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Abstract
The present review examines the primary (heatwaves and air pollution) and cascading (population density, traffic and noise, health issues, and biodiversity loss) hazards in urban settlements. The motivation is to understand the interaction between hazards in urban areas to develop a novel holistic approach that enhances urban sustainability. Three objectives are (i) to monitor valuation studies that reveal willingness to pay (WTP) for major urban-related challenges, (ii) to assess non-marketed valuation studies, and (iii) to examine the interactions between the hazards and their impacts on people and the environment. Based on Environmental Valuation Reference Inventory and Ecosystem Services Valuation Database, from 5329 studies, 80 were retrieved that focus solely on the economic measures of 220 WTP values for different ecological and recreational issues during the period 2000-2023. The findings show that regarding the mean WTP (MWTP) values, the valuation studies reveal a MWTP of 142€ for heatwaves mitigation, whereas for air pollution 76€. Moreover, in terms of cascading hazards, the highest MWTP was for population density (298€), followed by biodiversity loss (96€), health issues (63€), and lastly by traffic and noise with 42€. However, biodiversity loss is the most significant stressor for all target groups (citizens, workers, and flora and fauna), therefore, policymakers should invest in green and blue infrastructure, energy-saving technologies, and transportation alternatives in order to improve urban resilience, safeguarding both human health and the natural environment.

Keywords: climate change, heatwaves, air pollution, biodiversity loss, population density, WTP, valuation studies

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1. Introduction

Urban environments, due to their high population density and extensive infrastructure, are especially susceptible to a wide range of primary and cascading (or secondary) hazards, their management is often called as "*multi-hazard assessment*" (Dall'Osso et al., 2014; S. Zhang et al., 2023). Over 55% of the global population resides in urban regions, and this figure is projected to increase to 68% by the year 2050 (WHO, 2021). Primary hazards refer to imminent dangers that immediately affect metropolitan areas, including heatwaves, air pollution, traffic and noise as primary hazards, whereas population density, health issues, and biodiversity loss are the cascading hazards. The occurrence of crises can affect the environmental equilibrium, a phenomenon called as "*multi-crisis*" (Halkos & Aslanidis, 2023c; Halkos & Zisiadou, 2020; Tooze, 2022). Therefore, the aim of the present review is to reveal individual's willingness to pay (WTP) preferences as an instrument of urban sustainability policies in dealing with multi-hazard occurrence.

Heatwaves, health repercussions, and biodiversity loss have become major issues for urban dwellers due to their rising frequency, intensity, and wide-ranging effects. Heatwaves are extended durations of extremely high temperatures, which can result in substantial damage to human security, infrastructure, and cultural heritage (Dasgupta, 2021; Halkos, Bampatsou, et al., 2024; Halkos, Koundouri, et al., 2024; Koundouri et al., 2024). Urban areas, with their concrete and asphalt surfaces, have a higher capacity to absorb and retain heat compared to rural regions, resulting in the phenomenon known as the urban heat island (UHI) effect (Degirmenci et al., 2021; Mohajerani et al., 2017). This phenomenon intensifies the consequences of heatwaves, resulting in exceptionally high temperatures that can overwhelm public health systems and raise death rates, especially among susceptible groups (e.g., the elderly, children) and specifically the energy poor households (Halkos & Aslanidis, 2023a). The prevalence of heatwaves, their adverse consequences on health, and the decline in biodiversity as urban hazards are a result of their interconnectedness and cumulative impact on one another (Lindley et al., 2019). Heatwaves not only result in immediate physical discomfort and health hazards, but they also lead to a decline in biodiversity by placing strain on plant and animal species that are not accustomed to intense temperatures.

Health impacts are a sequential danger that arise from first occurrences such as heatwaves, air pollution, traffic and noise. Urban areas experience elevated levels of air pollution as a result of the dense presence of vehicles, industrial operations, and energy usage. These activities emit pollutants into the air (Sicard et al., 2023). In addition, urban air quality frequently worsens during heatwaves as a result of elevated levels of ground-level ozone and particle matter, which intensify respiratory problems such as asthma and chronic obstructive pulmonary disease (COPD). The World Health Organisation (WHO) (2022) states that heatwaves and inadequate air quality are responsible for a substantial part of illness and death in metropolitan areas, highlighting the urgent requirement for adaptive interventions in public health infrastructure. Urban sustainability can also be negatively impacted even by poor soil conditions, as the pollution from heavy metals (Aslanidis & Golia, 2022), these contaminants can further worsen respiratory and cardiovascular ailments, resulting in higher rates of hospitalisation, decreased lifespan, and even untimely mortality. The WHO (2024) states that air pollution causes around 4.2 million deaths each year, with a considerable majority occurring in urban regions. In addition, air pollution has a role in climate change by releasing greenhouse gases and short-lived climatic pollutants, including black carbon, which directly cause warming and indirectly impact weather patterns and worsen air quality.

Urban biodiversity decline is a prominent hazard that is mostly caused by the mentioned primary and cascading hazards. Urban expansion frequently results in the destruction or fragmentation of natural habitats, which in turn leads to a decrease in urban plant and animal life. The decrease in biodiversity diminishes the ability of urban ecosystems to adapt to environmental changes and risks. For instance, the decrease in green areas and tree coverage not only reduces the cooling benefits supplied by plants, thereby exacerbating the UHI phenomenon (Founda & Santamouris, 2017), but also disturbs the local ecological equilibrium, rendering urban regions more vulnerable to other primary or cascading hazards (Aslanidis & Golia, 2022). Furthermore, the decline in biodiversity can undermine the functioning of ecosystem services such as the purification of air and water, hence exacerbating health hazards for urban populations (Mutafoglu et al., 2017).

Some research questions (RQ) that can be stated are:

RQ1: How primary hazards impact an individual's WTP preference on urban sustainability?
RQ2: How cascading hazards can affect an individual's WTP preference on urban sustainability?
RQ3: In which way hazards affect local citizens?
RQ4: How hazards impact the local flora and fauna?
RQ5: What is the impact of hazards on workers, either from indoor or outdoor employment?

The motivation of the present review is to comprehend the interaction between primary and cascading hazards in urban areas, aiming to create a novel holistic approach that improves urban sustainability based on individuals' preferences for urban ecosystem services preservation. The review's objective are (i) to monitor valuation studies that reveal MWTP for multi-hazard occurrence (i.e., primary and secondary hazards), (ii) to assess valuation studies that are based primarily on non-marketed techniques (e.g., choice experiments and continent valuation method), and (iii) to examine the current body of work on the interaction between air pollution, heatwaves, and their effects on human health, as well as the influence of biodiversity on urban areas. The structure of the present research begins with Section 2 on the literature review of the primary and cascading hazards, followed by Section 3 that presents the methodology, Section 4 in which the revealed WTP levels for copying with urban-related challenges are categorized, Section 5 that focuses on the limitations and future research, and Section 6 that concludes the paper and offers policy implementations.

2. Primary and Cascading Hazards

The following studies highlight various aspects that influence WTP for environmental goods such as air pollution and biodiversity loss, as well as socio-economic issues such as the impact of traffic and noise on someone's health and the working and living conditions. Firstly, climate change through heatwaves can negatively influence indoor and outdoor jobs, leading to social exclusion and energy poverty. Secondly, air pollution is a major driver of climate change and a health hazard, causing respiratory, cardiovascular, mental, cancer, and chronic diseases. Thirdly, population density can aggravate people's wellbeing by worsening the residential and commercial conditions as well as through the traffic and noise pollution. Fourthly, biodiversity loss is crucial as it negatively impacts ecosystem services, recreational and cultural values, and diminishes the economic benefits of natural environments, as demonstrated by economic valuation studies using choice experiments (CE) and contingent valuation methods (CEM). In short, understanding people's preferences is crucial for urban planning and ecosystem services conservation efforts.

2.1. Heatwaves

Climate change though heatwaves has a profound impact on living and working conditions, affecting both indoor and outdoor jobs with serious health (Barreca et al., 2016) and productivity consequences (Ciuha et al., 2019; Lowe et al., 2011; Varghese et al., 2019; P. Zhang et al., 2018). In essence, both the business sector and local citizens would be burdened with severe economic losses due to increased absenteeism, reduced work hours, and potential operational shutdowns during extreme heat events.

On the one hand, indoor working and living conditions can become extremely challenging during heatwaves. Firstly, employees in factories, warehouses, and certain office environments may experience dangerously high indoor temperatures (Ciuha et al., 2019; Xiang et al., 2014). Moreover, inadequate building insulation and poor ventilation exacerbate these problems, trapping heat inside and making indoor spaces intolerable, this is also an impact of urban heat island effects as the building materials can trap the heat during summers, making the indoor working and living conditions intolerable (Founda & Santamouris, 2017; Halkos & Aslanidis, 2023a), these poor household conditions can lead to phenomena of social exclusion (Halkos & Aslanidis, 2023b). As a consequence, the employers, managers, and directors ought to prioritize the amelioration of indoor conditions in order to protect their worker’s health and maintain productivity. Secondly, building conditions do not only affect indoor workers but also the energy poor households, energy poverty creates vicious cycles towards vulnerable social groups (Halkos & Aslanidis, 2023a; Li et al., 2021; Thomson et al., 2017) such as the unemployed, the students, and the elderly people (Gigante et al., 2024; van Steen et al., 2019).

In more detail, nature-based solutions (NbS) can deal with the severe impacts of UHI effect in large cities, ameliorating the wellbeing of indoor workers and citizens overall. For example, circular economy can provide water-saving solutions for alternative uses (e.g., safe reusable water, industrial wastewater, green roofs, living walls) (UNEP, 2023) and boost the overall economic performance under the sustainable development’s principles (Halkos & Aslanidis, 2024a, 2024b). Additionally, energy-saving technological-based solutions can build resilience against climate change (Degirmenci et al., 2021).

On the other hand, outdoor workers, such as those in construction, restaurants and cafés, and delivery services, face even greater risks during heatwaves phenomena due to direct exposure to the elements. The physical nature of these jobs, combined with high temperatures, significantly increases the likelihood of heat-related accidents (Varghese et al., 2019) and additional costs for claims or other work-oriented policies (Ireland et al., 2023). More specifically, the heat-related accidents can account for the one-percent of annual work-related incidents (Drescher & Janzen, 2023; Ireland et al., 2023). Employers must implement measures such as adjusting work schedules to cooler parts of the day, providing shaded areas, ensuring frequent breaks, and supplying ample hydration. Therefore, ongoing monitoring of worker health and conditions is essential to ensure safety during heatwaves.

In the literature, several surveys showed that NbS can act as a means of temperature regulation and by showing the importance of maintaining urban sustainability. In the literature, the construction, maintenance, and utilization of city-centre or sub-urban parks is linked to higher WTP (Andrews et al., 2017; Arabomen et al., 2019; Bertram et al., 2017; W. Y. Chen, 2015). More specifically, Andrews et al. (2017) focused on how parks can affect citizens' preferences and the results of WTP ranged from 18€[1] to 45€, the lower values were received by non-users, whereas the higher values from users of the parks. Arabomen et al. (2019) showcased the issue of urban trees conservation in Nigeria that attained a WTP of 16.58€. Similarly, Bertram et al. (2017) presented that the cleaning and maintenance conditions of an urban park in Germany can attract a higher WTP, for instance the WTP values ranging from 120€ for medium additional maintenance to 125€ for high maintenance, furthermore the WTP ranged from 168€ to 199€ for medium and high cleaning respectively. Lastly, Chen (2015) illustrated high WTP values for the importance of heritage trees in the city, typically trees (e.g., rare species or with historical and commemorative significance).

Moreover, the water supply and quality can also be crucial parameters that affect the citizens' WTP for environmental conservation and protection (Khan et al., 2019; Perez Loyola et al., 2021). Overall, a future pathway for climate change adaptation requires a holistic approach in urban planning that includes integrated solutions in order to promote the working and living conditions.

2.2. Air Pollution

Air pollution is not only one of the main drivers of climate change, but also a health-related hazard. Air pollution can be produced by various contaminants, with particulate matter (PM2.5 and PM10), ground-level ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), and nitrogen oxides (NOx) being the most commonly investigated ones (Brook et al., 2004). There is substantial data indicating that both short-term and long-term exposure to air pollution, particularly coarse and fine particulate matter, significantly raises the incidence of illness and death in the population (C. Liu et al., 2019; Sanyal et al., 2018). According to the WHO (2018), around 7 million fatalities occur annually due to exposure to fine particles in polluted air. This makes air pollution the fourth leading cause of mortality globally (Brauer, 2016). Among the most investigated effects of air pollution on health seem to be respiratory (mainly asthma) and cardiovascular diseases, mental disorders, cancer and chronic diseases (Dominski et al., 2021). Air pollution can also cause haze, a visibility impairment that results from the reduction of the ability to see distant objects and the alteration of the clarity and colour of what is visible due to the particulate from air pollution emissions (Boyle et al., 2016).

Multiple studies have conducted assessments on the financial burden of health issues caused by air pollution. A considerable proportion of the overall healthcare spending is allocated to respiratory illnesses. According to Shen et al., (2017), it was estimated that in 2014, the cost associated with PM2.5 in China was between 17.2 and 57.0 billion Yuan. The presence of major air pollutants in Shanghai, China, is associated with an annual financial loss of 197 million USD due to asthma patient visits (Guo & Chen, 2018). Between 2017 and 2025, an estimated 5.56 billion euros will be allocated to the National Health System in England (Pimpin et al., 2018).

[1] All WTP values in the present paper are expressed in the Euro (EUR) currency as of values in April 2024, including the changes based on inflation. Furthermore, 1 EUR was equal to 1.0793 USD in 17 of April 2024.

Other studies tried to evaluate the severity of air pollution, taking into account tourists' (Perez Loyola et al., 2021) and residents preferences (Lera-López et al., 2014; Petcharat et al., 2020) using stated preferences models, mainly CE and CVM. They show that respondents' primary demand is for clean air and they are willing to contribute through financial support to enhance the ecosystem services in their region. Indicatively, in Bang Kachao they are willing to pay 21.16€ annually for a 50% increase in clean air (Petcharat et al., 2020), in Israel national were willing to pay up to 47.68€, while regional respondents up to 73.68€ to maintain high levels of air quality based on ecosystems' local air-purification levels (Raviv et al., 2021), while in the United States, they are willing to pay 149.41€ per year for development programs that eliminate the 20% of the worst visibility days (Boyle et al., 2016).

Lera-López et al. (2014) found a WTP equal to 6.90€ for reducing air pollution, and that stakeholders who reside in close proximity to major roads have a greater incentive to mitigate environmental expenses. Additionally, individuals who are younger, more educated, and more environmentally conscious are more inclined to pay a premium for the reduction of externalities. This is likely due to the influence of their values and the environmentally friendly subculture that has developed over the past three decades of global green movement campaigning. However, a study that targeted tourists' preferences found that visitors prioritise the reduction of garbage (120.48€) over air pollution reduction (Perez Loyola et al., 2021). Z. Liu et al., (2022) highlighted the effects of air pollution on residents' WTP for green amenities in Beijing, finding a higher WTP under increased pollution levels, with the maximum WTP reaching 272.52€ corresponding to maximum pollution.

2.3. Population Density, Traffic and Noise

Population density due to residential and commercial expansion as well as traffic, and noise are critical factors in shaping urban sustainability as these determinants can heavily impact residents' WTP preferences. On the one hand, population density strains urban resources, leading to overcrowding and heightened demand for housing. On the other hand, traffic congestion and noise pollution contribute to higher emissions, reduced air quality, and lower quality of life, making it harder for cities to achieve sustainability goals.

2.3.1. Residential and Commercial characteristics

Climate change can significantly impact both residential and commercial conditions by driving up energy demand for air conditioning, which can overwhelm electrical grids and result in power outages. Additionally, high temperatures due to climate change can elevate cooling costs, leading to financial pressure on households and businesses alike.

On the one hand, the urban planners can strengthen residential conditions in building resilience against heatwaves by adopting NbS. In the recent literature, the main issue that people brought into the spotlight is to showcase how public attitudes can be augmented by the amelioration of their natural environment, either for green or blue NbS. In a Chinese study, Zhang et al. (2019) revealed that the average WTP was about 20€ per year for green roofs as NbS in order to cope with UHI effect. Similarly, a study in Portugal by Teotónio et al. (2020) demonstrated that dwellers reveal higher WTP for accessible instead of inaccessible green roofs, moreover, another parameter that can positively impact WTP is the existence of green walls as a complementary NbS.

Urban sustainability plays a pivotal role in peoples' preferences. For example, Park et al. (2017) through a hedonic pricing method presented how households' prices in the vicinity of an urban park can lead to a WTP for 388€ . Moreover, a CVM study in Greece showed that the benefits of an urban park project can reach a WTP of 5.11€ (Latinopoulos et al., 2016), similarly, the WTP of urban green spaces conservation in China was almost doubled (12.97€) (Song et al., 2015). A study on air quality problems declared that exceedance in particulate matter can severely impact life satisfaction and well-being, therefore the reduction of such problem attained a WTP of approximately 1390€ (Ambrey et al., 2014). Moreover, Khan et al. (2019) monitored that a higher WTP can be linked to the amelioration of water quality in river. Another solution might be the supply of recycled water can be utilized for alternative reasons such as open space irrigation or domestic use (Bennett et al., 2016).

On the other hand, regarding the commercial conditions, the sector of tourism is important for achieving high wellbeing levels and finding sustainable ways for recreation. Retail businesses may experience reduced foot traffic as customers avoid going out in extreme heat, further impacting revenue. In the literature, through a CVM on three tourist routes in Chile with different durations and proximity to nature, the impact of heritage value of these routes has reached a mean WTP range from 19.3€ to 21.1€ (Báez-Montenegro et al., 2016). Additionally, a WTO range from 174€ to 181€ was linked to eco-tourism recreational activities such as hiking in Colorado, strengthening the argument that tourists value even high values for nature-based tourism (Keske & Mayer, 2014).

2.3.2. Traffic and Noise

Human-caused environmental noise is widespread in developed nations. In 2017, the European Environmental Agency (EEA) (2020) reported that almost 20% of individuals in the European Union were subjected to road traffic noise levels surpassing 55 dB LDEN (yearly weighted day-evening-night noise average). Accumulating data suggests that being exposed to traffic noise can have negative effects on health. In 2018, the WHO (2018a) issued guidelines containing suggestions for safeguarding health and providing policy guidance in the European Region. The WHO derived their guidelines from systematic investigations commissioned to assess the health impacts of road noise. Furthermore, there are signs that both the intensity and origin of traffic noise may have an impact on mental well-being (Hegewald et al., 2020). One possible way in which noise can impact mental health is by eliciting an emotional reaction of annoyance (Beutel et al., 2016), depression (Seidler et al., 2017), anxiety disorders (Generaal et al., 2019), dementia and Alzheimer's Disease (Andersson et al., 2018).

Several studies tried to estimate the benefits from reduced traffic and noise pollution. Indicatively, Bravo-Moncayo et al. (2017) found that the estimated mean WTP to reduce road traffic annoyance is 14.60€ in Quito, Ecuador; Calleja et al. (2017) found that the weighted average WTP amounts to 10.36€ per visitor for a noise reduction in Retiro Park, located in Madrid, Spain; Kang et al. (2021) found that respondents' average WTP to reduce living noise from construction activities was 4.37€ in South Korea; Lera-López et al. (2014) monitored that the WTP for a reduction of noise and air pollution due to road traffic in Pyrenees, Spain was 5.94€; while Merchan (2014) found that the WTP for noise-mitigation program was 438€.

2.4. *Biodiversity Loss*

The importance of addressing biodiversity loss lies in its detrimental impact on ecosystem services, as well as its negative effects on recreational and cultural values. Additionally, it diminishes the economic benefits derived from natural environments, as evidenced by economic valuation studies that utilise CE and CVM to assess ecosystem services, urban forests, and natural landscapes (Halkos, 2021). Recent research has examined different approaches to assess preferences and WTP for environmental goods and ecosystem services, with a specific emphasis on urban and rural settings.

Studies such as Bertram et al. (2017) examined the differences in the recreational value of urban parks in Germany. The findings unveiled discrepancies in the WTP between weekdays and weekends, as well as between various degrees of additional maintenance and cleaning. Specifically, the WTP amounted to 125.10€ for high levels of maintenance, and 199.98€ for high levels of cleaning. Andrews et al. (2017) investigated how the location of urban parks affects WTP, emphasizing the importance of perceived park quality and accessibility with maximum WTP being placed for the construction of a city centre park (34.65€) and for park users (40.58€ and 45.02€). Ratzke (2022) explores the concept of urban biodiversity as a valuable aspect of the environment and emphasises the significance of comprehending the preferences of people in urban planning and conservation endeavours. The study utilises CE and CVM methods to determine that individuals possess a noteworthy WTP (212.8€) in order to preserve urban biodiversity. This WTP is indicative of their recognition and admiration for the ecological, recreational, and aesthetic advantages offered by varied urban ecosystems.

Previous research has examined particular conservation scenarios, such as the WTP for biodiversity conservation in Dachigam National Park, India (Bhat & Sofi, 2021), and Gunung Santubong National Park (GSNP), Malaysia (Kamri et al., 2017), which found that the WTP for biodiversity conservation in India was 3.60€ and 1.66€ for conserving the GSNP in Malaysia. In these studies, people's preferences were influenced by factors like the rarity of species and the perceived recreational advantages. (Petcharat et al., 2020) used a CE approach to estimate the non-market value of ecosystem services in the Bang Kachao Green Area, Thailand, focusing on the preferences for different conservation attributes. Their findings showed a significant WTP (50.77€) for ecosystem services, particularly for clean air and recreational services. Similarly, Wondifraw et al. (2021) applied a CE approach to evaluate ecosystem services at Mount Guna, Ethiopia, revealing strong preferences for forest preservation, water conservation, and recreational access.

B. Chen & Qi (2018) examined protest reactions in CVM studies focussing on urban green spaces. This underscores the importance of meticulous questionnaire design in order to minimise biases. These studies emphasise the intricacies of economic valuation methodologies and the need for strong experimental design and analysis to obtain precise and practical insights for environmental and urban policymaking. Their findings are consistent with the research conducted by Bernath & Roschewitz (2008) utilised the theory of planned behaviour to elucidate the differences in visitors' WTP for recreational advantages.

Vojáček & Louda (2017) conducted an economic assessment of ecosystem services in the Eastern Ore Mountains, while Blaeij et al. (2011) examined the economic challenges associated with expanding commercial wetlands (with WTP ranging between 3.56€ and 5.18) and highlighted the significance of cross-scale governance in managing ecosystem services efficiently. Rocchi et al. (2019) assessed the expenses and advantages of overseeing Natura

2000 sites in Umbria, Italy, using a cost-effectiveness analysis, highlighting the significance of involving stakeholders, and found that they are WTP 10.04€ for a large change scenario. In a study conducted by Japelj et al. (2016), the researchers examined the hidden preferences of inhabitants in Ljubljana, Slovenia for recreational activities in urban forests. The findings revealed a strong inclination towards environments that are more natural and less crowded, as well as for information boards and waymarks. In their study, Khan et al. (2019) examined public perceptions on the benefits provided by river ecosystems. They discovered a significant inclination towards valuing the cleanliness of rivers and the preservation of biodiversity, with their WTP equal to 3.22€ decrease in erosion intensity.

H.-S. Chen & Chen (2019)utilized a CE methodology to assess the economic worth of Green Island in Taiwan, with a particular focus on aspects such as the preservation of environmental quality and biodiversity. This study emphasises the impact of various characteristics of natural places, such as the purity of water and the protection of coral reefs, on the willingness of tourists and residents to pay for conservation and management projects finding that the WTP for increasing and maintaining the natural landscape was 74.27€, 62.04€ for species restoration scheme and 34.73€ for increasing environmental education. In a similar manner, Dahal et al. (2018) employed the CV approach to calculate the WTP for the conservation of waterfront open spaces. Their findings demonstrated a substantial public inclination towards environmental amenities and the availability of clean water with WTP 94.14€ to preserve open spaces. These studies emphasise the significance of including public preferences in environmental policy planning to improve sustainable management practices.

Research such as the study conducted by Aizaki et al. (2006) highlights the diverse functions of agricultural landscapes through the use of CV. They found that the WTP for recreation, flood prevention, recharging groundwater, soil erosion prevention, organic resource utilization, development of favourable landscapes and wildlife protection was 3.96, 8.86, 6.90, 6.08, 7.91, 5.38 and 8.75€ respectively. This research shows how the non-market values connected with rural landscapes might impact policy formulation in Japan. Research conducted by Bateman et al. (2008) supports this notion by demonstrating the presence of decoy effects in CE tests. These effects reveal that the way alternatives are presented can influence respondents' preferences and their estimates of WTP, which show that for different levels of increase in bird numbers and plant cover at the lake, the WTP ranges between 21.45 and 44.62€. By incorporating asymmetric dominance effects into decision modelling, researchers can uncover potential biases that must be considered in order to maintain the accuracy and reliability of economic valuation studies.

Soy-Massoni et al. (2016) study evaluates ecosystem services in coastal agricultural landscapes of Costa Brava, Catalonia. It highlights their diverse functions, including erosion regulation, water purification, and cultural benefits like recreation and tourism. The study suggests stakeholders prioritize conservation methods for these services, emphasizing the need for integrated landscape management strategies. Conversely, Cook et al. (2018) and Hang et al. (2023) present an alternative viewpoint by examining the WTP for the conservation of certain natural sites, such as Heidmörk in Iceland and Cat Ba Marine National Park in Vietnam. These studies employ CVM to quantify the WTP of both local inhabitants and tourists for conservation initiatives, emphasising the economic advantages of safeguarding these natural resources. Their research indicates that individuals acknowledge the significance of these natural regions for biodiversity. However, their WTP (it ranges between 113.10€ and 164.55€ and 46.25€ in each study respectively) is also affected by the perceived advantages in terms of recreation, aesthetics, and economics that result from conservation efforts. This suggests the necessity of focused awareness campaigns to improve funding for conservation.

Finally, Einarsdóttir et al. (2019) examined the conservation significance of wind farms by employing a CVM framework to ascertain the willingness of the general people to pay in order to uphold the natural scenery in Iceland and found that their WTP was 240.71€. This study examines the crucial overlap between the advancement of renewable energy and the protection of natural landscapes. It highlights the opposition from the public towards potential harm to the environment, even when there are advantages to be gained from renewable energy. Cong et al. (2019) conducted a study to investigate visitors' preferences and WTP for enhancing rural landscapes in China. The findings revealed that there were varied preferences among tourists for different landscape qualities, such as vegetation diversity and cleanliness, between 10.05€ and 57.17€. Their research indicates that implementing customised management practices that take into account different preferences might improve tourists' enjoyment and promote sustainable rural development. Koundouri et al. (2023) conducted a meta-analysis on marine and freshwater ecosystems and found that over 63% of European nations (17 out of 27), there is a strong inclination to financially contribute towards enhancing marine and freshwater habitats, surpassing the estimated readiness to pay for terrestrial ecosystems.

3. Material and Methods

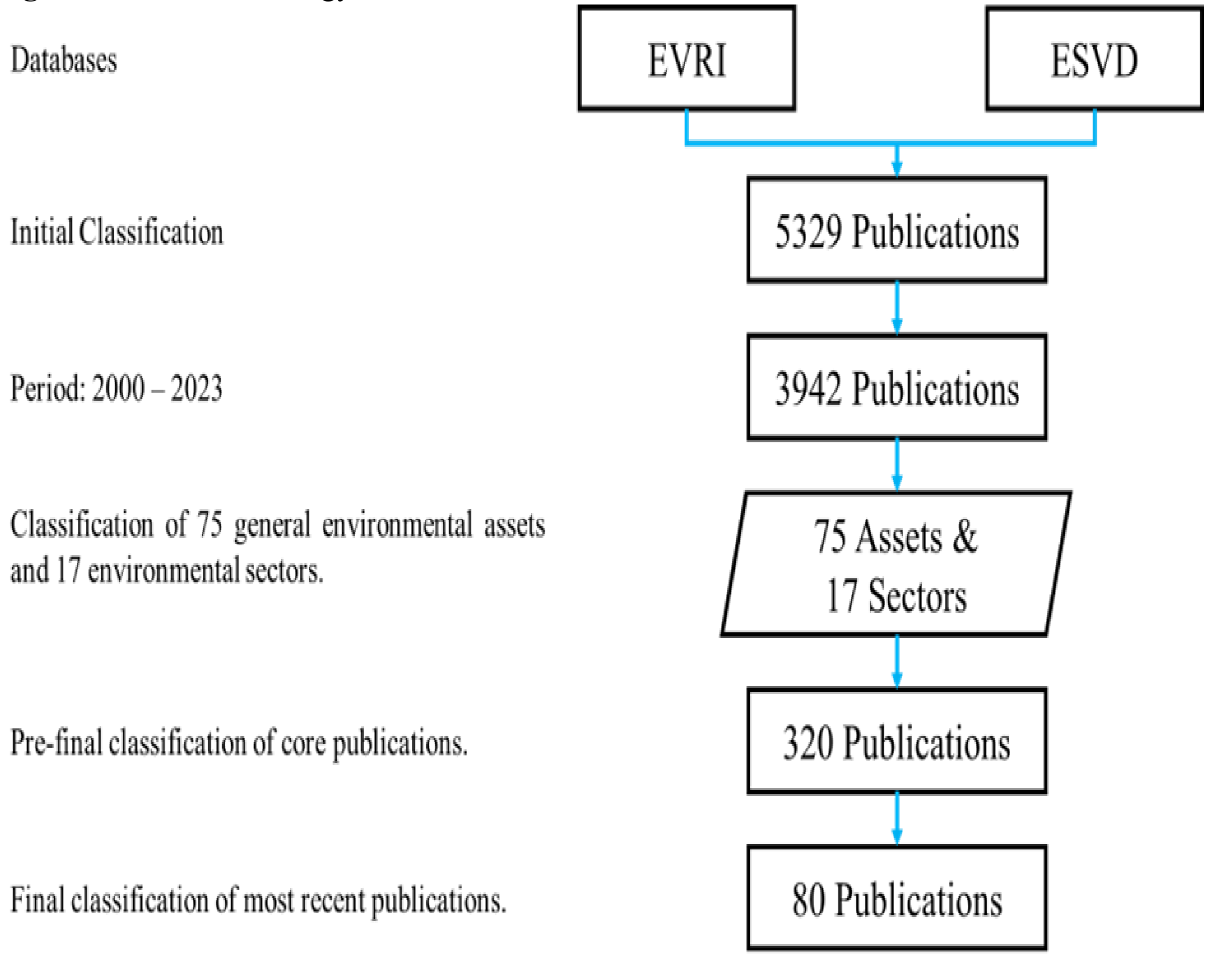
A review collects, analyses, and provides relevant policy implications based on robust and well-rounded evidence that is in line with several eligibility criteria in order to cover a series of research objectives. The current review sheds light on three objectives regarding (i) the observation of valuation studies that reveal WTP for primary and cascading hazards, (ii) the assessment of non-marketed valuation studies, and (iii) the examination of the interactions between the hazards along with their impacts on people and the environment. Moreover, in an attempt to reduce potential post-hoc decision bias, the researchers formulated and selected the most appropriate key factors that impact urban sustainability.

3.1. Guidelines, eligibility criteria, and search plan

The present review has utilized a standardized mapping review in order to create an eligible framework for the analysis of primary and cascading hazards in urban areas, as mentioned before. An extensive review has been conducted in the present study, based on the Environmental Valuation Reference Inventory (EVRI) (2024) and Ecosystem Services Valuation Database (ESVD) (2024) databases, the EVRI database was prioritized in research needs regarding duplicate articles, specifically in issues related to ecosystem services, primary and cascading hazards. It ought to be mentioned that both EVRI and ESVD are well-known and reliable databases that store empirical valuation studies with an extensive coverage over environmental assets and human health effects.

For the eligibility criteria, the 80 most recent publications were selected by two reviewers (PSA and LP), who independently conducted the search of each publication's eligibility and accuracy, both supervised by a professor (GH). A joint decision led to the conclusion of the final publications sample based on their relevance and the review's objectives. In essence, there was restriction in the date of publications in order to present solely the state-of-the-art research pathways, focusing on the period 2000-2023. Moreover, the authors (PSA and LP) independently extracted the data from all included studies in a Microsoft Excel file, again supervised by a professor (GH). For the data screening, analysis, interpretation of the results, the following parameters were inspected: WTP (€ in April 2024 levels), year of publication, country or region studied (**Table A.1**, **Appendix A**), environmental and socio-economic (age, income, gender, and educational status).

Figure 1: The methodology structure of the extracted studies.



Regarding the screening and search plan (**Figure 1**), from the total 5329 extracted publications, after customizing the period to 2000-2023 we reached 3942 studies. Further screening the databases, based on the selection of 75 related to our scope general environmental assets and 17 environmental sectors (**Appendix B**), and considering that it is reasonable to focus solely on the economic measures of WTP or willingness to accept (WTA) in some minor cases, therefore penultimate number of publications were 320 studies from which the selection of the most recent and adequate led to the final 80 stated preference studies (**Table C.1** in **Appendix C**) from which 220 WTP values have been extracted.

3.2. Descriptive statistics of the socioeconomic parameters

From the 80 studied publications, the socioeconomic parameters from the studies' samples were checked and presented in **Table 1** in order to obtain a clearer understanding of responders' age, income status, gender, and educational level. When there was lack of a parameter in a valuation study, then this parameter was replaced by the national average based on the databases of the World Bank and Our World In Data. The average responder's age is 42 years (ranging from 16 to 55 years), the average income is 29,303€ (ranging from 50€ to 124,173€), the 49.9% of responders are women (ranging from 0% to 72%), and the average responder has a university degree by 38.6% (range from 5.4% to 91%).

Table 1: Descriptive Statistics of the Socioeconomic parameters.

	Mean	Median	Min	Max	STDEV	Skewness	Kurtosis
Age	42.508	41.700	16.900	55.500	6.383	–0.297	0.410
Income	29,303.903	27,852.340	50.835	124,173.000	21,599.581	0.942	1.453
Gender (1=Female)	0.499	0.506	0.000	0.720	0.093	–3.195	14.748
Education	0.386	0.366	0.054	0.910	0.213	0.250	–0.690

Note: The WTP values are presented in Euro (€) in April 2024 levels.

4. Results and Discussion

The impact of – primary and cascading – hazards is pivotal for urban planners and policymakers in an attempt to strengthen urban sustainability and resilience against natural or anthropogenic phenomena. Answering **RQ1** and **RQ2**, **Table 2** presents the impact of primary and cascading hazards at a category level, more specifically, the highest mean WTP (MWTP) values are attributed to population density issues reaching almost 300€ (with the second highest deviation and maximum value of all studies) and to heatwaves that revealed a mean WTP of almost 140€, a WTP two times lower than the impact of population density. Next in order, the MWTP of biodiversity loss is 96€, followed by air pollution (76€), health issues (63€), and traffic and noise (42€).

Table 2: WTP values for the impact of primary and cascading hazards at a category level.

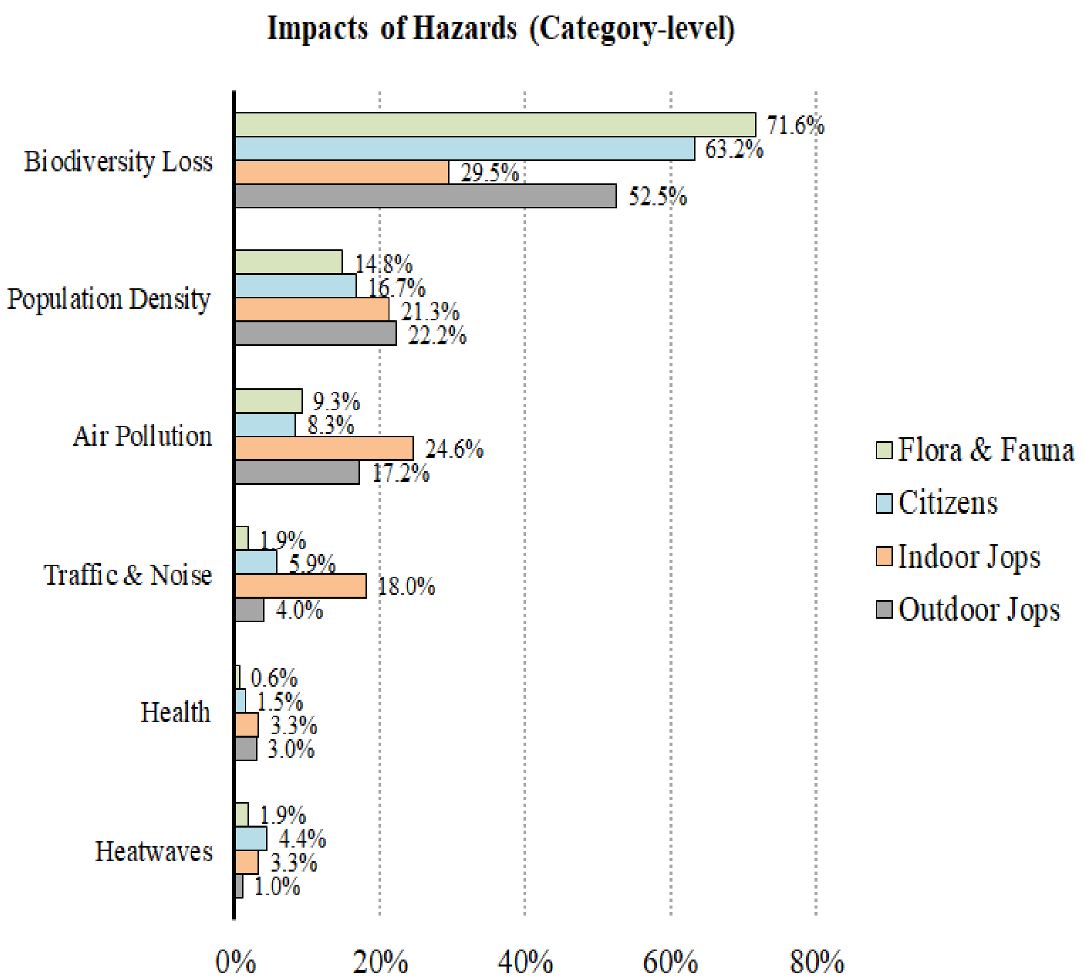
Categories	**Mean**	**Median**	**Min**	**Max**	**STDEV**	**Skewness**	**Kurtosis**
Air Pollution	76.10	68.88	6.90	272.45	69.37	1.41	2.28
Biodiversity Loss	96.65	18.52	–0.62	1,561.56	238.41	4.34	19.77
Health	63.29	24.78	18.58	146.52	72.14	1.71	-
Heatwaves	142.81	2.78	0.04	702.60	280.47	1.68	1.17
Population Density	298.87	19.89	0.14	4,136.49	779.13	4.08	18.61
Traffic & Noise	42.50	5.71	3.53	438.00	124.59	3.46	11.98
Total Sample	**125.14**	**18.76**	**–0.62**	**4,136.49**	**373.80**	**6.98**	**64.13**

Note: The WTP values are presented in Euro (€) in April 2024 levels.

Having the MWTP levels for copying with the above public issues in mind, **Figure 2** is going to explain their impact on people (**RQ3**), fauna and flora (**RQ4**), and indoor or outdoor workers (**RQ5**). From a citizen-oriented perspective and by answering **RQ3** in tandem with **RQ1** and **RQ2**, citizens welfare is tremendously impacted by population density (16%), followed by air pollution (8%), and traffic and noise (6%). However, health issues and heatwaves present an interesting result by affecting only 1.5% and 4.4% respectively.

The highest impact of biodiversity loss is by far the most significant of all the hazard categories, obviously affecting the fauna and flora (71%) responding to **RQ4**, but also heavily impacting citizens' wellbeing (63%) as well as the outdoor (52%) and the indoor (29%) workers' welfare. From a worker's perspective based on **RQ5** in line with **RQ1** and **RQ2**, outdoor jobs are impacted severely by population density (22%), followed by air pollution (17%), traffic and noise (4%). Nevertheless, health and heatwaves seem to not impact severely their welfare as they reached only 3% and 1% respectively. Additionally, indoor jobs are affected mainly by air pollution (24%), population density (21%), traffic and noise (18%), but interestingly, health (3%) and heatwaves (3%). The issue that heatwaves seem to not affect the wellbeing of workers might be also a limitation of the present review regarding the lack of valuation studies regarding the workers' welfare of outdoor jobs.

Figure 2: The impact of impact of primary and cascading hazards at people, fauna, and flora under the scope of category level.



Moving on the impact of hazards on sub-category level it is apparent that now most of the variables have changed, for example, air pollution MWTP dropped from 76.10€ to 67€ due to overlapping with other sub-categories (e.g., mortality or morbidity). These results further answer the **RQ1** and **RQ2**, in which **Table 3** shed light on how urban planners can focus on more stressing issues, for instance, the highest MWTP is attributed to the residential sprawl as part of the population density (with the greatest standard deviation equal to 814€), whereas the commercial part of population density seems to affect less with a MWTP equal to 83€. The second highest MWTP is linked to the wellbeing of workers and local citizens, reaching 92€, followed by the health parameter of mortality (85€), air pollution (67€), traffic and noise (42€), and lastly by morbidity health-related issues (18 €).

Table 3: WTP values for the impact of primary and cascading hazards at a sub-category level.

Sub-categories	**Mean**	**Median**	**Min**	**Max**	**STDEV**	**Skewness**	**Kurtosis**
Air Pollution	67.67	47.68	6.90	272.45	70.06	1.83	3.69
Morbidity	18.58	-	-	-	-	-	-
Mortality	85.65	-	24.78	146.52	86.08	-	-
Living/Working Conditions	92.84	17.61	–0.62	1,561.56	232.14	4.47	21.08
Commercial	83.18	21.11	19.30	181.14	86.46	0.61	–3.31
Residential	355.27	19.98	0.14	4,136.49	814.56	3.74	16.00
Traffic & Noise	42.50	5.71	3.53	438.00	124.59	3.46	11.98

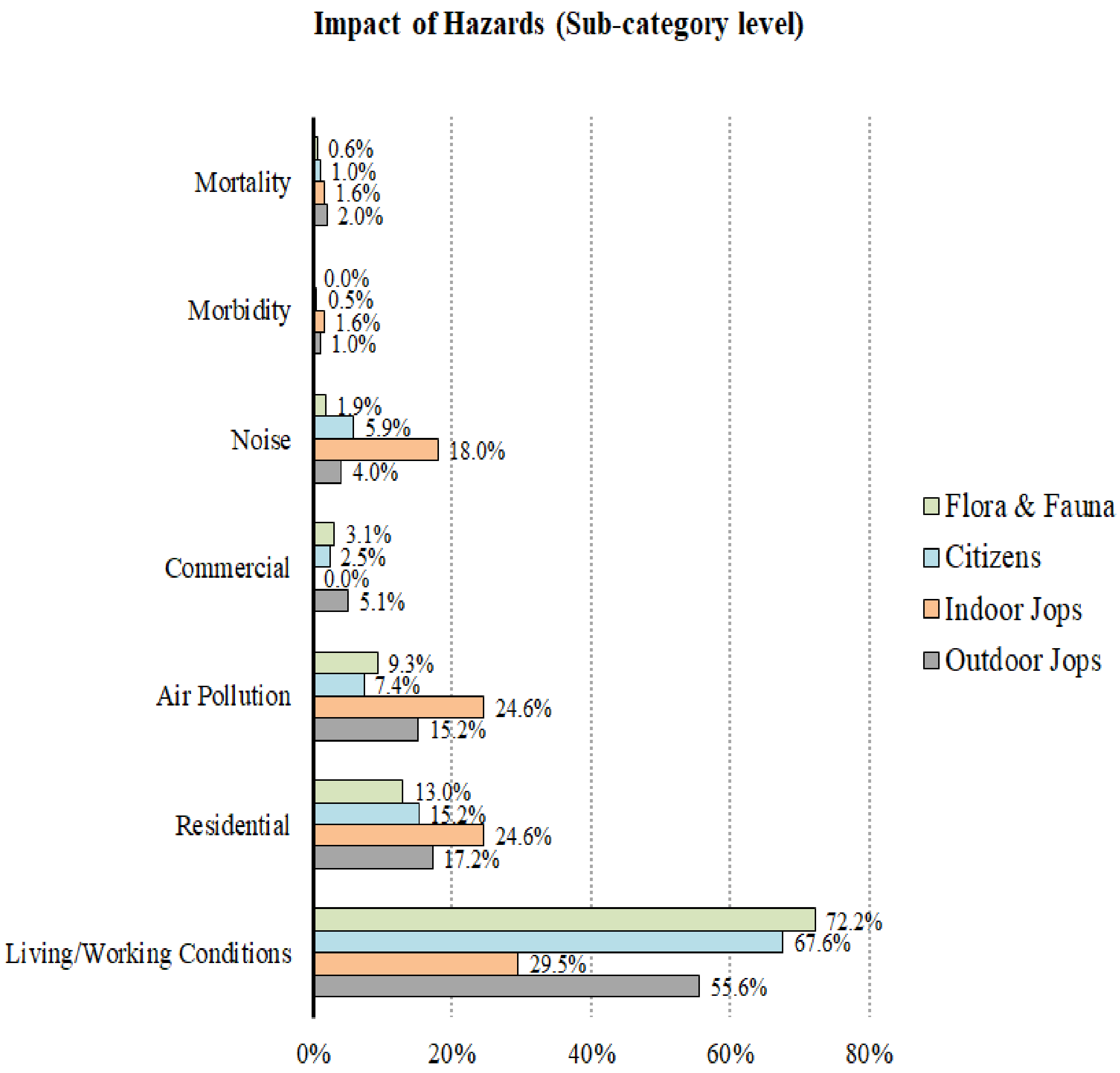
Note: The WTP values are presented in Euro (€) in April 2024 levels.

Bearing in mind the MWTP levels for dealing with the urban-related issues, **Figure 3** is going to explain their impact on people, fauna and flora but on a sub-category level. The highest impact on peoples' lives is related mainly to their living and working condition as a proxy of the biodiversity loss, but it also contains elements of the rest hazards. Moreover, the multiplication of residential houses seems to heavily affect the indoor (24%) and outdoor (15%) jobs. The indoor jobs are mainly affected due to the fact that people who work on crowded neighbourhoods do not have easy access to open spaces during their breaks, whereas the outdoor workers might also deal with the same issue.

From a citizen-oriented perspective (**RQ3** in line with **RQ1** and **RQ2**), citizens wellbeing relies heavily in the studied valuation publications on residential (15%) and air pollution (7%) factors, followed by traffic and noise (6%) as well as the commercial growth (5%), but interestingly less by health-related problems such as mortality (1%) or morbidity (0%). A question is whether there is a proper understanding of how health can be impacted by natural or anthropogenic-driven phenomena and why common peopled do not link their wellbeing with the aforementioned challenges.

Regarding the **RQ5** in comparison with **RQ1** and **RQ2**, the outdoor workers depend on residential (17%) and air pollution (15%) factors, moreover, the opening of new commercial shops or the proliferation of short-and-long-term homestays seem to affect their WTP preferences by 5%. Similarly, for the indoor workers residential and air pollution elements have the same influence by 24.6% their WTP choice, also interesting is the fact that the commercial growth does not affect their preferences according to the valuation studies. Again, for both the outdoor and indoor workers, the noise, mortality, and morbidity issues do not play an important role on their WTP preferences, however a potential explanation is that it might be a limitation due to the lack of data availability regarding this aspect of workers' welfare.

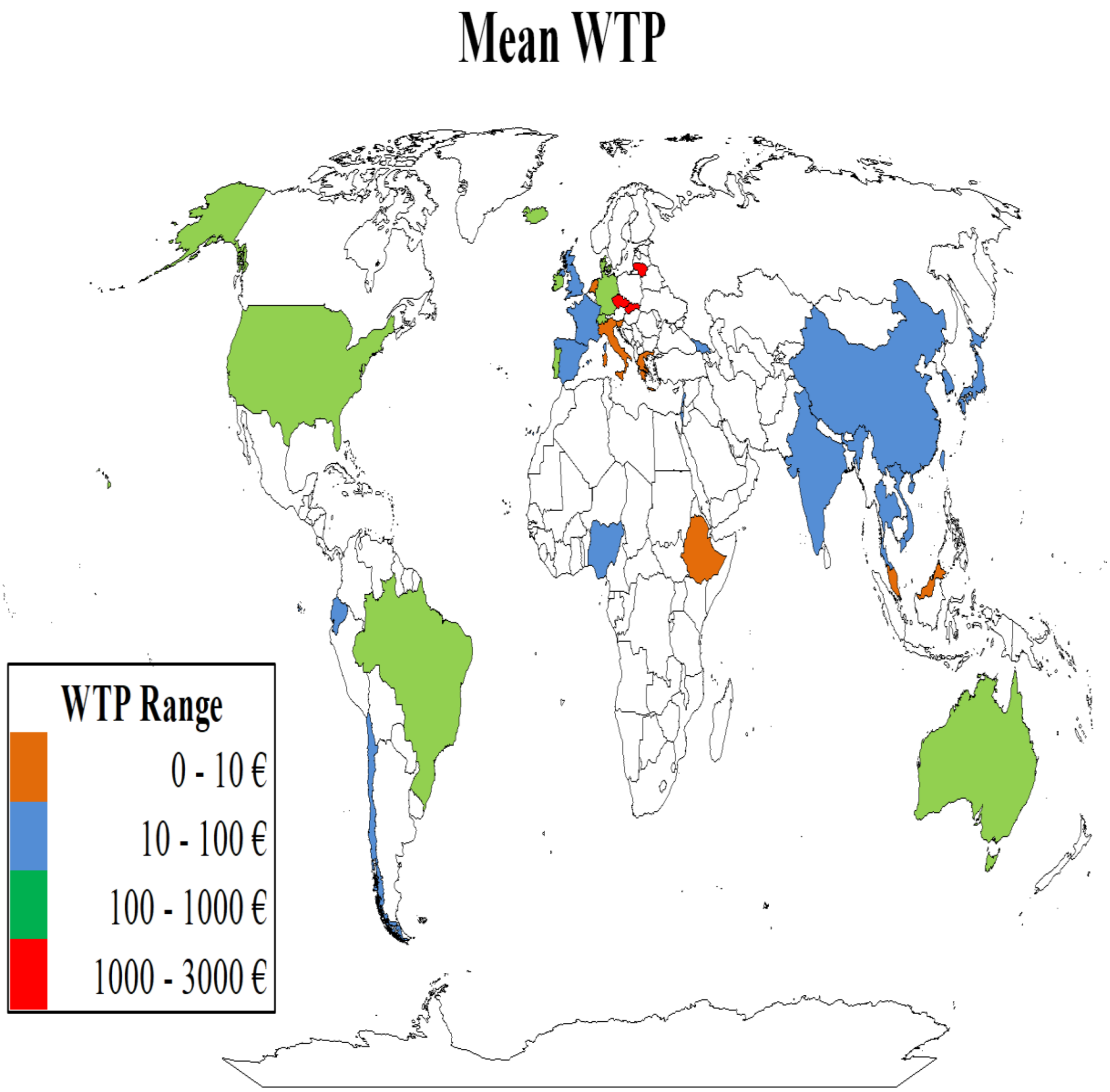
Figure 3: The impact of impact of primary and cascading hazards at people, fauna, and flora under the scope of sub-category level.



The MWTP on a global scale analysis, as presented in **Map 1**, shows that the lowest MWTP ranging from 1.66€ to 10€ are in six countries, more specifically in Malaysia, Slovenia, Ethiopia, Netherlands, Greece, and Italy. The second category contains mainly mediocre MWTP values, ranging from 10€ to 100€ in 16 countries and is going to be explained in sub-samples. The first sub-group has MTWP range from 16€ to 20€ is linked to France, Nigeria, Georgia, Thailand, and Chile. Moreover, the second sub-group has MWTP range from 20€ to 45€ and refers to the United Kingdom, Japan, India, Israel, South Korea, and China. In addition, the third sub-group has MWTP range from 45€ to 78€ and in linked to Lebanon, Vietnam, Taiwan, Spain, and Ecuador.

The third group with relatively high MWTP has range from 123€ to 478€ and is composed of nine countries, in more detail, the countries of the third group are Brazil, the United States, Switzerland, Iceland, Germany, Australia, Denmark, Ireland, and Portugal. Lastly, the group with the highest MWTP values and with range from 1,138€ to 2,906€ are Slovakia, Czech Republic, and Lithuania.

Map 1: Mean WTP values for building urban sustainability.



5. Limitations and future research in urban sustainability

Limitations in valuations studies are focused mainly on data availability. It was apparent in the lack of data availability regarding the heatwaves' impact on indoor and outdoor jobs. Moreover, regarding the health-related parameters, there are confounding variables that correlate health issues with other phenomena such as air or soil pollution. In the present review there was observation solely of air pollution, whereas soil pollution was omitted from the 80 selected studies. Lastly, the present review sheds light on non-market valuation, but this type of valuation is inherent of bias (e.g., different scenarios) and uncertainty (e.g., responders' behaviour change) regarding its methodology, however the 80 selected studies were meticulously chosen regarding their methodology status.

Future research in valuation studies and especially on urban sustainability should focus on building resilience against climate change and heatwaves, addressing primary hazards such as heatwaves, air pollution, and traffic noise, as well as cascading hazards like population density, violence, and biodiversity loss. Phenomena such as energy poverty, criminality, and violence would be a challenge for urban planners, but the provision of financial help packages in order to install green infrastructure and cooling strategies is going to be unavoidable. The integration of climate-resilient transportation and noise reduction measures will be key to addressing primary hazards, simultaneously, studies will delve into managing the social impacts of cascading hazards by promoting equitable access to green spaces, fostering social cohesion, and implementing biodiversity conservation within urban settings to create more livable, inclusive, and resilient cities.

Seeking to address all the risks above, ARSINOE project[2] aims to create climate-resilient solutions for Europe by combining systems innovation with the specific socio-ecological and economic conditions of various locations. The reviewed literature in this discussion paper can effectively bolster ARSINOE's objectives by presenting empirical data on how public preferences and WTP for environmental and socio-economic commodities, such as air pollution, biodiversity, ecosystem services, living and working conditions, and natural park preservation, might inform climate adaptation plans as the questionnaire form in **Figure D.1** in **Appendix D**. Indicatively, Ratzke (2022) study on urban biodiversity preferences and Soy-Massoni et al. (2016) research on ecosystem services in coastal agricultural landscapes are in line with ARSINOE's objective of customising climate resilience solutions to unique regional attributes. These studies offer unique perspectives on how stakeholders perceive and value environmental assets. This information is essential for developing NbS that are both ecologically successful and supported by the public.

In addition, the ARSINOE project, which advocates for inclusive and collaborative methods for climate adaptation, can utilise the techniques employed in these research endeavours, such as CVM and discrete CE, to involve local populations in the decision-making procedures. On the other hand, the project can also enhance and broaden the current body of literature by implementing these valuation approaches in different situations/case studies and incorporating them into a more comprehensive climate adaptation framework based on systems thinking. ARSINOE integrates scientific, economic, and social viewpoints to improve our comprehension of the valuation of distinct ecosystem services and environmental commodities in different places. This, in turn, enhances the efficacy of climate adaptation strategies and NbS programs.

6. Conclusions and Policy Implications

This study highlights the importance of understanding citizens' WTP preferences for environmental and socio-economic goods and services in addressing urban sustainability under the scope of multi-hazard assessment. It reveals that citizens prioritize reducing biodiversity loss, air pollution, and the negative effects of traffic and noise. These issues have significant economic implications for urban planning and conservation initiatives. The loss of biodiversity

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[2] For more information about the ARSINOE Project, please check: https://arsinoe-project.eu/

impacts ecosystem services and human well-being. Variations in WTP values among different countries and circumstances highlight the need for customized solutions.

More specifically, the results from the review methodology on 80 valuation studies revealed that regarding **RQ1**, the most important primary hazard is linked to climate change and specifically with heatwaves, revealing a MWTP of 142€, whereas the issue of air pollution is only 76€. Furthermore, based on **RQ2**, the individuals' preferences for the cascading results showed that population density caused by residential and commercial activities is the most important issue for policymakers, with a MWTP of 298€. This is followed by biodiversity loss at 96€, health problems at 63€, and lastly by traffic and noise at 42€. Nevertheless, it is biodiversity loss that severely affects the conditions of all target groups, mostly the flora and fauna (**RQ4**), followed by local citizens (**RQ3**), and then outdoor and indoor workers (**RQ5**).

The policy implications for both primary and cascading hazards should be covered in order to raise levels of urban sustainability. Firstly, climate change impacts indoor and outdoor jobs, leading to phenomena such as social exclusion and energy poverty. Solutions such as energy-saving technologies based on circular economy solutions can help indoor-related parameters. Moreover, outdoor workers face increased risks during heatwaves due to direct exposure to elements; therefore, the government in tandem with employers, must implement measures such as adjusting work schedules, providing shaded areas, ensuring frequent breaks, and providing ample hydration. Secondly, air pollution is a major driver of climate change and a health hazard, causing respiratory, cardiovascular, mental, and chronic diseases. Therefore, policymakers should invest in green and blue solutions, to exemplify, to create green spaces (e.g., green roofs or walls) as well as to provide proper water supply and blue infrastructure (e.g., fountains) to create liveable urban conditions. Thirdly, the population density and its linkages to traffic and noise pollution are significant issues in both developed and developing countries, affecting health and mental well-being. So, policymakers must promote sustainable transportation alternatives in order to cope with traffic jams, whereas the construction industry should respect the working hours without deranging urban neighbourhoods. Understanding people's preferences is crucial for urban planning and conservation efforts. Lastly, considering the significant WTP for biodiversity and ecosystem services, it is crucial for urban planners to give priority to the establishment of NbS and green spaces, such as urban parks, green roofs, and restored wetlands. These solutions can offer several advantages, such as enhancing climate resilience, providing opportunities for recreation, and adding aesthetic value. Targeted interventions are necessary in densely populated metropolitan areas to mitigate climate change impacts.

In conclusion, addressing both primary and cascading hazards is crucial for building urban sustainability. Economic valuation studies emphasise the need for strong experimental design, cross-scale governance, stakeholder involvement, and understanding public preferences in environmental and urban policymaking. Therefore, policymakers should incorporate WTP estimates to prioritise investments in green infrastructure, biodiversity protection, and pollution mitigation as a means to ensure that resources are allocated efficiently and in line with public needs. This is achievable only through integrated planning that not only mitigates direct environmental risks, but also anticipates and manages the chain reactions that can be triggered. In a nutshell, urban sustainability strategies that follow economic valuation mentality can enhance resilience against primary and cascading hazards.

Appendix A

Table A.1: WTP values extracted by the 80 publications considering the country level (the countries are presented in alphabetical order).

Country	Average	Min	Max	STDEV
1. Australia	192.91	0.19	1,390.21	484.43
2. Brazil	123.27	82.02	164.52	58.34
3. Chile	20.07	19.30	21.11	0.93
4. China	43.67	0.44	272.52	57.05
5. Czech Republic	1,561.56	-	-	-
6. Denmark	223.40	-	-	-
7. Ecuador	78.46	14.60	149.63	66.68
8. Ethiopia	3.24	1.90	6.10	1.97
9. France	16.37	6.36	38.62	13.85
10. Georgia	19.18	18.66	19.69	0.73
11. Germany	189.81	32.40	468.72	136.98
12. Greece	5.11	-	-	-
13. Iceland	172.79	113.10	240.71	64.20
14. India	31.84	3.60	66.84	33.06
15. Ireland	413.32	0.14	1,211.80	501.24
16. Israel	43.11	24.92	73.68	19.16
17. Italy	9.55	1.07	14.62	5.08
18. Japan	31.13	3.96	223.55	72.18
19. Lebanon	45.72	43.51	47.92	3.12
20. Lithuania	2,906.49	1,676.49	4,136.49	1739.48
21. Malaysia	1.66	-	-	-
22. Netherlands	4.37	3.56	5.18	1.15
23. Nigeria	16.58	-	-	-
24. Portugal	478.08	288.72	721.80	168.13
25. Slovakia	1,138.80	1,062.15	1,215.45	108.40
26. Slovenia	2.72	–0.62	17.61	5.17
27. South Korea	43.27	3.33	388.30	121.24
28. Spain	59.92	5.94	438.00	117.47
29. Switzerland	165.49	113.39	219.71	38.41
30. Taiwan	47.26	20.92	74.27	21.60
31. Thailand	19.49	5.88	50.77	16.23
32. United Kingdom	30.53	18.38	45.02	10.38
33. United States	129.49	0.04	1193.55	272.84
34. Vietnam	46.25	-	-	-
Total Sample	**125.14**	**–0.62**	**4,136.49**	**373.80**

Note: The WTP values are presented in Euro (€) in April 2024 levels.

Appendix B

75 General environmental assets: Air (Local), Air (Global), Human health ; Air (Local), Air (Regional), Air (Global), Human health ; Air (Local), Air (Regional), Buildings ; Air (Local), Air (Regional), Buildings, Flood control/dams, Human capital Air (Local), Air (Regional), Human health ; Air (Local), Air (Regional), Parks and open spaces, Landscape ; Air (Local), Air (Regional), Trees or Plants, Forest ; Air (Local), Buildings, Crops, Estuaries, Human health ; Air (Local), Human capital ; Air (Local), Human health ; Air (Local), Human health, Other assets, Fresh water ; Air (Local), Parks and open spaces ; Air (Local), Parks and open spaces, Buildings, Other assets, Flood control/dams, Fresh water, Landscape ; Air (Local), Parks and open spaces, Flood control/dams, Drinking water, Forest ; Air (Local), Parks and open spaces, Trees or Plants ; Air (Local), Wetlands/constructed wetlands, Estuaries, Human health ; Air (Regional), Human health ; Air (Regional), Trees or Plants, Crops, Human health ; Buildings ; Buildings, Crops, Human health ; Buildings, Cultural monuments, Forest ; Buildings, Forest ; Buildings, Fresh water ; Buildings, Fresh water, Salt water, Estuaries, Canals, Landscape ; Buildings, Human capital, Landscape ; Buildings, Human health ; Buildings, Landscape ; Buildings, Other assets ; Cultural monuments ; Cultural monuments, Beach ; Cultural monuments, Buildings, Landscape ; Cultural monuments, Buildings, Other assets; Cultural monuments, Forest ; Cultural monuments, Landscape ; Cultural monuments, Other assets ; Cultural monuments, Salt water, Beach ; Human health ; Landscape ; Landscape, Buildings, Trees or Plants; Landscape, Fresh water; Landscape, Other assets; Landscape, Other assets, Forest, Trees or Plants; Landscape, Parks and open spaces; Landscape, Parks and open spaces, Forest, Fresh water; Landscape, Parks and open spaces, Other assets, Trees or Plants; Landscape, Riparian; Landscape, Salt water; Landscape, Trees or Plants, Canals; Landscape, Woodland; Parks and open spaces; Parks and open spaces, Buildings, Other assets, Flood control/dams, Trees or Plants, Landscape, Riparian; Parks and open spaces, Buildings, Other assets, Landscape; Parks and open spaces, Cultural monuments, Buildings; Parks and open spaces, Cultural monuments, Buildings, Other assets; Parks and open spaces, Cultural monuments, Buildings, Woodland; Parks and open spaces, Cultural monuments, Trees or Plants, Crops, Fresh water, Drinking water, Landscape; Parks and open spaces, Cultural monuments, Trees or Plants, Landscape, Woodland; Parks and open spaces, Other assets; Parks and open spaces, Other assets, Landscape; Parks and open spaces, Other assets, Trees or Plants; Parks and open spaces, Other assets, Trees or Plants, Human health; Parks and open spaces, Trees or Plants; Parks and open spaces, Trees or Plants, Fresh water; Parks and open spaces, Trees or Plants, Landscape, Woodland; Trees or Plants; Trees or Plants, Drinking water, Fresh water, Ground water; Trees or Plants, Forest; Trees or Plants, Forest, Woodland; Trees or Plants, Fresh water; Trees or Plants, Fresh water, Human capital, Landscape, Riparian; Trees or Plants, Fresh water, Woodland; Trees or Plants, Landscape; Trees or Plants, Landscape, Woodland; Trees or Plants, Rainforest; Trees or Plants, Woodland

17 Environmental Stressors: Climate change, Climate change, Congestion/crowding ; Climate change, Infrastructure development/habitat conversion; Climate change, Infrastructure development/habitat conversion, Predominantly anthropogenic substance; Climate change, Infrastructure development/habitat conversion, Resource extraction; Congestion/crowding; Congestion/crowding, Infrastructure development/habitat conversion; Congestion/crowding, Infrastructure development/habitat conversion, Predominantly anthropogenic substance; Congestion/crowding, Infrastructure development/habitat conversion, Resource extraction; Infrastructure development, habitat conversion; Infrastructure development, habitat conversion, Noise; Infrastructure development, habitat conversion, Noise, Toxic substance ; Infrastructure development, habitat conversion, Resource extraction ; Infrastructure development, habitat conversion, Toxic substance ; Noise ; Noise ; Non-toxic substance, Predominantly anthropogenic substance; Toxic substance; Predominantly anthropogenic substance

Appendix C

Table C.1: The WTP values extracted from the studies.

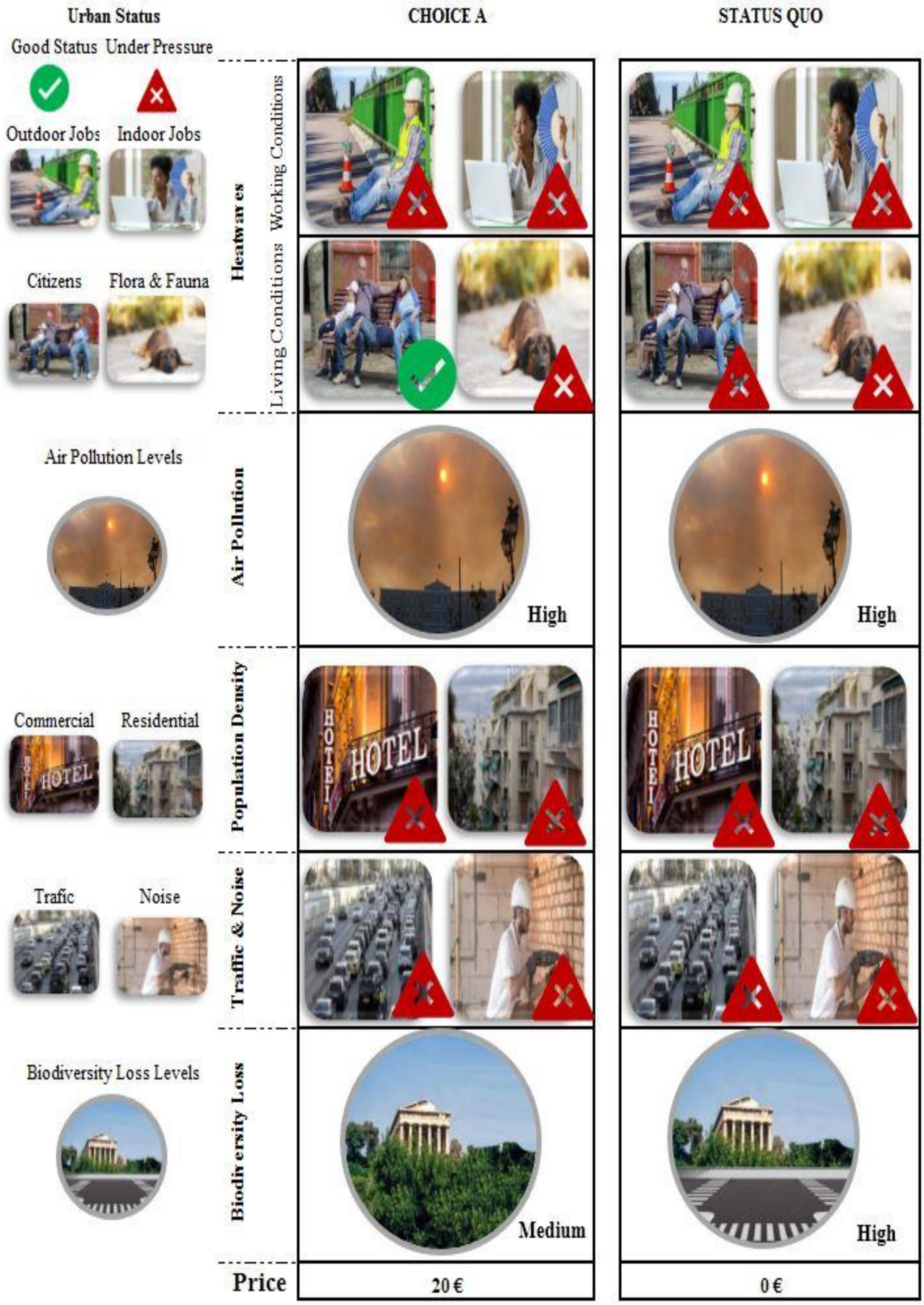
Title of the study	WTP Values	Reference
Estimating the Willingness to Pay to Preserve Waterfront Open Spaces Using Contingent Valuation.	3	(Dahal et al., 2018)
The Contingent Valuation Study of the Wind Farm Búrfellslundur - Willingness to Pay for Preservation.	1	(Einarsdóttir et al., 2019)
The Role of Public Information in Increasing Homebuyers' Willingness-to-Pay for Green Housing: Evidence from Beijing.	2	(L. Zhang et al., 2016)
Valuating Renewable Microgeneration Technologies in Lithuanian Households: A study on Willingness to Pay	2	(Su et al., 2018)
Willingness-to-Pay and Free-Riding in a National Energy Efficiency Retrofit Grant Scheme.	3	(Collins & Curtis, 2018)
Economic Valuation of Green Island, Taiwan: A Choice Experiment Method.	6	(H.-S. Chen & Chen, 2019)
Understanding Tourists' Willingness-to-Pay for Rural Landscape Improvement and Preference Heterogeneity.	4	(Cong et al., 2019)
Acoustic and Economic Valuation of Soundscape: An Application to the 'Retiro' Urban Forest Park.	1	(Calleja et al., 2017)
Contingent valuation approach in measuring the multifunctionality of agriculture and rural areas in Japan.	8	(Aizaki et al., 2006)
An extension of the Theory of Planned Behavior to predict willingness to pay for the conservation of an urban park.	1	(López-Mosquera et al., 2014)
Decoy effects in choice experiments and contingent valuation, asymmetric dominance.	4	(Bateman et al., 2008)
Recreational benefits of urban forests: Explaining visitors' willingness to pay in the context of the theory of planned behavior.	4	(Bernath & Roschewitz, 2008)
Can Personality Traits Explain Where and With Whom You Recreate? A Latent-Class Site-Choice Model Informed by Estimates From Mixed-Mode LC Cluster Models With Latent-Personality Traits.	6	(Morey & Thiene, 2017)
Can tenants afford to care? Investigating the willingness-to-pay for improved energy efficiency of rental tenants and returns to investment for landlords.	2	(Collins & Curtis, 2017)
Protest response and contingent valuation of an urban forest park in Fuzhou City, China.	4	(B. Chen & Qi, 2018)
Choice Experiments for Estimating the Non-Market Value of Ecosystem Services in the Bang Kachao Green Area, Thailand.	6	(Petcharat et al., 2020)
Community preferences for recycled water in Sydney.	2	(Bennett et al., 2016)
Conservation of Maritime Cultural Heritage: A Discrete Choice Experiment in a European Atlantic Region.	1	(Durán et al., 2015)
Contingent valuation and motivation analysis of tourist routes: an application to the cultural heritage of Valdivia, Chile.	3	(Báez-Montenegro et al., 2016)
Contingent Valuation of Road Traffic Noise: A Case Study in the Urban Area of Quito, Ecuador.	1	(Bravo-Moncayo et al., 2017)
Economic governance to expand commercial wetlands: within-and cross-scale challenges.	2	(Blaeij et al., 2011)
Differences in the Recreational Value of Urban Parks Between Weekdays and Weekends: A Discrete Choice Analysis.	4	(Bertram et al., 2017)
Direct and Indirect Valuation of Air-Quality Regulation Service as Reflected in the Preferences Towards Distinct Types of Landscape in a Biosphere Reserve.	4	(Raviv et al., 2021)
Economic Valuation of Ecosystem Services: Application of a Choice Experiment Approach on Mount Guna Services, North West of Ethiopia.	3	(Wondifraw et al., 2021)
Economic valuation of recreational attributes using a choice experiment approach: An application to the Galapagos Islands.	3	(Perez Loyola et al., 2021)
Economic Value of Ecosystem Services in the Eastern Ore Mountains.	1	(Vojáček & Louda, 2017)

Ecosystem Services Valuation For Enhancing Conservation And Livelihoods In A Sacred Landscape Of The Indian Himalayas.	3	(Sinha & Mishra, 2015)
Effects of air pollution on Beijing residents' willingness to pay for green amenities.	14	(Z. Liu et al., 2022)
Environmental conservation value of an endangered species: the case of Cypripedium Japonicum.	1	(Kim et al., 2021)
Estimating the Cost of Air pollution in South East Queensland: An Application of the Life Satisfaction Non-market Valuation Approach.	1	(Ambrey et al., 2014)
Good parks – Bad Parks: The Influence of Perceptions of Location on WTP and Preference Motives for Urban Parks.	6	(Andrews et al., 2017)
Households' willingness to pay for green roof mitigating heat island effects in Beijing (China).	2	(L. Zhang et al., 2019)
How Does Probability Judgment Influence Contingent Valuation Method to Estimate WTP for Natural Disaster Reduction.	1	(He & Zhai, 2017)
Improving noise policies in South Korea: non-market valuation based on an impact pathway approach.	8	(Kang et al., 2021)
Integrating economic landscape valuation into Mediterranean territorial planning.	2	(Molina et al., 2016)
Investing in Sustainable Built Environments: The Willingness to Pay for Green Roofs and Green Walls.	3	(Teotónio et al., 2020)
Italian Consumers' Willingness to Pay for Eucalyptus Firewood.	1	(Palmieri et al., 2020)
Valuation of recreational benefits and visitor conflicts in an urban forest.	1	(Kleiber, 2001)
Latent Preferences of Residents Regarding An Urban Forest Recreation Setting in Ljubljana, Slovenia.	20	(Japelj et al., 2016)
Lie Detection in Stated Preferences: the Recoding and the Reward Approaches.	3	(Mahieu et al., 2015)
Multifunctional Recreation and Nouveau Heritage Values in Plantation Forests.	1	(Rolfe & Windle, 2015)
Noise Pollution in National Parks: Soundscape and Economic Valuation.	1	(Iglesias Merchan et al., 2014)
Park Accessibility Impacts Housing Prices in Seoul.	1	(Park et al., 2017)
Payment Vehicle as an Instrument to Elicit Economic Demand for Conservation.	1	(Carneiro & Carvalho, 2014)
Preferences of Tourists With Regard to Changes of the Landscape of the Tatra National Park in Slovakia.	2	(Getzner & Švajda, 2015)
Protecting the Environment: For Love or Money? The Role of Motivation and Incentives in Shaping Demand for Payments for Environmental Services Programs.	1	(De Martino et al., 2017)
Provision of ecosystem services from the management of Natura 2000 sites in Umbria (Italy): Comparing the costs and benefits, using choice experiment.	2	(Rocchi et al., 2019)
Public Attitudes, Preferences and Willingness to Pay for River Ecosystem Services.	7	(Khan et al., 2019)
Public Awareness and Willingness to Pay for Tackling Smog Pollution in China: A Case Study.	1	(Y. Wang et al., 2016)
Public willingness-to-pay for conserving urban heritage trees in Guangzhou, south China.	2	(W. Y. Chen, 2015)
Revealing preferences for urban biodiversity as an environmental good.	2	(Ratzke, 2022)
Rider Preferences and Economic Values for Equestrian Trails.	1	(Hu et al., 2015)
Rural environment stakeholders and policy making: Willingness to pay to reduce road transportation pollution impact in the Western Pyrenees.	2	(Lera-López et al., 2014)
Rural Households' Demand for Frankincense Forest Conservation in Tigray, Ethiopia: A Contingent Valuation Analysis.	1	(Tilahun et al., 2015)
Sand Dunes Management: a Comparative Analysis of Ecological versus Economic Valuations Applied to the Coastal Region in Israel.	1	(Kutiel & Becker, 2020)
Sense of Place and Willingness to Pay: Complementary Concepts When Evaluating Contributions of Cultural Resources to Regional Communities.	3	(Morrison & Dowell, 2015)
Sequence Effects in the Valuation of Multiple Environmental Programs Using the Contingent Valuation Method.	2	(Longo et al., 2015)

Social Sustainability of Renewable Energy Sources in Electricity Production: An Application of the Contingent Valuation Method.	4	(Botelho et al., 2016)
The importance of ecosystem services in coastal agricultural landscapes: Case study from the Costa Brava, Catalonia.	7	(Soy-Massoni et al., 2016)
The contingent valuation study of Heidmörk, Iceland - Willingness to pay for its preservation.	2	(Cook et al., 2018)
The Environmental Benefits of Organic Wine: Exploring Consumer Willingness-to-Pay Premiums?	1	(Ogbeide et al., 2015)
The value of naturalness of urban green spaces: Evidence from a discrete choice experiment.	1	(Bronnmann et al., 2020)
Towards multifunctionality of rural natural environments? An economic valuation of the extended buffer zones along Danish rivers, streams and lake.	1	(Münch et al., 2016)
Transport Infrastructures, Environment Impacts and Tourists' Welfare: a Choice Experiment to Elicit Tourist Preferences in Siena, Italy.	2	(Bimonte et al., 2016)
Valuation of Haze Management and Prevention Using the Contingent Valuation Method with the Sure Independence Screening Algorithm.	1	(G. Wang et al., 2016)
Valuing Local Residents' Willingness to Pay for the Conservation of Cat Ba Marine National Park, Vietnam.	1	(Hang et al., 2023)
Valuing Shifts in the Distribution of Visibility in National Parks and Wilderness Areas in the United States.	3	(Boyle et al., 2016)
Valuing the Benefits of an Urban Park Project: A Contingent Valuation Study in Thessaloniki, Greece.	1	(Latinopoulos et al., 2016)
Reducing Wildfires in Georgia: A Cost Benefit Analysis of Agricultural Burning Practices in the Dedoplistskaro Municipality, Georgia.	2	(Westerberg et al., 2017)
Visitor Willingness to Pay U.S. Forest Service Recreation Fees in New West Rural Mountain Economies.	2	(Keske & Mayer, 2014)
Who pays more to preserve a natural reserve, visitors or locals? A confidence analysis of a contingent valuation application.	2	(Aoun, 2015)
Willingness and motivation of residents to pay for conservation of urban green spaces in Jinan, China.	1	(Song et al., 2015)
Willingness to pay for biodiversity conservation in Dachigam National Park, India.	1	(Bhat & Sofi, 2021)
Willingness to pay for conservation of natural resources in santubong national park.	1	(Kamri et al., 2017)
Willingness to Pay for Measures of Managing the Health Effects of Heat Wave in Beijing, China: a Cross-sectional Survey.	1	(Y. Zhang et al., 2016)
Willingness to Pay for Public Health Policies to Treat Illnesses.	2	(Bosworth et al., 2015)
Willingness to Pay for Riparian Zones in an Ozark Watershed.	1	(Lewis et al., 2017)
Willingness to pay of committed citizens: A field experiment.	2	(Ami et al., 2014)
Willingness To Pay Towards A Public Good: How Does A Refund Option Affect Stated Values?	1	(O'Neill & Yadav, 2016)
Willingness-to-Pay for Environmental Services Provided by Trees in Core and Fringe Areas of Benin City, Nigeria.	1	(Arabomen et al., 2019)

Appendix D

Figure D.1: The choice experiment card for air pollution scenario for the card of 20€.



Note: The structure of this questionnaire has been designed by the author, Prof. G. Halkos based on the consultations of the ARSINOE Project team.

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