SPECIFIC PAYMENTS FOR ECOSYSTEM SERVICES AS PART OF THE WATER AND FOREST MANAGEMENT IN ROMANIA

Costica MIHAI*, Simona-Roxana ULMAN, Krisztina-Melinda DOBAY*****

Abstract

Water and forests play a major role in the functioning of biosphere, their interactions being able to provide an extensive range of vital goods and services for the society, and, thus, significantly contributing to human wellbeing. With the aim of offering a better perspective of the national context, in this paper we analyzed (1) the level of recognition of the connection between forests and water in the policy of Romania, as extent of the EU Water Framework Directive and other EU directives; (2) the link between forests and water and their effects on human wellbeing in the context of Romania in the period between 2006-2016; (3) the description of some initiatives related to the payments for ecosystem services in Romania. Our findings emphasized the important role that forests and investments in terms of their extension are able to play in relation to water.

Keywords: water, forests, payments for ecosystem services, human wellbeing

Introduction

Protecting environment has become an important issue in the context in which "today's environmental problems are increasingly complex" (Burke *et al.*, 2017) and represent a "threat" to human wellbeing (Dunlap and Scarce, 1991). In this way, it is considered that now it is the moment of learning how to advance without producing negative environmental side effects (Strange and Bayley, 2008, p. 17). More, the theoretical and practical tendency to pay greater attention to the environment is observed, sustained and encouraged nowadays. This is made in the context in which the dependence of human wellbeing on nature is more and more

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recognized, i.e. the multiple benefits that people obtain from ecosystems (MEA, 2005; TEEB, 2010; Grizzetti, 2016). Among these benefits, the ones related to water and forests are of great importance and they are indeed at the core of sustainable development, especially in terms of economic and human wellbeing (Haddadin, 2001).

Romania is among the countries that still confront to the challenge of finding an optimal balance between sustainable forest and water management (Rosculete *et al.*, 2019, p. 140). Moreover, the ecosystem services concept, including the ones referring to water and forests, seems to remain at a superficial level, its implementation still being in an explorative stage (Grizzetti, 2016, p. 186).

Taking into consideration these assumptions, our paper aims to discuss about:

- regulatory frameworks, especially those relevant for forest-water interactions and some national peculiarities regarding the payments for ecosystem services mechanism in Romania;
- links between: forests, water, economic and human wellbeing in the Romanian context of the period between 2006-2016;
- three case studies regarding local initiatives of improving water services through payments for actions related to trees, focusing on their characteristics and structure.

1. Theoretical approach regarding ecosystem services from the perspective of the interaction between water and forests

Taking into consideration the importance of the natural capital in general and of the forests, as one essential part of this type of capital, in particular, for the future of human societies, concreted into some fundamental benefits, their maintenance at an adequate status have to be especially addressed (Mihai, 2005, p. 449). As one response to this challenge, Ecosystem Services (ES) are usually defined as the benefit people obtain from nature (MEA, 2005; Brogna *et al.*, 2017), being a concept that aims at raising the awareness about the importance of preserving ecosystems and biodiversity (MEA, 2005). ES are related to: water supply and air purification, natural waste recycling, soil formation, pollination and mechanisms of regulation that nature (if there is no human intervention) uses them to control climate conditions and animal populations, insects and other organisms (EC, 2009).

In the context of the strong link between forests and water (Andréassian, 2004; Sun and Segura, 2013; Brogna *et al.*, 2017; Ellison *et al.*, 2017; Filoso *et al.*, 2017; Leonardi and Pettenella, 2018; Bran *et al.*, 2019; Nisbet *et al.*, 2020), among the ecosystem services, those related to them are considered to be of prime importance. Governments and societies are increasingly aware of the role that forests play in protecting watersheds, nearby their aquatic habitats and species; regulating stream temperature; filtering water; preventing erosion, landslides and the loss of soil or mitigating destructive events, such as flooding; providing an effective and approximately secure measure for tackling diffuse pollution from agriculture;

helping with carbon storage and other environmental benefits (Nisbet *et al.*, 2011; Ellison *et al.*, 2017; Leonardi and Pettenella, 2018; Nisbet *et al.*, 2020). Taking into account these amount of environmental benefits, in the words of Ellison *et al.* (2017, p. 51), "forests and trees must be recognized as prime regulators within the water", their positive effects "demanding wider recognition". In this way, reducing deforestation, investing in forest landscape restoration and preservation are part of adaptation, mitigation and sustainable development processes (Ellison *et al.*, 2017, p. 51). More, connecting forests to water management may offer the perspective of optimizing the provided ecosystem services of vital importance to the functioning of the biosphere, to society and to human wellbeing (Bastrup-Birk *et al.*, 2018, p. 7).

Moving on, obtaining the proper ecosystem services is achievable through financial support. Rubel (2012, p. 1) points on the general situation, still actual nowadays and emphasized more and more by the research studies, in which there is a relative higher environmental concern, but limited financial resources dedicated to solving and improving environmental issues. In this context, the payments for ecosystem services (PES) might be among the proper solutions to this problem, while they "can generate additional alternative resources, allocate funds to environmentally friendly management practices and sustainable production patterns, create incentives for investments, and increase the involvement of the private sector in environmental protection" (Rubel, 2012, p. 1). Leonardi and Pettenella (2018, p. 41) also remind the problems of budget austerity and include PES, among other voluntary, market-based mechanisms, "as an alternative source to public funding, and as an alternative source of income for private land owners for, among others, the provision of hydrological services". In addition, the PES schemes have to consider the specificity of the profile of public goods consumers from different regions, potentially closely related to the water and forest ecosystems, their interactions and other implications starting from them (Mihai and Hanganu, 2018).

PES are defined in different ways, but the most common used definition refers to them as "a voluntary transaction, where a well-defined environmental service (ES), or a land-use likely to secure that service is being 'bought' by a (minimum one) service buyer from a (minimum one) service provider if, and only if, the service provider secures service provision (conditionality)" (Wunder *et al.*, 2008). A less strict definition is the one offered by Muradian *et al.* (2010), mentioning that they represent: "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources". More particular, directly referring to the link between forests and water, the PES are defined as follows: "a transfer of resources between at least 2 actors, explicitly targeted at improving water services (either primarily or bundled with other services) that pays (cash or in kind) for actions related to trees"[1].

[1] Payments for Ecosystem Services (Forest for water) (PESFOR-W), COST Action (CA15206), Available online: https://www.forestresearch.gov.uk/research/pesforw/ (accessed on January 2020).

Local and regional structural elements, such as: the ecosystem structure, process and services; the type of actors; the institutional background etc. are recommended to be particularized when designing PES (Leonardi and Pettenella, 2018, pp. 41-42). Also, the key design aspects should consider the degree of: voluntariness (i.e. entering into an agreement and participating into it through a free and informed process of negotiation by the contracting parties), directness (i.e. receiving direct payments from the ultimate beneficiaries of the environmental service by the individual providers of that service), commoditization (i.e. if compensation received by environmental service providers has been determined by transaction involving a tradeable commodity), additionality (i.e. if the payment directly contributes to the increased provision of environmental service) (Leonardi and Pettenella, 2018, pp. 43-44).

In this way, payments for ecosystem services schemes represent a mechanism for enhancing the services provided by environment, including the one related to water and forests. For this, international, regional and national levels of regulatory frameworks need to be taken into account in the approaches related to the framework for forest-water interactions and, also, related to the foundation for the development of PES mechanisms.

2. Legal framework

2.1. The presence of Ecosystem services (ES) concept in the Romanian political discourse

A study called "Assessment of Ecosystems and Ecosystem Services in Romania" was recently elaborated and it analyzed the policy documents relevant for the main sectors related to ecosystem services as presented in Table 1 (NEPA *et al.*, 2017, p. 10).

Table 1. Relevant policy documents by sectors

Policy sector	Policy document
Water	Water National River Basin Management Plan 2015-2021
Marine	National Strategy Monitoring Program for the marine environment 2014-2020 Article 12 - Technical Assessment of the MSFD 2012 obligations: reports for the Regional Seas - Black Sea
Forestry	European Strategy for the forest sector Forest Code National Rural Development Program 2014-2020
Biodiversity	National Strategy Action Plan for biodiversity conservation 2014-2020

Climate Change – Mitigation and Adaptation	National Strategy for Romania on Climate Change 2013-2020 National Action Plan 2016-2020 on Climate Change
Fisheries and Aquaculture	National Strategy for the fishery sector 2014-2020 National Multi-Annual Strategic Plan for aquaculture 2014-2020 Operational Program for Fisheries and Maritime Affairs 2014-2020

Source: NEPA, NINA, ROSA, WWF Romania, p. 10[2]

The concept of ES is also met in other documents related to environment, as, for example: *Law no. 197/2018 regarding the sustainable development of mountain region* and *Ecotourism Development National Strategy - context, vision and goals - 2016-2020* (Tudorachi *et al.*, 2015) etc.

Regarding Payments for Ecosystem Services (PES), to our knowledge, the collocation "compensatory payments" is more frequently used both in the political debate and in the strategic documents. More, Payments for Forest Water Services (W-PES) are not explicitly mentioned and no other substitute is used for defining W-PES in the legislation, in the strategic documents or in the political discourse. Our conclusion is also supported by the findings of UN (2018) in a report called "Forests and Water. Valuation and payments for forest ecosystem services", where there is explicitly mentioned: "No references could be found on payments for water-related ecosystem services from forests in 30 out of 56 UNECE countries" and, in this list, Romania is present (Leonardi and Pettenella, 2018, p. 52). Thus, as a practical vehicle for environmental conservation and economic development, the concept of PES proves to be difficult to implement and any initial successes might be capable of facilitating learning processes and institutional change (Wang and Wolf, 2019, p. 5).

2.2. Legal framework for freshwater management in Romania

The necessity of having into attention the water issue and, also, of increasing the level of awareness regarding the closely link between water and forests is also certified by the United Nations Development Programmes (UNDP) in their approach on development. Water is of primary interest among the UN Sustainable Development Goals, its importance being emphasized in *Goal 6: Clean water and sanitation*. Moreover, the link between water and forests is accepted and recognized in SDG 6.6, which explicitly focuses on the necessity of protecting and restoring water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. This is

[2] NEPA, NINA, ROSA, WWF Romania (2017), Assessment of Ecosystems and Ecosystem Services in Romania, in Demonstrating and promoting natural values in support of decision-making processes in Romania Project (EEA 2009 - 2014).

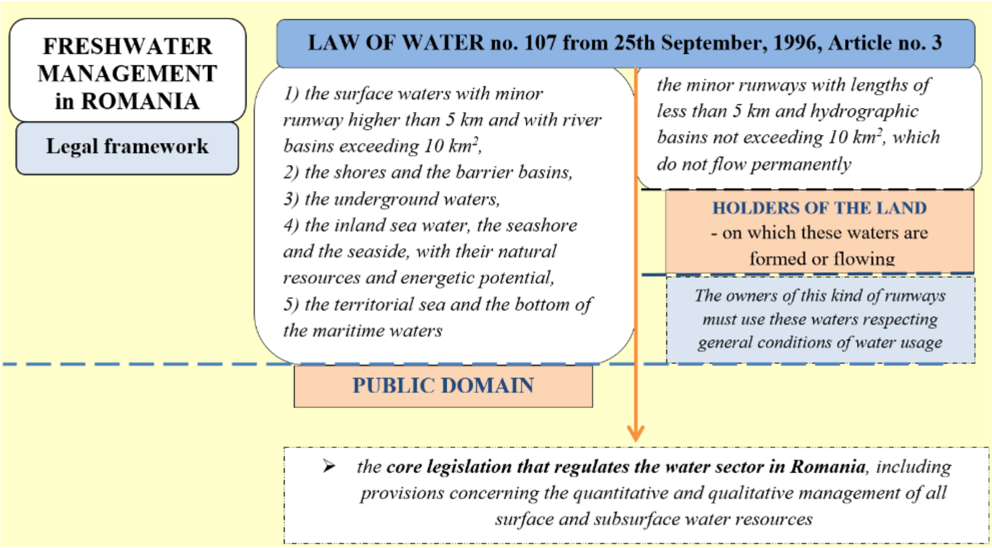
made in the context in which "more and more countries are experiencing water stress, and increasing drought and desertification is already worsening these trends"[3].

In addition, according to Nisbet *et al.* (2020, p. 3), the main aim of European Union's water policy is to ensure the availability of good quality water in a sufficient quantity, in order to properly respond for both people's needs and the environment. The EU's legal framework on water refers to issues like access, extraction and management of freshwater and main important water issues (quality, quantity, regimes flooding, erosion control, ecological status, recreation) etc., the reference document being the EU Water Framework Directive.

As pointed out by European Commission (EC, 2020, p. 12), "the EU's legal framework on water is ambitious, but implementation is lagging behind and greater efforts are needed to restore freshwater ecosystems and the natural functions of rivers in order to achieve the objectives of the Water Framework Directive".

In Romania, the freshwater management is mainly regulated by Law of Water no. 107 from 1996, modified and completed by the Law 310/2004, Law 112/2006, Law 146/2010, as well as Government Decision 270/2012, and the more recent Government Decision 1095/2013. Its main points are described in Figure 1.

Figure 1. Law of Water no. 107, 1996 – main topics



Source: authors' representation

[3] UNDP. UN Sustainable Development Goals. Available online: ttps://www.undp.org/content/undp/en/home/sustainable-development-goals.html. (accessed on February 2020).

The most important water issues in Romania are the following:

- Romania is among the EU countries most subject to large flooding events - surpassed only by Poland, Czechia and Slovakia for the frequency of 100-year floods.
- Floods have been occurring in Romania with growing frequency over the past centuries.
- Romania is almost a water-stressed country, with several river basins already below the water stress and/or water scarcity level (on a per capita basis).
- Many dams have deteriorated and have to be operated well below their initial design level to ensure safety.
- Significant impact of climate change, with more droughts and floods, is expected (World Bank, 2018).

2.3. Connection between forests and water in the legal framework

The connection between forests and water is referred within the Romanian legal framework, and some exemplifications of these references are the following:

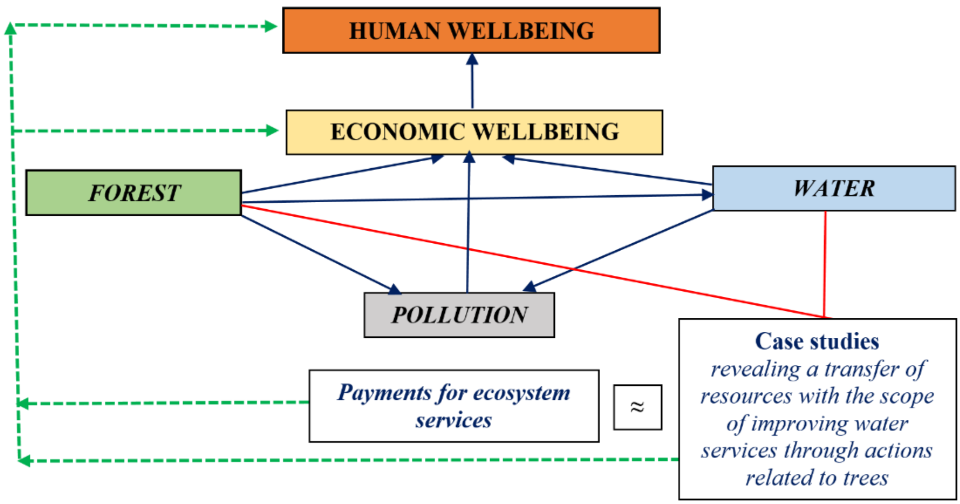
- *Law no. 289(r2)/2002, Article no. 2 (applied since 26/02/2014) (with subsequent amendments)*: "the forest protection belts are of the following types: ... d) protection of dams and shores against currents, floods, ice, and others".
- *Law of Water no. 107/1996, Article no. 31, paragraph 1 (with subsequent amendments)*: "Forests with special protective functions in reservoir basins, those with a high degree of torrents and erosion, major river beds in the Danube, as well as forest belts along the rivers undoubtedly belong to the group of forests with special water protection functions and are carried out through intensive treatments, cuts or short regeneration treatments being forbidden".
- *Environmental Protection Law no. 137/1995, Art. 53 (with subsequent amendments)*: "Owners of forests, forest vegetation outside the forest fund and grassland have the following obligations: ... f) comply with the forestry regime established for the conservation of woody vegetation on wooded pastures that perform soil protection functions and water resources".

3. Connections between forests and water in the context of Romania in the period between 2006 and 2016 – preliminary study

Millennium Ecosystem Assessment (MEA) (2005, p. VI) links the ecosystem services, including the ones of the water and forests and their interactions, to human wellbeing, while also analyzing their strength and offering indications of the extent to which it is possible for economic factors to mediate the linkage. As stated in the introduction part, its conceptual framework is based on the fact that "people are integral parts of ecosystems and that a dynamic interaction exists between them and other parts of ecosystems, with the changing human condition driving, both directly and indirectly, changes in ecosystems and thereby causing changes in human wellbeing" (MEA, 2005, p. V).

Also based on this assumption, our endeavor directly emphasizes on the links among the share of forest area, including also the afforestation aspect, water from the perspective of its exploitation and human wellbeing, including also elements of economic wellbeing and pollution, as primary other important markers of the society and environment in general. Sun and Segura (2013, p. 121), in their graphic, offer a clear picture in which the "interactive processes among forests, climate, water and human systems" are emphasized, pointing on the links between: forests and water; forests and humans; water and humans. In their paper, it is also emphasized the fact that understanding these interactions is "essential in advancing actionable sciences and developing robust climate change mitigation and adaptation strategies and methodologies" (Sun and Segura, 2013, p. 120).

Figure 2. Conceptual framework for analysing the link between forests – water – economic and human wellbeing, in Romania in the 2006-2016 period



Source: authors' representation

Moreover, we have to mention the fact that it is a commune practice that the relation of influence between environment and society, with its two components, i.e. economic and social, to start from environment, as a main determinant of society's wellbeing (Costanza *et al.*, 2015; Wackernagel and Rees, 1995; van de Ker and Manuel, 2017; Ayres *et al.*, 2001; Dietz and Neumayer, 2007; Hediger, 2006; Harvey and Bell, 1995; Strange and Bayley, 2008; Banerjee, 2003; Robinson, 2004). In this way, we particularized the environmental dimension in terms of water, forests and pollution issues, called in the literature "the threefold relationships" (Rosculete *et al.*, 2019, p. 141). More, we sustain the point of view according to which the economic dimension is not an end in itself, but a means for achieving human wellbeing (van de Kerk and Manuel, 2017; Ulman *et al.*, 2020).

These are the main arguments for establishing our conceptual framework, presented in Figure 2, starting with the environmental aspects related to water, forests and pollution affecting firstly the economic performance and then, as an end, also affecting human wellbeing, evaluated in terms of food and drink sufficiency, safe sanitation, education, health, gender equity, income distribution, population growth and good governance (van de Kerk and Manuel, 2017). For this, we analyzed the relationships between forests and water and their influences on the economic and human wellbeing in Romania, along the 2006-2016 period of time. Further, we presented a brief description of three case studies relevant for our topic.

3.1. Methodology

In the first part, we analyze the human wellbeing model in relation to economic wellbeing and some environmental factors related to forests and water in Romania, along the 2006-2016 period of time. These represent main suppliers of ecosystem services that significantly contribute to improving human wellbeing, at least from the theoretical point of view and especially in the local contexts. For this, we used data collected from Sustainable Society Index (SSI), Eurostat and NIS (National Institute of Statistics)[4] and the used indicators are presented in Table 2.

The main aim is to observe the relation between water and forests and their effects on human wellbeing, as final scope of economic and environmental actions.

Table 2. Indicators taken into analysis

Indicator/Source of each indicator	
Human Wellbeing (Human_Wellbeing)	
Human wellbeing is evaluated in terms of three categories: (1) basic needs (sufficient food, sufficient to drink, safe sanitation), (2) personal development and health (education, healthy life, gender equality) and (3) a well-balanced society (income distribution, population growth and good governance), as one of the three dimensions of a sustainable society, nearby economic and environmental wellbeing (http://www.ssfindex.com/ssi/indicator-description/).	SSI
Economic Wellbeing (Ec_Wellbeing)	
Economic wellbeing is evaluated in terms of two categories: (1) transition (organic farming and genuine savings) and (2) economy (GDP, employment, and public debt) (http://www.ssfindex.com/ssi/indicator-description/).	SSI
Share of forest area (Share_forest_area)	
The indicator measures the proportion of forest ecosystems in comparison to the total land area (% of total land area) [sdg_15_10].	Eurostat
Area of the land submitted to afforestation schemes (Area_afforest_schemes)	

[4] NIS (National Institute of Statistics). Available online: http://statistici.insse.ro:8077/tempo-online/ (accessed on May 2020).

Afforestation represents all works done for planting of seedlings or sowing a land area in order to create new forest trees, both on forest lands that has been exploited mature stand and on lands without forest vegetation [AGR304A].	NIS
Water exploitation index (Water_Exploitation_Index)	
The indicator presents the annual surface water abstraction as a percentage of the country's long-term annual average surface water resources available for abstraction. The warning threshold of 20% for this indicator distinguishes a non-stressed from a water scarce region, with severe scarcity occurring where the WEI exceeds 40%.	Eurostat
Greenhouse gases (Greenhouse_gases)	
This indicator uses the common measure for Emission of Greenhouse Gases (GHG): the amount of emitted CO2 (emissions per capita per year). Thus other GHG emissions, like CH4, N2O, HFCs, PFCs and SF6, are not included.	SSI

Source: SSI, Eurostat and NIS

We opted to use path analysis, as an extension to multiple regression analysis - a methodological tool that uses quantitative data to disentangle the various (causal) processes underlying a particular outcome (Lleras, 2015). More, our endeavour is based on the fact that path analysis is most helpful in testing the relationships between variables (such as relation between human and economic wellbeing or water and forests issues in relation to human and economic wellbeing) within a certain context that, in our paper, is the Romanian one in the period between 2006 and 2016. Path coefficients in path models are derived from the values of a Pearson product moment correlation coefficient and/ or a standardized partial regression coefficient (Wolfle, 1977). In these models, estimation of parameters permits decomposition of the correlation matrix. Validation of path analysis results is based on the values of several criteria: Goodness-of-fit (GFI), Adjusted GFI (AGFI), and Normed fit index (NIF) (Shumacker and Lomax, 2016).

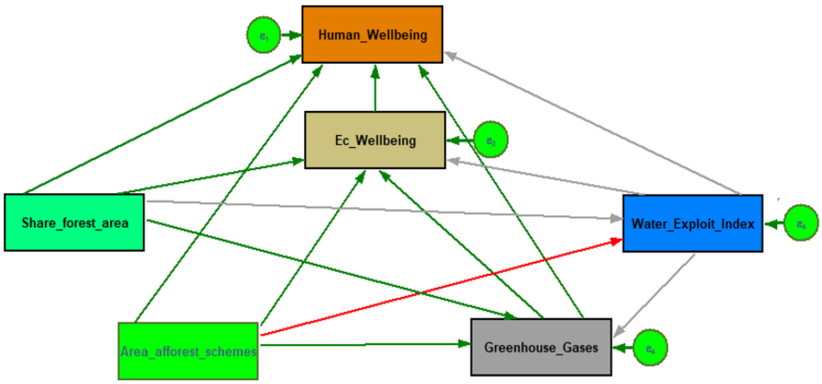
In this regard, path analysis helped us disentangle the complex interrelationships between human and economic wellbeing, environmental indicators related to trees, water and pollution and identify the most significant paths involved in predicting the outcome of human wellbeing, as analysed in the next part.

3.2. Path analysis

As already mentioned in the section dedicated to methodology, path analysis was used to investigate the relation between human and economic wellbeing and the selected environmental variables related to forests, water and pollution, while also observing, in the case of significant relationships, whether their effects are direct or indirect. In detail, the proposed model hypothesizes that increases in (1) the share of forest area and in (2) the area of the land submitted to afforestation schemes, along with a decrease of (3) water scarcity and (4) greenhouse gases are firstly associated with an increase in economic wellbeing and, then, in human wellbeing.

In order to determine the **total effects** of the selected variables on human wellbeing, but also the direct and indirect ones, we established that: (1) Human_Wellbeing is an endogenous variable; (2) Economic_Wellbeing; Greenhouse_Gases and Water_Exploit_Index represent intervening endogenous variables; (3) Share_forest_area and Area_afforest_schemes are exogenous variables (Figure 3).

Figure 3. Path diagram – total (cumulative) effects on the level of Human Wellbeing in Romania, in 2006-2016



Legend: green lines – positive effects, red lines – negative effects, gray lines – insignificant effects)
Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

For a better understanding of our results, we opted for presenting the type of effects obtained from our path analysis (i.e. positive, negative, insignificant) among our variables in Table 3, while the estimates for all relationships in the measurement models (the path coefficients using regression analysis) can be found in Appendix 1.

Table 3. Total (cumulative) effects of the chosen environmental variables on the level of Human and Economic Wellbeing in Romania, in 2006-2016 period

Dependent variable	Independent variable	Effects Romania 2006-2016
Human_Wellbeing (Eq. 1)	Ec_Wellbeing	**positive**
	Water_Exploitation_Index	insignificant
	Greenhouse_gases	**positive**
	Share_forest_area	**positive**
	Area_afforest_schemes	**positive**
Ec_Wellbeing (Eq. 2)	Water_Exploitation_Index	insignificant
	Greenhouse_gases	**positive**
	Share_forest_area	**positive**
	Area_afforest_schemes	**positive**

Water_Exploitation_Index (Eq. 3)	Share_forest_area	insignificant
	Area_afforest_schemes	**negative**
Greenhouse_gases (Eq. 4)	Water_Exploitation_Index	insignificant
	Share_forest_area	**positive**
	Area_afforest_schemes	**positive**

Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

In this model, Human_Wellbeing (Eq. 1) depends on the following partial regression coefficients: Ec_Wellbeing, Greenhouse_gases, Share_forest_area and Area_afforest_schemes. Ec_Wellbeing (Eq. 2) is influenced by Greenhouse_gases, Share_forest_area and Area_afforest_schemes. Water_Exploitation_Index (Eq. 3) depends on Area_afforest_schemes; while Greenhouse_gases (Eq. 4) is influenced by Share_forest_area and Area_afforest_schemes.

In this way, our results show that human wellbeing is positively influenced by the economic wellbeing, by the national performance regarding greenhouse gases in terms of their sustainable coordination, by the share of forest area and, also, by the area of the land submitted to afforestation schemes. In other words, the improvements to the levels of mentioned indicators positively contributed to enhancing human wellbeing in Romania along the 2006-2016 period. Consequently, more attention to the forests issues like the share area and the schemes of afforestation meant more economic wellbeing and, also, more sustainable amount of emitted CO_2. Also, more land included in an afforestation scheme translated into a higher performance of water exploitation. These findings seem to be relevant for observing the link between forests and water and, also, their effects on human wellbeing in Romania. Following this objective, the next step was to analyze their direct and indirect effects.

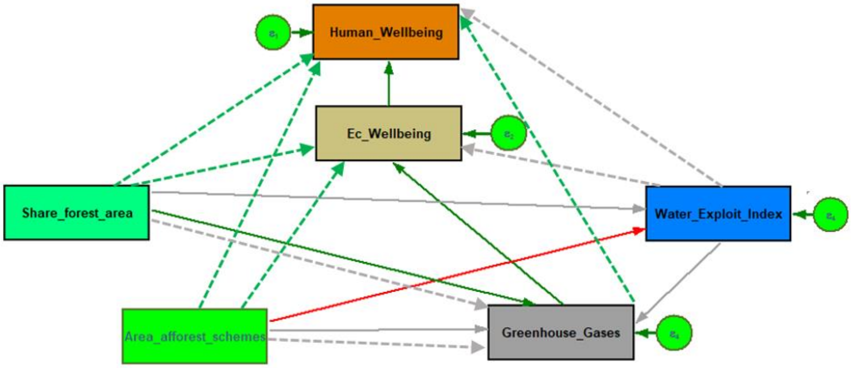
Moving on, we examined the **direct and indirect relationships** among the selected variables, paying attention especially on the human wellbeing, as an outcome of the hypothesized model, but also to the indicators related to forests and water. In this way, path analysis helped us disentangle the interrelationships observed in the analysis of the total effects of the exogenous and intervening endogenous variables on wellbeing indicators, as presented in Figure 4 and Tables 4.1. and 4.2. (detailed in Appendix 2).

Main findings of the analysis are the following.

Human_Wellbeing is (1) directly affected by Ec_Wellbeing and (2) indirectly affected by (2.1) Greenhouse_gases and Share_forest_area via the Ec_Wellbeing mediator and by (2.2) Area_afforest_schemes through the Water_Exploit_Index as mediator.

Ec_Wellbeing is (1) directly affected by Greenhouse_gases and (2) indirectly affected by (2.1) Share_forest_area via the Greenhouse_gases mediator and by (2.2) Area_afforest_schemes through the Water_Exploit_Index as mediator.

Figure 4. Path diagram – Direct and indirect effects on the level of Human Wellbeing in Romania, in 2006-2016



Legend: green lines – positive effects, red lines – negative effects, gray lines – insignificant effects
Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

From our analysis, it may be observed that Water_Exploit_Index and its evolution register significant links to other three variables: Greenhouse_gases, Ec_Wellbeing and Area_afforest_schemes. In this regard, the fact that the schemes for afforestation significantly and positively contribute to the reducing of water scarcity and, thus, to the improvement of the water indicator performance may show the important role that forests and investments in terms of their extension are able to play in relation to water. Although there are studies observing the effect of reducing water availability in the situations of re- and afforestation (Liu *et al.*, 2016; Andréassian, 2004; Rind *et al.*, 1990; Scott and Lesch, 1997; McGuinness and Harrold, 1971), as Ellison *et al.* (2017, p. 51) mentioned, in the correct spatial setting, forest restoration can positively impact water also in terms of availability. In this context, our result showing a positive link between water availability and afforestation schemes is consistent to other studies confirming that functions inherent to forests offer solutions to water availability (Ellison *et al.*, 2012; Hesslerová *et al.*, 2013; Syktus and McAlpine, 2016; Ellison *et al.*, 2017). This is strengthened by the assumption of Sun and Segura (2013, p. 120), stating that "fresh water scarcity is becoming more problematic across the planet due to increasing (…) land use change such as deforestation" in the context in which "a great deal of land conversion has come at the expense of forests" (Filoso *et al.*, 2017, p. 8).

Referring to the Romanian situation, as Bran *et al.* (2019, p. 111) pointed, national forests have also registered a steady decline over time (from 50% during the Middle Ages to about 37% in the modern era) due to deforestation for expanding the agricultural area and to the need for fuel and building materials. More, it may be also observed that the three indicators regarding forests and water in Romania seem to significantly contribute to improving the level of economic wellbeing that, as the sustainable development theory shows, is not an end in itself, but a mean for obtaining human wellbeing (van de Kerk and Manuel, 2017; Ulman *et al.*, 2020).

Table 4.1. The direct effects of different environmental variables related to water and forests on Human and Economic Wellbeing

Predictor	Predictand	Direct effects Romania 2006-2016
Ec_Wellbeing	Human_Wellbeing	**positive**
Greenhouse_gases	Ec_Wellbeing	**positive**
Share_forest_area	Water_Exploitation_Index	insignificant
Area_afforest_schemes		**negative**
Water_Exploitation_Index	Greenhouse_gases	insignificant
Share_forest_area		**positive**
Area_afforest_schemes		insignificant

Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

Table 4.2. The indirect effects of different environmental variables related to water and forests on Human and Economic Wellbeing

Predictor	Mediator	Predictand	Indirect effects Romania 2006-2016
Water_Exploit_Index	Ec_Wellbeing	Human_Wellbeing	insignificant
Greenhouse_gases			**positive**
Share_forest_area			**positive**
Area_afforest_schemes	Water_Exploit_Index		**positive**
Water_Exploit_Index	Greenhouse_gases	Ec_Wellbeing	insignificant
Share_forest_area			**positive**
Area_afforest_schemes	Water_Exploit_Index		**positive**
Share_forest_area	Water_Exploit_Index	Greenhouse_gases	insignificant
Area_afforest_schemes			insignificant

Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

This analysis and the obtained results may constitute a link between the theoretical background presented in the first part of the paper and the three case studies described in the above section. This part aimed at observing the general link between forests and water, as essential environmental resources, in the Romanian context and, then, their role in the process of development related to economic and social wellbeing.

3.3. Romanian local initiatives of improving water services through payments for actions related to trees

With the main goal of observing the foundation for the development of specific national payments for ecosystem services mechanism in Romania, as part of the water and forest management, there were also investigated some local initiatives of improving water services through payments for actions related to trees, focusing on their characteristics and structure.

Case Study 1 - Ecological restoration of the land from the CARASUHAT agricultural polder, belonging to the public domain of Mahmudia village from Danube Delta

The Local Council of Mahmudia, nearby the World Wildlife Fund (WWF)[5] Romania and The Administration of Danube Delta Biosphere Reservation implemented the project entitled “Ecological rehabilitation of the lands belonging to public domain of Mahmudia local administration in CARASUHAT agricultural area from Danube Delta”, or shortly, “RECO-Mahmudia”, funded through European Regional Development Fund (ERDF) and Cohesion Fund (CF) Operational Programme for Romania for the period 2007-2013, entitled “Operational Programme Environment” (SOP ENV). Its main objective was to reconnect 924 ha from this area to the natural circle of the Danube, Sf. Gheorghe arm, through restoration of the complex of ponds, lakes and channels that offered, before being drained and dusted, food, shelter and breeding ground for many of the plant species, birds and fish that are threatened with extinction. One way of doing this was through planting trees (native delta species - white poplar, willow and ash) on 10 ha. The total value of the project was equal to 12.711.624 lei, approx. 2.820.000 euro. The payments were regular, being elaborated 16 reimbursement requests. The implementation period was of 42 months, from 1 March, 2012, to 30 August, 2015. The benefits of the project were concreted in the rehabilitation of 18 types of habitation representing important feeding and nesting areas for many species of community interest. Beneficiaries of services provided by the case study were: local communities (1); households (1300); firms (50 - especially pensions); farmers (4). The restoration of natural processes contributed to the long-term conservation of biodiversity and for the regeneration of the natural resources of the delta zone. Also, the project proposed solutions to the ecological and socio-economic major problems of Danube Delta, caused especially by the transformation of 35% of the delta territory that, in time, produced loss of biodiversity and a decrease in natural resources that can be used by the local community. Information regarding this project may be found on the page of WWF[6], as a partner within the project, on a series of press releases[7].

[5] WWF data, available online: https://www.worldwildlife.org/ (accessed on January 2020).

[6] https://www.worldwildlife.org/.

[7] http://www.proiecteue.ro/proiecte.php?proiect=5286;

Case studies 2 and 3 - Iezer and Ciocanesti fishponds – pilot

Within the Danube PES Project, called *Promoting Payments for Ecosystem Services and Sustainable Finance Mechanisms in the Danube Basin (Danube PES)*, WWF Romania has chosen pilot areas from Calarasi county (Iezer – 530 ha and Ciocanesti – 233 ha) for demonstrating the way of efficiently utilizing the public funds for stimulating the economic growth while environment conservation actions are also included. Their main objectives were: testing the integration of environmental friendly measures in aquaculture management; the evaluation of this aquatic environment scheme from the point of view of the transition to a responsible aquaculture; improving water quality, affected by the intensive agricultural practices on the land around the farms; the access of the ichthyophagous birds for feeding, by draining a smaller number of fish ponds, by reducing the area covered by nets and by slowing the spread of the reed. Among the actions within the projects, the plantation of trees was also present. Beneficiaries of services provided by the case study are the local communities and tourists that come to visit the farms. Information regarding these PES schemes may be found on the WWF web page[8].

In detail, referring to the Ciocanesti case study, the natural values of the farm from here have been officially recognized through its inclusion in the site Natura 2000 "Ciocănești Dunăre" (ROSPA0021). According to the data found on the web page of WWF (http://www.wwf.ro), the annual value of the environment services was related to: fish production (3,202 €/ha); carbon sequestration - reed, vegetation, trees (5856 euro) and trees (3550 euro). Since 2010, WWF – Romania is present in the area with a conservation project that aims to maintain the benefits offered by the wetland such as biodiversity, climate regulation, water quality, recreation and, also, fish production. The financial support came from Operational Program Fishery, Axis 2 – Aquaculture, fishery in inland waters, processing and marketing of products from fishery and aquaculture, Measure 2.1 – Aquaculture, Action 2.1.4 – Measures for aquatic environment, Operation 2.1.4.1 – Environmental Protection; other project is funded by the Danube Competence Center under the Biodiversity and Tourism call for proposals, and, also, from the land owner's investments, that till then has improved its business, combining fishery, protecting the environment and practicing ecotourism.

Iezer pilot site, also located on the Romanian Lower Danube, within the former Danube floodplain in Calarasi County, is a relatively similar case. Here, much of the former mosaics of wetlands and natural channels, reed beds and patches of natural floodplain forest have been lost, but some remain, especially around the highly productive fish ponds. These ponds contribute considerably to the local economy, but, in the same time, to biodiversity conservation. According to WWF,

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http://greenly.ro/arii-protejate/reconstructia-ecologica-din-incinta-carasuhat-mahmudia; https://www.romaniapozitiva.ro/administratie/incep-lucrarile-de-reconstructie-ecologica-la-mahmudia/;https://old.wwf.ro/ce_facem/dunrea_i_delta_dunrii/proiecte_finalizate/mahmudia__prima_zon_umed_din_delta_dunrii_reconstruit_de_o_comunitate/ etc.

[8] https://www.worldwildlife.org/.

ecosystem services and their financial value from this area were in terms of: fish production (2750 euro/ha); biodiversity maintenance (hunting penalties) (50750 euro); carbon sequestration (reed, soil vegetation and trees) (6050 euro/year); biomass production (reed) (67150 Euro/year).

A successful demonstration of extensive fish ponds management in these pilots might have application for the many other fish ponds along the Lower Danube, in Romania as well as Bulgaria, Moldova and Ukraine, many of which are valuable wetland areas whose benefits extend far beyond fish production.

All the three case studies were presented as relevant examples for the Romanian local initiatives regarding ecosystem services and PES that explicitly target improving water services through actions related to trees in a COST project entitled "Payments for Ecosystem Services (Forest for water)" - PESFOR-W COST Action (CA15206) (2016-2020), covering 40 countries. Its main aim is "to synthesize knowledge, provide guidance and encourage collaborative research to improve Europe's capacity to use Payments for Ecosystem Services (PES) to achieve Water Framework Directive (WFD) targets & other policy objectives through incentives for planting woodlands to reduce agricultural diffuse pollution to watercourses"[9] . Table 5 contains synthetizes essential reference information regarding each case study.

Table 5. Romanian case studies on PES

IDENTIFICATION	SPECIFICATIONS		
	Case 1 *Ecological restoration of the land from the CARASUHAT agricultural polder, belonging to the public domain of Mahmudia village from Danube Delta*	**Case 2** *Iezer fishpond - pilot, Promoting Payments for Ecosystem Services and Sustainable Finance Mechanisms in the Danube Basin (Danube PES)*	**Case 3** *Ciocanesti fishponds - pilot, Promoting Payments for Ecosystem Services and Sustainable Finance Mechanisms in the Danube Basin (Danube PES)*
Name of catchment/s the case study drains to	Danube (DONAU) watershed	Danube (DONAU) watershed	Danube (DONAU) watershed
Programme/scheme	European Regional Development Fund (ERDF) and Cohesion Fund (CF) Operational programme for Romania for the period 2007-2013, entitled "Operational Programme Environment" (SOP ENV).	Promoting Payments for Ecosystem Services and Sustainable Finance Mechanisms in the Danube Basin (Danube PES) - The Danube PES Project	Promoting Payments for Ecosystem Services and Sustainable Finance Mechanisms in the Danube Basin (Danube PES) - The Danube PES Project, WWF Danube-Carpathian Programme
Organisations responsible for the programme/scheme	Ministry of Environment and Forests - MANAGING AUTHORITY	WWF (Danube-Carpathian Programme)	WWF (Danube-Carpathian Programme)
Organisation responsible for the case study	Local Council of Mahmudia; WWF Romania; The Administration of Danube Delta Biosphere Reservation	SC Piscicola SA Călărași (Iezer); WWF Romania	S.C. Ciocăneşti-Piscicola S.R.L.; WWF Romania
NUTS Code of broad region	RO2-MACROREGIUNEA DOI; RO41-Sud-Vest Oltenia; RO225-Tulcea	RO2-MACROREGIUNEA DOI; RO41-Sud-Vest Oltenia; RO312-Călăraşi	RO2-MACROREGIUNEA DOI; RO41-Sud-Vest Oltenia; RO312-Călăraşi
Name of municipality where the case study is located	Mahmudia commune, Tulcea county, Romania	Iezer fishponds, Calarasi county	Ciocanesti commune, Calarasi county
Establishment year	March, 2012	January, 2010	January, 2010
Duration (time horizon)	short term (< 5 years)	short term (< 5 years)	short term (< 5 years)

Source: authors' representation based on the COST questionnaire

[9] More, details regarding these case studies may be found on the following link: https://public.tableau.com/profile/rik.de.vreese#!/vizhome/SpatialRepository-PaymentsforEcosystemServicesForestsforWaterCOSTactionCA15206PESFOR-W/Spatialrepository.

Payments characteristics and structure

The description of our case studies was made according to the detailed presentation of each key design aspect from a study called “Forest and Water: Valuation and Payments for Forest Ecosystem Service” (UN, 2018).

All the three cases received EU funding. In the first case, the payment source was a public one. In the last two case studies, the payment source was a combined one, public and private. In all the cases, the duration (time horizon) was a short one (< 5 years), while the period of establishment was different. Closely analyzing these three, in the words of Leonardi (2015), “PES-like” case studies, acting in a rather complex institutional framework, we consider that all of them were voluntary without negotiation (fixed payments), but, in the case of schemes from Calarasi county, the negotiation was more present, but within a certain regulation framework.

All the three case studies may be considered to have a high extent of additionality as additional effects of the payments regarding the ecosystem service provisions were registered. Referring to the degree of directness, all the three cases may be characterized as less direct, although the last two cases may also improve (at least in time) its directness extent. In terms of degree of commoditization, in the first case, we met the payments for more environmentally-friendly practices, while, in the situation of the cases from Ciocanesti, we consider that the financial resources received by the providers of environmental services may be catalogued more as incentives that do not fully cover the opportunity costs of more ecofriendly actions and, also, markets as consolidated payment flows among services, beneficiaries and providers.

Conclusions

The synergies between forests and water management may positively contribute to the optimizing of their provided ecosystem services. Payments for ecosystem services schemes, in general, and payments for water services schemes, in particular, provide a mechanism for enhancing the services provided by forests.

PES may represent an efficient mechanism, especially in the absence of an enabling legislative framework or functioning local governance, but it is a concept not very common in the Romanian political or legal discourse and, also, not frequently put into practice in Romania. More, there is no explicit mention and no other terms/words/concepts used for defining Payments for Forest Water Services (W-PES) in the Romanian legislation, in the strategic documents or in the political discourse.

Our findings emphasized the important role that forests and investments in terms of their extension are able to play in relation to water. Moreover, in this paper, it was observed that human wellbeing is positively influenced by the economic wellbeing, by the national performance regarding greenhouse gases in terms of their sustainable coordination, by the share of forest area and, also, by the area of the land submitted to afforestation schemes, positively contributing to enhancing human wellbeing in Romania along the 2006-2016 period even in the conjuncture in which much progress was not registered in the levels of analyzed environmental indicators.

We also identified and generally described 3 local initiatives following the less strict definition of PES in order to understand the level of development of this kind of payments in the Romanian context. These represent shy attempts of putting into practice the PES and even less explicit orientation for improving water services through payments for actions related to trees, but they may represent starting points and have application for other cases, and, thus, promote the benefits of forestry payments for supporting water quality and supply and the necessary steps for obtaining them.

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References

Andréassian, V. (2004), Waters and forests: from historical controversy to scientific debate, *Journal of hydrology*, 291(1-2), pp. 1-27.

Ayres, R., Van den Berrgh, J. and Gowdy, J. (2001), Strong versus weak sustainability: Economics, natural sciences, and consilience, *Environ. Ethics*, 23, pp. 155–168.

Banerjee, S. B. (2003), Who sustains whose development? Sustainable development and the reinvention of nature, *Organ. Stud.*, 24, pp. 143–180.

Bastrup-Birk, A., Springgay, E., Kurnik, B. and Zal, N. (2018), Forest and Water Interactions (chapter 2), In: *Forests and Water: Valuation and Payments for Forest Ecosystem Service*, United Nations publication issued by the Economic Commission for Europe (ECE), pp. 4-13.

Bran, F., Rădulescu, C. V., Bodislav D. A. and Burlacu, S. (2019), The anthropic pressure on the forest space. Dysfunctions and risks in Romania, *Quality-Access to Success*, 20(S2), pp. 111-121.

Brogna, D., Vincke, C., Brostaux, Y., Soyeurt, H., Dufrêne, M. and Dendoncker, N. (2017), How does forest cover impact water flows and ecosystem services? Insights from “real-life” catchments in Wallonia (Belgium), *Ecological Indicators*, 72, pp. 675-685.

Burke, T. A., Cascio, W. E., Costa, D. L., Deener, K., Fontaine, T. D., Fulk, F. A., Jackson, L. E., Munns Jr, W. R., Orme-Zavaleta, J., Slimak, M. W. and Zartarian, V. G. (2017), Rethinking environmental protection: Meeting the challenges of a changing world, *Environ. Health Persp.*, 125, pp. A43–A49.

Costanza, R., Cumberland, J. H., Daly, H., Goodland, R., Norgaard, R. B., Kubiszewski, I. and Franco, C. (2015), *An Introduction to Ecological Economics*, London, UK: CRC Press, Taylor & Francis Group.

Dietz, S. and Neumayer, E. (2007), Weak and strong sustainability in the SEEA: Concepts and measurement, *Ecol. Econ*., 61, pp. 617–626.

Dunlap, R. E. and Scarce, R. (1991), Poll trends: Environmental problems and protection, *Public Opin. Q.*, 55(4), pp. 651–672.

European Commission (2020), *EU Biodiversity Strategy for 2030. Bringing nature back into our lives*, COM (2020) 380, Brussels: European Commission: DG Environment.

Ellison, D. N., Futter, M. and Bishop, K. (2012), On the forest cover–water yield debate: from demand- to supply-side thinking, *Glob. Change Biol.*, 18(3), pp. 806–820.

Ellison, D., Morris, C. E., Locatelli, B., Sheil, D., Cohen, J., Murdiyarso, D., Gutierrez, V., Van Noordwijk, M., Creed, I. F., Pokorny, J. and Gaveau, D. (2017), Trees, forests and water: Cool insights for a hot world, *Global Environmental Change*, 43, pp. 51-61.

European Commission (2009), *Ecosystem Goods and Services*, Publication Office, Environment.

Filoso, S., Bezerra, M. O., Weiss, K. C. and Palmer, M. A. (2017), Impacts of forest restoration on water yield: A systematic review, *PloS one*, 12(8), e0183210, pp. 1-26.

Grizzetti, B., C. Liquete, P. Antunes, L. Carvalho, N. Geamănă, R. Giucă, M. Leone, McConnell, S., Preda, E., Santos, R. and Turkelboom, F., (2016), Ecosystem services for water policy: insights across Europe, *Environmental Science & Policy*, 66, pp. 179-190.

Haddadin, M. J. (2001), Water scarcity impacts and potential conflicts in the MENA region. *Water Int.*, 26, 460–470.

Harvey, M. T. and Bell, P. A. (1995), The Moderating Effect of Threat on the Relationship Between Population Concern and Environmental Concern, *Pop. Environ. A J. Interdiscip. Stud*., 17(2), pp. 123–133.

Hediger, W. (2006), Weak and strong sustainability, environmental conservation and economic growth, *Nat. Res. Modeling*, 19(3), pp. 359–394.

Hesslerová, P., Pokorný, J., Brom, J. and Rejšková–Procházková, A. (2013), Daily dynamics of radiation surface temperature of different land cover types in a temperate cultural landscape: consequences for the local climate, *Ecol. Eng.*, 54, pp. 145–154.

Leonardi, A. (2015), *Characterizing governance and benefits of payments for watershed services in Europe*, University of Padova.

Leonardi, A. and Pettenella, D. (2018), Payments for Forest-Related Watershed Ecosystem Services (chapter 5), in *Forests and Water: Valuation and Payments for Forest Ecosystem Service*, United Nations publication issued by the Economic Commission for Europe (ECE), pp. 41-59.

Liu, Y., Xiao, J., Ju, W., Xu, K., Zhou, Y. and Zhao, Y. (2016), Recent trends in vegetation greenness in China significantly altered annual evapotranspiration and water yield, *Environ. Res. Lett.*, 11(9), 94010, pp. 1-14.

Lleras, C. (2005), Path Analysis, *Encyclopedia of Social Measurement*, 3, pp. 25-30.

McGuinness, J. L., Harrold, L. (1971), Reforestation influences on small watershed streamflow, *Water Resources Research*, 7(4), pp. 845–852.

Mihai, C. (2005), Nivelul capitalului natural și necesitatea conservării lui, *Analele Științifice ale Universității Alexandru Ioan Cuza din Iași*, *Științe Economice*, Tomul L/LI, Iași.

Mihai, C. and Hanganu, M. (2018), Particular aspects of consumer profile of the public goods generated in a region with extensive agricultural activities: the case of Dorna Valley area of Romania, *Reflecting on Europe's (Dis)Order: Scenarios for the EU's Future*, *Eurint 2018*, Alexandru Ioan Cuza University of Iasi, pp. 272-288.

Millennium Ecosystem Assessment (2005), *Ecosystems and Human Well-being: Synthesis*, Washington, USA: Island Press, DC.

Muradian, R., Corbera, E., Pascual, U., Kosoye, N. and May, P. H. (2010), Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services, *Ecological Economics*, 69(6), pp. 1202–1208.

Nisbet, T. R., Andreucci, M. B., De Vreese, R., Högbom, L., Kay, S., Kelly-Quinn, M., Lyubenova, M.I., Leonardi, A., Ovando, P., Quinteiro, P., Pérez Silos, I. and Valatin, G. (2020), *Forests for Water Services: A Step-by-Step Guide for Payment Schemes*, European Cooperation in Science & Technology - in course of publication.

Nisbet, T., Silgram, M., Shah, N., Morrow, K. and Broadmeadow, S. S. (2011), Woodland for water: Woodland measures for meeting water framework directive objectives, *Forest Research Monograph*, 4, Forest Research Surrey 156.

Rind, D., Goldberg, R., Hansen, J., Rosenzweig, C. and Ruedy, R. (1990), Potential evapotranspiration and the likelihood of future drought, *J. Geophys. Res. Atmos.*, 95(D7), pp. 9983–10004.

Robinson, J. (2004), Squaring the circle? Some thoughts on the idea of sustainable development, *Ecol. Econ.*, 48(4), pp. 369–384.

Rosculete, C. A., Rosculete, E. and Bonciu, E. (2019), The role of forests in the sustainable development of Romania, *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series*, 48(2), pp. 140-149.

Rubel, O. (2012), *Economic and Institutional Analysis of the Feasibility of Payments for Ecosystem Services in Ukrain*e, Geosoft EOOD Press.

Scott, D. F. and Lesch, W. (1997), Streamflow responses to afforestation with Eucalyptus grandis and Pinus patula and to felling in the Mokobulaan experimental catchments, South Africa, *Journal of Hydrology*, 199, pp. 360–377.

Shumacker, R. E. and Lomax, R. G. (2016), *A Beginner's Guide to Structural Equation Modelling*, New York, USA: Routledge.

Strange, T. and Bayley, A. (2008), *Sustainable Development: Linking Economy, Society, Environment*, Paris, France: OECD.

Sun, G. and Segura, C. (2013), Interactions of forests, climate, water resources, and humans in a changing environment: research needs, *British Journal of Environment & Climate Change*, 3(2), pp. 119-126.

Syktus, J. I. and McAlpine, C. A. (2016), More than carbon sequestration: biophysical climate benefits of restored savanna woodlands, *Sci. Rep.*, 6(1), 29194, pp. 1-11.

TEEB (2010), *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundation*, London and Washington: Earthscan.

Tudorachi, D. (coord.) (2015), Strategia naţională de dezvoltare a ecoturismului în România - context, viziune şi obiective - 2016-2020/Ecotourism Development National Strategy - context, vision and goals - 2016-2020, Bucharest, Romania: INCDT.

Ulman, S. R., Mihai, C. and Cautisanu, C. (2020), Peculiarities of the Relation between Human and Environmental Wellbeing in Different Stages of National Development, *Sustainability*, 12(19), 8106, pp. 1-26.

UN (2018), *Forests and Water: Valuation and Payments for Forest Ecosystem Service*, United Nations publication issued by the Economic Commission for Europe (ECE).

Wackernagel, M. and Rees, E. W. (1995), *In Our Ecological Footprint. Reducing Human Impact on the Earth*, Gabriola Island, Canada: New Society Publishers.

Wang, P. and Wolf, S. A. (2019), A targeted approach to payments for ecosystem services, *Global Ecology and Conservation*, 17, pp. 1-7.

Wolfle, L. M. (1977), An introduction to path analysis, *Multiple Linear Regression Viewpoints*, 8, pp. 36–61.

World Bank (2018), *Romania Water Diagnostic Report*, Washington, DC: World Bank.

Wunder, S., Engel, S. and Pagiola, S. (2008), Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries, *Ecological Economics*, 65(4), pp. 663–674.

van de Kerk, G.; Manuel, A. (2017), *A Sustainable Society Index-Your Compass to Sustainability*, The Netherlands: Sustainable Society Foundation. 2017 (retrieved from http://www.ssfindex.com).

Appendix

Appendix 1 . Standardized path coefficients

Predictor	Predictand	Estimate	Sig
Water_Exploit_Index	Ec_Wellbeing	-0.326	0.453
Greenhouse_gases	Ec_Wellbeing	14.489	**0.000**
Share_forest_area	Ec_Wellbeing	0.184	**0.001**
Area_afforest_schemes	Ec_Wellbeing	1.803	**0.019**
Ec_Wellbeing	Human_Wellbeing	3.706	**0.000**
Water_Exploit_Index	Human_Wellbeing	-0.121	0.453
Greenhouse_gases	Human_Wellbeing	5.370	**0.000**
Share_forest_area	Human_Wellbeing	0.068	**0.015**
Area_afforest_schemes	Human_Wellbeing	0.668	**0.049**
Share_forest_area	Water_Exploit_Index	0.259	0.191
Area_afforest_schemes	Water_Exploit_Index	-21.739	**0.000**
Water_Exploit_Index	Greenhouse_gases	-0.225	0.453
Share_forest_area	Greenhouse_gases	0.127	**0.000**
Area_afforest_schemes	Greenhouse_gases	1.245	**0.003**

Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0

Appendix 2. Direct and indirect effects among variables

DIRECT EFFECTS				
Predictor	**Mediator**	**Predictand**	**Estimate**	**Sig**
Ec_Wellbeing	-	Human_Wellbeing	3.706	**0.000**
Greenhouse_gases		Ec_Wellbeing	14.489	**0.000**
Share_forest_area		Water_Exploit_Index	2.585	0.191
Area_afforest_schemes		Water_Exploit_Index	-21.739	**0.000**
Water_Exploit_Index	-	Greenhouse_gases	0.000	0.453
Share_forest_area	-	Greenhouse_gases	0.022	**0.000**
Area_afforest_schemes	-	Greenhouse_gases	0.101	0.328
INDIRECT EFFECTS				
Water_Exploit_Index	Ec_Wellbeing	Human_Wellbeing	-0.121	0.453
Greenhouse_gases	Ec_Wellbeing	Human_Wellbeing	5.370	**0.000**
Share_forest_area	Ec_Wellbeing	Human_Wellbeing	0.068	**0.015**
Area_afforest_schemes	Water_Exploit_Index	Human_Wellbeing	0.668	**0.049**
Water_Exploit_Index	Greenhouse_gases	Ec_Wellbeing	-0.326	0.453
Share_forest_area	Greenhouse_gases	Ec_Wellbeing	0.184	**0.001**
Area_afforest_schemes	Water_Exploit_Index	Ec_Wellbeing	1.803	**0.019**
Share_forest_area	Water_Exploit_Index	Greenhouse_gases	0.006	0.515
Area_afforest_schemes	Water_Exploit_Index	Greenhouse_gases	0.489	0.457

Source: SSI, Eurostat and NIS databases, computed in StataMP 13.0