

Economic Valuation of Ecosystem Services and Biodiversity Conservation with Choice Modelling in the Codru Forest in the Republic of Moldova.

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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 financed by the Rufford Foundation was conducted in the Codru forest and the Codru Nature Reserve within it, which are situated in the developing country of the Republic of Moldova. The main objective of the project was to estimate and present the monetary value of benefits coming from ecosystem services and biodiversity conservation in this forest and protected area. The choice modelling technique was applied to survey 201 Moldovan citizens and then to calculate their willingness to pay (WTP) for better protection and sustainable management of the Codru forest ecosystem and its biodiversity. The results of the Codru Quest project showed that the respondents had been willing to pay 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 citizens of this developing country attach to ecosystem services and biodiversity in the study area.

Keywords:

Biodiversity conservation, choice modelling, economic valuation, ecosystem services, forest ecosystem, stated preference technique

Лесная экосистема, метод заявленных предпочтений, моделирование выбора, сохранение биоразнообразия экономическая оценка, экосистемные услуги

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 are 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. This situation leads to the degradation of forests and decline in forest cover (ValuES, 2017).

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 (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

Use values		Non-use values
Direct values	Indirect values	Existence, bequest, and altruistic values
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, BIOTIC, 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 and financed by the Rufford Foundation (The Rufford Foundation, 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 project was designed to answer the following research questions:

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?

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). The present article draws upon the main results and conclusions from this report.

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 at a distance of 49 km from the capital city Chisinau.

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).

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. 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 123 000 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 to 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 for a guided walk. Generally, there are about 3500 tourists visiting the Codru Nature Reserve annually (Iscenco *et al.*, 2017a).

Research 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 m³. In 2015, the volume of timber extracted from the forest and sold on the market doubled, reaching 4579 m³ (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 (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).

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.

Methodology

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 for improvements in the quality and provisioning of an environmental “good” or their willingness to accept compensation 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 (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 (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.

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 might care about its existence and conservation, thus having use and non-use values attached to the environmental “good” in question.

For determining the 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 (Pearce *et al.*, 2002). Our calculations via the probability sampling method resulted in the 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.

Surveying process

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 (Magenta Consulting, 2017).

Survey design

The 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

#	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.	Highest education level	1	Primary school (classes 1 – 9)
		2	Secondary school (classes 10 – 12)
		3	University, Bachelor degree
		4	University, Master degree
5.	Main occupation (employment)	1	Not working (unemployed, 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 Codru Nature Reserve (users vs. non-users)	1	Yes
		2	No
		3	Don't know

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 1).

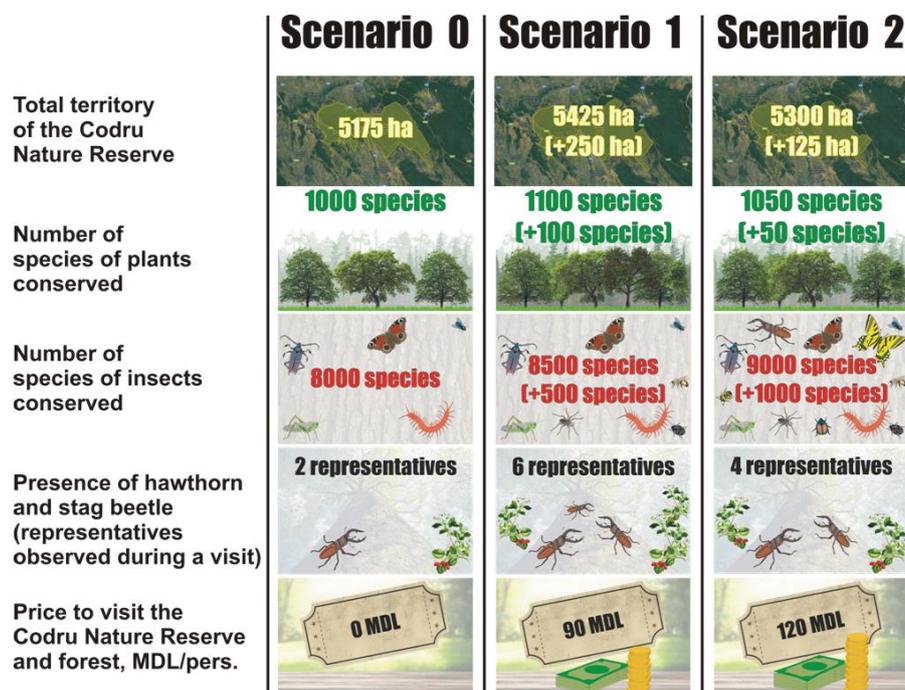


Figure 1. Example of a choice set from the Codru Quest survey with the status quo option (Scenario 0), alternative scenarios (Scenario 1 and 2), their attributes, and the visitor price for each option. Source: MEGA (2017b).

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 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: Adapted from 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).

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. As a result, the authors ended up with the operational sample size of only 107 respondents.

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 (Resende *et al.*, 2015). 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., $WTP = 0$).

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. 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.

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).

The most notable socio-economic differences between the two groups of respondents can be observed in relation to the education level 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.

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”.

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	1	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).

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.

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.

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.

Table 5. Attitude towards the Natural Environment and Forest Ecosystems and 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	5.5

Source: Adapted from MEGA (2017b).

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 survey.

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 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	-13 798
	95% Confidence Interval (+- on mean value)	9	- 10.99	5.83	20 405
	Extended CI boundaries ‡	17.71	17.71	17.71	61 985
2.	Number of species of plants conserved				
	Mean WTP †	-4.53	-16.01	-11.65	-40 775
	95% Confidence Interval (+- on mean value)	9.02	14.28	10.22	35 770
	Extended CI boundaries ‡	5.35	5.35	5.35	18 725
3.	Number of species of insects conserved				
	Mean WTP †	22.42	12.54	16.30	57 050
	95% Confidence Interval (+- on mean value)	16.14	11.803	12.54	43 890
	Extended CI boundaries ‡	15.88	15.88	15.88	55 580
4.	Presence of symbolic species: small-flowered black hawthorn and stag beetle				
	Mean WTP †	26.57	13.33	18.36	64 260
	95% Confidence Interval (+- on mean value)	19.86	12.71	14.37	50 295
	Extended CI boundaries ‡	24.56	24.56	24.56	85 960

Note: † 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.

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.

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 variables 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*.

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.

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.

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 2).

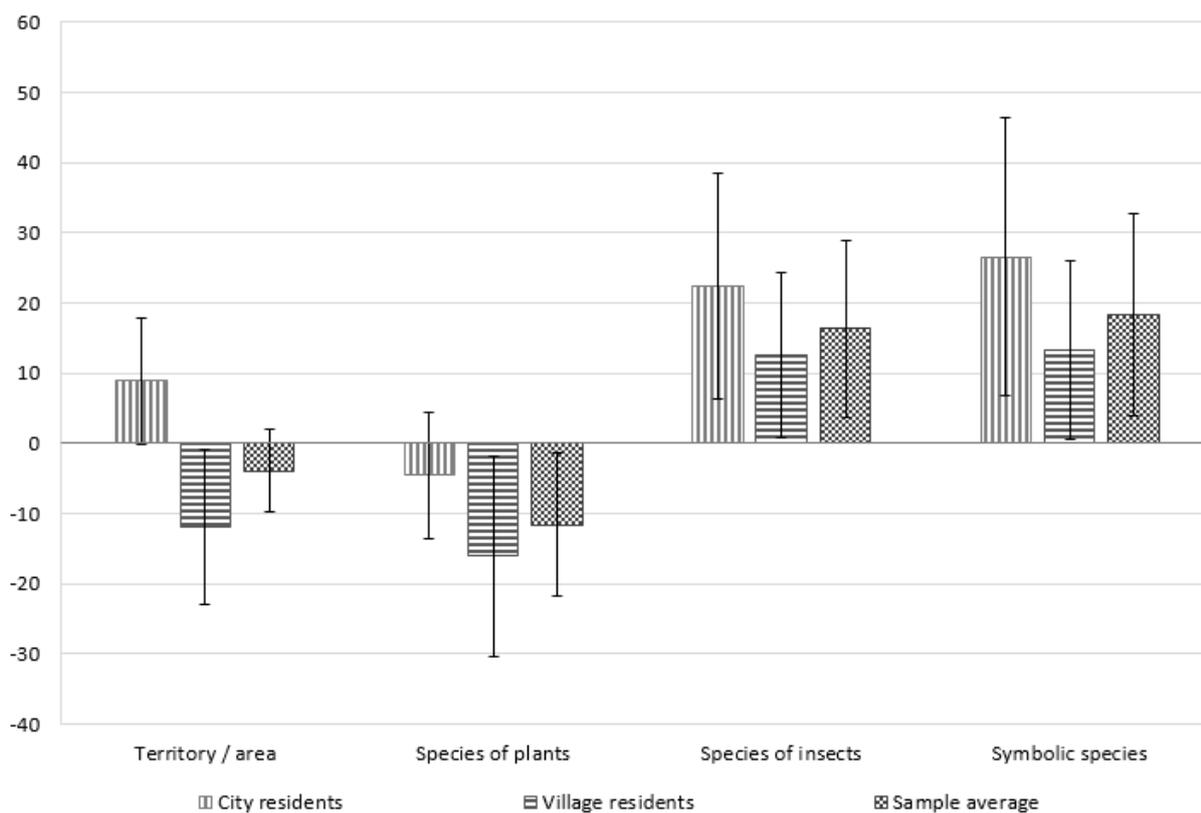


Figure 2. Comparison of the mean WTP estimates and confidence intervals of city residents, village residents, and population sample average in the Codru Quest project, in Moldovan lei (MDL)
Source: Adapted from Iscenco *et al.* (2017a).

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. 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. 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.

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.

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. 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 the villages situated in close proximity to the Codru forest and the Reserve. 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. 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. Considering all this, 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.

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. 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, the research results 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. 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.

Nevertheless, the CM study within the Codru Quest project also showed that 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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