Valuation of Marine Ecosystem Services in the Black Sea

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Abstract

The Black Sea region faces pressures on ecosystem services (ES) due to invasive species, waste, eutrophication, and biodiversity loss. We apply a stated preference technique, i.e. a choice experiment (CE), aiming to compare three hypothetical scenarios regarding the welfare impact of ES on citizens' lives in terms of willingness-to-pay (WTP). Initially, the distributed questionnaires underwent an econometric pre-test regarding the orthogonality of all CE scenarios in R-studio. Questionnaire distribution occurred from 29/05/2023 to 21/11/2023 with a total number of 375 responders from the three pilot sites: Turkey, Romania, and Georgia. The highest WTP occurred in Turkey (56.72€) for all scenarios followed by Georgia (49.04€), and Romania (47.96€). Moreover, the greater WTP value is demonstrated by Scenario C (25.51€) followed by Scenarios B (25.17€) and Scenario A (25.11€). Interesting socioeconomic characteristics derived from Cross-Tabulation Analysis that notably cannot impact the WTP are income, gender, and age. Furthermore, marital status and education might affect the WTP only in Romania, however, this is not demonstrated in Turkey or Georgia. Interestingly, the higher level of education in Romania is linked to lower WTP, nevertheless, education typically relates to environmental sensitivity. Another aspect is that occupation can change responders' WTP in Romania and Georgia, but not in Turkey. In essence, the economic valuation of ES through CE methodology can offer policymaking insights into Blue Growth initiatives.

Keywords: ecosystem management; human impacts; valuation studies; choice experiment; stated preferences; blue economy; sustainable development goals

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1. Introduction

Environmental conservation and protection are fundamental for policymaking agendas globally, as they can promote a deeper understanding of the interlinkages between environmental sustainability and societal well-being. In the same manner, marine environmental protection is an integral part of sustainable development in the safeguarding of our natural environment (WCED, 1987). More specifically, there is a plethora of ecosystem services (ES) and functions provided by coastal and marine ecosystems, but it is their protection that can lead to higher well-being levels (Eggert and Olsson, 2009; MEA, 2005). One important case study of ES conservation is the Black Sea.

There are several factors that push the environmental stability in the Black Sea. Some multi-stressors are biodiversity loss because of invasive species, waste (e.g., microplastics), and eutrophication (e.g., algal blooms). The protection of marine biodiversity is crucial to environmental integrity in the Black Sea, nevertheless, biodiversity loss events have proliferated the recent decades (Gamfeldt et al., 2015; Sala and Knowlton, 2006). For instance, invasive species (e.g., jellyfish) are responsible for the diminished population of local predators, ushering to environmental destabilization (Dasgupta, 2021; Shiganova and Bulgakova, 2000). Furthermore, eutrophication is another stressor created due to excessive amounts of nutrient inputs (e.g., phosphorus (P) and nitrogen (N)). Both anthropogenic and natural sources can accelerate the emergence of eutrophication (Borysova et al., 2005; Halkos and Galani, 2013). Undoubtedly, the waste crisis, and specifically the plastic pollution at the Black Sea is detrimental to marine ecosystems (Atabay et al., 2020; Paiu et al., 2020; Simeonova et al., 2020). All of the above phenomena necessitate international and European institutional intervention such as the novel EU action plan on zero pollution. The environmental degradation monitoring calls for inter-regional coordination and cooperation, in essence, it is advisable that the institutional framework be strengthened with practical nature-based (NbS) and technological-based solutions (TbS).

A prerequisite for an institutional framework is the availability of proper policy instruments, for example, economic valuation techniques that can approach the ES values through proper *willingness-to-pay* (WTP) estimation (Halkos, 2023; Markandya et al., 2019). Biodiversity conservation has been the subject of two profound reports: (i) "The Economics of Ecosystems and Biodiversity" (TEEB) (Kumar, 2012; TEEB, 2010) and "The Economics of Biodiversity: The Dasgupta Review" (Dasgupta, 2021). The aforementioned reports provided

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a well-rounded framework for measuring the economic aspects of biodiversity, aiming to unveil the covert linkages between economic growth and environmental sustainability.

The novelty of this manuscript is the evaluation of marine ES in Turkey, Romania, and Georgia regarding the WTP estimation for marine protected areas (MPAs). The present study tries to cover the research gaps regarding the amelioration of Black Sea marine conditions and to promote Blue Growth actions in the broader region.

Some research questions (RQ) can be linked to the impact of socioeconomic parameters in the three pilot sites (i.e., Turkey, Romania, and Georgia) on the WTP levels either per proposed price or per hypothetical scenario, for example:

RQ1: Is gender a pivotal factor for WTP estimation?

RQ2: How can age impact the WTP evaluation?

RQ3: Is there an interrelation between the income level and WTP?

RQ4: How being married can be a pressing factor for WTP?

RQ5: Educational level is a prerequisite for environmental sensitivity?

*RQ*6: Can WTP estimation be severely affected by employment status?

The structure of research begins with Section 2 which delves into the recent literature review for the multi-stressors in the Black Sea, Section 3 is devoted to the Materials and Methods, Section 4 is attributed to the Results and Discussion, Section 5 presents core management implications and finally, Section 6 concludes the paper and provides state-of-the-art policy implications.

2. Institutional frameworks for copying with Black Sea's multi-stressors

Marine conservation planners ought to blueprint strategies against global mega-trends such as rapid biodiversity loss (Duarte, 2000; Gamfeldt et al., 2015; Halkos and Matsiori, 2011, 2014; Koundouri et al., 2023a; Pressey et al., 2003; Worm et al., 2006). A seemingly difficult challenge due to the multidimensionality of biodiversity and its effects on human health and well-being (Sala and Knowlton, 2006). Stachowicz et al. (2007) proposed that both temporal and spatial heterogeneity should be taken into account when observing the linkages between marine biodiversity and ecosystem functions. Another important aspect as mentioned by Beaugrand et al. (2010) is that a biodiversity rise might have negative impacts, the reason why is that there should be harmony between – phytoplanktonic and zooplanktonic– biodiversity, otherwise there might be fewer ecosystem functions even for humans.

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Invasive species can deregulate the local biodiversity. It has been monitored a zooplankton decline due to a rapid emergence of planktivorous fishes and jellyfish in the Black Sea in the decades of 1970s and 1980s. Sala and Knowlton (2006) and Shiganova and Bulgakova (2000) observed a similar relation as there was a reduction of pelagic predatory fish for the same reason. Dasgupta (2021) distinguished that top-predators overfishing ushered to "more planktivorous fish at lower trophic levels". Hence, it is pivotal that policymakers shed more light on these issues, aiming to have a stable and healthy marine ecosystem in the Black Sea.

Eutrophication has been a long-lived challenge for the Black Sea (Borysova et al., 2005). The Black Sea has been characterized as "one of the most contaminated seas in the world" because of commercial, industrial, and civilian activities by the six surrounding coastal states, i.e. the Russian Federation, Ukraine, Romania, Bulgaria, Georgia and Turkey (Halkos and Galani, 2013). In addition, the flows from the main European and Asian rivers, inter alia Danube, Sakarya, Kizil, on, Dnipro, and Dniester or other minor rivers, transfer marine litter into the basin (Borysova et al., 2005).

The waste crisis is a significant stressor on marine ecosystems. Marine litter such as plastic bottles and bags burdens the Black Sea (Atabay et al., 2020; Paiu et al., 2020; Simeonova et al., 2020). Moreover, heavy pollution derives from wastewater discharges and air pollutants (Borysova et al., 2005). Microplastics in marine litter are also an integral part of the EU Action Plan on Zero Pollution (EC, 2021a). Having these multi-stressors in mind, the following will present the main institutional tools that can strengthen conservation strategies in marine ecosystems.

2.1. Institutional Framework for the Protection of Marine Ecosystems

Cooperation at international or regional level is crucial for the transition towards sustainable development. The United Nations Convention[1] on the Law of the Sea (UNCLOS, 1982) accelerated the cooperation among States in relation to semi-enclosed seas. There are several anthropogenic or natural-driven challenges in semi-enclosed basin nature (Remoundou

[1] UNCLOS at Article 122 (definition of enclosed seas) and Article 123 (States' responsibilities) calls, inter alia, for cooperation on (i) management and conservation of natural resources, (ii) protection and preservation of the marine environment, and (iii) strengthening of scientific research and policymaking.

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et al., 2009). Pressures on marine biodiversity, especially in MPAs, can derive from plenty of economic activities inter alia tourism, fisheries, shipping industries, and aquaculture (Griffiths et al., 2020; Magris et al., 2018). The spotlight is on the MPAs because they consist of sanctuaries for endangered species, pivotal for marine biodiversity resilience (EC, 2015).

Integrated coastal zone management (ICZM) necessitates holistic and comprehensive policies for the protection of marine biodiversity. An ICZM can safeguard the quality of life in coastal regions, either for environmental protection (e.g., erosion, flooding, and storms) or anthropogenic resilience (e.g., climate change and pollution) (CEC, 2006; Halkos and Matsiori, 2018a, 2018b). In parallel, there are four Regional Sea Conventions (RSCs): (i) the Helsinki Commission (HELCOM) for the Baltic Sea established in 1974, (ii) the Oslo and Paris (OSPAR) Commissions in 1992, (iii) the Barcelona Convention in 1976 for the Mediterranean, and (iv) the Bucharest Convention in 1992 for the Black Sea.

These RSCs are contributing to the safeguarding of MPAs through the implementation of robust management and networking frameworks (EEA, 2015). Nevertheless, the complexity of the European marine-focused framework can be an obstacle to practical implementation. Figure 1 illustrates a naive categorization of several European policies and strategies, the figure's inner circles show the core European policies, whereas the outer circles present the broader framework.

Central policies in Europe regarding the protection of marine ecosystems are provided in the EU Marine Strategy Framework Directive, the Water Framework Directive, and the directives regarding birds and habitats. First, the EU *Marine Strategy Framework Directive* (MSFD) focuses mainly on marine biodiversity conservation and citizens' well-being (EC, 2008a). Second, the water framework directive aims at pollution abatement (European Parliament, 2000). Third, the directives on birds (European Parliament, 2013) and habitats (European Parliament, 1992) consider the protection of biodiversity (e.g., fauna and flora) in the European continent.

Moving to the second inner circle of Figure 1, these frameworks aim for the proper management of fisheries. The four objectives of the Common Fisheries Policy (CFP) (2023) are contributing to (i) productivity issues, (ii) better market structures, (iii) provision of healthy food, and (iv) economical prices in local products and services. In addition, the action plan on sustainable and resilient fisheries deals with over-fishing through initiatives on stabilizing the fish stocks (EC, 2023a). Both policies promote the efforts of the EU's biodiversity strategy for 2030, which will be explained in the next steps.

Figure 1: The European Framework for Marine Biodiversity.

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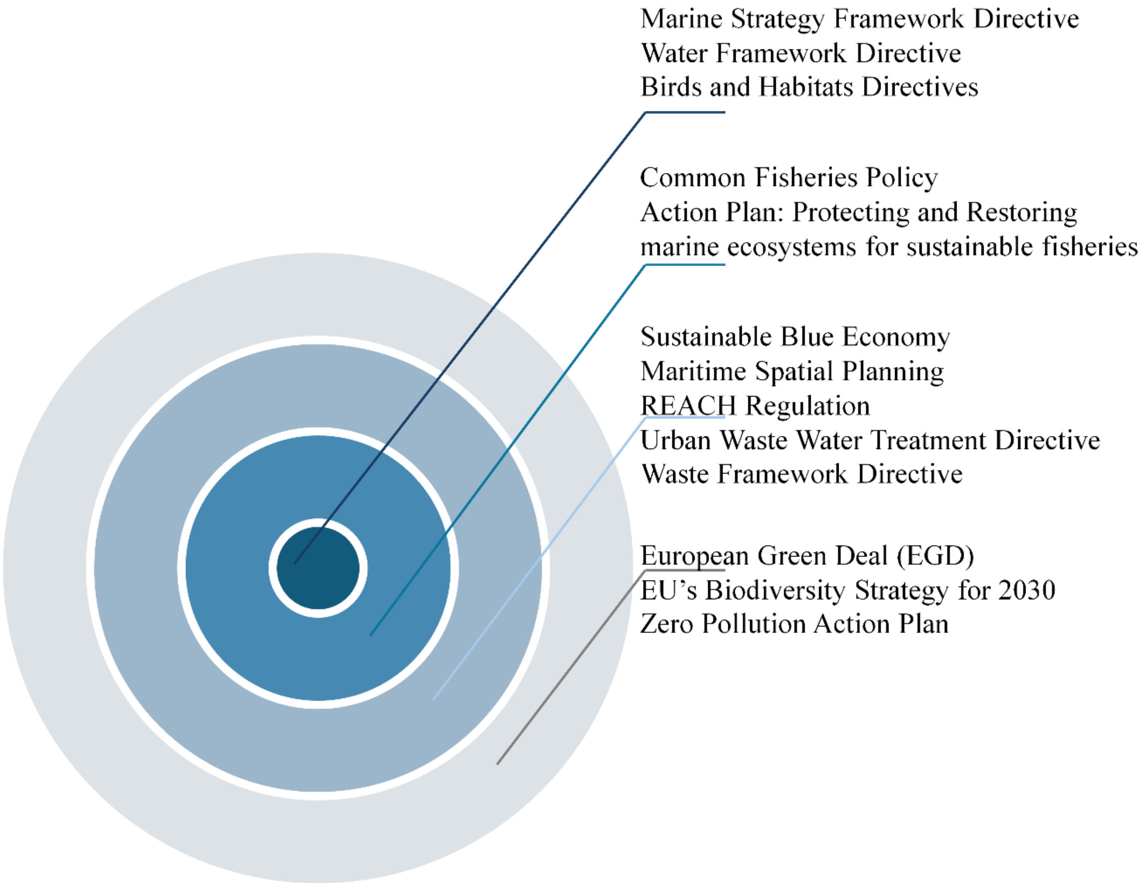

Source: Figure created by the authors.

Blue economy prerequisites for spatial planning and waste management. The EU's blue economy policy framework (EC, 2021b) in tandem with the marine spatial planning frameworks (European Parliament, 2014) tries not only to boost inter-regional collaborations, but they consider the MPAs conservation. However the waste crisis pressures the above efforts and operations, for instance, the rivers' runoffs from the Black Sea bordering states impose challenges for local economies and ecosystem preservation. The EU answered this conundrum through the REACH Regulation (EC, 2023b), the urban waste water treatment directive (EEC, 2014), and the Waste Framework Directive (EC, 2008b). This institutional framework copes with waste flow reduction and is mainly for the aversion of hazardous waste to reach water bodies. These runoffs are typically responsible to a great extent for the eutrophication at the Black Sea.

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The "umbrella" European institutional framework coordinates and monitors the above strategies, directives, and policies in order to safeguard marine biodiversity. Central is the role of the European Green Deal (EGD) (EC, 2019), which takes into consideration all sectors' activities regarding the mitigation of climate change, environmental conservation, and human well-being. Additionally, the EU Action Plan on Zero Pollution (EC, 2021a) aims to conserve water quality through a plethora of best practices in plastic litter and microplastic reduction by 50% and 30% respectively. Thus the reduction of waste in water bodies is a prerequisite for sustainable development. In parallel, the EU Biodiversity Strategy for 2030 (EC, 2020) has been put into action to stop biodiversity loss in the European region in line with the Convention on Biological Diversity imperatives. Having in mind these four categories of policies in the EU, the international efforts to protect marine ecosystems have spearheaded the sustainable development pathways.

The 17 Sustainable Development Goals (SDGs) have been developed by the United Nations (UN) in 2015. The protection of marine resources belongs to the scope of SDG 14 (i.e. life below water), which sub-targets promote blue growth initiatives by dealing with the issues of eutrophication, over-fishing, plastic pollution, and climate warming (Koundouri et al., 2023b; UN, 2016). Several aspects of SDG 14 are necessary and indispensable for a proper institutional framework for the development of trade-offs or co-benefits (Nilsson et al., 2018). SDGs have expanded the efforts of their predecessors, i.e. the Millennium Development Goals (MDGs). For example, MDG 8 and its target 2 considered biodiversity loss as a significant challenge of our future, however in 2013 almost one-third of marine fish stocks were over-exploited, destabilizing the global fisheries' sustainable production (UN, 2013). In essence, the transition from MDGs to SDGs alerted not the incapability of the MDGs, but what Vandemoortele (2011) noted as "*The debate about the post-2015 framework should not be about the usefulness of global targets but about their improved architecture and enhanced relevance*". Next in order, the economic valuation of marine ecosystem services is going to be presented as a powerful tool for policymakers to blueprint sustainable and inclusive strategies on MPAs protection under ICZM.

2.2. Economic Valuation of Ecosystem Services

The *total capital* of our economies consists of three important integral parts, i.e. natural, human, and man-made capitals (Dasgupta, 2021; Halkos, 2023; Nijkamp, 2012). First, all forms of natural resources are part of the *natural capital* (e.g., renewable energy sources). Second, all

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intellectual characteristics are intrinsic parts of the *human capital* (e.g., experiences and skills). Third, the built environment is part of the *man-made* capital (e.g., infrastructure). Additionally, UNESCO (2003) necessitated an expansion of the previous total capital scheme by taking into account the *social* (e.g., society's engagement) and *cultural* (e.g., historic aspects) capitals.

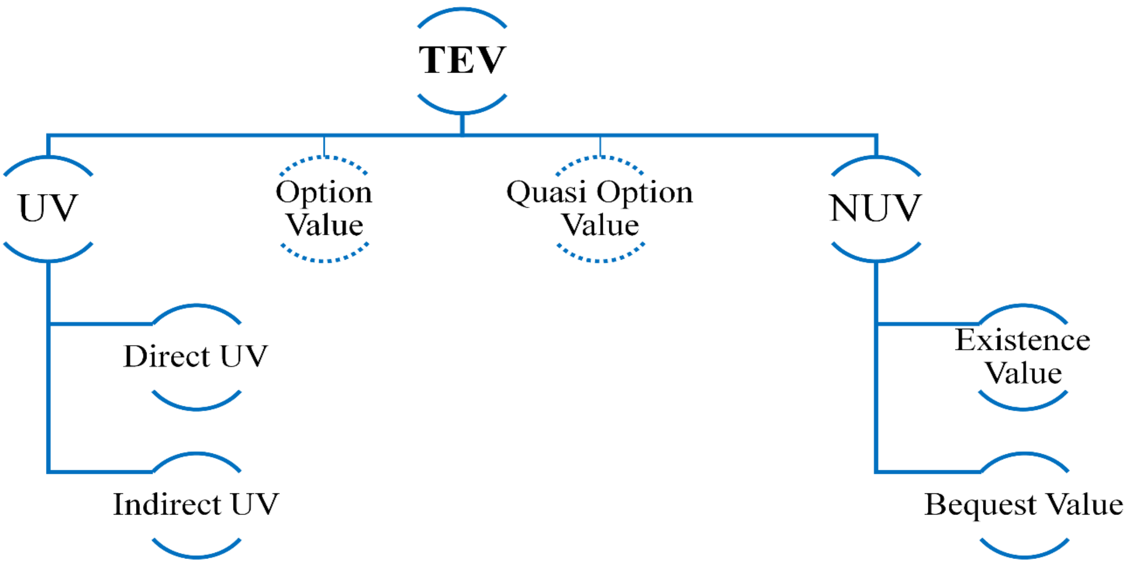
Having the types of capital in mind, the explanation of economic valuation techniques can lead to a better understanding of how to monitor ES measurement through robust econometric valuation. Economic valuation of ES is able to uncover covert socioeconomic elements that are interlinked with individuals' consumption attitudes, ultimately these econometric techniques estimate the total value of ES through existing or hypothetical markets (Stergiopoulou et al., 2020). The *total economic value* (TEV) (eq. 1 and Figure 2) of ES can be categorized into *use values* (UV) and *non-use values* (NUV).

$$TEV = UV + NUV \quad (1a)$$

$$TEV = (DUV + OV + QOV) + NUV \quad (1b)$$

Moreover, a policymaker should not consider only the UV and NUV because there are also the *option value* (*OV*) and the *quasi-option value* (*QOV*) of the ES. It is important to mention that the UV derived from ES can be evaluated via observable data sources, whereas NUV can be observed via revealed preference techniques (e.g., travel-cost method) or stated preference methods (e.g., contingent valuation) (Halkos, 2023).

Figure 2: Total economic value of ecosystem goods and services.



Source: Figure created by the authors based on Halkos (2023).

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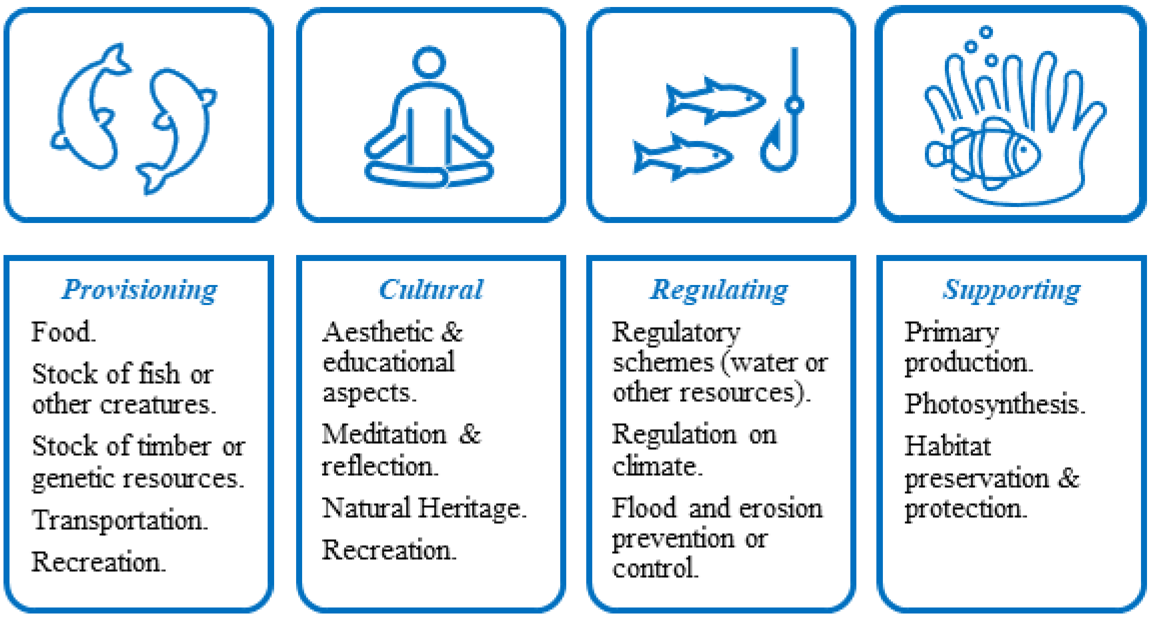
Millennium Ecosystem Assessment (MEA) agglomerated the core fundaments of ES that showcase how the natural environment might affect citizens' lives, i.e., through provisioning, cultural, regulating, and supporting services (MEA, 2005). The ES from MEA is illustrated in Figure 3. Essentially, the evaluation of TEV can become a powerful policymaking tool as it can unveil the interlinkages between UV and NUV.

The Economics of Ecosystems and Biodiversity (TEEB) presented in 2010 the potential of environmental economics valuation and their impact on biodiversity conservation (Kumar, 2012; TEEB, 2010). Eventually, "The Economics of Biodiversity: The Dasgupta Review" focused on the Black Sea due to the emergence of several anthropogenic-driven multi-stressors (Dasgupta, 2021, p.407). Both frameworks necessitate environmental integrity in marine ecosystems.

Figure 2: The benefits of natural goods and services.



Source: Figure produced by the authors based on MEA (2005).

The beneficial impact of ES on peoples' well-being can be evaluated through willingness-to-pay (WTP)[2] techniques (Halkos and Matsiori, 2012, 2011; Markandya et al., 2019). Additionally, economic theory over the estimation of WTP can be exercised either through the revealed preferences (e.g., price-response) or from stated preferences (e.g., a personal

[2] A person's WTP can be defined as the maximum price that a person is willing to buy for one product (Varian, 1992).

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preference) (Breidert et al., 2006; Louviere et al., 2000). In addition, there is a discussion regarding the WTP estimation on ES at the Black Sea. Appendix A (Table A.1) includes information regarding different studies' motivations, geographical location, and the associated references. For instance, the estimation of economic losses due to nutrient enrichment (Knowler et al., 1997; Taylor and Longo, 2010, 2009) or from invasive species (Knowler, 2005). Public health issues due to diminished water quality (Remoundou et al., 2014, 2011), and the waste crisis (Brouwer et al., 2017). However, in the literature (Table A.2) there is a focus on positive environmental aspects, inter alia, the cultural liaisons with environmental quality (Baulcomb et al., 2015; Fletcher et al., 2014), the beneficial impact of seagrass meadows in economic activities (Stergiopoulou et al., 2020), and recreational fishing (Aydın et al., 2013).

3. Materials and Methods

In the present research, we conduct primary research in three Black Sea bordering countries, namely, Turkey, Romania, and Georgia. It should be mentioned that Bulgaria has not participated in the questionnaires as similar primary research has been performed in the framework of "RECONNECT" Regional cooperation for the transnational ecosystem sustainable development, Interreg V-B "Balkan-Mediterranean 2014-2020" (Stergiopoulou et al., 2020).

3.1. The Black Sea

The Black Sea region has linkages to the Atlantic Ocean through the Mediterranean Sea. Black Sea covers 436,402 square kilometers and is unequivocally an economically important body of water as it connects European and Asian markets, moreover, local economies are highly dependent on the Black Sea due to diverse economic activities, inter alia fishing, tourism, and recreation, shipping, and transport. Essentially, the Black Sea is a pivotal biodiversity hot spot as it contains a rich marine life and supports 180 species of fish, including either edible marine species (e.g., turbot, anchovy, and horse mackerel) or other species (e.g., bottlenose dolphins and seals), as well as phytoplankton and zooplankton.

Our research includes three Pilot Sites (PS), more specifically PS1 is Turkey, PS3 is Romania, and PS6 is Georgia. All these countries are part of the Black Sea region together with Russia, Ukraine, and Bulgaria, nevertheless, the last three coastal regions have been excluded by the research sample due to either the Russo-Ukrainian War (Russian Federation and Ukraine)

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or the fact that a similar project has already been held on that region (e.g., Bulgaria) as in Stergiopoulou et al. (2020).

3.2. The Choice Experiment Questionnaire

Choice Experiment (CE) modeling belongs to the stated preference methodologies (Louviere and Hensher, 1983; Louviere and Woodworth, 1983), CE is utilized in economic valuation in order to estimate the welfare effect of non-marketed goods or services through hypothetical scenarios. CE modeling allows for marginal changes evaluation considering multi-dimensionality, making it easy for interviewees to sincerely reveal their preferences in more detail (Nalle et al., 2004). CE scenarios have different levels of the utilized attributes in order to grasp the marginal values of changes that are intertwined with the environmental status (Boxall et al., 1996), even for the monitoring of cultural bequest values related to ES (Oleson et al., 2015).

Having the above in mind, in our research, the CE questionnaire has been distributed on the Google Forms platform. The language of the questionnaire is primarily in English but there was also the choice for a translated edition into the local countries' language (i.e, in Turkish, Georgian, and Romanian), additionally, the choice cards WTP was expressed in both in euros and in local currencies (i.e. Turkish lira, Romanian leu, and Georgian lari). Overall the responders' input to express their WTP by comparing the presented Status Quo and its improvements as explained below. The collection of the questionnaire answers was conducted from 29/05/2023 to 21/11/2023, amassing 375 responses, in more detail, 118 (31.47%) responses from Turkey, 108 (28.8%) from Georgia, and 149 (39.73%) from Romania. It ought to be mentioned that all Scenario cards have been tested for orthogonality using advanced econometric and programming techniques in R-studio.

The questionnaire structure has five parts and the CE part consists of three different scenarios. The five parts of the CE questionnaire commenced with general interviewees' opinions on the Black Sea (Part I), and geographical-related information (Part II), followed by the CE scenarios (Part III), the demographic and attitude profile (Part IV), and lastly by the interviewees' feedback (Part V). All three CE scenarios have four price levels, i.e. 10€, 20€, 40€, and 80€ respectively, or even the choice of zero WTP (i.e., the Status Quo). Moreover, the five attributes are (i) the status of edible and charismatic fish being either in "good" or "under pressure" status, (ii) the existence of marine litter, (iii) the condition of the beach either being "occupied" or "natural", (iv) the MPA zoning with four activities (e.g., anchoring, professional

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fishing, recreational fishing, and recreational activities), and (v) carbon sequestration at low, medium, or high levels linked to Zostera Seagrass.

3.3. Demographic and attitude characteristics

The main socio-economic characteristics of the three pilot sites are illustrated in Appendix B (Table B.1). Most of the responders in all pilot sites are females, more specifically 60% are females, 37.6% are males, and a noteworthy part of the sample (2.4%) preferred to not specify their gender orientation. Similar to our study gender statistics can be found in the literature review (Baulcomb et al., 2015; Remoundou et al., 2014; Stergiopoulou et al., 2020), nevertheless in the study of Fletcher et al. (2014) the male responders attained 60% of the sample.

Regarding the responders' age, the preponderance of the Romanian sample (26%) belongs to the category "46-55 years old", while a relatively younger majority group is in Turkey (31%) in the category "35-45", and in Romania (30%) in the category "26-35 years old". Our study's results follow the literature's outcomes, as the highest percentage in all pilot sites belongs to the age range "29-44 years old".

Moreover, it should be noted that our study has employed seven different income levels and currencies as in Appendix B. Referring to the marital status, overall the majority of the responders are married (57%), followed by the people who specified that are single (35%), whereas 5.87% are separated or divorced or even widowed (1.33%).

Moving forwards, education plays an important role in environmental sensitivity, in our study the responders' educational level is significantly high, as they have attained a university degree (30%), a post-graduate degree (27%), or a doctorate (32%). Additionally, the responders' occupation can be important to WTP estimation. Most of the respondents work full-time in the public and private sectors by 53% and 19% respectively, accordingly only a minor percentage work part-time in these sectors at 2% and 3%. The rest responders are either students (8%), unemployed (2.13%), homemakers (1.33%), pensioners (1.07%), or "others" (8.27%). Last but not least, two-thirds of the responders' occupations are related to the natural environment.

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Table 1: Descriptive Statistics

	Georgia			Romania			Turkey			All Pilot Sites		
	Scenario A	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*	*Scenario A*	*Scenario B*	*Scenario C*
Mean	27.39	26.69	28.39	22.85	22.93	23.00	25.74	26.59	25.81	25.11	25.17	25.50
Median	35.00	35.00	37.50	30.00	35.00	35.00	36.25	35.00	37.50	35.00	35.00	37.50
Maximum	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Std. Deviation	13.24	13.5	13.49	15.8	16.38	16.41	13.95	14.45	14.85	14.60	15.04	15.22
Skewness	-0.94	-0.83	-1.05	-0.39	-0.44	-0.43	-0.65	-0.88	-0.68	-0.64	-0.70	-0.69
Kurtosis	2.30	2.12	2.49	1.37	1.35	1.34	1.81	2.05	1.69	1.72	1.74	1.71
Jarque - Bera	19.86	17.54	21.31	20.30	21.89	21.60	14.02	18.09	16.19	51.22	55.35	56.22
Prob. (JB)	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Obs.	118	118	118	149	149	149	108	108	108	375	375	375

Table 1 illustrates the descriptive statistics of each pilot sites based on scenario approaches. As it is observed, each pilot site has no big volatility regarding the WTP values per Scenario. More specifically, Georgia has a lowest average WTP equal to 26.69€ (Scenario B), while the highest average WTP equals to 28.39€ (Scenario C). Romania's values have even less volatility with the average WTP range being 22.85€ - 23.00€. In the same path, Turkey provides average WTP values ranging from 25.74€ to 26.59€. In all three cases, the maximum WTP observed equals to 37.50€ which is logical considering the 4 available price options given in the questionnaire, while the minimum WTP recorded in all cases is 0.00€, and it represents responders who decided to remain at Status Quo are not willing to pay for any improvements based on the three proposed Scenarios.

When examining the interviewee responses, it is crucial to examine whether the observations follow the normal distribution. By using the Jarque Bera diagnostic testing, we can support the belief that all scenarios in all pilot sites do not follow the normal distribution since the null hypothesis is rejected in all cases.

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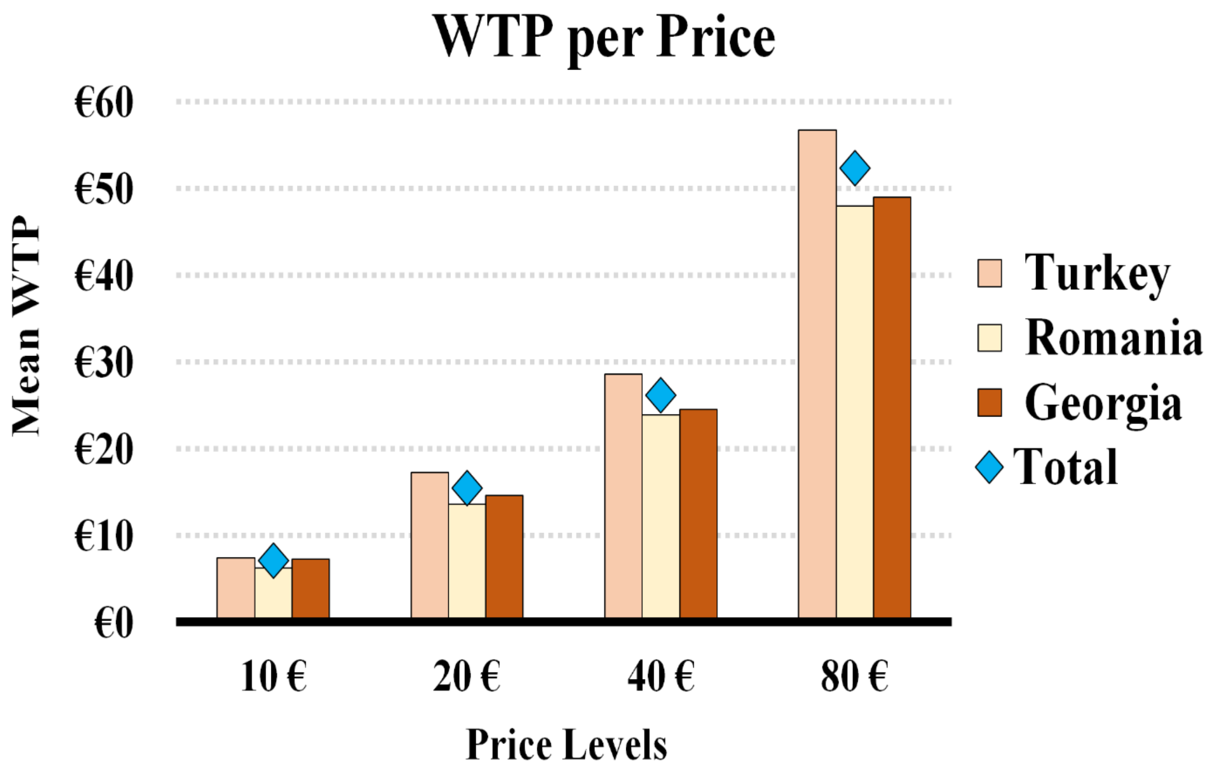
4. Results and Discussion

The main results section, regarding the WTP estimation, is dedicated to all CE scenarios and for all price levels in the three pilot sites. The mean WTP per price for each CE scenario is presented in Figure 4. Moreover, the results in Appendix C (Table C.1) illustrate the mean WTP per price of all three scenarios and the total WTP estimations regarding the total sample.

Figure 4: Willingness to pay per price



Keeping in mind the lowest WTP provided in the CE cards (i.e., 10€) the total WTP estimation of all pilot sites equals 7.08€, which is comparable with the lowest option in the study of Taylor and Longo (2009) with 7.73€. The highest WTP result is attributed to Turkey (7.37€), followed by Georgia (7.23€) and Romania (6.26€), moreover, Romanian WTP is lower than the total price for all pilot sites in this example.

Regarding the second price in the CE cards (i.e., 20€) the mean WTP for all pilot sites is 15.43€, comparable to the lowest choice in the study of Baulcomb et al. (2015) with 17.49€. Turkey again has the highest mean WTP (17.29€), followed by Georgia (14.58€) and Romania (13.6€).

Moving forward to the third price option (i.e., 40€) the overall WTP is 26.2€, comparable to Stergiopoulou et al. (2020) who retrieved a WTP for coastal protection and

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fishing restriction the values of 23.98€ and 20.82€ respectively. Furthermore, Baulcomb et al. (2015) found that the WTP values for substantial jellyfish bloom reduction and moderate species population visibility are 29.95€ and 24.66€ respectively. Remoundou et al. (2014), similarly to our result, found that the WTP for health risk reduction can be equal to 25.54€. Our study found that Turkey there is the highest mean WTP (28.59€) followed by Georgia (24.52€) and Romania (23.89€).

Lastly, the fourth available choice (i.e., 80€) reveals that the mean WTP for all pilot sites is 52.34€, which is similar to the WTP for aesthetic benefits and cultural heritage with WTP equal to 55.31€ and 43.05€ respectively. The highest mean WTP is linked to Turkey (56.72€), which is followed by Georgia (49.04€) and Romania (47.96€).

Wanting to unveil the covert factors that might have impacted the responders' WTP choices, we performed a Cross-Tabulation Analysis based on the socioeconomic characteristics. Through Cross-Tabulation Analysis one could use the study's results in order to answer the six research questions as presented in the introduction section.

First, in Turkey the responders' gender (RQ1) and age (RQ2) seem to not seriously impact the WTP because most of the responders prefer higher mean WTP, moreover surprisingly the same stands for income levels (RQ3) and marital status (RQ4). Peculiarly, educational level (RQ5) does not lead to the conclusion that lower educational levels can usher in lower WTP for ES improvements, considering that there are few participants of lower educational status. Lastly, as can be seen in Appendix B (Table B.1) most responders work full-time either in the public or private sectors, but occupational status (RQ6) concentrates on higher mean WTP levels.

Second, in Romania, gender orientation (RQ1) plays no significant role in WTP, whereas higher age (RQ2) is linked to even higher WTP levels. Referring to the income parameter, the lower the income, the lower the responders' WTP. Interestingly, the married responders (RQ4) in Romania seem to choose lower mean WTP levels, possibly due to households' needs and the limited disposable income for environmental amenities. It is also surprising that citizens with higher educational levels (RQ5) express lower WTP for environmental improvements, it is peculiar as it is expected that this type of responders tends to be environmentally sensitized considering their better income status. Furthermore, in Romania, full-time occupation (RQ6) is linked to higher mean WTP.

Third, in Georgia and similarly to the previous pilot sites gender (RQ1), age (RQ2), and marital status (RQ4) have a minor impact on WTP, considering that the majority prefers higher WTP. It is strange to find that the income levels (RQ3) do not have an important impact on

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WTP, for example, even the lower income levels do not seem to be linked to lower mean WTP. Moreover, education (RQ5) is not a factor in pushing WTP choices, while full-time employment (RQ6) tends to be linked to higher mean WTP.

Having in mind the different WTP choices, now it is time to delve into the impact of the three different hypothetical CE scenarios. WTP is undoubtedly a powerful tool for policymakers, however hypothetical future scenarios can expand the economic actions and initiatives on blue growth.

The structure of each CE scenario has as a prerequisite the Status Quo condition in all three cases, more specifically in Figure 5 and in more detail in Appendix C (Table C.2) there is the provision of all WTP values per CE scenario per country. This means that the same Status Quo among the pilot sites allows for comparison in the hypothetical future conditions regarding the MPA zoning specification. Essentially, there are three CE scenarios, firstly, Scenario A is full inclusion of all attributes in the MPA zoning (i.e., amateur fishing, anchoring, professional fishing, and recreation), secondly, Scenario B does not include amateur fishing, and thirdly, Scenario C excludes both amateur fishing and anchoring.

Principally, the highest WTP for all pilot sites is linked to Scenario C with a WTP of 25.51€ contrary to Scenario B (25.17€) and Scenario A (25.11€). Leading to the conclusion that the responders desire to pay more for a radical answer to overfishing and marine litter.

Regarding the Turkish sample, the responders have primarily chosen Scenario C (28.39€) over Scenario A (27.39€) and Scenario B (26.69€). One might suppose that the responders are willing to pay more for coastal protection from marine litter and improvements linked to species status, leading to a "sacrifice" attitude towards the MPA zoning of ES of the Black Sea. Another comment can be found in the fact that Scenario A has greater WTP than Scenario B, meaning that the responders find it a mediocre policymaking action to just restrict amateur fishing.

Contrary to the previous results, Georgia expresses higher WTP values for Scenario B (26.60€) against Scenario C (25.81€) and Scenario A (25.74€). It is therefore surprising that the responders call only for the exclusion of amateur fishing in Scenario B and not a more drastic actions as in Scenario C with the exclusion both of amateur fishing and anchoring.

Moreover, in Romania, the responders have selected Scenario C (23€) over Scenario B (22.94€) and Scenario A (22.85€), this decision possibly lies with the amelioration of environmental conditions, either to species status or to coping with waste. One should bear in mind that another important factor is the higher levels of carbon sequestration that might usher in a monetary "sacrifice" for the sustainable development of MPA zoning.

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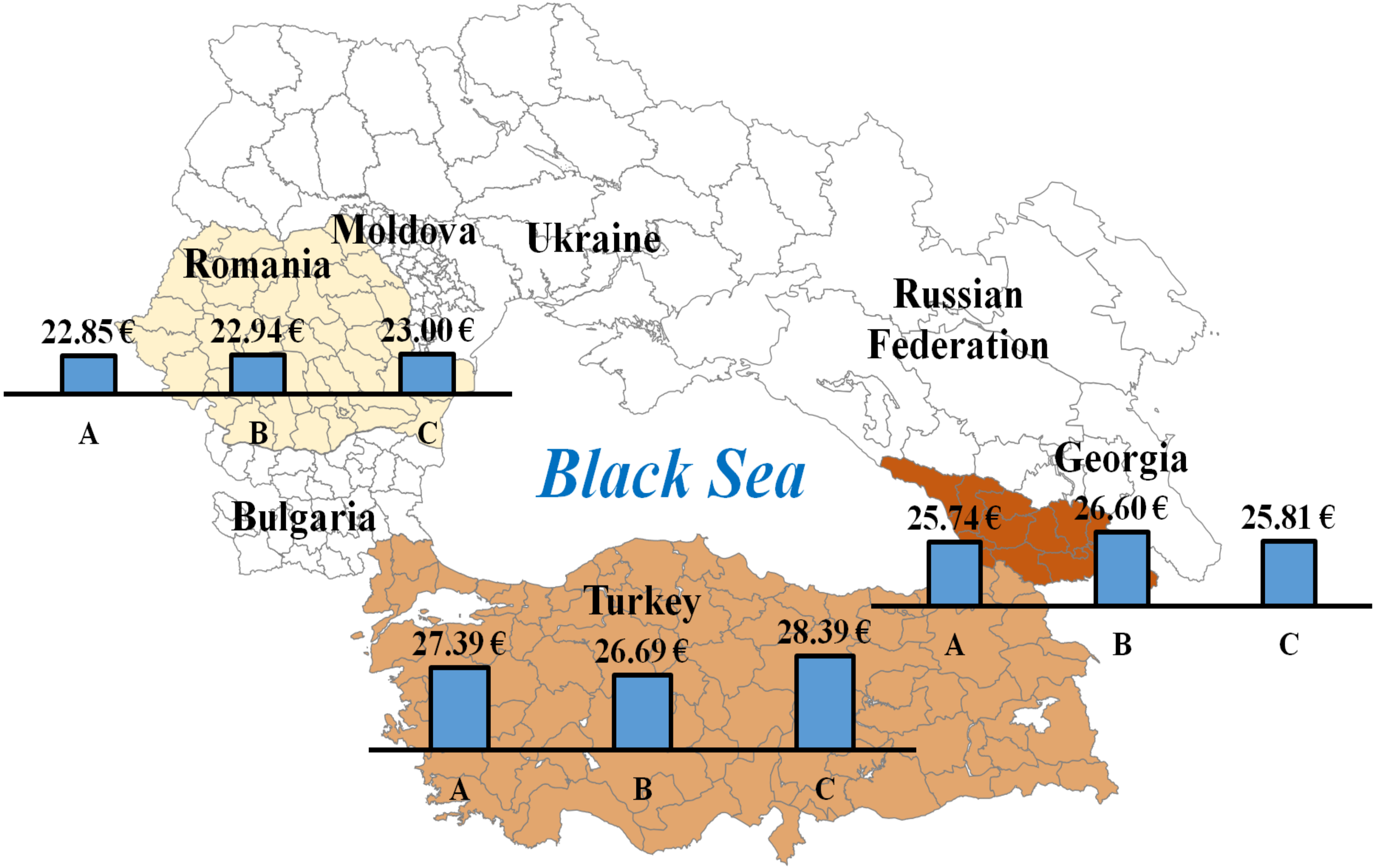
Figure 5: Willingness to pay per scenario in the three pilot sites



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5. Management Implications

In our study, Turkey revealed the highest WTP estimation in all three CE scenarios, followed by Georgia, and Romania. More specifically, focusing on the WTP per price, Turkey's WTP range was from 7.37€ to 56.72€, Georgia's range was from 7.23€ to 49.04€, whereas Romania's WTP range was from 6.26€ to 47.96€. Overall the WTP per price has a range from 7.08€ to 52.34€.

The WTP estimations from the case studies showcase the need for public support regarding the environmental protection in the Black Sea, paving the way for important Blue Economy breakthroughs, policies, and initiatives. Such instruments can leverage the high WTP values in order to establish sustainable tourism and eco-friendly fisheries. More specifically, sustainable tourism must take into account the marine biodiversity, attracting eco-responsible tourists. In a similar way, sustainable fisheries that comply with the European institutional framework on marine conservation can confirm economic benefits.

Moreover, we proposed some hypothetical scenarios by improving the environmental condition (i.e., WTP results per scenario). WTP of Scenario A (i.e., all attributes) is 25.11€, with the highest WTP in Turkey (27.39€), followed by Georgia (25.74€), and lastly by Romania (22.85€). Next in order, for Scenario B (i.e., all attributes without amateur fishing) WTP is 25.17€ with the highest WTP linked again with Turkey (26.69€), followed by Georgia (26.6€), and Romania (22.94€). Additionally, the results for Scenario C (i.e., all attributes except amateur fishing and anchoring) WTP is 25.51€ in which Turkey showcased the highest WTP (28.38€), then Georgia (25.81€), and Romania (23€). Essentially, the stricter Scenario C, the higher the responders' WTP, as Scenario C presents higher WTP than Scenarios B and A with WTPs of 25.51€, 25.17€, and 25.11€ respectively.

Given the highest WTP for Scenario C, ES management ought to safeguard vulnerable marine habitats. This could be achieved by establishing MPAs, where fishing and anchoring are either restrained or banned. Therefore the conservation of critical ecosystems and biodiversity hotspots can be achieved. Furthermore, technology-based solutions (e.g., satellite surveillance and drone monitoring) can negate negative human-driven activities in these MPAs.

Finally, intergovernmental initiatives among Turkey, Georgia, and Romania can re-align environmental policies, integrating the diverse strategies under a novel "umbrella policy" for the Black Sea. This integrated institutional framework can be achieved by standardizing fishing quotas, establishing uniform guidelines for marine tourism, and creating joint enforcement teams to monitor compliance across borders. Additionally, incentivization can play

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a significant role in the realization of these strategies. Apparently, all these can be attained only if public engagement and education campaigns are taken into consideration.

6. Conclusions

The present study aspires to uncover covert socioeconomic characteristics that can impact the overall WTP for ecosystem services conservation in the Black Sea via stated preference CE scenarios. Marine protected areas are safeguarded by the European institutional framework in order to boost policies and strategies in blue growth, considering the amelioration of citizens' well-being and the strengthening of local economies.

Pivotal is for policymakers to delve into the socio-demographic parameters that can affect the citizens' WTP for ecosystem services as mentioned in the six research questions. We performed a Cross-Tabulation Analysis in order to untangle the reasons why they have responded to these WTP levels. Surprisingly, some socioeconomic characteristics that do not play a significant role in WTP shaping are income, gender, and age. Furthermore, marital status and education might affect the WTP only in Romania, on the contrary there is no such result in Turkey or Georgia. In Romania, although the higher level of education ushers to lower WTP, it is surprising as education typically leads to environmental sensitivity. Last but not least, employment status might be an important factor in Romania and Georgia, but not in Turkey.

We would like to propose some policy implications regarding the safeguarding of marine ecosystems, primarily in the Black Sea but also applicable to other water bodies. First, the European institutional framework ought to stimulate through educational campaigns the environmental sensitivity and importance of our Seas. This policy can be linked also to sustainable tourism. Second, maritime spatial planning under the scope of integrated coastal zone management can mitigate marine litter and other negative externalities. Third, ecosystem-based management is a prerequisite for marine ecosystem services protection, for instance, nature- or technological-based solutions can accelerate the transition towards blue growth infrastructure. Fourth, sustainable fisheries management is crucial for the protection of local species populations and the red alarm for the emergence of invasive species that can lead to biodiversity loss. Overall these policy implications are interlinked to the aforementioned results of our hypothetical scenarios.

To recapitulate, our study aims to evaluate ecosystem services improvement in the Black Sea via non-marketed stated preference CE scenarios. Biodiversity loss, waste, and algal blooms that lead to eutrophication are multi-stressors in the Black Sea, therefore, we attempt to present how alternative scenarios can change stakeholders' answers regarding the ecosystem

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services improvement. In a nutshell, the economic valuation of ecosystem services via CE modeling can lead to a robust Blue Growth framework.

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Appendix A

Table A.1: A literature review on ecosystem services at the Black Sea.

Motivation of the study	**Location**	**Reference**
Estimate losses associated with nutrient enrichment of the Black Sea.	Regional.	(Knowler et al., 1997)
Assess losses from invasive species in the Black Sea.	Regional.	(Knowler, 2005)
Assess the recreational damage associated with algal blooms caused by nutrient flows into Varna Bay, Bulgaria.	Varna, Bulgaria.	(Taylor and Longo, 2010)
Assess the recreational damage associated with algal blooms caused by nutrient flows into Varna Bay, Bulgaria.	Varna, Bulgaria.	(Taylor and Longo, 2009)
Aiming to reduce the level of public health risk from bathing and improve water quality and the overall level of marine biodiversity.	Karaburun and Sile, Turkey & Sevastopol, Yalta, Odessa, Nikolaev, Eupatoria and Kherson, Ukraine.	(Remoundou et al., 2011)
Adopt a tax reallocation scheme as the payment vehicle and monitor whether the value of environmental goods is sensitive to the source of public financing.	Karaburun and Sile, Turkey & Sevastopol, Yalta, Odessa, Nikolaev, Eupatoria and Kherson, Ukraine.	(Remoundou et al., 2014)
One reason for selecting Turkey as a case study was that, with its extensive coastline, there were likely to be numerous strong links between marine ecosystems and the Turkish culture.	Istanbul and Şile, Turkey.	(Fletcher et al., 2014)
Economic valuation of cultural ecosystem services.	Istanbul and Şile, Turkey.	(Baulcomb et al., 2015)
Recreational fishing in the coastal areas, which have high total economic value.	Ordu, Turkey.	(Aydın et al., 2013)
Assess social costs of marine debris washed ashore and litter left behind by beach visitors in different coasts.	Burgas & Varna, Bulgaria.	(Brouwer et al., 2017)
Valuation of environmental services by the seagrass meadows, aiming to capture the economic dimension of the benefits from seagrass to humans.	Gradina-Zlatna Ribka, Bulgaria.	(Stergiopoulou et al., 2020)

Table A.2: Valuation methods and WTP (EUR at 2024 prices) of the studies at the Black Sea.

Method	**WTP**	**Reference**
Bioeconomic model	Generated revenues of EUR 3.83 million annually. *	(Knowler et al., 1997)

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Bioeconomic model	Economic profit reduction from EUR 29.82 million per year to EUR 0.292 million. **	(Knowler, 2005)
Choice experiment	Mean WTP a pay a one-off tax of EUR 12.94 for algal-free beach. Leading to an aggregated WTP of EUR 1.73 million for Varna's 2010 population. ***	(Taylor and Longo, 2010)
Choice experiment	WTP for a program that entails 1 week of algal bloom about EUR 28.34; 18.03; and 7.73 with high, medium, and low visibility respectively. ****	(Taylor and Longo, 2009)
Choice experiment	255,62 and 250,76 for high and medium water quality; 220,11 and 218,79 for high and medium biodiversity; and 190,44 and 320,69 for medium and low health risk.+	(Remoundou et al., 2011)
Choice experiment	WTR for Ukraine and Turkey. Ukraine: 99.9 and 109.35 for medium and high-water quality; 94.21 for high biodiversity; and 4.94 for health risk reduction. Turkey: 424.8 and 552,12 for medium and high-water quality; 494,66 for high biodiversity; and 25.54 for health risk reduction. ++	(Remoundou et al., 2014)
Choice experiment	EUR 11.45 and 17,49 for moderate and substantial species visibility. 21.79 and 38.71 for moderate and substantial traditional food; 19.21 and 26.95 for moderate and substantial bloom; 24.66 and 38.71 for moderate and substantial species population. +++	(Baulcomb et al., 2015)
Contingent Valuation & Travel Cost	EUR 8,372.7 and 133,963.2 for contingent valuation method and travel cost method respectively. ++++	(Aydın et al., 2013)
Choice experiment	EUR 10.06 for plastic litter removal and 8.61 for cigarettes removal. +++++	(Brouwer et al., 2017)
Choice experiment	EUR 42.79 and 43.74 for 5% and 20/40% fish abundance, 78.36 for water clarity, and 3.01 carbon sequestration. 55.31 and 76.96 for aesthetic benefits, 23.98 for coastal protection, 20.82 for light fishing restriction, moreover, 34.04 and 43.05 for underwater cultural heritage. ++++++	(Stergiopoulou et al., 2020)

*2.25 million USD at 1989 prices (4.15 million USD at 2024 prices, or 3.83 million EUR at 2024 prices).
**12.29 million EUR at 2008 from Remoundou et al. (2009) (16.58 million EUR at 2024 prices) and 0.217 million EUR (0.292 million EUR at 2024 prices).
***9.73 EUR at 2010 prices (12.94 EUR at 2024 prices). (1.73 million EUR at 2024 prices)
**** 33; 21; and 9 BGN at 2009 prices (are 55.44; 35.28; 15.12 BGN at 2024 prices, with 1 BGN equal to 0.51 EUR).
+€189.35 and €185.75 for high and medium water quality; €163.05 and €162.07 for high and medium biodiversity; and €141.07 and €237.55 for medium and low health risk (€1 at 2009 prices is €1.35 at 2024 prices).
++ Ukraine: €74 and €81 for medium and high-water quality; €69.79 for high biodiversity; and €3.66 for health risk reduction. Turkey: €314.67 and €408.98 for medium and high-water quality; €271.42 for high biodiversity; and €18.92 for health risk reduction. (€1 at 2009 prices is €1.35 at 2024 prices).
+++41 and 61 TL for moderate and substantial visibility; 76 and 135 TL for moderate and substantial traditional food; 67 and 94 TL for moderate and substantial bloom; 86 and 135 TL for moderate and substantial population. (1TL at 2012 prices is 9.56TL at 2024 prices; 1 TL at 2024 prices is 0.03 EUR at 2024 prices).
++++ 31,500 TL and 504,000 TL at 2013 prices (279,090 TL and 4,465,440 TL respectively at 2024, with 1 TL equal to 0.03 EUR at 2024).
+++++ 1 EUR at 2017 prices is equal to 1.22 EUR at 2024 prices.
++++++ 1EUR at 2019 prices is equal to 1.21at 2024 prices.

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Appendix B

Table B.1: Socio-demographic characteristics in the three Pilot Sites

	Turkey	Romania	Georgia	Total
GENDER				
Male	45.76%	32.88%	35.19%	37.60%
Female	50.87%	65.77%	62.04%	60.00%
Prefer not to say	3.37%	1.35%	2.77	2.40%
AGE				
18 – 25	13.56%	10.74%	17.59%	13.60%
26 – 35	23.73%	18.79%	30.56%	23.73%
36 – 45	31.35%	26.17%	19.44%	25.87%
46 – 55	14.41%	26.85%	12.04%	18.67%
56 – 65	11.02%	13.42%	11.11%	12.00%
Older than 65	5.93%	4.03%	9.26%	6.13%
INCOME*				
Level 1	3.39%	12.75%	23.15%	12.80%
Level 2	26.27%	21.48%	19.44%	22.40%
Level 3	25.42%	12.08%	15.74%	17.33%
Level 4	24.58%	9.39%	15.74%	16.00%
Level 5	17.80%	10.07%	6.48%	11.47%
Level 6	0.85%	16.11%	9.26%	9.33%
Level 7	1.69%	18.12%	10.19%	10.67%
MARITAL STATUS				
Single	35.59%	33.56%	37.04%	35.20%
Married	56.78%	60.40%	54.63%	57.60%
Separated/Divorced	7.63%	3.36%	7.41%	5.87%
Widowed	0.00%	2.68%	0.92%	1.33%
EDUCATION				
Has not attended/completed any education level	0.00%	0.00%	0.00%	0.00%
Primary School	0.00%	0.67%	1.85%	0.80%
Lower Secondary School	0.00%	0.00%	1.85%	0.53%
General/Vocational lyceum (upper secondary)	4.24%	4.03%	0.00%	2.93%
Institutes of vocational training (upper secondary)	2.54%	4.03%	1.85%	2.93%
Technical Vocational Institutes (Tertiary education)	1.69%	0.67%	3.71%	1.87%
Universities, higher military schools, Open Universities	37.29%	33.56%	17.59%	30.13%
Post Graduate Studies (Msc., MBA, MA, Mit, MPHIL)	22.04%	28.86%	30.55	27.20%
Doctorate	32.20%	26.84%	38.89%	32.00%
Other	0.00%	1.34%	3.71%	1.60%
OCCUPATION				
Full-time job in the public sector	44.07	58.39%	57.41%	53.60%
Part-time job in the public sector	0.00%	2.01%	6.48%	2.67%
Full-time job in the private sector	18.64%	25.50%	12.96%	19.73%
Part-time job in the private sector	5.08%	0.00%	5.56%	3.20%

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Unemployed	3.39%	0.00%	3.70%	2.13%
Pensioner	0.85%	2.01%	0.00%	1.07%
Student	10.17%	6.05%	8.33%	8.00%
Farmer	0.00%	0.00%	0.00%	0.00%
Homemaker	0.85%	2.01%	0.93%	1.33%
Other	16.95%	4.03%	4.63%	8.27%
Is your work focused on the environment?				
Yes	61.86%	59.73%	82.41%	66.93%
No	38.14%	40.27%	17.59%	33.07%

* The questionnaire for each pilot site includes 7 income levels that correspond to each country's economy. More specifically, according to Turkey's economy, we provided the following levels of income (0₺ - 6,999₺ , 7,000₺ - 149,999₺, 150,000₺ - 349,999₺, 350,000₺ - 549,999₺, 550,000₺ - 1,224,999₺, 1,225,000₺ - 1,899,999₺, 1,900,000₺+). According to Romania's economy, we provided the following levels of income (0 LEI – 5,999 LEI, 6,000 LEI – 11,999 LEI, 12,000 LEI – 23,999 LEI, 24,000 LEI – 35,999 LEI, 36,000 LEI – 47,999 LEI, 48,000 LEI – 71,999 LEI, 72,000 LEI+). According to Georgia's economy, we provided the following levels of income (0₾ - 7,999₾, 8,000₾ - 15,999₾, 16,000₾ - 23,999₾, 24,000₾ - 31,999₾, 32,000₾ - 39,999₾, 40,000₾ - 47,999₾, 48,000₾ +).

Appendix C

Table C.1: Willingness to pay results per price in the three pilot sites (PS)

	10 €	20 €	40 €	80 €
PS1: Turkey	7.37 €	17.29 €	28.59 €	56.72 €
PS3: Romania	6.26 €	13.60 €	23.89 €	47.96 €
PS6: Georgia	7.23 €	14.58 €	24.52 €	49.04 €
Total	7.08 €	15.43 €	26.20 €	52.34 €

Table C.2: Willingness to pay results per scenario in the three pilot sites (PS)

	Scenario A	Scenario B	Scenario C
PS1: Turkey	27.39 €	26.69 €	28.39 €
PS3: Romania	22.85 €	22.94 €	23.00 €
PS6: Georgia	25.74 €	26.60 €	25.81 €
Total	25.11 €	25.17 €	25.51 €

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