

On the Edge of the Drop: Water Stress and National Security in Bulgaria in the Context of Marketing-Based Approaches to Adaptive Water Governance

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Abstract. *Water stress is increasingly recognized as a critical challenge for public governance, social stability, and national security. While it is often addressed primarily as a technical or environmental issue, its social, behavioral, and institutional dimensions receive comparatively less attention. This paper examines water stress in Bulgaria as a complex socio-political risk arising from the interaction between physical resource constraints, governance capacity, public behavior, and institutional trust. The study adopts an interdisciplinary analytical approach combining a structured literature review, comparative analysis of international water crisis cases, and an indicative empirical survey assessing public awareness and behavioral responses to water stress. The analysis highlights how deficiencies in institutional communication, transparency, and demand management can amplify societal impacts, even where physical water availability is not critically constrained. Building on these findings, the paper proposes an integrated analytical framework that structures water stress governance across three interrelated phases: prevention, crisis management, and long-term adaptation (the PCA model). Within this framework, marketing-based and behavioral governance instruments are conceptualized as mechanisms linking technical measures with public behavior and institutional legitimacy, rather than as substitutes for infrastructural or regulatory solutions. The results indicate substantial adaptive potential at the societal level, reflected in a willingness to change behavior that remains underutilized due to fragmented institutional signals and limited public trust. The PCA model is presented as an analytical, not causally tested, framework, offering transferable insights for adaptive water governance where critical infrastructure management intersects with social trust and behavioral change.*

Keywords: Water stress; National security; Public governance; Behavioral change; Social marketing; Institutional trust.

Introduction

Water stress acquires specific characteristics in the Bulgarian context. Significant losses in the water supply network, aging infrastructure, and limited capacity for preventive planning further exacerbate system vulnerability. Water supply restrictions and crisis situations - including the cases in cities of Pernik (2019-2020) and Pleven (2024-2025) - demonstrate that the problem is not isolated, but structural and recurrent.

Water stress, however, cannot be reduced to physical resource scarcity only. Water supply restrictions affect institutional trust, perceptions of fairness in public policies, and citizens' willingness to comply with imposed measures. In this way, water stress is transformed from an environmental and infrastructural challenge into a socio-political risk with potential consequences for social stability and national security.

Dominant water governance policies traditionally emphasize infrastructure investments, regulation, and emergency measures. Although technical and regulatory instruments are necessary, their effectiveness in crisis situations is strongly mediated by public behavior, perceived

legitimacy, and institutional communication. Consequently, water stress governance must incorporate instruments aimed at managing demand, public attitudes, and trust.

In the present study, marketing is not employed in a typical commercial sense, nor as an umbrella concept for all non-technical governance measures. Instead, it is approached as an integrative governance framework that coordinates instruments of different theoretical origins - social marketing, behavioral interventions, public communication, and mechanisms for citizen participation - insofar as they are directed toward influencing demand, behavior, and institutional trust in the governance of critical resources.

Building on this understanding, the article proposes the conceptual Prevention-Crisis-Adaptation (PCA) model, which structures water stress governance into three interrelated phases: prevention, crisis management, and long-term adaptation. The model has a conceptual-analytical character and serves to systematize and interpret empirical observations, without claiming causal empirical testing within the scope of the present study.

The PCA model addresses the question of how and to what extent marketing-based and behavioral governance instruments can support adaptive water management and reduce the risks that water stress poses to social stability and national security in Bulgaria.

The research problem addressed in this study concerns the lack of systematic integration of marketing-based and behavioral instruments in the governance of water stress, despite their demonstrated effectiveness in international practice. In Bulgarian public policies, such instruments are applied in a fragmented and reactive manner and are rarely conceptualized as part of a broader framework of national security and sustainable governance of critical infrastructure.

The aim of this study is to analyze the relationship between water stress and national security in Bulgaria by examining the role of marketing-based and behavioral instruments in the adaptive governance of water resources.

The main objectives of the article are: to clarify how water stress is transformed from an environmental and infrastructural challenge into a socio-political risk for national security; to assess the limitations of traditional governance approaches based predominantly on technical and regulatory measures; to analyze the potential of marketing-based and behavioral instruments as governance mechanisms influencing consumption patterns, public trust, and institutional resilience; to propose an integrated conceptual framework for the adaptive governance of water stress, applicable to the Bulgarian context.

Literature review

Water stress is traditionally defined as a condition in which available water resources are insufficient to meet the needs of households, the economy, and ecosystems within a given temporal and spatial context (UNESCO/WWAP, 2021). The operationalization of the concept encompasses both quantitative indicators - such as the ratio between water abstraction and available resources, the frequency of droughts, and access to safe drinking water - as well as qualitative dimensions related to institutional capacity and resource governance (European Environment Agency, 2023).

In international and institutional frameworks, water stress is commonly operationalized through standardized indicators that capture the balance between water availability and withdrawals. SDG indicator 6.4.2 defines water stress as the ratio of total freshwater withdrawals to available renewable freshwater resources, accounting for environmental flow requirements (United Nations, (2021). Similarly, the Water Exploitation Index Plus (WEI+), widely used by the European Environment Agency, measures pressure on water resources by integrating abstraction

intensity and regional hydrological conditions (EEA, 2018). These indicators provide a robust quantitative baseline but primarily capture physical and resource-based dimensions of water stress.

Conceptually, water stress differs from water scarcity, which refers to absolute or structural shortages of water resources, and from water security, which encompasses the capacity of societies and institutions to ensure reliable access to water of adequate quantity and quality while managing related risks. In this study, water stress is treated as a social governance risk that links physical resource pressure with management capacity, social behavior, and institutional trust, thereby connecting scarcity dynamics to broader water security outcomes.

In contemporary scientific literature, water stress is examined as a multidimensional problem that extends beyond physical scarcity to encompass governance-related, institutional, and social dimensions. Foundational WOS-indexed studies frame water stress as a systemic risk to water security, arising from the interaction between hydrological pressure, governance performance, and social vulnerability (Vörösmarty et al., 2010; Mekonnen & Hoekstra, 2016). At the same time, bibliometric and systematic reviews indicate that dominant research strands and indicator-based frameworks—including SDG indicator 6.4.2 and the Water Exploitation Index Plus (WEI+)—provide a robust quantitative foundation but rarely integrate behavioral, communication, and marketing-based mechanisms for demand management (Aguirre & Paredes Cuervo, 2023; FAO, 2024; Sondermann, 2022). This gap motivates the analytical focus and research objective of the present study.

In the European context, intensifying droughts and extreme climatic events further exacerbate these dynamics. Data from the European Environment Agency indicates that an increasing proportion of EU territory is exposed to high levels of water stress, with even traditionally resource-rich regions experiencing growing vulnerability (European Environment Agency, 2023). In this sense, water stress is increasingly established as a structural risk rather than a temporary deviation.

The literature on critical infrastructure governance increasingly conceptualizes water supply systems as a key element of national security due to their potential to generate cascading effects in the event of system failure or prolonged service restrictions (European Commission, 2022). Disruptions in water supply can lead to public health risks, economic losses, disruptions to the normal functioning of public services, and heightened social tension (OECD, 2022; UNESCO/WWAP, 2021).

Empirical studies demonstrate that limited governance capacity - such as aging infrastructure, high levels of non-revenue water, lack of coordination, and delayed institutional responses - often amplify the effects of natural stressors and transform water stress into a full-scale crisis (OECD, 2022; World Bank Group, 2021). In this context, water security cannot be achieved solely through supply augmentation or technical optimization if these measures are not accompanied by effective demand management and the alignment of public expectations.

A key contribution of contemporary literature lies in the recognition that water crises constitute not only technical failures, but also communicative and behavioral breakdowns. Water supply restrictions imply the need for broad public compliance, which cannot be sustainably achieved solely through coercive measures or administrative prohibitions (Tortajada & Biswas, 2018).

The absence of transparent and timely communication, unclear rules regarding the allocation of restrictions, and the perceived unfairness of implemented measures often lead to a decline in institutional trust and increased social tension, which in turn amplifies risks to national

security (OECD, 2022). In this way, water stress functions as a socio-political amplifier capable of eroding the legitimacy of public authority.

From this perspective, water stress may be interpreted as a trigger for governance failure when institutional responses are delayed, opaque, or perceived as unjust. Consequently, water governance becomes a component of the broader framework of societal and institutional resilience.

For the purposes of the present analysis, it is necessary to draw a clear distinction between the different groups of instruments that are often subsumed under the general label of “marketing based.” Social marketing aims at long-term change in social norms, while behavioral interventions originate from behavioral economics and seek to influence specific decision-making processes. Public communication focuses on legitimacy and risk management, whereas mechanisms of participation and transparency are grounded in the literature on public governance. Within the scope of this article, these instruments are analyzed jointly not because of their conceptual equivalence, but due to their shared functional role in the governance of water stress.

Against this background, a growing body of research highlights the importance of behavioral and marketing-based instruments as complements to traditional water management policies. Behavioral interventions, including social comparisons, consumption feedback, and message framing - have demonstrated measurable effects on reducing water consumption, particularly when supported by institutional legitimacy (Ferraro & Price, 2013).

Social marketing extends this approach by emphasizing audience segmentation, an understanding of the motivations and barriers to behavioral change, and the formation of long-term social norms (Kotler & Lee, 2008). In the context of water crises, marketing-based instruments function as mechanisms for demand management and for sustaining public trust, rather than as one-way information campaigns.

International cases from Cape Town and California clearly demonstrate that the combination of regulatory measures, price signals, and targeted communication can lead to rapid and sustained changes in consumer behavior (Hanak & Mount, 2015; Tortajada & Biswas, 2018; Rodina, 2019). These examples illustrate that marketing-based instruments constitute a key component of adaptive governance, particularly under crisis conditions.

Despite this, in Bulgaria and more broadly across Southeast Europe, marketing-based and behavioral instruments remain weakly integrated into national water security strategies. Analytical and policy approaches remain largely dominated by technical and regulatory perspectives, while instruments aimed at shaping public behavior and strengthening institutional legitimacy are only marginally integrated.

While standardized indicators such as SDG 6.4.2 and WEI+ are central to international monitoring frameworks, they offer limited insight into behavioral responses, communication dynamics, and institutional legitimacy. This study addresses this gap by complementing indicator-based assessments with an analytical framework that explicitly integrates behavioral and marketing-based governance instruments.

The present study addresses this gap by proposing a structured analytical model that integrates marketing-based governance instruments into water stress governance as a national security risk. The model embeds these instruments across the phases of prevention, crisis management, and adaptation within the specific institutional and infrastructural context of Bulgaria.

Methodology

Research Design and Approach

Within the scope of the present study, key concepts are employed as analytical categories rather than as strictly quantitatively operationalized variables. “Water stress” is analytically examined using a set of proxy indicators, including the frequency of water supply interruptions, spatial differences in resource availability, and perceived scarcity at the household level. “National security” is approached in terms of social stability, institutional reliability, and the governance of critical infrastructure, while “marketing-based instruments” are analytically operationalized through the identification of behavioral interventions, communication strategies, and mechanisms for public participation applied across the different phases of the Prevention-Crisis-Adaptation model (Figure 1).

The main research hypothesis posits that technical and regulatory measures are insufficient for the effective governance of water stress unless they are complemented by marketing-based and behavioral instruments aimed at managing demand, public attitudes, and trust in institutions.

Data Sources

The study draws on three data groups: (1) secondary sources, including international and national strategic and policy documents, institutional reports, and statistical data issued by the European Commission, the European Environment Agency, the OECD, UNESCO, and the World Bank, as well as national policy documents and official statistics from the Ministry of Environment and Water, the National Statistical Institute, and the National Institute of Meteorology and Hydrology, complemented by peer-reviewed academic literature on water security, critical infrastructure governance, and behavioral interventions in resource management; (2) comparative case evidence on water stress governance practices in Cape Town and California, compiled from publicly available policy documents, institutional reports, and academic studies; and (3) primary empirical data from an author-administered survey titled “Consumer Experience and Awareness of Water Stress” (n = 101). The selection of institutional and academic sources is intended to minimize bias and to support comparability across international and national contexts.

Empirical Survey

The empirical survey aims to examine respondents’ level of awareness and understanding of the concept of water stress, their personal experience with water scarcity, and the behavioral responses adopted in such contexts, including the persistence of these responses over time. In addition, the survey explores perceptions of institutional actions and communication related to water stress, as well as respondents’ willingness to modify their behavior when provided with more comprehensive and structured information.

The sample consists of 101 respondents, and the questionnaire includes both closed-ended and open-ended questions. The quantitative data were analyzed using descriptive statistical techniques, while qualitative responses were examined through thematic analysis in order to identify recurring patterns, perceptions, and attitudes.

The sample includes respondents from different age groups and regions of the country, with a predominance of urban residents and individuals with secondary and higher levels of education. Due to the voluntary nature of participation and the limited sample size, the findings cannot be interpreted as representative of the national population. Instead, they provide indicative insights into attitudes and behavioral responses within specific social groups.

The empirical component of the study has an exploratory and indicative character and does not aim at national-level representativeness. This methodological choice is deliberate and consistent with the overall objective of the article, which is to develop an analytical framework and a conceptual

model supported by empirical observations. Conducting a comprehensive and representative field study would require a different research design and a substantially broader scope.

Methods of Analysis and Data Validation

The methodological design integrates three complementary analytical layers: a structured synthesis of the conceptual and policy evidence, a comparative interpretation of reference cases, and a descriptive statistical assessment of the Bulgarian context. This design supports an integrated reading of water stress as both an institutional challenge and a behavioral governance problem, while maintaining a clear distinction between conceptual inference and empirical description.

First, the literature and policy evidence was reviewed with the purpose of consolidating working definitions and identifying recurring explanatory mechanisms relevant to the study. Rather than reiterating the full state of the art, the review was used to extract the key constructs applied in the paper - water stress, water security, critical infrastructure vulnerability, and marketing-based instruments for behavioral governance - and to establish the conceptual links through which water stress can translate into socio-economic disruption and security-relevant risks.

Second, the analysis employs a qualitative comparative interpretation of two reference cases - Cape Town and California - focused on the governance instruments deployed under water stress and the documented behavioral outcomes. The objective is not institutional benchmarking, but the identification of transferable mechanisms (e.g., demand management, trust-building, transparency, targeted behavioral interventions) that can inform the Bulgarian context conceptually. The qualitative content analysis proceeds through systematic thematic structuring of evidence from documents and peer-reviewed studies, maintaining traceability of the analytical steps without formalized coding.

Third, the empirical component applies descriptive statistical analysis to selected indicators for Bulgaria, including the scale of water supply restrictions, their spatial distribution, and survey-based measures of awareness, experience, and behavioral intention. The purpose is to illustrate the magnitude and distributional profile of water stress, and to provide empirical anchors for the conceptual argument, rather than to test causal hypotheses. Data processing and visualization were performed using Microsoft Excel and IBM SPSS.

To support analytical robustness, the analysis relies on consistency checks across sources and methods: convergence between institutional statistics and policy narratives, alignment between the Bulgarian indicators and patterns observed in reference cases, and internal coherence between closed-ended survey results and open-ended responses. This triangulated logic strengthens interpretive robustness while acknowledging the exploratory nature of empirical evidence.

Methodological Limitations

The empirical survey has an exploratory character and does not claim statistical representativeness at the national level. Nevertheless, it provides valuable empirical insights into consumers' attitudes, behaviors, and perceptions and serves as a basis for formulating governance- and communication-related recommendations.

The methodological choices are directly aligned with the research questions of the article: the analysis of policies and literature addresses the relationship between water stress and national security; the comparative analysis of international cases supports the identification of applicable governance instruments; and the quantitative data and survey results provide an empirical foundation for interpreting behavioral responses in the Bulgarian context.

Given the exploratory research design and the limited empirical base, the PCA model is not subjected to formal empirical testing. Its role in the present study is conceptual and analytical, serving to structure empirical observations and formulate testable hypotheses for future research.

Accordingly, the research aims to examine water stress in Bulgaria as a socio-political risk by combining comparative case analysis, secondary statistical data, and an indicative empirical survey, allowing for analytical replication of the proposed framework in comparable contexts.

Results and discussions

The discussion interprets the presented results considering the existing theoretical and governance frameworks, without claiming quantitative testing of causal relationships.

Data on the hydrogeographic distribution of water resources reveals a pronounced spatial mismatch between resource availability and demographic and economic concentration. Regions with the highest relative water yield are characterized by low population density, whereas densely populated and economically active areas are more vulnerable to water stress, regardless of overall national resource endowment (see Table 1). This pattern underscores the structural nature of vulnerability and limits the interpretation of water stress as a problem of physical scarcity alone.

The results of the survey “Consumer Experience and Awareness of Water Stress” (n = 101) provide an indicative empirical basis for analyzing the social dimensions of water stress. The data show that the concept of “water stress” is relatively recognizable: 60% of respondents report having heard of it, and nearly half assess their level of knowledge as good or very good. At the same time, a substantial share of participants demonstrates a fragmented understanding of the concept, pointing to a deficit in systematic and institutionally supported communication.

Particularly revealing are the data on personal experience with water scarcity. Approximately 80% of respondents report frequent or temporary problems with water supply, confirming that water stress in Bulgaria is a lived reality for a significant portion of the population. This lends the problem a clear social dimension and helps explain its potential to evolve into a source of social tension under conditions of ineffective governance.

At the same time, the results reveal a pronounced deficit of institutional trust. More than three quarters of respondents assess the actions of local authorities and water utilities as insufficient, while 84% describe institutional communication as weak or entirely lacking. These assessments are consistent with international studies indicating that governance and communication deficits often amplify the social effects of water stress, regardless of the actual degree of resource scarcity.

Alongside the survey data, trends in bottled mineral water consumption in Bulgaria show a sustained upward trajectory over the period 2018-2023, with a marked acceleration after 2021 (see Figure 2).

The increasing consumption of bottled water can be interpreted as an indirect behavioral indicator of perceived insecurity regarding the quality and reliability of public water supply. The available data does not allow for a direct causal link between resource scarcity and individual consumer decisions. However, the coincidence of more frequent water supply restrictions, intensified public debates on water infrastructure, and the sharp increase in consumption after 2021 suggests the emergence of individual compensatory strategies.

The survey data indicates a high declared readiness for behavioral adaptation within the examined sample, which may be interpreted as an indication of an existing potential for change in consumer behavior. A substantial proportion of respondents report sustained changes in their water-saving habits, including after the subsiding of crisis periods.

It is important to emphasize that these results should not be generalized at the national level. Nevertheless, they are analytically significant, as they suggest that a lack of willingness to adapt is not the primary constraint on effective water stress governance. Rather, the problem appears to lie in the absence of targeted, consistent, and trusted institutional signals capable of channeling this behavioral potential into sustainable collective practices.

The present analysis employs empirical results to analytically illustrate the PCA model rather than to subject it to formal testing. The data allows for tracing how different governance and behavioral processes are positioned across the phases of prevention, crisis management, and adaptation.

In the prevention phase, the limited and fragmented understanding of water stress, combined with a declared readiness for informed behavior, highlights the role of systematic communication and social marketing. The absence of such instruments increases the likelihood that resource pressure will escalate into a crisis.

The crisis management phase is characterized by high sensitivity to institutional communication and the perceived fairness of implemented measures. The empirical results indicate that, in the presence of deficits in transparency and timely information, even technically well-founded restrictions may lead to a decline in public trust and the emergence of social tension.

In the adaptation phase, sustained behavioral changes and individual coping strategies point to potential for long-term transformation. However, without integration into a broader institutional framework, such adaptations remain fragmented and do not reduce systemic vulnerability.

The comparative analysis of international and Bulgarian cases demonstrates that effective water stress governance involves distinct interventions across the phases of prevention, crisis, and adaptation, with marketing-based governance instruments playing a key role in each of them (see Table 2).

Quantitative assessments of the effects of behavioral and marketing-based interventions on water consumption are available for international cases such as Cape Town and California; however, comparable systematic data are lacking in the Bulgarian context. For this reason, the present study treats these instruments as conceptually grounded hypotheses for future testing, without assuming direct institutional policy transfer.

Accordingly, the effectiveness of marketing-based governance instruments should be understood as conditional and context-dependent. It is strongly influenced by levels of institutional trust, administrative capacity, and the degree of public legitimacy of policy measures, which constitute significant constraints in the Bulgarian case.

The PCA model complements indicator-based monitoring (e.g., SDG 6.4.2, WEI+) by specifying governance and behavioral mechanisms through which pressure translates into socio-political risk.

The integration of empirical observations into the PCA model reveals the existence of a structural gap between societal readiness for adaptation and institutional governance capacity. This gap is analytically significant, as the observed mismatch transforms water stress from a manageable resource-related problem into a risk to social stability.

From a national security perspective, the key insight does not lie in water scarcity per se, but in the way institutions manage expectations, communication, and trust. The limited governance capacity functions as a risk multiplier that amplifies the effects of water stress and increases the likelihood of social tension.

In this context, marketing-based and behavioral governance instruments emerge as a connecting mechanism between technical solutions and actual public behavior. Their role is not to

replace infrastructure investments, but to enhance their social feasibility and long-term sustainability. The following conclusions should therefore not be interpreted as prescriptive recommendations, but as analytically grounded interpretations of potential governance trajectories.

Figures and tables

Table 1. Hydrogeographic distribution and vulnerability to water stress in Bulgaria

Altitude zone (m)	Share of national water resources (%)	Key regions (examples)	Vulnerability (examples of water stress)
> 1600	12.2	Rila, Pirin	Low - sparsely populated
600-1600	44.0	Balkan Mts., Rhodopes	Medium - Pernik crisis 2019-2020
300-600	25.9	Fore-Balkan, Srednogie	Some rural settlements under rationing
< 300	18.7	Danube & Thracian plains	Several NE villages affected by shortages

Source: National Statistical Institute (2023); Hristova-Ivanova (2024)

Table 1 supports the research aim by illustrating regional disparities between hydrological availability and vulnerability, highlighting the role of governance and infrastructural factors in shaping water stress outcomes.

Table 2. Comparative cases and marketing-based governance instruments across the phases of the PCA model

PCA Model Phase	Cape Town (South Africa)	California (USA)	Bulgaria - Pernik (2019-2020)	Bulgaria - Pleven (2024-2025)
Prevention	Social marketing; long-term water-saving norms	Educational programs; water audits	Absence of systematic prevention; limited information campaigns	Limited anticipatory communication; absence of targeted preventive campaigns
Crisis management	“Day Zero” campaign; social feedback mechanisms	Restrictions; differentiated tariffs; public accountability	Emergency water regimes; fragmented risk communication	Rationed water supply; reactive communication; limited transparency
Adaptation	New water sources; digital monitoring; water reuse	Transparency; citizen participation	Infrastructure improvements without structured marketing-based instruments	Planned infrastructure measures; lack of an integrated behavioral approach

Source: Rodina (2019); Hanak & Mount (2015); Matikinca et al. (2020); National Statistical Institute. (2023); Energy and Water Regulatory Commission. (2025)

Table 2 compares international and national cases across the prevention, crisis, and adaptation phases, demonstrating how marketing-based governance instruments complement technical measures under different institutional conditions.

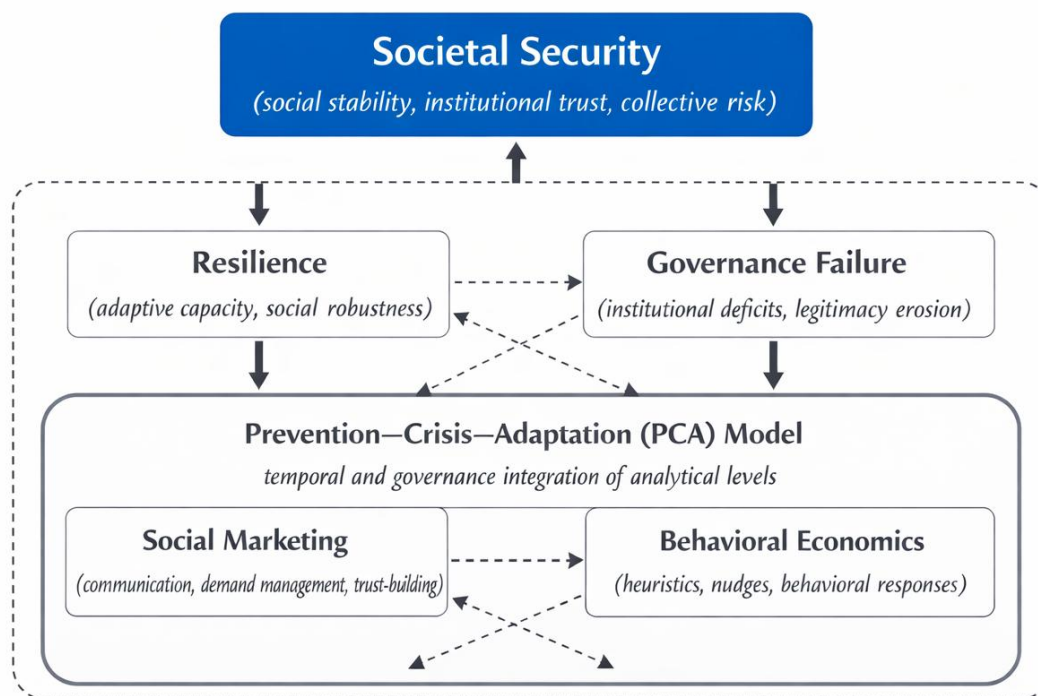


Figure 1. Hierarchy of the theoretical framework and positioning of the PCA model

Source: Author's systematization.

Figure 1 highlights the analytical relationship between physical resource pressure, institutional capacity, and behavioral dynamics, thereby clarifying the role of marketing-based and behavioral instruments across the different governance phases.

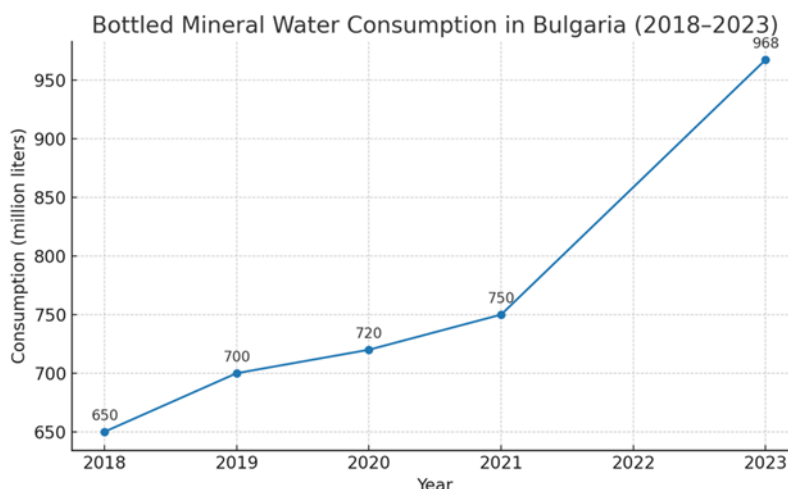


Figure 2. Bottled mineral water consumption in Bulgaria, 2018-2023

Source: National Statistical Institute; industry data (2018-2023)

Figure 2 presents trends in bottled water consumption as an indirect behavioral indicator of perceived water insecurity and declining trust in public water supply systems.

Conclusion

The present study examines water stress as an increasingly significant factor for social stability and national security in Bulgaria, analyzed not only as an environmental and infrastructural challenge, but as a complex socio-political risk. By combining an analytical literature review, a comparative analysis of international case studies, and an indicative empirical survey, the article explores the interrelationships between physical water scarcity, limited governance capacity, public behavior, and institutional resilience.

The analysis demonstrates that water stress in Bulgaria does not constitute an isolated or temporary deviation, but rather a structural problem reproduced across different regions and time periods. Empirical observations indicate that a substantial proportion of the population has direct experience with water supply restrictions, lending the issue a clear social dimension. In this context, water stress functions as a risk multiplier capable of eroding institutional trust and intensifying social tension in the presence of limited governance capacity.

The survey provides an indicative empirical basis for analyzing the behavioral and communicative aspects of water stress. The findings reveal a declared readiness for behavioral adaptation within the sample examined, alongside a critical assessment of institutional responses and communication. These results should not be interpreted as representative of general societal attitudes, but rather as illustrative empirical observations that support the formulation of analytical and governance-related hypotheses.

The principal scientific contribution of the study lies in the development of the conceptual Prevention-Crisis-Adaptation (PCA) model, which structures water stress governance into three interrelated phases and positions marketing-based and behavioral governance instruments as a key connecting mechanism between technical solutions, public behavior, and institutional legitimacy. The model does not replace engineering or regulatory approaches, but complements them by focusing on demand management, communication, and trust.

Within the framework of this study, national security is conceptualized as a function of social stability, institutional reliability, and governance capacity to address systemic risks. In this sense, water stress is interpreted through the lenses of societal security, resilience, and the risk of governance failure, whereby limited institutional effectiveness may transform a resource-related problem into a socio-political crisis.

The practical implications of the analysis suggest that sustainable water stress management requires an integrated approach combining technical, regulatory, and behavioral instruments. The high declared willingness to change behavior among segments of the population creates potential for targeted interventions in social marketing, risk communication, and mechanisms for citizen participation. Within an appropriate institutional framework, such instruments may contribute to higher levels of public compliance, greater transparency, and enhanced resilience of the water sector.

The proposed PCA model should be regarded as an analytical framework outlining logical relationships and governance mechanisms, while requiring targeted empirical testing through broader, representative, or experimental research designs. The study also has several limitations. The limited size and non-representative character of the survey necessitate caution in generalizing the findings. In this sense, the survey data should be treated as an illustrative empirical foundation for formulating analytical and governance-related hypotheses, rather than as evidence of generalized societal attitudes.

Although the analysis is focused on the Bulgarian context, the study offers several insights of broader relevance. First, the findings confirm that water stress in modern societies rarely manifests solely as physical resource scarcity, but more often as a governance and behavioral challenge related to trust, communication, and institutional legitimacy. Second, the PCA model may be viewed as a contextual adaptable analytical framework applicable to different national and regional settings in which the governance of critical resources unfolds across phases of prevention, crisis, and adaptation. Its usefulness does not stem from the universality of specific instruments, but from the framework's capacity to integrate diverse governance and behavioral approaches depending on the institutional environment.

In conclusion, the study demonstrates that water stress management in Bulgaria cannot be sustainable if approached solely as a technical or infrastructural issue. The integration of behavioral and marketing-based governance instruments within an adaptive model such as PCA offers an opportunity for better alignment between public policies, public behavior, and institutional legitimacy. In this way, the article contributes to the interdisciplinary debate on water security by outlining directions for future research and policy development aimed at building long-term resilience under conditions of increasing water stress.

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