

Economic valuation of the ecosystem services and biodiversity conservation in the Codru forest in the developing country of the Republic of Moldova: application of the choice modelling technique in the Codru Quest project.

**Abstract:**

Economic valuation of ecosystem services is a useful scientific tool for supporting conservation and sustainable management of natural ecosystems and protected areas. For this reason, the Codru Quest project was conducted in the Codru forest and the Codru Nature Reserve within it to estimate and present the monetary value of benefits of the ecosystem services and biodiversity conservation in this forest and the protected area. The choice modelling technique was applied to survey 201 urban and rural citizens of Moldova and then to calculate their willingness to pay for better protection and sustainable management of the Codru forest ecosystem and its biodiversity. The results showed that the respondents were willing to pay (WTP) about 0.77 EUR per person per visit for conservation of greater insect biodiversity and approximately 0.87 EUR per person per visit for better protection of endangered species of both flora and fauna. This corresponds to a total WTP of 2688.19 EUR per year for the first attribute of the environmental "good" in question and 3027.92 EUR per year for the second one. These monetary estimates represent mainly the recreational, existence, bequest, and altruistic values that Moldovan citizens attach to ecosystem services and biodiversity in the study area.

**Keywords:**

Biodiversity conservation, choice modelling, Codru forest, Codru Nature Reserve, economic valuation, ecosystem services, environmental economics, forest ecosystem, stated preference technique, willingness to pay.

**1. Introduction**

Forest ecosystems are one of the ecosystem types that have the richest biodiversity. They are also one of the most rapidly degrading ecosystems due to human activities (European Environment Agency, 2016). Such activities include excessive land conversion, unsustainable natural resource management, logging, poaching, pollution, destruction of habitats, and other disturbances by human interventions. Some of the reasons of this damaging mismanagement of forest ecosystems is overestimation of short-term gains from direct use of natural resources in a forest and underestimation of long-term benefits of their conservation and sustainable management (ValuES, 2017). In other words, cutting as many trees as possible in a forest and selling wood on the market as soon as possible is usually seen as a better and more profitable option than conserving the forest, protecting its biodiversity, and managing its natural resources sustainably. This factor leads to the degradation of forests and decline in forest cover. For instance, in the developing country of Moldova, the share of forest cover has drastically declined, from approximately 60% of total land cover of the country to about 11-15% (Moldsilva, 2011).

The prioritization of short-term gains over long-term sustainable benefits in decision-making over forest resources can be explained by the fact that in most cases only market-based monetary value of forest ecosystems is accounted for (Hanley and Barbier, 2009). The value of other "services" provided by these ecosystems that people benefit from (soil formation, carbon sequestration, watershed protection, habitat and

biodiversity management, pollination, etc.) is very difficult to consider and use, as these “services” are not clearly seen and understood, are not traded on the market, and do not have prices to be compared with other priced forest uses. Hence, such non-market ecosystem services of forests are usually discarded from decision-making, which paints the wrong picture of unsustainable immediate use of forests being the most favourable and beneficial option. Generally, the failure to consider non-market gains, provided by key services of any ecosystem in current policy-making and natural-resource-management decisions, is one of the main reasons for the widespread disappearance of many ecosystems and habitats all over the Earth (Hanley and Barbier, 2009).

As a way to correct this imbalance of priorities in natural resource use and make non-market ecosystem services suitable for consideration in decision-making, the techniques of economic valuation of ecosystem services and biodiversity were developed. They represent a scientific tool for translating the services provided by natural ecosystems into monetary values that can then be used in cost-benefit analysis (CBA), land use planning, and environmental policy-making (Resende et al., 2015). Economic valuation techniques are able to estimate and present an entire spectrum of values of ecosystem services: direct use values (timber, non-timber products, recreation, etc.), indirect use values (pollination, nutrient cycling, soil formation, carbon sequestration, etc.), and even non-use values (pure existence of ecosystems, their benefits for future generations, their historical and cultural significance, etc.) (Table 1). This makes them invaluable in assessing and demonstrating how important and valuable ecosystem services can be, especially when no actual market for these services exists (OECD, 2006).

Table 1. Various values provided by forest ecosystems.

<b>Use values</b>		<b>Non-use values</b>
<b>Direct values</b>	<b>Indirect values</b>	<b>Existence, bequest, and altruistic values</b>
Timber	Nutrient retention and cycling	Existence of wild places and landscape
Non-timber forest products	Soil formation and retention	Existence of charismatic species
Firewood	Erosion control	Resources for future generations
Grazing	Pollination	Historical / cultural / religious heritage
Wild food products	Habitat for wildlife species	
Medicinal resources	Catchment protection	
Genetic materials	Micro-climate regulation	
Tourism and recreation	Carbon sequestration	
Scientific research	Waste treatment	
Educational opportunities		

Source: Adapted from Hanley and Barbier (2009).

One category of economic valuation techniques, the stated preference (SP), is especially effective in eliciting non-use values of ecosystem services. This is an important strength of the SP category, as non-use values can be high enough to change the result of a CBA, decision, or policy in favour of nature conservation.

The SP techniques are comprised of a number of methods. These methods rely on the researcher directly asking people about their willingness-to-pay (or willingness-to-accept compensation) for changes in the provision and quality of ecosystem services and biodiversity (Hanley and Barbier, 2009). This can be achieved by creating hypothetical markets for environmental “goods” in question and using interviews and surveys to infer the respondents’ willingness to pay (WTP) or willingness to accept compensation (WTA) (Carson, 2000).

Among the variety of the SP techniques, choice modelling (CM), also known as conjoint analysis and conjoint choice analysis, has recently started to receive much attention from researchers and practitioners in Environmental Economics. The CM technique relies on the characteristics theory of value, which implies that the value of any ecosystem service can be defined according to a range of distinctive characteristics (attributes) that can be represented in a variety of levels (Hanley and Barbier, 2009). A researcher using the technique offers a selected group of respondents to complete specially constructed questionnaires with a series of scenarios. Each scenario varies in the levels of attributes of the target ecosystem service, producing a somewhat different environmental “good” to value. By choosing the preferred scenarios and their associated payment option (visitor price, increase in local tax, voluntary donation, etc.), the respondents communicate their WTP not only for the target ecosystem service as a whole, but also for each of its attributes. This, along with elicitation of non-use values and consistency with welfare economic theory, makes CM technique an increasingly preferred valuation option for ecosystem services and biodiversity conservation (OECD, 2006).

Due to increasing popularity of the SP techniques, especially the CM, a good number of reliable economic valuation studies exists (for instance, Bennett et al., 2004; Costanza, 2000; De Groot et al., 2012; Rolfe et al., 2004). Unfortunately, in this body of studies, comparatively little research was done in developing countries (Resende et al., 2015). However, it is the developing countries that depend on natural resources and ecosystem services the most and at the same time suffer the most from their degradation and depletion. The Republic of Moldova is one example of this. There is only a couple of studies on the value of ecosystem services and biodiversity conservation in this country, and even fewer that explicitly use economic valuation techniques to elicit indirect use and non-use values of these environmental “goods” (for example, BIOTICA, 2016; Popa et al., 2014; Transilvania University of Brasov, 2015). The research project “The Codru Quest” implemented by Iscenco et al. (2017a) in 2016 – 2017 became the first case of applying the CM technique to valuing forest ecosystem services and biodiversity conservation in Moldova (MEGA, 2017a).

The project “The Codru Quest: Economic Valuation of the Ecosystem Services of the Codru Protected Area” was a scientific research initiative of the organization Moldovan Environmental Governance Academy (MEGA) on the economic valuation of ecosystem services and biodiversity in the Codru forest and the protected area of the Codru Nature Reserve within it in the Republic of Moldova. The main goal of the project was to apply the CM technique in this developing country to estimate and

present the indirect use and non-use economic values of ecosystem services and biodiversity conservation in the above-mentioned forest and the protected area (The Rufford Foundation, 2017). The Codru Quest was designed to answer a number of research questions, namely:

1. How do Moldovan citizens perceive such environmental non-market "goods", as ecosystem services and biodiversity in the Codru forest? Specifically, how much do they value environmental benefits, especially those unrelated to direct use of natural resources, coming from the forest and the protected area within it?
2. Considering the economic value of the ecosystem services provided by the Codru forest and the Codru Nature Reserve, how much are people willing to pay annually to conserve ecosystems and biodiversity there?
3. How do Moldovan citizens benefit from forest ecosystem services and biodiversity? What is their attitude towards their conservation? Finally, how do these benefits and attitudes in combination with socio-economic characteristics influence people's willingness to pay for better nature conservation?

The outcomes of the project and the answers to its research questions were summarized in the publication "The Codru Quest: Final Report" (Iscenco et al., 2017a). In addition, a methodological guidebook entitled "The Codru Quest: Methodology" that comprehensively described the application of the CM technique in the project, was released (Iscenco et al., 2017b). The present article draws upon the main results and conclusions from these two publications.

The article is structured as follows. Chapter 2 describes the study area of the research project, outlines the problem with conservation of ecosystem services and biodiversity in this area and the goal of the project, as well as presents the authors' assumptions related to the problem and the research. Chapter 3 introduces the CM technique used for the research work, explains how the target population sampling was done, lists the surveying methods applied, and mentions how econometric model was chosen and applied to obtain the WTP estimates. Chapter 4 describes the results of the Codru Quest project and provides answers to the research questions stated above, including WTP for ecosystem services, biodiversity, their conservation, and the influence of socio-economic characteristics of the respondents on the resulting WTP. Chapter 5 presents a brief discussion on the outputs of the research, their relation to the conservation of ecosystems and biodiversity in the study area, and the challenges and limitations of the project that may have affected these outputs. The article concludes with some remarks on the overall research work done within the Codru Quest project, acknowledgments of the partners and sponsors, who supported the project, and a list of references used.

## **2. Aim of the research**

### **2.1. Study area**

The area chosen for the economic valuation research in the project was the Codru forest and the Codru Nature Reserve within it. They are located in the central part of the Republic of Moldova, specifically on the intersection of the Straseni, Hincesti, and Ialoveni regions, at a distance of 49 km from the capital city Chisinau (Figure 1).

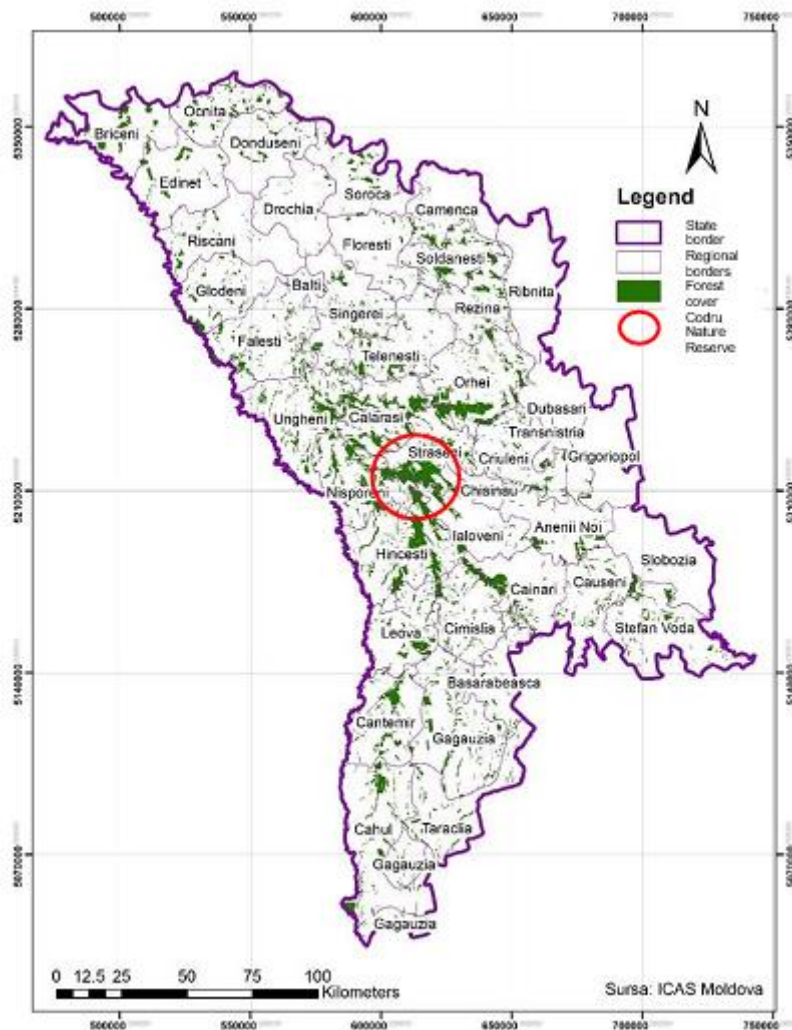


Figure 1. Map of the Republic of Moldova with the location of the Codru forest and the Codru Nature Reserve. Source: Adapted from Transilvania University of Brasov, 2015.

The Codru forest is one of the remnants of a once vast forest covering more than half of the country's land. It is mainly an oak forest, with oak trees occupying about 49% of its territory. The other tree species present in this forest ecosystem are ash, hornbeam, beech, maple, and poplar (Moldsilva, 2017).

The biodiversity of the Codru forest includes more than 1 000 species of protected plants, representing half of Moldova's flora; 43 species of mammals; 145 species of birds; 7 species of reptiles; 10 species of fish; and over 8 000 species of insects. It is also the habitat for a number of species, which are included in the Red Book of Moldova as vulnerable, endangered, and critically endangered for the country (Ministry of Environment of Moldova, 2015). Some of these species, such as the longhorn beetles *Morimus funereus* and *Rosalia alpina*, are even featured in the IUCN Red List of Threatened Species as vulnerable (IUCN, 2018).

Two examples of the endangered species used in the Codru Quest research were the plant small-flowered black hawthorn (*Crataegus pentagyna*) and the insect stag beetle (*Lucanus cervus*). The authors included these species into the valuation

scenario described in CM surveys as proxies for the overall biodiversity of the Codru forest. This was done due to these species being easily identifiable, familiar to Moldovan citizens, symbolic for the flora and fauna of Moldova, and endangered and critically endangered for the country. At the same time, the populations of the black hawthorn and the stag beetle are in decline in Moldova and all over Europe (Harvey et al., 2011).

The Codru Nature Reserve is one of the nationally protected territories in Moldova that covers approximately 5175.8 ha of the Codru forest. It is the oldest protected area in the country, established back in 1971, when Moldova was part of the former Soviet Union. Nowadays the state agency Moldsilva administers the area (Moldsilva, 2017).

The Codru Nature Reserve includes 720 ha of strictly protected zone and 4455.8 ha of buffer zone. Visitors can enter the former only for official research and nature conservation activities, while the latter is accessible for people under the permission of the Reserve's administration (Moldsilva, 2017). Approximately 123000 ha of transition zone surround the strictly protected and buffer zones. In the former all activities are allowed with the condition that they do not cause any damage the Codru forest ecosystem. Besides having been created for scientific research and nature conservation purposes, the protected area also offers certain recreational and touristic value. Visitors can access the transition and buffer zone and go on excursions in the Codru forest for free. Only visits to the Museum of Nature situated in the administration building near the forest have a visitor price of 20 Moldovan lei (MDL) (1 EUR) for adults, 10 MDL (0.5 EUR) for students, and 100 MDL (5 EUR) for a guided walk. Generally, there are about 3500 tourists visiting the Codru Nature Reserve annually. In 2016, for instance (the most recent available data), 2630 visitors were registered coming to the protected area (Iscenco et al., 2017a).

## 2.2. Problem

In spite of the natural value and national importance of the Codru forest and the Reserve within it, the ecosystems and biodiversity there are threatened by damaging human interventions. One of these interventions is the unsustainable logging resulting in the increasing rate of deforestation. In 2014, for instance, the governing agency Moldsilva permitted the cutting of trees and sales of timber for a volume of 2487 m<sup>3</sup>. In 2015, the volume of timber extracted from the forest and sold on the market doubled, reaching 4579 m<sup>3</sup> (CrimeMoldova, 2016). There are also about 800 – 1000 cases of illegal logging in the Codru forest and the protected area registered by rangers and the local police every year (Ecology.md, 2015). However, many cases of illegal logging remain undetected and/or unprosecuted. In addition, the amount of damage done to the forest ecosystem is either unknown or not communicated publicly (CrimeMoldova, 2016).

Besides deforestation, the Codru forest ecosystem and biodiversity suffer from poaching, collection of vulnerable and endangered plant species, disturbance by visitors going on recreation to the forest, and solid waste pollution left by people there. The mitigation of these issues is hindered by prioritization of direct use of land and natural resources of the forest and immediate profits from selling them, insufficiency of financial resources and rangers for proper control, protection, and management of the forest, challenging socio-economic situation in the region, and extensive state-level corruption. All this leads to overconsumption of natural resources, degradation

of ecosystem services, and loss of biodiversity and habitats in the Codru forest (CrimeMoldova, 2016).

### 2.3. Goal and assumptions

The Codru Quest project was designed to contribute to resolving the above-mentioned problem through scientific perspective. The goal of the project was to estimate and present the indirect use and non-use economic values of ecosystem services and biodiversity conservation in the Codru forest and the Codru Nature Reserve.

It was envisioned that achievement of this goal would contribute to understanding of how Moldovan citizens perceive these non-market environmental "goods". It would also shed some light on how much people value environmental benefits coming from the forest and the protected area when they are conserved and managed sustainably. Such understanding could help project stakeholders, concerned about the problem, to raise awareness and organize educational campaigns on the importance of forest ecosystem services and biodiversity. This in turn could raise concern of other Moldovan citizens and local communities and engage them in nature conservation and lobbying for sustainable management of the Codru forest.

Besides all the above, having monetary representation of indirect use and non-use values of ecosystem services in the Codru forest and the Reserve could help concerned stakeholders and decision-makers to integrate these values into the protected area management strategies, land use plans, cost-benefit analyses (CBA), and policies on natural resource use. Such use of the research outputs could balance direct-use, short-term gains from unsustainable scenarios with extra "weight" given to scenarios of long-term benefits achieved due to nature conservation and sustainable management of the Codru forest and the Reserve.

## 3. Methodology

### 3.1. Choice modelling technique

The choice modelling (CM) / conjoint analysis / conjoint choice analysis technique is one of methods of economic valuation of ecosystem services and biodiversity. It is able to elicit indirect use and non-use values of these non-market environmental "goods". Moreover, it can do so for not only the ecosystem services and biodiversity as a whole, but also for specific characteristics (attributes) and changes in their quality and provisioning. This is why the CM technique (specifically its choice experiments variation) was chosen as the most appropriate methodological option for achieving the goal of the Codru Quest project and answering its research questions.

The CM technique comes from the "family" of the stated preference (SP) techniques. The latter uses carefully constructed interviews and surveys to ask respondents for their willingness to pay (WTP) for improvements in the quality and provisioning of an environmental "good" or their willingness to accept compensation (WTA) in the case of diminishing quality and reduced supply of that "good" (Hanley and Barbier, 2009). Alternatively, interviews and surveys can offer the respondents to choose their preferences among different hypothetical scenarios with changes in quality and provisioning the environmental "good". These preference choices then allow researchers to infer the respondents' WTP or WTA. Mentioning of a payment vehicle attribute (visitor price, increase in local tax, voluntary donations, etc.), which

represents the measure of wellbeing of the respondents in the interview or survey, enables the estimation of WTP or WTA for the "good" as a whole, as well as for each of its attributes. This is precisely what the CM technique is all about: asking the respondents to choose their most preferred scenario from several choice sets with different scenarios, one of which is the "do nothing" / status quo / baseline scenario that represents the current situation, and then estimating WTP / WTA from the respondents' choices in each choice set (Bateman, 2002).

Using the CM technique to measure individuals' preferences can give estimates on how much certain ecosystem services and attributes of biodiversity conservation, for example, in a forest, are worth to these individuals and the entire society. This advantage can help to determine what characteristics of a certain project or policy are significant based on people's values for the changes in quality and provisioning of ecosystem services they can potentially bring. In addition, the estimates of people's values and preferences obtained through the CM technique are reliable in terms of being consistent with the welfare economic theory (Pearce et al., 2002).

Certainly, as all other economic valuation methods, the CM technique has its disadvantages. For instance, the welfare value estimates obtained with this technique are very sensitive to the design of the surveys and the entire research process, chosen attributes and their levels, and framing of the valuation scenario presented to the respondents via interviews or questionnaires. The cognitive burden on the respondents due to complex structure of CM surveys with a number of choice sets and multiple scenarios to choose from also affects the precision and quality of WTP / WTA estimates (OECD, 2006). These and other challenges that the research process had met were mitigated as much as possible within the limits of the Codru Quest project. Further comes the description of the steps taken to implement the CM technique and obtain the WTP estimates for ecosystem services and biodiversity conservation in the Codru forest and the Codru Nature Reserve.

### 3.2. Target population sampling

To apply the CM technique and estimate WTP for ecosystem services and biodiversity conservation in the study area, the project included off-line interviews with Moldovan citizens residing around the Codru forest and relatively close to the protected area within it, as well as on-line surveys with residents of the capital city Chisinau. The first target group was important, as it represented direct users of natural resources and ecosystem services of the forest. The direct users are dependent on the quality and provisioning of ecosystem services for their livelihood and wellbeing. The second group was included in the surveying process to account for respondents, who might not be users of the Codru forest, but who still might care about its existence and conservation, thus having use and non-use values attached to the environmental "good" in question.

For determining the target population sample size for surveying, the probability sampling, specifically the simple random sampling method, was used. It gives every element of the sample frame an equal chance to be included into the target population sample. The method has several advantages, including that it is very simple to use and that it satisfies the statistical theory requirements for deriving the properties of sample estimators (Pearce et al., 2002).



Our calculations resulted in the target population sample size of 384 respondents. However, only 301 respondent was actually surveyed: 100 respondents during the survey-testing phase of the research to pre-test and adjust the design of the CM questionnaire and 201 people during the final surveying phase. This under-representation of the target sample was the consequence of time and budget constraints of the Codru Quest project. Nevertheless, this limitation was compensated to a certain extent by eliciting additional relevant information about WTP and attitudes towards the environmental “good” in question from each surveyed respondent.

The final sample size of 201 respondents was split into two groups: 101 rural residents from the nine villages situated around the Codru forest (Lozova, Stejareni, Capriana, Micleuseni, Huzun, Horodca, Bursuc, Dragusenii Noi, and Condrita) and 100 urban residents from Chisinau.

### 3.3. Surveying methods

The surveying of the respondents from the target population sample was done by two methods: on-line / e-mail survey and computer-assisted personal interviews (CAPI). The first method was applied for the group of 100 urban residents and the second one for the sample of 101 rural respondents from the nine target villages near the Codru forest. Due to limitations in time, different interviewers surveyed these two groups: the authors focused mainly on the citizens of Chisinau, while for interviewing the residents of the villages a marketing research company was employed.

The sample of Chisinau respondents was surveyed by contacting them via e-mail or social networks, inviting them to take part in the survey, and then providing them with the link to the on-line questionnaire. This method was used with the urban residents based on the assumption that they have access to information technology and internet connection and that they are used to on-line questionnaires. Individual respondents in this group were selected haphazardly, without considering any specific socio-economic characteristic. The respondents' contacts were obtained from public databases and the ones of partner organizations.

The contracted marketing research company interviewed the respondents from the rural area in their households. It employed the CAPI method because the dominant majority of village residents did not have access to internet, or even to a computer. Therefore, on-line surveys would not work in the villagers' case. The company did all the interviews by sending its interviewers to the target village, who then visited households and conducted face-to-face interviews that lasted about twenty minutes. During that time, every interviewer had access to the CM questionnaire via tablet computer connected to internet. The number of respondents to be surveyed in every village was calculated from the population of that village.

While conducting CAPI in the villages, the company's interviewers applied the “last birthday” criterion to select the specific respondent to interview from each household. This criterion determined the actual respondent as the person, who had been the last one in the household to celebrate his/her birthday. If that person was not present during the first visit to the household, the interviewers still tried to reach him/her by coming back some other time or the other day. This selection approach ensured that there was no dominance of any particular category of respondents, who stay in a

household longer than its other members, for example, unemployed, retired people, mothers with children, etc. (Magenta Consulting, 2017).

The main surveying process within the Codru Quest project had lasted for about 2.5 weeks. Before that, for about a month, a testing phase took place in order to prepare, test, iterate, and test again the CM survey design. This phase included discussions in small focus groups, consultations with a specialist from the Codru Nature Reserve, and finally on-line testing with a sample of 100 respondents. When the feedback from these first respondents was analysed and the final survey design was elaborated, the earlier test versions of the questionnaire were discarded.

### 3.4. Survey design

The final design of the CM survey within the Codru Quest project was structured as follows. In the first section, the respondents were asked about their basic demographical characteristics. These included age, gender, marital status, place of origin, highest education level, main occupation, and involvement in any environmental organization. The survey also inquired whether the respondents had visited the Codru forest and the Reserve in the last two years (Table 2). The survey began with these simple questions, so that the respondents could answer them quickly and could immediately get into the “flow” of completing the survey.

Table 2. Categorical variables related to socio-economic characteristics of the respondents in the Codru Quest project.

#	Variable	Unit	Options used
1	Gender	1	Male
		2	Female
2	Marital status	1	Not married
		2	Married
		3	Living in a relationship
		4	Separated or divorced
3	Residence (place of origin)	1	In a city
		2	On the outskirts of a city
		3	In a village
4		1	Highest education level
		2	Primary school (classes 1 – 9)
		3	Secondary school (classes 10 – 12)
		4	University, Bachelor degree
		5	University, Master degree
5	Main occupation (employment)	1	Not working (unemployed, on leave, pensioner, etc.)
		2	Working at home / freelancer
		3	Salaried worker
		4	Pupil / student
		5	Independent farmer
6	Involvement in an environmental organization	1	Yes
		2	No
		3	Don't know
7	Previous visits to the Codru forest and the	1	Yes
		2	No

	Codru Nature Reserve (users vs. non-users)	3	Don't know
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Source: Adapted from MEGA, 2017b.

Then the focus of the CM survey design shifted to the attitudinal questions and the ones about the respondents' use of the Codru forest and the Reserve. In the following sections, the respondents provided their information on their level of interest in environment protection in general, their attitude towards protected areas and forests in the country, frequency of visits to the Codru forest, activities done during these visits, and distance they need to travel to reach the forest. This information helped to separate direct users of the target environmental "good" from non-users. Additionally, the respondents were asked about the availability of a substitute "good", such as another forest, besides Codru, that they could visit (MEGA, 2017b).

The next section of the CM survey presented the respondents the valuation scenario. The latter was constructed based on data about the current situation in the Codru forest and the Reserve in relation to their use and conservation. The sources of these data were literature reviews, three expeditions to the forest, consultations with the protected area administration and local guide, and interactions with the local community. Then, the valuation scenario featured the description of the status quo / baseline scenario with the present area of the Codru Nature Reserve, some statistical information about the biodiversity of flora and fauna in it, and the presence of endangered species in the Codru forest and the protected area. For visualizing the last attribute, two biodiversity proxies were used: small-flowered black hawthorn and stag beetle.

After familiarizing the respondents with the status quo, the hypothetical "market" and alternative scenarios were presented to the respondents. The scenarios described possible improvements in the provisioning and quality of ecosystem services and biodiversity conservation in the Codru forest and the Reserve as outcomes and impacts of the implementation of a hypothetical development plan. It was stated that the Ministry of Environment of Moldova, the responsible state agency Moldsilva, and the Codru Nature Reserve administration would prepare and implement the plan based on the respondents' choices collected through the CM survey. Key activities of the hypothetical plan would include enlargement of the territory of the protected area through possible annexing of additional forest areas near the Capriana village, as well as through reforestation and other nature conservation activities. These activities would be financed via the visitor price mechanism. It means that each visitor coming to the Codru Nature Reserve would have to pay a certain price to the protected area in order to enter its buffer zone and benefit from its ecosystem services. This was the payment vehicle of the valuation scenario. In the following choice sets, the respondents had to choose the scenarios with the most attractive attributes to them and the visitor price, which they would be willing to pay for each visit to the Codru forest and the protected area (Figure 2).

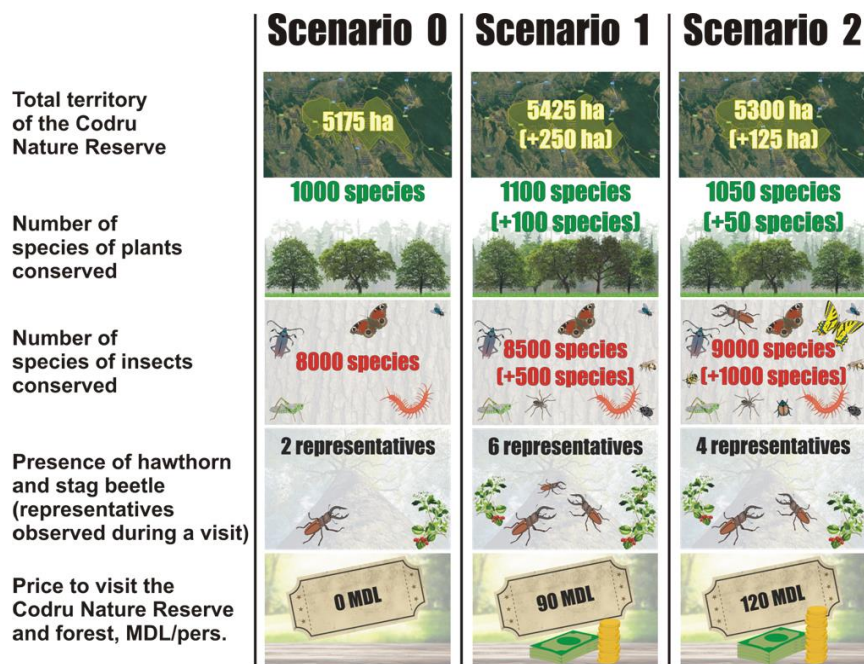


Figure 2. Example of a choice set from the Codru Quest survey with the status quo option (Scenario 0), alternative scenarios (Scenario 1 and 2), their attributes, and the visitor price for each option. Source: MEGA, 2017b.

The valuation scenario was followed by six choice sets. Each set contained three alternative scenarios of different quality and provisioning of ecosystem services and biodiversity conservation in the Codru forest and the Reserve. The first scenario in all choice sets was always the status quo. The rest of them featured four attributes of the target environmental “good”, the payment vehicle, and changes in their levels between different choice sets (Table 3). The number of choice sets and the distribution of changes in attribute levels in each set were decided with the help of fractional factorial design and statistical software.

Table 3. Attributes of ecosystem services and biodiversity conservation in the Codru forest and the Codru Nature Reserve and their levels presented in the CM survey of the Codru Quest project.

#	Attribute	Number of Levels	Values of Levels
1	Total territory of the Codru Nature Reserve, ha	3	5175; 5300; 5425
2	Number of species of plants conserved	3	1000; 1050; 1100
3	Number of species of insects conserved	3	8000; 8500; 9000
4	Presence of symbolic species: small-flowered black hawthorn and stag beetle (representatives observed during a visit)	3	2; 4; 6
5	Price to visit the Codru Nature Reserve and the Codru forest, MDL	5	0; 30; 60; 90; 120

Source: Iscenco et al., 2017a.

After the respondents indicated their preferences in every choice set, a series of follow-up questions were offered to them. These were designed to determine the

relevance, credibility, and realism of the visitor price as the selected payment vehicle; the respondents' attitude towards the concept of paying for ecosystem services; and their rationale behind the chosen alternative scenarios and the associated WTP. The respondents' answers to the follow-up questions were also used to identify free-riding (the respondent believed that he/she would not be paying for the good) and protesting (the respondent believed that someone else should pay for the good) behaviour among them. The respondents with such behavioural signs were then removed from the final sample (MEGA, 2017b).

The last sections of the CM survey asked the respondents to mark the income category most appropriate to them personally and their households, as well as offered space to write optional comments and feedback for us. The latter was a very useful addition to the survey design, as it allowed gathering valuable inputs on the socio-economic situation of the respondents, the attitude towards state authorities managing natural resources in the country, the level of people's trust towards them, and the influence of these factors on the respondents' preferences. In turn, these inputs helped to estimate and explain the mean WTP for each of the attributes of the target environmental "good".

### 3.5. Validity of responses

Before proceeding to the estimation of the respondents' WTP for ecosystem services and biodiversity conservation in the Codru forest and the Reserve, all the survey answers in the sample were analysed and non-valid answers were identified. In the total sample of 201 respondents surveyed, the responses of 24 (12%) of them were considered non-valid. The main reasons behind this decision were free-riding and protesting behaviour identified. Such behaviour is not related to the respondents' welfare change and therefore introduces bias in the research results. After removing these non-valid entries, the sample size reduced to 177 respondents in total, among which 87 were from the target villages and 90 from the city Chisinau.

Unfortunately, later in the analysis of the respondents' data, there was a need to reduce the operational sample size even more. The issue was the obvious inconsistencies in the datasets, especially the one with urban residents. This was discovered by connecting socio-economic characteristics of the respondents (Table 2) to their expressed preferences. The inconsistencies were related to the consequentiality of the payment vehicle and the resulting strategic behaviour of the respondents. Specifically, the residents of Chisinau, who were not using the Codru forest and the Reserve directly, displayed strong strategic behaviour by having positive responses to an increase in visitor price. Such behaviour was clearly in conflict with the underlying welfare economic theory. Therefore, to preserve the validity of the research results, the respondents with signs of this strategic behaviour were removed from the final datasets. Only the ones, who had truly used the forest and the protected area in the last two years and who expressed preferences consistent with the economic theory, remained. As a result, the authors ended up with the operational sample size of only 107 respondents.

Such drastic reduction of the sample size (only 53% from the entire number of respondents surveyed were left in the datasets) was an undesirable, but necessary thing to do, as it gave the final datasets with only valid responses that are consistent with the welfare economic theory. In addition, the proportion of city residents to village inhabitants (62% to 38% respectively) became aligned with the real share of

urban to rural residents in the national population of Moldova (57.47% to 42.7% respectively) (National Bureau of Statistics of the Republic of Moldova, 2017). With such final valid sample, the mean WTP for the target environmental “good” and its attributes could be estimated and then aggregated to the target population sample size without the use of weights to account for real distribution of urban and rural respondents in the sample (Iscenco et al., 2017a).

### 3.6. Econometric model

To estimate WTP for ecosystem services and biodiversity in the Codru forest and the Reserve from the final dataset with 107 respondents, as well as to understand the effect of socio-economic variables on people's choices in relation to the Codru forest conservation scenarios, the logit (logistic probability unit) model was used. It is a statistical regression, which is designed to examine discrete choices and which is based on the cumulative logistic function. The logit model fits especially well in the analysis involving binary choice cases, where the dependent variable can assume only two values. In the Codru Quest case, this dependent variable was related to the respondents' WTP for the target environmental „good”, such that it can take the value of 1 (the person is willing to pay, i.e.,  $WTP > 0$ ) or 0 (the person is not willing to pay, i.e.,  $WTP = 0$ ). In addition, the model is a convenient analytical tool in that it performs well in approximating the normal distribution of the error term in the regression and that the integral for the probability has a closed form (Resende et al., 2015).

While choosing the most appropriate regression for the Codru Quest data analysis among the variations of the logit model, the authors experimented with conditional logit and mixed logit. Ultimately, the choice was made in favour of the mixed logit model, because in the Codru Quest survey design the attribute levels of in the status quo scenario had not been incorporated into any of the alternative scenarios. Due to this fact, it was impossible to include more than one level for each attribute in the regression. In turn, this did not allowed doing the testing on the hypothesis of independence of irrelevant alternatives (IIA), which is crucial for the conditional logit estimates to be valid. The mixed logit model, unlike the conditional logit, does not strictly depend on the IIA hypothesis. In addition, the mixed logit model takes into account the fact that people with different socio-economic background view the same environmental „goods” differently (Pearce et al., 2002). This was a realistic and relevant consideration for the Codru Quest data with two very different groups of respondents: one from the urban environment, and another one from the rural setting.

However, even in using the mixed logit model to estimate the respondents' WTP, an issue appeared. It was related to the inconsistencies in the datasets and the consequentiality of the payment vehicle. As it has been mentioned earlier, there was an attempt to deal with the issue by connecting the mixed logit estimates to the socio-economic characteristics of the respondents to see how the latter affects the respondents' preferences and valuations, and then by removing the entries with observed strategic behaviour. This move revealed significant differences in preferences between the residents of urban and rural areas. To deal with such large heterogeneity between the two groups, the method described in Kragt and Bennet (2011) was applied. There, the authors had to deal with similar heterogeneity in individual preferences in a CM study in Tasmania. The method involved the inclusion of interaction terms on the choice variables and the censored normal distribution on visitor price to capture systematic heterogeneity between city and village residents. After applying it to the Codru Quest data, the significance levels of the interaction

terms had changed. Specifically, the interaction terms of all attributes except visitor price became significant and positive. This translated into consistently lower WTP estimates for the respondents from the target villages compared to the ones from Chisinau. In relation to the visitor price interaction term, the assumption was that its insignificance had been the result of the model already capturing the heterogeneity in the target groups.

The mixed logit model uses the maximum likelihood procedures for estimation. It is a method for calculating parameters of observations in a statistical model by finding the parameter values that maximize the likelihood of making the observations given the parameters. Estimation by the maximum likelihood procedures can be done with the help of a statistical software. The open-source software R was used for econometric analysis of the Codru Quest data.

The estimations resulted in the mean WTP values of the respondents' utility change affected by the changes in the attributes of the target environmental "good" from their current level (status quo) to some different level (the levels of the alternative scenarios), as well as the 95% confidence intervals on these values. The mean WTP was then aggregated to the target population of direct users of the Codru forest and the Reserve. The users were the people, who actually visited the forest and the protected area at least once in the last two years. Certainly, in doing so, many non-users among Moldovan citizens, who might still have existence, bequest, and altruistic values attached to the target environmental "good", were excluded. The approximate population number for aggregation, 3500 visitors per year, was obtained from the background research on the yearly number of visitors to the Codru Nature Reserve, as well as from consultations with a specialist from the protected area.

## 4. Results

### 4.1. Profile of respondents

Socio-economic characteristics of the respondents affect their expressed preferences and the magnitude of WTP for the environmental "good" in question. Therefore, it is important to present the socio-economic profile of the respondents surveyed in the Codru Quest project (Table 4).

Table 4. Socio-economic characteristics of the respondents in the Codru Quest project.

#	Variable	From city	From villages	All respondents	All respondents, %
1	Gender				
	Male	39	41	80	39.8
	Female	61	60	121	60.2
2	Marital status				
	Not married	65	14	79	39.3
	Married	6	76	82	40.8
	Living in a relationship	26	1	27	13.4
	Separated or divorced	2	2	4	2.0
	Other	1	8	9	4.5

3	Residence (place of origin)				
	In a city	78	7	79	39.3
	On the outskirts of a city	8	0	8	4.0
	In a village	14	100	114	56.7
4	Highest education level				
	Primary school (classes 1 – 9)	3	32	35	17.4
	Secondary school (classes 10 – 12)	45	23	68	33.8
	University, Bachelor degree	34	14	48	23.9
	University, Master degree	13	2	15	7.5
	Other	5	30	35	17.4
5	Main occupation (employment)				
	Not working / unemployed	3	45	48	23.9
	Working at home / freelancer	8	6	14	7.0
	Salaried worker	30	33	63	31.3
	Pupil / student	59	4	63	31.3
	Independent farmer	0	13	13	6.5
6	Involvement in an environmental organization				
	Yes	30	2	32	15.9
	No	67	99	166	82.6
	Don't know	3	0	3	1.5
7	Previous visits to the Codru forest and the Codru Nature Reserve (users vs. non-users)				
	Yes	53	73	126	62.7
	No	47	28	75	37.3

Source: Adapted from MEGA, 2017b.

Among all the respondents, the majority (57%) were from rural environment, while the others (43%) came from urban setting. This redistribution happened, because a share (14%) of Chisinau residents, in spite of living and studying or working in the city, was originally from a village.

In terms of gender of the respondents, most of them were women: 60% share of women in the sample against 40% share of men. Such distribution maintained also in each separate group of respondents: from the city Chisinau and from the nine villages around the Codru forest.

The average age in the sample was 20 – 30 years. Most of the urban residents were young, while the majority of rural residents were older than the average age.

The most notable differences between the two groups of respondents can be observed in relation to the marital status, education level, and employment situation. Overall, the shares of married and unmarried respondents were practically equal. However, while Chisinau residents were mostly unmarried (65%), the ones living in



villages were already married in their majority (76%). This can be correlated with the dominant average and median age in each group, as well as the prevalent level of education and employment situation. In the sample of the respondents surveyed in Chisinau, most of them (59%) were still studying in either a secondary school or university. In the sample of surveyed villagers, the situation was the opposite: almost all of them had graduated from primary or secondary school (only very few of them, 14%, completed university education), and were engaged in either salaried work or farming, or were unemployed for various reasons.

Besides studying or working, many (30%) respondents from Chisinau indicated that they were also involved into volunteering for an environmental organization or into supporting it. In comparison to them, practically none of the village residents was connected to any organization in the field of environment. This may explain certain share of entries with strategic behaviour observed in the database of the city residents.

With regard to the respondents' income level, among the ones, who agreed to share their personal and household income, the large majority (72%) was earning less than 3 000 MDL (approximately 140 EUR) per month. While this amount was representative for the city residents, it was much lower for the respondents coming from the rural environment: only 1 000 MDL (about 47 EUR) per month. In terms of household income level, 62% of all respondents stated the amount less than 5 000 MDL (approximately 235 EUR) per month, while having 2-3 family members. In the rural area, the share of respondents' households earning below the 5 000 MDL level reached 72% (Iscenco et al., 2017a).

Finally yet importantly, in the group of city residents, only about half of them were direct users of the Codru forest and the Reserve. These respondents claimed that they had indeed visited the forest and the protected area in the last two years. In the group of village residents, the share of direct users was much higher: 73%. Due to this, the overall sample of the Codru Quest respondents had the majority of people (62%), who had visited the Codru forest and the Reserve at least once and therefore were expected to have certain attitude towards the provisioning and quality of the target environmental "good".

#### 4.2. Relation and attitude towards the environmental "good"

According to the respondents' answers to the attitudinal and behavioural questions in the CM survey (Table 5), people's attitude towards the natural environment and its protection in general is significantly (51%) or moderately (46%) positive.

Table 5. Attitude towards the natural environment, forest ecosystems in general, and the Codru forest with the Codru Nature Reserve in particular, as well as experience in using them among the respondents in the Codru Quest project.

#	Question and answer options	From city	From villages	All respondents	All respondents, %
1	Interest in nature and environment protection in general				
	Large	52	51	103	51.2
	Medium	48	44	92	45.8
	Small	0	4	4	2.0
	None	0	2	2	1.0

2	Frequency of visits to a forest in the last twelve months				
	0 times	10	15	25	12.4
	1 – 5 times	53	45	98	48.8
	6 – 10 times	15	29	44	21.9
	More than 10 times	21	12	33	16.4
	Don't know	1	0	1	0.5
3	Time spent during the last visit to a forest				
	Less than 1 hour	9	5	14	7.0
	1 – 2 hours	26	41	67	33.3
	3 – 5 hours	44	37	81	40.3
	More than 5 hours	19	12	31	15.4
	Don't know	2	6	8	4.0
4	Distance from the Codru forest and the Codru Nature Reserve				
	Less than 1 km	23	9	32	15.9
	1 – 5 km	33	89	122	60.7
	6 – 10 km	11	1	12	6.0
	More than 10 km	29	2	31	15.4
	Don't know	4	0	4	2.0
5	Another forest (substitute "good") available nearby				
	Yes	73	60	133	66.2
	No	17	40	57	28.3
	Don't know	10	1	11	5.0

Source: Adapted from MEGA, 2017b.

The majority of the respondents (89%) also claimed that they are in favour of existing protected areas in forest ecosystems in Moldova, their development and expansion, as well as establishment of new protected areas in the country. The dominance of these preferences is more or less the same in both groups: of urban and rural residents. Such positive attitude may indicate the presence of strong non-use values towards the target environmental "good" among the respondents, thus justifying the choice of the SP / CM technique for economic valuation in the Codru Quest project.

Most of the people surveyed in the project had also direct relation to forest ecosystems, as well as were direct users of their services. Only a few respondents (12%) did not visit a forest last year. The rest were there at least once, while many (38%) paid more than five visits to a forest. The average duration of a visit was about 2 – 3 hours, while the majority of the respondents (56%) stated that they had spent more than three hours during the last visit to a forest.

When visiting the forest, the respondents mainly enjoyed the cultural services of its ecosystem, namely the recreational benefits. When surveyed, people indicated that their most common activities in the forest were having a walk among the nature, enjoying silence and relaxation, and having a picnic among the woods. This output indicates that Moldovan citizens have strong direct value for recreational amenities of forests.

In terms of accessibility of the target environmental "good" to the respondents, for most of them (77%) the Codru forest and the Codru Nature Reserve were at a relatively close distance of maximum 5 km. Certainly, the distance was shorter for the village residents and longer for a good number of the city residents. Many (66%)

people also stated that they had another forest nearby, which could provide them with similar recreational benefits. The presence of this substitute "good" could have influenced the magnitude of the respondents' WTP.

#### 4.3. Willingness to pay

The estimation of the respondents' WTP brought a number of additional insights on the attitude of Moldovan citizens towards ecosystem services and biodiversity conservation in the Codru forest and the Reserve, as well as on the valuation of benefits people receive from these services.

For a start, the shares of the respondents willing to pay for the environmental "good" in question and the ones, who were not willing to do so (who stated that they had chosen the status quo / baseline scenario in all choice sets) were quite close to each other: 54% to 46% respectively. This distribution occurred mainly due to the prevalence of "zero-bidders" among the village residents: 65% of them preferred the baseline scenario with no visitor price to pay. The situation was the opposite among city residents: 74% of them chose an alternative scenario at least once, thus expressing the willingness to pay for the "good".

Among the respondents, who were willing to pay for improvements in ecosystem services and biodiversity conservation in the Codru forest and the protected area, the majority (about 70%) indicated existence, altruistic, and bequest values as the main reasons for their WTP. The remaining "bidders" (about 30%) referred mostly to the direct use values, such as recreational benefits described earlier.

The main reason given by those respondents, who were unwilling to pay, was related to the perception that it is the Ministry of Environment, the Codru Nature Reserve administration, and/or the Moldovan Government, who should financially support the quality and provisioning of the target environmental "good", not citizens. These were mainly protest bids that were removed from the final sample during the analysis. However, such unwillingness to pay may be related to the attitude of the respondents towards the Moldovan Government as the one exploiting natural resources in an unsustainable and corrupt way and therefore the one, who should pay for its "sins". The indicators to such attitude were observed in the comments that the respondents and interviewers left in the last question of the CM survey. Another significant reason for "zero bids" was the challenging economic situation of the respondents. This was especially prominent in the group of rural residents: 57% stated that they could not afford to pay the prices indicated in the alternative scenarios of the CM survey. Finally, those respondents, who claimed that they were not interested in nature conservation and that forest ecosystems did not represent a priority to them, were in the minority: only about 9% of the group of "zero bidders".

Referring to the magnitude of the respondents' WTP estimates, the use of the CM technique allowed obtaining mean WTP for each of the specific attributes of the target environmental "good". Due to the very small final sample size, the confidence intervals on the WTP estimates were quite large. Nevertheless, the results still brought valuable data on how much Moldovan citizens were willing to pay to improve the quality and provisioning of ecosystem services in the Codru forest and the Reserve (Table 6).

Table 6. Results of estimation of the Codru Quest data by the mixed logit model with the respondents' mean WTP values and confidence intervals for each attribute of the target environmental "good".

#	Attribute and its parameters	From city	From villages	Sample average	Aggregated values
1	Total territory of the Codru Nature Reserve				
	Mean WTP*	8.93	-11.94	-3.94	-13798
	95% Confidence Interval (+- on mean value)	9	-10.99	5.83	20405
	Extended CI boundaries**	17.71	17.71	17.71	61985
2	Number of species of plants conserved				
	Mean WTP*	-4.53	-16.01	-11.65	-40775
	95% Confidence Interval (+- on mean value)	9.02	14.28	10.22	35-770
	Extended CI boundaries**	5.35	5.35	5.35	18725
3	Number of species of insects conserved				
	Mean WTP*	22.42	12.54	16.30	57050
	95% Confidence Interval (+- on mean value)	16.14	11.803	12.54	43890
	Extended CI boundaries**	15.88	15.88	15.88	55580
4	Presence of symbolic species: small-flowered black hawthorn and stag beetle				
	Mean WTP*	26.57	13.33	18.36	64260
	95% Confidence Interval (+- on mean value)	19.86	12.71	14.37	50295
	Extended CI boundaries**	24.56	24.56	24.56	85960

\* WTP is expressed in Moldovan lei (MDL).

\*\* Extended CI boundaries refer to the extension of the confidence interval boundaries to account for the different preferences across the sample.

Source: Adapted from Iscenco et al., 2017a.

The first thing to notice in the Codru Quest results is the negative sign on the mean WTP for two attributes: territory of the Codru Nature Reserve and the conservation of biodiversity of plants. The average WTP values per person were -3.94 MDL (-0.19 EUR) for the territory of the protected area and -11.65 MDL (-0.56 EUR) for the conservation of plant species. The values aggregated to 3500 visitors per year yielded -13798 MDL (-650.16 EUR) and -40775 MDL (-1921.31 EUR) respectively. These negative WTP values were driven mainly by the estimates from the rural residents: they expressed -11.94 MDL (-0.56 EUR) as mean WTP for the territory and -16.01 MDL (-0.75 EUR) for the protection of flora biodiversity within it. In comparison, these estimates in the group of urban residents were 8.93 MDL (0.44 EUR) and -4.53 MDL (-0.21 EUR) respectively. Such expression of negative WTP may point to the disutility that the respondents (mainly the ones from the target villages) experience (or believe that they would experience) with

the expansion of the protected area and inclusion of more plant species under the conservation status.

The other two attributes, conservation of more insect species and abundance of endangered species on the examples of small-flowered black hawthorn (*Crataegus pentagyna*) and stag beetle (*Lucanus cervus*), were valued positively by all respondents, both from Chisinau and the target villages around the Codru forest. Mean WTP for the first attribute, the conservation of greater insect biodiversity, was 16.30 MDL (0.77 EUR) per person and 57050 MDL (2688.19 EUR) aggregated for the approximate number of visitors per year. The mean values for the second attribute, better protection of endangered species and hence their greater abundance, were 18.36 MDL (0.87 EUR) per person and 64260 MDL (3027.92 EUR) aggregated per year respectively. The magnitude of mean WTP for both attributes was largely influenced by higher values in the group of Chisinau residents: 22.42 MDL (1.06 EUR) against 12.54 MDL (0.59 EUR) among village residents for the first attribute and 26.57 MDL (1.25 EUR) against 13.33 MDL (0.63 EUR) for the second one. This difference in the magnitude of estimates between the two groups can be explained by socio-economic characteristics, such as higher income rate among city residents. Nevertheless, these positive WTP values in both groups indicate the utility of all the respondents in "consuming" the above-mentioned attributes of the target environmental "good" and the value people attach to them. The utility and value may lie in observing more insects (beetles, butterflies, etc.) while visiting the Codru forest (direct use recreational value) or knowing that endangered species of plants and animals in the forest are better protected and are thriving (non-use existence value).

All the mean and aggregated WTP values obtained may appear rather low. This is mainly due to the low number of visitors in the Codru Nature Reserve, relatively low income levels of the respondents, and other specifics of the socio-economic situation in a developing country, such as the Republic of Moldova.

The Codru Quest project did not attempt to define the total value of benefits related to ecosystem services and biodiversity conservation of the Codru forest and the Reserve based on the aggregated WTP values obtained. Such number would be a severe underestimation of the total economic value of the environmental "good" in question, since it would not capture many other ecosystem services providing significant benefits to both people and the natural environment (for instance, carbon sequestration, soil formation, underground water purification, habitat creation and maintenance, etc.).

#### 4.4. Influence of socio-economic variables

In order to assess how the socio-economic variables affected the likelihood of an individual expressing WTP for ecosystem services and biodiversity conservation in the Codru forest and the Reserve, these variables were connected to the chosen econometric model (specifically, the mixed logit model). The former included age, gender, marital status, education level, occupation, personal and household income, and proximity to the Codru forest and the protected area.

Gender turned out to be the most influential socio-demographic characteristic in determining the probability that a respondent would be willing to pay for the environmental "good" in question. Specifically, women not only represented the majority of all respondents surveyed in the targeted population sample, but also were

more likely to select a non-baseline scenario than men were. This result indicates that women were more likely to support the improvements in the quality and provisioning of ecosystem services in the Codru forest and the Reserve and to pay for these improvements, *ceteris paribus*. However, the correlation between gender and likelihood of an individual having WTP did not translate directly into the magnitude of WTP values.

Other socio-economic variables, such as marital status, occupation, and distance to the study area were also important in explaining the respondents' preferences and determining the probability of their WTP. However, their effect was not as high as the one of gender.

In relation to the personal and household income, this characteristic did not have significant effect in determining the respondents' choices of alternative scenarios and the likelihood of them expressing WTP. The cause here may lie in the fact that the influence of the income variable had already been captured by the heterogeneity and specifics of the two different groups of respondents: city residents with higher level of income and village residents with lower income level.

## **5. Discussion**

In the Codru Quest project, the WTP (both per capita and aggregated) of Moldovan citizens (both from urban and rural environment) for certain aspects of ecosystem services and biodiversity conservation in the Codru forest and the Codru Nature Reserve was estimated. The focus was mainly on indirect use and non-use values of the forest ecosystem services, such as habitat for wild flora and fauna, existence of natural landscape and charismatic species of plants and insects, their availability for future generations, and the cultural and historic heritage associated with the Codru forest. Nevertheless, it is reasonable to expect that while choosing their preferences in the Codru Quest survey, the respondents did take into consideration the direct use values of the forest ecosystem as well. For instance, their answers to the attitudinal and behavioural questions of the CM survey indicate a prominent effect of recreational value on the resulting WTP.

In the project, there was no intent to estimate the WTP to preserve the entire Codru forest and the Reserve with all the indirect use and non-use values of their ecosystem services. That would have been a very complex and extremely challenging task. Instead, the benefits of the CM technique were used to calculate economic values of specific non-market characteristics and gains of nature conservation in the study area. These values represent the importance that Moldovan citizens assign to the Codru forest and the protected area in relation to the services supplied by the local ecosystem and biodiversity. The values estimated in the study do not refer to an economic amount that can be appropriated directly by the Codru Nature Reserve, the local community, or any other economic actor, nor do they reflect the market value of the Codru forest and the protected area. However, being "translated" into the "language" of money, they can serve as a useful monetary metric and a measure of welfare. This measure can be used to counterbalance the market gains from exploiting the forest in CBA, land-use planning, and decision-making, hence supporting the case of long-term sustainable management of the study area and conservation of biodiversity in it (Hanley and Barbier, 2009). Arguments provided by the economic valuation research that speak in favour of long-term sustainable use of

natural resources and ecosystem services in the study area are important in addressing the problems described earlier in this article. Unfortunately, only several economic valuation studies were conducted on ecosystem services in the Republic of Moldova (examples here include BIOTICA, 2016; Popa et al., 2014; Transilvania University of Brasov, 2015). Therefore, the Codru Quest project, as well as any other study in the domain of environmental economics and on this developing country, helps in framing the economically and socially backed case for sustainable management of protected areas, natural resources, and ecosystem services in Moldova.

Furthermore, the results of the project display an interesting picture regarding the relation and attitude of Moldovan citizens towards ecosystem services and biodiversity conservation in the Codru forest and the Reserve. The comparison of the WTP estimates among different attributes of the target environmental “good”, as well as between the urban and rural residents, reveals that people value various aspects of ecosystem services and biodiversity conservation differently (Figure 3).

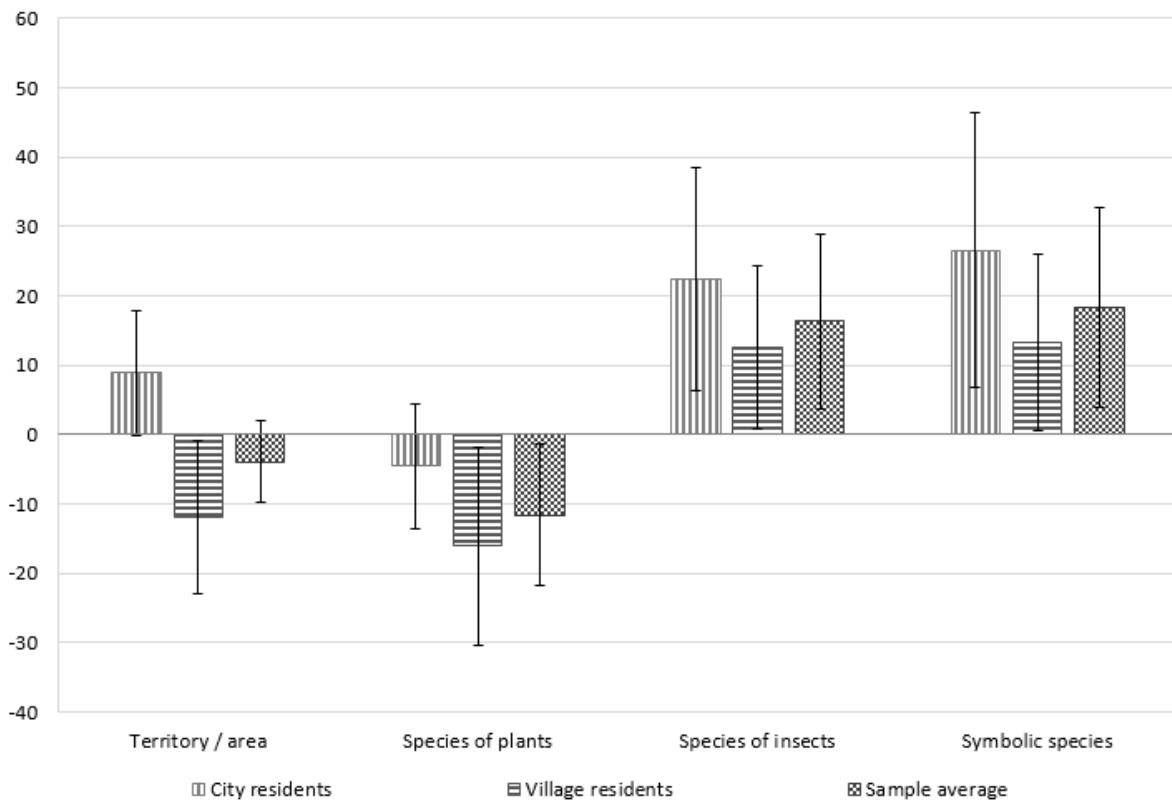


Figure 3. Comparison of the mean WTP estimates and confidence intervals of city residents, village residents, and population sample average in the Codru Quest project, in Moldovan lei (MDL). Source: Adapted from Iscenco et al., 2017a.

From the Codru Quest results, it can be seen that the territory of the Codru Nature Reserve designated for nature conservation activities and the possibility of its expansion was valued negatively, at a total of -13798 MDL (-650.16 EUR). There was another aspect of environment protection in the Codru forest and the protected area that received negative valuation from the respondents: conservation of higher number of plant species. The aggregated WTP for it was -40775 MDL (1921.31 EUR). However, while in the former case (the territory and its expansion), the negative WTP

was driven mostly by the negative preferences of village residents, in the latter case (conservation of plant species), respondents from both the city and the villages were unanimous in their expression of negative WTP.

The other two characteristics of the target environmental “good” included in the CM study, conservation of higher number of insect species and abundance of endangered species on the examples of small-flowered black hawthorn (*Crataegus pentagyna*) and stag beetle (*Lucanus cervus*), were valued positively by both groups of respondents. Their aggregated WTP for the insect species conservation was estimated at 57050 MDL (2688.19 EUR) and for the protection of endangered symbolic species at 64260 MDL (3027.92 EUR).

This heterogeneity in the valuation of various aspects of nature conservation in the Codru forest and the Reserve between urban and rural residents can be explained by the different socio-economic conditions and preferences of the two social groups prevalent in Moldova.

### 5.1. Effects of the socio-economic conditions

The respondents surveyed within the Codru Quest project represent two different social groups living in different socio-economic conditions. One can expect these conditions to influence the preferences and the WTP of the respondents from each group differently.

One of these social groups includes residents of a city and its suburban areas (in the Codru Quest it was Chisinau). These people belong to middle or upper middle class and have more or less stable daily job and source of income. Among the Codru Quest respondents from this group, the average personal income was about 2000 – 4000 MDL (100 – 200 EUR) per month, while the average income for a household was approximately 5000 – 9000 MDL (250 – 450 EUR) per month. However, besides urban parks, city residents have very limited interaction with outside green spaces. They are mostly non-users of forest ecosystems. Nevertheless, these people can still attach non-use values (existence, bequest, and altruistic ones) to a forest or a protected area situated not far away from the city of their residence. Therefore, urban residents may still have positive WTP for preservation and even expansion of forests outside the city and conservation of biodiversity in them, even though they are not using forest ecosystems in any noticeable direct or indirect way. Indeed, the answers to attitudinal and behavioural questions in the CM survey, collected from the Chisinau respondents, confirm the prevalence of existence and bequest values in this social group. At the same time, extra information elicited about the respondents also shows that more than half (53%) of them visited the Codru forest at least once during the last year and that the purpose of their visit(s) was recreational. This fact indicates that the city residents may also be willing to support nature-related improvements in their favourite recreational sites, as well as their expansion to enjoy more of the direct recreational value of forest ecosystem.

The other social group surveyed in the Codru Quest project is represented by rural residents of nine villages situated in close proximity to the Codru forest and the Reserve (Lozova, Stejareni, Capriana, Micleuseni, Huzun, Horodca, Bursuc, Dragusenii Noi, and Condrita). This group is comprised of mostly aged people, who either prefer to live in rural environment or have no other way but to stay there due to various socio-economic reasons. They are usually independent farmers, unemployed, or retired



people. Their limited sources of income include local low-paid jobs and remittances from their children working in cities in Moldova or abroad. Some villagers also earn certain profit from selling fruits and vegetables from their gardens and farms, as well as non-timber products from the nearby forest. The average personal income of the respondents from this group was about 1000 – 2000 MDL (50 – 100 EUR) per month, while the average income for a household did not go above 5000 MDL (250 EUR). Rural residents are direct users of natural resources and ecosystem services of the forest, especially of timber and non-timber products. They largely depend on these resources for personal wellbeing and welfare. These people also have their land with gardens and farms situated close to the Codru forest and the protected area and gain from the indirect benefits of forest ecosystem services, such as soil formation and pollination, as well. Nevertheless, the answers of the respondents from this social group to the attitudinal and behavioural questions in the CM survey show that these people also considered existence and bequest values in their preferences and WTP.

Different socio-economic conditions of the respondents from the city and the villages help to understand the difference in valuing the territory of the Codru Nature Reserve and its possible expansion for nature conservation purposes. While the respondents from Chisinau live at a distance from the protected area and do not feel the direct effects of its enlargement on themselves, the village residents have their farms, gardens, and orchards situated in close proximity of the Codru forest and the protected area within it. Therefore, when presented the scenario with the enlargement of the Reserve area, the respondents from the villages could have experienced anxiety and fear of losing their land, as well as access to the forest for gathering timber and non-timber products. Such situation would have been a significant blow to people's already weak economic situation in the region. Therefore, the villagers' concerns over the effects of the protected area expansion on their access to natural resources, security of the land, and welfare were likely to influence the negative WTP for the territory of the Reserve.

The negative valuation of conservation of more plant species by both groups of respondents is likely to be connected to the specific ways people use the Codru forest ecosystem. The city residents benefit from the forest as a place for recreation, walks, picnics, picking up flowers, etc. The village residents prioritise the forest as a source of timber and non-timber products. Furthermore, there is a practice (although illegal one) for inhabitants of rural areas near forests to collect and commercialize certain endangered plant species, especially during national holidays. One common example is for people to pick and sell different species of snowdrops (*Galanthus plicatus*, *G. nivalis*, and *G. elwesii*), all of which are included into the Red Book of Endangered Species of the Republic of Moldova and listed there as either vulnerable or critically endangered (Ministry of Environment of the Republic of Moldova, 2015). Even the fine of 2000 MDL (about 100 EUR) does not stop people from collecting snowdrops and selling the flowers at the sides of roads and in cities. Even if a person doing such activity is caught and fined, the profit earned until that moment is likely to exceed the fine (Point.md, 2016). Considering all of the above, both groups were likely to consider the conservation of more species of flora as a limitation of the space allowed for recreation and of the non-timber products that are permitted to collect. This consideration thus translated into the negative WTP for the flora conservation attribute.

Shifting to the positive WTP for the conservation of more insect species and for better protection of endangered species expressed by both urban and rural respondents, the estimates here reflect not only existence, bequest, and altruistic values attached to these attributes of the target environmental "good", but also certain indirect use values. For the city residents, these indirect use values may represent the visual amenity of observing rich biodiversity of beetles and butterflies when coming to a forest for recreation. The village residents may connect richer biodiversity of forest ecosystem with pollination for their farms, gardens, and orchards: the more insects there are in a forest nearby, the better they do the pollination "job" for the farmers and gardeners. In relation to the endangered symbolic species, comparatively significant positive WTP for their conservation may have been influenced by the factor of scarcity, as well as anxiety over losing something rare and symbolic to the country, such as the small-flowered black hawthorn and the stag beetle.

Finally, the relatively high share of respondents with null WTP, especially among villagers (26% in the group of urban residents and 65% in the other group comprised of rural residents), brings yet another perspective to the influence of socio-economic conditions on the valuation of ecosystem services. Combined with the respondents' answers to attitudinal and behavioural questions and comments in the final section of the CM survey, the large amount of zero-bids in the results shows how widespread poverty in the rural areas in Moldova negatively affects the ability of local communities to express WTP for environmental protection and biodiversity conservation. This happens even if local community members in these areas understand the benefits they get from healthy natural ecosystems nearby. The issue is exacerbated by people's knowledge of extensive state-level corruption in the country and the resulting lack of trust in state institutions and their initiatives. In these conditions, even though half of the respondents (about 51% in both groups) showed strong interest in nature conservation in the Codru forest and the Reserve and willingness to support it, many of these people did not believe that the collected visitor fees would truly go into financing the conservation of the forest ecosystem and biodiversity and would really result in the improvements described in the alternative scenarios.

Besides the s

ocio-economic conditions, the signs and magnitude of the WTP estimates may be affected by other factors related to the challenges and limitations faced while conducting the Codru Quest study.

## 5.2. Effects of challenges and limitations of the study

It is clear that the WTP estimated in the Codru Quest study does not represent the total economic value of the protection of ecosystem services and conservation of biodiversity in the Codru forest and the Codru Nature Reserve. The study focused just on several characteristics of the environmental "good" in question.

Nevertheless, it is reasonable to assume that the resulting WTP for even these several characteristics may be underestimated. One of the reasons here may be that the valuation scenario in the CM survey did not capture important linkages between different components of the forest ecosystem (for example, connection between the abundance of plants and the population of insects) and their influence on the provisioning and quality of ecosystem services. There may also be an effect of underestimating future flows of valuable ecosystem services resulting from better protection of the ecosystem and its biodiversity. Hence, it is possible that, while

reflecting on the valuation scenario in the CM survey, the respondents were not aware of these linkages and future flows and therefore did not consider them in their preferences and WTP.

Another reason to believe in the underestimated WTP of this study may be the consideration of only one part of the Codru forest and the Reserve area by the respondents. Specifically, people might have taken into account only the buffer zone of the protected area (4455.8 ha out of the total 5175.8 ha), as this is the territory they could enter and benefit from direct ecosystem services, while the strictly protected zone (720 ha) is restricted for visitors. This might have affected the resulting WTP in a way that the estimates do not cover the value of ecosystem services and biodiversity conservation in the entire Codru forest and the Reserve. Similar assumption of the protected area consideration effect on the underestimation of WTP can be found in a number of other SP studies. For instance, Resende et al. (2015) acknowledges this effect on the respondents' WTP in their contingent valuation study on the ecosystem services provided by the Serra do Cipó National Park in Brazil.

Other challenges, limitations, and biases may have also affected the results of the Codru Quest project. One of the obvious limitations is the very small final sample size. While the minimum required population sample size was estimated to be 384 respondents, only 100 respondents were surveyed during the pilot phase of the project and only 201 individuals in its second phase. Furthermore, due to the challenges faced in the data analysis, such as large heterogeneity between the two groups of the respondents, inconsistencies in responses to visitor price increase, and strategic behaviour, there was a need to mark a significant number of responses as non-valid. This necessary action drastically reduced the sample size by 47%, leaving only 107 respondents with valid responses. It is likely that such small population sample size affected the significance and magnitude of the estimation parameters and hence the resulting WTP. In this respect, one should be careful in using the WTP estimates from very small population samples.

The small sample of the respondents surveyed and the impossibility to conduct additional surveys to increase it were the effects of strict constraints of the project. Typically, a qualitative economic valuation study requires a couple of years to be done properly and to give valid and reliable results from a full representative population sample. Usually, such a study also has a budget of approximately 20000 - 30000 EUR (Pearce et al., 2002). The Codru Quest project was realized in the period of only 10 months (November 2016 – August 2017) with the total budget of only 8000 EUR (Iscenco et al., 2017a). Such a short timeline and limited budget were set up due to the experimental nature of the project: the Codru Quest was the first attempt to conduct a CM study in Moldova. Nevertheless, these constraints inevitably led to the result-influencing limitation of the small population sample size.

One more factor influencing the signs and magnitudes of the WTP in the Codru Quest study may have been the selection of the target population for aggregating the estimates. As it has been mentioned earlier, the mean WTP was aggregated to the approximate number of 3500 visitors to the Codru Nature Reserve per year. This focus on only direct users of the Codru forest and the protected area has likely excluded a large number of indirect users and non-users of the target environmental "good", who might still have existence, bequest, and altruistic values attached to the "good". This should be an important result-influencing factor, especially considering that the goal

of the project was to estimate and present specifically the indirect use and non-use economic values of ecosystem services and biodiversity conservation in the forest and the protected area.

Finally yet importantly, the Codru Quest results may have been shaped by the issues, which are common in a CM study. These issues are hypothetical market bias and the influence of the survey design. The former may have manifested itself in the respondents not believing in the hypothetical valuation scenario and the market for the target environmental "good" described in it. Hence, the individuals surveyed may have stated WTP, which is different from the "real" WTP. The survey design may have affected how the respondents perceived and visualized the gains and losses from each of the alternative scenarios and the status quo option. For example, the negative WTP for conservation of more plant species and the positive WTP for protection of greater diversity of insects may have been influenced by visual representation of these attributes in the Codru Quest survey. There, the respondents may have perceived images of insects (colourful beetles and butterflies) as more visually interesting and appealing than plain forest and plants, which affected people's preferences to some degree.

Overall, the experience of the Codru Quest study demonstrates that a CM study and its results can be influenced by a broad range of various factors: from the specifics of the survey design and hypothetical valuation scenario to the coverage of the target population sample and constraints of the entire study design. The effects of such factors is difficult to observe and predict, which means that more CM studies experimenting with these factors need to be conducted in order to improve the performance, quality, and reliability of further economic valuation research.

### 5.3. Choice modelling and ecological-economic modelling

A number of the challenges and constraints faced in the project and described above are typical to any CM valuation study. Just like in the Codru Quest survey, any other CM questionnaire may describe attributes of an environmental "good" in question as separate individual characteristics. This simple and reductionist approach helps the respondents to understand the valuation scenario and the alternative scenarios in the choice sets better. However, it comes with a high "price". By separating the characteristics of the environmental "good", one neglects important interrelationships between them. One also misses the effects these interrelationships have on the development of each characteristic, as well as of the "good" as a whole. Furthermore, it should not be expected that the respondents to know and understand all these connections or the inherent complexity of ecosystems and then consider all these aspects in their WTP (Resende et al., 2015). On the other side, when such interrelations are incorporated into the valuation scenario and choice sets and are well explained to the respondents, the latter are likely to consider the linkages and their effects while expressing preferences. This may result in different WTP estimates that stand closer to the "real" WTP of the respondents.

To make the latter happen, the recommendations of Resende et al. (2015) and Hanley and Barbier (2009) were followed. They suggest that, if the time and budget allow, a CM study should be combined with an integrated ecosystem assessment done by ecological-economic modelling. This approach has the potential of capturing more fully the ecosystem functioning and dynamics underlying the provision of its key services that are valuable to the natural environment and the

respondents of a CM study (Hanley and Barbier, 2009). The ecological-economic modelling is also able to account for interrelationships between different structural elements and attributes of ecosystems, as well as anthropogenic impacts (both damaging and beneficial) on them, and then represent these interrelationships in a simplified and understandable way (Resende et al., 2015).

By combining a CM study with ecological-economic modelling, the complexities and linkages within ecosystems can be presented and explained to the respondents much better. This would allow people to assess the valuation scenario and choice sets in a more informed and subjective manner and to state personal preferences more properly. The result of such a combined ecological-economic valuation study could be that the individual attributes of the environmental "good" in question are valued differently and that the "integrated" value of the "good" exceeds the WTP of each attribute and ecosystem service considered separately (Hanley and Barbier, 2009).

## **6. Concluding remarks**

Economic valuation of ecosystem services and biodiversity conservation represents a useful tool for capturing, assessing, and demonstrating the importance and value of these environmental "goods", especially when there is no actual market with clearly visible prices for them. In fact, these non-market "goods" are the ones that are the most valuable and bring the most benefits to the natural environment and the local communities in the long term. This is applicable to practically every forest ecosystem and protected area, including the ones that were in the focus of the present study: the Codru forest and the Codru Nature Reserve within it. Here, in the Codru Quest project, it was determined that people are willing to pay about 0.77 EUR per person for conservation of greater insect biodiversity in the forest and approximately 0.87 EUR per person for better protection of endangered species of both flora and fauna (such as the small-flowered black hawthorn and the stag beetle). This gave the aggregated value of 2688.19 EUR per year for the first attribute and 3027.92 EUR per year for the second characteristic. These estimates of willingness to pay show that people appreciate and value conservation of forest biodiversity, although it is not traded on real markets. Moreover, when the estimated economic values are combined with valuation of other non-market ecosystem services (recreation, pollination, soil formation, carbon sequestration, etc.), altogether their benefits are likely to outweigh the gains from marketable uses of the forest ecosystem (timber harvesting, land conversion, etc.), especially in the long run. A properly done cost-benefit analysis that incorporates all these values of all possible ecosystem services would support the scenario of conservation and sustainable management of the Codru forest, its natural resources, and biodiversity. The analysis would also bring clear arguments for choosing the sustainability scenario explained in the understandable "language" of money.

In order to estimate the indirect use and non-use values of the non-marketable ecosystem services and biodiversity conservation in the Codru forest and the Reserve, the stated preference technique was applied. Specifically, the choice modelling method was used to collect, calculate, and demonstrate values of specific characteristics of the target environmental "goods", such as conservation of plants and insects and protection of endangered species of both flora and fauna. This is what the CM method is best at: helping to estimate non-use values of concrete attributes of environmental "goods" and changes in their provision and quality. In addition, this economic valuation method can assist in discovering people's attitudes

towards the characteristics in question, as well as the influence of socio-economic factors on the importance and magnitude of people's valuation of each characteristic. In the Codru Quest project, the CM survey and the respondents' answers to its questions revealed the negative valuation of the protected area expansion by the rural residents and of the conservation of more plant species by both city and village residents. This can be a useful insight for future planning and decision-making in terms of reforestation and afforestation campaigns in rural areas in Moldova, as well as for designing awareness raising and educational initiatives on the value of forest ecosystems among the Moldovan population.

Certainly, the SP technique and particularly the CM method have their drawbacks, just like any other methodological option of economic valuation. For instance, the CM method is prone to underestimating the value of an ecosystem as a whole, as well as insufficiently capturing the complexity of the ecosystem and the future benefit flows from its services. The method is also vulnerable to biases and flaws that might appear in defining and framing the valuation scenario and choice sets in a survey. Besides all the above, a CM study requires sufficient sample size of the target population to give reliable results, just like any other economic valuation research. These drawbacks affected the Codru Quest study and influenced the resulting WTP estimates. Therefore, further research is needed on the value of ecosystem services and biodiversity conservation in the Codru forest and the Reserve. It should also be coupled with ecological-economic modelling to reflect the complexities and interrelations of the forest ecosystem and biodiversity within it in the research results.

In conclusion, the ecosystem of the Codru forest and the Codru Nature Reserve within it provides a number of valuable ecosystem services even in the present situation of unsustainable use of its natural resources. When sufficiently protected and sustainably managed, these services can offer practically unlimited direct and indirect gains to wellbeing and welfare of both urban and rural citizens of the Republic of Moldova.

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