which enables them to evaluate precisely, the amount of the compensation due to the departing lessee". We can see that the compensation conditions are very strictly regulated !

It should be noted that the texts stipulate compensation for the lessor if the intervention of the lessee were to deteriorate the property leased[20].

2.2. The consequences of a change of practices initiated by the lessor.

If the implementation of practices promoting ecosystem services requires inserting of environmental clauses into the lease, this affects the relationship between the parties in several ways. The conventional status of rural leases is modified with respect to two points.

Firstly, the rent to be paid by the lessee, is reduced. In practice, this rent is set between the *maxima* and *minima* prescribed by Prefectoral Order[21]. The text covers circumstances that would justify either increasing or reducing the rent. The same would be true for the insertion of environmental clauses: in this case the *minima*

[18] Art. L. 415-12 rural code, and more precisely Art. L. 411-77.
[19] Cass. 3e civ., 12 mai 2015, n° 13-23.123, *RD rur*. 2015, 229, obs. Crevel S.
[20] Art. L. 411-72 rural code.
[21] Art. L. 411-11 rural code.

would not be applied for determining the amount of rent.

Secondly, the lessee would be more vulnerable to an annulment of the lease or to it not being renewed[22] Article L. 411-31 of the French Rural and Marine Fisheries Code introduced a specific hypothesis for annulment of the lease. This article recaps any lack of due performance by the lessee which might justify a legal claim for annulling the lease. It stipulates that the mere non-compliance with the environmental causes might justify annulment of the lease. In this respect, Article R.411-9-11-4 of the French Rural and Marine Fisheries Code states that the lease defines the conditions under which the lessor checks each year that the lessee has complied with the practices agreed upon. This weakens the lease since, in principle, it would mean demonstrating that the lessee has acted in such a way as to compromise satisfactory exploitation of the property. In theory, the lessee is perfectly free to exploit the property while not respecting these specific commitments. One may however wonder, concerning practices which promote the development of ecosystem services, whether the distinction is really useful, since, given that farming protects the environment, the actions that favour the environment and the farming of the land are highly interrelated. This unbreakable relationship is perhaps the best guarantee for due performance of these commitments.

[22] Causes for annulment may be invoked to support a refusal to renew a rural lease : Art. L.411-52 rural code.

ECOSYSTEM SERVICES AND LIABILITY LAW

The effect of ecosystem services on civil liability law

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The expression, "ecological services"[1], appeared in French liability law for the first time in the Environmental Liability Directive of 21 April 2004[2], which is transposed[3] in Articles L. 160-1, and the following articles, of the French Environmental Code. Article L. 161-1-I-4° states that "the following constitute environmental damage within the meaning of the code: measurable direct, or indirect, deterioration in the environment that: (...) affects ecological services (...)". The insertion of this clause into environmental liability law is hardly surprising given that, as Mme. Mélodie Fèvre points out in her thesis[4], we are now witnessing a crisis in the functionalities of ecosystems and, consequently, a crisis in the services they perform. Also, environmental liability has been viewed as an effective, even "magical", legal tool, to ensure the repair of environmental damage and, more specifically, that related to ecosystem services.

Yet, beyond the limited use of environmental liability in law[5], it is mainly its limited scope that explains why environmental liability does not hold much sway in French law. By limiting this liability to certain resources[6], applying it only to farmers in the context of their professional activity[7], covering pure ecological damage only[8], addressing only events that caused damage prior to 30 April 2007, and by excluding environmental damage that occurred under certain circumstances[9], it is no surprise that such - special - environmental liability has failed to meet the desired objectives (at least to fully meet them), which include restoring ecological services to their original state[10]. However, we should not paint too negative a picture because environmental liability has a number of advantages ; it represents a form of liability that is almost without fault[11], a compensation regime entirely in line with the aim being pursued, and the absence of the condition of seriousness with respect to damage to ecosystem services[12]. Put another way, it is not a question of wanting this

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[1] Or "ecosystem services" insofar as this book treats them as synonyms.

[2] Directive 2005/35/CE du Parlement Européen et du Conseil du 21 avril 2004 sur la responsabilité environnementale en ce qui concerne la prévention et la réparation des dommages environnementaux, *J.O.U.E.* L.143/56 du 30/04/2004.

[3] Loi n° 2008-757 du 1er août 2008 relative à la responsabilité environnementale et à diverses dispositions d'adaptation au droit communautaire dans le domaine de l'environnement.

[4] Fèvre M., *Les services écologiques et le droit, Une approche juridique des systèmes complexes*, Thèse, 2016, p. 52.

[5] Here, we can cite a recent judgement by the *Cour de Cassation* (the French supreme court) which refused, under the terms of Article L. 162-1 of the French Environmental Code, to uphold the environmental liability of a vehicle-trekking company for the reason that the Court of Appeal had not determined "whether the company's business activity (...) came within the scope of that covered by compensation of damage caused to the environment" (Cass. 3ème civ., 29 septembre 2016, n° de pourvoi : 15-20048).

[6] Art. L. 161-1-I-4° C. env.

[7] Art. L. 162-1 C. env.

[8] Art. L. 162-2 C. env.

[9] Art. L. 161-2 C. env.

[10] Art. L. 161-9 C. env.

[11] Art. L. 162-1-1° du code précité.

[12] Art. L. 161-1-I-4° C. env.

special, environmental-liability regime to disappear, but of arguing that it is insufficient. This deficiency has undoubtedly led legislators to react by enshrining recently, on the one hand, compensation for ecological damage within the French Civil Code[13], and, on the other, by consolidating existing legislation, through the creation of a provision for class action in environmental matters[14].

While the terms “ecological services” or “ecosystem services” is not expressly used in the text on the new class action, there is every reason to believe that such actions are fully covered by them because Article L. 142-3 -1-II of the French Environmental Code covers all forms of harm arising from damage in the areas referred to in Article L. 142-2 of the code. Now, given that it is nature that is in question here, i.e. the environment, it is clear that damage to ecological services falls within the scope of this newly created class action. However, things are much clearer when we consider forms of civil liability due to illegal acts, designed to compensate for ecological damage under the French Civil Code. Indeed, Article 1247 of the code states that “...ecological harm, consisting of non-negligible damage (...) to the collective benefits derived by society from the environment, constitutes legitimate grounds for repair”. Although Article 1247 does not use the term "ecological services" or “ecosystem services”, collective societal benefits derived from the environment are certainly synonymous with them to the extent that the benefits correspond to services – i.e. to the benefits that society derives from ecosystems, which are handled more clumsily in the French Civil Code through its reference to the environment. The anthropocentric nature[15] of the text leaves no doubt that ecosystem services fall within the sphere of civil liability due to illegal acts, as laid down in Article 1246, and the following articles, of the French Civil Code. Therefore, the question is no longer whether ecological services are covered by Article 1247 of the aforementioned code, but whether the reference to ecological harm, in particular that caused by the degradation of such services, influences civil liability due to illegal acts.

The answer for the legislators responsible for the Article in question is obvious: most certainly. Most certainly, because, in civil liability, ecosystem services not only influence the conditions for implementing civil liability (§1) but also the liability regime itself (§2).

1. The impact of ecosystem services on the conditions for implementing civil liability

The implementation of civil liability requires three cumulative conditions: an operative event, damage, and a causal link between the first two elements. However, the inclusion of ecosystem services in civil liability offers an opportunity to rethink at least two of these fundamental conditions. On the one hand, because harm necessarily requires damage, while damage does not automatically result in harm,

[13] Cf. art. 1246 et s. Civil code, loi n° 2016-1087 du 8 août 2016 pour la reconquête de la biodiversité, de la nature et des paysages.
[14] Cf. art. L. 142-3-1 Environmental Code, loi n° 2016-1547 du 18 novembre 2016 de modernisation de la justice du XXIe siècle.
[15] M. Fèvre, *op. cit.*, p. 37.

there is a need to know whether ecosystem services - the collective benefits that society derives from the environment - constitute damage or harm. In other words, ecosystem services provide an opportunity to clarify, once again, the distinction between damage and harm (1.1). On the other, civil liability has always been considered from the starting point of operative events: personal actions, the action of things, and vicarious actions. However, it is striking to note that civil liability, in relation to ecosystem services, rather ignores the operative event, taking account only of the nature of the damage. Such indifference again raises the question of the scope for constructing civil liability regimes not on the basis of operative events, but on the nature of the damage. Therefore, ecosystem services provide an opportunity to rethink, perhaps to its detriment, the nature of civil liability itself (1.2).

1.1. Using ecosystem services to distinguish between damage and harm

The drafting of article 1247 of the French Civil Code provides an opportunity to highlight the distinction made in some academic thinking between damage and harm[16]: damage refers to the injury itself, whereas harm refers to the consequences – patrimonial or other– of the injury. Article 1247 C. states that "ecological harm, consisting of significant damage to the elements or functions of ecosystems or the collective benefits derived by society from the environment, (...) constitutes grounds for repair. Given this, we would have to conclude that damage to the elements of ecosystems, as well as to their functions or the collective benefits derived by society from the environment, all constitute ecological harm. Yet, if we look more closely, legislators are confusing damage and harm here, by giving each the same weight.

Ecological harm would initially be established if there is damage to elements of ecosystems. However, an ecosystem is defined as a "dynamic complex of plants, animals and microorganisms and their non-living environments which, by their interaction, form a functional unit"[17]. In other words, this would comprise damaging one of these elements and consequently, for example, causing damage to a plant that is part of the ecosystem being considered. The ecological harm would then consist of damage to the ecosystem's functions, i.e. its functional manifestations. Ecological harm could, lastly, be established in a case of damage to the collective benefits derived by society from the environment, i.e. the ecosystem services or functional manifestations of ecosystems that are useful to society. So, let us again take up the distinction between damage and harm supported by some academic thinking in this area. Damage refers to the injury itself, i.e. the property damaged, while harm aims to determine the consequences of the injury, i.e. the loss in utility from the property as a result of the damage[18]. Hence, we can say that damage to the elements of the

[16] "Damage, strictly speaking, refers to the injury suffered, which has to be assessed where it occurs, whereas harm, which is the consequence of the injury, appears as the effect, or after-effect, of damage: damage to physical integrity, that is to say, bodily injury, may thus lead to patrimonial harm(...) and extra-patrimonial harm (...)" (Le Tourneau Ph. et al, *Droit de la responsabilité civile et des contrats, Régimes d'indemnisation*, Dalloz-action, 2017-2018, n° 1304). For a fuller discussion, see Article 1304, and the following articles, of the code.

[17] Cf. glossaire Ecosystème(s).

[18] The modern theory of property (théorisée par les professeurs Zénati-Castaing F. et Revet Th., *Les biens,* PUF, 3e ed., 2008) defines things in two ways. On the one hand, property is defined objectively in the sense that it is a quality of a property belonging to a person. This conception invites us to return

ecosystems only enables us to identify the property that has been damaged as a result of the harmful event, i.e. the damage to ecosystem elements. Conversely, the undermining of the collective benefits that society derives from ecosystems tends to highlight no longer the damage itself but the harm to elements of ecosystems resulting from the damage, i.e. the lost, or at least degraded, functions or utilities of ecosystems. It follows from this analysis that legislators, by means of Article 1247 of the French Civil Code, create an unfortunate confusion between damage and harm; damage does not necessarily lead to harm : damage to the elements of ecosystems does not inevitably result in the degradation or loss of an ecosystem function or service. In other words, while it is fundamental for establishing civil liability, to stress the property that has been damaged, in this case the ecosystem, it is useless, in terms of the conditions for implementation, to then list the forms of repairable harm for the simple reason that the purpose of civil liability, when invoked, is to repair all harm, such as, for example, the degradation, or loss, of ecosystem functions, or the collective benefits derived by society from such ecosystems.

On the other, legislators, by assigning the same importance to damage, to the functions of ecosystems and to the collective benefits derived by them from society, have at least clarified the distinction between these two types of harm which are, *a priori*, reparable. In her thesis, Mme. Fèvre makes a clear distinction between the two since, according to her, "a function takes the form of a service only when social practices and needs recognise a service as such, i.e. when the function is useful in terms of meeting a societal need, or, more generally, to furthering society's well-being, not that of a natural entity"[19]. In other words, ecosystems have both intrinsic utilities - ecosystem functions - and extrinsic utilities - collective benefits derived by society - because they benefit society and are consequently perceived as doing so. To put it another way, an ecosystem has its own functions that benefit either other ecosystems (intrinsic utility) or society (extrinsic utility). This distinction echoes the proposal made by Professor Guillaume Beaussonie, who sees, in ecosystem services, the extrinsic utilities of a property - i.e. an ecosystem – "whose particularity is that it benefits everyone, beyond any benefits to its single owner, who cannot prevent such benefits from being derived."[20] Also, it is, without doubt, because of this particularity - a utility that benefits all - that it is difficult to deal with repairable damage in terms of civil liability, insofar as the former is founded on the concept that repairable harm must relate to a person, whereas ecosystem services are considered to be collective benefits.

The degradation or loss of ecosystem functions, in terms of repairable harm, certainly comes up against a requirement for personal civil liability, except for the

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to the concept of a property. In terms of the modern academic thinking on property, a thing becomes a property, subject to the law, only as a result of the fact that it can be usefully alienated. On the other, it is subjectively defined as the exclusive relationship between a legal person and a property, a relationship which allows the holder to exploit all the utilities that the property offers. Also, if we accept that property, the foundation of all subjective rights, is protected by civil liability (Cf. Jean S., *La protection des droits subjectifs par la responsabilité civile*, Thèse, Toulouse, 2012) in addition to the pursuit of specific actions, we may thenreconcile perfectly, on the one hand, the damage and the property, which is subject to a subjective right, and, on the other, the harm and the utility. Thus, damage makes it possible to designate, for the purpose of determining liability, the property damaged, while harm enables the identification of the degraded or lost utility of the property resulting from the damage.

[19] M. Fèvre, *op. cit.*, p. 49.

[20] Beaussonie G., « The legal definition of ecosystem services ».

consideration, as put forward by Professor Mireille Bacache, that the adaptation of civil liability to accompany the development of compensatory needs will have to be satisfied with a requirement for there to have been objective harm[21]; and the same problem arises when it comes to considering the degradation, or loss, of collective benefits derived by society from the environment. Indeed, as Professor Mustapha Mekki points out, ecological harm, whether it be collective or individual, may be either concrete or subjective[22]. We can consider, then, that victims, as individuals, can seek, on the basis of an operative event establishing civil liability according to the French Civil Code[23] (personal actions, the action of things, and vicarious actions); that is to say, compensation for personal harm suffered, on condition that they can demonstrate that they have suffered the loss of an ecosystem service, i.e. a utility of their property which may be collective but must also be individual. On the other hand, matters become more complicated when it comes to obtaining compensation for the degradation or loss of ecosystem services as referred to in Article 1247 of the French Civil Code. Defining environmental benefits as collective inevitably comes into conflict with the conventional conception of civil liability which requires harm to be of a personal nature. However, Article 1246, and the following articles, of the French Civil Code offer no scope for compensating for individual harm. This can be clearly seen by listing the persons who are authorised to act in such matters – public authorities such as the French Agency for Biodiversity – or by considering the compensation regime itself, including how damages and interest are allocated. Thus, there are only two alternatives: either compensation for ecological harm covering ecosystem services leads to the distortion, or at least the adaptation, of civil liability under Article 1246, and the following articles, of the French Civil Code or, strictly speaking, what is in question is not civil liability. In any event, ecosystem services offer an opportunity to rethink not only the conditions of civil liability but also the concept of civil liability itself.

1.2. The use of ecosystem services to the detriment of civil liability itself

Those with an interest in civil liability law know that it has always been able to adapt to the compensatory requirements of its time. There are effectively two ways to succeed in this feat, which sometimes work in combination ; either on the grounds of civil liability, by facilitating, for example, compensation for bodily injury; or by focusing on the conditions for the implementation of civil liability. In the latter case, it is possible, for example, to select an operative event that is easier to substantiate, to recognise new damage that may be repaired, or to reduce the requirement to establish the causal link. Also, if we want to accept that civil liability, when it is implemented to compensate for damage, whether this be individual or collective, remains civil liability, then it is important that these conditions of implementation be adapted to the intended purpose, on condition, however, that such conditions remain valid. Therefore, nothing prevents ecological damage, in this case the degradation or loss of

[21] Bacache M., « L'action de groupe en matière environnementale », *Énergie - Environnement – Infrastructures*, n° 3, Mars 2017, étude 8, n° 24 et s.
[22] Mekki M., « Responsabilité civile et droit de l'environnement. – Vers un droit spécial de la responsabilité civile environnementale ? », *Responsabilité civile et assurances*, n° 5, Mai 2017, dossier 4, n° 17.
[23] With the exception of Articles 1246 to 1252 of the French Civil Code.

collective benefits to society, from being covered by civil liability, even if this would be special form of civil liability, as legislators intended by dedicating a specific chapter to it in the French Civil Code. Consequently, ecosystem services are better candidates for a rethinking of civil liability, than for removal from civil liability regimes altogether.

Civil liability has always been considered from the starting point of an operative event. As a result, the French Civil Code lists civil liability regimes based on personal actions, the action of things, and vicarious actions. However, certain academic researchers working on the subject have been calling for decades for the construction of civil liability regimes that are no longer based on an operative event but on the nature of the damage[24]. In fact, positive law already does so under some civil liability regimes since, for example, victims of road accidents are certain to obtain compensation for damage resulting from bodily injury even if they have committed a fault provided that the fault is not inexcusable and is not the exclusive cause of the accident, whereas those same victims will obtain limited, or no, compensation for other types of damage[25]. The determination of a *ratio legis* adapted to the nature of the damage is in accordance with the historical development of civil liability. Moreover, the Chancery's civil liability reform project moves in this direction, in that, for example, specific rules are laid down according to whether the damage results from material or bodily injury[26]. This being the case, taking into account the nature of the damage is currently only envisaged when deciding which civil liability regime applies, not when considering the conditions for its implementation However, it seems possible, with the insertion of compensation for ecosystem services, to conceive of a form of civil liability based exclusively on damage.

This is not a new idea since Boris Starck, in his thesis on the theory of guarantees, has already proposed a hierarchy of protected interests - according to the German system - by determining the type of damage[27]. According to this, some academic thinkers consider that damage to the body - i.e. bodily injury - is the higher protected interest, in such a way that it would justify specific treatment to benefit victims. Conversely, other types of damage, because they constitute less important interests, would require, at the same time or alternatively, more stringent conditions for civil liability, such as a fault, or a less benign civil liability regime, such as, for example, the requirement of a minimum value for the damage, when the latter is material[28]. What is striking in terms of ecosystem services, when it comes to invoking civil liability covered in Article 1246, and the following articles, of the French Civil Code, is that no specific operative event is required. In other words, the nature of the operative event does not matter since, to invoke this form of civil liability, it suffices that ecological damage, i.e. damage to an ecosystem, has occurred.

Conversely, the wording of Article 1247 of the French Civil Code provides information about the role that legislators intended it to have, in terms of a hierarchy

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[24] Starck B., *Essai d'une théorie générale de la responsabilité civile considérée en sa double fonction de garantie et de peine privée*, thèse, éd. Rodstein, 1947.

[25] Art. 3 et 5 de la loi n°85-677 du 5 juillet 1985 tendant à l'amélioration de la situation des victimes d'accidents de la circulation et à l'accélération des procédures d'indemnisation.

[26] Cf. art. 1267 et suivants reform project, march 13, 2017.

[27] Starck B., *op. cit.*

[28] This is already the case for defective products when the damage must have a value greater than 500 euros.

of protected interests. In fact, the provisions require “non-negligible” damage to the elements of the ecosystems. In other words, it is not enough for ecological damage to merely occur, it must be ecological damage of a certain gravity. While the idea of the gravity of damage is not unknown in civil liability, as it makes it possible to differentiate how damage is dealt with under certain liability regimes (that covering defective products, for example), there was not, until compensation for environmental damage was enshrined in the French Civil Code, any requirement for its use as a condition for implementation in civil liability regimes. This new feature leads to the conclusion that the environment is not the most important protected interest, at least for civil liability. A requirement for the gravity of damage to be used when determining the conditions of implementation of civil liability is deplorable in at least two respects. Firstly, as Mr. Huglo suggests, a “small” injury can lead to “great” harm, while a “large” injury can lead to a "small” degree of harm[29]. And secondly, the gravity of ecological damage tends to result in unequal treatment - again when considering the conditions for the implementation of civil liability - since the civil liability referred to in Article 1246, and the following articles, of the French Civil Code does not allow, in particular, compensation for the degradation or loss of the collective benefits derived by society from the environment, when the harm does not relate to individual persons. However, it is very easy to imagine that victims of this same harm might claim compensation because it is personal and affects them as individuals. If this is the case, victims will certainly have to rely on another civil liability regime in the French Civil Code, but the gravity of the ecological damage will not be required when considering the conditions for implementation under the chosen civil liability regime. This option does not mean that the protected interest - the ecosystem - has been prioritised in a way that leads to the victims being treated unequally, to the extent that the collective benefits derived by society can be both collective, and individual, extrinsic utilities. Ultimately, then, ecosystem services certainly have an impact on the conditions under which civil liability is implemented. It remains to be seen if this is also the case when we consider the civil liability regime itself.

2. The impact of ecosystem services on the civil liability regime

Ecosystem services, when grounds of ecological damage are involved, also have an impact on the civil liability regime, on at least two levels. On the one hand, when it comes to considering the procedural aspects of an action, which certainly are not prohibitive in terms of the action’s effectiveness, but which must be clarified in order to have a coherent basis when dealing with the ecological damage (2.1). On the other, the same observation, this time much more inconveniently, must be made about the compensation itself, in terms of which the regime is at present unsatisfactory, or at least offers scant incentive to take action (2.2).

[29] Huglo Ch., « La difficile application de la réparation du préjudice écologique devant le juge », *Énergie - Environnement – Infrastructures*, n° 6, Juin 2017, dossier 15, n° 3.

2.1. Ecosystem services at the action stage of civil liability

Article 1248 of the French Civil Code states that "action to compensate for ecological damage is open to any person having the legal standing and interest to act, such as the State, the French Agency for Biodiversity, local and regional authorities and their consortia whose territories are affected, as well as public organisations and associations that have been approved, or established, for at least five years at the date of the start of proceedings, and whose purpose is the protection of nature and/or the environment". This provision, which must, in particular, allow compensation for the degradation or loss of ecosystem services, provides an opportunity to highlight the procedural aspects of civil liability actions[30]. Given the requirement of legal standing and interest to act, we must focus on the issue of the combination of actions.

As a matter of principle, the combination of these two procedural conditions is not a requirement insofar as, in accordance with Article 31 of the French Code of Civil Procedure, once the interest to act has been established, there is no need to demonstrate the corresponding legal standing. It is only by exception, when only a specific person or persons is, or are, entitled to take action that legislators offer the option of meeting the conditions for legal standing to act in order to defend the interests of persons deemed as not having a personal interest to act. Yet, Article 1248 does not follow suit because both standing and interest are required. We can only hope that this is a result of clumsy drafting since it is difficult to see why legislators would have drawn up a list[31] of persons with the legal standing to act, only to require that they also demonstrate that they have an interest to act. It makes more sense to believe that legislators wanted to separate these two conditions. On the one hand, the persons listed as having the legal standing to act need not demonstrate their interest to act ; but on the other, all other persons have to show an interest to act, from which their legal standing to act will be deduced. However, regular recourse to such actions for compensation for collective harm, without the addition of an action for the compensation of personal harm, seems unlikely, except if we deem that altruistic motives alone can overcome inertia among those with nothing personal to gain. Also, one should rely rather on a combination of actions in order to obtain compensation, in particular, for the degradation or loss of an ecosystem service.

If we put aside environmental liability, which acts as a weak form of regulatory enforcement, several civil actions can operate cumulatively when they do not pursue the same ends, even when it comes to obtaining compensation for harm arising from environmental damage. Indeed, several interests may be harmed as a result of the same bodily injury : those of persons who personally suffer harm and who must then submit claims, either individually by resorting to one of the forms of civil liability covered by the French Civil Code, with the exception of those set out in Articles 1246 to 1252, or through a class action under Article L. 142-3-1 of the French Environmental Code; and those of people who suffer collective harm and who will then have to bring their action on the basis of Article 1246, and the following articles, of the French Civil Code. It is at this stage that it is essential to define the harm done and this could be based on a classification of environmental harms[32] to

[30] This question is not considered in detail as part of this work, but it should nevertheless be noted that there is a risk of confusion between the admissibility and the merits of the action. In this respect,
[31] *A priori* non-exhaustive by the use of the phrase "such as".
[32] Neyret L. et Martin G.-J., *Nomenclature des préjudices environnementaux*, LGDJ, 2012.

determine the scope of possible claims. Once these have been identified, nothing prevents claims being made in combination, at least when it comes to distinguishing between collective and individual harm; compensation for the first would be sought on the basis of Articles 1246 to 1252 of the French Civil Code, and the latter would require either recourse to an individual action based on an operative event recognised by the French Civil Code - with the exception of Article 1246, and the following articles, – or a class action based on Article 142-3-1 of the French Environmental Code. Having said that, special care must be taken in this latter case. A combination of actions is possible here because this is clearly stipulated in law. Indeed, decisions made on the basis of a class action have *res judicata* standing, but only with respect to members of the class, and in such a way that this does not prohibit those who claim to have suffered personal injury from acting individually. Moreover, members of the class cannot find themselves blocked by this *res judicata* standing in the sense that they can still act individually with respect to a personal injury that has not featured in the decision based on the class action. Therefore, subject to the determination of the scope of repairable harm and an interpretation consistent with the distinction between interest and legal standing, the law has a range of instruments that can be marshalled to deal with environmental damage, and, hence, the degradation or loss of collective benefits derived by society from the environment. Having said that, an analysis of the civil liability regime shows that enthusiasm should be tempered when it comes to considering compensation for harm.

2.2. Ecosystem services when considering compensation

In terms of damage to the collective benefits derived by society from the environment, once these have been identified and measured, the French Civil Code has ranked the means of compensation by giving priority, according to Article 1249, paragraph 1[33], to compensation in kind, which is the form most consistent with the idea of compensation, since it involves offsetting the harm. Also, it is only failing this, i.e. in the event of such compensation being impossible or insufficient, that a claim for damages and interest can be submitted. There is nothing particular to add about in-kind compensation since it has the merit of matching the harm suffered. In other words, if in-kind compensation consists in restoring a lost ecosystem service, then that form of liability has played its role in full.

On the other hand, where compensation is paid in the form of damages and interest, it is not certain that civil liability will enable the victim's situation to be restored even if, by breaching the principle of the non-allocation of damages and interest[34], monies

[33] Art. 1249, paragraph 1, C civ.: "Compensation for ecological damage sets a priority on compensation in kind."

[34] Cass. crim., feb., 22, 1995, *Bull. crim.* 1995, n° 77. Judges would exceed their powers if they were to decide on the allocation of the damages and interest awarded to the victim. The solution arises not only from the function of the damages and interest, because their aim is to provide the victim with the means to obtain satisfactory replacemeents, but also from the principle that each person is free to manage his/her property as he/she wishes : Cass. 2ème civ., july, 8, 2004, *Bull. civ.* 2004, II, n° 391 : "The principle of full reparation does not imply control over the use of the monies allocated to victims; the latter retain their right to use them freely". The Chancellery initiative to reform civil liability is also moving in this direction, given that Article 1264 states that "the victim is free to dispose [as he/she sees fit] of the sums allocated".

are set aside for restoring the environment. Beyond any breach of the principle of non-allocation, the allocation of damages and interest, as provided for by legislators, may not achieve the objective sought given the potential for a mismatch between the harm suffered and the allocation made. Article 1249 (2) of the French Civil Code states that "in the event of the impossibility of law or fact or insufficiency of the compensation measures, the judge will order the person liable to pay damages and interest, allocated to restoringthe environment, or to the plaintiff or, if the plaintiff cannot implement the necessary measures to that end, to the public authorities". However, as Professor Mathilde Hautereau-Boutonnet rightly points out, allocation which covers such a broad scope as "the environment" can lead to "the damages and interests not being used to repair the ecological harm determined during the litigation process, but to repair the environment more generally, beyond this specific harm."[35] The risk is higher in the case of an action with multiple plaintiffs. In such a case, it is certain that the sum awarded to compensate for the same ecological harm, once divided among the various plaintiffs, may be allocated not necessarily for repairing the environmental harm suffered but for repairing the environment which means that in the end, it is possible that it will be the collective, rather than ecological, harm suffered, that will be compensated. How real is the risk of a mismatch between the allocation of damages and interests and the harm suffered ? Very real, when the damages and interest are affected by the impossibility, or insufficiency, of compensation in kind! Judges may first come up against a *de facto* impossibility because of the complexity of the measures that would have to be implemented to attempt to repair the harm suffered ; they may then find that the law does not enable such measures, for example, in cases of separate judicial and administrative authorities where the measures envisaged severely contradict an administrative authorisation issued; lastly, judges have very wide powers given that the mere observation of the inadequacy of the measures to be taken offers the option of awarding damages and interest. It is, therefore, regrettable that legislators have not given themselves the means of ensuring that the allocation of damages and interest matches the ecological harm suffered because they have added the further complexity of an impractical regime[36], to the complexity involved in understanding ideas such as ecosystem services when considering the conditions for civil liability. Moreover, the recourse to damages in the case of a plurality of plaintiffs for the same civil-liability action, based on Article 1246, and the following articles, of the French Civil Code, coupled with other civil-liability actions, this time seeking compensation for personal harm through a class action under Article L. 142-3 of the French Environmental Code or based on personal actions, the action of things, and vicarious actions under the civil code, can lead to a legal tangle. Beyond the difficulty of identifying the causes of repairable harm, it is the multiple allocation of damages and interest to the various victims that risks coming up against the principle of full compensation, if the sums awarded exceed the cost of repairing the harm done. Yet, for the time being[37], punitive damages and interest are not allowed, and even if they were, it would be appropriate, at least for actions based on Articles 1246, and the following articles, of the French Civil Code, for them to be justified not on the basis

[35] Hautereau-Boutonnet M., « Quelle action en responsabilité civile pour la réparation du préjudice écologique ? », *Énergie - Environnement – Infrastructures*, n° 6, Juin 2017, dossier 14, n° 20.
[36] For some solutions to address these difficulties, cf. Hautereau-Boutonnet M., *ibid.*, n° 23.
[37] The civil-liability reform initiative of the *Chancellerie (*another term for The French Ministry of Justice, cf. http://www.justice.gouv.fr/histoire-et-patrimoine-10050/chancellerie-garde-des-sceaux-aux-origines-des-mots-23874.html), presented on 13 March 2017, provides for this in article 1266-1.

of the gravity of the damage but on that of the operative fact which necessarily involves fault.

This analysis shows that the integration of ecosystem services, by invoking ecological harm, certainly influences civil liability, either because it forces it to be adapted or even distorted, or because it suggests that the civil liability regime be reviewed. If, for the time being, such civil liability seems to be insufficiently precise for it to be efficient, both in terms of the conditions for its implementation and in terms of the regime itself, it must be recognised that it opens, or reopens, the possibility of shaping a civil liability regime adapted to the challenges of the 21st century, under which a main priority would be the maintenance of financing a compensation policy based on harm suffered, and the preservation of an interest much greater than personal injury: the environment. There are many ways to do this that fall both outside of and within the scope of the civil liability regime. It is reassuring to see that the civil liability regime is being adapted by creating new tools, such as, the enshrinement - in cases of ecological damage - of a truly substantial and autonomous action to prevent illicit practices[38], with the prospect of also developing instruments for the future that recognise punitive damages and interest.

[38] Article 1252 of the French Civil Code provides that "irrespective of compensation for environmental harm, a judge, who is minded to address a request to that effect by a person mentioned in Article 1248, may prescribe reasonable measures to prevent or stop the damage".

ANNEXES

GENERAL GLOSSARY

The following definitions correspond to those which are the most widely found in international publications, whether they be institutional reports or research papers. There is not always a consensus about them, so we have indicated some controversial points without attempting to resolve the debate.

Soil conservation agriculture

The United Nations *Food and Agriculture Organisation*[1] gives a formal definition of conservation agriculture based on three inseparable principles, namely :

- crop rotations (extended and diversified)
- permanent organic soil cover
- nominal soil disturbance

The extension and diversification of crop rotation is the first measure to be taken for any agroecological approach. Complex, well-managed crop rotation makes it possible to avoid soil compaction problems, diseases and perennial weeds. It also plays an important role in maintaining fertility while limiting pest risk. In addition to diversified crop rotation, Conservation Agriculture promotes the establishment of vegetation cover in between crops, while maintaining crop residues *in situ*. The soil is thus permanently covered by a living or dead (mulch) organic cover which protects it against mechanical destruction by rain, acts as a barrier against wind and regulates the temperature at the soil surface. This cover is a key factor in fertilisation management, due particularly to the inclusion of Fabaceae species (which symbiotically fix atmospheric nitrogen). Finally, conservation agriculture requires minimal soil disturbance. The strategic objective is to protect the surface layer, between 0 and 20 cm in depth, which is the most biologically active zone, but also the one most vulnerable to erosion. Many essential biological functions and ecosystem services depend on the living organisms in this zone.

The practical definition of conservation agriculture is still subject to debate and there is as yet no legal or regulatory definition of it.

Agroecology

The term was introduced for the first time in a scientific publication in 1928, by B.M. Bensin[2], a Russian agronomist stationed in the USA. His aim was to define the use of ecological concepts for agronomical research. The preoccupations that led to its development at the time were the fight against erosion and diffuse pollution.

It is commonly accepted that agroecology has three dimensions, being a scientific discipline, a social movement and a set of agricultural practices[3].

Only the last dimension has been integrated in law, i.e. the set of practices which constitute so-called agroecological production systems. Agroecology is defined in Article 1 of the Act of 13 October 2014 on the future of agriculture, food and forests as “agroecological production systems whose organic production methods combine economic and social efficiency, particularly by offering a high level of social, environmental and sanitary protection”. In more practical terms, “these systems favour the autonomy of farms and improve their competitiveness, by maintaining or increasing their economic profitability, by improving the

[1] FAO, 2015, *The main principles of conservation agriculture*, http://www.fao.org/ag/ca/

[2] Bensin, B.M, 1928, *Agroecological characteristics: description and classification of the local corn varieties' chorotypes*, Publisher unknown.

[3] Wezel A, Bellon S, Doré T, et al., 2009, Agroecology as a science, a movement and a practice. A review. *Agronomy for Sustainable Development*, 29, 503–515.

added value of produce and by reducing the consumption of power, water, fertiliser, plant protection products and veterinary medicines, particularly antibiotics. They are based on biological interactions and the use of ecosystem services as well as on the potential of natural resources, particularly that of water, biodiversity, photosynthesis, soils and air, by maintaining their capacity to renew themselves qualitatively and quantitatively. They also help to attenuate the effects of climate change while facilitating adaptation.
The development of these agroecological systems is underpinned by the scientific discipline of agroecology. Agroecology aims to modernise agriculture by increasing its economic, environmental and social efficiency while keeping a critical eye on all types of agriculture, from the most intensive to the most extensive. More than simply being a "science for applying ecological concepts for the implementation of sustainable production systems"[4], agroecology cuts across disciplines, integrating agronomy, ecology, sociology and economics in order to study interactions between plants, animals, human beings and the environment at different scales of food production systems, "from seed to table".
Agroecology is also recognised as being both a social and even a political movement. Initiated in the 1960s, following the green revolution and growing awareness of the negative impact of industrial agriculture on ecosystems, a wide range of stakeholders, politicians, producers and consumers have adopted this agroecological approach. This dimension will not however be directly dealt with in this book.

Biodiversity
The French governmental order defining the official vocabulary of the environment (JORF [French government gazette] on 12 April 2009, page 6438), classifies 'biodiversity' and 'biological diversity' as synonyms. Biodiversity corresponds to the "diversity of living organisms, which is appraised by considering the diversity of species and of genes within each species, as well as the organisation and distribution of ecosystems".
From the ecologists' point of view, this definition fails to include the functional component of biodiversity, i.e. the diversity of ecological functions. Indeed, the diversity of living organisms is not in itself a sufficient condition for ensuring the diversity and resilience of ecological functions; functions which are both indispensable for maintaining the state of the system and for supporting the ecosystem services from which society benefits.

Ecological offsetting
Offsetting may take different forms, but in all situations, conveys the idea of rebalancing: an advantage which compensates for a disadvantage. This objective of ecological neutrality implies being able to measure the aforementioned advantages and disadvantages and then ensuring that the offsetting compensates, both in quantity and quality, for the deterioration, as long as necessary until the damaging actions have ceased. In other words, the results of the offsetting should be equal, in ecological terms to the losses caused by the impact of a given project.

Disservice(s)
Disservices correspond to various states or processes related to the functioning of ecosystems which, unlike ecosystem services, are considered to have a negative effect for people. In the example given by Mark Sagoff in 2011, a farmer of almond trees considers pollination to be a service whereas his neighbour, who produces self-fertilised mandarin orange trees, sees it as a disservice. This is because the second producer has invested in trees that produce mandarins without pips (seeds) which can be sold at a higher price, whereas pollination encourages the

[4] Gliessman SR, 2006, *Agroecology: The Ecology of Sustainable Food Systems*. New York, USA, CRC Press Taylor & Francis, New York.

return of mandarin orange trees that produce fruits with pips[5].
This definition is not very clear, which makes it both controversial and not especially useful. Firstly, what some people think is a service may be perceived by others as a disservice, as shown by the example above. Secondly, societal advantages tend to be considered only over the short or medium term. So, an immediate disservice may turn out to be a service in the long run and, conversely, an immediate service may turn out to be a disservice in the future because of the overall evolution of the environment or society. Finally, a disservice to society might turn out to be beneficial for the functioning of the ecosystem. For example, fire is likely to reinforce the resilience of an ecosystem.

Ecosystem(s)
An ecosystem is a "Dynamic complex of plants, animals and micro-organisms and their non-living environments which, by their interaction, form a functional unit".
The limits which physically define an ecosystem are often arbitrary, as the functional unit may vary according to the scale on which the work is done (from very local to national or even global, according to the organisms/processes studied) and the level of accuracy adopted.

Ecological processes and functions
Ecosystems may be grasped and understood through a series of interlocking elements: the entities that comprise them (for example, the animal and plant species, and their breeds and varieties), the processes in which these entities play a part (for example, plant reproduction and nectar gathering by bees) and the functions generated by these processes (for example, pollination).
These phenomena are fundamentally important for the equilibrium and functioning of ecosystems (such as the nutrition cycle, formation of soils, primary production, etc.) and occur independently of any possible human beneficiary.
The formal distinction between ecological processes and functions is still sometimes controversial (see, for example, the definitions of MEA 2005, TEEB 2010[6] or the CGDD 2010[7] - a French agency of the Ministry for Ecological Transition and Solidarity, responsible for promoting sustainable development), nevertheless, both these terms refer to an ecocentric vision of the functioning of ecosystems and describe phenomena that are specific to the ecosystem and necessary for maintaining its ecological, physical and chemical state; this is unlike the concept of ecosystem service, which, being anthropocentric, necessarily refers to something that is of use or benefit to society.
There is no definition in law of the concept of "ecological functions". In the absence of prescriptive texts, academics have recently described ecological functions as the "interaction between biological and physical elements, and processes that maintain ecosystems and their functioning". The same book specifies that "the ecological functions of soils include the role they play in ecosystems, such as: serving as a breeding ground for biodiversity; contributing to the storage, filtering and transformation of nutrients, substances and water, the replenishing of groundwater; and carbon sequestration or regulation"[8].

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[5] Sagoff M., 2011, "The Quantification and Valuation of Ecosystem Services", *Ecological Economics*, 70 (3), pp. 497-502
[6] The Economics of Ecosystems and Biodiversity (TEEB), 2010. *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB*, Progress Press, Malta.
[7] *Projet de caractérisation des fonctions écologiques des milieux en France* [Project for characterising ecological functions of environments in France.] *Service de l'économie, de l'évaluation, et de l'intégration du développement durable, Etudes et Documents.*[Department for Economics, Assessment and Integration of Sustainable Development, studies and documents].
[8] Neyret L. and Martin G.-J. (dir.), *Nomenclature des prejudices environnementaux [*Nomenclature of

However, it should already be noted that the distinction between ecological function and ecosystems service is an unwieldy one. Indeed, the ecological function (which, moreover, results from several processes) only becomes a 'service' if society can potentially derive some advantage from it. Some authors criticise the abusive use of the term "ecosystem service" to refer to functions that ultimately do not benefit society. This is particularly true for some regulation services, and services related to the functioning of soils for which people have to invest in order for the ecological function (for example predation by aphids) to be considered and valued as an ecosystem service (for example, the regulation of wheat pests, which is only a benefit if the wheat is harvested).

Quality/health of soils

The health of soils may be defined as the capacity of the soil to function over a long period of time, like a living system, both within the limits of its ecosystem and with its external environment (*Dictionnaire d'Agroécologie de l'INRA [INRA Dictionary of Agroecology]*, 2017[9]).

It concerns, in particular, the capacity of the soil ecosystem to support the plant production necessary for the long-term survival of the ecological functions of the natural or cultivated ecosystem, while contributing to the qualitative and quantitative preservation of natural resources such as air, water and biodiversity.

Part of the scientific community makes a distinction between this idea and that of the quality of soils which mainly focuses on the physicochemical properties of soils, while others consider the two concepts to be synonyms.

In any event, the preservation and improvement of the health of soils, through both their biotic and abiotic components, are now recognised as key factors in any conception of sustainable agronomic systems.

For the moment, neither the quality nor the health of soils are defined in law.

Ecosystem service(s)

The definition of the concept of ecosystem service is still controversial. The definition and classification put forward by the Millennium Ecosystem Assessment (MEA) in 2005 are today much criticised even though several authors continue to refer to them.

In this book we shall again define the conceptual framework presented and discussed by the French General Commissariat for Sustainable Development (a government agency that provides data and understanding in this area) as part of the French evaluation of ecosystems and ecosystem services (EFESE). In its interim report[10], "the EFESE defines ecosystem goods and services as socio-economic advantages drawn by society from the sustainable use of the ecological functions of ecosystems". This document also specifies that a service "is only an ecosystem service as a result of its close dependence on ecosystem functioning" and that "the characterisation of an advantage is key to the notion of service. […] An ecosystem service can thus be described by an ecological advantage or function. However, neither the ecological advantage nor the ecological function alone can characterise the service: this can only be done by relating the two elements".

Moreover, we shall use, as far as possible, the European Environment Agency's (EEA's) Common International Classification of Ecosystem Services (CICES), which divides ecosystem services into three categories:

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environmental harm], LGDJ, 2012, p16.

[9] http://dicoagroecologie.fr/

[10] EFESE: Rapport intermédiaire [Interim report]. Thema Analyses. December 2016. CGDD. *Service de l'économie, de l'évaluation, et de l'intégration du développement durable* [Department for the Economics, Assessment and Integration of Sustainable Development].

- Supply services - sometimes referred to as "take-home" services: the set of services of alienable goods (i.e. that can be bought and sold) that can be marketed such as clean water, wood, cereals, fruits and vegetables, etc.
- Regulation and maintenance services, which are indirect advantages of ecosystem functioning such as the pollination of crops, pest control, climate stabilisation or protection against natural disasters. These are generally services that are in the public interest and which do not generate alienable goods, even though this statement has to be tempered by the emergence of intangible personal property such as greenhouse gas quotas.
- Cultural and innovation services which are the recreational, aesthetic, educational, scientific and spiritual benefits derived from the functioning of ecosystems.

It should nevertheless be noted that they sometimes they refer to other categories, particularly "support services" such as those defined by the MEA (2005), which correspond to a category of services required for the production of other ecosystem services and which are thus not used directly by people. This category is no longer recognised by the predominant scientific community as belonging to the services category due to the fact that they cannot be directly related to a benefit, "support services […] are [thus] considered to be ecological functions in the EFESE, not ecosystem services".

Furthermore, in the case of agroecosystems, INRA's[11] collective scientific expertise report "Agriculture and biodiversity", supports another, more operational, classification of these same services, which is still widely used by agroecologists and distinguishes between three categories of ecosystem services: "(1) input services, which contribute to the supply of resources and to the maintenance of physicochemical supports for agricultural production [...] and services which regulate the positive or negative biotic interactions [...] ; (2) production services contributing to agricultural income: naturally this mainly concerns plant production, taking into account the quantity but also the stability over time and the quality of products, as well as animal production, once again including the quality of products; (3) services proffered but not included in indirect agricultural income, which include monitoring the quality of water, carbon sequestration, and the aesthetic value of landscapes".

As different authors have noted[12], three terms are frequently used, sometimes as if they were synonyms, and sometimes with clear distinctions: namely the concepts of ecosystem services, ecological services and environmental services. In this book we have followed the most common usage, and ecosystem services and ecological services are considered to be synonyms. On the other hand, since the concept of an environmental service is controversial, depending on the discipline involved, and because it has been discussed by jurists wishing to distinguish it from the concept of ecosystem services, we consider these two concepts to be different.

Environmental service(s)

The meaning of the term "environmental service" varies according to the authors and their disciplines. In agronomy, this term is regularly used as a synonym of "services produced, but not included, in direct agricultural income" (such as the creation of an aesthetically pleasing landscape or flood reduction in floodable grasslands upstream of a city) as presented by ESCo 2008 (INRA), and, as such is a subcategory of ecosystem services. For economists, on the other hand, these services correspond to positive externalities resulting from the actions of an

[11] Le Roux X, Barbault R., Baudry J., Burel F., Doussan I., Garnier E., Herzog F., Lavorel S., Lifran R., Roger Estrade J., Sarthou J.-P., Trommetter M., *Agriculture et biodiversité* [Agriculture and biodiversity] *Valoriser les synergies, 2008, Expertise scientifique collective, rapport* [Capitalising on synergies, 2000, Collective scientific expertise report], INRA.

[12] Lamarque P., Quétier, F. and Lavorel S., 2011, The diversity of the ecosystem services concept and its implication for their assessment and management, Comptes rendus Biologies [Biological reports], pp. 441-449.

actor. Moreover, in its definition[13], the FAO adopted this economic version of environmental services provided *via* externalities.
The EFESE defines environmental services as "services that actors provide to each other or to society as a whole (most often this involves exchanges of services between suppliers and beneficiaries), and which aim to reduce the pressure exerted on ecosystems or improve their functioning".
No legal standard has yet defined environmental services. In some of the discussions by jurists, they are considered to be advantages that people derive from the functioning of ecosystems following human intervention[14]. This conception of environmental service also explains that when people participate in the functioning of ecosystems, they may be paid for environmental services (PES).

Soil
Soil is the outermost layer of the Earth's crust, subjected to change and reconstitution through the combined action of water, air, temperature and living organisms. It is thus the main interface between the mineral and organic worlds and furthermore constitutes the most important habitat in the biosphere. It is a major natural resource, just like water and air, which, moreover, is not renewable due to its formation dynamics and extremely slow regeneration.
It is important in both socio-economic and environmental terms since it provides resources (food, biomass, and raw materials), support (human activities, landscape units, cultural heritage) and also storage, filtering and transformation of many substances (water and carbon, for which it is the world's main source of storage). Soil is subject to various threats of deterioration, such as erosion, the loss of organic matter, contamination, forced impermeability, compaction, the loss of biodiversity, salinization, flooding and landslides.
However, the law offers soil no complete and coherent protection.

Glossary of legal terms

The following definitions do not have any scientific significance; they are intended to facilitate dialogue between disciplines and to make it easier for non-jurists to read the book.

Property
Anything likely to be alienated (bought, sold)

Contract
A contract is a meeting of minds between two or more people for the purpose of creating, modifying, transmitting or ending obligations.

Current law in force
Body of law applicable at the present time.

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[13] FAO, 2007, *La situation mondiale de l'alimentation et de l'agriculture : payer les agriculteurs pour les services environnementaux*, Rome [The worldwide food and agriculture situation: paying farmers for environmental services]: FAO
[14] *Cf.* Fèvre M., *Les services écologiques et le droit. Une approche juridique des systèmes complexes*, thèse [Ecological services and law. A legal approach to complex systems. Thesis] Université Côte d'Azur, 2016, p. 27.

Doctrine
Legal literature.

Fruits
Property of all kind which periodically provides benefits, while not diminishing the substance of the property. It may be civil (such as rent from a farm lease), industrial, (such as the harvests of a field) or natural (such as wild strawberries).

Real estate
Property which, by nature, cannot be moved

Standard
Term which is generally accepted as being equivalent to a legal rule

Definition
Intellectual conceptualisation of a thing, an act, an event or situation falling into a pre-existing legal category from which it is then possible to determine the legal regime to be applied.

Real (referring to things and not persons)
One example is that of environmental 'real obligations' which concern a thing.

Regime
A set of rules applicable to a given legal category.

Easement:
In private law, this is an obligation imposed on real estate, with or without buildings (servient estate) for the benefit of another real estate belonging to a distinct owner (the dominant estate), such as, for example, the right of way. In public law, an administrative easement is an obligation affecting private properties for the benefit of the public interest, such as, for example, easements imposing obligations on a property within the perimeter of a drinking water catchment.

Selective bibliography

Books, thesis

- Angel M., La nature a-t-elle un prix ? Critique de l'évaluation des biens environnementaux, Presses des Mines, Paris, 1998
- Bispo A., Guellier C., Martin E., Sapijanskas J., Soubelet H. et Chenu C. (coord.), Les sols. Intégrer leur multifonctionnalité pour une gestion durable, Quae, coll. Savoir Faire, Versailles, 2016
- Boutonnet M. (dir.), Le contrat et l'environnement, Etude de droit interne, international et européen, PUAM, 2014
- Camproux-Duffrène M.-P. et Sohnle J. (sous la dir.), Marché et environnement, Bruylant, Bruxelles, 2014
- Cans Ch. (sous la dir.) La responsabilité environnementale. Prévention, imputation, réparation, Dalloz, Coll. Thèmes et commentaires, Paris, 2009
- Chabert A., Expression combinée des services écosystémiques en systèmes de production - agricole conventionnels et innovants : étude des déterminants agroécologiques de gestion du sol, des intrants et du paysage, Thèse Toulouse, INPT, 2017
- Chardeaux M.-A., Les choses communes, L.G.D.J., Bibliothèque de droit privé, Paris, 2006
- Coriat B. (sous la dir.), Le retour des communs, La crise de l'idéologie propriétaire, Les liens Qui Libèrent, Paris, 2015.
- Cornu M., Orsi F. et Rochfeld J. (sous la dir.), Dictionnaire des biens communs, Quadrige-PUF, Paris, 2017.
- Deffairi M., La patrimonialisation en droit de l'environnement, IRJS éd., Paris, 2015
- Desrousseaux M., La protection juridique de la qualité des sols, LGDJ, bibliothèque de droit de l'urbanisme et de l'environnement, Paris, 2016
- Farooq M., Siddique K., Conservation Agriculture. Springer International Publishing, 2015.
- Fèvre M., Les services écologiques et le droit. Une approche juridique des systèmes complexes, thèse Université Côte d'Azur, 2016
- Gobat J.-M., Aragno M., Matthey W., Le sol vivant. Bases de pédologie - Biologie des sols, 3ème édition, Collection : Science et ingénierie de l'environnement, Presses Polytechniques Romandes, 2013.
- Hautereau-Boutonnet M., Truilhé-Marengo E. (sous la dir.), Quelle(s) valeur(s) pour la biodiversité ?, mare&martin, coll. Droit, science et environnement, Paris, 2017
- Kiss A. (dir.), Carbiener R., Doumbé-Billé S., Fromageau J., Guttinger Ph., L'Écologie et la loi : le statut juridique de l'environnement : réflexions sur le droit de l'environnement, L'Harmattan, coll. Environnement, Paris, 1989
- Langlais (sous la dir.), L'agriculture et les paiements pour services environnementaux : quels questionnements juridiques ?, PUR, à paraître, 2018
- Lucas M., Etude juridique de la compensation écologique, LGDJ, bibliothèque de droit de l'urbanisme et de l'environnement, Paris, 2015
- Maris V., Nature à vendre. Les limites des services écosystémiques, Quae, coll. Sciences en questions, Versailles, 2014
- Méral P., Pesche D. (coord.), Les services écosystémiques, Repenser les relations nature et société, Quae, coll. Nature et Société, Versailles, 2016
- Monteillet V., La contractualisation du droit de l'environnement, Dalloz, nouvelle bibliothèque de thèses, Paris, 2017
- Neyret L. et Martin G.-J., Nomenclature des préjudices environnementaux, LGDJ, Paris, 2012

- Parance B., de Saint Victor J. (sous la dir.), Repenser les biens communs, CNRS éd., Paris, 2014
- Roche P., Geijzendorffer I., Levrel H., Maris V., (coordin.) Valeurs de la biodiversité et services écosystémiques. Perspectives interdisciplinaires, Quae, collection Up date Sciences technologies, Versailles, 2016

Reports

- Bellec P., Lavarde P., Lefèbvre L. et Madignier M-L, Propositions pour un cadre national de gestion durable des sols, CGEDD-CGAAER, 2015
- Courtoux A. et Claveirole C., La bonne gestion des sols agricoles : un enjeu de société, Avis du Conseil économique, social et environnemental, 2015
- Chevassus-Au-Louis B. et al., Approche économique de la biodiversité et des services lies aux écosystèmes – Contribution à la décision publique, Centre d'Analyse Stratégique, La documentation française, Rapports et documents, Paris, 2009
- Duval L., Binet T., Dupraz P., Leplay S., Etrillard C., Pech M., Deniel E., Laustriat M., Paiements pour services environnementaux et méthodes d'évaluation économique. Enseignements pour les mesures agro-environnementales de la politique agricole commune. Etude réalisée pour le ministère en charge de l'agriculture. Rapport final, 2016
- FAO, The state of food and agriculture. Paying farmers for environmental services, 2007.
- FAO and ITPS, Status of the World's Soil Resources (SWSR)- Technical Summary, Rome, 2015
- Fondation Nicolas Hulot pour la nature et l'homme, Droits réels au profit de la biodiversité : comment le droit peut-il contribuer à la mise en œuvre des paiements pour services environnementaux ?, Rapport de la mission économie de la biodiversité, 2013
- Jones A., Panagos P., Barcelo S., Bouraoui F., Bosco C., Dewitte O., Gardi C., Erhard M., Hervas J., Hierderer R., Jeffery S., Lükewille A., Marmo L., Montanarella L., Olazabal C., Petersen J.-E., Penizek V., Strassburger T., Toth G., Van den Eeckhaut M., Van Liedekerke M., Verheijen F., Viestova E., Yigini Y., The state of soil in Europe: A contribution of the JRC to the European Environment Agency's environment state and outlook report, SOER 2010, Reference report, Luxembourg, 2012.
- Les services écosystémiques rendus par les écosystèmes agricoles. Une contribution au programme EFESE, résumé de l'étude réalisée par l'INRA, oct. 2017
- Les paiements pour Préservation des Services Ecosystémiques comme outil de conservation de la biodiversité. Cadres conceptuels et défis opérationnels pour l'action, CDC Biodiversité, Mission Économie De La Biodiversité, Les Cahiers Biodiv'2050 : comprendre, février 2014, n° 1.
- P. Puydarrieux, Y Kervinio et O Darses « L'évaluation française des écosystèmes et des services écosystémiques », rapport intermédiaire, CGDD, FRB, ministère de l'env, déc 2016

Articles, contributions to collective books

- Barnaud C., Antona M. et al., Vers une mise en débat des incertitudes associées à la notion de service écosystémique, VertigO- la revue électronique en sciences de l'environnement, vol.11, n° 1, mai 2011
- Billet P., De la relativité de la neutralité environnementale en matière de compensation écologique, EEI, n° 6, Juin 2017, Dossier 10
- Billet Ph., La « neutralité environnementale » : esquisses juridiques, in Mélanges en l'honneur de François Collart-Dutilleul, Dalloz, Paris, 2017, p. 103

- Boisvert V., Les services écosystémiques : un nouveau concept ?, In : Le pouvoir de la biodiversité. Néolibéralisation de la nature dans les pays émergents, Boisvert V., Thomas F., IRD Editions, coll. Objectifs Suds, QUAE, Marseille, 2015
- Camproux-Duffrène M.-P., « Le marché d'unités de biodiversité : questions de principe », RJE 2008, p. 87
- Combe M., Le régime juridique de l'obligation de compensation écologique, EEI, n° 6, juin 2017, Dossier n° 8
- Costanza R., d'Arge R., De Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., R.O'neill, Paruelo J., Raskin R-G., Sutton P., Van den Belt M., The value of the world's ecosystem services and natural capital, Nature, 1997, p. 387
- Denizot A., L'obligation réelle environnementale ou droit réel de conservation environnementale ? Brève comparaison franco-chilienne de deux lois estivales », RTD civ. 2016, p. 949
- Doussan I., Compensation écologique : le droit des biens au service de la création de valeurs écologique et après ?, in Repenser la propriété, un essai de politique écologique, Guibet-Lafaye C., Vanuxem S. (dir.), PUAM, 2015, p. 99
- Dupont V., Lucas M., « La loi pour la reconquête de la biodiversité : vers un renforcement du régime juridique de la compensation écologique ? », Cahiers Droit Sciences & Technologies, 2017, n°7, p. 143.
- Etrillard C., Paiements pour services environnementaux : nouveaux instruments de politique publique environnementale, Développement durable et territoires, vol. 7, n°1, p. 6
- Etrillard C., La compensation écologique : une opportunité pour les agriculteurs, Dr. rur. mars 2016, n° 441, Etude 10.
- Ford A.E.S., Graham H., White P.C.L., Integrating Human and Ecosystem Health Through Ecosystem Services Frameworks. Ecohealth, 2015, 12, p. 660.
- Gibbs H.K., Salmon J.M., Mapping the world's degraded lands. Applied Geography, 2015, 57, p. 12.
- Grimonprez B., « La compensation écologique d'après la loi biodiversité », Dr. Patr., n° 263, 1er nov. 2016
- Hautereau-Boutonnet M., « La reconquête de la biodiversité par la conquête du droit civil... », JCP G 2016, 948
- Hermon C., L'agroécologie en droit : état et perspective, RJE., 3-2015, p. 420
- Hermon C., Plaidoyer pour une simplification du droit relatif à la protection de l'environnement dans le secteur agricole, In : Les futurs du droit de l'environnement : simplification, modernisation, régression ?, Doussan I. (sous la dir.), Colloque annuel de la SFDE, 20 et 21 novembre 2014, Bruylant, Bruxelles, 2016, p. 243
- Holland J.-M., The environmental consequences of adopting conservation tillage in Europe: reviewing the evidence. Agriculture, Ecosystems and Environment, 2004, 103, 1–25.
- Keith A.M., Schmidt O., McMahon B.J., Soil stewardship as a nexus between Ecosystem Services and One Health. Ecosystem Services, 2016, 17, 40–42.
- Langlais A., Les paiements pour services environnementaux, une nouvelle forme d'équité environnementale pour les agriculteurs ? Réflexions juridiques, Dr. rural, mai 2013, n° 413, Etude n° 7
- Langlais A., L'appréhension juridique de la qualité des sols agricoles par le prisme des services écosystémiques, Dr. rural, août 2015, n° 435, Etude n° 20
- Labous K. et Gruger H., Produire de la biodiversité : un avenir pour les agriculteurs, Dr. Env., sep. 2017, n° 259, p. 291
- Larkin R.P., Soil Health Paradigms and Implications for Disease Management. Annual Review of Phytopathology, 2015, 53, 199–221.
- Lucas M., Le contrat au service de la compensation écologique, EEI, 2017, Dossier n° 11

- Lucas M., La compensation écologique des zones humides en France : vers une intégration des services écosystémiques ?, Dr. Env., 2014, n° 219, p. 19.
- Martin, G.-J., La compensation écologique : de la clandestinité honteuse à l'affichage mal assuré, RJE, 4-2016, p. 606
- Martin G.-J., Les biens-environnements, une approche par les catégories juridiques, RIDE, 2015/2, p. 139
- Martin G.- J., Les potentialités de l'obligation réelle environnementale, Dr. Env., oct. 2016, p. 334
- Martin G.-J., Les unités de compensation dans la loi n° 2016-1087 du 8 août 2016 pour la reconquête de la biodiversité, de la nature et des paysages, Droit et Ville, 2017, n° 83.
- Martin G.-J., « Pour l'introduction en droit français d'une servitude conventionnelle ou d'une obligation propter rem de protection de l'environnement », RJE 2008, p. 123
- Martin G.-J., L'obligation réelle environnementale : un objet juridique non identifié ?, Annales des Loyers, avril 2017, p. 123.
- Pomade A., Les paiements pour services environnementaux contribuent-ils à l'émergence d'un « gradient de juridicité » ?, VertigO - la revue électronique en sciences de l'environnement, Vol. 11, n° 1, mai 2016
- Quétier F., Quenouille B., Schwoertzig F., Gaucherand S., Lavorel S. et Thiévent P., Les enjeux de l'équivalence écologique pour la conception et le dimensionnement de mesures compensatoires d'impacts sur la biodiversité et les milieux naturels, Sciences, eaux et territoires, IRSTEA, HS 25 mars 2012.
- Reboul-Maupin N., Grimonprez B., Les obligations réelles environnementales : chronique d'une naissance annoncée, D. 2016, p. 2074.
- Reeve J.R., Hoagland L.A., Villalba J.J., Carr P.M., Atucha A., Cambardella C., Davis D.R., Delate K., Organic Farming, Soil Health, and Food Quality: Considering Possible Links. Advances in Agronomy, 2016, 137, 319–368.
- Trébulle F.G., « Le marché des unités de biodiversité, quelles perspectives ? », EEI 2017, n°6, dossier 1.
- Van Lang A., La compensation des atteintes à la biodiversité : de l'utilité technique d'un dispositif éthiquement contestable, RDI 2016, p. 586
- Vanuxem S. « Les services écologiques ou le renouveau de la catégorie civiliste de fruits ? », Revue de droit de McGill, 2017, n° 62, p. 73.

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