Biodiversity and economy: new management and accounting approaches, tools and practices

Ciprian Ionescu, Hélène Leriche, Michel Trommetter

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Entreprises, territoires et environnement

Biodiversity and Economy:

NEW MANAGEMENT AND ACCOUNTING APPROACHES TOOLS AND PRACTICES

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LVMH

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Executive summary

Because the development of human societies and, from the economic point of view, that of their organizations, imposes measuring sustainability against the yardstick of the planet and its ecology, now is the time to offer approaches which group together these economic and ecological priorities. Defining the fundamental constraints of the dynamics of these *social-ecological systems** through the development of a *framework of viability** has enabled us to study the capacity of the current regulation instruments and approaches to meet these constraints. By studying the most advanced management and accounting tools, we are able to support this approach to sustainability and offer a new management model which falls within the economic and ecological constraints imposed by the chosen framework. The ecosystem **Viability Management Model (VMM)** therefore belongs to the perspective of *strong sustainability** and is supported by tools and approaches which are being developed, specifically ***voluntary approaches**** and *environmental accounting**. In order to equip organizations so that they may attain ecological and economic efficiency, the **VMM offers a two-step approach, making it possible to identify three different situations and consequently offer economic and/or fiscal optimisation processes.**

Interpretation

C. Ionescu's thesis was conducted under the direction of M. Trommetter as a follow-up to ORÉE's Biodiversity and Economy working group reflexions and work on the CIFRE thesis by J. Houdet. It was a question of defining the conditions of viability of ecosystems and organizations, and finding ways to reconcile them. The document attempts to report on the main results which actors are encouraged to use.

The evaluation of existing approaches has made it possible to build the VMM and present its implementation. Specific focusses present the definition of the framework of viability, the analyses of corporate strategies, voluntary approaches and environmental accounting. The different concepts and key principles in this work on the stakes of biodiversity and economy, viability and sustainability are clarified in the inserts of this document.

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- I. Evaluation of existing approaches for organizations (Ecosystem functioning; Two conceptions of development/sustainability)
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Focus on:

- The development of the framework of reference for the viability of ecosystems and organizations over time
- The environmental strategies of organizations (Values of biodiversity, economic costs)
- The analysis of voluntary approaches
- Environmental accounting as a management instrument

- A few references to find out more (Bibliography; Links; List of the figures; Acronyms)
- Presentation of the thesis partners
- ORÉE's works on Biodiversity and Economy

Keywords: ecosystem, biodiversity, ecosystem service, organization, business, firm, company, social-ecological system, viability, sustainability, resilience, adaptive management, ecological threshold, profitability, indicator, voluntary approach, environmental accounting, financial accounting, beneficiary pays principle, ecological solidarity, ISO 14001, payment for ecosystem service, Forest Stewardship Council, organic farming, Full Cost Accounting, Sustainable Cost Accounting, environmental reporting, environmental expenditure.

Editorials

Patricia Savin, Chairwoman
Nathalie Boyer, General Delegate, ORÉE

"The keyword for our relationship with nature is no longer possessive control, but rather responsibility", D. Bourg. For over 10 years, ORÉE has been demonstrating the necessary and possible reconciliation between the preservation of the biosphere and economic activity. This is the fruit of the reflexions and discussions led within its Biodiversity and Economy working group, and the theses supported by ORÉE. Thus, BBII, the Business and Biodiversity Interdependence Indicator (2008) is used by a considerable number of businesses. Its development supported the thesis by Joël Houdet (2010) which offers biodiversity accountability to organizations. In line with this, the thesis by Ciprian Ionescu (2016) builds approaches and tools to *"Building tools to manage multiple and intertemporal relationships between biodiversity and economy"*. Summarized below, what this work provides is undeniable: congratulations Ciprian. The tool proposed currently, the VMM, is designed for businesses and communities, who are invited to test it and complete the ORÉE working group reflexions. And I would like to salute the initiative of Michel Trommetter, thesis supervisor, and the ORÉE team, and particularly Hélène Leriche, Head of Biodiversity and economy for ORÉE. We would like to thank all our members for the loyalty and commitment they have shown, with the partners of the thesis LVMH, Yves Rocher in the front line, as well as Compta Durable and Veolia. We hope that this document will provided added understanding and the keys to accountability regarding biodiversity. Good reading.

Michel Trommetter, Director of research at the INRA Applied Economics Laboratory (UMR GAEL), Director of the UMPF Doctoral School of Economic Science and co-Chair of ORÉE's Biodiversity and Economy working group

This work belongs to a research process which has started 10 years ago and whose targets are on the one hand to show that economic activities are not only a source of impacts but that they depend first and foremost on biodiversity and ecosystem services, and on the other to co-build approaches which aim at managing these relationships of interdependence, not as a constraint, but as a challenge within the strategy of economic actors.
This research which was carried out in a little over three years, aims at proposing ways of meeting these targets. The concepts used are not new, but this work helps to identify and offer new paths in their building without betraying these key concepts. It is a true interdisciplinary construction approach.
This approach is all the more interesting in that it challenges disciplines. Thus Luc Abbadie, ecologist and president of the jury, voiced thoughts during the defence of the thesis: who knows how to measure resilience? What is an irreversibility and at what level of scale? This thesis work clearly provides new accounting approaches which belong to the recent research dynamics aiming at tightening the links between ecologies and economy, with several recent theses defended.

Sylvie Bénard, Director of Environment, LVMH group
Claude Fromageot, Director of Sustainable Development, Rocher group, Director of the Yves Rocher Foundation – Institut de France and co-Chair of ORÉE's Biodiversity and Economy working group

We are delighted that this important work is being published as it will help to make approaches between biodiversity, economy and management accessible. We believe that it is essential to highlight the importance of duration in this still-emerging field. Ever since Jacques Weber launched the biodiversity and economy working group in 2008, showing once again his creative intuition and his associative genius, several noteworthy works have marked the long road taken by ORÉE and the associated stakeholders. What seems remarkable to us in the global corporate approach is the association between the experimentation in the field by the actors, resulting in publications on Biodiversity and its relationships with the economy and the climate, and further academic focus, with the two theses defended under the supervision of Michel Trommetter of INRA. We wanted to support the important thesis work by Ciprian Ionescu, because we firmly believe that our businesses, our organizations, all of us together, have new pathways for opening up to a future which is already too close at hand, already too present. Yes, as economic actors rooted in the territories and on the markets, we are certain of a necessary and urgent groundswell, of a deep change in the method and representations of our affairs. Unfortunately, we have to admit that we are still relatively powerless and that we do not really know how to broach the issue of our different operational professions. The opportunity of links between actors, within ORÉE, is of great help, as we can, independently and with no collusion, discuss, debate and share experience, in an extended "dispute", which even though it may appear long, is in fact essential for us. Because the complexity, to quote Edgar Morin, of the issues necessitates bringing together the various stakeholders around the table of negotiations, according to Bruno Latour. Therefore we share the will to develop practices and a few strong levers which will lead our organizations (public, economic and human) towards more sustainable collective practices, and why not towards a new ecological economy, to quote the words of Lauriane Mouysset. The thesis by Ciprian Ionescu is an invaluable contribution to this objective. On behalf of all those taking part in the Biodiversity and Economy working group alongside ORÉE, our wholehearted thanks go to Ciprian Ionescu, his thesis director Michel Trommetter, and his manager Hélène Leriche.

Issue

"In the capitalist system, the creation of profit is what drives the action. Stick to this basic rule and develop motivating regulations which change the way in which profits are created: you still have a market capitalist, but one who benefits first and foremost from maintaining the viability of the planet and the societies which live there" (Weber, 2008)

By questioning the interdependence between humans and *biodiversity** and more specifically the relationships between economy and biodiversity, this document shows how biodiversity can be considered in the management of human activities, on a day to day basis and in a *sustainable development** perspective.

Biodiversity

Biodiversity can be defined as "all the living fabric of the planet" or as "the multiplicity of interactions between organisms on changing environments" (Barbault and Weber, 2010). This expression takes us beyond the framework of life sciences and the protection of nature by repositioning human beings and their societies in the living world. This vision of the world highlights the interconnections between living and anthropogenic systems and their resulting feedbacks. Biodiversity and ecosystems condition the evolution of human societies which develop there, the orientation of their lifestyles and their cultures. In return, the behaviours of human societies make up the intrinsic evolutionary factors of biodiversity (Barbault, 2006).

Adopted internationally in 1992, the Convention on Biological Diversity (CBD) extends the responsibilities of our societies in order to preserve the living world's potential to evolve and to prescribe its sustainable uses and fairly share the benefits derived from biodiversity. But how can these stakes by integrated into the governance of countries and into decision-making processes (public and private, individual and collective)? In part by developing and mobilising management tools adapted to the structuring of human societies and their activities (particularly to organizations): methods of economic regulation with regards to biodiversity and indicators for monitoring and steering the interactions between human activities and biodiversity for the actors.

To make sure that the preservation of ecosystems and the economic performance of organizations do not remain opposed, we consider the interactions between actors with regards to biodiversity and the benefits that actors can derive from it (*ecosystem services**).

Reconciling economy and ecology

Ecosystem services

Biodiversity was welcomed into the economic world in 2005, when the Millennium Ecosystem Assessment proposed a conceptual framework of the interactions between biodiversity, *ecosystem services**, human well-being and the underlying forces responsible for change (MEA, 2005).

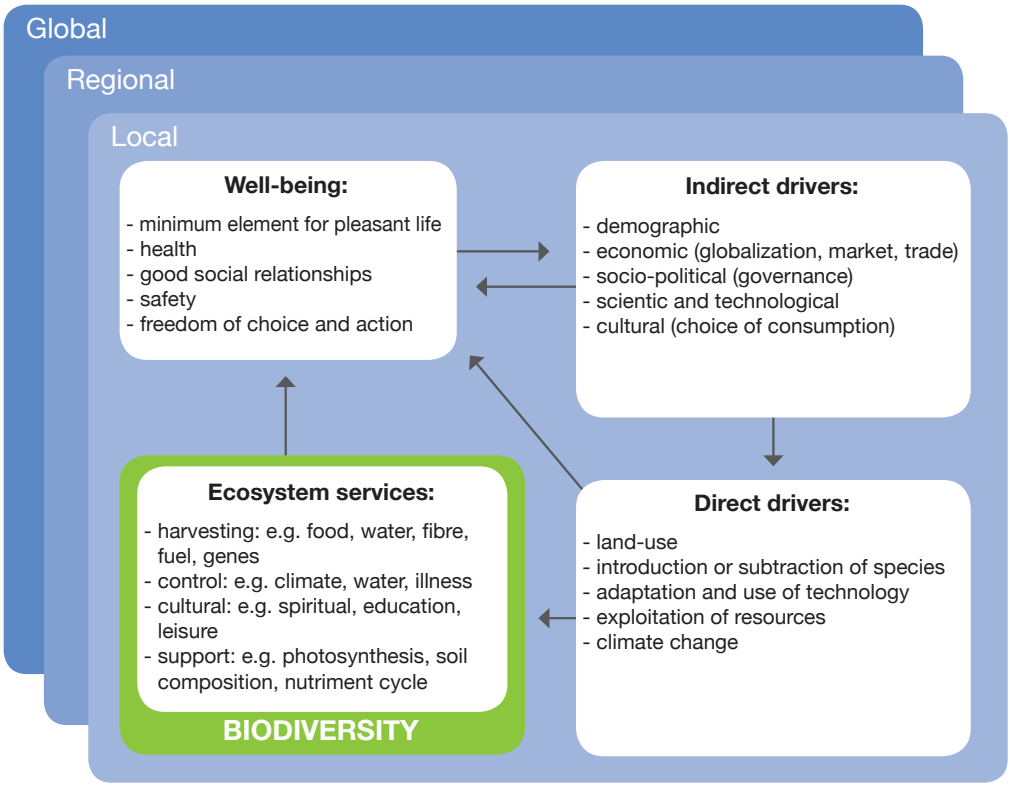

Figure 1: Biodiversity at the heart of ecosystem services and the dynamics of interaction between socio-economic and ecological systems (MEA, 2005)

And what new forms might the regulation of access and the use of these profits take? How can we differentiate between a polluter pays principle and a beneficiary pays principle to maintain these ecosystem services? How can these dynamic interactions between human activities and biodiversity be taken into account without jeopardising short term competitiveness and maintain the long-term possibles? Which tools, specifically accounting tools, could be mobilised for this?

By first talking about the way ecosystems and organizations are dependent on each other, we can take them as a whole system - the *social-ecological system** and look for the conditions for maintaining ecosystems in a desirable and resilient state, and therefore of the *viability** of this system.

From the point of view of the biosphere, we can determine the conditions of viability by relying on *ecological resilience**, a concept which designates the capacity of a system to support a disruption and maintain its ability to evolve. It conveys the importance of biodiversity and ecological thresholds. From the corporate point of view, we have considered the *economic demands** which condition their finalities as constraints for their viability (for organizations, their capacity to generate profit, and for public administration and non-profit organizations, their capacity to respect a budgetary balance.

Following these preliminary considerations, we studied the tools which are best suited to the demands of sustainability given by the framework of viability of social–ecological systems. Thus, *voluntary approaches** and *environmental accounting** have been used as a foundation for the development of a management module that the economic actors can use. This social-ecological systems viability management model (VMM) of stems from an approach comprising two modules which makes it possible to identify three different situations and offers economic and/or fiscal optimisation processes.

The actors are invited to use it.

I. Evaluation of existing approaches for organizations

The interdependence between human being and biodiversity as fundamental

Organizations and living systems are of paramount importance for human societies. Living systems condition corporate activity when organizations, through their activities, act on *ecosystem functioning** and their dynamics.

Ecosystem functioning

This interpretation of the biosphere by the services that each of us, each territory, each group/society, with a variety of points of view, can derive from it must not allow us to forget that the foundation of human well-being resides in *ecosystem functioning**. It is what guarantees living systems life and adaptive dynamics and is therefore the basis for the development of our societies and thus of our economies.

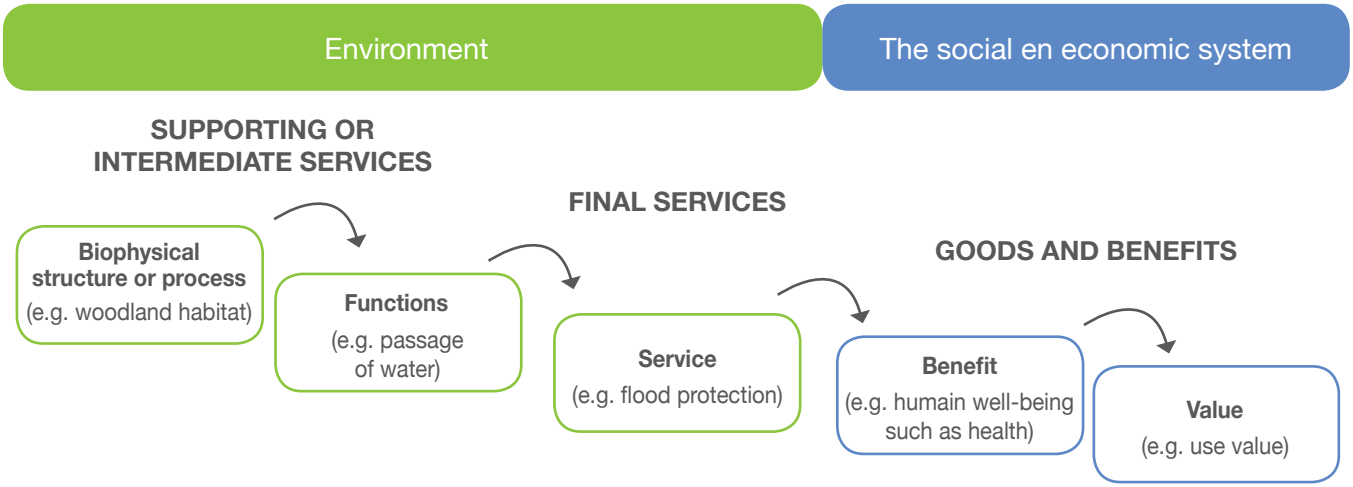

Figure 2: Cascading flow of ecosystem services (according to Haines-Young and Potschin, 2013)

This interdependence of organizations and ecosystems makes it possible to take them as one system alone: the *social-ecological system**.

In the framework of economic theories of sustainable development, we are adopting a strong definition of sustainability, which stipulates that the natural capital must be strictly preserved distinctly form other capitals.

This idea is consistent with that of viable development inspired by the mathematical theory of viability on which we rely to define the essential constraints of the viability of social-ecological systems, in a context of change and growing disruption (climate change and biodiversity erosion).

Two conceptions of development/sustainability

The most frequently mentioned definition of sustainable development is from the Brundtland Report (WCED, 2011): “a development which meets the needs of the present without compromising the ability of future generations to meet their own need”. The interpretations which have been made of this definition, particularly of the meaning given to the word “development”, have led to two distinct paradigms of sustainability: weak sustainability, linked to the green economy and natural resources, and strong sustainability, which is attached to the ecological economy movement.

Neoclassical environmental economists consider this development by taking into consideration environmental issues and integrate the natural capital into the usual neoclassical growth models by prescribing the maintaining of the level of well-being (measured by the level of income, usefulness or consumption). To ensure the non-decrease in well-being over time, the global capital available to individuals must not diminish. It is made up of the natural capital and the artificial capital made by humans (comprising the physical capital, human and intellectual capital). But here it is subject to two interpretations:

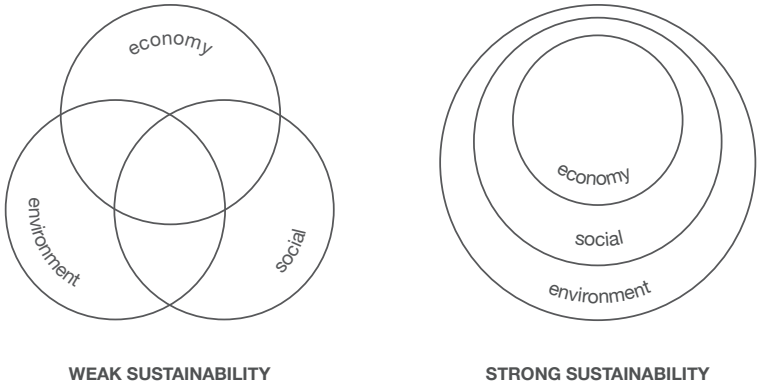

Figure 3: Two conceptions of sustainable development (Passet, 1979)

• **Weak sustainability** sees the natural capital and the artificial capital made by humans as substitutable. A decrease in natural capital can therefore be compensated by an increase in artificial capital, in order to maintain the capacities of productions and well-being over time. Technical solutions can be seen as alternatives to the decline of natural resources. It is the stock of capital in its entirety which must remain constant and the environmental impacts simply minimized by means of regulations.
According to the so-called Hartwick rule (1977) the investment must be at least as important as the depreciation of the natural capital at all times. In this way, returns equal to the difference between the price and the marginal cost of resources must be levied as the resources are depleted; they must then be reinvested to produce a substitute capital for the depleted resources; and lastly they must grow from period to period at a rate equal to the discount rate. This implies that the value of the different capitals is measured by the prices system. The elements of the natural capital are thus integrated into the commercial sphere via the internalisation of externalities.
This idea of a weak sustainability is considered as the dominant orthodox approach to sustainable development. This represents the outlook which has been adopted by most of the international institutions (the United Nations, the World Bank, the European Union and even the World Business Council for Sustainable Development (WBCSD)).

• **Strong sustainability** considers ecosystems and human organizations as being interdependent and rejects the hypothesis of the substitutability of the different forms of capital. The "critical" natural capital (the essential elements of this capital which are deemed to be unreplaceable) must be strictly maintained. The ecological economy takes into account the specific features of the ecological phenomena which produce a discipline which is a cross between economy and ecology. It is a question of reintegrating the economic system into the biosphere which is a finished and materially closed system, thus defining the limits of the economic system. In this framework, innovative strategies such as voluntary approaches are developed and are deemed more ambitious than the institutional constraints.
Deep Ecology is bio centred and the most radical trend. Another approach considers that we should not deteriorate beyond a certain level the elements of natural capital which underpin essential ecological functions (elements of "critical natural capital") and which cannot be substituted by artificial capital, or even natural capital. Exceeding certain thresholds may therefore lead to irreversible consequences, jeopardizing essential functions for humans and the planet. In a time of great uncertainty, minimum standards of safety as regards conservation must be set in order to avoid engaging in areas where the risks appear to be critical (Richard, 2012). Growth is conditioned by ecological criteria, and the natural capital considered as the main factor limiting economic development.

We consider strong sustainability to be a solid and appropriate conceptual framework for the regulation of economic activities where both ecological and economic stakes inherent to organizations can overlap.

We are offering a *reference framework for the viability of social-ecological systems**, dedicated to support human organizations and their activities, the functioning of living systems and consequently human well-being. It consists of a definition of all the viability constraints, ecological (maintaining ecosystems in a socially desirable and ecologically resilient state) and economic (maintaining the profitability of organizations and the budgetary balance of public administrations and non-profit organizations).

What methods – instruments, tools, approaches, etc. – do we have at our disposal to integrate social-ecological system dynamics into this framework?

Supporting economic activities in a sustainable development

Traditional neoclassical regulation tools (regulatory and economic) which aim at attaining ecological targets and rooted exclusively in economic considerations (optimal level of pollution) cannot meet environmental stakes. In theory, they are directed towards attaining social optimum but their possible short-term economic efficiency (according to the Pareto principle: an economic state in which it is not possible to improve an agent's situation without deterioring another's one) must not hide the progressive deterioration of living systems, and therefore that of the economic system in the long term.

More recently, *voluntary approaches** and *environmental accounting** have appeared in response to environmentally-based criticism with regard to traditional instruments. These instruments, set up in a non-binding manner, are supposed to pursue more ambitious ecological objectives than those specified by traditional regulations, and produce benefits which make it possible to compensate or even exceed the costs of their implementation.

These two recent and often acclaimed categories of tools provide interesting elements to help integrate social-ecological system dynamics in our *viability framework**.

Voluntary approaches: economic operating to be retained

*Voluntary approaches** generally enable organizations to guarantee their economic viability. Their environmental objectives present them as being more efficient than constraining regulations but they often have little knowledge of ecosystems complexity. A detailed review of these approaches, a proposal for typology and a matrix for the decision-making processes which lead to their adoption have been developed (Ionescu, 2016) in order to appreciate better their potential regarding our issue. To conclude, these approaches include a heterogeneous category of environmental regulation instruments whose common denominators are (i) the intentional character of their implementation by organizations; (ii) the pursuit of environmental objectives which are assumed to be higher than those of the regulations; and (iii) a supposedly higher economic efficiency for the agents involved. They result from the will of non-profit organizations to go beyond the regulatory demands which are deemed too lax, beyond that of organizations and economists who wish to improve the cost-efficiency ratio of regulations, and the recent perception of the interdependences linking organizations and ecosystems. They thus search to reconcile profitability and environmental preservation. Although their operating methods vary, they all propose to compensate the costs incurred by the organization to reduce its environmental externalities, through the direct or indirect benefits procured by the different external stakeholders.

In order to test the capacity of these instruments to meet the viability constraints of social-ecological systems (the aim of our work), extensive research has been conducted to a selection of approaches. According to the criteria of effective environmental management (influencing ecosystem structures), their representativeness (the ability to be widely deployed from the point of view of space and/or number of organizations), and by avoiding overlapping, we focussed on four of them: the ISO 14001 standard, payment for ecosystem services (PES), Forest Stewardship Council certification (FSC), and the Organic Farming standard (AB).

It was a question of evaluating whether: 1- The level set for the environmental targets was sound? 2- Existing environmental objectives had been met? 3- The results were obtained by the instrument and to what degree?

The evaluation of this selection with regards to the viability of social-ecological systems has shown that these approaches can be economically efficient and the objectives of economic viability globally attained. In most cases, they make it possible to compensate or even exceed the cost of their implementation by means of a number of mechanisms: direct payment by the beneficiaries of ecological services, non-monetary benefits such as new markets, image, etc.), or bonuses (higher sales prices).

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However they do not generally pursue targets which make it possible to guarantee the viability of ecosystems as they do not take the functioning of ecosystems (with the exception of FSC certification) into consideration. By focussing on organizations boundaries, these approaches cannot apprehend ecosystems on ecologically relevant spatial scales and only propose to manage aspects of the ecosystem for which there are utilitarian interests for the organization (as to its durability) and that of the stakeholders deemed legitimate (to reap profits or avoid disadvantages). The possible negative ecological influences on environments which are not claimed by those actors who are deemed legitimate are not taken into consideration even though they are fundamental to ensure a sustainable management of ecosystems.

Because ecological *resilience** implies focussing on an ecosystem in its totality, on a wide and relevant spatial scale and the economic viability of organizations raises questions both of governance on different territorial scales and the capacity of regulation and information systems to convey heterogeneous monetary and ecological data.

However we have noted the interesting way in which they function economically which consists of compensating the possible additional costs of environmental regulation by access to a number of benefits (particularly economic ones) granted by external stakeholders in exchange for the generation of positive externalities (or the reduction of negative externalities).

Environmental accounting: a basis for sustainability

*Environmental accounting**, another category of heterogeneous environmental instruments was developed quite recently and has spread progressively over the last ten years.

Accounting, which dates back to the invention of writing (circa 3500 BC), can include a number of very varied approaches which group information systems based on the regular and systematic recording of variables (sizes, quantities) (Richard, 2012). The term generally designates "monetary accounting", information systems which enable the measurement and distribution of wealth and which cover highly different realities. According to the scale, we are talking about microeconomic accounting (e.g. an organization's private accounting) or macroeconomic accounting (e.g. a country's national accounting), and according to regulations, about compulsory, standardized and regulated financial accounting (or general accounting) which describes, measures and analyses monetary data connected with the interactions between internal and external organization (i.e. other economic agents), or management accounting (also known as cost accounting), which is not regulated and which deals with evaluating from a monetary point of view, describing and analysing certain internal corporate data (flow, stocks, performances).

While neoclassical regulation instruments pursue ecologically inappropriate objectives, there are among the heterodox approaches (Gowdy and Erickson, 2005), environmental accounting practices which could be suited to our ecological constraints but which would suppose an extensive reform of accounting conventions.

As in the case of the first ORÉE thesis (Houdet, 2010, 2012) which dealt, in a logic of minimizing the transaction costs linked to the development, with the appropriation and implementation of indicators to encourage the emergence of co-viability dynamics within social-ecological systems, the work carried out by C. Ionescu (2016) proposes targeting accounting information systems, and estimating to what degree they could evolve to take into account the firm's interactions with biodiversity and ecosystem services. To do this, environmental accounting can be considered as an interesting information, evaluation and even regulation tool.

Among the most frequently used microeconomic *environmental accounting** used, two categories can be distinguished:

- Technically simple accounting tools inspired by financial accounting and adapted to environmental issues. Among them, (i) differentiated environmental accounting (environmental expenditure) which strive to highlight the economic effects of imposed or voluntary environmental regulations for the organization, and (ii) environmental reporting approaches which propose on the contrary to inform the "green" flow of the organization in the form of non-monetary physical indicators. Both these instruments adapt to the different constitutional contexts in which they are deployed and it is the level of ecological requirements of these contexts to which the organizations applying them are subjected which determines the ecological relevance of their results.

- More elaborate instruments from the accounting point of view and which are more ambitious as to the green regulation of organizations. They actually attempt to change the rules of financial accounting in the sense of taking the natural capital into consideration. However, two antagonistic approaches can be distinguished. *Full Cost Accounting (FCA)**, whose conceptual scope has been borrowed from the green economy and weak sustainability, which aims at reaching environmental objectives determined via economic criteria (as optimal level of pollution);

In our opinion, this is open to criticism due to the ecologically inadequate objectives that it pursues.

On the other hand, *Sustainable Cost Accounting (SCA)** belongs to a strong perspective of sustainability and tends towards the renewal of natural capital, through respect of environmental limits and the emergence of new economic models. However, consideration of the economic viability of organizations is lacking here, in as far as only one voluntary application can be considered on a short term basis (the extensive reform of accounting practices that it supposes only appearing to be realistic in the long term). It would be necessary to extend its environmental targets and the spatial scale of regulation (local? national?) and also to consider a global reform of accounting.

To meet our social-ecological system viability stakes, we have chosen SCA which, because it is built on principles of strong sustainability, corresponds to the aims of this work.

These analyses results underpin the development of a tool which will make it possible to reach economic and ecological efficiency for the actors: The ecosystem Viability Management Module (VMM).

II. Economic and ecological efficiency: the VMM, the

To develop viable strategies, steer them and report on them, organizations must be able to reconcile economic and ecological requirements.

We believe that an approach consistent with a *strong idea of sustainability** can be implemented on a territorial scale on condition that, besides preserving the natural capital, it focuses on preserving the economic viability of the organizations it involves. This is what we have perceived in the light of the lessons learned, and in particular from the analyses of the *voluntary approaches** and *environmental accounting practices** with regards to the *framework of viability** that we have defined.

The VMM approach

We propose an environmental Management Model which would guarantee the Viability of social-ecological systems (VMM) from the short term:

- in the first module, its ecological efficiency is guaranteed by an adaptive territorial-scale management approach.
- in the second module, the competitive drawbacks likely to occur are highlighted by the appropriate accounting systems, and these situations are corrected and optimized by implementing adaptive redistributive processes (sustainable remunerations or temporary support).

Thus, the VMM organizes the coupling of the various environmental management tools: adaptive management, environmental accounting and payment for environmental services. Its systemic functioning was inspired by that of voluntary approaches. It enables the creation of environmental improvement whose costs are compensated by a share of the profits made by the stakeholders.

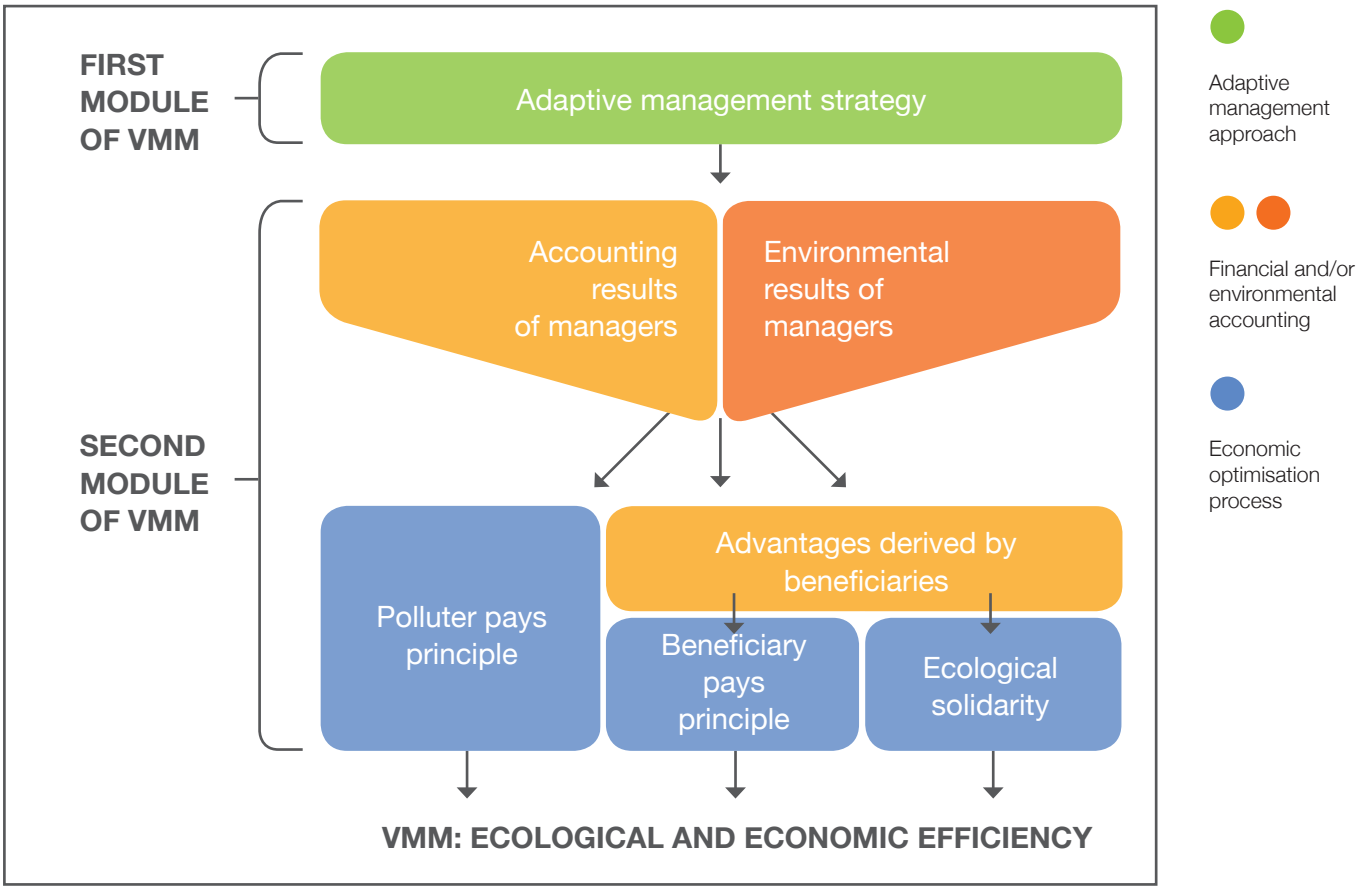

Figure 4: The social-ecological system Viability Management Model (VMM) (Ionescu, 2016)

social-ecological system Viability Management Model

The VMM how to

1st module: ensuring the ecological resilience of the social-ecological system

Because *biodiversity** is the basis of human well-being, the model must have a robust ecological foundation and here adaptive management approaches (Kingsford *et al.*, 2011) are particularly interesting. The manner in which they consider the ecosystem scale is relevant. This perimeter of analysis and work, which is often distinct from the perimeter of organizations or their logistics chain, makes it possible to define, with the actors thus identified, the socially desirable state of the *social-ecological system**. Associated with learning (experience, follow-up, experimentation, etc.) the practices can therefore be adapted according to the actions implemented. This process allows them to guarantee the *resilient** feature which goes with this state. Here the existence of *ecological thresholds** is taken into consideration. The experimentation and learning approaches make it possible to define ecological management targets in order to avoid shifts when these thresholds are not identified and to reach the desirable state. They help to guarantee the ecological resilience of social-ecological systems, their *viability** (Aubin, 1991).

Viability of ecosystems, resilience and thresholds (from ecological and management points of view)

In the light of global climate change, the conditions of existence of ecosystems are conditioned first and foremost and conservatively by the mitigation of climate change. "**The viability [of ecosystems]** implies that all the biological cycles function in conditions such that there is permanent renewal of its structures and functions, in such a way as the production potential is maintained and that we do not encumber its future production" (Griffon and Weber 1996).

This viability is guaranteed by the **ecosystems' property of resilience** which enables them to face up to disruptions. Generically speaking, resilience is the capacity of a system to recover one or several of its properties despite upheaval due to disruptions that the system itself does not control. From an ecological point of view, the resilience of an ecological system is also its ability to absorb a disruption or an environmental variation and maintain its structure and the way it functions before triggering a transition towards another alternative state. Biodiversity, as an endless reserve of functional response to environmental change, is considered as fundamental for the resilience of ecosystems. Study of this ecological resilience highlights existing thresholds (or breaking points, tipping points) between a multitude of stable states in the dynamics of ecosystems. This concept of **ecological threshold**, explored at theoretical and empirical levels, can characterise the definition of ecological resilience: the conditions for keeping an ecological state resilient are those which keep the ecosystem away from the ecological thresholds.
Here we must distinguish between the identification of "ecological thresholds" and the determination of "regulation limits" (or "management thresholds").

- **Ecological thresholds:** the points where ecosystems shift between a set of stable states and another set of alternative stable states, often identified empirically; the tipping thresholds are only based on scientific data and observations. Environmental management currently mobilises scientific data relative to ecological thresholds on a large scale and in particular the regulation of liquid or gaseous pollutant discharge whose regulations often depend on dose-response relationships, showing thresholds for the determination of the restrictions of exposure to pollutants. In the framework of the adaptive management of ecosystems, solutions to local ecological issues are identified and implemented. The originality of the system lies in the fact that the prescriptions are regularly re-evaluated and adapted in the light of the ecosystem's responses. The use of ecological thresholds therefore makes it possible, by means of experimentation and the learning that it implies, to make them easier to determine in the case of uncertainties and, when they have been identified, to integrate them into the management processes in order to respect them. However, difficulties of a social nature appear, difficulties linked to the determination of reference states (or desirable states) of ecosystems, and technical difficulties connected to the accurate identification of thresholds.
- **Regulation limits of management thresholds:** the maximum intensity tolerated (by the regulatory institutions) for certain anthropogenic environmental factors or deteriorations beyond ecological risks considered to be unacceptable, are to be foreseen. The regulation limits generally result from decisions to be made between ecological-type information (such as the existence of tipping points) and other sometimes rival considerations, inherent to the human populations concerned (social or economic criteria for example). They offer the possibility of taking the cumulative effects into account efficiently and specifically by means of an definition process: the identification of relevant ecological thresholds on the scale of an ecosystem involving several actors, discussion between stakeholders and distribution of management units and validation of possible new projects on condition that they remain within these limits.

For those managing ecosystems, these adaptive management demands may be a source of profit through the reestablishment of ecosystem services which are favourable to the organization, or through their transition towards alternative and cost-effective economic models (positive externalities). But they can also be costly and weigh on their competitiveness (negative externalities). The VMM then uses processes, in its second module, to avoid such "ecological accounting losses" for managers.

2nd module: optimizing accounting to guarantee economic viability for organizations in the social-ecological system

- *Step one: identify and characterise the economic situation of the actors concerned:*

An adaptation of differentiated environmental accounting practices allows us to consider the economic consequences of adaptive management for each organization on the territory. It allows us to evaluate, using different tools, three important aspects of the situation:

* The economic consequences of adaptive management for each manager in the social-ecological system, using differentiated environmental accounting.
* The ecological state of the social-ecological system for each perimeter of responsibility of each manager/organization, using environmental reporting.
* Setting up of an account of the economic benefits derived from the environmental improvements (via the provision of ecosystem services) on the scale of the social-ecological system.

In addition to this, *differentiated environmental accounting** and *environmental reporting** enable the identification of the legitimate managers to be taken into consideration. To support them, the *analysis matrix of interaction situations between organizations and ecosystems, and their associated objectives** in terms of strategies for the actors can be used.

- *Step two: Establishing the different contexts of ecological accounting losses and compensating for them by means of optimisation processes:*

The stakes of viability are determined by differentiated environmental accounting and environmental reporting helps to determine the level of improvement of the environment managed by the evaluation of the state of resilience (non-resilience, resilience and even optimisation of ecological potentialities).

According to these diagnostics, we can then identify adapted optimisation processes according to the threat inherent to each of these contexts.

There are three types of tools for implementing optimisation processes:

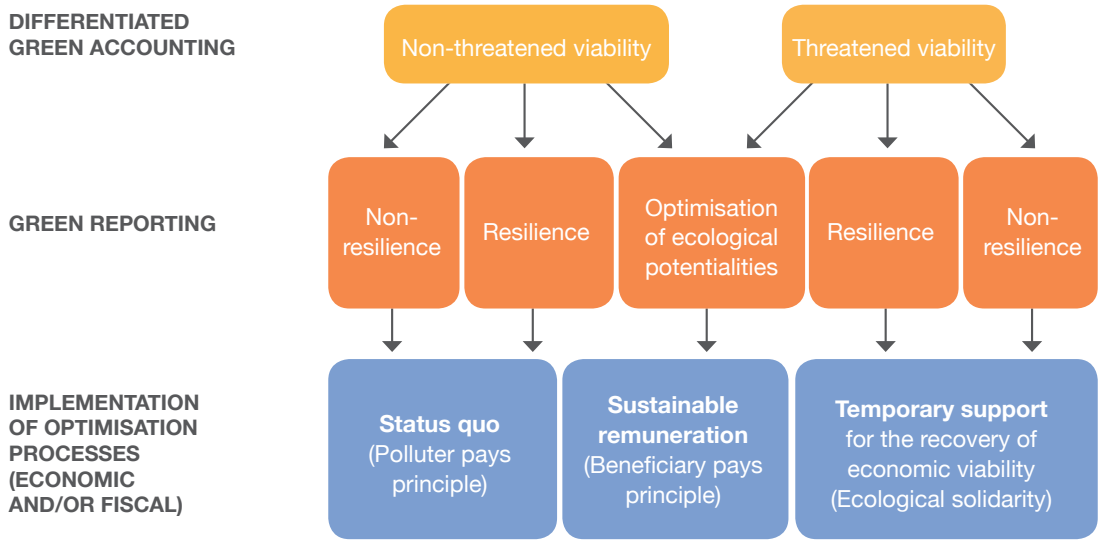

Figure 5: Accounts optimisation for the economic viability of organizations in the socio-ecosystem (2nd VMM module) (Ionescu, 2016)

- A **status quo** process, based on the polluter pays principle, for non-resilient or strictly resilient ecosystems and economically viable organizations;
- A process of **sustainable remuneration** by those benefitting from the ecosystem service, based on the polluter pays principle, where the manager optimizes the ecological potentialities of the managed ecosystems whatever their accounting results;
- A **temporary**, economical and technical **support** process, financed by the beneficiaries of the ecosystem. This application of the concept of ecological solidarity is applicable where the ecosystems managed are non-resilient or strictly resilient.

Results expected from the VMM for the social-ecological system

The technical support proposed in virtue of ecological solidarity is fundamental in the VMM. They are of ecological-type (designed for example for the optimisation of certain ecosystem services which are favourable to the manager) and/or strategic support-type (identification of new sales opportunities, changing over to new economic models, implementation of voluntary approaches, creation of an innovative voluntary approach, etc.) and encourage managers to shift towards economically viable operating methods and thus guarantee the temporal dimension of the process. In the VMM, financial and technical aid as well as sustainable incentives is provided by those benefitting from ecosystem services, by means of the benefits resulting from the ecological improvements which go with adaptive management. In a logic of ecological solidarity, the benefits procured from "local" ecosystem services at territorial level and whose beneficiaries can be precisely identified, must be assessed and presented in appropriate environmental accounting. The model can also mobilise the benefits derived from "global", ecosystem services on variable scales and for whom there are a large and diffuse number of beneficiaries, by means of a variety of economic and/or fiscal instruments.

The synergy proposed by the VMM makes it possible to exceed the limits of the tools mobilized:

* Where adaptive management appears inadequate with regards to heavily man-made social-ecological systems, the second module of VMM makes it possible to exceed this limit by focussing on the economic viability of the social-ecological system.
* Whereas the payment for ecosystem services search for the provision of a single service, only compensate the decrease in negative externalities and appear to be inefficient in the long term, the VMM offers the identification of positive externalities which enable the institutionalisation of an authentic beneficiary pays principle which is socially acceptable and viable in the long term.

We believe that beyond finding a solution to our problem, such an approach would encourage interesting territorial grass-roots projects, favourable to both environmental and economic improvements (the expanding tourist trade and the attractiveness of the territory, creation of short circuits, industrial ecology, etc.) and to the strengthening of social cohesion on the territories.

The VMM is based on several hypotheses, the most significant being those relative to the success of the stages of adaptive management and its capacity to develop innovative economically viable models. Their experimentation and the strengthening of the method would necessitate, as a first step, the theoretical testing of the VMM in a number of contexts, followed by the implementation of empirical experimentations (for example on the reduced scale of a rural community). It will then be up to organizations, and specifically the members of ORÉE's Biodiversity and Economy working group who made this work possible and accompanied it, to procure the tool and consider applying it.

It will thus be possible to complete and improve certain hypotheses by evaluating:

- The management of the time lag between the implementation of adaptive management practices and the appearance of monetary benefits;
- The capacity of local public administrations to capture the monetary benefits produced;
- The flexibility of these administrations regarding the adjustment of contributions.

The experimentation of this model will also make it possible to define the presence of local environmental services beneficiaries; the existence of adequate legal framework; The financial capacity of the managers to implement the adapted management operations; The comparison between territorial benefits and the costs of implementation; The ability to develop innovative economically and ecologically viable models.

The VMM uses tools and approaches which are already available for actors and which are being improved continuously. The VMM methodology is open to all to be set up and improved thanks to the progression of the tools it uses on its different modules and above all by the feedback from the actors and territories implementing it.

Focus on the development of the framework of reference

In order to establish the capacity of the approaches and tools available to organizations to reconcile economic and ecological stakes for a sustainable development, a framework of reference has been designed to test them.

Basic principles of *viability**

Jacques Weber clarifies viable development based on four assumptions:

1. Prior to the elaboration of any management strategy, the definition of long term, ethical and political (in the strongest meaning of the word) objectives must be made;
2. The diversity of human communities (socio-diversity) is at least as important as biodiversity;
3. The viability of these communities and that of the ecosystems (close or remote) from which they gain their sustenance are mutually, but not exclusively, decisive. The economic and social decisions should be made under the constraint of maintaining the viability of ecosystems, as should the decisions for managing areas be linked to the maintaining of the viability of lifestyles;
4. The connivance with ecosystems must replace conflict in order to play on natural variabilities, rather than deny them and try to constrain them. Rather than searching for the optimum, it would be better to develop adaptive strategies regarding natural variabilities such as economic variabilities.

Viable development consists therefore of looking for a long term co-viability of living systems, and the social and economic systems they support. It is less a question of preserving than managing, with the constraint of maintaining viability. Viability in no way means preserving balance, there is nothing preventing us from making new ecosystems.

• **The mathematical theory of viability** characterises a system through different variables, including the changes which make up its dynamics. Precise thresholds match these variables of viability, variables beyond which the system leaves its field of viability and can then follow irreversible trajectories towards non-viable states. On the other hand, if systems maintain themselves within their field of viability, they can be viable, undergo stationary change, or make their way towards wider fields of viability. The theory of viability seeks to determine regulation methods, methods of controlling the system which will help it to maintain itself in its field of viability in time, in the presence of uncertainty.

• **The specialists of ecological resilience** consider human and ecological dynamics to be closely linked, and often qualify the subjects of their analyses as “social-ecological systems” (or “socio-ecosystems”), (Ollagnon, 1989). Among the interactions which govern them are feedback loops: positive feedback which amplifies the changes and destabilises the systems (for example overfishing which depletes stocks and triggers an increase in prices which can further increase pressure on the resource) or negative feedback which lessens the changes and stabilises the dynamics of the systems (thus predation leads to a decrease in the number of prey which in turn regulates predator populations) (Mathevet and Bousquet, 2014).

Elaboration of the ecosystem viability framework

Here we have chosen to limit the social sphere mainly to the economic sphere, and specifically to the microeconomic entity of the organization.

We propose to define a formal reference framework to reconcile economy and ecology, encompassing systems which are made up of biological, physical and chemical elements, products of human activities, and their interactions. It is therefore shown as an area of two-dimensional constraints:

- The viability constraints of ecosystems (ecological resilience);
- Corporate viability constraints (profitability/budgetary balance).

This theoretical framework of reference which enables the integration of ecological and economic systems in viability trajectories is known as a “viability framework”.

- From the point of view of ecosystems: ecological resilience is ensured by keeping systems away from the ecological thresholds, i.e. away from the limit values of the key variables of the system beyond which they shift into undesirable and potentially irreversible alternative states. If such thresholds do not appear, are not identified, or when there is a certain degree of uncertainty with regards to them, approaches such as adaptive management integrate knowledge regarding ecological thresholds and must make it possible to maintain social-ecological systems in desirable and resilient states.
- From the point of view of organizations: the economic viability of an organization represents its minimum ability to compensate its operating costs through the activity of production of goods or services – commercial or not – that it pursues. For organizations, the viability constraints are those of making a profit.

Putting into practice

Using this framework, we can (i) evaluate the relevance and the performance of the existing regulation models (with regards to the defined viability constraints), and (ii) guide the construction of new efficient management models (relative also the viability constraints).

If we talk about interdependence and therefore the joint evolution of economic and living systems (due to their interdependence), we are considering their dynamics as those of a sole (meta) system. Our framework of reference is integrated into the theoretical framework of viability, and follows the precepts of viable development as they were defined by J. Weber. It is also in line with strong sustainability which stipulates that the economic and natural capitals are complementary and must be maintained independently over time through the preservation of the "critical natural capital" and the respect for environmental limits. We thus propose paths for an operationalization of this strong sustainability even though social-ecological systems evolve in a framework of instability, the disruptions not all being foreseeable, and the adaptive responses of the ecosystem elements not widely known. Our framework of reference defines which tools, approaches and instruments designed for environmental regulation make it possible to manage socio-ecological systems by respecting the ecological (resilience) and economic (profitability/budgetary balance) constraints.

Are the usual approaches to environmental regulation (in its widest meaning) efficient with regards to the viability constraints imposed by our framework of reference? Current regulation approaches are of two main types:

- **Passive and reactive strategies** which respect institutional environmental constraints (at best). Since the raising of awareness on the detrimental effects of environmental deterioration on human well-being (1970s) and the highlighting of external environmental costs generated by economic development, environmental economists have tried to integrate the environment into the neoclassical general equilibrium model which strives to find the economic optimum of environmental deterioration or by cost-profit analysis. Public authorities then develop the operationality by means of regulation instruments designed to reach this optimum: price regulation (via regulatory standards: taxes and subsidy), and regulation by quantities (exchangeable quotas, right to pollute). The social acceptability of these instruments is problematic but the foundations of these approaches (determination and respect for an optimum of environmental deterioration) also have important limits form the ecological point of view, these tools being likely to lead in the long term to the deterioration of ecological systems. Thus Pearce (1976) showed that a systematic discrepancy between the level of assimilation of environmental deteriorations by ecosystems (to be established scientifically) and the level of deterioration prescribed by the calculation of optimum pollution (or the cost-profit analysis) which causes a progressive erosion of living systems.

This category of instruments does not therefore meet our aim.

- ***Voluntary approaches**** which set up innovative and even proactive strategies. Over the last few decades, tools have appeared in organizations which are presented as being more efficient from the environmental and economic point of view than traditional regulation tools, tools which develop specific environmental strategies known as voluntary approaches. Public administration does not have a part in this, and only occupies a subsidiary place. Taken from practice and not for theoretical economy, they are defined by OECD as "arrangements by which organizations commit to improving their environmental performance beyond the legal requirements". The appearance of these approaches shows two major changes: the will, shared by new categories of actors (particularly non-profit associations and companies), to take an active part in the environmental regulation of human activities (an activity which had up until then been reserved for public administration) and the possible reconciling of profitability and the integrity of ecosystems. Proactive or innovative strategies are thus developed by organizations with the aim of reaping a return on investment. This presupposed higher financial environmental efficiency explains the interest for these highly heterogeneous approaches which are based on a variety of theoretical foundations and pursuing a variety of aims. In certain situations, they offer organizations the possibility of a double benefit, both ecological and economic, or in other circumstances, they offer the means of avoiding external environmental constraints (e.g. avoiding a regulation, avoiding pressure applied by activists, etc.). They have been tested with regards for our framework of viability.

Focus on the environmental strategies of organizations

The whole economic system, the different structures and processes which comprise it (specifically the activity of production and consumption of goods and services, and redistribution) and the activity of the various economic agents and organizations, are essential to human well-being. It is important to guarantee its sustainability.

A wide variety of actors but the same imperative of viability

The requirements of economic viability may be different according to the actors and the economic theories:

- **For companies:**

In the neoclassical theory, the company is reduced to the owner of the financial capital who is in charge of managing the activity. If we consider that the sum of individual interests leads to general interest, the unique finality of the firm resides in maximising its profit. The supposed perfection of the market which is the fundamental assumption of this theory is nevertheless brought into question.

For contractual approaches (transaction costs, property rights, agency theory), the organization does not have its own specific objective, all that count are the contractual relationships which represent the result of the individual search for utility maximisation.

For the approaches based on skills and which group together the three behaviourist managerial and evolutionary theories founded on common and complementary principles, the aims of the agents do not bear on precise elements, but are the result of "routines", in other words of the experience and skills built.

A wide variety of finalities according to the different analytical perspectives but a common objective can be seen to emerge: the generation of profit, the elementary condition for other finalities to be pursued.

- **For public administration:**

The functioning of public administrations aims at satisfying the interests of the general public and its activities. Even though they are useful to society, they are not profitable or considered as such (services such as health or education). But even if public administrations do not target profitability, they are not exempt from economic constraints and the notion of budgetary constraints and budgetary rules are essential for running public administrations. We consider that the respect for their economic constraints and a balanced budget make up the fundamental conditions of their sustainability, i.e. those without which the other finalities of these organizations cannot be attained.

- **For non-profit institutions serving households:**

Their constraints can be assimilated to those of public administrations in their quality as a producer of non-commercial goods and services: they consist of respecting a balanced budget, (equal expenditure and income) and this requirement is the essential condition of their viability.

Two conception of the interest of integrating these environmental stakes

Recognition of the environmental stakes by the economic world questions the *values of biodiversity** and even the *economic costs** which should be internalized in economic models.

Values of biodiversity, economic costs

Even though the economic interpretation of the importance of biodiversity for human societies is subject to a number of questions, the value of the living world is given in **economic values** following a very precise typology (Mouysset, 2015):

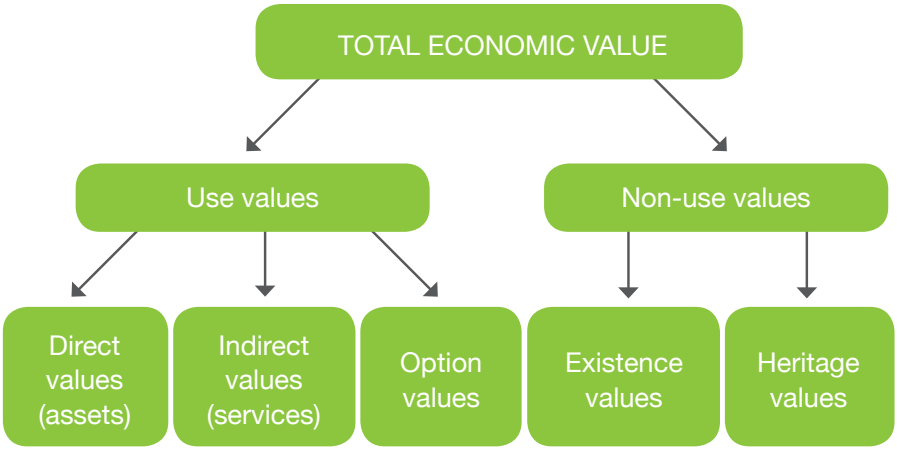

Figure 6: Total economic value of biodiversity (according to Mouysset, 2015)

- **Direct value** describes the direct dependence that some human activities have on biodiversity such as the fishing or logging industries;
- **Indirect value** illustrates the extent to which biodiversity can protect or maintain human activities particularly by soil renewal thanks to micro fauna or the regulation by birds of pests harmful to crops;
- **Option value** concerns this yet unknown or unexploited biodiversity which is nevertheless important for economic development. Biological knowledge and medication both know how much they owe to corals or tropical forests;
- **Heritage value**, represents these direct, indirect or optional uses for future generations and their development;
- **Existence value**, or intrinsic value, reminds us that biodiversity also has a value outside production; an iconic, cultural and spiritual value.

Human activities are responsible for the current massive and rapid collapse of biodiversity – which is what makes this extinction unique. Overexploitation of biological resources, the destruction and dilapidation of habitats all contribute to the disruption of how the biosphere functions, as a victim of climate change, pollutions and the invasion of opportunistic species. The vicious circles which feed on this weaken even further the ability of the living world to respond to these different pressures. In this way human societies establish a non-sustainable economic development with the frantic growth of industrial organizations (Barbault, 2006). Out of the 24 services derived from ecosystems studied by the Millennium Ecosystem Assessment (MEA, 2005), 15 are in the course of being dilapidated or are exploited in a non-rational manner. As an example, over the last 50 years, fisheries and the availability of fresh water have been exploited far beyond the levels which can ensure a form of sustainability.

All the changes directly or indirectly induced in the dynamics of the biosphere by human activities increase the probability of rupture phenomena appearing (including accelerated, brutal and potentially irreversible changes), with important consequences on human well-being (MEA, 2005): the sudden deterioration of water quality, the collapse of the fishing industry, disruptions at the level of local climate, etc. leading to diminishing well-being and an increase in inequalities.

In 2007, the Stern report assessed the economic consequences of inaction before 2050 with regards to climate change on a global scale, whereas The Economics of Ecosystems and Biodiversity (TEEB, 2009) proposes an assessment of the costs of inaction with regards to the erosion of biodiversity and the ecosystem service loss. Taking as a reference the level of biodiversity estimated in the year 2000, the authors have established that the yearly monetary loss caused by the disappearance of ecosystem services could in 2050 be more than 7% of the world GDP, 13,938 billion euros.

The influence of neoclassical environmental economists has resulted in organizations incurring new costs, through the integration of their externalities, but according to two different perspectives.

- **The win-lose perspective** considers that these costs economically jeopardise organizations which only take into consideration their negative externalities as a reaction to external pressure (regulatory, social), in order not to lose the right to carry out their activity. Environmental issues, which are generally treated through standards or regulations, imply an investment which provides little or no financial return, and can sometimes reduce productivity.

- **The win-win perspective**, shared by an increasing number of organizations, considers that the staggered effects of environmental regulations can be positive for their financial performance, particularly due to the reduction of environmental nuisances: material-saving, energy-saving, lowering of the cost of processing solid, liquid and gaseous effluents, improvement of the corporate image, improvement of processes, etc. Although the development of specific environmental regulations results in heavy costs for companies, it can, in certain situations, create economic profits and cover these costs partly, completely or even exceed them through the innovation generated as supported by the "Porter hypothesis" (Porter, 1991).

Due to the fact that these perspectives are focused essentially on economic parameters, none of them appear to be appropriate to meet the challenges raised by environmental deterioration: the win-lose perspective would not encourage companies to implement any environmental adjustments, and as for the win-win perspective, it can only induce the selection of the most profitable actions in the short term, with the risk of leaving out those which are ecologically necessary in the long term.

We consider that environmental actions should not be subject to economic considerations but that they should first and foremost be based on respect for the integrity of ecosystems and the health of populations with, in retrospect, the aim of reaching ecological objectives with the least possible global cost for society. It is then possible to study corporate strategies by their perception and taking the environmental questions which concern them into account.

Characterisation of the environmental strategies of organizations

Environmental strategies and in particular those of organizations are guided by two main forces:

- The monetary consequences of taking the environment into consideration on the one hand – the environment being traditionally limiting (win-lose perspective) or sometimes on the contrary favourable (win-win perspective);
- The intensity of external pressure which can be in the form of institutional pressure and/or pressure applied by the stakeholders (external organizations, internal sub-entities, informal gatherings, etc., e.g. clients, associations, unions, civil society, the media, etc.). The question here is that of integrating these externalities in order to avoid losing the right to conduct the organization's activity. This corporate approach is closely linked to the stakeholder theory of and to the field of corporate social responsibility (CSR), rooted in contractual conceptions of the firm, and belong to a perspective of weak sustainability.

Pressure (institutional, stakeholders)	**Weak external pressure**	**Strong external pressure**
Environment perceived as independent	Innovative strategies	
Environment perceived as an opportunity	Proactive strategies	
Environment perceived as a constraint	Passive strategies	Reactive strategies

Figure 7: Typology of environmental strategies according to the perception of the relationships with the environment (constraint/opportunity) and the degree of societal pressure (Ionescu, 2016)

We propose a typology of environmental strategies based on the perception of relationships with the environment (opportunity/ constraint), and the degree of external pressure.

Thus different scenarios can be defined:

- **Passive strategy**: the strategy aims at minimizing the constraints, and therefore the costs by cost-profit analyses or regulations avoidance.

- **Reactive strategy**: the organisation strives to avoid regulatory constraints (circumvention or avoidance strategies (lobbying etc.)), to minimize the costs (cost-profit analyses) and also to meet stakeholders' requirements with the lowest possible cost. Its change in practices can simply limit itself to a "greening" of its image (greenwashing), without actually modifying its processes, its environmental management or its economic model.

- **Proactive strategy**: the limitation of environmental deteriorations can be a source of profitability for the organizations, whether or not it is subject to particular external constraints along these lines. It therefore respects the possible environmental regulations and voluntarily develops complementary environmental actions which can provide short-term return on investment (energy and raw material savings, etc.), or even a longer term (innovations).

- **Innovative strategy**: this emerging view makes it possible to go beyond a dominant perspective where only the influences affecting ecosystems are taken into account, and see the mutual influences between organizations and ecosystems. This perspective highlights the influence that the organization can have on ecological structures and the evolution of ecosystems, and expresses the dependence of the organizations with regards to biodiversity. It is therefore possible **to identify unusual interfaces** with ecosystems and discover in this way **new areas of strategic management**: (i) the benefits gained from how ecosystems functions through ecosystem services, and (ii) the feedbacks that the ecological influences (positive or negative), caused by the organization itself or by a third party can have on the activity of the organization itself (in the short, medium or long term, and in a possible synergy with influences generated by other organizations).

If we go beyond traditional strategic management of the impacts on ecosystems (minimising the cost of reducing environmental deteriorations etc.) it is then possible to directly or indirectly optimise the creation of value (win-win logic) in the short, medium or long term, through the adoption of new environmental strategies. Innovative economic models in which the environmental dimension has a major role can emerge specifically in the heart of the organization itself (development of ecological-type service activities), in its supply flow, in its processes and production modes, in the design of products, in management and in the compensation of its environmental impacts, etc.

An innovative and sustainable strategy

The emergence of this innovative strategy strongly challenges the traditional running of the organization and also of investments. The management of impacts on living systems is anticipated beyond just meeting institutional constraints and the organization can seek to elicit them when they provide new commercial opportunities. The expectations of stakeholders are taken into consideration with a strong collaborative dimension – with a will to improve relationships, to set up new valorising partnerships, or in a contractual perspective, specifically in the case of positive influences–with the possible setting up of specific voluntary instruments.

Moreover, managing your dependence on biodiversity and ecosystem services will mean above all that the organization must watch over the sustainable functioning of the ecosystems which underlie it (new exclusive management modes, new clauses in management contracts, appropriation of areas, negotiations with the stake holders influencing the availability of ecosystem services, etc.), and even modifications to structures or processes. With these voluntary management and specific tools and processes, organizations will be able to implement these innovative strategies.

Focus on the analysis of voluntary approaches

The analysis studied the approaches designed to increase the ecological and/or economic environmental regulations and which are characterised by:

- The voluntary nature of the commitment of organizations, as opposed to traditional constraining instruments;
- The ecological objectives supposed to be more demanding than those to which organizations are subject through legislation;
- The preserving of the economic interests of the agent regulated by the minimisation of private costs and even profit-making.

A distinction between these standardised approaches to environmental management was carried out according to the initiator of the approach and the type of mechanism it belonged to, and enables us to offer a typology.

Mechanism mobilized \ Main business source of the the VA	NGO/non-profit organization serving households	Company/non-profit organization serving businesses		Public administration
Management system		ISO 14001		EMAS
Management standard	FSC MSC	PEFC UEBT LEED	HQE	AB European ecolabel MAE
Legal tool		PSE		PSE

Figure 8: Typology of standardized voluntary environmental management approaches (Ionescu, 2016)

For the interactions they propose to manage, are these instruments capable of leading social-ecological systems to a desirable resilient state? In order to answer this question we have developed an analysis matrix based on the interactions between the organizations and ecosystems concerned and the control of management. It enables us to identify the situations, the actors and their possible strategies.

Due to the variety of interactions between organizations and ecosystems, the specific stakes in terms of strategy for organizations are different. We can characterise them according to a variety of criteria: ecological (type and sensitivity of ecosystems, nature, quantity, quality of ecosystem services, etc.) or socio-economic (number and type of agents involved, financial capacity of agents, degree of dependence on ecosystem services, etc.). We propose to differentiate them following two characteristics which are essential from our point of view for the strategic objectives of organizations: (i) the type of interactions which occur there – influence or dependence –, and (ii) whether or not they hold the rights of use associated with the ecosystems involved, and therefore of the control or non-control of their management arrangements.

This matrix supports the approach of the 2nd VMM module.

The organization's relationship to the ecosystem	The decision-making power of an organization vis-à-vis ecosystem management	Strategic aim for the organization regarding the sustainability of the benefits derived from ecosystem (ecosystem services)
Beneficiary of ecosystem services but without capacity of direct influence on the functioning of the upstream ecosystem	Yes →	Securing the management methods ensuring the benefits derived by the organization itself. (e.g.: an industry supplying in wood)
	No →	Control acquisition of the ecosystem management in order to ensure a sustainable management and benefits derived from it. (e.g.: water supply of a local community)
Beneficiary of ecosystem services with a direct influence on the functioning of the upstream ecosystem	Yes →	Implementing improved management modes that ensure the sustainability of the benefits derived by the organization. (e.g.: farming business)
	No →	Negotiate an implementation of a shared sustainable management methods to ensure the organization's profits. (e.g.: fishing industry)
Non-beneficiary of ecosystem services but it influence the ecosystem functioning, upstream of other beneficiaries' activities	→ Yes/No →	Reduce the adverse pressures and even supporting sustainable management of the benefits derived from this ecosystem by other organizations, recognized as "legitimate" (e.g.: territorial planning/building and public works industry, pollutant-releasing activity)

Figure 9: Analysis matrix of interaction situations between organizations and ecosystems, and the associated strategic targets (Ionescu, 2016)

Focus on environmental accounting as a management

The expression "environmental accounting" refers to a wide variety of tools of which Jacques Richard proposes a typology in order to avoid confusion between tools with very different ambitions.

• **Outside-in environmental accounting:** This establishes a differentiation of certain corporate expenditures in order to take environmental issues into account. Most generally speaking, the reduction of environmental incidences corresponds to regulatory obligations (process standards for example), and even voluntary strategies and approaches. This accounting category is widely distributed and used, at least at European level, so it is operational and technically successful. Nevertheless, the system does not appear to be capable of resulting in the implementation of environmental management in the idea of strong sustainability (maintaining of natural capital) and is a recording and communication tool of which we cannot expect ecological changes. It cannot therefore be used in our viability framework.

• **Non-monetary inside-out environmental accounting:** this specifically covers:

- Extra-financial reporting proposed by (EFR) which has no measures aiming at preserving the natural capital and has no place in a strong conception of sustainability. The absence of incentives for defining enforceable management targets for the following financial year questions the ecological vocation of such an approach.
- Environmental reporting (Article 225 of the Grenelle 2 bill) which is designed for the regular monitoring of the interactions between an organization and its environment in a perspective of restitution and transparency for stakeholders. It suffers from a lack of parameters with regards to biodiversity, to the state and functioning of ecosystems, a lack of assessment of the real impacts on the environments, and of incentive to publish management targets for the following years.
- Life Cycle Analysis (LCA) is similar to CSR approaches but has a completely different aim. These sporadic confidential analyses are designed to internally modify the corporate functioning (e.g. production process, choice of supply) according to the results obtained.

• **Full Cost Accounting (FCA):** this covers the monetary evaluation approaches of costs resulting from the economic activities of an organization, the social and environmental externalities costs. The FCA was initiated to re-establish the veracity of market prices and attempt to correct a biased allocation of resources, leading to a deterioration of ecosystems in the absence of regulations and the consideration of these external costs. By determining the monetary values associated with the environment to integrate the externalities, it is based on the neoclassical precepts of environmental economy, and belongs to a weak perspective of sustainable development with possible substitution between the capitals. There are three main methods of evaluating externalities: costs of damage, avoidance costs (or inspection costs), and the willingness to pay method. The evaluation of the costs linked to the loss of ecosystem services, a method which can be associated with that of the cost of damage, is currently widely used to take into account the destruction or conversion of ecosystems and the erosion of biodiversity. Proposed by Costanza from the 90s, its deployment has accelerated since the publishing of the TEEB report (2009) and the constitution of its associated databases. To estimate the yearly value of the flow of ecosystem services, this method uses various evaluation techniques according to the kind of services involved: market prices, contingent valuation, joint analysis, transportation costs, hedonic prices, etc. (Levrel et al., 2012). A number of organizations mobilise or have mobilised this technique. A first generation of FCA projects is presented in detail in the article by Antheaume (2004), which covers a dozen or so cases including two initiatives: BSO Origin and Ontario Hydro. A new generation of FCA approaches conducted by organizations saw the light in the early 2010s with the publication of the Environmental Profit and Loss account (EPL) by the sports goods manufacturer Puma (Puma, 2011), whose methodology was subsequently taken up by other organizations.

Despite the fact that it is progressing, this method is subject to much controversy, both dogmatic and technical, specifically as to the reliability of the data produced and its reductionist aspect. It does not provide any substantial breakthrough for decision-making with regards to the physical indicators of impacts and the monetary impacts of internal costs. By ranking the environmen-

tal impacts, FCA does not deal with all the external effects of an activity. And lastly, in its narrowest meaning, analysts have highlighted how much FCA becomes a communication tool for external stakeholders. The results then supply decisions made upstream, according to considerations other than environmental or social ones.

To conclude, whatever FCA's finalities, reaching them is for the time being strongly compromised by the technical and conceptual limitations of the economic evaluation methods of externalities, with the exception of objectives which are only for pure communication means. But apart from this, this type of process is not capable of measuring the viability of ecosystems because it is not supplied by ecological considerations.

• **Sustainable Cost Accounting or natural capital accounting (SCA):** the major conceptual distinction between the approaches of (SCA) and those of (FCA) is their attachment to two distinct and opposing perspectives of sustainability. SCA was inspired by ecological economy, and a systemic perspective of the different capitals imposes maintaining the different capitals independently over time, in order to avoid the collapse of the ecological systems which support them. It is a question of preserving all the capitals independently and only spending the profit made from them. Certain components of the natural capital can be deteriorated, under certain strict conditions, because they are renewable and/or substitutable. From an accounting point of view, this implies a monitoring of the flows of capitals, to evaluate whether the organization is getting nearer or moving away from sustainability. Thus the costs of sustainability (costs of restoring or maintaining of the natural capital) are deducted from the conventional measure of profit, in order to determine a theoretical level of sustainable profit (or loss), the basic concept of the different acceptations of corporate SCA. Calculation of the "sustainable national income" is determined by these differences in the conservation of the environmental functions between the real practices of the organization and a standard level of conservation defined scientifically. If the difference is negative in physical terms, organizations must estimate the costs of restoring the function involved.

SCA has two major non-conflictual approaches, (based on the same conceptual foundations), which pursue distinct and potentially complementary targets.

- SCA's "alarmist" approach bears on the necessity of changing the economic model. The integration of all the capitals into accounting must automatically lead to their preservation rather than the reaching of a sustainable situation. The establishment of a yearly "balance sheet" will make it possible to estimate the path left from the organization to sustainability during the financial year concerned. It is a monetary representation of the differences between the current activities of an organization and its sustainable functioning.
- The SCA's "reformist" approach, whose most successful form appears to be the CARE method (Richard, 2012), and whose object is to redefine the accounting rules to trigger a transition towards a sustainable economic system. The major innovation is the proposal of accounting mechanisms to strictly speaking internalize the costs of sustainability. This is specifically the accounting concept of depreciation, from corporate accounting in historical costs, which is approved. Thus in the absence of changes to the neoclassical economic theory it is possible to build a strong sustainability through the application of age-old accounting rules in historical costs. In accounting, depreciation is the loss of value suffered by an asset due to its use (phenomenon of wear and obsolescence). It contributes in this way to giving a faithful image of the corporate situation, in the accounting balance specifically. Moreover, the depreciation can be considered as progressive integration, through the income statement, of the purchasing value of an asset, throughout its supposed period of use, which enables the efficient renewal of the organization's fixed assets. It is therefore the accounting process which is essential to the maintenance of the physical capital of organizations.

"Reformist" SCA proposes to extend these rules to other capitals, the natural capital and even the human capital. In the case of the CARE model, these new accounting rules lead to the constitution of a triple depreciation line (rather than the triple bottom line applied to extra-financial reporting). The depreciation of natural capital, which is what interests us exclusively here, represents the deterioration of ecosystems (the depreciation of the physical capital represents the loss of the capacity to use fixed assets), the fixed capital of the organization. It reports on the difference between the organization's real situation and the standard level

of its sustainable activity – a level which is determined scientifically. The minimum level of environmental conditions is defined using the concept of critical natural capital (the environment in its entirety is critical) that must be preserved respecting the environmental limits. The accounting model adapted to the renewal of the environment (CARE), centred on the renewal of the functional capacities of the different capitals (physical, natural, human), is illustrated by the works of Richard (2012).

Even if SCA is of considerable interest, it also has certain limits. Firstly, its attachment to the concept of critical natural capital conveys a number of ambiguous characteristics and the variety of its interpretations is potentially problematic for the viability of ecosystems. Moreover, environmental limits shown in the approach are somewhat lacking in precision. Ecological thresholds, or the tipping points of ecosystems, appear impossible to define accurately for all the natural capital. Adaptive management methods may make it possible to extend these requirements to multiple and evolving objectives based on a variety of indicators. Lastly, the setting up of SCA presents a few problems of a more technical order. (i) The environmental aspects are taken into account by flow analysis tools which have a tendency to consider the different parameters separately, without their systemic dimension, linked to the functioning of ecosystems. (ii) Calculation of sustainable costs is sometimes difficult to identify on the market of the sustainable substitutes for certain ecologically damaging organizations practices. The appearance of innovative alternatives which are the source of new corporate operating modes, and in doing so, of new sustainable economic models, is limited. (iii) Their implementation categorically implies a redefining of profit, resulting for the organization in new depreciation costs of the new capitals incorporated into accounting and which are potentially significant reduction of the net result that it can lead to, for fear of being subjected to a competitive disadvantage (decrease in payment of dividends and reduction of investments)

A few references to find out more

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- GRI : https://www.globalreporting.org
- MEA : http://www.millenniumassessment.org
- OCDE : http://www.oecd.org/
- TEEB : http://www.teebweb.org
- PUMA : http://fr.puma.com/
- FMI : http://www.imf.org/

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Acronyms

AB: (Agriculture Biologique) – Organic Farming
AEM: Agro-Environment Measures
BBII: Business and Biodiversity Interdependence Indicator
BPP: Beneficiary Pays Principle
CBD: Convention on Biological Diversity
CARE : (Comptabilité Adaptée au Renouvellement de l'Environnement) – Accountability Adapted to the Renewal of the Environnement
CSR: Corporate Social Responsibility
EMAS: Eco-Management and Audit Scheme
EPL: Environmental Profit and Loss account
FCA: Full Cost Accounting
FSC: Forest Stewardship Council
GDP: Gross Domestic Product
GRI: Global Reporting Initiative
HQE: (Haute Qualité Environnementale) - High Environmental Quality
IMF: International Monetary Fund
ISO: International Organization for Standardization
LCA: Life Cycle Analysis
LEED: Leadership in Energy and Environmental Design
MEA: Millennium Ecosystem Assessment
MSC: Marine Stewardship Council
OECD: Organization for Economic Cooperation and Development
PEFC: Program for the Endorsement of Forest Certification schemes
PES: Payment for Ecosystem Service
SCA: Sustainable Cost Accounting
TEEB: The Economics of Ecosystems and Biodiversity
UEBT: Union for Ethical BioTrade
VA: Voluntary Approaches
VMM: Ecosystem Viability Management Model
WBCSD: World Business Council for Sustainable Development
WCED: World Commission on Environment and Development

Traduction
Arabel Borel
Layout
Impribeau (Sainte-Ode), cover ORÉE

Printed on PEFC certified paper.

Presentation of the thesis partners

As the world leader in the field of luxury, the LVMH Group, chaired by Bernard Arnault, brings together over 70 exceptional houses. It is the only actor present at the same time in the five major luxury sectors: Wines & Spirits, Fashion & Leather goods, Perfumes & Cosmetics, Watches & Jewellery and Selective distribution. Present in 90 countries, it currently employs 125,000 people and has over 3,800 shops. In 2015 it reported sales of 35.7 billion euros.

All LVMH actors share three fundamental values which were stated by Bernard Arnault at the time the Group was created: to be creative and innovative, offer excellence and show entrepreneurial spirit.

Respect for these values is one of the keys to the performance of the Group's Houses, their rooting in the times and in the society around them. From its creation, the Group has always wanted to make sustainable development one of its strategic objectives. A commitment which is in line with the position that a group such as LVMH must occupy in French and international society.

Biodiversity is a major environmental stake since most of the products are from natural raw materials and living processes: vines and wine making for Wines & Spirits; plants for Perfumes & Cosmetics; wool, cotton, linen, silk, leather etc. for Fashion & Leather Goods; wood for the shops; wood, paper, cardboard for packaging and promotional items. LVMH was awarded National Biodiversity Strategy Recognition in 2012, and is a member of the Board of Directors of the Foundation for Research on Biodiversity and a member of the Board of Directors of the European Business and Biodiversity platform and the Advisory Board of Biodiversa.

Yves Rocher, who was born in La Gacilly in Bretagne, is the founder of the cosmetics company of the same name. Faithful to his roots, Yves Rocher made La Gacilly the cradle of the brand and the headquarters of its activities. As a botanist, harvester, manufacturer and retailer, Yves Rocher is the only brand of beauty products in the world to have chosen to control all the professions of its activity. At Yves Rocher, plants are at the heart of all the formulas and they are a source of inspiration and innovation, with over thirty new active ingredients created and developed every year by Yves Rocher research.

Having identified its interdependence with biodiversity using the Business and Biodiversity Independence Indicator (BBII) and other work carried out in 2010, Yves Rocher wished to develop indicators to initiate a piloting of its dependence on natural capital. It is consistent with these values and its biodiversity strategy that Yves Rocher wanted to support the doctoral thesis submitted in 2016 relating to new methods of approaches of biodiversity by economics, management and accounting. These works, rich and promising for the future, complement the contributions and publications that ORÉE supported in 2015, for the COP21 climate in Paris, about the relationship between Climate and Biodiversity.

Compta Durable® is the first independent firm registered with the Order of Chartered Accountants and Company Auditors, exclusively dedicated to the convergence of accounting and financial expertise and sustainable development. It was born from a desire to help organizations to understand their non-financial performance better and to improve how it is taken into consideration in their strategies. This dual expertise in accounting and sustainable development has enabled the development of innovative work in the field of social and environmental accounting.

Labeled by the Finance Innovation pole of Paris Europlace, our research cell supports the creation and development of a new accounting instrument that takes into account the natural capital and the human capital of organizations: the CARE method. Research and innovation are in the DNA of Compta Durable and it is for this reason that Ciprian Ionescu's thesis works have found their place in our projects.

The consideration of ecosystems by organizations requires an approach and tools adapted to the complexity of life. After three years of collaboration, Ciprian Ionescu's work and proposals enable us to enrich the approaches chosen by the firm by taking better account of biodiversity in the CARE model.

Veolia is the world reference of optimized resource management. Present on five continents with over 174,000 employees, the Group designs and deploys solutions for the management of water, waste and energy, which take part in the sustainable development of cities' and industries'. Through its three complementary activities, Veolia helps to develop access to resources, to conserve them and to ensure their renewal. In 2015, Veolia formalized its 9 commitments to sustainable development, including one dedicated to biodiversity. To help to limit the loss of biodiversity in the world, Veolia acts on reducing the impact of its activities and those of its customers on nature. The Group also creates favourable conditions for the preservation and restoration of biodiversity on land and associated spaces under its management.

The company launched into the identification and assessment of its interdependence with ecosystemic services and the possibility of valorizing them economically. After a first report drafted using the BBII at Group level, several case studies have been conducted on facilities operated by Veolia. Thus, giving value to biodiversity actions can bring legitimacy to decision-making on specific projects. Through this approach, Veolia enhances its operational expertise and can differentiate in its offers and contracts.

ORÉE's works on Biodiversity and Economy

ORÉE ASSOCIATION: ITS OBJECTIVES, ITS MISSIONS

ORÉE, a multi-stakeholder association created in 1992, brings together more than 170 companies, local authorities, associations, academic and institutional organizations to develop a common approach at territories scale.

3 priority actions:

Biodiversity and Economy
CSR reporting and local anchorage
Circular economy

ORÉE THE FOCAL POINT OF THE FRENCH INITIATIVE FOR BUSINESSES AND BIODIVERSITY OF GLOBAL PARTNERSHIP FOR BUSINESS AND BIODIVERSITY : www.entreprises-biodiversite.fr

Global Partnership for Business and Biodiversity was set up to reach the objectives of the Convention on Biological Diversity (CBD). This program controlled by the CBD Secretariat, meets the private sector's commitment to biodiversity. ORÉE, as the focal point of the French Initiative of this Global Partnership for Business and Biodiversity manages the French platform whose role is to bring together the various stakeholders working on the themes of "Business and Biodiversity" and also to present the best practices in this field.

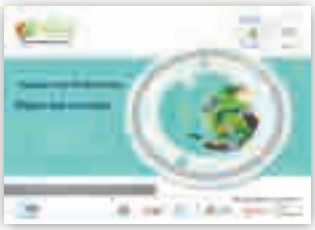
2013-2015

ORÉE'S COMMITMENT RECOGNIZED AS A NATIONAL BIODIVERSITY STRATEGY

ORÉE's commitment was recognized as a National Biodiversity Strategy (SNB) for its vision: "Biodiversity as the shared foundation for stakeholders"

As a member of the monitoring committee of the National Biodiversity Strategy, ORÉE is a key partner of the Ministry of Ecology for the deployment of the SNB 2011-2020.

ORÉE'S BIODIVERSITY AND ECONOMY PUBLICATIONS, IN 2013 AND 2015



2015 - Climate and Biodiversity:
Stakes and solutions.
Actors of today and the future at the interface of climate and biodiversity stakes
(French/English)

2013 - Management of biodiversity by stakeholders: from awareness to action
(French/English)

ORÉE'S BIODIVERSITY AND ECONOMY WORKING GROUP

- "Biodiversity and Economy – Prospective" working group

This working group, co-Chaired by Claude Fromageot, Director of Sustainable Development of the Rocher Group and Director of Yves Rocher Foundation – Institut de France, and Michel Trommetter, Director of Research at the INRA Applied Economics Laboratory (UMR GAEL), Director of the UMPF Doctoral School of Economic Science, deals with the dynamics between ecosystems and organizations. Its objective is to develop a process to integrate the interdependence between biodiversity and organizations into their strategic management.

- "Building and Biodiversity" working group

The aim of this working group set up by ORÉE and the association HQE in Juin 2013 is to assess the impacts and dependencies of a building on biodiversity.

For more informations: **www.oree.org**