

## Article

# Favorable and Adverse Impacts of Dams Constructed on the Nestos River as Perceived by the Residents

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## Abstract

Hydropower dams constitute key components of sustainable energy and water resource management, while their long-term operation increasingly depends on social acceptance and local community support. Within this context, the current study investigates residents' perceptions of the environmental, social, and economic advantages and adverse impacts associated with the operation of the Nestos River dams. It explores the role of the NIMBY (Not In My Back Yard) phenomenon in shaping local attitudes. Data were collected during 2020–2021, and a stratified random sampling design was applied, involving 1101 residents living in mountainous, semi-mountainous, and lowland areas of the Nestos River basin. Reliability analysis and factor analysis were employed to assess the consistency of responses and identify the underlying factors shaping residents' perceptions. The results indicate that respondents recognize significant benefits associated with the dams, particularly clean energy production and the creation of lacustrine ecosystems, while simultaneously expressing concerns regarding the disruption of the river's natural flow, biodiversity degradation, and landscape alteration. The findings also reveal complex, spatially differentiated NIMBY dynamics, suggesting that although dams are perceived as socially beneficial infrastructures, their localized impacts influence community acceptance. Overall, the study highlights the importance of incorporating local perceptions into the planning and management of hydraulic infrastructures and provides evidence supporting socially acceptable and sustainable approaches to existing and future dam projects.

**Keywords:** Nestos River; dams; stratified random sampling; factor analysis; hydroelectric energy; NIMBY; hydropower perception



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## 1. Introduction

Renewable energy sources (RES) include hydropower, wind, solar, geothermal energy, biomass, and marine energy, and constitute fundamental pillars of the global strategy for sustainable development and climate change mitigation [1]. In Greece, the institutional framework for electricity generation from RES was established through Article 2 of Law 2773/1999 and subsequently amended by Law 3468/2006 and Article 17 of Law 3489/2006, which also provides for the operation of hybrid power stations [2]. The European Union, aiming to strengthen its leading role in global energy policy and climate protection, places particular emphasis on the promotion of RES as a key instrument of the

energy transition and launches the European Green Deal, which, among multiple pathways, prioritizes RES to meet its ambitious climate goals [3,4].

Hydropower, as a mature and reliable technology, occupies a significant position in the energy mix of many countries, as it offers low greenhouse gas emissions and the capacity for energy storage. At the same time, dam construction has been associated with considerable environmental challenges. Alterations in the natural flow regime of rivers, obstruction of fish migration, loss or degradation of wetland habitats, and biodiversity alteration are documented impacts observed in many regions worldwide [5–8]. International experience from countries such as Brazil [9], Lithuania [10], and Sweden [11] indicates that such projects may also deliver environmental benefits, including the creation of lacustrine ecosystems, flood protection, and water quality improvement, provided that appropriate management measures are implemented [12].

Furthermore, the operation of reservoirs created by dams can support multiple uses creating economic and social benefits, such as irrigation [13], recreation, and tourism development [14], offering opportunities for fishing, swimming, hiking, and other forms of outdoor recreation [15,16]. However, increased human presence and activity may exert additional pressures on ecosystems, including pollution and disturbance of wildlife [17]. Mácová and Kozáková [18] investigated, among other things, the recreational human pressure arising from the presence of a large-scale reservoir system on the Vltava River in the Czech Republic and found a significant increase in visitation due to the variety of recreational uses closely associated with its lacustrine ecosystems. Studies investigating the locals' views provide understanding of their expectations regarding dam construction or operation, as well as the provision of negative effects or benefits, and are very useful in the decision-making process [14], given that rational dam siting, planning, and management are thus critical parameters for achieving a balance between benefits and environmental risks.

Social acceptance is a key determinant for both the implementation and long-term legitimacy of renewable energy system (RES) projects. Although RES generally receive broad public support within the energy transition context, environmental awareness does not necessarily correspond to sufficient knowledge levels. Moreover, willingness to provide financial or practical support for RES initiatives is closely linked to individuals' understanding of, and beliefs regarding, their benefits [19].

Local opposition is commonly interpreted through the NIMBY ("Not In My Back Yard") framework; however, many researchers consider this approach overly simplistic. It fails to account for concerns related to site selection, perceived environmental and landscape impacts, risk perceptions, benefit distribution, and limited public participation in planning processes [20]. The gap between general support for renewable energy and opposition to specific projects may therefore reflect conditional acceptance or perceived democratic deficits rather than self-interested behavior [21].

The concept is multidimensional, while community acceptance is shaped by procedural and distributive justice, institutional trust, stakeholder engagement, and perceived fairness in benefit sharing [22,23]. Opposition may also arise from disruptions to place attachment and local identity, which are embedded in socio-cultural contexts [24]. The educational dimension is also relevant, as teachers' willingness to implement RES programs depends on their attitudes, perceived competence, and perceptions of community support [25].

Accordingly, the NIMBY framework has been widely criticized for its limited explanatory power in capturing public responses to energy infrastructure [26]. Alternative approaches emphasize landscape values, equity, institutional trust, and collaborative planning [27,28]. In this context, perceived procedural and distributive fairness are central to the legitimacy and acceptance of decision-making processes [29]. Finally, proximity

effects are context-dependent and vary with project stage (proposed vs. operational) [30]. Early identification of stakeholder expectations and integration of design-phase factors can improve risk management and infrastructure performance, including dams [31].

While previous studies have investigated the NIMBY phenomenon and public perceptions of dams and renewable energy projects, relatively limited attention has been paid to the integrated assessment of local perceptions regarding long-established, multi-purpose hydraulic infrastructures and their environmental, social, and economic dimensions. This interdisciplinary research combines perspectives from environmental management, social acceptance, and sustainable water resources planning, providing a more comprehensive understanding of the interactions between local communities and the operation of hydraulic infrastructures. In this respect, the study sheds further light on the emerging era of “social hydraulics”, where the sustainable management and operation of hydraulic infrastructures increasingly depend not only on technical performance but also on social acceptance and community engagement. Furthermore, the identification of the underlying dimensions shaping residents’ perceptions may contribute to a better understanding of the factors influencing social acceptance and support the sustainable management of existing hydraulic infrastructures and the planning of future dam projects.

To address these issues, the present research is guided by the following research questions:

RQ1: How do local communities perceive the environmental, social, and economic advantages and disadvantages associated with the operation of the Nestos River dams?

RQ2: To what extent do these perceptions differ among mountainous, semi-mountainous, and lowland communities?

RQ3: What role does the NIMBY phenomenon play in shaping local attitudes towards the operation of the dams?

RQ4: Which underlying factors emerge from residents’ perceptions of the perceived advantages and adverse impacts associated with the Nestos River dams?

Within this context, the present study investigates the residents’ perceptions regarding dams constructed on the Nestos River; and more specifically it examines the perceptualized favorable and adverse environmental, economic and social impacts, as well as the role of the NIMBY phenomenon in shaping attitudes.

This paper is organized as follows: The study area and methodological framework are initially outlined, encompassing data collection and analytical techniques. The following section provides empirical findings regarding residents’ perceptions of the environmental, social, and economic effects of the Nestos River dams. The findings are then discussed in relation to the pertinent literature on hydropower development, social acceptance, and the NIMBY phenomenon. The closing section presents the conclusions, highlighting key implications for sustainable dam management, future research directions, and study limitations.

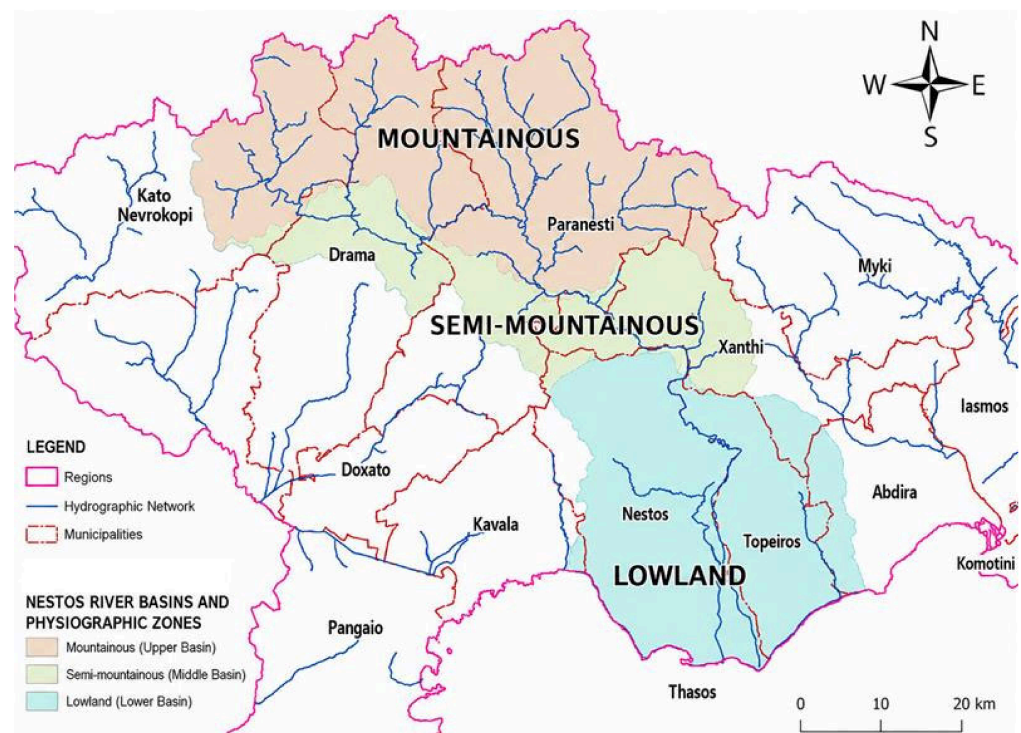
## 2. Materials and Methods

### 2.1. Study Area

The study area (Figure 1) was formed by the Municipalities of Topiros, Nestos, Xanthi (Stavroupoli Municipal Unit), Paranesti, the Municipality of Drama (Sidironero Municipal Unit), and Kato Nevrokopi within the boundaries of Nestos River basin.

Nestos River serves as a geographical boundary between the regions of Macedonia and Thrace and passes through the Regional Units of Drama, Xanthi, and Kavala in the northern part of Greece. Originating from the Rila Mountain range in Bulgaria, the river traverses southwestern Bulgaria and northern Greece, entering Greek territory northwest of Drama between the Orvilos and Rodopi mountains [32]. Its upper course is divided into two arteries, the White and Black Nestos and then merges with secondary tributaries, including the Despatis, Diavolorema and Arkoudorema. The river extends for a total length

of 234 km, of which 130 km flow within Greek borders. Of the total 6178 km<sup>2</sup> catchment area, about 60% lies within Bulgaria. The steep topography and high-altitude mountain peaks characterize the surrounding landscape [33].



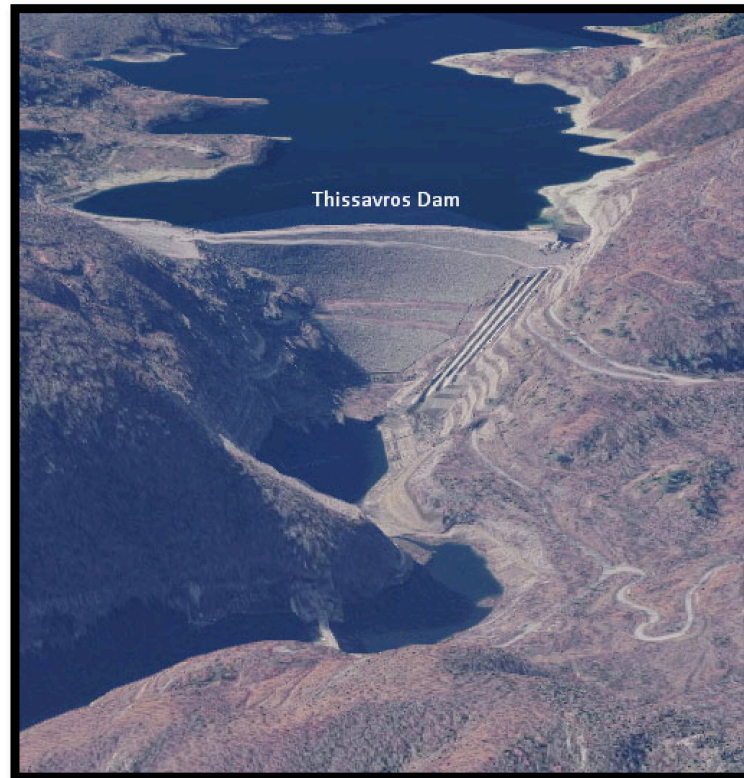
**Figure 1.** Map of the study area with the Nestos River basin. (Source: authors using QGIS 4.0).

The Directorate of Water Management of the Region of Eastern Macedonia and Thrace (REMTH) maintains primary regulatory authority over water resource protection and management within the Nestos River basin, adhering to the revised River Basin Management Plan for the Thrace Water District updated in 2017. In addition, first- and second-level local administrative bodies collaborate regionally in the implementation of The Water Framework Directive 2000/60/EC.

The Nestos River basin has been fundamentally altered by hydraulic infrastructures for hydropower generation and agricultural irrigation purposes. In the mountainous part of the basin, the two main hydropower dams operated by the Public Power Corporation are Thissavros (Figure 2) and Platanovryssi (Figure 3), whose construction was completed by 2000. Their combined annual electricity production is estimated at approximately 680 GWh.

Specifically, the Thissavros infrastructure utilizes three generation units with a total installed capacity of 384 MW and an active reservoir capacity of 680 hm<sup>3</sup>, whereas the Platanovryssi infrastructure operates two units with a total installed capacity of 116 MW and an active reservoir capacity of 72 hm<sup>3</sup> [34].

Conversely, surface water usage in the lower part of the basin primarily supports irrigation, mainly in the agricultural area of the Nestos Delta, where the irrigated area has been estimated at 142 km<sup>2</sup>, of which 131 km<sup>2</sup> are located around the Delta and 11 km<sup>2</sup> in the northern and central part of the basin [35,36]. Annual irrigation requirements exceed 200 million m<sup>3</sup>, while the total irrigated area in the basin has also been estimated at 189,000 stremmas according to data from the local land reclamation organizations of Thalassia–Kremasti [37].



**Figure 2.** Thissavros Dam (Source: Google Maps [https://www.google.com/maps/place/%CE%A6%CF%81%CE%AC%CE%B3%CE%BC%CE%B1+%CE%98%CE%B7%CF%83%CE%B1%CF%85%CF%81%CE%BF%CF%8D,+%CE%A3%CE%B9%CE%B4%CE%B7%CF%81%CF%8C%CE%BD%CE%B5%CF%81%CE%BF+661+00/@41.3544479,24.3620731,846m/data=!3m2!1e3!4b1!4m6!3m5!1s0x14ac1188556400b3:0xe69d5df40c069bc3!8m2!3d41.354444!4d24.366944!16s%2Fm%2F04tmxr6?entry=ttu&g\\_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D](https://www.google.com/maps/place/%CE%A6%CF%81%CE%AC%CE%B3%CE%BC%CE%B1+%CE%98%CE%B7%CF%83%CE%B1%CF%85%CF%81%CE%BF%CF%8D,+%CE%A3%CE%B9%CE%B4%CE%B7%CF%81%CF%8C%CE%BD%CE%B5%CF%81%CE%BF+661+00/@41.3544479,24.3620731,846m/data=!3m2!1e3!4b1!4m6!3m5!1s0x14ac1188556400b3:0xe69d5df40c069bc3!8m2!3d41.354444!4d24.366944!16s%2Fm%2F04tmxr6?entry=ttu&g_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D) accessed on 17 May 2026).



**Figure 3.** Platanovryssi Dam (Source: Google Maps [https://www.google.com/maps/place/%CE%9B%CE%AF%CE%BC%CE%BD%CE%B7+%CE%A0%CE%BB%CE%B1%CF%84%CE%B1%CE%BD%CF%8C%CE%B2%CF%81%CF%85%CF%83%CE%B7%CF%82/@41.3546389,24.3621905,1251m/data=!3m1!1e3!4m6!3m5!1s0x14ac13fba33e1385:0xf8fce5466fe713ab!8m2!3d41.3507523!4d24.4209576!16s%2Fg%2F122cy\\_z6?entry=ttu&g\\_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D](https://www.google.com/maps/place/%CE%9B%CE%AF%CE%BC%CE%BD%CE%B7+%CE%A0%CE%BB%CE%B1%CF%84%CE%B1%CE%BD%CF%8C%CE%B2%CF%81%CF%85%CF%83%CE%B7%CF%82/@41.3546389,24.3621905,1251m/data=!3m1!1e3!4m6!3m5!1s0x14ac13fba33e1385:0xf8fce5466fe713ab!8m2!3d41.3507523!4d24.4209576!16s%2Fg%2F122cy_z6?entry=ttu&g_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D) accessed on 17 May 2026).

Consequently, the public perceptions examined in the present study concern an already operating system of hydraulic works that affects hydropower production, water regulation, irrigation, and the broader hydrological functioning of the Nestos River basin. This complex also includes the Toxotes Dam (Figures 4 and 5) in the lower course, which functions exclusively for irrigation management.



**Figure 4.** Toxotes Dam (Source: the authors).



**Figure 5.** Toxotes Dam (Source: Google Map [https://www.google.com/maps/place/%CE%93%CE%AD%CF%86%CF%85%CF%81%CE%B1+%CE%9D%CE%AD%CF%83%CF%84%CE%BF%CF%85/@41.086219,24.7735877,216m/data=!3m1!1e3!4m6!3m5!1s0x14ac28520ad91353:0x1ac49f1a5fc5a4dd!8m2!3d41.0697343!4d24.7572693!16s%2Fg%2F11g8zr9g7p?entry=tту&g\\_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D](https://www.google.com/maps/place/%CE%93%CE%AD%CF%86%CF%85%CF%81%CE%B1+%CE%9D%CE%AD%CF%83%CF%84%CE%BF%CF%85/@41.086219,24.7735877,216m/data=!3m1!1e3!4m6!3m5!1s0x14ac28520ad91353:0x1ac49f1a5fc5a4dd!8m2!3d41.0697343!4d24.7572693!16s%2Fg%2F11g8zr9g7p?entry=tту&g_ep=EgoyMDI2MDYyMi4wIKXMDSOASAFQAw%3D%3D) accessed on 17 May 2026).

## 2.2. Background and Developments of Hydraulic Infrastructures

In the past ten years (2016–2026), no significant new dams have been built on the Nestos River's main stem. The core hydroelectric and irrigation dam complex, including

the Thissavros Dam (172 m, completed 1996) and Platanovryssi Dam (95 m, completed 1999), was completed in the late 1990s [38].

However, several targeted infrastructural modifications and policy initiatives occurred within the last decade:

- The Toxotes Irrigation Network PPP (2022–2026): A Public–Private Partnership (PPP) contract was approved in June 2022 to develop irrigation networks connected to the existing Toxotes Dam. This project involves transporting water to the Xanthi plains to replace groundwater usage with surface water, designed to serve 25,000 hectares [17,39].
- The Toxotes Eel Pass Construction (2021–2022): Environmental agencies proposed an eco-mitigation project in late 2021 to build a specialized fish pass at the existing Toxotes facility, facilitating the natural migration of local eel populations.
- Temenos Dam (Planned): While proposed as the third major dam in the complex, construction of the Temenos Dam has not materialized within the last ten years, though it is often mentioned in studies of the Nestos Basin.

The existing dams on the Nestos remain key infrastructures for the generation of hydroelectric power (Thissavros, Platanovryssi) and irrigation (Toxotes).

### 2.3. Sample and Data Collection

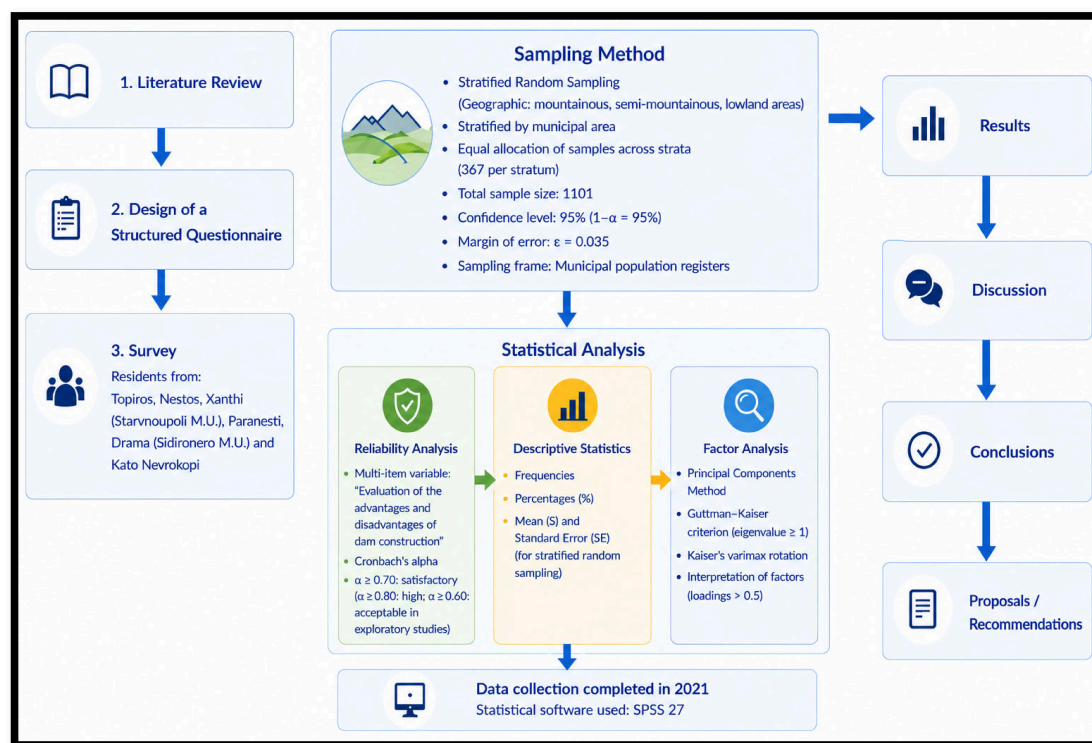
The methodology employed in this study (Figure 6) commenced with an extensive literature review. This was followed by the design of a structured questionnaire, which constituted the main tool for data collection. The survey included a pre-sampling pilot study of 50 residents. Personal interviews were conducted addressing 1101 residents from the Municipalities of Topiros, Nestos, Xanthi (Stavroupoli Municipal Unit), Paranesti, the Municipality of Drama (Sidironero Municipal Unit), and Kato Nevrokopi. Face-to-face personal interviews were selected as the data collection method, as several studies consider them as the most effective means of gathering statistical information [40]. The questionnaire items used in the analysis are provided in the Supplementary Materials.

The questionnaires that participants were asked to complete were anonymous; once collected, they were sealed in an envelope and stored in the researcher's office, where only the Scientific Director and the researcher had access. There was an informed consent in Greek, which was obtained from all participants through voluntary completion of the anonymous questionnaire after they had been informed about the scientific purpose of the study and the confidential use of their responses for research purposes only. The 1st page of the questionnaire was accompanied with the consent form that every participant in the survey had read prior to accepting the questionnaire.

The sampling framework was based on the 2011 population census, which represented the most recent officially available demographic information during the design and implementation of the survey. The author Dr. Giannopoulos conducted interviews to collect the data from January 2020 to August 2021. According to the 2011 population census, the population of the study area amounted to 60,747 inhabitants, comprising the aforementioned municipalities. In order to interpret the flow chart of the research, GenAI ChatGPT Business (OpenAI), GPT-5.5 was used to generate Figure 6 by inserting a full description of the methodology used, and to create Graphical Abstract by incorporating the complete manuscript, after reviewing and editing the output and accepting full responsibility for the contents of this publication.

The sampling method applied in this study was stratified random sampling, as it allows the classification of the population into smaller, homogeneous strata. This method ensures more accurate estimates of population parameters and their associated errors, as well as of individual subgroups, without the need for additional sampling. Geographic stratification (mountainous, semi-mountainous, and lowland areas) proved particularly

useful for obtaining detailed information from each distinct stratum [41]. The target population consisted of residents within the administrative boundaries of the municipalities under study. The mean value ( $S$ ) and the standard error of the population proportion ( $S_p$ ) were calculated using the formulas of stratified random sampling.



**Figure 6.** Flow chart of research (Source: GenAI ChatGPT Business).

In stratified random sampling, separate probability samples were drawn from each stratum to calculate the sample size. This design was chosen to ensure that all predefined geographic strata were represented while also reducing the risk of an unbalanced sample, which could occur with simple random sampling. When properly implemented, stratified sampling can improve the precision of population estimates compared to a simple random sample [42]. This procedure requires a complete and accurate population sampling frame, without omissions or duplications [43], for which municipal population registers were used.

In stratified random sampling, the population is divided into groups based on shared characteristics, forming homogeneous subsets referred to as strata, and a random sample is selected from each stratum [42]. Consequently, this method presupposes the existence of a population sampling frame free of omissions or duplications [43].

In the present study, equal allocation of samples across strata was adopted. The determination of sample size for proportion-related variables, as well as the equal allocation scheme, was based on the formulas of stratified random sampling. Accordingly, the total sample size was set at 1101 individuals, with 367 respondents in each stratum. This calculation was based on a confidence level of 95% [ $(1 - \alpha) = 95\%$ ] and a margin of error  $e = 0.035$ , while no finite population correction was required, as the sample size ( $n$ ) remained small relative to the total population size ( $N$ ). Data collection was completed in August 2021. Statistical analysis of the data was conducted using the SPSS 27 statistical software package.

The sampling frame comprised the municipalities and municipal units whose settlements lie within the Greek part of the Nestos River basin and fall within the scope of its infrastructure management. These administrative units provided the operational

framework for identifying the resident population within the study area. The sample encompassed the Municipalities of Topiros and Nestos, the Stavroupoli Municipal Unit of the Municipality of Xanthi, the Municipality of Paranesti, the Sidironero Municipal Unit of the Municipality of Drama, and the Municipality of Kato Nevrokopi. For the stratified analysis, Topiros and Nestos formed the lowland zone, Stavroupoli and Paranesti the semi-mountainous zone, and Sidironero and Kato Nevrokopi the mountainous zone. While the researchers did not record exact residential coordinates or precise settlement-to-dam distances, the analysis systematically compares perceptions across the three physiographic zones within the affected part of the basin rather than estimating a direct proximity effect.

The target population comprised 60,747 residents distributed across three physiographic strata: 38,791 residents in the lowland stratum, 10,507 in the semi-mountainous stratum, and 11,449 in the mountainous stratum. Municipal population registers were used as the operational sampling frame, and stratified random sampling with equal allocation was applied. Equal allocation was selected to provide an adequate and directly comparable sample size in all three physiographic zones, particularly in the two smaller population strata.

Let  $L$  denote the number of strata,  $N_k$  the population size of stratum  $k$ ,  $N$  the total target population,  $P_k$  the expected population proportion within stratum  $k$ ,  $t$  the critical value corresponding to the selected confidence level, and  $e$  the maximum permissible sampling error. The required total sample size was calculated as:

$$n = \frac{Lt^2 \sum_{k=1}^L N_k^2 P_k (1 - P_k)}{N^2 e^2 + t^2 \sum_{k=1}^L N_k P_k (1 - P_k)}$$

Using:

$$\begin{aligned} L &= 3 \\ N_1 &= 38,791, N_2 = 10,507, N_3 = 11,449 \\ N &= 60,747, t = 1.96, P_k = 0.50, e = 0.035 \end{aligned}$$

the calculation yielded:

$$n = 1098.796$$

Under equal allocation, the required sample size per stratum was:

$$n_k = \frac{n}{L} = \frac{1098.796}{3} = 366.265$$

This value was rounded upward to 367 respondents per stratum. The final achieved sample therefore comprised:

$$n = 3 \times 367 = 1101$$

respondents, with 367 completed interviews in each physiographic stratum.

Because equal allocation resulted in different sampling fractions among the three strata, estimates referring to the study population as a whole were calculated by weighting the stratum-specific estimates according to their population shares:

$$W_k = \frac{N_k}{N}$$

The corresponding weights were:

$$\begin{aligned} W_{\text{lowland}} &= \frac{38,791}{60,747} = 0.63857 \\ W_{\text{semi-mountainous}} &= \frac{10,507}{60,747} = 0.17296 \\ W_{\text{mountainous}} &= \frac{11,449}{60,747} = 0.18847 \end{aligned}$$

Accordingly, estimates for the entire study population were calculated as:

$$\hat{P}_{st} = \sum_{k=1}^L W_k \hat{P}_k$$

Equal allocation was thus used for direct comparisons among the three physiographic strata, whereas population weighting was applied to the overall estimates reported for the entire study area.

#### 2.4. Reliability Analysis

Reliability analysis was applied to the multi-item variable “Evaluation of the advantages and disadvantages of dam construction” in order to assess the internal consistency of the measurement scale. Specifically, Cronbach’s alpha coefficient was employed, as it is widely used to evaluate the internal consistency of questionnaire items [44] and reflects the extent to which data are consistently measured using the same scale [45].

The coefficient represents the squared correlation between an individual’s observed score on a given scale, and the true score that would have been obtained if all possible items had been included [46]. The questionnaire items (variables) are considered by many researchers as equivalent, with respect to measurement accuracy, a key assumption for the application of this method [44].

A Cronbach’s alpha value of 0.70 or higher is generally regarded as satisfactory [45], while values exceeding 0.80 are considered by many researchers highly satisfactory. In applied research, however, it is common practice to accept lower alpha values, down to 0.60, particularly in exploratory studies [46].

#### 2.5. Factor Analysis

For a measurement instrument to be useful, it must first be reliable and subsequently valid. Validity was assessed through factor analysis [46], a technique that allows the construction of new variables that are largely uncorrelated [47], with the aim of optimizing data understanding and interpretation [48,49].

Factor analysis seeks common factors among a set of variables [50], placing greater emphasis on interpreting their underlying structure, rather than on variability alone [51,52]. The method of principal components was applied, which is based on the spectral decomposition of the variance–covariance (correlation) matrix [51,52]. The criterion for determining the significance of the extracted components followed the Guttman–Kaiser approach, which recommends retaining components with eigenvalues equal to or higher than one [44,53].

In addition, Kaiser’s varimax rotation was applied to the matrix of principal factors [54] in order to maximize the variance of each factor. This rotation improves factor interpretation by producing high loadings on one factor and near-zero loadings on the others [46].

Finally, the analysis examines the existence of factors capable of explaining the correlations among variables and their meaningful interpretation, where feasible [51,52]. According to Fragkos [44], variables are considered to belong to a given factor when their loading exceeds 0.5 value in the rotated factor loading matrix.

### 3. Results

Residents’ perceptions of the advantages and disadvantages of dam construction on the Nestos River were assessed separately for the lowland, semi-mountainous, and mountainous parts of the study area, and then reassessed for the entire sample (Table 1).

**Table 1.** Evaluation of the advantages and disadvantages of dam construction.

|               | Study Area<br>(Entire Sample, $n = 1101$ )                                 | Very Important |       | Important |       | Moderate |       | Insignificant |       | Not at All Important |       |
|---------------|----------------------------------------------------------------------------|----------------|-------|-----------|-------|----------|-------|---------------|-------|----------------------|-------|
|               |                                                                            | $p\%$          | $p$   | $p\%$     | $Sp$  | $p\%$    | $Sp$  | $p\%$         | $Sp$  | $p\%$                | $Sp$  |
| Advantages    | Energy production                                                          | 48.3%          | 0.018 | 42.2%     | 0.018 | 7.0%     | 0.009 | 1.3%          | 0.004 | 1.1%                 | 0.004 |
|               | Flood protection                                                           | 42.6%          | 0.018 | 47.1%     | 0.018 | 8.6%     | 0.010 | 0.9%          | 0.003 | 0.8%                 | 0.003 |
|               | Storage of large water volumes for future use                              | 37.1%          | 0.017 | 38.4%     | 0.018 | 21.6%    | 0.015 | 2.3%          | 0.005 | 0.6%                 | 0.003 |
|               | Maintenance of continuous river flow                                       | 30.4%          | 0.017 | 48.7%     | 0.018 | 18.2%    | 0.014 | 1.9%          | 0.005 | 0.7%                 | 0.003 |
|               | Development of lacustrine ecosystems                                       | 27.4%          | 0.016 | 44.2%     | 0.018 | 22.8%    | 0.015 | 4.0%          | 0.007 | 1.7%                 | 0.005 |
|               | Pollutant retention in reservoirs                                          | 30.1%          | 0.017 | 35.4%     | 0.017 | 25.3%    | 0.016 | 6.9%          | 0.009 | 2.2%                 | 0.005 |
| Disadvantages | Creation of recreational infrastructure in the artificial lakes            | 27.0%          | 0.016 | 40.5%     | 0.018 | 23.7%    | 0.015 | 5.8%          | 0.008 | 2.9%                 | 0.006 |
|               | Flow regulated by humans rather than nature                                | 20.6%          | 0.015 | 36.1%     | 0.017 | 27.7%    | 0.016 | 11.9%         | 0.012 | 3.7%                 | 0.007 |
|               | Reduced sediment supply to the delta and outlets—coastal erosion           | 22.9%          | 0.015 | 48.8%     | 0.018 | 24.3%    | 0.015 | 3.3%          | 0.007 | 0.7%                 | 0.003 |
|               | Changes in water characteristics (e.g., temperature)—impacts on fish fauna | 31.6%          | 0.017 | 45.3%     | 0.018 | 20.5%    | 0.014 | 2.2%          | 0.005 | 0.5%                 | 0.002 |
|               | Obstruction of fish migration (for reproduction, feeding, etc.)            | 31.8%          | 0.017 | 42.8%     | 0.018 | 19.3%    | 0.014 | 4.6%          | 0.008 | 1.5%                 | 0.005 |
|               | Submergence of land previously used for forestry or livestock              | 21.0%          | 0.015 | 30.5%     | 0.017 | 41.1%    | 0.018 | 5.0%          | 0.007 | 2.3%                 | 0.005 |
|               | Degradation of riparian vegetation ecosystems                              | 28.4%          | 0.016 | 41.5%     | 0.018 | 25.5%    | 0.016 | 2.6%          | 0.005 | 2.1%                 | 0.005 |
|               | Climate change (more humid and rainy, especially hot summer afternoons)    | 39.2%          | 0.018 | 34.9%     | 0.017 | 23.2%    | 0.015 | 1.9%          | 0.004 | 0.8%                 | 0.003 |

### 3.1. Perceived Favorable and Adverse Impacts in the Lowland Area

In the lowland area, the most prevalent positive perceptions concern energy production, which is rated as a “very important advantage” by 46.9% of respondents, while flood protection (47.1%), maintenance of continuous river flow (49.9%), development of lacustrine ecosystems (45.2%), pollutant retention (35.7%), water storage (39.8%), and recreational infrastructure (39.8%) are most frequently evaluated as “important advantages.” Regarding the disadvantages, respondents mainly identify as “important disadvantages” the reduced sediment supply to the delta and river mouth and the consequent coastal erosion (50.1%), changes in water characteristics affecting fish fauna (46.9%), barriers to fish migration (42.2%), anthropogenic regulation of river flow (33.0%), and degradation of riparian vegetation (41.1%). Flooding of land previously used for forestry or livestock activities is most frequently assessed as a “moderate disadvantage” (40.3%), while climate change is perceived as a “very important disadvantage” (39.0%).

### 3.2. Perceived Favorable and Adverse Impacts in the Semi-Mountainous Area

In the semi-mountainous area, the energy dimension is even more pronounced. Energy production is evaluated as a “very important advantage” by 55.9% of respondents, while water storage is also rated as “very important” by 40.1%. Flood protection (44.7%), maintenance of continuous flow (42.0%), development of lacustrine ecosystems (40.3%), pollutant retention (40.3%), and recreational infrastructure (35.1%) are mainly classified as “important advantages.” With respect to disadvantages, the category “important” prevails for anthropogenic regulation of flow (32.4%), reduced sediment supply to the delta

and river mouth and associated coastal erosion (46.9%), changes in water characteristics affecting fish fauna (36.8%), barriers to fish migration (39.5%), and degradation of riparian vegetation (36.8%). Flooding of land previously used for forestry or grazing is mainly considered by the residents as a “moderate disadvantage” (35.7%), while climate change is most frequently evaluated as a “very important disadvantage” (43.1%).

### 3.3. Perceived Favorable and Adverse Impacts in the Mountainous Area

In the mountainous area, the advantages are primarily rated as “important,” including energy production (46.9%), flood protection (49.3%), maintenance of continuous flow (51.0%), development of lacustrine ecosystems (44.4%), and recreational infrastructure (47.7%). Water storage is recorded as a “very important advantage” (37.6%), whereas pollutant retention is downgraded to a “moderate advantage” (33.8%). Among disadvantages, the “important” category predominates for anthropogenic regulation of flow (49.9%), reduced sediment supply to the delta and river mouth and coastal erosion (46.0%), changes in water characteristics affecting fish fauna (47.7%), barriers to fish migration (47.7%), and degradation of riparian vegetation (47.0%). Flooding of land previously used for forestry or livestock activities is mainly assessed as a “moderate disadvantage” (49.0%), while climate change is evaluated as a “very important disadvantage” (36.5%).

Overall, differences among strata are limited. Nevertheless, a greater emphasis on the “very important” category for energy production is observed in the semi-mountainous and, subsequently, the lowland areas compared to the mountainous zone. However, even in the mountainous area, energy production is rated as “very important” by 46.3%, with only a marginal difference of 0.6 percentage points from the “important” category (46.9–46.3%). This appears to be logical, as industrial units and more households are typically located in semi-mountainous and even more in lowland zones, resulting in a higher demand for energy. Mountain communities are especially vulnerable to energy poverty, according to Katsoulakos and Kaliampakos’s [55] extensive research on the energy identity of mountainous Greek areas.

Similarly, pollutant retention is upgraded to “important” in the lowland and semi-mountainous areas, while in the mountainous area it is classified as “moderate,” with a difference of 3.8 percentage points, relative to the “important” category (33.8% versus 30.0%). According to Połomski and Wiatkowski’s [21] review of the scientific literature on the benefits and drawbacks of dam operation, the scientific community has identified pollution and contamination as an urgent issue, demonstrating the need for special legislation to limit and control them.

### 3.4. Perceived Favorable and Adverse Impacts in a Generalized Context of the Nestos River Area

For the entire sample, as detailed in Table 1, all advantages prevail in the categories “very important” and “important.” Specifically, energy production emerges as “very important” for 48.3% ( $sp = 0.018$ ). High proportions in the “important” category are recorded for maintenance of continuous flow (48.7%,  $sp = 0.018$ ), flood protection (47.1%,  $sp = 0.018$ ), development of lacustrine ecosystems (44.2%,  $sp = 0.018$ ), recreational infrastructure (40.5%,  $sp = 0.018$ ), and pollutant retention (35.4%,  $sp = 0.017$ ). Water storage exhibits a “double peak,” with 37.1% ( $sp = 0.017$ ) rating it as “very important” and 38.4% ( $sp = 0.018$ ) as “important.” Among disadvantages, peaks are mainly observed in the “important” category for reduced sediment supply to the delta and river mouth and associated coastal erosion (48.8%,  $sp = 0.018$ ), changes in water characteristics affecting fish fauna (45.3%,  $sp = 0.018$ ), barriers to fish migration (42.8%,  $sp = 0.018$ ), degradation of riparian vegetation (41.5%,  $sp = 0.018$ ), and anthropogenic regulation of flow (36.1%,  $sp = 0.017$ ). Climate change is highlighted as a “very important disadvantage” by 39.2% ( $sp = 0.018$ ), while flooding

of land previously used for forestry or livestock activities most frequently appears as a “moderate disadvantage” (41.1%,  $sp = 0.018$ ).

### 3.5. Reliability Analysis and Factor Analysis

Reliability analysis and factor analysis were applied to the variables which interpret the impacts of the artificial dams on the Nestos River area. To assess the consistency of equivalent questionnaire items within this multi-item variable, reliability analysis was conducted. The value of Cronbach’s alpha coefficient was relatively high (0.7458), providing strong evidence that the scale scores are internally consistent, indicating that the items tend to measure the same underlying construct. This is further supported by the high individual alpha values, as deletion of any item did not result in a substantial increase in reliability coefficient.

Prior to factor analysis, all necessary suitability tests were performed. The Kaiser–Meyer–Olkin (KMO) measure yielded a value of 0.795, while Bartlett’s test of sphericity rejected the null hypothesis that the correlation matrix is an identity matrix. Similarly, partial correlation coefficients, as estimators of relationships among individual variables, were low. Measures of Sampling Adequacy (MSA) for the variables, appearing along the diagonal of the anti-image correlation matrix, exhibited high to very high values, supporting the appropriateness of factor analysis. Table 2 presents the variance explained by each of the three extracted factors, including the eigenvalue, the percentage of variance accounted for, the cumulative variance for each factor, and the overall variance explained by the solution. The table indicates that three factors have been extracted, each with a characteristic root exceeding one, accompanied by a gradual change in slope. The second column indicates the percentage of variation attributable to each factor, whereas the third column reflects the percentage of variation due to each factor after rotation. Table 3 presents the three extracted factors.

**Table 2.** Total variance.

| Component | Total Variance Explained |               |              |                                     |               |              |                                   |               |              |
|-----------|--------------------------|---------------|--------------|-------------------------------------|---------------|--------------|-----------------------------------|---------------|--------------|
|           | Initial Eigenvalues      |               |              | Extraction Sums of Squared Loadings |               |              | Rotation Sums of Squared Loadings |               |              |
|           | Total                    | % of Variance | Cumulative % | Total                               | % of Variance | Cumulative % | Total                             | % of Variance | Cumulative % |
| 1         | 3495                     | 24,967        | 24,967       | 3495                                | 24,967        | 24,967       | 3432                              | 24,511        | 24,511       |
| 2         | 2719                     | 19,424        | 44,391       | 2719                                | 19,424        | 44,391       | 2093                              | 14,950        | 39,461       |
| 3         | 1204                     | 8603          | 52,994       | 1204                                | 8603          | 52,994       | 1895                              | 13,533        | 52,994       |
| 4         | 0.934                    | 6675          | 59,669       |                                     |               |              |                                   |               |              |
| 5         | 0.880                    | 6284          | 65,953       |                                     |               |              |                                   |               |              |
| 6         | 0.747                    | 5336          | 71,289       |                                     |               |              |                                   |               |              |
| 7         | 0.719                    | 5135          | 76,424       |                                     |               |              |                                   |               |              |
| 8         | 0.582                    | 4157          | 80,581       |                                     |               |              |                                   |               |              |
| 9         | 0.564                    | 4027          | 84,608       |                                     |               |              |                                   |               |              |
| 10        | 0.496                    | 3542          | 88,150       |                                     |               |              |                                   |               |              |
| 11        | 0.464                    | 3317          | 91,467       |                                     |               |              |                                   |               |              |
| 12        | 0.450                    | 3214          | 94,680       |                                     |               |              |                                   |               |              |
| 13        | 0.399                    | 2848          | 97,528       |                                     |               |              |                                   |               |              |
| 14        | 0.346                    | 2472          | 100,000      |                                     |               |              |                                   |               |              |

Extraction Method: Principal Component Analysis.

The first factor comprises the variables “Energy production,” “Flood protection,” “Storage of large volumes of water for potential future use,” “Maintenance of continuous

river flow,” “Development of independent lacustrine ecosystems,” “Pollutant retention in reservoirs,” and “Creation of recreational infrastructure in the formed lakes,” and it was labeled “Advantages of dams.”

**Table 3.** Rotated factor loading matrix.

| Variables     |                                                                            | Factor Loadings Matrix |              |              |
|---------------|----------------------------------------------------------------------------|------------------------|--------------|--------------|
|               |                                                                            | 1                      | 2            | 3            |
| Advantages    | Energy production                                                          | <b>0.653</b>           | −0.022       | −0.075       |
|               | Flood protection                                                           | <b>0.706</b>           | −0.080       | −0.007       |
|               | Storage of large water volumes for future use                              | <b>0.717</b>           | 0.002        | 0.050        |
|               | Maintenance of continuous river flow                                       | <b>0.730</b>           | 0.042        | −0.065       |
|               | Development of lacustrine ecosystems                                       | <b>0.763</b>           | 0.115        | −0.028       |
|               | Pollutant retention in reservoirs                                          | <b>0.658</b>           | 0.082        | 0.182        |
|               | Creation of recreational infrastructure in the artificial lakes            | <b>0.661</b>           | 0.074        | −0.007       |
| Disadvantages | Flow regulated by humans rather than nature                                | 0.071                  | <b>0.508</b> | 0.227        |
|               | Reduced sediment supply to the delta and outlets—coastal erosion           | 0.011                  | <b>0.797</b> | 0.055        |
|               | Changes in water characteristics (e.g., temperature)—impacts on fish fauna | 0.034                  | <b>0.785</b> | 0.126        |
|               | Obstruction of fish migration (for reproduction, feeding, etc.)            | 0.017                  | <b>0.670</b> | 0.173        |
|               | Submergence of land previously used for forestry or livestock              | 0.014                  | 0.157        | <b>0.819</b> |
|               | Degradation of riparian vegetation ecosystems                              | −0.040                 | 0.142        | <b>0.836</b> |
|               | Climate change (more humid and rainy, especially hot summer afternoons)    | 0.015                  | 0.235        | <b>0.615</b> |

The second factor includes the variables “Water flow is determined by humans rather than by nature,” “Reduction of sediment supply to the delta and river mouth—coastal erosion,” “Changes in water characteristics (e.g., temperature) affecting fish fauna,” and “Obstruction of fish movements for reproduction, feeding, etc.,” and it was labeled “Adverse ecological impacts on the river”.

The third factor consists of the variables “Flooding of large land areas previously used for forestry or livestock activities,” “Destruction of riparian vegetation ecosystems,” and “Climate change (more humid and rainy conditions, particularly during hot summer afternoons),” and it was labeled “Adverse land use impacts”.

#### 4. Discussion

Placing these findings within an international context facilitates their interpretation and enables meaningful comparisons with similar studies. In terms of energy policy, it has been observed that for systems dominated by hydropower production, socially perceived benefits are particularly prominent. Along the lines of Nestos in Greece and based on a recent study by [56], the clean energy generated by small hydropower plants in Portugal is ranked among the most valued ecosystem services. Of course, these perspectives are shaped by each country’s energy map, energy policy, and RES installations. In Norway, for example, 1769 hydropower plants were in operation at the beginning of 2023, and under typical annual conditions hydropower accounts for approximately 88% of total electricity generation [57]. Conversely, in countries such as Poland, the share of hydropower in the electricity mix remains low, with the energy transition relying much more heavily on wind and photovoltaic energy [58]. The Swedish paradigm sheds more light on how local communities perceive the benefits of dams, particularly those associated with hydroelectricity. Indeed, Ref. [59] found that public acceptance of renewable energy improves when procedural justice is upheld—through fair and inclusive decision-making processes—and when distributional justice ensures that costs and benefits are shared equitably.

Furthermore, international studies indicate that artificial reservoirs and adjacent wetlands, when properly designed and managed, can serve as habitats for aquatic bird fauna,

which aligns with the findings of Nestos and, more specifically, with the high ranking of the “development of lacustrine ecosystems” and “recreational infrastructure”. In Extremadura, Spain, the creation of reservoirs near rice fields has been associated with increased concentrations of dabbling ducks, highlighting the area as one of the most important wintering sites [60]. Similarly, in Sweden, an inventory of 89 artificial wetlands showed that appropriate design and targeted management are linked to increased species richness; notably, multiple small wetlands can equal or even exceed a single large wetland in terms of regional diversity and chick production. Recommended practices include extensive flooded surfaces and continuous management to limit emergent aquatic vegetation and shrub, or tree cover in the surrounding area. These findings support the view that wetland complexes within agricultural mosaics can provide functional habitats for breeding waterbirds [61].

Similarly, the disadvantages highlighted by residents of the Nestos River—such as anthropogenic control of water flow, barriers to fish migration, changes in water quality, and reduced sediment delivery to the delta—are well documented. Globally, dams disrupt river connectivity, with consequences for movement, dispersal, and diversity of fish populations [62–65]. Tamang et al. [66] conducted an in-depth analysis of local perceptions regarding the adverse impacts of a mega-dam in the Teesta River basin in Sikkim, India, identifying biodiversity loss, ecosystem degradation, and water pollution as the most critical concerns. The present findings, consistent with related evidence from international literature, underscore the need for a comprehensive understanding of both the direct and indirect impacts of dam construction, as well as their interactions with local communities. Such developments are driving significant transformations and giving rise to new socio-environmental and economic systems that shape sustainable land management practices [67].

The findings of Nestos are also related to the broader issue of environmental flows, that is, the maintenance and restoration of ecologically compatible flow regimes in regulated rivers. This connection is particularly relevant to the present study, as residents attributed high importance to the maintenance of continuous river flow, while also identifying anthropogenic regulation of flow, changes in water characteristics, barriers to fish migration, degradation of riparian vegetation, and reduced sediment supply to the delta as important disadvantages of dam construction. In this context, the Brisbane Declaration and Global Action Agenda—2018 on Environmental Flows calls for the protection and restoration of environmental flows, places them at the core of integrated water resources management and recognizes them as fundamental to the achievement of water-related sustainable development goals. It also proposes 35 actionable recommendations across policy, governance, management, and research domains, while emphasizing community participation, rights, and the socio-cultural dimensions of water-related decision-making [6].

The concerns expressed by communities along the Nestos River are supported by existing scientific evidence. Water quality is affected both within reservoirs and downstream due to thermal stratification and the trapping of sediments and inorganic nutrients (mainly nitrogen and phosphorus), processes that alter temperature regimes and induce hypoxic conditions, particularly at lower latitudes [68]. Moreover, sediment retention in reservoirs leads to sediment deficits downstream, intensifying channel erosion and morphological adjustments and reducing sediment supply to coastal zones and deltas, thereby accelerating coastal erosion and degrading deltaic systems [69].

Beyond these ecological effects, residents’ perceptions may also reflect local environmental changes associated with the presence of large reservoirs. Previous studies suggest that artificial reservoirs can influence local microclimatic conditions [70] through changes in humidity, evaporation processes, and local temperature patterns [71], although the magnitude and spatial extent of these effects depend on the geographical and hydrological

characteristics of each system [72]. In the Nestos River basin, the relatively high importance attributed to climate-related impacts may therefore be associated with perceived local environmental changes surrounding the reservoirs, complementing broader concerns regarding the ecological consequences of dam operation.

While ecological drawbacks are widely addressed in interdisciplinary literature, there remains a notable gap concerning the hydro-social potential and impacts of such projects, particularly in relation to the factors shaping how communities residing near dams perceive them [73,74]. According to the findings, and to bridge this gap, factor analysis revealed how affected communities perceive the disadvantages arising from the construction and operation of the existing dams in Nestos. More specifically, they consider the negative effects to be a two-dimensional issue, focusing on the semi-mountainous and lowland areas. The differentiated attitudes observed among the three physiographic zones may be interpreted as being consistent with the NIMBY phenomenon. Communities located closer to the dams exhibit greater skepticism and place greater emphasis on environmental costs, whereas more distant communities tend to focus on energy-related and protective benefits [24,75,76]. This pattern is consistent with risk perception theory, according to which residents who are directly exposed to impacts tend to perceive higher risks and react more strongly [77–79].

The results further demonstrate that, beyond technical and environmental considerations, decision-making justice and active public participation constitute critical parameters. International experience shows that large-scale projects achieve higher levels of social acceptance when transparent and participatory processes are incorporated, with emphasis on early information provision and meaningful consideration of local perceptions [80–82]. Conversely, lack of trust in authorities and perceptions of unequal distribution of benefits and burdens intensify the NIMBY phenomenon and may lead to social conflict [83,84].

Overall, the findings of this study underline that dam construction on the Nestos River cannot be evaluated solely on techno-economic grounds. A holistic approach is required, taking into account: (a) the ecological consequences, with emphasis on maintaining hydrological connectivity and biodiversity [85,86]; (b) the social perception and the psychological dimension of citizens' relationship with place [24,87]; and (c) ensuring energy and environmental justice through participatory processes [80,82].

## 5. Conclusions

The present study investigated residents' perceptions of the environmental, economic, and social impacts associated with the long-term operation of the dams on the Nestos River. The findings indicate that, after several decades of operation, local attitudes cannot be interpreted in terms of either unequivocal acceptance or outright opposition. Rather, residents across all three physiographic zones recognize the benefits associated with the dams, particularly in relation to hydropower generation, water storage, flood protection, and irrigation, while simultaneously expressing concerns regarding altered flow regimes, reduced sediment transport, changes in water characteristics affecting aquatic ecosystems, barriers to fish migration, and riparian habitat degradation.

The spatial patterns identified in the study contribute to a better understanding of the NIMBY phenomenon in the context of the Nestos River dams. Respondents from the semi-mountainous areas placed greater emphasis on the benefits associated with energy production, whereas those from the lowland areas attached greater importance to reduced sediment transport and its downstream consequences. In the mountainous areas, residents assigned greater importance to altered flow regimes, fish-related impacts, and riparian degradation, while also recognizing the benefits associated with water storage and flood protection. Given the physiographic basis of the sampling design, these results suggest

that residents' evaluations of the dams vary across the river basin according to the different environmental and functional characteristics associated with their operation.

Overall, the Nestos River case study demonstrates that social acceptance toward long-established hydraulic infrastructure remains dynamic and subject to evolution long after project commissioning and prolonged operation. While prolonged familiarity with the infrastructure may enhance local recognition of the ecosystem and economic services provided by the dams, it does not alleviate deep-seated concerns regarding environmental alterations, procedural inclusion, equity, and the uneven spatial distribution of localized costs and benefits. Consequently, this study advances the theoretical interpretation of NIMBY-related behaviors within a post-construction paradigm, demonstrating that local community responses are more accurately conceptualized as granular, lived evaluations of localized trade-offs rather than a static, binary opposition to nearby infrastructure. To expand upon these insights, future research should integrate geocoded residential datasets, precise proximity-to-dam metrics, explicit upstream–downstream typologies, and longitudinal comparative designs to more empirically track the co-evolution of geographic proximity, place attachment, and long-term social acceptance. Finally, certain limitations of this study should be noted. Although the cross-sectional design and the localized geographic focus on the Nestos basin reflect a specific spatial and temporal context, the framework utilized the most recent officially available census data at the time of the fieldwork. Additionally, while equal stratification was intentionally chosen to ensure robust statistical subgroup analyses, face-to-face interactions may introduce minor social desirability responses. Rather than compromising the current findings, these limitations establish a solid baseline for future longitudinal and comparative research.

#### *Policy Implications and Management Recommendations*

To translate these empirical findings into actionable and sustainable water resource management, policy interventions should move away from generic solutions and adopt spatially differentiated strategies tailored to the unique socio-ecological characteristics of each zone within the Nestos River basin:

- **Mountainous Zone (Thissavros and Platanovryssi Hydropower System):** Management strategies in this high-proximity area need to prioritize rigorous flow regulation monitoring and active ecological restoration, focusing on riparian zones and reservoir shores to enhance fish and habitat connectivity. To address localized grievances regarding disruptions to traditional forestry and grazing land uses, regional authorities should consider establishing formal benefit-sharing mechanisms. These frameworks should be co-designed with local communities to ensure distributive fairness and mitigate post-construction NIMBY dynamics.
- **Semi-Mountainous Zone (Transitional Corridor):** Policy initiatives should focus on balancing the transitional functions of the river—such as flow regulation and water storage—with eco-compatible recreational and tourism development. To enhance institutional trust, targeted public consultations and transparent information campaigns could be implemented to clearly communicate how dam operations balance upstream and downstream environmental needs. Furthermore, local spatial planning frameworks should incorporate strict environmental thresholds to prevent tourism from compromising habitat integrity or water quality.
- **Lowland Zone (Toxotes Dam and Deltaic Environment):** In this agricultural and ecologically sensitive downstream area, policy frameworks should prioritize equitable water allocation, the preservation of strict ecological flows, and continuous monitoring of sediment transport to protect deltaic and coastal ecosystems. Management frameworks should formalize the active involvement of local water users and farm-

ers in environmental monitoring, ensuring that agricultural water demands do not compromise downstream ecosystem functions.

- **Basin-Wide Governance:** Across the entire Nestos basin, localized mitigation measures and community-development initiatives would benefit from being supported by institutional mechanisms of transparent accountability and open data access. Navigating these complexities requires the creation of permanent, multi-stakeholder advisory bodies—uniting municipal authorities, agricultural associations, environmental agencies, scientific institutions, and dam operators—to institutionalize stakeholder participation, identify emerging risks, and rebuild long-term institutional trust.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18136678/s1>, Extract of questionnaire items used in the analysis of residents' perceptions regarding the advantages and disadvantages of dam construction on the Nestos River.

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**Institutional Review Board Statement:** Ethical review and approval were waived for this study by Institution Committee due to Legal Regulations (According to Article 279, paragraph 2a-2b, Greek Law 4957/2022 of “New Horizons in Higher Education Institutions: Strengthening the quality, functionality and connection of HEIs with society and other institutions”, of Greece, that this study is exempt from ethical review. In Greek law only funded research projects that, according to the declaration of the scientific director, include research on humans, on material originating from humans, such as genetic material, cells, tissues and personal data, on animals or on the environment, both natural and cultural, are mandatorily submitted for approval to the Hellenic Research and Development Authority and the project cannot begin to be implemented at the HEI or the research institution unless it has first received the relevant approval.)

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