

# Eco-Leadership and Green Human Resource Management as Drivers of Environmental Security and Critical Infrastructure Resilience

**Dafinka Sidova**

Department of National and  
International Security  
New Bulgarian University  
Sofia, Bulgaria

ORCID: [0000-0001-6254-2874](https://orcid.org/0000-0001-6254-2874)

**Valentin Vasilev**

Department of National and  
International Security  
New Bulgarian University  
Sofia, Bulgaria  
[vvasilev@nbu.bg](mailto:vvasilev@nbu.bg)

**Petar Arabadzhyski**

Department of National and  
International Security  
New Bulgarian University  
Sofia, Bulgaria  
[parabadzhyski@nbu.bg](mailto:parabadzhyski@nbu.bg)

**Abstract**— The main aim of this paper is to examine the role of eco-leadership and Green Human Resource Management as key drivers for strengthening environmental security and the resilience of critical infrastructure. In the context of increasing environmental risks, climate challenges, and the growing need for the protection of natural resources, organizations responsible for managing critical infrastructure face the necessity of integrating sustainable management practices and innovative leadership models.

The study examines the concept of eco-leadership as a managerial paradigm oriented toward aligning organizational strategic objectives with the principles of sustainable development and environmental security. In particular, it emphasizes the role of Green Human Resource Management as a strategic instrument for fostering an organizational culture grounded in sustainability, environmental responsibility, and the effective governance of human capital.

Furthermore, the research explores the development of green competencies, mechanisms for enhancing employee motivation, the emergence of “green jobs,” and the critical importance of continuous training and organizational development in the construction of sustainable management systems. Within this framework, special attention is devoted to the contribution of the human factor to strengthening the resilience of organizations responsible for critical infrastructure, particularly in contexts characterized by environmental risks and crisis situations.

In conclusion, by identifying key challenges and best practices related to the implementation of eco-leadership and Green Human Resource Management, the paper derives recommendations for sustainable policies and managerial strategies that contribute to strengthening environmental security and critical infrastructure resilience

The paper uses a conceptual research approach based on a narrative review of literature and selected good practices to develop a model linking eco-leadership, Green Human Resource Management and security outcomes.

**Keywords** - Critical Infrastructure Resilience, Eco-Leadership, Environmental Security, Green Human Resource Management.

## I. INTRODUCTION

The topic of environmental security is becoming increasingly important in light of current global climate change, rising environmental threats, and the growing vulnerability of natural resources. It is becoming a crucial component of the Human Security Concept, with the preservation of the environment and the guarantee of sustainable circumstances for human life and societal advancement at its center. [1]

Energy systems, water supplies, transportation networks, and communications are examples of critical infrastructure that is especially vulnerable to the effects of environmental conditions. Serious socio-economic repercussions may result from disruptions to its operation brought on by natural catastrophes, climate change, or environmental crises. In this situation, both national and international security strategically prioritize the resilience of critical infrastructure.

In this process, the human element plays a particularly significant role [2] - [4]. Human resource management should be seen as a strategic tool for creating sustainable companies that can successfully address environmental issues rather than just as an administrative task. This makes it clear that new management techniques must be incorporated, with eco-leadership and Green Human Resource Management standing out among them.

Conversely, eco-leadership is seen as a modern management approach that integrates social responsibility, strategic thinking, and a dedication to sustainable development. It is the development of an organizational culture where environmental values are included into daily operations and decision-making processes [5], [6]. In this way, leaders are crucial in encouraging innovation,

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sustainable behaviour, and employee engagement. This idea expands on traditional leadership paradigms and offers fresh insights into their thorough analysis and use.

The main contribution of the paper is the development of a conceptual model that integrates eco-leadership, Green Human Resource Management and security-oriented organizational capacities. The model highlights the role of green competencies, employee motivation, psychological resilience and inter-team coordination as mechanisms through which human capital can support environmental security and critical infrastructure resilience.

## II. MATERIALS AND METHODS

For the past few years, at both global and national levels, scholarly and expert debates are increasingly intensifying regarding the significance of the eco-friendly orientation of leadership and human resource management. In this context, the relationship between the sustainability of management processes and the assurance of environmental security is directly proportional; that is, as the former strengthens, the latter is correspondingly enhanced.

The study applies a conceptual research approach based on a narrative review of academic publications and selected project documents related to eco-leadership, Green Human Resource Management, environmental security and critical infrastructure resilience. The reviewed sources were grouped into thematic categories: green competencies, employee motivation, green jobs, crisis preparedness, psychological resilience and inter-team coordination. Based on these categories, a conceptual model was developed to explain the relationship between eco-leadership, Green Human Resource Management and security outcomes.

Thus, a key indicator of the effectiveness of eco-leadership is the extent to which environmental human rights are protected in both quantitative and qualitative terms. In particular, these rights encompass equitable and non-discriminatory access to essential natural resources - including land, shelter, food, water, and clean air - which are fundamental to human survival and well-being across both personal and professional domains. Furthermore, the protection of environmental human rights serves as a critical benchmark for sustainable governance and organizational responsibility. In this regard, three core environmental human rights can be distinguished: the right to a safe, clean, healthy, and sustainable environment (including within the workplace); the right to clean and accessible drinking water; and the right to safe, hygienic, and accessible sanitation and working conditions [7].

From that point of view, as Stefanova, Popescu and Vasilev [8] draw the attention, it is important to underline that recruitment, training, performance evaluation, motivation, and staff development are all important aspects of human resource management that incorporate environmental concepts. Moreover, the development of so-called "green competencies", which encompass knowledge, skills, and attitudes connected to environmental preservation, effective resource use, and

sustainable thinking, is a crucial component of Green Human Resource Management [9]. In this context, employee training and development acquire strategic importance, as they support the building of organizational capacity to address environmental challenges.

Another important factor is employee motivation. Therefore, employers who provide suitable incentives for environmentally conscious behavior foster more employee involvement and a deeper sense of commitment to sustainability objectives. Because they are associated with activities that mitigate adverse environmental impacts, so-called "green jobs" are becoming increasingly significant in this process.

Recent developments in Green Human Resource Management have led to the conclusion that Green Human Resource Management helps companies become more resilient and competitive in addition to improving their environmental performance. Furthermore, organizations can more successfully manage risks associated with environmental crises and guarantee long-term stability by fostering a culture of sustainability and engagement. In this sense, it is an integrated management method that systematically integrates sustainable development objectives and environmental principles into every aspect of human capital management [10]. In addition, Green Human Resource Management is becoming a crucial component for improving organizational adaptation, efficiency, and resilience in the face of escalating environmental threats and increased demands on businesses for sustainable operation, especially in important infrastructure-related industries.

Incorporating sustainable values and environmental standards into traditional HR processes is the core of Green Human Resource Management [11], [12]. Consequently, this entails creating a corporate culture where environmental responsibility is ingrained in workers' daily conduct in addition to formally introducing "green" rules.

Important indicative characteristics for identifying Green Human Resource Management can be derived from several of its key features:

- **Green Recruitment and Selection** – this dimension extends the scope of recruitment and selection procedures by incorporating elements related to the overall understanding of environmental challenges faced by organizations and the importance of their activities in addressing these issues. Candidates with sustainable thinking, environmental awareness, and a desire to take part in green activities are becoming more and more sought after by organizations. By incorporating these factors into the hiring process, teams that can support the organization's sustainability goals are formed [13].
- **Training and development of green competencies** is a central element of Green

Human Resource Management. These competences include, among other things, an understanding of environmental dangers and regulations, the ability to use resources efficiently, and attitudes that are focused on sustainable conduct. Building capacity for environmental crisis prevention and response is facilitated by training and development programs Ziolkowska [14], Matura, and Singh [15] highlight in their studies. This is especially crucial for organizations in charge of key infrastructure,

- **Performance appraisal with an environmental focus** involves the introduction of environmental indicators into performance evaluation systems, encouraging employees to actively contribute to sustainability goals, according to Cabral and Dhar [16]. This may include metrics related to waste reduction, energy efficiency, or participation in green initiatives,
- **Motivation and stimulation of green behaviour** – as argued by Gigauro, Vasilev, and Sidova [17], motivational mechanisms play a crucial role in encouraging environmentally responsible behaviour. Financial and non-financial incentives, recognition, and participation in sustainability-oriented projects create conditions for higher employee engagement,
- **Development of “green jobs”** - Afsharbakeshlo, Omidvar and Gigauro [18] affirm that the creation of job positions related to the management of environmental processes and sustainable practices is an important step toward integrating sustainability into the organizational structure. These positions contribute to better resource management and the reduction of environmental risk.

To emphasize, the effectiveness and practical manifestation of eco-leadership are intrinsically linked to the successful implementation of Green Human Resource Management. In particular, leaders who demonstrate a sustained commitment to the principles of sustainable development facilitate the adoption of green practices and the cultivation of an environmentally oriented organizational culture. With this in mind, eco-leadership functions as a critical catalyst that guides, shapes, and accelerates the transformation of human resource management toward a comprehensive model of sustainability-oriented governance.

In an attempt to enrich this research, an ongoing project under the Programme 2021 - 2027 Interreg VI-B Central Europe could be pointed as a good practice – “Resilient, Sustainable and Innovative social Entrepreneurship in Central Europe” [19]. In the core of the project lays the

priority of enhancing digital and green skills of 25 social economy enterprises, as well as fostering management of change attitude, it's expected to trigger a concrete change in peripheral areas ecosystem, leveraging on the social economy potential.

Another good example is a “Enhancing the development of Centers of Vocational Excellence in the Danube Region by fostering competence and skill development, business-education cooperation and transnational networking” [20] project, full completed in 2025. Three public institutions from Hungary, Serbia and Slovenia combine their efforts to foster competence and skill development in high-quality vocational education and training programs with a special focus on green skills and learning competences.

In 2019 a successful project between Hungary and Romania was closed - “Green Skills Platform for Sustainable Employment Development” [21]. The most valuable achievements are related to contributing to increase of the employment in the area by providing employees skills for green companies, improving the business environment through integrated development measures and providing knowledge to employers, managers, entrepreneurs, and potential entrepreneurs to manage (open) more friendly environment businesses.

Organizational sustainability is directly impacted by Green Human Resource Management, especially when it comes to critical infrastructure. Organizations can more successfully identify and manage environmental risks, respond appropriately to emergencies, preserve business continuity, and lessen adverse environmental impacts by developing skilled and engaged human capital. In this sense, Green Human Resource Management functions not only as a tool for sustainable development, but also as an essential component of security systems. On account of the fact that the human factor plays a key role in the prevention, management, and recovery from environmental incidents, which highlights the importance of investments in training, motivation, and development, the following main part of this paper is focused on its role in the resilience of critical infrastructure.

### III. RESULTS AND DISCUSSION

In the contemporary context, the resilience of critical infrastructure has traditionally been examined through the lenses of technology, physical security, and financial investment. However, with the increasing severity of environmental risks and climate change, the human factor emerges as the most critical and simultaneously the most vulnerable component of the security system. The human element acts as a resilience multiplier: a well-trained and motivated workforce can significantly enhance the effectiveness of technical and organizational measures [22]. Employees within organizations responsible for critical infrastructure—such as energy, transport, water supply, communication systems, and healthcare services - are not merely executors of technical tasks. They are key

actors whose decisions, actions, and professional behaviour can either prevent or mitigate the consequences of environmental crises. This necessitates a transition from traditional Human Resource Management toward strategic Human Capital Management, shifting from an administrative approach to the development of human competencies, experience, and adaptability [23].

Organizational culture and training play a pivotal role in building long-term resilience. The development of a sustainability-oriented culture implies shared responsibility for environmental security, proactivity in identifying threats, and zero tolerance for behavioural patterns that may compromise vital systems. It is precisely in this context that eco-leadership becomes essential—leaders who demonstrate commitment to environmental values foster trust and inspire employees to adhere to sustainability principles.

Such a culture is cultivated through consistent policies and a continuous learning process. Modern training programs should incorporate regular simulation exercises addressing environmental crises such as floods, wildfires, and energy infrastructure failures. As highlighted by the EU Civil Protection Knowledge Network, the development of these competencies is essential for enhancing preparedness and response to environmental risks [24].

Effective response to environmental crises imposes specific requirements on the human factor that extend beyond technical competence. Several personnel characteristics are of critical importance under conditions of high risk and time pressure. These include situational awareness (the ability to rapidly assess a dynamically changing environment), adaptive decision-making (the capacity to act effectively in situations where predefined plans are no longer applicable), and efficient communication and coordination among multidisciplinary teams (technical, emergency response, environmental, and managerial) involved in crisis management.

A key prerequisite for successful crisis management is the psychological resilience of personnel involved in crisis response, enabling them to withstand stress and maintain clear and focused cognitive functioning.

In addition to the examined components of Green Human Resource Management, this analysis focuses on two aspects that may significantly influence the resilience of critical infrastructure during real environmental crises: psychological resilience of personnel and inter-team coordination.

The first aspect concerns psychological resilience and employee well-being. Workers operating under conditions of high stress, tight decision-making deadlines, and information scarcity during environmental events - such as floods, fires, or failures in energy and water supply infrastructure - must make rapid and appropriate decisions while maintaining cognitive clarity. This necessitates the implementation of well-being, resilience, and mindfulness programs that support employees in coping with psychological pressure during crisis situations [25].

The second aspect relates to real-time coordination among teams. Environmental challenges are rarely addressed by a single isolated team. A key prerequisite is seamless synchronization among technical, emergency, environmental, and managerial units. The introduction of environmental Key Performance Indicators into incentive and reward systems [26] is also crucial, as it aligns employee behaviour with sustainable procedures and ensures accountability for environmental outcomes. Regular simulation exercises involving multiple teams represent an especially valuable tool, as the lack of coordination is often a critical factor in the failure of large-scale incident responses.

These two aspects complement the existing components of Green Human Resource Management by adapting them to the specific requirements of critical infrastructure. In this way, the interconnection between eco-leadership, green human resource management, and the human factor capable of translating sustainability principles into practice is completed. Human potential, systematically developed through contemporary human capital management approaches, is established as the third dimension of the triangle: “environmental security – critical infrastructure – human resources” [4].

In organizations responsible for critical infrastructure, Green Human Resource Management practices can support system security by ensuring that employees are trained to recognize environmental risks, follow emergency procedures, communicate effectively during crises and participate in coordinated recovery actions. Therefore, the human factor should be considered an operational component of infrastructure resilience.

#### IV. CONCEPTUAL MODEL: GREEN HUMAN RESOURCE MANAGEMENT – ECO-LEADERSHIP – SECURITY AND POLICY, AND MANAGERIAL RECOMMENDATIONS

As a result of the theoretical and practical research, the authors propose a conceptual model Green Human Resource Management - Eco-Leadership – Security (incl. critical infrastructure resilience), shown on “Fig. 1”.

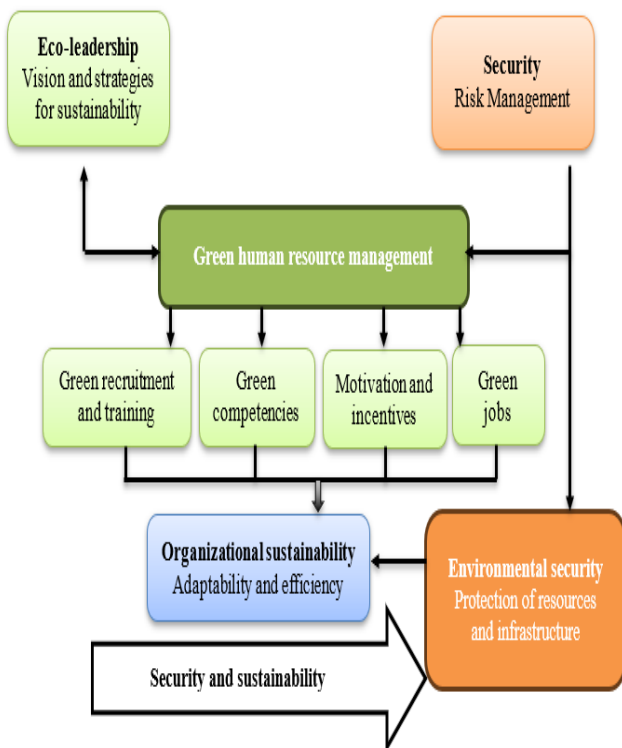


Fig. 1. A conceptual model Green Human Resource Management - Eco-Leadership – Security. (authors' interpretation)

The model shows that eco-leadership and Green Human Resource Management do not function in isolation, but in synergy. Eco-leadership provides the strategic framework and value orientation, while Green Human Resource Management supplies the tools for their practical implementation. As a result, sustainable human capital is developed, which contributes to enhancing organizational security and resilience [27].

The model suggests that eco-leadership provides the strategic direction and environmental values of the organization. Green Human Resource Management translates these values into HR practices such as recruitment, training, performance appraisal, motivation and employee development. These practices contribute to the development of green competencies, employee engagement, psychological resilience and inter-team coordination. These organizational capacities support risk prevention, crisis response and recovery after environmental incidents. As a result, human capital becomes an operational factor in strengthening environmental security and critical infrastructure resilience.

Based on the derived summaries, conclusions, and specific challenges, several key Policy and Managerial Recommendations can also be presented at three levels:

- **At the institutional and organizational level – 1.** Organizations managing critical infrastructure should introduce annual training modules on environmental risk recognition, emergency

response, resource efficiency, crisis communication and inter-team coordination; **2.** Introduction of green skills standards in education and professional qualification systems; **3.** Promotion of public–private partnerships for developing sustainable management practices; **4.** Integration of environmental criteria into all human resources processes (recruitment, performance evaluation, development); **5.** Establishment of internal policies for sustainable human capital management; **6.** Development of training and development programs for green competencies; **7.** Implementation of systems for evaluating employees' sustainability performance,

- **At the leadership and human capital level – 1.** Development of eco-leadership skills through specialized training and coaching; **2.** Encouraging ethical and sustainable decision-making; **3.** Active engagement of leaders as ambassadors of sustainable organizational culture; **4.** Stimulating environmentally responsible behaviour through motivational mechanisms; **5.** Increasing employee awareness and engagement in sustainability goals; **6.** Supporting the development of initiative and innovation in green practices,
- **At the security and risk management level – 1.** Green Human Resource Management indicators should be included in risk management dashboards, including employee participation in environmental training, completion of crisis simulations, compliance with sustainability procedures and contribution to energy and waste reduction targets; **2.** Development of training and response scenarios for environmental crises; **3.** Enhancing organizational readiness and resilience through the human factor.

## V. CONCLUSIONS

The significance of eco-leadership and Green Human Resource Management goes beyond corporate responsibility and becomes a strategic issue for security and sustainable development in the context of intensifying climate change, rising environmental threats, and a more complicated global environment. In addition to modifying their technology, organizations in charge of critical infrastructure must change their management approaches by incorporating people as a vital resource for sustainability and resilience.

According to Singh and Kumar [28], and Evangeline [29], the successful integration of eco-leadership and Green Human Resource Management produces a synergistic effect that results in the development of an organizational culture based on accountability, flexibility, and proactive environmental risk management. Human capital participates actively in processes that provide environmental security through the development of green capabilities, involvement, and sustainable behaviour.

It is especially crucial to remember that critical infrastructure resilience cannot be reduced to a technical or

technological problem [4]. It is heavily reliant on the calibre of management and leadership as well as the capacity of enterprises to create a culture of readiness, learning, and flexibility. In this way, Green Human Resource Management becomes a crucial tool for strengthening resilience and lowering susceptibility in uncertain and crisis situations.

In the future, there is a growing need to develop integrated models that link environmental security, human resource management, and strategic leadership into a unified conceptual framework. The practical application of such models could contribute to more effective risk management, enhanced competitiveness, and the creation of long-term value for society.

Future research should empirically test the proposed model through case studies, surveys or interviews with organizations responsible for energy, water, transport, communication or healthcare infrastructure.

In summary, investments in eco-leadership and Green Human Resource Management are essential rather than optional. They serve as the cornerstone for creating ethical, safe, and sustainable companies that can handle the challenges of the future. The conditions for the efficient preservation of environmental resources, the integrity of vital infrastructure, and the preservation of public welfare are exactly established by this integrated approach.

The high practical value of such research lies in its ability to support organizations and public institutions in developing proactive strategies for sustainability, resilience, and crisis preparedness. In an environment characterized by increasing ecological, technological, and social risks, integrated interdisciplinary models can provide a solid foundation for informed decision-making and long-term organizational stability. Furthermore, these approaches contribute to strengthening cooperation between management structures, employees, and society in the pursuit of sustainable development goals.

In summary, investments in eco-leadership and Green Human Resource Management are essential rather than optional. They serve as the cornerstone for creating ethical, safe, and sustainable companies that can handle the challenges of the future. The conditions for the efficient preservation of environmental resources, the integrity of vital infrastructure, and the preservation of public welfare are exactly established by this integrated approach.

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