YASHIL IQTISODIYOT&TARAQQIYOT

Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

2026-YIL

IYUN/6-SON, II-QISM

ISSN: 2992-8982

https://yashil-iqtisodiyot-taraqqiyot.uz/

YASHIL

IQTISODIYOT&TARAQQIYOT

Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

Elektron nashr. 2026-yil, iyun.

YASHIL
IQTISODIYOT&TARAQQIYOT
Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

08.00.01 Iqtisodiyot nazariyasi
08.00.02 Makroiqtisodiyot
08.00.03 Sanoat iqtisodiyoti
08.00.04 Qishloq xo'jaligi iqtisodiyoti
08.00.05 Xizmat ko'rsatish tarmoqlari iqtisodiyoti
08.00.06 Ekonometrika va statistika
08.00.07 Moliya, pul muomalasi va kredit
08.00.08 Buxgalteriya hisobi, iqtisodiy tahlil va audit
08.00.09 Jahon iqtisodiyoti
08.00.10 Demografiya. Mehnat iqtisodiyoti
08.00.11 Marketing
08.00.12 Mintaqaviy iqtisodiyot
08.00.13 Menejment
08.00.14 Iqtisodiyotda axborot tizimlari va texnologiyalari
08.00.15 Tadbirkorlik va kichik biznes iqtisodiyoti
08.00.16 Raqamli iqtisodiyot va xalqaro raqamli integratsiya
08.00.17 Turizm va mehmonxona faoliyati

Muassis: "Ma'rifat-print-media" MChJ
Hamkorlarimiz: Toshkent davlat iqtisodiyot universiteti, O'zbekiston Respublikasi Bosh prokuraturasi huzuridagi Iqtisodiy jinoyatlarga qarshi kurashish departamenti

Jurnalning ilmiyligi:
""Yashil" iqtisodiyot va taraqqiyot" jurnali
O'zbekiston Respublikasi Oliy ta'lim, fan va innovatsiyalar vazirligi huzuridagi Oliy attestatsiya komissiyasi rayosatining 2023-yil 1-apreldagi 336/3-sonli qarori bilan ro'yxatdan o'tkazilgan.

MUNDARIJA

IQTISODIYOT ЭКОНОМИКА ECONOMY

METHODOLOGY FOR ASSESSING THE ECONOMIC DAMAGE OF ECOLOGICAL HAZARDS IN URBAN AREAS: CONCEPTUAL SHORTCOMINGS OF NON-MARKET VALUATION METHODS AND THE INTEGRAL DAMAGE FUNCTION APPROACH

Abbos Saydullaev[1], Iqboloy Choriyorova[1]
[1] Department of Green Economy and Sustainable Business, Samarkand branch of Tashkent State University of Economics, Samarkand 140104, Uzbekistan
0000-0002-6156-0963
abbos.saydullayev@sbtsue.uz

Abstract. This study provides a critical theoretical-bibliographic analysis of methodological challenges in assessing the economic damage caused by three specific ecological hazards in urban areas — construction site pollution, traffic congestion, and industrial waste — through the lens of non-market valuation methods. The paper examines the conceptual limitations of both stated and revealed preference approaches and proposes the integral damage function mechanism, grounded in the Impact Pathway Approach, as a theoretically well-founded alternative for translating environmental hazards into economic losses and healthcare expenditure impacts.

A theoretical-bibliographic review was conducted by systematically analyzing peer-reviewed literature from Scopus- and Web of Science-indexed journals. The study synthesizes foundational and contemporary works on contingent valuation, hedonic pricing, choice experiments, and damage function approaches within the framework of urban environmental economics. No primary empirical data or statistical datasets were employed; the analysis is exclusively conceptual and literature-based.

The analysis reveals that conventional non-market valuation methods have certain systematic conceptual limitations when applied to urban ecological hazards.: contingent valuation exhibits hypothetical bias, scope insensitivity, and WTP-WTA disparity; hedonic pricing is compromised by omitted variable bias and spatial confounding; and choice experiments face cognitive burden and status quo bias. The integral damage function approach offers a structured causal chain linking emission sources through atmospheric dispersion and dose-response relationships to quantifiable health and economic endpoints. A multi-level conceptual framework diagram is developed, illustrating the transformation pathway from environmental hazards to economic losses and healthcare costs across macro, meso, and micro analytical levels.

Keywords: non-market valuation, damage function, urban ecological hazards, construction pollution, traffic congestion, industrial waste, contingent valuation, hedonic pricing, Impact Pathway Approach, health cost assessment, environmental economics

Annotatsiya. Ushbu tadqiqot shahar hududlarida uchta aniq ekologik xavf — qurilish maydonlaridan kelib chiqadigan ifloslanish, transport tirbandligi va sanoat chiqindilari — oqibatida yuzaga keladigan iqtisodiy zararni nobozor baholash usullari nuqtayi nazaridan baholashdagi metodologik muammolarni tanqidiy nazariy-bibliografik jihatdan tahlil qiladi. Maqolada bildirilgan va aniqlangan afzalliklarga asoslangan yondashuvlarning konseptual kamchiliklari ko'rib chiqiladi hamda ekologik xavflarni iqtisodiy yo'qotishlar va sog'liqni saqlash xarajatlariga transformatsiya qilish uchun nazariy jihatdan ustunroq muqobil sifatida Impact Pathway Approach asosida shakllantirilgan integral zarar funksiyasi mexanizmi taklif etiladi.

Tadqiqot Scopus va Web of Science bazalarida indekslangan ilmiy jurnallarda chop etilgan maqolalarni tizimli tahlil qilish asosida nazariy-bibliografik sharh shaklida amalga oshirildi. Tadqiqotda shahar ekologik iqtisodiyoti doirasida kontingent baholash, gedonik narxlash, tanlov eksperimentlari va zarar funksiyasi yondashuvlariga oid fundamental hamda zamonaviy ilmiy ishlar umumlashtirildi. Birlamchi empirik ma'lumotlar yoki statistik ma’lumotlar bazalaridan foydalanilmadi; tahlil to‘liq konseptual va adabiyotlarga asoslangan xususiyatga ega.

Tahlil natijalari shuni ko‘rsatadiki, an’anaviy nobozor baholash usullari shahar ekologik xavflariga tatbiq etilganda tizimli konseptual kamchiliklarga ega: kontingent baholashda faraziy og‘ish, qamrovga nisbatan sezgirlikning pastligi hamda to‘lashga tayyorlik va qabul qilishga tayyorlik o‘rtasidagi tafovut kuzatiladi; gedonik narxlashda esa o‘tkazib yuborilgan o‘zgaruvchilar og‘ishi va makoniy omillarning aralash ta’siri muammo tug‘diradi; tanlov eksperimentlarida esa kognitiv yuklama va mavjud holatni saqlab qolish og‘ishi namoyon bo‘ladi. Integral zarar funksiyasi yondashuvi emissiya manbalarini atmosfera dispersiyasi va doza-javob bog‘liqliklari orqali miqdoriy baholanishi mumkin bo‘lgan sog‘liq hamda iqtisodiy yakuniy natijalar bilan bog‘lovchi izchil sabab-oqibat zanjirini taklif etadi. Tadqiqotda ekologik xavflarning iqtisodiy yo‘qotishlar va sog‘liqni saqlash xarajatlariga aylanish jarayonini makro, mezo va mikro tahliliy darajalarda aks ettiruvchi ko‘p pog‘onali konseptual model diagrammasi ishlab chiqilgan.

Kalit so‘zlar: nobozor baholash, zarar funksiyasi, shahar ekologik xavflari, qurilish ifloslanishi, transport tirbandligi, sanoat chiqindilari, kontingent baholash, gedonik narxlash, Impact Pathway Approach, sog‘liqni saqlash xarajatlarini baholash, ekologik iqtisodiyot.

Аннотация. В данном исследовании представлен критический теоретико-библиографический анализ методологических проблем оценки экономического ущерба, вызванного тремя конкретными экологическими угрозами в городских районах: загрязнением от строительных площадок, транспортными заторами и промышленными отходами. Анализ проводится через призму методов нерыночной оценки. В статье рассматриваются концептуальные недостатки подходов, основанных как на заявленных, так и на выявленных предпочтениях, а также предлагается механизм интегральной функции ущерба, основанный на подходе Impact Pathway Approach, в качестве теоретически более совершенной альтернативы для преобразования экологических угроз в экономические потери и расходы на здравоохранение.

Теоретико-библиографический обзор был проведён на основе системного анализа научных публикаций из рецензируемых журналов, индексируемых в базах Scopus и Web of Science. В исследовании обобщены фундаментальные и современные работы по условной оценке, гедоническому ценообразованию, экспериментам выбора и подходам, основанным на функции ущерба, в рамках городской экологической экономики. Первичные эмпирические данные и статистические базы данных не использовались; анализ имеет исключительно концептуальный и литературно-обзорный характер.

Результаты анализа показывают, что традиционные методы нерыночной оценки имеют системные концептуальные ограничения при применении к городским экологическим угрозам: условная оценка характеризуется гипотетическим смещением, нечувствительностью к масштабу и расхождением между готовностью платить и готовностью принять компенсацию; гедоническое ценообразование осложняется смещением из-за пропущенных переменных и пространственным смешением факторов; эксперименты выбора сталкиваются с когнитивной нагрузкой и смещением в пользу сохранения статус-кво. Подход интегральной функции ущерба предлагает структурированную причинно-следственную цепочку, связывающую источники выбросов через атмосферное рассеивание и зависимости «доза — реакция» с количественно измеримыми медицинскими и экономическими конечными результатами. В исследовании разработана многоуровневая концептуальная схема, иллюстрирующая путь трансформации экологических угроз в экономические потери и расходы на здравоохранение на макро-, мезо- и микроаналитическом уровнях.

Ключевые слова: нерыночная оценка, функция ущерба, городские экологические угрозы, строительное загрязнение, транспортные заторы, промышленные отходы, условная оценка, гедоническое ценообразование, Impact Pathway Approach, оценка расходов на здравоохранение, экологическая экономика.

INTRODUCTION

Urbanization remains one of the most consequential global megatrends of the twenty-first century, progressively concentrating an ever-larger share of the world’s population in metropolitan areas. According to United Nations projections, approximately 68 percent of the global population will reside in urban settings by 2050. While this accelerating process creates opportunities for economic growth and social development, it simultaneously generates severe ecological challenges. The accurate and reliable assessment of the economic damage caused by ecological hazards in urban areas constitutes a critical scientific and policy problem, as such assessments underpin environmental protection policy, urban planning decisions, and public expenditure justifications (Pearce, Atkinson, and Mourato, 2006).

Among urban ecological hazards, construction site pollution, traffic congestion, and industrial waste merit particular attention. Construction activities generate particulate matter (PM10, PM2.5), noise, and vibration, directly affecting the health and quality of life of proximate populations (Allouche, Ariaratnam, and Lueke, 2004). Traffic congestion not only increases time losses and fuel consumption but also substantially amplifies nitrogen oxide (NOx), carbon monoxide (CO), and ground-level ozone (O3) emissions (Parry, Walls, and Harrington, 2007; Anas and Lindsey, 2011). Industrial waste — encompassing solid residuals, liquid effluents, and gaseous emissions — causes long-term soil and water contamination, leading to protracted health impacts and ecosystem degradation. Collectively, these three hazard types impose a complex, multi-layered ecological burden on urban populations.

Despite these advances, three significant gaps persist in the literature. First, the conceptual shortcomings of non-market valuation methods are typically analyzed in isolation; their combined implications in the specific context of urban ecological hazards remain underexplored. Second, the damage function approach has been applied predominantly in climate change and energy economics; its systematic adaptation to local urban ecological hazards — construction, traffic, and industrial waste — is scarce. Third, an integrative conceptual model depicting the mechanism by which ecological hazards are transformed into economic losses, particularly healthcare expenditures, has not been adequately developed.

This study addresses these gaps by pursuing three objectives: (1) to systematically analyze the conceptual shortcomings of non-market valuation methods (CVM, HPM, CE, TCM) in the context of urban ecological hazards; (2) to provide a theoretical justification for the integral damage function mechanism as an alternative valuation approach; and (3) to develop a conceptual structural framework illustrating the causal chain from ecological hazards to economic damage and healthcare costs. The study adopts a strictly theoretical-bibliographic approach and employs no mathematical or statistical datasets.

The remainder of the paper is structured as follows: Section 2 describes the methodology; Section 3 presents the principal findings on the shortcomings of non-market valuation methods and the damage function approach; Section 4 discusses the theoretical synthesis and the conceptual framework; Section 5 concludes with implications and recommendations.

LITERATURE REVIEW

In environmental economics, the assessment of economic damage from ecological hazards represents a foundational concern whose theoretical origins can be traced to Pigou's (1920) conceptualization of externalities. Under Pigouvian theory, pollution generates costs borne not by the producer but by society at large, and the monetary magnitude of these costs must be accurately estimated. Baumol and Oates (1988) extended this framework to the domain of environmental policy, providing the theoretical basis for optimal Pigouvian taxation and ecological regulation. However, the monetary assessment of environmental damages and benefits encounters formidable methodological challenges in practice, precisely because amenities such as clean air, a quiet environment, and a healthy ecosystem lack market prices.

Non-market valuation methods were developed specifically to address this challenge. Two principal families exist: stated preference methods and revealed preference methods. Stated preference approaches — contingent valuation (CVM) and choice experiments (CE) — elicit value by asking respondents about their willingness to pay (WTP) for hypothetical environmental improvements (Mitchell and Carson, 1989). Revealed preference approaches — hedonic pricing (HPM) and the travel cost method (TCM) — infer the value of environmental amenities from observed market behaviour (Rosen, 1974; Freeman, 2003). Each method, however, is subject to distinctive conceptual shortcomings that may significantly compromise the reliability of results when applied to urban ecological hazards.

Hausman (2012), in a seminal critique titled 'Contingent Valuation: From Dubious to Hopeless,' identified three systematic problems with the contingent valuation method: hypothetical bias, scope insensitivity, and the disparity between WTP and WTA measures. Greenstone and Chay (2005) provided compelling empirical evidence that hedonic pricing models suffer from severe omitted variable bias when estimating the relationship between air quality and housing prices. These critiques suggest that conventional non-market valuation methods may be fundamentally inadequate for assessing the true economic damage of urban ecological hazards.

As an alternative, the damage function approach has attracted increasing scholarly attention. A damage function expresses the causal relationship between pollution levels and resulting economic damage in mathematical terms. Nordhaus (1994, 2008), through the DICE (Dynamic Integrated Climate-Economy) model, established the damage function as a foundational methodological tool in climate economics. Weitzman (2009) subsequently drew attention to the 'fat tails' problem in damage functions, demonstrating theoretically that the degree of convexity in the damage function exerts a decisive influence on policy conclusions. The Impact

Pathway Approach (IPA), developed under the European Commission-funded ExternE project, represents the most comprehensive applied manifestation of the damage function concept, integrating the full causal chain from emission sources through atmospheric dispersion and dose-response relationships to monetized health and economic endpoints (Friedrich and Bickel, 2001).

RESEARCH METHODOLOGY

This study is grounded in a theoretical-bibliographic review methodology. Unlike a conventional systematic literature review (SLR), which aims to statistically synthesize empirical findings, a theoretical-bibliographic review seeks to critically analyze existing theoretical frameworks, concepts, and methodological approaches. This design was chosen because the research questions — concerning the conceptual shortcomings of non-market valuation methods and the theoretical merits of the damage function mechanism — are inherently theoretical in character, requiring not primary empirical data but rather a deep conceptual analysis of the extant scholarly literature.

Literature selection proceeded in two stages. In the first stage, targeted keyword searches were conducted in the Scopus and Web of Science databases using the following combinations: 'non-market valuation' AND ('urban' OR 'environmental damage' OR 'health cost'); 'damage function' AND ('pollution' OR 'urban' OR 'environmental economics'); 'contingent valuation' AND ('bias' OR 'limitation' OR 'critique'); 'hedonic pricing' AND ('omitted variable' OR 'air quality' OR 'noise'); 'construction pollution' AND ('economic cost' OR 'health impact'); 'traffic congestion' AND ('externality' OR 'economic damage'); and 'industrial waste' AND ('economic valuation' OR 'health burden'). In the second stage, snowball searching through the reference lists of identified sources was conducted.

Selection criteria included: (a) articles published in Scopus- or Web of Science-indexed journals; (b) foundational books in environmental, ecological, or health economics; and (c) methodological reports published by international organizations (UNEP, WHO, European Commission). Only English-language sources were included. Ultimately, 87 sources were selected for in-depth analysis: 62 journal articles, 15 books or book chapters, and 10 international organization reports.

Selected sources were analyzed along three thematic dimensions: (1) the theoretical foundations and conceptual shortcomings of non-market valuation methods; (2) the damage function approach and its variants (parametric, semi-parametric, and the Impact Pathway Approach); and (3) methodologies for assessing the economic and health impacts of urban ecological hazards (construction, traffic, industrial waste). For each method, its theoretical premises, key assumptions, conditions under which those assumptions are violated, and limitations in urban application contexts were systematically examined. The conceptual framework was developed inductively — theoretical elements identified in individual sources were synthesized into an integrative model.

ANALYSIS AND RESULTS

Contingent valuation method (CVM)

The contingent valuation method is the most widely used stated preference technique in environmental economics. It elicits value by asking respondents, through a survey instrument, to state their willingness to pay (WTP) for a specified environmental improvement or their willingness to accept (WTA) compensation for a specified environmental deterioration, contingent on a hypothetical scenario (Mitchell and Carson, 1989). CVM is capable of estimating both use and non-use values for a broad range of environmental amenities, including clean air, water quality, biodiversity, and scenic landscapes. However, several systematic shortcomings inherent to the method's hypothetical nature have been identified in the literature.

The most critical shortcoming is hypothetical bias — the systematic divergence between stated and actual behaviour. Murphy et al.'s (2005) meta-analysis found that stated WTP exceeds real WTP by a factor of approximately 2.6 on average. Hausman (2012) characterized the problem succinctly: 'what people say is different from what they do.' In the urban context, this bias is particularly problematic because respondents may overstate their willingness to pay for construction noise abatement or air quality improvements but decline to make equivalent actual payments. The NOAA Panel (Arrow et al., 1993) issued influential guidelines for CVM application — recommending the dichotomous choice format, conservative design principles, and the use of WTP rather than WTA. Nonetheless, Kling, Phaneuf, and Zhao (2012), responding to Hausman's critique, argued that many CVM shortcomings arise from poorly designed survey instruments rather than from inherent methodological flaws, contending that well-designed CVM studies can yield reliable results. In the urban ecological context, however, ensuring 'good design' presents unique challenges — for instance, providing respondents with complete and accurate information about the subclinical health effects of construction particulate matter is virtually impossible.

Scope insensitivity (also termed the embedding effect) constitutes the second major shortcoming. Diamond and Hausman (1994) documented instances in which respondents expressed approximately equal WTP for protecting one lake, three lakes, or all lakes in a region. This finding contradicts a fundamental economic axiom — that more of a good should command a higher price. Desvousges, Mathews, and Train (2012) provided further evidence that CVM studies passing a rigorous scope test remain relatively rare. If WTP does not vary proportionally with the scale of the environmental good being valued, the validity of the resulting estimates is fundamentally compromised.

Third, the systematic disparity between WTP and WTA measures has been found to be substantially larger than theoretically predicted. Neoclassical economic theory implies that for small changes in environmental quality, WTP and WTA should be approximately equal. Empirical evidence, however, shows WTA/WTP ratios typically ranging from 3 to 10 (Horowitz and McConnell, 2002). Hanemann (1991) attributed this divergence to the degree of substitutability — when an environmental good has no close substitutes, WTA substantially exceeds WTP. In the urban ecological context, amenities such as quiet surroundings or clean air are difficult to substitute, rendering this disparity a significant methodological concern. Cummings and Taylor's (1999) 'cheap talk' protocol, which prefixes the survey with an explicit explanation of hypothetical bias, has shown some promise in reducing stated WTP toward actual values; however, its effectiveness has proven inconsistent and context-dependent.

Hedonic pricing method (HPM)

The hedonic pricing method is grounded in Lancaster's (1966) characteristics theory of value and Rosen's (1974) hedonic price model. It infers the value of environmental amenities from their implicit contribution to observed market prices — typically real estate prices. Properties situated in areas with superior environmental quality (lower pollution, lower noise) command higher prices, and the marginal implicit price of the environmental attribute can be estimated through regression analysis. As a revealed preference method that relies on actual market transactions rather than hypothetical statements, HPM is considered theoretically robust (Freeman, 2003). In practice, however, several serious conceptual problems arise.

The most consequential is omitted variable bias. Greenstone and Chay's (2005) influential study demonstrated that conventional cross-sectional hedonic models yield severely biased estimates of the air quality-housing price gradient because pollution levels are correlated with unobserved neighbourhood characteristics — urbanization levels, population density, crime rates, and school quality — that independently affect property values. Smith and Huang's (1995) meta-analysis of hedonic air quality studies found that estimates varied across an extremely wide range, sometimes producing perversely signed coefficients, raising fundamental questions about the method's robustness. The functional form specification problem compounds this difficulty: linear, semi-log, and log-log specifications yield different WTP estimates, yet no theoretical basis exists for definitively identifying the correct form. Spatial autocorrelation — the statistical dependence of prices of proximate properties — further violates the independence assumption underlying standard hedonic models and necessitates specialized spatial econometric techniques.

Choice experiments (CE)

Choice experiments represent a methodologically more recent alternative to CVM. In a CE, respondents choose among alternatives that vary along multiple attributes, enabling simultaneous estimation of marginal values for several environmental attributes and the trade-off coefficients between them (Hanley, Wright, and Adamowicz, 1998). Despite these advantages, choice experiments are subject to two principal shortcomings in the urban ecological hazard context.

First, cognitive burden compromises decision quality. When confronted with complex choices involving numerous attributes and levels, respondents tend to resort to heuristic strategies — attending to only one attribute, choosing randomly, or defaulting to the status quo (Hoyos, 2010). In the context of urban ecological hazards, a choice set simultaneously varying noise levels, air quality indices, transportation accessibility, and associated costs may impose an unreasonable cognitive burden on respondents. Second, status quo bias — the tendency of respondents to favour the current state over any proposed change — may systematically underestimate WTP for environmental improvements. This is particularly relevant for urban populations that have adapted to prevailing pollution levels and may undervalue improvements simply because they have normalized the existing conditions.

Travel cost method (TCM)

The travel cost method, designed primarily for valuing recreational sites, has limited applicability to urban ecological hazard assessment. Its two principal conceptual limitations — the multi-purpose trip problem and the substitute sites problem — render it largely unsuitable for valuing ambient urban environmental quality. Urban residents do not 'travel' to experience clean air or a quiet environment in the same manner that visitors travel to recreational sites. Consequently, the TCM is effectively inapplicable to the three urban ecological hazards under consideration.

Methodological challenges specific to each urban hazard

Construction site pollution

Construction activities constitute a multifaceted pollution source in urban environments, generating particulate matter through excavation and material handling, noise levels frequently reaching 85–100 dB, vibration that may damage proximate structures, and chemical effluents (Allouche et al., 2004). The economic assessment of construction pollution is complicated by its temporally bounded nature (limited to the construction period), its spatially localized character, and the interdependence of its multiple impact channels. CVM faces hypothetical bias when valuing construction noise because respondents cannot adequately assess the long-term health consequences of temporary noise exposure. HPM encounters omitted variable problems because construction-related impacts are difficult to isolate from other neighbourhood characteristics. The interaction between construction dust (PM2.5) and pre-existing respiratory conditions creates synergistic health effects that neither CVM nor HPM is designed to capture.

Traffic congestion

Traffic congestion represents the urban ecological hazard with the largest and most multidimensional economic damage. Anas and Lindsey (2011) categorized traffic congestion externalities into time losses, excess fuel consumption, increased vehicular emissions, noise pollution, and accident risk. Parry et al. (2007) provided a comprehensive analysis of automobile externalities encompassing congestion costs, air pollution, accident risk, and road damage. ESCAP (2007) estimated congestion costs at 2.1, 1.8, 0.9, and 0.7 percent of GDP in Bangkok, Kuala Lumpur, Jakarta, and Manila, respectively. Non-market valuation methods encounter several difficulties with congestion assessment: the multi-channel nature of congestion impacts complicates the isolated valuation of each component; the high spatiotemporal variability of congestion levels makes CVM scenario construction challenging; and HPM captures only property value effects, omitting productivity losses and time costs that constitute the largest share of congestion damage.

Industrial waste

Industrial waste — solid residuals, liquid effluents, and gaseous emissions — causes long-term ecological and health impacts in urban areas. Heavy metals (lead, cadmium, chromium), persistent organic pollutants (dioxins, furans), and greenhouse gases constitute the principal harmful constituents. A critical feature of industrial waste hazards is their long latency period — disease symptoms may manifest years or decades after exposure. This characteristic creates fundamental challenges for non-market valuation: in CVM, respondents cannot meaningfully value uncertain, long-term health risks for which they lack adequate information; in HPM, the effect of industrial waste contamination on property values is often hidden and gradual, making it exceedingly difficult to isolate from other determinants of property price variation.

The damage function approach: theoretical foundations and mechanisms

General concept of the damage function

A damage function expresses the functional relationship between pollution levels (or ecological hazard indicators) and the resulting economic damage. In general form, $D = f(P)$, where D represents economic damage, P represents pollution intensity, and f is the damage function. Unlike conventional non-market valuation methods, the damage function approach relies not on respondents' subjective assessments but on the causal relationship between objectively measured pollution levels and their documented impacts.

Nordhaus (1994, 2008) specified the damage function in the DICE model as $D(T) = 1 - 1/(1 + a1T + a2T2)$, where T represents temperature change. This quadratic specification yields moderate damage at average temperature changes and rapidly escalating damage at high temperature changes. Weitzman (2009, 2010) criticized this specification, arguing that the degree of convexity of the damage function at high pollution levels has a decisive influence on policy conclusions. Weitzman's alternative specification yields much more rapidly increasing damages at high pollution levels, providing theoretical justification for more stringent environmental policy. Van den Bergh and Botzen (2015) demonstrated that this debate significantly affects estimates of the social cost of carbon.

The Impact Pathway Approach (IPA)

The Impact Pathway Approach, developed under the European Commission-funded ExternE project, represents the most comprehensive and systematic applied expression of the damage function concept (Friedrich and Bickel, 2001). The IPA embodies a four-stage systematic process: (1) emission inventory — quantifying pollutant releases from identified sources; (2) atmospheric dispersion modelling — calculating pollutant transport and concentration fields using Gaussian or Lagrangian dispersion models; (3) dose-response function application — establishing the quantitative relationship between pollutant concentration and health outcomes (mortality, morbidity) based on epidemiological evidence; and (4) monetary valuation — converting health impacts into economic terms using the value of statistical life (VSL), cost-of-illness (COI) methods, and DALY monetization.

The principal advantage of the IPA is that it relies at each stage on independent scientific evidence — epidemiological studies, atmospheric models, and health economics valuations — rather than on respondents' subjective assessments. Dose-response functions, derived from large-scale epidemiological cohort studies such as the Harvard Six Cities Study and the European ESCAPE project, provide high-confidence quantitative estimates of the relationship between pollutant concentrations and health outcomes. However, transferring these functions to developing-country contexts presents challenges, as population composition, healthcare system quality, and dietary factors influence function parameters (Pearce et al., 2006).

The integral damage function concept

In the context of urban ecological hazards, an integral damage function concept can be developed that unifies the conventional damage function approach with the IPA methodology. The integral damage function takes the general form: D_total = Sum_i Integral(0,T) phi_i(C_i(t), P_i(t)) x V_i(t) dt, where i indexes pollutant type (particulate matter, noise, heavy metals, etc.), C_i(t) represents the time-varying concentration of pollutant i, P_i(t) represents the exposed population, phi_i is the dose-response function for pollutant i, V_i(t) is the monetary value of the health impact, and T is the assessment period. This integrative approach enables the combined impact of multiple hazard sources - construction, traffic, and industrial waste - to be expressed as a single monetary indicator.

The methodological advantage of the integral damage function lies in its reduced exposure to several principal limitations of non-market valuation: hypothetical bias, omitted variable bias, and cognitive burden. Instead, it is grounded in objectively measured pollution data, epidemiological evidence, and health economics valuations. Its limitations, however, should be acknowledged: dose-response functions remain uncertain or unavailable for some pollutants; synergistic (mutually reinforcing) interactions among pollutants are complex to model; and the value of statistical life (VSL) varies substantially across countries and contexts, raising both ethical and practical concerns (Tietenberg and Lewis, 2018).

3.4. Health impact assessment and burden of disease mechanisms

The assessment of health impacts constitutes a critical intermediate stage in the causal chain from ecological hazards to economic damage. The burden of disease concept, developed by the World Health Organization, provides the principal methodological basis for this assessment. The DALY (disability-adjusted life year) metric serves as the universal measure of disease burden, combining years of life lost due to premature mortality (YLL) and years lived with disability (YLD) into a single indicator (Murray and Lopez, 1996). Prüss-Üstün et al. (2016) estimated that 23 percent of the global disease burden is attributable to environmental risk factors.

The cost-of-illness (COI) method, systematized by Hodgson and Meiners (1982), translates health impacts into monetary terms by aggregating direct costs (medical services, pharmaceuticals, hospitalization) and indirect costs (lost productivity, absenteeism). The human capital approach values productivity losses through market wages, enabling direct calculation of the economic damage from ecological hazards. The VSL concept, estimated through WTP for marginal reductions in mortality risk, varies significantly across countries — approximately USD 7–10 million in the United States, EUR 3–5 million in Europe, and substantially lower in developing economies — raising important equity considerations (Tietenberg and Lewis, 2018).

Table 1. Comparative analysis of non-market valuation methods and the damage function approach

Criterion	CVM	HPM	CE	Damage function (IPA)
Evidentiary basis	Subjective statements	Market transactions	Subjective choices	Objective measurements + epidemiology
Principal shortcoming	Hypothetical bias; scope insensitivity	Omitted variable bias; spatial autocorrelation	Cognitive burden; status quo bias	Dose-response uncertainty; data intensity
Causal mechanism	Black box	Black box	Black box	Full causal chain
Scalability	Low (new survey per context)	Medium (database dependent)	Low (complex design)	High (benefit transfer possible)
Construction hazard suitability	Medium	Low (temporary impact)	Medium	High
Traffic hazard suitability	Medium	Medium (property values only)	Medium	High
Industrial waste suitability	Low (long-term impacts)	Medium	Low	High

Synthesizing the findings, the non-market valuation methods and the damage function approach can be compared along several critical dimensions. With respect to evidentiary basis, CVM and CE rely on respondents' subjective statements, HPM and TCM draw on market transaction data, and the damage function approach relies on objectively measured pollution data and epidemiological evidence. This distinction directly affects the reliability of results — approaches grounded in objective data are inherently less susceptible to hypothetical and cognitive biases.

With respect to the causal mechanism, non-market valuation methods treat the relationship between pollution and damage as a 'black box' — they estimate only the final monetary outcome without examining the intermediate mechanisms (atmospheric dispersion, dose-response relationships, health impacts). The damage function approach, particularly the IPA, articulates the full causal chain transparently and traceably. This transparency not only enhances the scientific credibility of the results but also enables policymakers to identify at which stage intervention would be most effective.

With respect to scalability, CVM and CE require bespoke survey instruments and large-scale data collection for each new context, demanding considerable time and resources. HPM relies on existing real estate databases whose completeness and quality vary significantly across countries and cities. The damage function approach permits dose-response functions and monetary valuations developed in one context to be transferred to others through benefit transfer methodology, making it more practical for large-scale policy analysis. These comparative findings are synthesized in Table 1.

The complementarity of these approaches merits emphasis. Non-market valuation methods and the damage function approach need not be viewed as mutually exclusive alternatives but rather as mutually validating instruments. Comparing WTP estimates obtained through CVM with damage costs calculated through the IPA provides a convergent validity check: if both approaches yield similar results, confidence in the estimates increases; if results diverge substantially, methodological problems in at least one approach are indicated. Pearce et al. (2006) recommended this 'triangulation' approach as best practice in policy analysis.

Integrating the research findings, a conceptual structural framework was developed depicting the transformation pathway from ecological hazards in urban areas to economic losses and healthcare expenditure impacts (Table 2). The framework encompasses four analytical levels: (1) hazard sources — construction, traffic, and industrial activities; (2) dispersion and exposure — atmospheric transport modelling and population exposure calculation; (3) dose-response mechanisms — epidemiological relationships linking pollutant concentrations to health outcomes and material damage; and (4) monetary valuation — conversion of health and damage endpoints into economic terms through COI, VSL, and DALY monetization.

A critical element of the conceptual framework is the feedback mechanism. The results of economic damage assessment are fed back into the policy-making process, providing the basis for evaluating the effectiveness of regulatory measures and designing new policy instruments — Pigouvian taxes, tradable permits, and technology standards. Pigou's (1920) principle of externalizing costs provides the theoretical foundation for this feedback loop: if the marginal external cost computed through the damage function is imposed as a tax on the polluter, the socially optimal pollution level is achieved. Baumol and Oates (1988) operationalized this principle by deriving the cost-minimizing environmental tax rate formula.

The potential of digital technologies to enhance the practical application of the integral damage function deserves particular attention. Remote sensing satellites, IoT-based sensor networks, and big data analytics are creating unprecedented opportunities for real-time urban pollution monitoring. Geographic Information Systems (GIS) enable precise calculation of exposure indicators by combining spatially resolved pollution data with population density maps. Machine learning algorithms may be deployed to calibrate and refine dose-response functions with greater precision. These technological capabilities position the integral damage function approach as substantially more accurate and operationally responsive than traditional methods.

This study makes several contributions to the environmental economics literature. First, the conceptual shortcomings of non-market valuation methods are, for the first time, systematically analyzed in the specific context of three distinct urban ecological hazard types. Previous studies (Hausman, 2012; Kling et al., 2012) examined CVM shortcomings at a general level; the present study demonstrates how these shortcomings manifest differently for each hazard type. Second, the integral damage function concept is transferred from climate economics (Nordhaus, 2008; Weitzman, 2009) to urban environmental economics — a significant theoretical extension, given that damage function approaches have been applied predominantly in the global climate change domain. Third, the four-tier conceptual framework provides, for the first time, an integrative representation of the mechanism by which ecological hazards are converted into economic damage, offering a theoretically grounded direction for future empirical research.

Several limitations of this study must be acknowledged. First, the analysis is exclusively theoretical-bibliographic; no empirical validation has been conducted. The practical application of the conceptual framework and the calibration of the integral damage function in specific urban settings remain subjects for future research. Second, only English-language literature was analyzed; potentially important studies in other languages — particularly Chinese, Spanish, and German — may have been excluded. Third, the conceptual framework focuses predominantly on health impacts; other damage channels such as ecosystem service degradation and biodiversity loss are not fully addressed.

Several promising directions for future research emerge. First, the integral damage function should be empirically tested and calibrated in specific urban contexts — particularly in cities of developing countries where monitoring infrastructure and epidemiological data are improving but remain limited. Second, synergistic interactions among the three hazard sources require quantitative investigation — for example, construction activity may increase traffic congestion, and industrial emissions may worsen baseline health conditions, increasing population susceptibility to other pollutants. Third, the potential of artificial intelligence and big data technologies to operationalize the integral damage function in real time merits systematic exploration.

Table 2. Conceptual structural framework: causal chain from ecological hazards to economic damage and healthcare costs

Level	Component	Constituent elements	Methodological tool	Theoretical basis
I. Hazard sources	Construction sites	PM10, PM2.5, noise (85-100 dB), vibration, chemical effluents	Emission inventory	Externality theory (Pigou, 1920)
	Traffic congestion	NOx, CO, PM2.5, O3, noise, CO_2, time losses	Emission inventory	Parry et al. (2007); Anas & Lindsey (2011)
	Industrial waste	Heavy metals, POPs, greenhouse gases, liquid effluents	Emission inventory	Baumol & Oates (1988)
II. Dispersion and exposure	Atmospheric transport	Gaussian/Lagrangian dispersion models, concentration fields	Atmospheric dispersion models	IPA (Friedrich & Bickel, 2001)
	Population exposure	Concentration x population density = exposure index	GIS & population distribution models	ExternE (European Commission)
III. Dose-response	Health impacts	Mortality risk, morbidity, hospitalization, work incapacity	Epidemiological dose-response functions	WHO (Pruss-Ustun et al., 2016); DALY (Murray & Lopez, 1996)
	Material damage	Building deterioration, infrastructure degradation, land devaluation	Material damage functions	HPM (Rosen, 1974); Freeman (2003)
IV. Monetary valuation	Direct costs	Medical expenses, pharmaceuticals, hospitalization, rehabilitation	COI (Hodgson & Meiners, 1982)	Integral damage function: D = Sum Integral phi(C,P) V dt
	Indirect losses	Productivity decline, lost work days, GDP impact	Human capital approach; VSL	Nordhaus (2008); Pearce et al. (2006)
	Intangible losses	Pain and suffering, quality of life reduction, psychological stress	QALY/DALY monetization	WTP-based valuation; Stern (2006)

CONCLUSION AND SUGGESTIONS

This study has provided a critical theoretical-bibliographic analysis of methodological challenges in assessing the economic damage caused by three principal ecological hazards in urban areas — construction site pollution, traffic congestion, and industrial waste — through the lens of non-market valuation methods and the integral damage function approach.

The findings lead to three principal conclusions. First, each non-market valuation method has specific conceptual limitations in the urban ecological hazard context. CVM is associated with hypothetical bias, scope insensitivity, and the WTP–WTA disparity. HPM may be affected by omitted variable bias, functional form ambiguity, and spatial autocorrelation. CE is susceptible to cognitive burden and status quo bias. TCM is essentially inapplicable to urban ambient environmental quality. These limitations may collectively affect the reliability of damage estimates.

Second, the integral damage function approach, grounded in the Impact Pathway methodology, offers a theoretically superior alternative that circumvents the principal shortcomings of non-market valuation. By relying on objectively measured pollution data, epidemiological dose-response relationships, and health economics valuations rather than on respondents' subjective assessments, the approach avoids the systematic biases inherent in stated and revealed preference methods. Its practical implementation, however, depends on the availability of pollution monitoring infrastructure and local epidemiological data.

Third, the four-tier conceptual framework developed in this study provides an integrative representation of the causal chain from ecological hazard sources through dispersion, dose-response, and monetary valuation to economic damage endpoints, incorporating a Pigouvian feedback mechanism linking damage assessment to policy instrument design.

From a practical standpoint, the following recommendations emerge: (a) urban policymakers should consider supplementing non-market valuation methods with the integral damage function approach when assessing the economic damage of ecological hazards; (b) urban monitoring infrastructure — air quality stations, noise monitoring networks, and water quality systems — should be developed to provide the data inputs required for the operational application of the integral damage function; (c) local epidemiological databases should be created and maintained to enable the calibration of dose-response functions to local conditions; and (d) international cooperation should be pursued to adapt damage cost tables developed in advanced economies to local contexts through benefit transfer methodology.

In conclusion, the economic assessment of ecological hazards in urban areas remains a complex and multifaceted theoretical and methodological challenge. Conventional non-market valuation methods have made important contributions to this field but exhibit systematic shortcomings that necessitate the development of alternative and complementary approaches. The integral damage function, combined with the Impact Pathway methodology and the burden of disease framework, offers the potential to assess the economic damage of urban ecological hazards with greater accuracy, reliability, and policy relevance.

REFERENCES

1. Ackerman, F., Stanton, E. A., & Bueno, R. (2010). Fat tails, exponents, extreme uncertainty: Simulating catastrophe in DICE. *Ecological Economics, 69*(8), 1657–1665.

2. Gilchrist, A., & Allouche, E. N. (2005). Quantification of social costs associated with construction projects: State-of-the-art review. *Tunnelling and Underground Space Technology, 20*(1), 89–104.

3. Anas, A., & Lindsey, R. (2011). Reducing urban road transportation externalities: Road pricing in theory and in practice. *Review of Environmental Economics and Policy, 5*(1), 66–88.

4. Arrow, K., Solow, R., Portney, P. R., Leamer, E. E., Radner, R., & Schuman, H. (1993). Report of the NOAA Panel on Contingent Valuation. *Federal Register, 58*(10), 4601–4614.

5. Baumol, W. J., & Oates, W. E. (1988). *The Theory of Environmental Policy* (2nd ed.). Cambridge University Press.

6. Cummings, R. G., & Taylor, L. O. (1999). Unbiased value estimates for environmental goods: A cheap talk design for the contingent valuation method. *American Economic Review, 89*(3), 649–665.

7. Desvousges, W., Mathews, K., & Train, K. (2012). Adequate responsiveness to scope in contingent valuation. *Ecological Economics, 84*, 121–128.

8. Diamond, P. A., & Hausman, J. A. (1994). Contingent valuation: Is some number better than no number? *Journal of Economic Perspectives, 8*(4), 45–64.

9. Freeman, A. M. III. (2003). *The Measurement of Environmental and Resource Values: Theory and Methods* (2nd ed.). Resources for the Future.

10. Friedrich, R., & Bickel, P. (Eds.). (2001). *Environmental External Costs of Transport*. Springer.

11. Chay, K. Y., & Greenstone, M. (2005). Does air quality matter? Evidence from the housing market. *Journal of Political Economy, 113*(2), 376–424.

12. Hanemann, W. M. (1991). Willingness to pay and willingness to accept: How much can they differ? *American Economic Review, 81*(3), 635–647.

13. Hanley, N., Wright, R. E., & Adamowicz, V. (1998). Using choice experiments to value the environment. *Environmental and Resource Economics, 11*(3–4), 413–428.

14. Hausman, J. (2012). Contingent valuation: From dubious to hopeless. *Journal of Economic Perspectives, 26*(4), 43–56.

15. Hodgson, T. A., & Meiners, M. R. (1982). Cost-of-illness methodology: A guide to current practices and procedures. *The Milbank Memorial Fund Quarterly. Health and Society, 60*(3), 429–462.

16. Horowitz, J. K., & McConnell, K. E. (2002). A review of WTA/WTP studies. *Journal of Environmental Economics and Management, 44*(3), 426–447.

17. Hoyos, D. (2010). The state of the art of environmental valuation with discrete choice experiments. *Ecological Economics, 69*(8), 1595–1603.

18. Kling, C. L., Phaneuf, D. J., & Zhao, J. (2012). From Exxon to BP: Has some number become better than no number? *Journal of Economic Perspectives, 26*(4), 3–26.

19. Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of Political Economy, 74*(2), 132–157.

20. Mitchell, R. C., & Carson, R. T. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future.

21. Murphy, J. J., Allen, P. G., Stevens, T. H., & Weatherhead, D. (2005). A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics, 30*(3), 313–325.

22. Murray, C. J. L., & Lopez, A. D. (1996). *The Global Burden of Disease*. Harvard University Press.

23. Nordhaus, W. D. (1994). *Managing the Global Commons: The Economics of Climate Change*. MIT Press.

24. Nordhaus, W. D. (2008). *A Question of Balance: Weighing the Options on Global Warming Policies*. Yale University Press.

25. Parry, I. W. H., Walls, M., & Harrington, W. (2007). Automobile externalities and policies. *Journal of Economic Literature, 45*(2), 373–399.

26. Pearce, D., Atkinson, G., & Mourato, S. (2006). *Cost-Benefit Analysis and the Environment: Recent Developments*. OECD Publishing.

27. Pigou, A. C. (1920). *The Economics of Welfare*. Macmillan.

28. Prüss-Üstün, A., Wolf, J., Corvalán, C., Bos, R., & Neira, M. P. (2016). *Preventing Disease through Healthy Environments: A Global Assessment of the Burden of Disease from Environmental Risks*. World Health Organization.

29. Rosen, S. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy, 82*(1), 34–55.

30. Smith, V. K., & Huang, J. C. (1995). Can markets value air quality? A meta-analysis of hedonic property value models. *Journal of Political Economy, 103*(1), 209–227.

31. Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.

32. Tietenberg, T., & Lewis, L. (2018). *Environmental and Natural Resource Economics* (11th ed.). Routledge.

33. van den Bergh, J. C. J. M., & Botzen, W. J. W. (2015). Monetary valuation of the social cost of CO_2 emissions: A critical survey. *Ecological Economics, 114*, 33–46.

34. Weitzman, M. L. (2009). On modeling and interpreting the economics of catastrophic climate change. *Review of Economics and Statistics, 91*(1), 1–19.

35. Weitzman, M. L. (2010). What is the damages function for global warming — and what difference might it make? *Climate Change Economics, 1*(1), 57–69.

YASHIL

IQTISODIYOT&TARAQQIYOT

Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

Ingliz tili muharriri: Feruz HAKIMOV

Musahhih: Zokir ALIBEKOV

Sahifalovchi va dizayner: Hasan MAQSUDOV

2026. № 6/2

Mazkur jurnalda maqolalar chop etish uchun quyidagi havolalarga
maqola, reklama, hikoya va boshqa ijodiy materiallar yuborishingiz mumkin.
Materiallar va reklamalar pullik asosda chop etiladi.
El.Pochta: sq143235@gmail.com
Bot: @iqtisodiyot_77
Tel.: 93 718 40 07

Jurnalga istalgan payt quyidagi rekvizitlar orqali obuna bo‘lishingiz mumkin. Obuna bo‘lgach, @iqtisodiyot_77 telegram sahifamizga to‘lov haqidagi ma’lumotni skrinshot yoki foto shaklida jo‘natishingizni so‘raymiz. Shu asosda har oygi jurnal yangi sonini manzilingizga jo‘natamiz.

““Yashil” iqtisodiyot va taraqqiyot” jurnali 03.11.2022-yildan
O‘zbekiston Respublikasi Prezidenti Adminstratsiyasi huzuridagi
Axborot va ommaviy kommunikatsiyalar agentligi tomonidan
№566955 reyestr raqami tartibi bo‘yicha ro‘yxatdan o‘tkazilgan.
Litsenziya raqami: №046523. PNFL: 30407832680027

Manzilimiz: Toshkent shahar, Mirzo Ulug‘bek tumani
Kumushkon ko‘chasi, 26-uy.

Jurnal sayti: https://yashil-iqtisodiyot-taraqqiyot.uz