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ENVIRONMENTAL SAFEGUARD AND SUSTAINABLE DEVELOPMENT: AN INSIGHT INTO PAYMENTS FOR ECOSYSTEM SERVICES[1]

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Abstract

This paper present a thorough reflection on Payments for Ecosystem Services (PES) programs, which may be viewed as the most innovative tools of the 'environmental policy toolkit'. These are incentive-based mechanisms, compensating landowners to manage the natural resources under their control in a sustainable way (generating environmental services such as biodiversity protection and ecotourism), instead of clearing land or excessively exploiting their natural resources. After briefly discussing the most significant findings in the environment and development research stream, we will present how the roots of PES lie in public economic theory, with regard in particular to

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environmental externalities. Later, after debating the proper definition of PES and its main concepts (e.g. additionality, perverse incentives, conditionality), we shall also comment the main case-studies on the topic, in order to provide clear examples of how these instruments may be applied in several different context (i.e. both in developing and developed countries, either by public or private agents). As it shall be shown, given their high adaptability to local conditions, PES are likely to become extremely important in next decades' environment safeguard interventions.

Keywords Externalities, environmental taxes and subsidies (H 23), Forestry (Q 23), Sustainability, environment and development (Q 56), Relation of economics to other disciplines (A 12).

Resumo

O texto contém uma reflexão sobre os Pagamentos por Serviços Ambientais (PSA), que podem ser considerados os instrumentos mais inovadores no âmbito das políticas ambientais. Estas compensações consistem na transferência de recursos (monetários ou outros) a quem ajuda a manter ou a produzir os serviços ambientais (por exemplo, proteção da biodiversidade e ecoturismo) numa maneira sustentável. Os mais importantes progressos na área de investigação sobre o ambiente e o desenvolvimento sustentável são discutidos em breve. Depois, com uma atenção particular às ligações com as teorias de economia pública, o presente artigo pretende analisar de que forma os programas PSA relacionam-se com os estudos sobre as externalidades ambientais. Ademais, as características principais dos PSA são descritas atentamente; são fornecidos também como exemplos explicativos os casos de maior sucesso, ilustrando como PSA podem ser estabelecidos em contextos muito diferentes (em países desenvolvidos e em desenvolvimento, por agentes públicos e privados). Enfim, será demonstrado como, apesar das suas complexidades e das longas investigações necessárias, os PSA podem tornar-se fundamentais pela proteção do meio-ambiente nos próximos anos.

Palavras-chave Externalidades e políticas ambientais; Economia florestal; Sustentabilidade, meio-ambiente e desenvolvimento; Relação da ciência económica com outras disciplinas.

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1. INTRODUCTION

Usually, the most studied economic models analyze how different variables (e.g. consumption, investments, public expenditure, etc.) contribute to economic growth, without considering how those variables affect natural resources and, more in general, life on Earth. Indeed, only few researches in development and ecological economics seem to pay enough attention to how growth itself and environment are interrelated (Farley and Daly, 2003). It turns out to be a remarkable shortage, unfortunately. In fact, if we consider the most important indicators over environmental degradation, a worrisome scenario is depicted. As a consequence, given the increasing relevance of the issue, in next decades scholars are expected to research new programs and tools to safeguard Earth's 'natural capital'.

As a contribution to researches in the environment and development field, the purpose of this paper is to present and discuss what may be perhaps considered the most innovative tools for environmental protection, i.e. Payments for Ecosystem Services (PES). In short, these are compensations made to the manager of an Ecosystem Service (ES) to persuade him not to excessively exploit nor polluting the natural resources under his control (Engel et al., 2008). Given their heterogeneity, PES represent important tools, but on the other side, since these programs are usually established according to place-based conditions, summarizing PES main features uniformly is not an easy task (Wunder et al., 2008). Nevertheless, general reports and guidelines have been already prepared by renowned agencies and researchers to offer a concrete overview of the topic (Smith et al., 2013); our paper includes several referrals to those publications, as well as new considerations and analyses. What is important to be mentioned since the very beginning of our study is that PES do not represent an 'universal panacea', the ultimate solution to all environmental problems, since they should be carefully integrated in a policy mix including public sector interventions such as regulation and taxation. However, note that PES schemes are originally set up to protect and improve the provision of one, or more, ES; as a consequence, other socio-economic considerations, albeit linked to compensations and local communities involvements, should have a secondary role. Therefore, for the sake of completeness, and to offer possible hints for future policymaking, we find it relevant presenting the most exemplary PES programs around the world, showing how effectively these may be adapted to very different contexts (Smith et al., 2013 b). In particular, the last part of this work shall discuss projects and initiatives with very peculiar features, since some of them take place in developed (e.g. France) and developing (e.g. Bolivia) countries and are run either by public (e.g. Costa Rica) or private economic agents. We shall also present the main features of a recent project (named Arbio) in Peruvian rainforest, that aims at creating a model to lower deforestation in the Amazon region and to promote instead its sustainable conservation in an innovative way (Recanati et al., 2015).

The paper is then structured as follows. Section 2 offers a general theoretical background on the environment-development relationship. Section 3 introduces the concept of 'ecosystem services' and briefly discusses the main tools for environmental safeguard. Section 4 presents PES from a general perspective, debating also its formal definition. Section 5 describes explanatory examples of PES in different part of the world. Section 6 concludes.

2. ENVIRONMENT AND DEVELOPMENT

The concept of sustainable development has been largely argued, promoted and criticized overtime by economists, sociologists and scientists: nonetheless, given its multifaceted nature, it is still controversial, and policies aimed at enhancing it, as the debates of the Conference of the Parties held in Paris in December 2015 have demonstrated[2], result hard to be agreed upon uniformly at the global level. Anyway, it is a concept which is supposed to play a central role for the well-being of future generations, and policymakers are required to face this issue seriously.

The most widely-accepted definition is that proposed in 1987 report *Our Common Future* (also known as Brundtland report) by the UN, according to which "*sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; the idea of 'limitations' imposed by the state of technology and social organization on the environment's ability to meet present and future needs*". Besides of its lavish language, this sentence is crucial as it highlights how between economic growth (intended as the way to produce goods and services able to satisfy people's need) and natural resources availability there exists a complex and fragile equilibrium. Consequently, 'growth' and 'development' should be intended as different concepts (and not used as synonyms, as it often occurs with mass-media): while the former is a quantitative concept referring to the increase in the physical dimensions of the economy (and of its relative waste stream), the latter is a qualitative evolution, a change towards an improved (and not larger) system or structure.

Outstanding contributions in this field have been those by development economist such as A. Sen (whose 'capability approach' does not view physical products as the final goods, rather as tools to develop the capabilities that allow one person to follow his

[2] Renowned experts have criticized the final text produced in Paris since it includes only promises rather than a binding treaty, while its clauses may be modified each five years.

favorite path of life) and S. Latouche (father of the 'degrowth' theory, advocating, perhaps too idealistically, a reduction in our consumption patterns).

But overtime several other scholars had already debated similar points; indeed, the idea that we should start looking after future generations' world, and stopping behaving as harmful 'cowboys' had already emerged a few decades ago.

During the 60's, possibly inspired by the spatial mission of that time, K. Boulding coined the expression "*spaceship Earth*" to argue that, similarly to how astronauts have to carefully manage the limited reserves included in their carrier to survive, the same perspective may be used to describe how humanity should deal with Earth's resources (Boulding, 1966).

To point out how science and economics are intertwined in this regard, N. Georgescu-Rogen applied the laws of thermodynamics (arguing that at the end of every process, the quality of energy is always worse than at the beginning) to economics: he maintained that an economic process aimed at goods production lowers the future availability of resources and then the possibility of further production; then, economic modelling should include also this kind of considerations, instead of only focusing on market mechanisms and their failures. In other words, entropy law and its relative ecological constraints should be put at the basis of a 'new economic thinking' (Georgescu-Rogen, 1971).

Following this mindset, one of his most distinguished students, H.E. Daly strongly maintained that economics students, not to neglect the implications of the laws of thermodynamics for global ecosystems, should be equipped with principles of biology, ethics and philosophy; otherwise, they would tend to concentrate their studies on finding perpetual growth models only. Quite ironically, Boulding, a few years before, had argued that "*anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist*"[3]. Furthermore, according to Daly, with the economic growth of past century, mankind, that throughout history had lived in an 'empty' world (economy was small, and the number of manmade economics services lower than that of ecosystem services provided by nature), is now living in a 'full' world, in which new sustainable behaviors with regard to consumption, waste management, etc. are required. In other words, while for conventional economic vision, economy is the whole, and the ecosystem a part of it (being technology the only limit), for ecological economics the contrary is true. Then, since we already 'filled' the world with our activities, achieving a sort of 'steady state' would be desirable: in it, development, intended as improvements in human living conditions, would be allowed to continue growing, while economic (and material) growth should be stopped (Farley and Daly, 2003).

[3] Attributed to Boulding in: United States Congress House (1973). *Energy reorganization act of 1973: Hearings, Ninety-third Congress*, p. 248.

More recently, a very interesting theory is that of the so-called 'planetary boundaries', developed by J. Rockström. Taking advantage of his background in natural sciences, he has identified nine[4] boundaries, the crossing of which would represent a tremendous threat for life on Earth. But even if just one of these gets worse, then all the others worsen too, causing damages to the biosphere. Two of them still need further computations, while, for those we have already reliable data, the situation appears already critical with regard to climate change, biodiversity loss and nitrogen cycle. The most astonishing evidence is the one concerning biodiversity loss. Its preindustrial value (representing the number of species becoming extinct each year) ranged between 0.1 and 1; currently, it is estimated that Earth loses more than 100 species per year. It is true that precise data over total global biodiversity are still missing (just think of how many species could still be discovered in Borneo or Amazon forests), but such a speed up is impressive. As for nitrogen cycle, it is crucial for life, being it one of the fundamental nutrients involved in the production of food. Human activities are now converting "*more nitrogen from the atmosphere into reactive forms than all of the planet's natural terrestrial processes combined*" (Rockström et al., 2009). Measured as the millions of tons per year of N_2 removed from the atmosphere for human activities, in the pre-industrial epoch its value was 0, today 135. Nitrogen and phosphorus cycles are usually intertwined: data for both of them are highly alarming. This affects mainly life in seas and oceans, where huge increases in nitrogen and decreases in oxygen level are creating sort of 'dead zones'. To conclude the analysis of Rockström's theory, and to further extend our perspective, some words on climate change are necessary as well.

From a certain point of view it is a tricky topic, since it is not straightforward to take into account numerous elements (e.g. the consumption of fossil fuels, the use of freshwater, extreme events like droughts and tsunamis, changes in temperatures, etc.) at the same time. Anyway, the large majority (97%) of climate experts agree that climate change and ecosystems degradation is mostly caused by human activities: they are not natural phenomena (Doran, 2009). It has also been created a network, *The Consensus Project*[5], in order to spread evidences of human damages to the natural world. There is still who sides himself against this position, but all the main environmental indicators demonstrate that high degrees of environment depletion arose when humanity entered the industrial revolution. Unfortunately, civil society is not well-informed on this debate, and several common places seem hard to get destroyed: indeed, if data are cherry-picked it is easy to induce wrong beliefs in uneducated people. However, a detailed report indicates that all the main scientific research centers agree that the alarming increase in global temperature started approximately at the half of past century, when heavy industrialization both in Western and Eastern blocks, alongside the first steps of

[4] These are: climate change, ocean acidification, biodiversity loss, chemical pollution, atmospheric aerosol loading, change in land use, stratospheric ozone depletion, freshwater consumption, effects on nitrogen and phosphorus cycles.
[5] http://theconsensusproject.com (last retrieved 21/01/2016).

development of former European colonies, occurred (EEA, 2012). Extremely similar results are obtained in the graphs relative to sea level and CO2 emissions: this cannot be a simple coincidence (Stern, 2007). Note that even the definition of 'climate change' itself needs a small digression. People often tend to confuse weather and meteorology with climate. Actually, the big difference between these concepts depends on the length of the phenomena under analysis. While the commonly-defined weather is made up of short-term fluctuations in a limited area, climate is the results of long-term (at least 30 years) observations on a larger area and is given by statistically significant average values. Climate depends on several factors (geographical[6], cosmic[7], etc.) and is affected by the interactions of numerous spheres. Being a gradual process, it may potentially have tremendous effects. What is most worrisome is the fact that still we do not know clearly solutions to all these issues, or even if and how they exist. What instead is certain is that now climate change speed reached alarming values (EEA, 2012). And what is even more preoccupying is that poor people will be those who will suffer the most from climate change effects: for many of them, jobs (either formal or informal) and more in general livelihoods conditions rely strongly on natural cycles. If climate variability gets unpredictable, massive social conflicts will arise. Ensuring the accession to basic services like primary education and health, even in harsh conditions, will ensure that nobody shall be left behind, in the path towards sustainable development (Verner, 2011). With regards to social justice, it should be noted that vulnerable people are those facing massive threats even if their contributions to GHG emissions environment degradation is extremely smaller than that of developed nations. There seems to be thus a disjuncture between future risk and past and present responsibility: nonetheless, only in a few occasions international community dealt seriously with this point, trying to figure out some remedies for vulnerable communities (Bird, 2014). Consequently, the limited public budgets of developing countries are allocating large share of assets to pay considerable adaptations to a climatic scenario they are scantly responsible for (Althor et al., 2016).

Indeed, an important term which has been coined is that of "*Anthropocene*"[8], to indicate how heavily in modern times the natural history of the world is influenced by mankind, how humans are exploiting the resources at their disposals[9]. The weight of humans on Earth is now heavier than ever: various indicators, including population, paper consumption, water supplies, all present an exponential growth, starting more or less 10.000 years ago, when human civilization exploded. Our system is not efficient: just think of the huge amount of food that gets wasted and how useful it could be in the fight against starvation in developing countries. So, as humans are able to change the structure

[6] Altitude, latitude, distance from the sea, continental masses and mountains orientations, marine currents.
[7] Shape and movement of Earth, Moon gravity on water.
[8] This expression refers to the Ancient Greek word "*ανθρωπος*" ("human") and the suffix "*–cene*" that characterizes all the epochs in which Cenozoic era is subdivided.
[9] Millenium Ecosytem Assessment, 2005: "*Over the past fifty years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, fiber and fuel.*"

of the Earth with their activities, they also need to understand and be aware of this change: the health of ecosystems is dependent on economy's physical size.

As mentioned above, it is during the 70's that all main indicators assumed alarming values: it is illustrated well by the comparison between the Genuine Progress Indicator (GPI) and Gross Domestic Product (GDP) (Kubiszewsky et al., 2013), the trends in Ecological Footprint (EF) and Biocapacity (BC) (UNEP, 2010), the study of the Living Planet Index (LPI) (WWF, 2014). These all indicate that a serious environmental degradation is currently underway[10] (Appendix A).

3. ECOSYSTEM SERVICES AND ENVIRONMENT PROTECTION

Recent economic studies have acknowledged that natural resources have an inner value, and so it makes sense speaking of a 'natural capital'[11]. This is in line with an ongoing tendency in several areas of economics, i.e. the inclusion of 'alternative types of capital' in models aimed at explaining current global trends in a more precise way (e.g. just think of studies on intellectual capital, social capital and human capital). Natural capital comprises the whole stock of natural resources on Earth, since it is responsible for providing goods and services in the long term (e.g. the flow of fish supplied by a river is potentially infinite). Hence, not only physical goods (timber, minerals, etc.), but also energy, biodiversity and, above all, ecosystems are included in this definition (e.g. a well-managed river provides also erosion control and water catchment). Ecosystems are thus crucial since they include both biotic grouping and abiotic environment: whenever these two elements are mixed, they interact and provide a flow of services. To use standard economic theory's terminology, ecosystems offer different kinds of benefits, to be classified in three categories:

[10] GDP commonly measures economic growth: it estimates the market value of final goods and services produced in a country within a given period of time. Instead, the main goal of GPI is to better represent the actual economic welfare generated by economic growth: its computation assumes Personal Consumption Expenditures (GDP main component) as a starting point, but then it is adjusted using twenty four socio-environmental indicators (e.g. pollution, income inequality, car accidents, volunteer work, noise pollution etc.).
EF measures the amount of biologically productive sea and land areas required for meeting the rates of resource use within a certain geographical space by a certain population. BC can be viewed as a sort of 'environmental bank account', as it is the actual amount available of biologically productive area. If EF gets larger than biocapacity, then there is an 'overshoot', an ecological deficit, meaning that we are consuming more resources than those naturally available. Using economic terminology, EF and biocapacity could be viewed as Demand and Supply of ES in the environmental markets.
LPI's rationale is that the number of animals currently alive can be viewed as a proxy of the quality of the environment. It measures more than 10,000 representative populations of mammals, birds, reptiles, amphibians and fish.

[11] Historically, this concept has been used for the first time by Schumacher in his 1973's book *Small is Beautiful*, and has been later deepened by many ecological economists such as the already mentioned Daly.

i) goods (harvests, water, etc.);

ii) services (recreation, tourism, erosion control, etc.);

iii) cultural benefits (heritage, spiritual benefits, etc.).

They may thus provide, regulate or support goods and services, also those with an inner cultural value. For example, with regard to watershed protection, protection from soil erosion, carbon sequestration and many others, economists started to use the terms 'ecosystem services' (ES) (Daily, 1997) (Appendix B). This goes against traditional economics since it puts forward the idea that also non-human life is able to produce essential resources: ecological health is thus key. The idea that natural world is priceless is then mistaken. Rather, attributing an economic value to natural assets creates a common framework for private and public agents to work together. As some authors pointed out in last decades, manmade economic world is not independent nor autonomous; indeed, economies, created by societies, are sustained by ecosystems. Ecologists and economists should hence work side-by-side. But usually economic activities are conducted independently, without considering the ecosystem in which they are inserted nor other activities underway in the same area, thus neglecting long-term costs and possible future conflicts. On the contrary, an ecosystem-based approach may provide managers and policymakers with an integrated tool to plan and balance human activities respecting local natural equilibria (WWF, 2014).

But, how can one concretely define such ecosystem services? Indeed, even if the idea behind the concept is quite intuitive, providing a formal definition may reduce future frictions and favour genuine cooperation. According to 2005 Millennium Ecosystem Assessment, ES are, broadly speaking, "*the benefits people obtain from ecosystems*" (MEA, 2005). Further details on ES are provided by Daily (1997): "*Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. […] In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well*".

All human activities are possible because of ES presence, but at the same time we put pressure on the biodiversity that supports such systems. Since humanity is reliant on ES natural provision, it is important to know how humanity itself interacts with surrounding environment. Note that ES are not always coming from commonly-intended natural realms; as a British study illustrates well, out of the eight broad habitats identified in its report, two (Urban and Enclosed Farmland areas) are intensively affected by human activities: nonetheless, they still provide several ES such as local climate regulation, cultural heritage, recreation and so on (Smith et al., 2013).

Unfortunately, current situation today is critical, and depends on a general negative historical trend. After WW2, the emphasis that the Western economic model attributed to consumption and the maximisation of food, water and energy supplied

caused an alarming decline in habitat conditions: for instance, almost 30% of UK biomes are either severely degraded or reduced (UK NEA, 2011). At the global level, over two thirds of vital natural services are in decline (MEA, 2005). Indeed, a serious analysis of ES may not limit itself to discuss ecological issues: since humans live in and affect natural areas, social and environmental issues are to be discussed at the same time, highlighting possible trade-offs and opportunities. In fact, the degradation of a rural area usually brings a worsening in living conditions (UNEP, 2008).

A parcel of land often may provide two or more ES at the same time: for example, forests preserve biodiversity, store carbon and defend from soil erosion. Being nature so interconnected and multiple benefits supplied altogether (cf. Rockström's planetary boundaries), win-win solutions are difficult to find, and many trade-offs are involved (Wunder, 2005).

Customary instruments used to price, to economically value an ES may be misleading, not allowing to carefully compute the value of the resources. Market prices indeed misrepresent the social value of an ES, being usually lower than it is; shadow prices instead help us in this task.

Moreover, focusing on a single ES, albeit simpler than assessing multiple ES, may be misleading in policymaking. In any case, it is key the comparison between two or more options, where the less costly will be preferred. Policymakers should be careful not to 'restrict their horizons', but to consider all the possible ES provided by a region. That is why recent scientific literature focused on valuing multiple ES at the same time (Barbier and Heal, 2006). The scientific rationale behind this is that isolating and valuing single ES is often difficult, given the many interactions between two or more ES. Therefore, valuing ES is not a simple task, rather it poses two important issues. The first point is that economists cannot be left alone in this assignment, but cooperation with biologists and ecologists is key. Secondly, also thanks to this interdisciplinary collaboration, economists should 'think outside the box', not considering a region as a totally isolated system, but as an integrated economic-ecological system.

De Groot et al. (2012) argue that attributing monetary value to ES may help raising awareness as well as conveying the importance of biodiversity and ecosystems. Evaluating ES is extremely difficult, since once cannot 'value the priceless' nor place monetary value to something 'of fundamental importance': but ongoing world's situation is critical.

As a consequence, the 'environmental policy toolkit' now includes several tools, in order to promote environmental safeguards in different ways:

- regulation and provision of services by government;
- voluntary efforts by business, communities and individuals;
- incentive or market-based mechanisms:

- charges (e.g. taxes and user fees);
- tradable permits (e.g. carbon sequestration offsets);
- certification schemes (e.g. eco-labels);
- payments for ecosystem services (PES).

Some of them attribute a leading role to the public sector, while several others rely on private agents' initiatives. In particular, we shall focus on PES since they represent the most innovative topic in this research field.

4. PAYMENTS FOR ECOSYSTEM SERVICES: DEFINITION AND MAIN FEATURES

Payments for Ecosystem Services (PES) represent perhaps the most relevant example of well-functioning markets for ES, being schemes that have already been largely adopted even in various developing tropical countries (those more threatened by climate change and environmental deterioration). These are innovative tools to translate external, non-marketed values of natural world into concrete financial incentives addressed to local actors (farmers, landowners, etc.) to provide ES (Engel et al., 2008). In spite of being a relatively young topic (first PES schemes have been implemented 15-20 years ago), overtime they have gradually proliferated around the world.

The most commonly-used definition of a PES scheme describes it as follows (Wunder, 2005). A PES is

1. a *voluntary* transaction where
2. a well-defined *environmental* service (or a land use likely to secure that service)
3. is being 'bought' by a (minimum one) *service buyer*
4. from a (minimum one) *service provider*
5. if and only if the service provider secures service provision (*conditionality*).

This may sound as a long and complex definition, but following notes and examples shall clarify it. Critical aspects of this definition are that:

- *entrance* into a PES agreement occurs on a voluntary basis, it is not compulsory. However, note that some government-financed schemes (e.g. China's SLCP) seem to not respect properly this requirement.

- even if some projects may involve intermediaries (between ES buyers and sellers), generally payments are made *directly* from service beneficiaries to providers. For doing so, it is necessary a clear distinction between *de iure* and *de facto* agents.
- *additionality* must be ensured: payments are made for actions over-and-above those that service providers would commonly undertake. In other words, the provider must demonstrate that those practices would have not been put into practice without the PES program.
- *conditionality* must be ensured: payments are actually made if and only if the delivery of ES benefits occurs. In other words, the provider must demonstrate how the practices he has implemented have actually contributed to safeguard environment;
- interventions should not be easily reversible. The *permanence* in time of practices adopted should be ensured, even after the period of implementation of the program.
- environmental *leakages* (i.e. the shifting of 'bad practices' to other areas as a consequence of the start of a PES project) must be avoided (Engel et al., 2008; Wunder et al., 2008).

The rationale behind PES is that who provides one or more ES (as any other services in 'ordinary' economy) should get paid for doing so (Smith et al., 2013). For instance, along the course of a river, a community living downstream, using the water of the river itself for drinking and farming purposes, may be willing to pay another upstream community for not polluting the same water. Or an international donor may be interested in paying a community in a forested area in a developing country to protect local species. Therefore, thanks to PES, previously un-priced ES (e.g. 'water quality') are now put a price on. Opportunity cost is a key concept here, since local actors, to maximize their profits, usually have to decide between two (or even more) possible land uses. For example, considering forest conservation, local landowners usually receive low benefits from it. More precisely, these benefits are lower than those they would get from alternative land uses (e.g. conversion to cropland and livestock). However, this deforestation (induced by the opportunistic behavior of ecosystem managers) may generate costs and/or damages to both local and global communities. Consequently, service users, paying ecosystem managers, may turn conservation into a more economically captivating option, convincing them to adopt it (Pagiola and Platais, 2007).

Assuming a public economics perspective, PES try to realize what Coase's theorem prescribed, i.e. through private negotiations what would otherwise be an externality gets instead internalized. Indeed, what we have provided before is a 'Coasean' definition, as it aims at explaining how PES work by means of the typical terminology used in public economics for (environmental) externalities. In Coase theorem the basic

idea is that, when the externality problem arises (i.e. when the actions of an economic agent affect the welfare of other individuals/communities), the 'victims' may reward (with money or in-kind transfers) the polluter in return for a reduction of his (polluting) economic activity[12]. It is then applied the 'beneficiary pays principle', while other traditional environmental policies (e.g. biodiversity offsetting[13], Pigouvian taxes, etc.) follow the 'polluter pays principle'. Regardless of the initial allocation of rights, according to Coase, then it exists a spontaneous tendency that enables the market to reach the optimal levels of production and pollution. In this way, the public sector (i.e. the government) would play a minimal role (smaller than that assumed with regard to other externalities-reducing policies, e.g. regulation and standardization). Indeed, instead of imposing strict regulations, standardizations or taxes, with PES it 'only' has to allocate rights and allow people to exchange them freely in the market (the main preconditions for the Coase theorem to work properly) (Coase, 1960). That is why Coase theorem is usually seen as a 'market solution' (Atkinson & Stiglitz, 1980).

According to these consideration, Wunder's definition seems to promote a win-win policy idea that is institutionally simple, direct and cost-effective, and as a consequence the dissemination of PES idea has been relatively quick and widespread. PES in fact result being very sustainable (not based on whims of donors, but on the self-interest of service users and providers) and efficient (only what is worth conserving gets conserved) at the same time. For doing so, however, remember that these mechanisms must be tailored to specific local conditions, payments to providers based on payments by users and services actually delivered (Wunder, 2008).

Anyway, recently the definition by Wunder has been questioned (Porras et al., 2008). Indeed, it has been noted that PES usually are established in situations with high coordination and transaction costs among and within the different categories of agents, high uncertainty, asymmetric information between parties involved in negotiations and cognitive barriers for assessing the tradable services. Furthermore, since PES seem to rely heavily on market institutions only, the fact that just one ES (carbon) presents a well-defined market is critical. Other critical points are the following:

- with regard to watersheds and biodiversity, ES tend to result too complex to commodify and monitor overtime, especially across decades;
- no referrals to poor ES providers are present, even if PES often take place in developing countries, with high poverty and income inequality rates;
- the criterion of voluntary participation seem to be complied with only in relation to collective/club goods.

[12] Note that, were the externality positive (i.e. producing benefits to other agents), individuals may find it convenient to subsidize that economic activity, to enlarge its scope.
[13] A scheme according to which damage in one place is compensated for by means of improvements elsewhere.

As a consequence, it has thus been noted that a PES scheme hardly succeeds in respecting the five requirements of Wunder's definition altogether. Even those PES programs usually indicated as exemplary sometimes do not comply with all those criteria (e.g. Costa Rica's national PES).

Then, possible different definitions have been proposed, but what should be clear is that PES are to be intended as "*transfers of resources between social actors, which aim to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources*" (Muradian et al., 2010). From this perspective, it appears clear how PES may turn out be powerful tools in the context of the widely-debated 'tragedy of the commons' (Hardin, 1968): indeed PES may help generating a sound collaboration between all the actors (or at least the most important ones) involved in environment protection.

In spite of their great potentialities, PES schemes must not be viewed as the unique, absolute solutions to environment degradation problems. Indeed, it may happen that, according to local conditions or agents' features, other tools are better-designed to address some issues. For example, if ES provision is hindered due to the credit constraints of services providers, then it may be helpful providing them with access to credit; if local ecosystem managers do not have the authority to manage ecosystems properly, then clarifying property rights may produce positive results. This to recall that PES may be applied only to the case in which ES benefits are viewed as externalities by ecosystem managers, leading to a mismanagement of natural resources (UNEP, 2008).

Similarly to what occurs with offsetting, also in this case geographical distance does not seem to represent a worrisome obstacle. Indeed, ES may bring positive effects to regions far from starting ecosystems (e.g. climate change mitigation improves global health): in such a case, PES present the advantage of linking two or more agents or communities, regardless of their geographical proximity. Moreover, PES may be developed at different spatial scales. Indeed there may be international, national, regional and local programs.

Regardless of their location and scope, all of them usually include the following actors (note that the first two may be sufficient to implement a PES program):

1. *Buyers*. They wish to secure the long-term provision of the ES they are dependent on. A necessary distinction to be made is that between the case in which buyers are the actual ES users and that in which buyers (in this case, usually governments and NGOs) operate as a third-party agent, on behalf of ES users. In the first case, we speak of 'user-financed' program, in the second of 'government-financed' program. User-financed programs proved to be more efficient, since the actors involved have first-hand information over the ES considered, are able to observe directly the proceedings of the programs and renegotiate the terms of the contract, if needed: this is why these programs are sometimes defined as 'Coasian', given the agents' great possibility of continuously negotiating. In government-financed

programs, instead, buyers (i.e. public sector agents) have fewer information and chances to directly monitor the program, and sometimes result to be excessively driven by political pressures, rather than genuine environmental care; this affects negatively projects' effectiveness, since project managers could aim almost exclusively at meeting the needs of certain target communities. In addition, government-financed programs are less able to adapt themselves to sudden changes in underlying conditions: as a consequence, several scholars now view them as a sort of ordinary subsidy programs (Wunder, 2008).

2. *Sellers*. They are able to safeguard the delivery of ES. This category then may include a wide range of actors, as PES may be organized also in protected areas and public lands (being government and local authorities in this case sellers). Being economic agents, these actors are interested in studying whether possible buyers of the ES they provide exist or not, and their economic value.
3. *Intermediaries/brokers*. Interested in environment safeguard, they basically help studying how to generate and sell ES. These may help reducing transaction costs, such as search and negotiation costs, favoring the relationships between buyers and sellers in general and designing scheme features.
4. *Knowledge providers*. They may be specialists, local policymakers, scientists, researchers, legal advisors, professional consultants: all of them have the duty of providing PES participants with key information during the various stages of project implementation, in order to ensure that a feasible PES is put in place.

PES schemes may thus present different features. For instance, there may be 'one-to-one', 'one-to-many', 'many-to-one', 'many-to-many' programs, according to the number of buyers and sellers involved (intermediaries may be present in each of these configurations) (Smith et al., 2013).

Given these heterogeneity of actors, future research may focus on the analysis of how different contracting powers among these may influence, either positively or negatively, the effectiveness of a PES scheme. Indeed, at times actors may have different (or even contrasting) interests, and the most powerful of them, via lobbying and bribery, may influence public policy critically ('capture theory'), potentially putting at risk the well-being of other communities. This problem however does not seem to affect small-scale user-financed programs, since these usually involve extremely intertwined communities (Fisher et al., 2008).

In any case, it is crucial to conduct a serious cost-benefit analysis before than starting a PES program. Case-studies illustrate that start-up costs approximately are equal to payments for ten years; costs reflect local socio-economic conditions: in Los Negros project in South America these were worth $ 184/ha, in Vittel project in France $ 4800/ha (Wunder et al., 2008; Smith et al., 2013 b). Note that payments may be made in different ways (e.g. cash, technical assistance, in-kind transfers), according to the needs of

recipients (rural communities may prefer one or a combination of these, according to local traditions and cultural values). However, even if conditionality remains one of PES main elements, a distinction between 'output-based' payments (based on actual ES provided) and 'input-based' payments (based on the implementation of certain resource or land management techniques) may still be done. This latter category is more common, especially in user-financed schemes, since measuring the impact of a certain management technique on project implementation area may be a long and time-consuming process. Furthermore, when a PES scheme deals with multiple ES, these can be 'packaged' and sold in different ways:

- 'Bundling', if one or more buyers pay for the whole package of ES arising from the same portion of land or body of water;
- 'Layering', if diverse buyers pay for the separate ES arising from the same portion of land or body of water;
- 'Piggy-backing', if not all ES generated are sold, but one (or more than one) ES is sold and the other services provided by the same portion of land or body of water are free of charge (possibility of free-riding for beneficiaries).

Alongside these economic considerations, at the very beginning of research design unintended consequences need to be studied as well, in order to prevent possible problems in the future. They for example may deal with environmental leakages (i.e. whether a program in an area will pressure ES elsewhere or not), perverse incentives (e.g. if reforestation is rewarded, somebody may find convenient to cut down tree and replant them) and equity issues (i.e. whether payments will be equally distributed within local communities and ES providers or not).

With regard to this last point, as we already mentioned, it is clear that PES schemes, involving rural communities either as users or providers of ES, may affect deeply their welfare. Nonetheless, PES must be primarily intended as instruments to improve the provision of ES. Indeed, even if PES projects take place mostly in low-income countries, whether poor people shall be affected by them depends on specific conditions, such as which ES are sought (Engel et al., 2008). Moreover empirical studies on the ability of PES schemes to improve poors' welfare produced contrasting results. In general great obstacles to poor inclusion are their lack of power (risking to be marginalized) and transaction costs (empirical studies in Latin America illustrate that higher transaction costs indeed represent greater obstacles than households' own limitations) (Wunder, 2005; Pagiola & Platais, 2007). On the other side, also measuring the benefits of PES is complex, since they are computed as the difference between payments received and the cost borne to provide ES: since these estimates are really difficult to measure, discovering the actual scope of PES social benefits is not that easy (Barbier & Heal, 2006). Anyway, as far as poor enrolment in PES schemes is concerned,

in perfectly voluntary projects they are assumed to participate only if they would be better-off than without it, but this assumption cannot be made for those (imperfect) PES programs the participation to which is not explicitly voluntary. Sometimes participation may be hindered also by the difficulty to demonstrate the legal title or control over certain parcels of land, and by the fact that usually buyers, to reduce transaction costs, prefer negotiating only with few big landholders rather than with many small ones.

Anyway, while the effects of PES contracts on ES sellers are generally positive (a stable flow of money, increases in land tenure, social capital and 'site propaganda'), the same cannot be said for the effects on non-sellers: since these include several categories of agents (service users, on-site landless people, off-site actors in the value-added chain), different kind of problems (including free-riding and social conflicts) may emerge.

Despite these considerations, additional objectives are often implicit in PES contracts, and these relevant (but still secondary) goals include usually regional development, employment creation and poverty alleviation (e.g. if poor farmers receive constant payments their disposable income is likely to increase). Remember in fact that for government-financed projects considering also social issues is a way to obtain political support to the program implementation: aware of this, local communities may however assume parasitic, rent-seeking behaviors, taking advantages of the situation. If it so happens, PES are not likely to bring benign effects, since the inclusion of several additional objectives may undermine the genuine development of a PES project and diminish available resources for pure environmental safeguard. Instead, user-financed programs are less subject to this kind of problem: in such schemes usually ES users and beneficiaries communities know each other, and the limited scale of the project does not allow to take too many objectives and considerations into accounting. As a matter of fact, 'targeting the poor' results then being a feature of government-financed programs, while positive welfare effects have been achieved by user-financed programs even without including proper poor-targeting goals (e.g. PSAH project in Mexico). However, case studies analysis shows also that, even if PES may produce limited gains over and above opportunity costs for ES providers, this type of schemes may lead to different improvements, for example in terms of health (e.g. better water quality thanks to a better management of a watershed) and security of (property) rights (since PES schemes may only be implemented in parcels of land the legal authority upon which must be clearly identified) (FAO, 2013). In other words, if project managers focus their efforts more on poverty alleviation, then environmental activities may get deprived of important resources, and vice versa. Similarly, choosing between maximizing benefit per $ spent and caring of welfare impact may limit PES effectiveness, either in a sense or in the other. Addressing too many issues at one time shall then make it difficult achieving any sort of good results.

It is interesting presenting the 'ecosystem services curse' issue too. In fact, despite their potential in environmental protection and poverty alleviation, PES may end up not

producing positive effects. Some precautions must be taken, preventing PES from damaging local development. Indeed, as resources-abundant nations may struggle to enjoy fully the benefits delivered by their resources, for example due to corruption, weak governance and connected inequalities (just think of the cases of Venezuela, Nigeria and oil), a similar occurrence may take place with PES as well, in ES-abundant regions. If with 'ordinary' resources problems are mostly due to poor legal systems, the well-management of ES may be undermined by payments volatility, rent seeking and disparities in bargaining power. Strengthening transparency, regulations and institutions, monitoring regional policies, ensuring that only 'real' ES providers are being paid are just some of the tools governments and international organizations may use to counter possible drawbacks (Pagiola and Platais, 2007).

In light of all these general considerations, how could one design a successful PES program? Some steps must be taken into account, in order to consider all relevant social, legal and technical aspects, to respect local traditional values, to be at the same economically convenient and to demonstrate additionality in environment safeguard. An accurate list of these steps may be like the following:

1. identification of possible saleable ES, related sellers and buyers;
2. identification of PES principles and solution of technical issues;
3. negotiations and definition of agreements structure;
4. PES implementation: monitoring and impact evaluation activities;
5. analysis of further developments of PES scheme, including future inclusion of other ES (if possible).

If at the beginning the focus shall be mostly on the study of whether ES exist in an area, prospects for their trade, and who are their buyers and sellers (some sort of questionnaires may be prepared to cover the main points), later project design shall include more specific aspects such as transaction costs, payments methods, duration of the contract, M & E, 'packaging' of ES, etc. (Smith et al., 2013). Albeit time-consuming, it represents a fundamental process: only facing carefully each single issue parts involved shall be sure that no further problem (or at least, no extremely worrisome problem) shall arise during PES implementation. Nevertheless, 'learning by doing' is also in this case an important player, since unexpected occurrences are likely to happen in programs (such as those of PES) aimed at lasting a long period of time. Intermediaries and consultants may participate in one or more steps, but the essential roles shall be those of ES sellers and buyers: in particular, without mutual trust (sometimes powered by tools for mutual control) between them, success (i.e. environment safeguard) shall be hardly reached.

5. PES EXAMPLES AND PRACTICAL CONSIDERATIONS

To integrate previous general considerations, we find it interesting presenting now a few examples of the most successful PES programs around the world, to illustrate how they work in practice. Albeit following PES take place in different continents, some common features may be highlighted: the design of a PES contract may require several years, all the clauses must be related to place-based conditions, targeting always plays a central role, and, as already mentioned, 'learning by doing' is necessary (since it is impossible to include in advance in the contracts all possible occurrences).

5.1. VITTEL, FRANCE

The Vittel case is considered to be a 'perfect' PES case study. It illustrates how private-sectors firms may participate in PES. This scheme takes place in Northeastern France, where the headquarters of Vittel (one of world's major companies in the bottled water sector) are located. In 1992 the company was bought by Nestlé. Vittel's water has always been associated with good health and wellbeing, thanks to its particular nutritional properties. French legislation for natural mineral water is severe, with many legally binding prescriptions. In the '80s, from several studies it emerged that intensive maize cultivation increased the concentration of pesticides and nitrate in Vittel catchment, putting at risk water's healthy brand. Five options were considered to solve the problem: out of these five, for both economic and environmental reasons, the best one involved the provision of incentives to local farmers for making them voluntarily change cropping practices. To better understand what concretely was going on, Vittel and INRA (France's agronomic research institute) conducted a detailed survey (AGREV) in 1989. The main objectives included the analysis of the conditions under which farmers would be willing to change their practices and the financial support needed to realize it. Four main categories of farmers, according to the extension and productivity of their lands, were identified, as well as several techniques to reduce nitrates and pesticides in soil. Putting into practice possible solutions has been a long (10 years of negotiations) and complex process. A constant element has always been farmers' involvement in the debate, being Vittel deeply interested in understanding their needs. Both parties showed interest in reaching an agreement. With regard to the monetary payment to farmers (around € 200/ha/year), the compensation should have not to be lower than opportunity cost of changing techniques plus an extra (as an incentive), while Vittel also had its own opportunity cost. Many elements entered the debate, including possible changes to French law on inheritance (prescribing that every son and daughter receives an equal amount of land even if not interested in farming it), considerations on Vittel importance for local economy and employment (almost 2.000 workers out of 10.000 local inhabitants) and the monopoly power of large landholders (impossible to be substituted with others). Finally,

Vittel and farmers' union agreed upon a wide package of incentives, which includes, among others, subsidies for the transition period between the use of previous (polluting) farming techniques and the adoption of the new ones, free provision by Vittel of organic compost to fertilize land and free techincal assistance by Vittel and the federation of local farmers. Each farmer discusses individually with Vittel other terms of the contract. With regard to conditionality, a specific type of contract has been created ("*prêt à usage*"), according to which not compliers with the terms of the contract would lose their land (it has never happened, however). Agrivair (an intermediary entity created specifically to facilitate the negotiations) has been later endowed with financial assets to buy the lands of retiring farmers and conceding them to young people wishing to establish a new agricultural firm, of course respecting Vittel's prescriptions. Being Agrivair's director a well-known entrepreneur has helped creating mutual trust between the two parts. By 2004 all farms in the area had implemented the new cropping techniques (cattle-ranching and composted manure replaced maize cultivation and agrochemicals pesticides) and approximately 90% of water sub-basin was protected (and water quality maintained). The long-termism of contracts (18-30 years) has been key to convince farmers to accept Vittel's proposals.

Therefore, what makes this case so interesting? Basically, at the end everyone is happy, and better-off than starting conditions. The ES sold by farmers to Vittel is 'improved water quality', necessary to guarantee Vittel's productions (no packaging of ES is necessary, being there only one ES). Of course, being a wealthy company afforded Vittel to invest in scientific researches and providing incentives to farmers: such investments resulted fundamental to keep producing bottled-water and selling it worldwide. Farmers receive financial and technical support by Vittel and specialized agencies for converting their cultivation techniques into more sustainable ones. Vittel has behaved well also differentiating the contracts (e.g. according to farm location) and adapting the terms of the contracts to local situations. Also local community received indirect benefits, since the company employs many local workers. Additionality of this program is indeed difficult to compute, but it is unlikely that water basin without direct Vittel's intervention would have bettered on its own. Also leakages (e.g. increased maize cultivations elsewhere) are difficult to be measured, while monitoring is ensured by Agrivair. Permanence is ensured as well, since farmers find new cultivation techniques economically convenient while payments for Vittel are necessary to safeguard local water basin. The case has involved numerous social, economic, legal and technical considerations, being all of them necessary to understand the ongoing situation and to stipulate successful contracts. Indeed primary reasons for success proved not necessarily being of financial nature. Rather, mutual trust, involvement of local workers and consultants and sustainability considerations have been at the center of the debate. Even if initially there have been imperfect knowledge, deep negotiations have helped reaching a positive conclusion. Important points include also establishing a strong and trustful

relationship with ES providers by means of active engagement (Perrot-Maître, 2006; Smith et al., 2013 b).

5.2. Los Negros, Bolivia

The Los Negros case is captivating since it is an example of how successful PES may include two ES simultaneously: 'habitat protection' and 'watershed protection'. The former is financed by US Fish and Wildlife Service, interested in preserving migratory birds' habitat; the latter by the farmers of Pampagrande municipality, interested in regulating water supplies for their crops. Indeed, in Bolivia water wastages and inefficiencies are serious problems: in Los Negros region, farmers estimate that during dry seasons the flows of water have almost halved in last two decades. Transfers are paid each year, provided that a specific committee monitors that conditionality condition has been complied with.

Los Negros valley has a 26,900 ha extension with two main villages, Los Negros and Santa Rosa. On one side, the valley borders with Amboró National Park, for which illegal encroachments became recently a serious problem. Another issue is water management during dry seasons, a matter that raised several conflicts between local communities, since intensive agriculture is the main revenue-generating activity for farmers of that region (2-3 harvests per year). The wish to obtain larger areas available for cropping induced also deforestation, putting at risk local unique biodiversity (UNEP, 2008). A local NGO in 2003 started designing a PES scheme aiming at preserving Los Negros watershed, given the relevance of the threats for the region and the relatively small number of people (1.328) to negotiate with. Both downstream and upstream communities were interested in PES. An external donor, US Fish and Wildlife Service was included in the consultations with local stakeholders, to demonstrate them how serious the program was (there were serious mutual trust shortages between the two rural communities). US agency agreed to pay for conserving Los Negros forests, important habitats for rare bird species. However, at least initially, attention has been mostly given to regulation of water supplies, but payments provided by US agency resulted being crucial to cover PES start-up costs ($ 46.000). At present, downstream payments for watershed protection are administered by Pampagrande municipality, while water users are not yet directly paying. On the other side, upstream landowners were invited to join the PES scheme on voluntary basis (i.e. choosing which parcel of land and for how long enrolling in the contract). As of late-2007, over 2.774 ha were being protected by almost 50 farmers; contracts' duration ranged between 1 and 10 years. Payments are provided yearly, and to monitor actual conditionality of the project GPS tools are used too. Note that payments are not cash, but in-kind transfers. They were discussed several alternatives (including road improvements) but upstream farmers preferred receiving beehives: this would have helped them to not waste quickly the money received, creating instead something that

lasts. This induced further improvements in environment conservation, since new jobs as beekeepers were created and forests as habitat for bees gained larger importance. A few farmers preferred receiving fruit tree seedling and barbed wire instead of beehives as compensation (criticizing beehives' inflexibility as economic assets). Decisive monitoring is ensured by specific project control teams, including members from all the communities and NGOs involved: costs for maps, GPS instruments, etc. are equally divided. The main task of these teams is controlling if land parcels have been actually conserved, noting any change or damage. Sanctions have been established gradually, basically when each problem or inefficiency emerged. With regard to additionality computations, avifaunal surveys and twelve signalers along Los Negros river and its tributaries are used to check the protection of natural habitats and watershed. In 2005 some sort of spatial differentiation has been introduced, since some vegetation types were viewed as more protection-worthy than others. Being a PES focused on environmental and resource management issues, landless and poor inclusion was not among the main objectives of the program: indeed, these, being without land to protect, are excluded. Nonetheless, a few of them still benefited from the PES, being hired to work on honey processing or having bought beehives from participant landowners. To sum up, this PES has been developed with the purpose of providing local water users with incentives to manage their water resources sustainably. Due to the lack of detailed information and effective institutional mechanisms this was a viable solution to overcome the problem. Improving the income of the majority of upstream farmers, the program has been able to achieve positive results both in biodiversity and watershed protection (Asquith et al., 2008). Interesting peculiarities of the program are:

- the customization of payments modes, according to the needs of participants;
- the fact that two services were included in a single PES scheme (it allowed the starting of the project, overcoming initial financial constraints; free-riding problems, due to some overlaps between the areas relevant for the two types of conservation, still have to be solved);
- the practice of conducting intensive data collection activities before implementing a PES scheme in this case has not been complied with. Alternatively, learning-by-doing as been a constant feature, justified by the willingness of analyzing what was actually going on only after that money had changed hands.

5.3. PSA, Costa Rica

Among all Central America nations, Costa Rica is an exception for its level of economic development and environmental safeguard: for example, an outstanding result has been reached last March, when government declared that the country energetic needs were being met by using renewable energies only.

When it was designed, Costa Rica's country-wide PES scheme (known as PSA, "*Pagos por Servicios Ambientales*") represented a pioneering experience. Nowadays, after almost 20 years from its start, it is widely considered as one of the best example of PES of its kind, and other countries in the region (e.g. Mexico) have tried to imitate it. Established in 1997, this PES program based itself on Law 7.575 of previous year, which identified the main four ES delivered by forests:

1. hydrological services;
2. biodiversity conservation;
3. mitigation of GHG emissions via carbon sequestration;
4. ecotourism, scenic beauty and related activities.

Bundling them has progressively helped to measure their environmental relevance. In addition, that very law also established the Fondo Nacional de Financiamento Forestal (FONAFIFO): it is a semi-independent agency appointed for managing PSA, composed of representatives of public and private sectors and whose budgetary decisions must be approved by the ministry of finance. PSA did not start from scratch: rather, environmental concerns had entered somehow national policies since the '70s, when incentives for timber plantations were provided. Following measures included certifications such as CAF (1986) and CPB (1995). Then, PSA had already a concrete basis, and early payments and schedules were taken from previous initiatives. However, the main changes induced by PSA included the fact that government budget was no longer appointed to sustain financially this scheme (being new taxes and payments from beneficiaries being introduced) and, above all, the very change of the general purpose of the program, from support to timber production to ES provision (note that pro-poor policies were not among primary objectives). Therefore, it would be wrong to state that PSA is a mere continuation of previous initiatives, since, especially in the last decade, several innovations have been put into practice.

The main source of income is represented by a 3.5% fuel tax (generating around $ 3-4 million per year), while others include the sale of ES to beneficiary agents. Specific new regulations are however needed, since, for example, if charging water users for upstream watershed management services has been successful (around $ 0.5 million per year), the same cannot be said for carbon and biodiversity.

Indeed, the importance of forests for hydrological services was recognized by Law 7.575 itself. PSA wished that, at least partially, PES would have been financed with payments from hydroelectric power producers. Since precise legal prescriptions were absent, FONAFIFO has been able to negotiate directly with water users and conclude several agreements. Later, the use of ES certificates (certifying the payment for the conservation of a hectare of forest) contributed to raise sharply the number of agreements (and amounts paid): at present, such agreements cover the full cost of environmental safeguard plus the administrative costs borne by FONAFIFO.

Contracts for biodiversity conservation have been financed mostly by the Global Environment Facility (GEF) managed by UNFCCC (around $ 8 million over 5 years). Other sources of finance come from a silvo-pastoral GEF project and Conservation International (around $ 1.2 million over 5 years). Efforts have been made to generate revenues from local tourism sector, but without success. As a consequence, a large area (over 900.000 ha), which does not present either the potential for water or carbon financing, lies outside protected areas in spite of being defined crucial for biodiversity conservation. Partial solutions are coming from the public sector.

With regard to carbon payments, since the very beginning of PSA, FONAFIFO developed Certified Tradable Offsets (certifying a net reduction in emission of 1 ton) and sold them. Norway's government and a consortium of Norwegian entrepreneurs have been the firsts to buy a relevant number (200.000) of such CTOs. The fact, however, that such emission reductions were due to avoided deforestation, and not to reforestation or afforestation (as prescribed by Kyoto Protocol's CDM), partially hindered the initial development of this sector. To overcome this issue, also in light of REDD+ program implementation, new types of contracts have been introduced, while further financing has come from the BioCarbon Fund of World Bank. Last but not least, also landscape payments were considered a key point, but agreements with rafting companies and hotels initially did not emerge, as in the case of biodiversity conservation. In spite of its great potential, this aspect is seriously hindered by problems of collective actions (Pagiola, 2008). In absolute terms, PSA program interests at least 10% of nation's forested area (more than proper protected areas): it involves approximately 1 million ha of forests, and helped increasing country's forest cover (from 20 to 50% of total land area).

However, most finances come from the fuel tax, as service users only partly pay for the ES they benefit from: PSA may thus be viewed as a 'supply side' PES scheme. A major cause for this is, now that PSA functioning is clear and well-described, the tendency of local people to free ride the payments borne by others.

Nevertheless, a serious decline in deforestation rate has indeed been registered, monetary value to biodiversity and forests has been attributed and a deeper understanding of socio-economic features of ecosystems achieved. PSA effect on households has instead been limited ($ 64/ha/year), since PSA itself was primarily designed to promote forest conservation (and not poverty alleviation) and poor landowners found it difficult to understand the convenience and importance of enrolling in PSA (Wunder et al., 2008).

This PES scheme hence has been successful in combining effectiveness, low implementation costs and balance equity: indeed, the mainstream strategies to reduce deforestation have been applied to national landscape and people. Recently priority has been given to areas at high-risk of getting deforested, rather than following the initial first-come first-served principle. Female-headed areas and indigenous communities have been included too, being each social group targeted by specific measures and contract

clauses. Generating direct payments, new jobs and healthier ecosystems the benefits of these PES seem clear (Pagiola & Platais, 2007; Porras et al., 2013).

To sum up, how have initial inefficiencies been tackled?

1. The lack of targeting in early stages of the program has been overcome thanks to the creation of specific priority areas since 2003 and by the fact that funds of several service users have their own targeting (e.g. watersheds with service user contracts).
2. The issue of undifferentiated payments country-wide has been solved by creating ad hoc adoptions of higher payments when needed, as in Río Segundo river basin.
3. To overcome initial undifferentiated modalities country-wide, new systems have been gradually developed: for example, agroforestry better suited to small farmers (including payment per tree methods) and natural regeneration (as a cheaper option than plantations for carbon sequestration).
4. Lastly, designing new improved impact monitoring systems and retrospective assessments has helped to solve the issue regarding the lack of information on PSA effectiveness.

In light of all these points, it should however be clear that PSA is not the unique panacea to solve all environmental degradation problems in Costa Rica; nonetheless, it is an important 'carrot' to include in a wider policy mix. After 20 years, which are then the main lessons learned from PSA?

- It is easier to introduce a new PES scheme if existing laws already regulate somehow ecosystems-related payments.
- If relevant regulations already exist, it is much easier to implement a government-financed scheme than a user-financed one.
- Payments for sustainable watershed management are easier to implement than those for carbon and biodiversity, for which serious issues regard measurement and beneficiaries' identification.
- Targeting and differentiated payments are crucial elements to solve problems connected with opportunity costs and differences in the level of ES provided.
- Due to changes of different nature (e.g. in national and international legislations), PES schemes should be flexible and able to be adapted to changing circumstances (Engel et al., 2008).

5.4. Arbio, Peru

Deforestation and excessive exploitation of natural resources are serious issues affecting many rainforest-rich developing countries (e.g. in Amazon, Congo basin, etc.) (FAO, 2015).

Madre de Dios is the third largest and the least populated Peru's region. It is on the South-East side of that Latin American country, in a strategic position at the border with Brazil and Bolivia.

Considered as one of the most important green areas of the planet, it hosts huge intact rainforests, a unique biodiversity and is striving to be resilient to climate change. Anyway, recently the region has been experiencing an increase in habitat loss and forest degradation mainly due to logging, mining and infrastructure (FAO, 2010). Trees are cut to plant new (and more profitable) species (e.g. palm oil) or to obtain additional areas to crop and livestock; this is endangering those plants, such as Brazilian nut, that to flourish need a pristine environment. Mining has been triggered by the exceptional endowments of this land of gold and other precious ores such that nowadays abusive extraction represents the illegal activity with the highest turnover (even more than drug); mining is dangerous also for its 'collateral' effects, such as soil erosion, mercury pollution, river contamination, etc. With regard to infrastructure, the creation of new networks has made accessible areas that just a few years ago were in the depth of the forest (and so difficult to be exploited by humans): roads, channels and railways are increasingly getting used by inhabitants of the poorest regions to move towards other areas (Barber et al., 2014). Serious concern has been raised in particular by the recently-built (2011) Interoceanic Highway (IH): it represents one of the main actions implemented by the intergovernmental forum Initiative for the Integration of the Regional Infrastructure of South America (IIRSA)[14], and aims at connecting Peruvian harbors on the Pacific with industrial clusters on Brazil's Atlantic coast. As a matter of fact, the rationale behind its construction is of economic nature (Vitte, 2009). Given the emergence of Far East economies and the intensification of Brazil-China relations (with China becoming Brazil's first trading partner in 2009), having a new road crossing the continent and reducing considerably the time for sending and receiving goods from Asia is key. Serious debates on the potential threats caused by IH to local biodiversity arose even before than its construction, and still continue today. In general, on the one hand, roads contribute to economic growth and lessen social tensions in high-density regions, easing internal migrations; on the other side, they contribute to the exploitation and loss of a rich natural patrimony, and harm indigenous people's survival, invading their lands often violating

[14] IIRSA, established in 2000, is an intergovernmental forum composed of all twelve South American nations, with the final purpose of promoting regional integration among them by means of development in infrastructure, energy, transport and telecommunication sectors. It is a multinational and multidisciplinary forum coordinating the investments of governments, financial institutions and private sector in the above-mentioned fields.

their rights. Therefore, in spite of their possible socio-economic benefits, such infrastructures tend to dramatically affect environment (Barrientos Felipa, 2012). In particular, with regard to IH, a major worry is that it was opened when Amazon had already lost significant shares of its original vegetation: the fact that an important part of its route crosses Madre de Dios department, one of the last largely environmentally-endowed areas in the planet, inhabited by several indigenous tribes, is alarming[15] (Dourojeanni, 2006).

It is in this multifaceted scenario that several environmentalist initiatives have emerged. Some of them involve important international donors, others are managed directly by local NGOs. Arbio, "*Asociación para la Resiliencia del Bosque frente a la Inter-Oceánica*" (Association for the resilience of the forest against IH), was born in 2010, aiming primarily at lowering the potential negative effects of IH construction.

Established in the forest near Puerto Maldonado (Madre de Dios capital), it now operates on a 1.631 ha concession and employs about twenty researchers and staff members, hosted in a modest base camp. In fact, according to Peruvian Forestry Law 27.308, private agents may obtain concessions on wide national forest areas: in doing so, they are responsible for all that occurs in their areas (e.g. paying sanctions if third-party loggers damage it). Such concessions are attainable by demonstrating the required qualifications to manage the prescribed portions of land, and last usually 40 years, with the obligation of presenting each 5 years a detailed and updated management plan. Being concessions part of national patrimony, in theory they could not be deforested excessively; nonetheless, from the authorities' viewpoint, it may result convenient to turn them into agricultural terrains, since production and related fees would increase (Giudice et al., 2012). To fight against these bad practices (and connected forest destruction), Arbio's mission includes the following objectives:

1) sustainable development of the Amazon;
2) coexistence of humans and forest;
3) endorsement of locals.

In particular, Arbio deals with 'productive conservation': it is not totally against IH (at 20 km from its base), acknowledging its importance for local transportation and international trade, but wishes to propose alternative economic, environmental and social development models. In other words, the specific objective of Arbio is to prevent its area from getting deforested or polluted, but they would like to succeed in this not via an absolute conservation, but by means of a productive model taking into account the ES

[15] Indigenous communities (10,000 individuals) are important and various elements, since there are 19 ethnic groups and 7 language families (high relative presences are reported in Manu province). They crop land with traditional low-impact methods. The recent increases in urban population and migration from bordering provinces, fostered by the development of IH and its supposed economic benefits, are serious concerns for indigenous tribes' vulnerability.

provided locally and forest products attained in a sustainable way (Arbio, 2013). Indeed, researches over the possibility for establishing a PES scheme are currently underway (Recanati et al., 2015): the cases of two specific ES, 'biodiversity conservation' and 'ecotourism/recreational services', are worth being discussed.

With regard to the first, we already briefly explained how Madre de Dios flora and fauna are critically endangered. ES beneficiaries (i.e. possible buyers) may include local government, civil society agencies and international donors. This latter possibility may produce significant outcomes from the very initial phases, since it would guarantee those resources needed especially to cover start-up costs. Local actors usually, due to corruption and opposition to projects run by Western operators, are harder to get convinced. Arbio, to assess the value of the biodiversity included in its concession, may contact specialized consultancy agencies or use proper methodologies such as the Business and Biodiversity Offsets Program (BBOP)[16] developed by Forest Trends Association or the wildlife habitat quality measures used in the computation of the Environmental Benefits Index (EBI)[17]. Payments for biodiversity conservation may be either monetary or in-kind transfers: however, given the location of Arbio base camp (in a wild area, difficult to be reached from a properly-so-called town) in-kind transfers consisting in tools and instruments, albeit useful, would be harder to be transported. Furthermore, additionality in this case is justified by the fact that without PES Arbio would not be able to protect more effectively its land, while conditionality checks (i.e. whether biodiversity gets actually protected) may take place, for example, by means of measurements in the increase (or decrease, if things go wrong) of a sample of selected representative species or by sightings by guardians and monitoring staff. Perverse incentives are avoided: since its origin, Arbio has been led by a genuine interest in preserving wildlife, therefore the idea that its staff starts to kill or transfer species just to demonstrate, at a later stage, that its work produces positive results appears completely wrongful.

Ecotourism would represent for Arbio another way to conserve environment and getting paid for doing so at the same time. Madre de Dios, given the uniqueness of its landscape and species, may potentially attract environmentally-friendly tourists. With this regard, the main problems for Arbio seem currently to be of logistic nature. Firstly, the concession is in a quite remote area, far from any international airport (Puerto Maldonado airport has flights only with other Peruvian cities) and reachable only after a long trip by boat or off-road vehicles. Secondly, accommodation possibilities are (being the concession in deep forest) still limited. Nonetheless, some sorts of 'eco-lodge' are being built without using polluting materials[18]. However, Arbio is likely to receive benefits from this activity: indeed, ecotourism both fosters attention on forest conservation and generates revenues useful for the economic maintenance of the concession. The costs

[16] http://bbop.forest-trends.org/pages/guidelines (last retrieved 03/11/15).
[17] www.iatp.org/files/Environmental_Benefits_IndexConservation_Reser.pdf (last retrieved 03/11/15).
[18] A similar example: www.ecoamazonia.com/en/lodge.html (last retrieved 29/01/16).

borne by Arbio for making this possible shall not present extremely high figures: these only include the efforts to improve the accommodation facilities of base camp area, while the guided tours in the forest shall present minimal costs. It has all the potentialities to become a profitable activity (similar projects charge around $ 200/night per couple), as other examples in the region already demonstrate. To sum up, ES beneficiaries, in addition to the protected forest, would be environmentally-friendly visitors, who do not fear to be hosted in austere (at present Arbio premises are without electricity and internet) but functional accommodations. Additionality and conditionality would in this case be strictly related, since Arbio shall be able to attract tourists (i.e. to get paid for conservation) if and only if the area they propose to visit is actually integer and well-managed; the prevention of leakages shall be crucial, to not draw the attention of potential visitors by shifting possible detrimental activities in other areas. In any case, to foster a sound development of this activity, a wider and deeper collaboration with tourism agencies is advisable, especially for international tourists. Another crucial issue regards the relationship with indigenous tribes. Visiting their villages, without the pretension of modifying their lifestyles nor exploiting their land, could be a plus for a 'real' natural trip in world's largest rainforest. This idea has already been put into practice by agencies such as Rainforest Expeditions since 1996. It has been possible also because some local communities wish to attract visitors as a way to defend their lands from the new infrastructures built in the region. For example, Rainforest Expeditions itself now hosts tourists in lodges managed by local people (which in return for their hospitality receive 60% of profits), but relationships with them are not always straightforward, since local dwellers usually tend to appreciate time and serenity more than money. Despite such differences in mindset, this sort of ecotourism initiatives shows how revenues may be generated while benefiting at the same time both environment and indigenous tribes. And since also in proximity of its concession some communities live, Arbio should try to take advantage of it.

At present, other potential ES do not seem to be eligible for a PES program managed by Arbio. For example, taking into account 'watershed protection', it would be difficult to demonstrate that operations carried out by Arbio, which borders a river only along one external side of its concession, actively contribute to protect local water basin.

Consequently, when discussing the implementation of a PES scheme in Arbio concession the following considerations must be taken into account:

- the concession (1.642,1 ha), in spite of representing a significant area, is even smaller than areas commonly hosting small-scale projects described in international guides and reports. This issue could potentially get solved with the acquisition of further land, so as to create a larger concession delivering an 'appropriate amount' of ES to be sold. However, interviewing Arbio staff on the main problems related to the enlargement of project areas, lack of funds and of (specialized and reliable) seem to be the main difficulties in doing so.

- the Peruvian concession system is, like, 'written in stone' and changes take place at an extremely slow rate. Indeed a new Forestry Law has been already approved a couple of years ago but it still has to be totally implemented. However, from the point of view of Arbio, the legislative situation is not very critical: after all, it has ensured so far a passable management of their area.
- the only stakeholders existing around Arbio base camp is the native community, the relationship with which requires a completely different mindset to approach. There are not relevant rural or urban communities nearby, if we do not consider people working in the other concessions and agricultural lands, while in 6 years in the area Arbio staff has never seen somebody of the government other than sporadic medical expeditions (but no inspectors). Some sort of scientific collaboration with academic scholars and researchers is possible, whereas agreements with governmental institutions other than the local universities, albeit possible, are better to be avoided (due to corruption and rent-seeking). Anyway, Arbio has a number of partners which are not governmental nor rural: these are some local organizations that work to reach a similar aim, i.e. preserving wildlife against the deterioration taken by IH (e.g. Camino Verde, Asociación Agricultura Ecologica, ACCA, etc.). Generally, given the similarity of purposes, if necessary it is possible to conclude agreements with this type of stakeholders (Arbio, 2013).

6. CONCLUSIONS

The principal aim of this work was presenting all the main features of PES schemes and of their relevance for sustainable development, and discussing some key explanatory examples.

Researchers studying the relationships between economic growth and environmental safeguard have already produced many reports and papers illustrating current critical situation. All the main indicators present alarming data (humanity is excessively taking advantage of the natural world): at present, we would need more than one planet Earth to sustain world's current rates of consumption and environment degradation, with negative consequences for both flora and fauna.

Thus it appears necessary investigating and implementing new tools to safeguard environment, so as to lower possible future negative breakdowns. Indeed, even if major events like COP conferences may pave the way for future international agreements on a large-scale, it is (perhaps, more) important also studying other possible solutions, especially those related with small-scale projects. Since these usually involve local

communities more deeply, they do not risk to be driven also by political pressures (i.e. mismanaged) as government-financed initiatives often are in developing countries.

That is why research on PES and similar market-based instruments should be fostered in next years. PES are likely to result useful and to increase in number all around the world, given their peculiar features: in particular, what makes them so interesting is the fact that their contracts do not have to follow many long clauses set at international level (such as the strict guidelines of REDD+ initiative), but agents may directly negotiate with each other and agree on a contract on the basis of specific local conditions and values. The examples of successful projects provided throughout our paper show how PES schemes may possibly be established in very different contexts, without compromising their effectiveness and efficiency. This does not mean that agents or communities are totally free in designing their projects: in fact, some general criteria must be complied with in any case. Compensations must be paid only when the provision of one (or more than one) target ES is effectively guaranteed and ensured for a long period of time, and when such environment protection does not raise bad practices or exploitative actions elsewhere. After these conditions have been positively checked, payments may occur under different forms, but, in order to convince an ES supplier to enter the PES contract, they should always be higher than his opportunity costs related with other activities. This is necessary for all the parties being fine when the PES agreement is eventually put into practice: on the one hand, ES suppliers are compensated for their good management; on the other hand, ES beneficiary accept to pay for the safeguard of the natural resources they are interested in.

Finally, PES contracts, albeit relevant and presenting high potentialities, are not to be seen as the universal panacea for resolving all environmental critical issues: rather, they are to be viewed as tools to be effectively combined with other public and private initiatives, in order to offer an integrated and complete buffer against exploitative actions. As hints for future researches, a deep analysis on the relationships between PES and other tools for environmental protection (and their combinations in different contexts) is worth being studied: in such a way, it should be possible to figure out where and when applying certain policies rather than others, and to concretely contribute to the safeguard of our planet.

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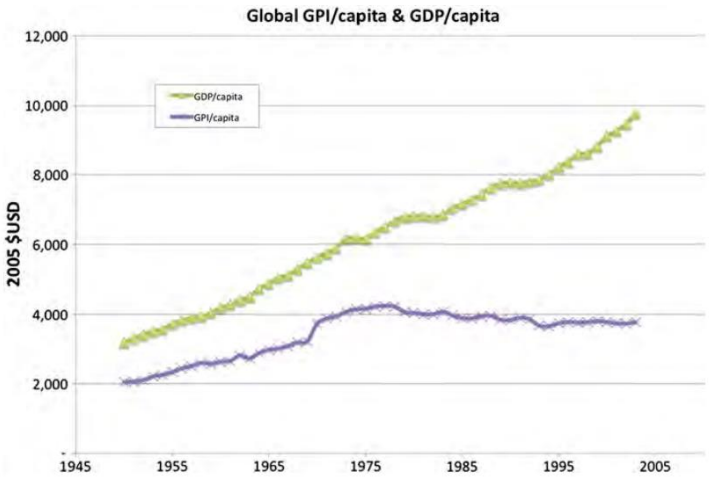
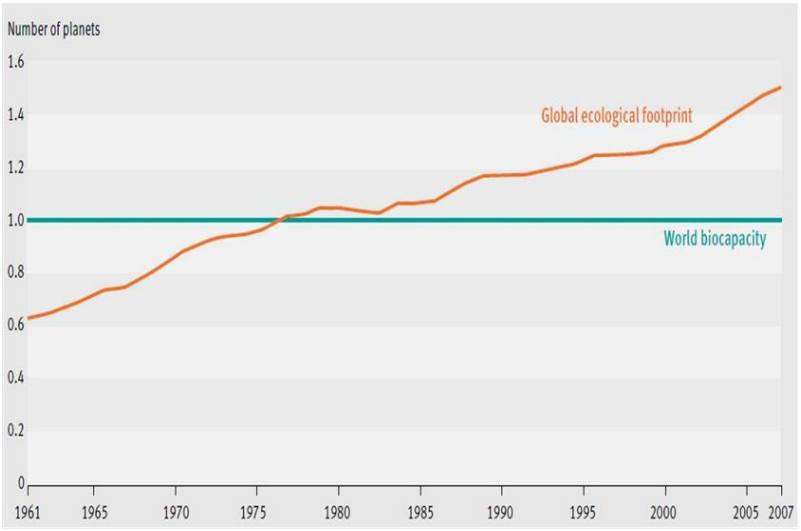
APPENDIX A – SUSTAINABLE DEVELOPMENT INDICATORS

GPI vs GDP:



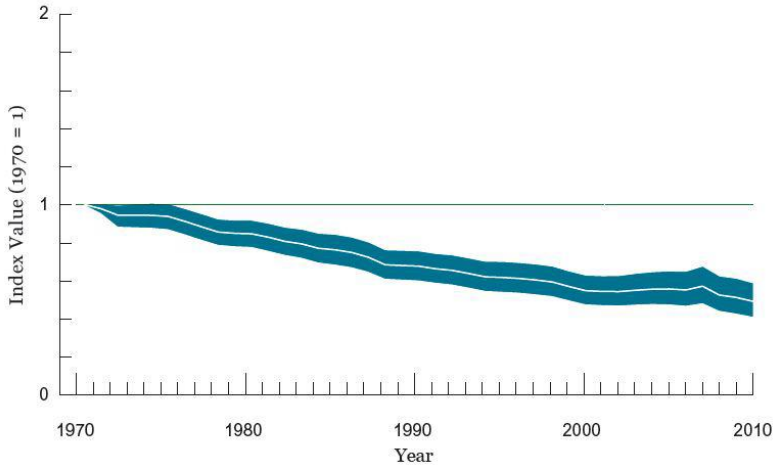
Source: Kubiszewsky et al., 2013.

Ecological Footprint vs Biocapacity:



Source: UNEP, 2010.

LPI:



Source: WWF, 2014.

APPENDIX B – LIST OF THE MAIN ES BY SERVICES PROVIDED

1. Provisioning services

- Food
- Raw materials
- Fresh water
- Medicinal resources
- Timber
- Bioenergy

2. Regulating services

- Local climate and air quality
- Carbon sequestration and storage
- Moderation of extreme events
- Waste-water treatment
- Crop pollination
- Biological control

3. Habitat or supporting services

- Habitats for species
- Maintenance of genetic diversity
- Soil formation
- Photosynthesis
- Nutrient cycling

4. Cultural services

- Tourism
- Recreation and mental and physical health
- Spiritual experience and sense of place
- Aesthetic appreciation and inspiration for culture, art and design