

Two sides of a coin

Analyzing benefits and limitations of payment for water ecosystem services in Lima's water fund

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Abstract

Payment for water ecosystem services has been gaining attention in Latin America because of the direct response for environmental conservation through economic mechanisms. By connecting nature services with people who benefit from them, it creates a sustainable intervention for the ecosystem's management while enhancing human well-being according to policy implementers. Nevertheless, these initiatives face obstacles to fulfill sustainable development characteristics. Using the case of the water fund in Lima as an example of PWS for watershed preservation, this research analyzes the sustainability scope of this market-based solution for protecting water ecosystems and the services they bring.

For that purpose, the case study is based on newsletters, strategic plans, websites' information, regulation documents, utility's master plan, and water tariff's study. The data collected is combined with a sustainable development theory analysis to provide a discussion that focuses on the benefits of having PWS as an environmental conservation response and the critiques that arise when trying to reach sustainable development features including a social, economic and environmental perspective. I found that not all of the benefits are included when using these mechanisms while some of the disadvantages are overcome through efforts already generated between stakeholders. Therefore, the market instrument could be considered a sustainable answer for governments, communities and private actors related directly or not with the ecosystem's conservation; however, there is room for improvement to achieve a closer sustainable development.

Keywords: ecosystem, PWS, sustainability, human welfare, advantages, disadvantages.

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Practices to make a better world can be feasible, it's just a matter of commitment and being aware of the damages to repair them. Ecosystems are helping us to reach a certain welfare, it's our time to create healthier ecosystems and understand dynamics that are far from the cities.

Content

- 1 Introduction.....6
- 2 Background.....7
 - 2.1 International experience on Latin American Water Funds 7
 - 2.2 Legal framework for PES in Peru 8
 - 2.3 Creation of the Water Fund in Lima 10
- 3 Theoretical Framework 11
 - 3.1 Payment for Water Ecosystem Services..... 11
 - 3.2 Theories of sustainable development and ecosystem services 12
 - 3.2.1 Weak Sustainability 13
 - 3.2.2 Strong Sustainability..... 15
 - 3.2.3 Capability Approach 16
 - 3.3 Criteria for assessment..... 18
 - 3.3.1 Benefits from PWS..... 18
 - 3.3.2 Limitations from PWS..... 19
- 4 Methodology 20
 - 4.1 Case Study 20
 - 4.2 Data collection..... 21
- 5 Results: The Lima Water Fund..... 21
 - 5.1 Private funds: Aquafondo..... 22
 - 5.2 Public funds: Sedapal 27
- 6 Discussion 29
 - 6.1 Benefits from PWS 29
 - 6.2 Limitations from PWS..... 32
- 7 Conclusions..... 35
- 8 References..... 37

1 Introduction

Most economies are growing and demanding more natural resources to continue the current production and consumption. There's a global demand for food, energy and water that puts pressure on ecosystem services. Then, the influence of ecosystems on human well-being becomes crucial. Therefore, solutions for natural resources conservation arise from different angles to diminish the pressure on them but still maintaining current standards of living in many parts of the world.

Payment for ecosystem services come as a solution that integrates social, economic and environmental aspects for nature conservation. Specifically, payment for water ecosystem services connects rural communities with water final users through market-based mechanisms, in which the final beneficiaries of the ecosystem service pay a certain price for conservation of upstream areas that contributes to the preservation of watershed. This payment scheme is adopted by different cities in Latin America in order to allocate the responsibility of the conservation to the users that are favored by the ecosystem service. Therefore, the idea behind this scheme is achieving sustainable development since it holistically combines economic development, social inclusion, and environmental sustainability.

However, these mechanisms for nature conservation can still present several issues when they're applied. The idea that market-based solutions are going to improve human welfare only by investing money on it seems as a simplistic approach of a complex situation in which communities' values and nature are not considered. For that reason, this thesis will explore different sustainability approaches on how to reach sustainable development through payment for water ecosystem services.

The research question that will guide the analysis throughout the document are:

RQ1: How are the PWS applied in Lima in relation to watershed conservation?

RQ2: How sustainable is PWS?

The thesis will start with a background section that explains the current situation of Latin America and Peru to tackle watershed conservation. The section will help to understand the motivations and objectives that international organizations have around ecosystem services; as well, it will present the legal context that Peru built up to reach a more sustainable management of natural resources through payment mechanisms. Then, a theoretical framework will be presented for analyzing the sustainability approach of PWS. From the theory, a list of advantages and disadvantages arises as criteria for assessing the sustainability scope that PWS has in the case of Lima. Following will be the results that answer the RQ1, plain data on how these mechanisms are applied will be described; as well, the explanation will be accompanied by a description on the design and implementation of different projects for watershed conservation. Next, the discussion section will link the theoretical outcome

described with the results from the previous section. The criteria of assessment will be the key point for discussing and answering the RQ2. The thesis will conclude on a summary of the document and remarks that comes from the connection of theory and practice for PWS.

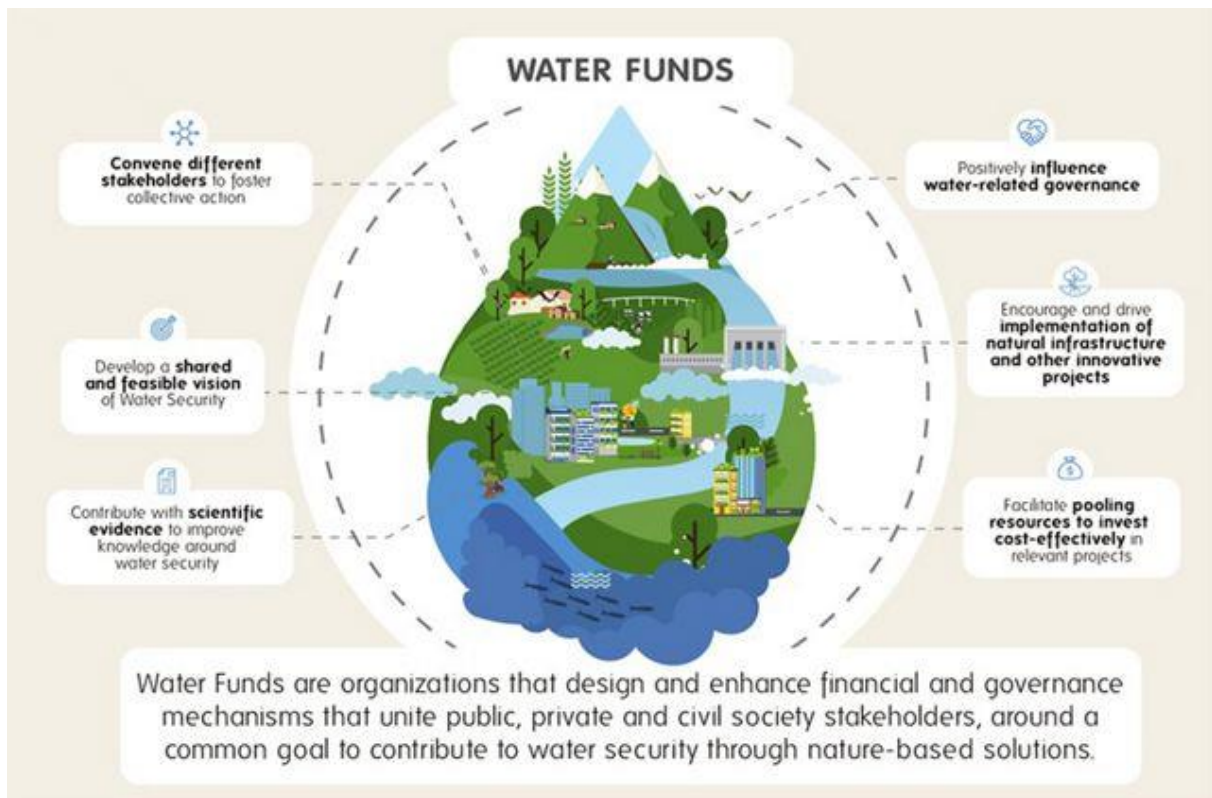
2 Background

2.1 International experience on Latin American Water Funds

Latin America water availability gathers 1/3 of the world's freshwater that aren't evenly distributed. In this scenario, areas that can provide freshwater to cities are endangered by deforestation and land degradation because of bad agricultural management. As a local response, Water Funds appear to provide water security with a vision that focus on the conservation of watershed.

Water Funds are organizations along Latin America whose aim is the design and promotion of “financial and governance mechanisms, engaging public, private, and civil society stakeholders in order to contribute to water security through solutions grounded on nature-based infrastructure and sustainable management of watersheds” (Latin American Water Funds Partnerships, 2019). The next figure shows the way in which Water Funds are able to contribute for water security, connecting rural communities with cities on the exercise of watershed conservation.

Figure 01: Descriptive image of water funds (Latin American Water Funds Partnerships, 2019).



For the creation of these mechanisms, Peru needed a legislation that could regulate and promote the use of market-based tool for nature conservation. Next, the description of the legal framework is given to contextualize the country’s current situation on the payment mechanisms for conservation.

2.2 Legal framework for PES in Peru

Since 2014, Peru has a new legislation that regulates “retribution mechanisms for ecosystem services”. The objective of Law N° 30215 is the promotion and supervision of actions related to the conservation, recovery and sustainable use of ecosystems in order to ensure its long-term existence (Law N° 30215, 2014). According to the Law, the retribution mechanisms for ecosystem services are defined as “the instruments used to transfer economic resources for the conservation of ecosystem services after an agreement between parties involved in the ecosystem service” (Law N° 30215, 2014, p. 526501). Based on that, the legislation is able to make a connection between public and private stakeholders for the conservation of watershed, for my particular case of the water fund in Lima. Considering the objective of the norm, utility companies are able to create economic mechanisms that contributes to the protection of watershed.

The law for ecosystem services focuses on general points that these mechanisms should fulfill minimally. Because the purpose of this research is to analyze the design of Lima’s water fund, it is necessary to look at the basic elements that regulate the design of this particular payment for water

ecosystem service. Therefore, the six elements that should be considered for the design of these instruments are described as follows (Law N° 30215, 2014, p. 526501):

- 1) Description of the structure and function of the ecosystem service, its source, function and current situation, promoting its articulation, compatibility and cadastral complementarity.
- 2) Identification and description of the parties involved in the ecosystem service.
- 3) Estimate of the economic valor of the ecosystem service, the costs necessary to maintain the flow of the ecosystem service, the willingness to pay and other economic values.
- 4) Establishment of agreements between providers and payers involved in the ecosystem service, in which different points are determined, such as the activities for conservation, recovery and sustainable use, the expected economic, social and environmental benefits and the modalities of retribution and their financing strategies.
- 5) Promotion of a platform made by different public and private stakeholders involved to the retribution mechanism for ecosystem services that monitor the fulfillment of the agreements and supervise the transparency of the retribution under the financing strategy considered.
- 6) Design of a monitoring system that allows to evaluate the progress of the actions for conservation, recovery and sustainable use of the ecosystems implemented by the mechanism.

Two years later, the government developed a legislation document that regulates the process for the implementation of the Law N° 30215. The supreme decree N° 009-2016-MINAM contents detailed points for the design of retribution mechanisms for ecosystem services that officialize its proper regulation. According to the article 6.3 of the document, the first step for the design of the instrument is the identification of the ecosystem services that are going to be part of the mechanism; once it is established, the providers and payers involved in the ecosystem service will be identified (Supreme decree N° 009-2016-MINAM, 2016).

Since the identification of the payers and providers is important for the design of the mechanism, it is worth to specify the conditions of these stakeholders detailed in the article 7 of the regulation document. On one hand, the providers contribute to the conservation, recovery and sustainable use of the source of a specific ecosystem service through technically feasible actions. Some of these actions consider traditional practices and they include the conservation of natural spaces, recovery of deteriorated areas and sustainable use of ecosystem services' source. On the other hand, the payers obtain an economic, social or environmental benefit and they retribute to the providers for the ecosystem service they are benefited from (Supreme decree N° 009-2016-MINAM, 2016).

Considering the conditions of the parties, it is understood that there is a retribution going from payers to providers once a voluntary agreement is reached between the parties. According to the policy document, the value of that retribution can be made by calculating the economic value of the ecosystem service, the costs incurred by providers for the actions taking place in the area or others that the parties recognize (Supreme decree N° 009-2016-MINAM, 2016). The regulation document doesn't stipulate any direct payment for communities or people but the retribution is used to finance (a) specific actions for the conservation, recovery and sustainable use of the ecosystem services' source and (b) productive development and basic sustainable infrastructure that are beneficial to population directly involved (Supreme decree N° 009-2016-MINAM, 2016). Moreover, as part of the financing strategy from payers, the article 9.4 of the document indicate the creation of common funds to manage monetary resources, giving the possibility to create mechanisms such as a trust fund for watershed conservation.

Regarding the retribution mechanisms for ecosystem services for water regulation, the legislation has an explicit chapter for them. It regulates the actions taken in order to maintain, increase and improve the quality and quantity of water for human use, irrigation, energy generation, among others. In this sense, the article 27 of the supreme decree indicates the role of the Service Providing Entities (SPE) or utility companies bringing water to population. These companies can function as payers for the water ecosystem services, they collect monetary resources through their tariffs that are managed separately by themselves or using trust funds, bank accounts and agreements with private institutions. The SPE formulate, approve and execute public invested projects for ecosystem services; as well, they can subscribe arrangements with the providers to develop an action plan for maintaining and developing water infrastructure in the area (Supreme decree N° 009-2016-MINAM, 2016). Also, the efforts from Sunass and the SPE are based on the Law for Modernization of Sanitation Services (Law N° 30045), that regulates SPE to include a collection fee for watershed conservation.

2.3 Creation of the Water Fund in Lima

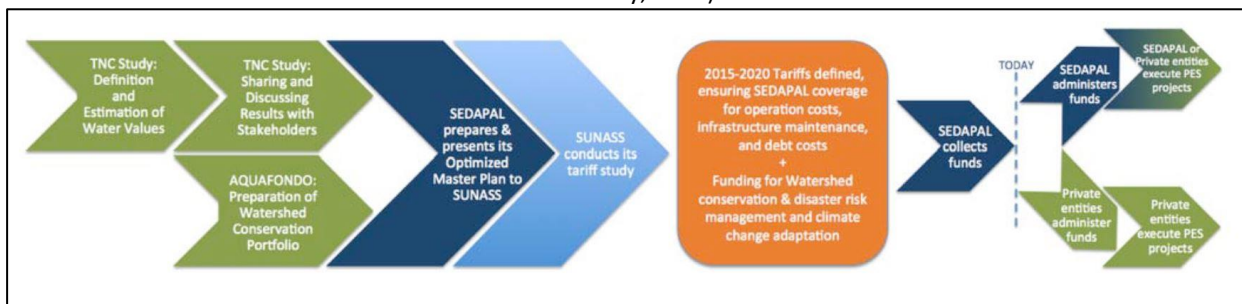
Although the creation of water funds (as a payment mechanism for water ecosystem services) in Peru is regulated today through legislations and supervised by government institutions, the first functioning water fund in Lima was created by private institutions under the name of Aquafondo. This organization was formed in November of 2010 by (Latin American Water Funds Partnership, 2019):

- 1) The Nature Conservancy (International NGO)
- 2) Fondo de las Américas (International NGO)
- 3) Grupo GEA (Peruvian NGO)
- 4) Pontificia Universidad Católica del Perú (Peruvian university)

- 5) Sociedad Peruana de Derecho Ambiental (Civil society association)
- 6) Unión de Cervecerías Peruanas Backus y Johnston (Private company)

However, Aquafondo has been not only responsible of the management for this initial water fund, it was also an important piece for institutional articulation in order to create the legislation previously described. The knowledge of Aquafondo on Lima’s watershed provides information for the formulation of a project portfolio that will be used by the SPE on the formulation of its Optimized Master Plan (OMP), as described in the next figure. It is worth mention that the SPE that provides water services to Lima’s population is Sedapal. The articulation between Sedapal and Sunass as public institutions is essential for the creation of a public water fund from final users of the service using water tariffs as a resource collection mechanism for watershed conservation.

Figure 02: Procedure for creating water funds by collecting resources through water tariff (The Nature Conservancy, 2016)



3 Theoretical Framework

3.1 Payment for Water Ecosystem Services

The relation between nature and humans is a constant concern for diverse stakeholders in society. Human well-being depends on the services provided by nature, usually known as “ecosystem services”, in which species sustain human life. These services maintain the production of ecosystem goods, such as seafood, timber, biomass fuels, industrial products, among others. Moreover, the collection and trade of these goods has an important impact on human’s economy (Daily, 1997).

Although the importance of ecosystem services and its relation with humans can be easily seen, it has received more attention since the creation of various working groups for The Millennium Ecosystem Assessment in 2001. The assessment collects the linkages between ecosystems and human well-being and how the changes in the services provided by ecosystems could affect humans development (Millennium Ecosystem Assessment, 2005).

Furthermore, the connection of nature with human well-being is related with sustainable development. According to Tallis et al. (2008), the merge of the concepts comes from different interests. On one side, environmental conservationists aim to increase public awareness for biodiversity protection by introducing it into a country's economic development. On the other side, agencies and NGOs from developed countries are looking at the management of nature under the perspective of sustainable development.

The connection between ecosystem services and sustainable development has an institutional impact and policy implications. Based on that, natural resources are involved in the construction of economic indicators of sustainability as in the formulation of market-based incentives for conservation. Therefore, considering that nature is a capital that flows into society, a cost-benefit analysis is used on the evaluation of economic efficiency of policies for conservation purposes in order to choose the best alternative (Wegner & Pascual, 2011). Under a neoclassical economic perspective, the consequences of each alternative need to be quantified to compare the policies proposed. Based on the previous explanation, there is a concern to generate a market for the trade of ecosystem services to preserve them.

In the sense of defining ecosystem services, the definition used in the document will be the one given by the Millennium Ecosystem Assessment (2005) which define them as a service that benefits people which includes: "provisioning services such as food, water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits" (Millennium Ecosystem Assessment, 2005, p. 27). Considering this, payment for water ecosystem services concentrates around three key component of Payment for Water Ecosystem Services (PWS): stakeholders, service delivery and contract (Martin-Ortega, Ojea and Roux, 2013).

3.2 Theories of sustainable development and ecosystem services

The Brundtland report encourages to find ways to deal with the future we share by ensuring "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 24). Based on that approach, three pillars are important to recognize for reaching the goal set from the UN report: economy, society and environment. This holistic approach of development recognizes that "social and economic development depends on the sustainable management of our planet's natural resources" (United Nations General Assembly, 2015, p. 9). Therefore, international organizations present a determination to preserve natural resources, such as freshwater resources, mountains, ecosystems, among others. Based on this perspective, the Sustainable Development Goals (SDGs) are created as a global

framework for countries to achieve sustainable development through targets determined by the United Nations.

Even more, when dealing specifically with payment for water ecosystem services in relation with sustainable development, it has two sides for consideration. First, the sustainable development contemplating future generations; second, the interaction of ecosystems with human well-being. These points have basis on economics because of the concern on intergenerational resource allocation efficiency through market mechanisms; as well, their attention to human development. Since payment for water ecosystem services is mainly based from a notion of weak sustainability, as it will be explained next, the benefits of the approach are gathered based on that theory. After that, theories of strong sustainability and capabilities approach will show how the scheme could be problematic to consider it as a sustainable solution for watershed conservation, helping to list the disadvantages of this market-based solution.

3.2.1 Weak Sustainability

The theoretical approach of weak sustainability relies on maintaining above zero the total net investment of society considering the substitutability essence of natural capital with man-made capital (Neumayer, 2013). That is to say, all the actions generated should not lead to a loss in welfare for society, including environmental, social and economic changes. Therefore, sustainable development can be reached if investments on manufactured capital are able to compensate nature's degradation by itself and/or applying regulation measures for offsetting environmental loss. Based on that, natural capital can be reduced as long as there is manufactured capital to exchange with as a response to market interactions.

Robert Solow was one of the pioneers to analyze this tension between natural and man-made capital. However, before explaining the way of consumers decide over time between one capital or another, the economist analyzes the intervention of market forces into the decision of nature's degradation. The price of exhaustible goods determines the level of extraction of natural resources. Then, "the market price and the rate of [natural resources'] extraction are connected by the demand curve" (Solow, 1974b, p. 260), so the scarcity of the good will determine its price. As a consequence, if the price eventually rises and the demand of the good diminishes because it's too expensive, preserving natural capital will be necessary. Therefore, the economist recognizes that nature is an exhausted resource and society can live with less amount of natural resources depending on the price stated.

On the other hand, considering the combination on the theory of recognizing nature as limited resources with market interactions and substitutability, Hartwick theorizes about the use of natural resources for future generations. He uses mathematical equations to define a rule of sustainable

development, in which all the profits coming from exhaustible resources should be invested in manufactured capital to maintain the consumption for future generations (Hartwick, 1977). Since “the economy cannot exhaust any natural resource and continue to have positive consumption and output” (Hartwick, 1977, p. 972), there will be always ways to preserve ecosystems to continue that intergenerational consumption.

Moreover, he uses a utilitarian perspective to theorize economic growth, in which society is the one who values the satisfaction (individual utility function) or social welfare (sum of individual utility functions) it gets from different types of capital allocated optimally over time. As Hartwick, Solow’s main assumption is that nature, as an exhaustible set of resources, can be substituted by manufactured capital. Consequently, this generation is allowed to reduce natural resources by consuming them (optimally) as long as they (optimally) exchange it with a stock of manufactured capital for future generations (Solow, 1974a). Furthermore, the market force interactions, through prices given for each type of capital, will determine the level of exchange between them and generations as long as the right price is paid.

In this sense, Solow proves mathematically that a utilitarian perspective is helpful for planning a right distribution of capital (natural and manufactured) between generation. As well, he mentions that for overcoming some difficulties of these perspective, an initial capital stock should be big enough to support a decent standard of living over time. Nevertheless, Solow doesn’t give a blank check for the substitutability of goods when considering the presence of exhaustible resources. For the author, natural capital can be substituted with manufactured capital after assuming that the elasticity¹ between those goods tolerate it, and this will depend on the rules that govern on the use of manufactured goods (Solow, 1974a). Because of that, the author is able to scrutinize the tension between nature and human welfare that is useful when analyzing ecosystem services and human well-being. So, the market price remains as one indicator for regulating the extraction of nature, but it will also depend on the intrinsic value given and welfare obtained by society from exhaustible resources.

The theory formulated by economists helps to understand the importance of connecting nature with economic development. As Solow and Hartwick stated before, the inclusion of exhaustible resources into the accountability of economic growth is helpful because of the services received from ecosystems. In this sense, the preservation of ecosystems services arises as a solution that connect

¹ Elasticity of substitution is defined as the “marginal rate of substitution, [it] measures the rate at which the consumer is just on the margin of trading or not trading” and the proportion at which he/she would do it depending on the value consumers give to the good (Varian, 2010, p. 50).

nature conservation with sustainable development. Therefore, it becomes essential to formulate market mechanisms that contribute to this goal.

By considering the importance of sustainable development formulated by economists in the past, Tallis et al. (2008) describes two routes in which ecosystem services can contribute to it. First, “a better understanding of how and at what rates ecosystems produce these services can be used to motivate payment for nature conservation” (Tallis et al., 2008, p. 9458); based on that, conservation investment can be increased after recognizing the value of ecosystem services. Second, this ecosystem conservation attention “could improve the success of projects that attempt to both conserve nature and improve the welfare of the rural poor” (Tallis et al., 2008, p. 9458). As a result, local people become part of market interactions for the goods and services they produce, contributing to their economic development.

3.2.2 Strong Sustainability

After explaining the theoretical approach of weak sustainability, it's important to explore other theories that look into that perspective as an insufficient way of including exhaustible resources to reach sustainable development. On an ethical point of view, “compensation cannot be used as an excuse to continue actions causing long-term environmental damages” (Spash, 1993, p. 127) even if they are substituted with other type of goods. In that sense, strong sustainability appears as a theoretical approach that takes natural capital as non-substitutable of other forms of capital (Neumayer, 2013). As well, it has to be considered the regenerative capacity of natural resources, so this type of capital will remain its environmental functions. Specifically, strong sustainability theory acknowledges that “rising consumption cannot compensate future generations for rising environmental degradation, that is, it cannot substitute for a declining stock” (Neumayer, 2013, p. 27).

Costanza and Daly show theoretically the problems of following weak sustainability as an approach to reach sustainable development. First, they demonstrate that the total income in society is a combination of goods and services that have market or not. Based on that, sustainability can be achieved if the total income in society is sustainable; therefore, each component of the income has to be the same way. For that purpose, “natural income must be sustainable; that is, any consumption that requires the running down of natural capital cannot be counted as income” (Costanza & Daly, 1992, p. 39). Considering this, the authors contemplate sustainable development with a focus on maintaining the total natural capital constant, instead of concentrating on utility (as Solow and Hartwick did). Hence, present generations can't be “responsible for their [future generations] happiness or utility –only for conserving for them the natural capital that can provide happiness if used wisely” (Costanza & Daly, 1992, p. 39).

Then, after criticizing the sustainable development definition from a weak sustainability perspective, the main contribution that the authors bring is about the relation between natural and manufactured capital. Costanza and Daly (1992) stipulate that:

Substitution of human-made physical capital for natural capital in the production of a given good is very limited, and that on the whole natural capital and human-made capital are complements in the production of any given good. (p. 41)

As a consequence, the idea of intergenerational allocation of capital is not strong enough since manufactured capital needs natural capital and human capital for its production. A substitution of these two capitals is not well-balanced because the creation of a future substitute takes more than what the environment can provide. For this reason, the lack of conscious on the value that ecosystems goods and services add to the production of manufactured capital is problematic for the conservation of exhaustible resources from a weak sustainability perspective.

After considering that manufactured and natural capital cannot be substitutes, Costanza et al. (1997) concentrate on the production of ecosystem services and estimate the contribution that they bring to society based on economic calculations. Since there's an intrinsic complementarity between those capitals, they highlight the important role that ecosystem services have on human welfare. For that reason, the valuation that the authors generate is relevant to determine the impact on human welfare if small changes in quality and quantity are made to ecosystem services (Costanza et al., 1997). This attention is not entirely considered when deciding on the implementation of payment mechanisms under a weak sustainability perspective. The focus of market-based solutions is related with the availability of exhaustible resources that could lead to conservation projects, without recognizing directly human welfare.

3.2.3 Capability Approach

As Costanza acknowledged before, there's a strong relationship between natural resources and human well-being. The Millennium Ecosystem Assessment stipulate the aspects in which changes in ecosystems could affect human well-being and poverty alleviation. Although the document focuses on economic variables to measure the impact of ecosystem changes and degradation in society, some features can be taken to contextualize the impact on human well-being. The report lists four main points of the impact on human well-being to be considered for this case (Millennium Ecosystem Assessment, 2005):

- a. Ecosystem services influence on basic needs, such as health, good social relationships, security and freedom on choice and action.
- b. The degradation of ecosystem services often causes significant harm to human well-being. Although it's difficult to estimate this influence, the report proves negative effects on livelihoods, health and local and national economies.
- c. The level of biodiversity should be determined by ethical concerns, including intrinsic values of species.
- d. Spiritual and cultural values of ecosystems are as important as other services for many local communities.

Considering the relationship showed between human well-being and ecosystem services, a weak sustainability perspective could be problematic since it doesn't include these aspects through market-based mechanisms for ecosystems' conservation. For that reason, the capabilities approach could be helpful to demonstrate problematic points in which payment schemes falls. These schemes use economic valuations to determine the payment needed for natural resources' protection, through cost-benefit analysis. The cost-benefit analysis is used to evaluate "the economic efficiency of alternative policies that impact on ecosystem services" (Wegner & Pascual, 2011, p. 492). Based on that, the capabilities approach explains the problems behind these valuation methods to choose the price to be paid.

First of all, Sen (1985) shows the problems that arise when valuation methods are used to indicate human well-being and social welfare. For the author, traditional welfare economics ranks subjectively different well-beings through individual utilities, creating a problem for valuating different functionings (Sen, 1985). Therefore, the focus of cost-benefit analysis for exhaustible resources is challenging because of the subjective aggregation of utility functions when it should be made collectively. As well, the indicator becomes questionable for measuring human well-being and welfare.

Under the capabilities approach, "different sections of the society should be active in the decision regarding what to preserve and what to let go" (Sen, 1999, p. 242). Then, the value that society gives for preserving to resources is a matter of balancing the costs attached to that purpose. For Sen (1999), an important part to be solved for the cost-benefit analysis is the capacity of people to be part of public discussions to decide on forms of living. The aggregation of utility makes it difficult to include community values around natural resources. Therefore, the consideration of intrinsic values given by communities are not included into cost-benefit analysis and it should be for the eventual creation of payment schemes. As a consequence, this situation creates problems when allocating a price for the

conservation of ecosystem services since they're not correctly valued, limiting the development of capabilities for communities who could be benefited from these market-based mechanisms.

As stated before, there's a utilitarian perspective from a weak sustainability point of view when creating mechanisms for natural resources conservation. However, as described in this section, the aggregation of different utilities to value natural resources and generate a cost-benefit analysis brings obstacles for society to reach its capabilities and human welfare.

3.3 Criteria for assessment

Considering the theory reviewed around sustainable development and its relation with nature conservation and human well-being, I formulated a criterion for assessment based on important aspects that arise when connecting ecosystem services and market-based mechanisms. The purpose of the list of criteria is to find out if water funds, as an example of payment for water ecosystem services, are a sustainable response for watershed conservation. Each advantage and disadvantage listed will be connected with perspectives from the cited authors.

3.3.1 Benefits from PWS

The advantages of the approach response to the benefits generated from using market-based mechanisms, such as PWS, for nature conservation without compromising society's economic growth. This integration generates sustainable development at the same time that exhaustible resources are recognized and preserved, according to the authors cited in previous sections. Considering this perspective, the benefits that appear could demonstrate that PWS are a sustainable solution for watershed conservation. Specifically, the advantages are described next:

- a. Market interactions (demand and supply of goods and services) determine the boundaries of the ecosystem production.*

The rate of extraction for exhaustible resources will be determined by the price paid in the market. Therefore, it's important to generate a market for ecosystem production because these interactions will help to preserve nature's productions as a supplier of services. "The scarcity rent must come to dominate the movement of market price, so the market price will eventually rise" (Solow, 1974b, p. 260) when extraction levels are too high. Considering that, consumers will pay to preserve the ecosystem production because they're demanding that service. Hence, the creation of a market and payment mechanisms will ensure the system to work and promote sustainable solutions.

- b. Attention on intergenerational allocation of natural capital.*

The payment mechanisms for ecosystem service's conservation, based on market interactions, bring a special awareness that future generations are entitled to enjoy natural resources.

Because of that, having a payment scheme will generate initiatives for preserving the services provided by nature that society will appreciate in the future. This practice will ensure a sustainable development when future generations will be able to benefit from the same ecosystem service that current generations enjoy.

c. Consciousness of the economic consequences if natural resources are exhausted.

An important aspect of market-based solutions relies on the whole economic consequences if all natural resources are exploited. Hartwick (1977) recognizes these consequences that puts in danger the current production and consumption. For that reason, the awareness that payment mechanisms bring are helpful to preserve natural resources sustained over time.

d. Awareness of the production generated from ecosystem services (quantitative and qualitative).

Payment mechanisms are motivated by the quantity and quality of production generated by the ecosystems. By improving this knowledge on the importance of the production, the value of the ecosystem service increases and its conservation becomes crucial. Therefore, there's a contribution for sustainable development through ecosystem services and their market-based schemes.

e. Focus on the improvement of nature conservation and rural population welfare.

As Tallis et al. (2008) mentioned, another way in which ecosystem services can contribute to generate a sustainable development are through the focus on nature conservation and rural population welfare. As a result, payment mechanisms incorporate that contribution into market schemes.

3.3.2 Limitations from PWS

The disadvantages of the approach consider the limitations of market-based mechanisms for nature conservation, like PWS. According to the cited authors, theories of strong sustainability and capability approach demonstrate issues around sustainable development based on a weak sustainability perspective. As well, they describe missing factors to be included in the implementation of payment schemes; hence, these limitations appear as criticisms to be considered. Specifically, the disadvantaged are described as follows:

a. No recognition of the importance of natural capital for other goods production.

After Costanza and Daly (1992) explain how natural and manufactured goods are not substitutes but rather complements in the production of any good, the strong sustainability theory highlights the importance of this relationship in the production of goods and services. Based on that, recognizing other goods production into payment mechanisms and project implementations for watershed conservation (in the particular case of this document) could improve the approach of market-based solution. The reason behind it is the consideration of

a true contribution that natural resources have in the current economic system to reach sustainable development.

b. No consideration of the impact on human welfare.

Apart from the production of other goods and services, Costanza et al. (1997) note the importance of changes in quantity or quality of natural capital because it might have an impact on human welfare that it wasn't considered. For that reason, considering the impact that changes in ecosystem services have on human welfare could promote a more sustainable market-based solutions for watershed conservation. Considerations that go beyond the availability of exhaustible resources and include human welfare impacts could enhance social perspectives of the payment scheme, making it a more sustainable scheme.

c. No recognition of different human welfare when setting prices.

The aggregation of different utilities into the valuation of natural resources, as explained before, generates problem for considering human welfare according to Sen's capability approach. Since valuation methods are the base for creating payment mechanisms, the lack of inclusion of human welfare brings an inaccurate calculation of prices for ecosystem services' conservation. Therefore, no recognizing different levels of human well-being is a limiting factor of payment for watershed ecosystem services to be considered as a sustainable solution.

d. No inclusion of communities' values when setting prices for water conservation.

As problematic as not including different human welfare, leaving aside communities' values creates obstacles to define payment mechanisms as sustainable. Considering the capability approach for human development, active involved for deciding on nature preservation aspects have to include diverse sections of the society (Sen, 1999), including their spiritual and cultural values (Millennium Ecosystem Assessment, 2005). For that reason, searching for these values in payment mechanisms for watershed conservation could help to assess the level of sustainability on market-based schemes.

4 Methodology

4.1 Case Study

The conduction of this research is based on a case study analysis. According to Bryman (2012), a case study allows a deep and intensive understanding of a specific case. This thesis uses the case of Lima's water fund as an example of a payment for watershed ecosystem service. Although the private water fund was created in 2010, the introduction of a percentage on the water tariff is new in the country.

As well, the most common use of a case is associated with a location, either a community or an organization (Bryman, 2012). When analyzing Lima's water funds, it could be categorized as a "unique case" (Yin, 2009) among the water funds in Latin America. Because of that, it's useful to have Lima as the case study since it presents two types of water fund as market-based schemes, Aquafondo as an organization that collects funds from private institutions and Sedapal as the SPE that obtains public funds through water tariffs.

Some limitations of using this particular case study are the unbalanced progress that both types of water funds have. Aquafondo has been working on Lima's watershed for almost 10 years, while Sedapal recently created the fund without implementing any projects yet. This could be a problem during the discussion section that connects both of my RQ, from a theoretical and practical aspects.

4.2 Data collection

After deciding on the case study, the data collected to answer my RQ are qualitative data. The sources used to build the case were secondary data. Newsletters and strategic plans from Aquafondo were given directly to me after asking for them to the executive direction of the organization. The utility's master plan and water tariff's study were retrieved from public institutions' official websites. As well, news and websites information were collected to describe the current situation of Lima's PWS and answer the RQ1.

Moreover, a literature review on theories related with sustainable development were examined. Theories of weak sustainability, strong sustainability and capabilities approach bring enough information to create a criteria for assessment PWS. Based on the theoretical approach, I was able to list the advantages and disadvantages of PWS to be considered as a sustainable solution for watershed conservation. Once the list is described, I cross-referenced my findings on the functions of water funds in Lima with my criteria of assessment based on a theoretical approach of sustainable development. This exercise is presented in the Discussion section to answer the RQ2.

5 Results: The Lima Water Fund

As stated before, there are two types of water funds in Lima depending on the source of financing, either private or public. Aquafondo oversees the management and execution of the fund coming from private monetary resources, while Sedapal is the Service Providing Entity (SPE) in Lima in charge of the public fund. Considering the dual nature of the monetary resources that supply the water funds in Lima, the next sections will provide a full description of the implementation and practices for each type

of water fund in Lima. The findings here are necessary to answer the first research question: *How are the PWS applied in Lima in relation to watershed conservation?*

5.1 Private funds: Aquafondo

According to Aquafondo's information, they channel "resources to conserve watershed of the Chillón, Rimac and Lurin rivers for contributing to the continuous provision of water to the population" (Aquafondo, 2015, p. 2). For this particular water fund, private companies and international organizations can make contributions to the trust fund by investing in two ways: (a) contribution to the patrimonial fund and (b) contribution to finance projects. The first one uses the interests generated by the trust fund to finance programs, projects and institutional strengthening for Lima's watershed conservation. The second type of investment allows to directly finance programs or projects developed in the watershed.

Considering the implementation of projects, Aquafondo's web site describe the four working line that the private water fund has to focus on actions taken for watershed management and conservation (Aquafondo, 2019a). Two of them concentrate on efforts directly on the watershed conservation, one on private public partnerships and the last one on education for a better management and use of water provisions. Each working line and their current situation will be described in the following paragraphs.

a. Management and conservation of water resources in Lima's watershed

The first working line has three main objectives. One objective refers to the water fund actions focusing on the conservation and recovery of water sources through afforestation and reforestation operations, the construction of infiltration trench for underground water recharge, improvement of riverside defenses and recovering the ancient practice of amunas². Another objective is the improvement of water quality that could be achieved through activities for reusing treated residual water since it will decrease the pressure on blue water and the pollution of water bodies. A third and final objective concentrates on the organization which finds important the promotion of sustainable economic activities that intervene directly in the watershed. In order to achieve this objective, Aquafondo works closely to recovery terraces for agriculture activities, to build small water reservoirs for improving the watershed

² The ancient practice of repairing high altitude surface water diversion channels is called "amunas". It consists of "diverting water from natural streams during the wet season to enhance infiltration in mountain slopes. Water delayed by a longer subsurface residence time increases yield and longevity of downslope springs during the dry months." (Ochoa-Tocachi et al., 2019, p. 584). Nowadays, the ancient practice is promoted by Aquafondo for watershed conservation in companionship with communities in the area (Aquafondo, 2016).

conditions, and to improve agricultural practices through natural pasture fencing, rotational grazing³ and livestock exclusion on the land to be recovered.

Aquafondo fulfilled diverse goals of its plan to reach the objectives set on this working line throughout the first semester of 2019. In that sense, the organization implemented three climate change adaptation measurements for different projects upstream of the watershed. For that purpose, three indicators are used to demonstrate the progress of the projects: i. Number of beneficiary population, ii. Quantity of water recharged, and iii. Extension of beneficiary area. The indicators are important for showing improvements not only at an environmental level but also at a social one with the people having more access to clean water. First goal, the water fund helped the community in San Pedro de Casta to recover and improve the natural infrastructure of amunas for underground water recharge. The project was implemented in 9200 m² of land for improving the ancestral practice. The results from the project show that 928 people in the community will have access to water, 518 400 m³ of water per year was recharged and 7has of agriculture land was benefited. As well, 58 people were trained for new job positions generated for maintaining natural infrastructure.

Second, the community of San Pedro de Casta has ancestral knowledge for building dams around the area, this expertise was supported by Aquafondo which helped to improve the dams using the ancestral practice from the community. As a result, 928 people have access to water in San Pedro de Casta, 27 000 m³ of underground water per year is recharged and 53has of land is benefited. Also, training workshops on maintenance and monitoring of ancestral infrastructure were given by Aquafondo to 49 people in the community.

Third, and last, Aquafondo is currently executing a project for assembling small water reservoirs upstream of the watershed, in which the organization is involved in the design and implementation of the infrastructure. The project considers building infiltration trenches in a 3 000m area. After completing the project, 700 people are going to have access to water in the area, 9 000 m³ of water will be stored and 10has of agriculture land will be restored. Besides the natural infrastructure maintenance, the water fund organized two workshops on maintenance and monitoring of the natural infrastructure created. The capacity building in the community is important for the organization since it will help to preserve the infrastructure created.

³ The practice of rotational grazing subdivides pastures into smaller areas so only one portion of pasture is grazed at a time while the remainder pasture rests (Undersander, Albert, Cosgrove, Johnson, & Peterson, 2014). "Resting grazed paddocks allows forage plants to renew energy reserves, rebuild vigor, deepen their root system, and give long-term maximum production" (Undersander et al., 2014, p. 1).

On the other hand, Aquafondo carries out hydrological monitoring in order to evaluate and track the development of water ecosystem conservation and their quality. For that purpose, several actions are implemented for tracing the conservation of the watershed. First, the water fund elaborated five studies to evaluate the situation of the watershed at different levels: 4 of them at hydrological level (assessing the hydrology, hydraulics, hydrogeology and hydrochemistry) and 1 of them at a social and educational level. Then, a time series analysis was made for future identification of the hydrological balance in the ecosystem, focusing on the runoff and evaporation levels of the amuna. As well, a meteorological station was installed for monitoring the climate variables that could affect the natural flow of the ecosystem.

b. Participatory water management and governance

This particular working line focuses on strengthening governance systems around water resources, either upstream the watershed or at final users' level. Aquafondo develops three specific actions to achieve the objectives of this working line. First, the organization provides support for the design and implementation of watershed management plans for stakeholders, upstream or downstream the basin. As well, Aquafondo advises the watershed council – CHIRILU⁴ for a better organization and management of the projects around the basins. Finally, the water fund brings support for enhancing competences of the integrated water resource management for key actors.

The achievements of the water fund during the first semester of 2019 focused on strengthening the watershed council activities. With this intention, Aquafondo supported the council through different activities. On one side, the organization verified the status of the current green infrastructure projects developed on Lima's watershed. On the other side, the water fund co-organized awareness activities and campaigns for municipalities at the downstream of the basin, final users of the ecosystem service to have cleaner rivers and stakeholder to create a communicators network for the watershed council.

c. Articulation of efforts for public-private partnerships

The efforts within this working line integrate private and public sector in order to bring eco-efficient actions in the use of water (Aquafondo, 2019a). For that purpose, Aquafondo has two

⁴ The name comes from the combination of the initials of the rivers that are part of the watershed: Chillón, Rímac and Lurín. The watershed councils are institutional panels for stakeholders related with the basin's management. In there, they discuss their problems in order to reach consensus, agreements and commitments about the actions implements in the watershed. For that purpose, the stakeholders elaborate a Water Resources Management Plan for a sustainable exploitation of natural resources (ANA, 2019).

main objectives: (a) management of public-private initiatives, and (b) counseling during the process of the Blue Certificate⁵. For the first objective, the water fund identifies and develops the initiatives; while for the second objective, it measures the water footprint and manages projects for compensation and reduction of water usage.

During the first semester of 2019, Aquafondo performed two activities to reach the objectives described before. First, the organization arranged a dialogue on water security and good practices from the private sector in an efficient use of water. The dialogue was organized by Aquafondo with a participation of public institutions, academia and private companies. Second, the water fund was able to help three companies for getting their Blue Certificate. Two of the companies manufacture food products, while the remaining one provides electric services to citizens⁶. Some of the benefits that companies get from the certificate are related with operational cost reduction from water usage and straightening company's image for clients, suppliers and communities. In this sense, the water fund creates private sector awareness for producing other good, in which water remains as an important input.

d. Water culture

The actions taken place in this working line are educational related and they concentrate on the promotion of a new culture for an efficient use of water in order to generate a responsible and conscious community (Aquafondo, 2019a). With this in mind, the organization proposes two main objectives: (a) efficient use of water in urban and rural areas, and (b) better agricultural practices in water management. Through awareness campaigns, the organization promotes a more efficient use of water in schools; while strengthening competences for technified irrigation and rotary grazing in rural areas to improve agricultural practices.

Through educational campaigns, Aquafondo was able to create awareness of the importance of water resources to final users in Lima. For that purpose, the organization co-ordinate a march in partnership with the Water National Authority (ANA for its Spanish acronyms), encouraging Lima's citizens to compromise on the efficient use of water. According to Aquafondo's newsletter, two thousand citizens participated in the march (Aquafondo, 2019b). Also, school students participated in workshops on the importance of preserving water resources.

⁵ The Blue Certificate is a recognition that water responsible companies get from the National Water Authority (ANA from its Spanish acronyms) when they participate to the "Water Footprint" Program and successfully implement their compromises taken when measuring their water footprint.

⁶ Ajinomoto, Frutarom and Enel.

Besides awareness campaigns, the water fund promotes the access to information regarding water resources through an online platform called “AQUARED”. The objective of the platform is to facilitate the exchange of information between organizations and specialized sites related with water resources conservation and management in Peru. Having over two thousands of entries, the platform collects articles, policy documents, projects, guidelines, videos and infographic materials about climate change, risk management, ecosystem services, natural infrastructure, and water sowing and harvesting (Aquared, 2019; Aquafondo, 2019c).

The organization is now on the process of creating its Strategic Plan for the next 5 years, this will be used as a guideline to coordinate future activities. The preliminary Strategic Plan document presents a section for evaluating the progress made by the water fund since 2015. The analysis is made for each component set on the previous Strategic Plan (2015-2018): Financial, Institutional, Technical, Hydrological monitoring and Project development. The achievements will help to describe the water fund’s operations and the scope of them during the previous years. Because of that, the focus will rest on the last three components since they would show the actions taken directly on the conservation of the watershed at a social and environmental level, instead of focusing on the funding aspects of it.

- a. Technical: Aquafondo participated with an important role for creating the watershed council – CHIRILU, promoting the inclusion of communities and the connection of public and private stakeholders into the watershed management and governance. As well, seven projects with communities, international NGO and the private sector were developed, all of them were aligned with the working line that focuses on the management and conservation of water resources.
- b. Hydrological monitoring: The water fund created a partnership with the academia through UTEC⁷ for stablishing a hydrological monitoring system in the watershed. This initiative consolidates the efforts of Aquafondo to follow up on the projects generated and to provide scientific evidence of the impacts of climate change at an environmental and social levels.
- c. Project development: The goals set on the Strategic Plan 2015-2018 were planned considering public funds coming from Sedapal through the percentage charged on water tariffs to the citizens of Lima. However, Aquafondo was not legally entitled to have access to that fund, making it difficult to fully reach and develop the actions proposed. Despite this situation, the

⁷ Engineering and Technology University [Universidad de Ingeniería y Tecnología], UTEC from its Spanish acronym.

organization was able to implement at least seven projects for conservation of the ecosystem, as related in the achievements of the first semester in 2019.

5.2 Public funds: Sedapal

After Aquafondo's intervention in Lima's watershed as the first water fund in the city, using market mechanisms through private monetary capital, Sedapal started to be included into partnerships with the current water fund. For that purpose, alliances were generated between the two institutions. First, Aquafondo and Sedapal created a project portfolio for intervention directly in the watershed for conservation purposes of the ecosystem. The project portfolio included 34 prioritized projects and 8 intervention in the area (Aguirre, 2017), which were categorized as:

- a. Natural pasture fencing or livestock exclusion
- b. Rotational grazing
- c. Recovering amunas
- d. Construction of infiltration trench
- e. Recovery terraces
- f. Reforestation
- g. Wetland restoration
- h. Construction of small water reservoirs

As for the partnership that both institutions established, in 2016 Aquafondo elaborated the first green infrastructure public investment project for Lima considering the Law N° 30215, the retribution mechanisms for ecosystem services law (Aquafondo, 2019d). However, the private institution is not qualified for executing projects using public funds; because of that, Sedapal should be the institution in charge to lead actions in the watershed employing public monetary sources.

Considering the application of the Law for Modernization of Sanitation Services (Law N° 30045) in the SPE activities, the National Superintendency of Sanitation Services (Sunass from its Spanish acronym), as the regulator, establishes the environmental compensation mechanisms in order to include them on the calculation of water tariffs among SPE. The procedure to include the payment mechanisms for water ecosystem services are regulated by the law previously mentioned. Therefore, the role of Sunass is important since it's the institution in charge of legislate, regulate and supervise the provision of sanitation services considering the interests of the government, investors and users. For that purpose, the institution coordinates with the SPE to include a payment mechanism for water ecosystem services, collected through the SPE's tariff. To put it in another way, Sunass (2019b) describe the procedure to include a payment mechanism for water ecosystem service (and eventually create a water fund) as:

- 1) The SPE elaborates an Optimized Master Plan (OMP) that includes such mechanism, designed based on a Water Diagnosis Baseline. The OMP must be presented to the Sunass.
- 2) The Sunass elaborates a Preliminary Tariff Study based in the OMP presented by the SPE. This preliminary study includes a proposal payment for water ecosystem service.
- 3) The Sunass pre-publishes the tariff study and collects comments from population in the area of intervention.
- 4) Based on the recommendations and suggestions made, the Sunass elaborates a Final Tariff Study which must include the tariff related with the payment mechanism for water ecosystem services.

In 2015, Sunass approved the Final Tariff Study, including the creation of a trust fund that collects 1% of the invoice amount charged to the final users (Sunass, 2015). This amount includes the drinking water and sewerage services. The percentage used was selected without any previous study of the amount needed for implementing projects on water ecosystem services conservation. Also, the Tariff Study didn't explain the impact on the ecosystem when creating the fund, such as the increment of the quantity of water, improvements on the quality of water and social benefits for communities in the watershed. Therefore, it seems that the percentage to feed the public water fund was arbitrarily considered to fulfill the requirements from the regulator.

Moreover, the Final Tariff Study includes an investment program with all the projects that Sedapal planned to achieve until 2020 using the public water fund created. As for the projects, the SPE pointed out four of them that are directly associated with water ecosystem services specifically on the basin of Rímac river⁸, they are described next:

Table 01. Projects related with water ecosystem services (Sunass, 2015)

Name of the project	Amount of investment (in US dollars) ⁹
Eight types of intervention on green infrastructure in upper and middle basins of the river + Trainings for communities	2 980 000
Treatment of riverbed and marginal areas of the river	4 470 000
Wastewater treatment plants in rural areas of the watershed	2 980 000
Two types of interventions of green infrastructure on slopes, lagoons areas, and dams of the watershed.	1 043 000
Total amount of investment (in US dollars)	11 473 000

⁸ It's worth to mention that the watershed in this case study includes the rivers Chillón, Rímac and Lurín. However, the projects only focus on the Rímac river.

⁹ All the amounts were given using Peruvian currency. The exchange rate used here is 0.298 US dollars for 1 Peruvian Sol.

According to the Study Tariff approved by Sunass, the whole investment in projects related with the conservation of water ecosystem services adds up to more than 11 million US dollars. Although the four projects are mentioned on the document, none of them have an identification or a designated team for their implementation, unlike other projects on the investment program list. In particular, Sedapal's OMP doesn't refer to the creation of the trust fund that appears on the Study Tariff, or the projects related with water ecosystem services using the water fund. Although the OMP mentions the importance of implementing projects on the basins of the rivers that provides water to Lima, the objectives of them are related with actions towards increasing river flows, adapting to climate change consequences in the watershed, and reducing vulnerabilities facing earthquakes (Sedapal, 2014). Since these objectives are wide, it's difficult to directly relate them with watershed conservation or payment schemes.

As well, according to public declarations from Sedapal's chairman, Francisco Dumler, the water fund generated from public monetary capital has been created but none of the projects has been executed until today (CanalN, 2019; Andina, 2019). On the declarations, Dumler explains the purpose of the public water fund and the inconveniences on using that money, which are mainly bureaucratic problems from different public institutions. Sedapal was unable to constitute a protocol for using the public water fund in the last two years since the trust fund was created because it's a new market mechanism. For that reason, projects are allocated into Sedapal's investment program but none of them are executed.

6 Discussion

Considering the criteria of assessment described on the section 3.3, the discussion will link the theoretical outcome described with the results from the previous section. The arguments showed here will evaluate the payment for watershed ecosystem services and I will try to answer the second research question: *How sustainable is PWS?*

6.1 Benefits from PWS

- a. *Market interactions (demand and supply of goods and services) determine the boundaries of the ecosystem production.*

Market interactions are the force that determine the rate of extraction or conservation of ecosystems. For Solow (1974b), scarcity is the characteristic of natural resources have to

dominate market price movements. Taking that into consideration, consumers will be willing to pay for nature conservation since the ecosystem production cannot stop. Creating a market for these goods and services will ensure the right function of the market system.

For the case of Aquafondo, the interactions considerations are not directly connected because of the private characteristic of the organization. The private water fund attracts funds through international organizations and companies that are interested on water resources conservation. The determination of the boundaries of the ecosystem service becomes secondary for the companies that contribute to the private water fund; the reason behind is related with the consideration of water as an input needed to their production. In this case, water is seen as a secondary input that are paid through water tariff.

On the other hand, Sedapal's uses water as a main input for its operations. The market interactions generated here are truly going to determine the boundaries of the ecosystem production. Water is part of the SPE business, so it's crucial for Sedapal to invest on nature conservation because it will have less input to transform and offer.

To sum up, market interactions are not fully considered on Aquafondo's operations, while Sedapal's business is based on the production that ecosystems bring. **Hence, the advantage is partially taken between both funds. By looking at them individually, the private water fund has a hard time to include market interactions into its activities, but the public water fund is part of these interaction.**

b. Attention on intergenerational allocation of natural capital.

The payment mechanisms for ecosystem service's conservation, based on market interactions, bring a special awareness that future generations are entitled to enjoy natural resources. Because of that, having a payment scheme will generate initiatives for preserving the services provided by nature that society will appreciate in the future. This practice will ensure a sustainable development when future generations will be able to benefit from the same ecosystem service that current generations enjoy.

Although there isn't a direct communication from Aquafondo or Sedapal worrying about allocation of natural capital between generation, they concern about the availability of water in the city. Market-based mechanisms in this case present an intrinsic and indirect concern on intergenerational allocation of natural capital. The attention is present when designing the scheme and implementing projects for watershed conservation; **so, the advantage is taken into the PWS scheme that both of water funds incorporate through projects or when setting an amount for investment.**

c. *Consciousness of the economic consequences if natural resources are exhausted.*

An important aspect of market-based solutions relies on the whole economic consequences if all natural resources are exploited. Hartwick (1977) recognizes these consequences that puts in danger the current production and consumption. For that reason, the awareness that payment mechanisms bring are helpful to preserve natural resources sustained over time.

For this particular aspect, Aquafondo is leading the awareness campaign of the economic consequences if water is completely exhausted. The private-public partnerships promote the articulation of efforts to share better practices to reduce companies water footprints. The private sector is aware of the economic impact that water scarcity could bring to their production. Additionally, Sedapal works to continue expanding its business model, through investments on green and gray infrastructure. The attention to the economic consequences is not directly presented but market forces are the ones creates the awareness that it might a risk from exhausting all natural resources. **Thus, the advantage described here is included in both of the water funds in Lima, directly or not.**

d. *Awareness of the production generated from ecosystem services (quantitative and qualitative).*

Payment mechanisms are motivated by the quantity and quality of production generated by the ecosystems. By improving this knowledge on the importance of the production, the value of the ecosystem service increases and its conservation becomes crucial. Therefore, there's a contribution for sustainable development through ecosystem services and their market-based schemes.

Aquafondo elaborated five studies to evaluate the situation of the watershed and its hydrological contribution as an ecosystem service's provider. As well, the organization is monitoring in order to evaluate and track the development of water ecosystem conservation. Furthermore, Sedapal does hydrological analysis to calculate the production generated from ecosystems, this valuation is connected with rates of financial return that the Optimized Master Plan has. As a result, **both of the water funds incorporate the attention to the production generated from ecosystems, fulfilling this advantage of the scheme into each one practices.**

e. *Focus on the improvement of nature conservation and rural population welfare.*

As Tallis et al. (2008) mentioned, another way in which ecosystem services can contribute to generate a sustainable development are through the focus on nature conservation and rural population welfare. As a result, payment mechanisms that incorporate such contribution into market schemes can be considered a more sustainable solution.

Considering this focus, Aquafondo is able to combine both nature conservation with rural population welfare. The first working line concentrates its efforts on preserving the watershed's environmental contribution, which leads to have more access to freshwater. As well, the private water fund implements projects that enhance rural population welfare through three aspects: i. creating sustainable economic activities for communities living in the watershed area, ii building infiltration trenches prevent rural communities to face natural disasters, and iii. Including them into the governance of the watershed.

The case of Sedapal is different mainly because the projects are not implemented yet, but also because of the design of the payment scheme. The 1% of the tariff that goes into the trust fund for watershed conservation lacks of social welfare support, it's a fund that, as explained before, is used to preserve the input needed to continue bringing water services to the city. However, the portfolio includes several green infrastructure projects for nature conservation as ecosystems provide services for its business.

In conclusion, Aquafondos's approach is including all the aspects of the advantage from the payment mechanisms. On the other hand, Lima's SPE includes nature conservation projects but it doesn't consider rural population welfare beyond their access to freshwater after ecosystem services are preserved. **Therefore, the advantage is partially included on the market-based scheme.**

6.2 Limitations from PWS

f. No recognition of the importance of natural capital for other goods production.

As explained before, recognizing the importance of ecosystem services into the production of other goods will promote a more adjusted vision of what sustainable development means. Costanza and Daly (1992) were the pioneers on stipulating the non-substitution characteristic of natural and manufactured goods. In the specific case of the water funds as conservation market-based mechanisms, two type of relations arise depending if it refers to the private or public fund.

First, the private water fund identifies private companies that could contribute to the trust fund since they are directly affected of water scarcity. The vision of Aquafondo relies on the inclusion of private companies into the board as payers since their production is going to be affected. For that purpose, the third working line of Aquafondo concentrates on private public partnerships to implement projects in the sense of watershed conservation. As well, the organization assists companies to obtain the Blue Certificate which recognizes the efforts to reduce companies' water footprint. The interest of companies on the preservation of

ecosystem services could be based on Corporate Social Responsibility, but the efforts behind can still be related with the consideration of water as a major input for their production.

On the other side, the Lima's SPE that created and manages the public water fund pays more attention to the cost of implementation projects for watershed conservation than the value that water has as an input. This can be seen on the way that Sedapal assigned the percentage to be collected from water tariffs. The 1% collection doesn't have a proper technical support of the loss in producing other goods if the watershed is not preserved.

Thus, the initiatives coming from Aquafondo overcome this limitation that market-based solutions have; while Sedapal doesn't consider this disadvantage when designing the financial tool. **Hence, the disadvantage is partially surpassed.**

g. No consideration of the impact on human welfare.

Noting the changes in quality and quantity of natural capital is important to describe the impacts that they have on human welfare (Costanza et al., 1997). As previously stated, going beyond the availability of exhaustible resources to include human welfare impacts from changes in ecosystem services could be a path for payment mechanisms to reach sustainable development.

In the case of Aquafondo, projects and campaigns highlight the consequences on the city if water scarcity occurs. Because of that, indicators to evaluate projects' achievements help to identify the impact that watershed recovery has on population benefited from access to water, water bodies recharged and land recovery. Furthermore, the awareness campaigns promoted by the private water fund help to increase the appreciation of the ecosystem service into human welfare. Also, the creation of the watershed council – CHIRILU for a better management of projects in the basins becomes essential for the governance at all level. These aspects are important for human welfare and for the recognition of water as a basic need.

For the case of Sedapal, as stated before, the SPE focuses on the costs of executing green infrastructure projects in the upper and middle sector of the watershed. The calculation of the investment needed and the form of collection from water tariffs don't perceive the impacts from changes (or improvements) of the ecosystem into human welfare.

To summarize, actions taken by Aquafondo are able to consider impacts on human welfare that goes beyond the production of manufactured goods. While Sedapal doesn't consider this holistic approach when designing projects, its main objective is to maintain the input needed to continue a good business. **Then, the limitation can be partially surpassed**, specially from the private water fund.

h. No recognition of different human welfare when setting prices.

Aggregation of individual preferences or utilities are problematic for the valuation of natural resources and the calculation of prices for their conservation. The criticism of cost-benefit analysis concentrates on the lack of inclusion of different types of human welfare, treating differences as similar choices to be taken for creating payment mechanism. As well, Sen (1985) points out that this subjectivism that focus on the functions of natural goods and services prevent human well-being as their capabilities are not fully reached.

Considering the above, private and public water funds in Lima don't consider enough different human welfare when designing and implementing market-based mechanisms. The publicity showed by both of them appeals to the whole concern of the city towards the scarcity of water. To start with, Aquafondo's consideration of including communities that live in the upper and middle sector of the basins is basically related with the main objective: water scarcity in Lima. However, one action from the private water fund can be considered as a recognition of a different basic need that enhance human welfare. The promotion of sustainable economic activities that intervene directly in the watershed could cover other needs for people living there. Aquafondo works to recover terraces for agricultural activities and improve their practices which brings monetary benefits to communities in the area. Although an increase of income is beneficial for a specific community, different from the aggregated utility used to determine payment mechanisms, other basic material needs are still missing like security or freedom of choice and action.

Consequently, this lack of recognition of different human welfares promotes inaccurate market-based schemes and projects design, the case of both water funds in Lima. **Therefore, the disadvantage cannot be considered as overcome**, either the private or the public water fund in Lima.

i. No inclusion of communities' values when setting prices for water conservation.

The importance of including communities' values relies on the impact that they might have on human development. Sen's capability approach (1999) proves mathematically that an active presence of different sections in society will improve social welfare.

Aquafondo has a wide understanding of this situation as explained before. The private water fund implements many projects in which communities' knowledge and values are included. In this case, one of the objectives of the first working line in the organization appreciates ancestral practices for watershed conservation, as the practice of amunas for water recharging. Although the inclusion of communities' values doesn't come from the design of

the scheme itself, the management of the trust fund takes into consideration the contribution of them when executing conservation projects.

In the case of Sedapal, the SPE doesn't support technically the use of the 1% as the collective tariff for creating the water fund. However, as in the case of Aquafondo, the prioritized projects from the public institution present 8 interventions that include communities' values based on ancestral practices for water recovery on the basins. Therefore, this can be understood as a concern to work hand-to-hand with communities to use these practices for re-evaluating them.

In summary, it seems that communities' values are included in the design of the projects from both of the water funds in Lima. The current situation of Aquafondo presents the interest that the organization has for ancestral practices. This concern spilled over the projects' design of Sedapal, which are not implemented yet and there isn't a notification of when it's going to happen. **So, this limitation can be considered overcome**, with the exception of Sedapal because it hasn't executed them but they're on its project portfolio.

After discussing each point from the criteria assessment to evaluate how sustainable PWS is, an overall and unique answer cannot be reached. The scheme is not completely perfect or imperfect. The way the water fund works provides evidence that not all of the advantages are considered, having room for improvements in the design and implementation of its actions. On the other hand, the discussion shows that some of the disadvantages are overcome, demonstrating the efforts to improve the economic tool for environmental conservation.

7 Conclusions

Growing economies are now facing a struggle to accomplish their current production and consumption without consideration of the environmental impact that comes with it. Along the document I described the theories that comes for describing way to reach sustainable development. Weak sustainability, strong sustainability and capabilities approach were used to defined a theoretical path to built up criteria of assessment for market-based solution for environmental conservation. The results showed that ways in which payment for water ecosystem services help to create a solution where society, economy and environment can be all together.

After discussing each point from the criteria assessment to evaluate how sustainable PWS is, an overall and unique answer cannot be reached. The scheme is not completely perfect or imperfect. The way the water fund works provides evidence that not all of the advantages are considered, having room for improvements in the design and implementation of its actions. On the other hand, the discussion

shows that some of the disadvantages are overcome, demonstrating the efforts to improve the economic tool for environmental conservation. Because of that, the market-based mechanism can still be considered a good tool to solve environmental degradation on a short or medium term, within the current economic system. Nevertheless, there is still a lot to do if stakeholders want to use this scheme as a sustainable tool for watershed conservation.

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