

Strategy for Integrating RTRW-Based Disaster Education to Control Land Use in Protected Natural Areas

Elsa Nur Aida*, Hariyanto, Eva Banowati, Rahma Hayati, and Erni Suharini

Master's Program in Geography Education, Universitas Negeri Semarang,
Semarang, Indonesia

*elsanuraida064@students.unnes.ac.id

Article Info	Abstract
Article history: Received: March 6, 2026 Accepted: April 26, 2026 Published: May 19, 2026 Keywords: Land use control Natural protection area Regional spatial plan Salatiga city This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. © 2026 Vidya Karya	This study analyzes the implementation of the Regional Spatial Plan (RTRW) in controlling land use within natural protection areas of Salatiga City. It focuses on land use conformity, influencing factors, and environmental implications. A mixed-method approach was employed, with data collected through field observations, in-depth interviews, and document analysis. Data were analyzed using data reduction, data display, and conclusion-drawing techniques. The results show that RTRW implementation is not yet optimal, as some land uses remain inconsistent with the spatial plan, particularly in areas under development pressure. Supporting factors include regulatory availability and local government commitment, while inhibiting factors involve weak supervision, limited inter-agency coordination, and low public awareness. These conditions may reduce the ecological functions of protected areas. SWOT and QSPM analyses indicate that strengthening spatial planning education, improving supervision, and enforcing regulations are key priorities to support sustainable land use control in natural protection areas.
To cite this article: Aida, E. N., Hariyanto, H., Banowati, E., Hayati, R., & Suharini, E. (2026). Strategy for integrating RTRW-based disaster education to control land use in protected natural areas. <i>Vidya Karya</i>, 41(1), 407-420.	

INTRODUCTION

Land use change in urban areas has emerged as a critical issue in spatial governance, particularly within protected natural areas that serve as ecological buffers and disaster mitigation zones. Rapid urban expansion, population growth, and increasing demand for land often lead to the conversion of protected areas into built-up land, thereby reducing ecological capacity and increasing vulnerability to environmental hazards such as flooding and landslides (OECD, 2020; World Bank, 2019). These dynamics indicate that land use control remains a significant challenge in ensuring the sustainability of protected areas in rapidly developing cities (Nugroho & Pramono, 2021; Muta'ali, 2015). From a spatial governance perspective, this issue reflects limitations in policy implementation, where formal regulations are not always effectively translated into practice due to institutional constraints and behavioral factors.

In the Indonesian context, the RTRW functions as a primary regulatory instrument for directing spatial utilization in accordance with environmental carrying capacity and disaster risk considerations (Undang-Undang Nomor 26 Tahun 2007; BNPB, 2021). The RTRW is designed to regulate land allocation, prevent incompatible land use, and support sustainable development through zoning mechanisms. However, previous studies reveal that the implementation of the RTRW often faces limitations, particularly in terms of weak

law enforcement, inadequate monitoring, and low public compliance with spatial regulations (Banowati & Hayati, 2019; Setiawan, 2018). These challenges can be further understood through governance theory, which emphasizes that effective spatial planning requires not only formal institutions but also coordination, participation, and shared responsibility among stakeholders.

RTRW and disaster education have a close and complementary relationship in spatial planning practices. The RTRW provides a structural framework through zoning regulations, while disaster education functions as a non-structural approach to increase public awareness, understanding, and compliance with spatial regulations. The integration of these two aspects is essential, as spatial plans alone are often insufficient without community support and awareness. Disaster education based on spatial planning can strengthen public participation in maintaining protected areas and reducing disaster risks.

Empirical evidence further strengthens the urgency of this issue. Previous research indicates that there is a significant land use inconsistency of approximately 20% between actual land use and the RTRW, particularly within protected natural areas. This inconsistency is mainly driven by the conversion of green open spaces and agricultural land into residential and commercial areas due to urban development pressures. In addition, reports from the Regional Development Planning Agency of Salatiga highlight frequent violations of spatial planning regulations, especially in protected zones that are increasingly utilized for built-up land.

These land use changes have direct environmental consequences, including the increased occurrence of hydrometeorological disasters such as flooding and landslides, particularly in hilly areas that were previously designated as protected zones. Furthermore, field observations reveal that public awareness and understanding of spatial planning regulations remain low, contributing to non-compliance in land use practices. This indicates that the implementation of the RTRW has not been effectively supported by educational approaches, particularly those related to disaster risk and spatial awareness.

Salatiga City was selected as the study area due to its specific geographical and environmental characteristics, including hilly topography and high rainfall intensity, which increase its vulnerability to hydrometeorological disasters such as flooding and landslides. In addition, the presence of protected natural areas that are increasingly under pressure from urban development makes Salatiga a relevant case for examining land use control issues. More specifically, this study focuses on Sidorejo and Sidomukti sub-districts, as these areas contain significant portions of protected zones that have experienced considerable land use change and development pressure. Empirical observations indicate that several protected areas in these districts have been converted into residential, commercial, and mixed-use developments, which are inconsistent with the RTRW zoning regulations. These conditions make Sidorejo and Sidomukti critical areas for analyzing the effectiveness of RTRW implementation and the role of disaster education in improving spatial compliance.

Several empirical studies highlight that land use deviations frequently occur in protected areas located near urban centers, where accessibility and economic pressures drive informal or unregulated development. This condition suggests that spatial planning policies tend to function more as normative guidelines rather than effective operational instruments capable of influencing actual land use behavior (Hariyanto, 2017; Hayati, 2020). From a behavioral perspective, this reflects the limited role of individual and collective awareness in shaping compliance, as explained in frameworks such as the Theory of Planned Behavior, which posits that attitudes, social norms, and perceived control influence decision-making related to land use practices.

In response to these challenges, disaster risk reduction approaches have increasingly emphasized the importance of community-based strategies, particularly through education and awareness-building initiatives (UNESCO, 2017; UNISDR, 2015). Disaster education

plays a crucial role in enhancing public understanding of environmental risks, strengthening adaptive capacity, and promoting more responsible land use practices. Within the context of adaptive and participatory governance, education can be seen as a mechanism to align policy objectives with community behavior by improving spatial literacy and fostering voluntary compliance.

Despite these developments, existing studies generally examine spatial planning and disaster education as separate domains. Research focusing on the integration of disaster education into RTRW implementation as an operational mechanism for land use control remains limited, particularly at the city scale and within protected natural areas (Djalante et al., 2013; Birkmann et al., 2013). This indicates a clear research gap, where the role of education in strengthening spatial planning effectiveness has not been sufficiently explored within an integrated governance and behavioral framework.

Therefore, this study offers a novel contribution by positioning disaster education not merely as a complementary component but as a core strategic instrument within the Regional Spatial Plan (RTRW) implementation to enhance land use control in protected natural areas. Unlike previous studies that focus primarily on regulatory or institutional aspects, this research integrates spatial analysis with strategic decision-making tools, including SWOT and the Quantitative Strategic Planning Matrix (QSPM), to identify priority strategies based on empirical conditions and expert judgment. By doing so, this study not only addresses the gap between spatial regulation and land use behavior but also provides a practical framework for strengthening spatial governance through education-based interventions.

Despite the existence of formal spatial planning regulations under the RTRW, practical challenges persist at the local level, particularly in disaster-prone protected areas where inconsistencies between designated zoning and actual land use are frequently observed. This indicates that the gap between spatial policy and land use behavior is not only institutional but also socio-cognitive in nature, highlighting the need for approaches that integrate regulatory and educational dimensions.

Addressing this gap, the present study proposes an integrated approach by positioning disaster education as a core strategic instrument within RTRW implementation, rather than merely a complementary component. This study combines spatial analysis with strategic decision-making tools, including SWOT and the QSPM, to systematically identify and prioritize strategies based on empirical conditions and expert judgment, thereby offering a more operational and context-specific framework for improving land use control in protected natural areas.

METHODS

This study employed a mixed-method approach combining qualitative and quantitative strategic analysis within a geographical perspective to formulate priority strategies for integrating disaster education into RTRW implementation. Qualitative methods were used to explore land use conditions and stakeholder perspectives through observations, interviews, and document analysis. Quantitative analysis was applied using structured decision-making tools, including spatial analysis, SWOT analysis, and the QSPM, to identify and prioritize strategic alternatives. This integrated approach enables a more comprehensive understanding of both spatial phenomena and strategic decision-making processes.

This study was conducted in the protected natural areas of Salatiga City, Central Java, Indonesia. These areas are designated under the RTRW as zones with ecological protection and disaster mitigation functions, including water catchment areas, slope stabilization zones, and environmental buffer zones. Salatiga City was selected as the study area due to its increasing urban development pressure and the presence of land use activities that

potentially deviate from protected zoning regulations, making it a relevant case for examining land use control challenges in disaster-prone urban environments.

This study was conducted in Salatiga City, Central Java, Indonesia, which is geographically located between 007° 17' 9.767" and 007° 25' 25.456" South Latitude and 110° 27' 58.86" and 110° 32' 6.478" East Longitude, covering an area of approximately 54.98 km². The research focuses on Sidorejo and Sidomukti sub-districts, as these areas contain significant portions of protected natural zones and are experiencing considerable land-use change pressure. The study area experiences significant land-use pressure, particularly due to the conversion of green open spaces into residential and commercial land, as indicated by land-use inconsistencies reaching approximately 20% compared to RTRW zoning. The location of the study area in Salatiga City is shown in Figure 1.

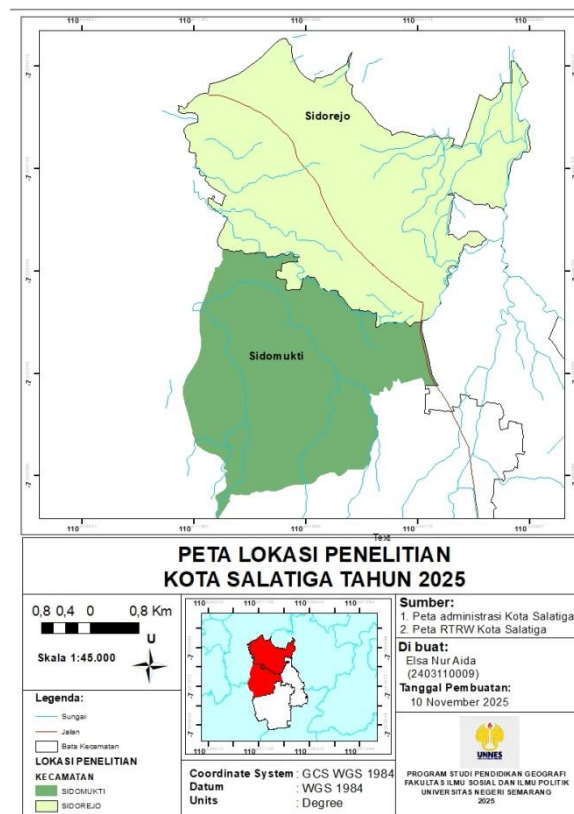


Figure 1 Location of the study area in Salatiga City

The population of this study consists of stakeholders and community representatives involved in land use activities and spatial planning in areas surrounding protected natural zones in the Sidorejo and Sidomukti sub-districts, Salatiga City. The sample was determined using purposive sampling, focusing on respondents with relevant knowledge, experience, or involvement in spatial planning, land use practices, or environmental management.

A total of 100 respondents participated in the study, including local stakeholders, community representatives, and experts representing the quantitative component of the research. This sample size was considered adequate, as the study emphasizes strategic assessment rather than statistical generalization, which is appropriate for SWOT and QSPM analysis in spatial planning research.

Data were collected from both primary and secondary sources. Primary data were obtained through questionnaires distributed to respondents and supported by field

observations and stakeholder interviews. Secondary data were collected from RTRW documents, land use maps, and institutional reports from relevant agencies.

Data analysis in this study was conducted through several integrated stages to formulate priority strategies for strengthening RTRW-based land use control through disaster education. First, spatial analysis was applied to assess the conformity between existing land use and RTRW zoning in protected natural areas. A spatial overlay technique was used to compare actual land use conditions with designated protected zoning functions. This analysis identified land use deviations, spatial inconsistency patterns, and potential disaster risk implications resulting from land use change.

Internal and external strategic factors were identified based on questionnaire responses, stakeholder interviews, and document analysis. Internal factors include strengths and weaknesses related to spatial planning implementation, institutional capacity, and disaster education practices. External factors consist of opportunities and threats associated with policy frameworks, socio-economic dynamics, and environmental conditions. These factors were quantitatively evaluated using the IFE and EFE matrices by assigning weights and ratings to each factor. Weighted scores were calculated to determine the strategic significance of each variable.

SWOT analysis was employed to examine the interaction between internal and external factors. Based on this interaction, alternative strategies were formulated into four categories: Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threat (ST), and Weakness–Threat (WT). The total weighted scores from the IFE and EFE matrices were then plotted into the Internal–External (IE) Matrix to determine the strategic position of the study area and identify whether growth, stability, or defensive strategies were most appropriate. Finally, the QSPM was used to prioritize the alternative strategies generated from the SWOT analysis. Each strategic factor was assigned an Attractiveness Score (AS) ranging from 1 to 4 based on the relative effectiveness of each strategy. The AS values were multiplied by the corresponding factor weights to obtain the Total Attractiveness Score (TAS). Strategies with higher TAS values were prioritized as the most effective recommendations for integrating disaster education into RTRW-based land use control in protected natural areas of Salatiga City.

The research instrument used in this study was a structured questionnaire designed to identify internal and external strategic factors influencing the integration of disaster education into the implementation of the RTRW. The instrument consisted of 16 items systematically divided into two dimensions: IFE and EFE. Internal factors included 8 items representing strengths and weaknesses, while external factors consisted of 8 items representing opportunities and threats. Each item was developed based on indicators related to spatial planning implementation, institutional capacity, and disaster education, ensuring alignment with the research objectives.

All questionnaire items were measured using a four-point Likert scale to assess the level of importance and influence of each strategic factor based on expert judgment. The scale ranged from 1 to 4, where 1 indicated very low or not important, and 4 indicated very high or very important. This measurement enabled the quantification of qualitative assessments for further analysis using IFE, EFE, SWOT, and QSPM approaches.

To ensure instrument validity, content validity was assessed using Aiken's *V* coefficient through expert judgment involving academics and practitioners in spatial planning and disaster management. The results show that Aiken's *V* value was 0.83, exceeding the acceptable threshold ($V > 0.80$). This indicates a high level of agreement among experts and confirms that all questionnaire items are valid and relevant for measuring the intended constructs. Instrument reliability was evaluated using Cronbach's alpha coefficient to measure internal consistency. The analysis produced a Cronbach's alpha value of 0.87, indicating high reliability. Therefore, the instrument is considered both valid and reliable for identifying internal and external strategic factors in this study. To enhance

methodological clarity, the overall research process is summarized in the following flow description and illustrated in Figure 2.

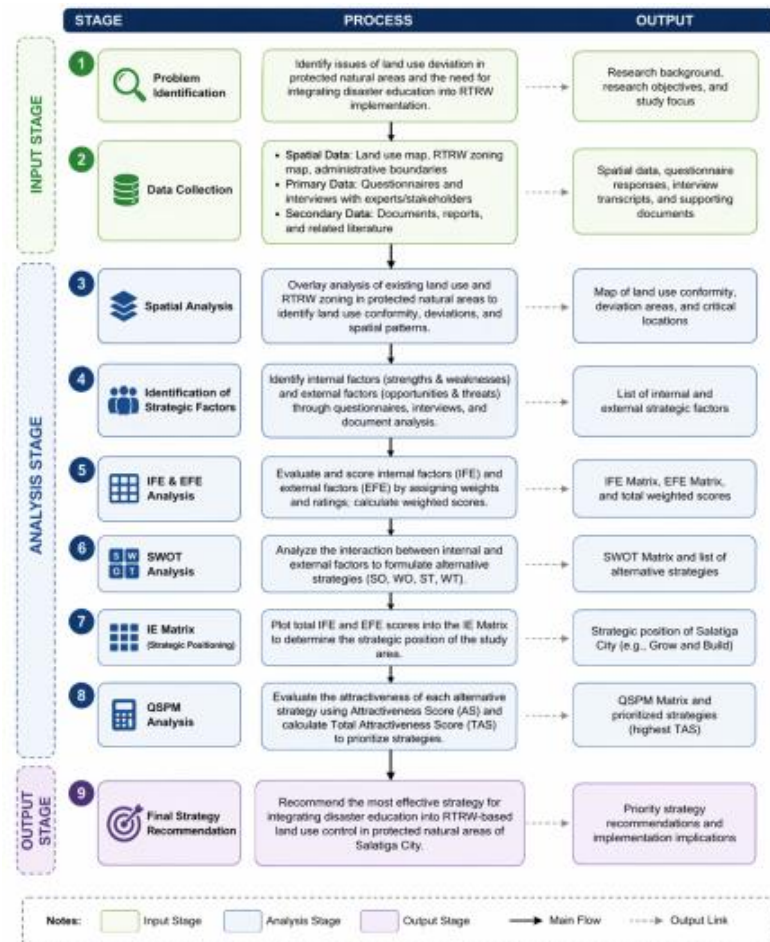


Figure 2 Research flowchart

The research was conducted through several sequential stages. First, problem identification was carried out to examine land use deviations in protected natural areas and the need to integrate disaster education into RTRW implementation. Second, data collection was undertaken, including spatial data (land use maps and RTRW zoning), as well as primary data obtained through questionnaires and stakeholder interviews. Third, spatial analysis was performed using an overlay technique to assess the conformity between existing land use and the RTRW zoning and to identify spatial patterns of deviation and potential risk areas.

Subsequently, internal and external strategic factors were identified based on the collected data and evaluated using the IFE and EFE matrices. These factors were then analyzed using SWOT analysis to formulate alternative strategies, which were further positioned within the Internal–External (IE) Matrix to determine the appropriate strategic orientation. Finally, the QSPM was applied to prioritize the most effective strategies, resulting in recommendations for integrating disaster education into the RTRW-based land use control in protected natural areas of Salatiga City.

RESULT AND DISCUSSION

Analysis of Existing Land Use and RTRW Zoning Conformity

Spatial analysis was conducted to examine the conformity between existing land use and the RTRW zoning in protected natural areas of Salatiga City. The analysis was performed using a Geographic Information System (GIS) approach, applying an overlay technique between the land use map and RTRW zoning map at a scale of 1:25,000. Spatial data were obtained from official regional planning documents and satellite-based land use classification.

The overlay process involved reclassification of land use categories and zoning functions into comparable classes, followed by spatial intersection analysis to identify areas of conformity and deviation. Land use types were categorized into forest vegetation, agricultural land, mixed gardens, and built-up areas, while RTRW zoning was classified based on ecological protection functions. The results were quantified by calculating the area and percentage of each land use category within protected zones using spatial analysis tools. This approach enabled the identification of spatial inconsistency patterns, particularly the distribution and concentration of built-up areas within designated protection zones. The composition of land use in protected natural areas is shown in Table 1.

Table 1 Land use composition in protected natural areas

Land use Type	Area (Ha)	Percentage (%)
Forest Vegetation	432.5	48.3
Agricultural Land	289.7	32.4
Mixed Gardens	96.4	10.8
Built-up Areas	76.8	8.5
Total	895.4	100

Table 1 shows that forest vegetation (48.3%) and agricultural land (32.4%) remain the dominant land use types within protected natural areas of Salatiga City, indicating that conservation functions are still partially maintained. However, the presence of built-up areas covering 8.5% of the total area reflects early signs of land use deviation within zones designated for environmental protection.

A more detailed spatial overlay (Figure 3) reveals that these deviations are not randomly distributed but tend to concentrate in specific critical locations, particularly along road corridors and in areas with higher accessibility. Clusters of built-up land are mainly found in the transitional zones between protected and developed areas, especially in parts of Sidomukti and Sidorejo Subdistricts, where urban expansion pressure is more pronounced. This pattern indicates a linear and edge-expansion spatial trend, where development gradually encroaches into protected zones from adjacent urban areas. Such spatial dynamics suggest that accessibility and proximity to urban centers are key drivers of land use change, increasing the risk of further encroachment if not effectively controlled.

The spatial conformity map (Figure 3) illustrates the distribution of land use relative to RTRW zoning in the protected natural areas of Sidorejo and Sidomukti. The legend differentiates protected zones from built-up land, enabling identification of spatial inconsistencies. The map indicates that several areas designated as protected zones have been converted into residential and commercial uses, particularly in zones with high accessibility and proximity to urban centers. This spatial pattern suggests that development pressure tends to concentrate in strategically located areas, resulting in deviations from RTRW zoning. These findings confirm that land-use change is not randomly distributed but follows accessibility and economic drivers, which increases environmental vulnerability, especially in hilly areas prone to landslides and flooding.

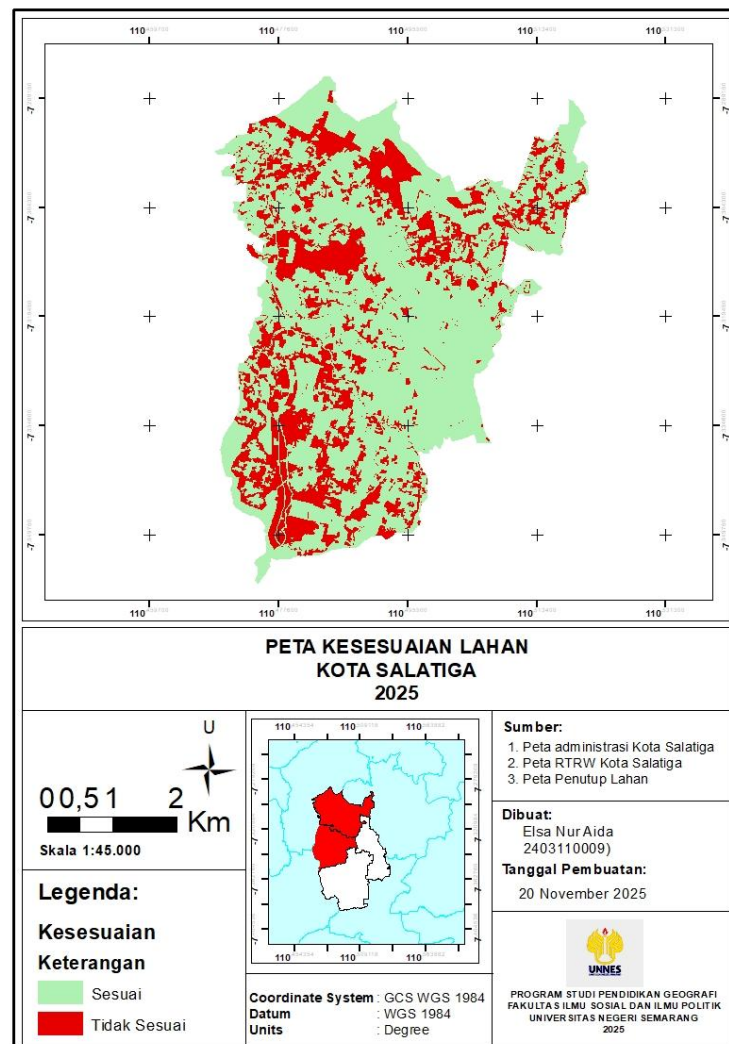


Figure 3 Study area and spatial conformity map of land use to RTRW zoning in Salatiga City (Sidorejo and Sidomukti)

The overlay analysis reveals that approximately 20% of land use is inconsistent with RTRW zoning. The majority of these inconsistencies occur in areas originally designated as protected zones but currently utilized for built-up purposes. This indicates weak spatial control and insufficient enforcement of zoning regulations. From an environmental perspective, such deviations reduce ecological functions, including water infiltration capacity and slope stability, thereby increasing disaster risk. These findings are consistent with previous studies highlighting that urban expansion often leads to the conversion of environmentally sensitive areas (UNESCO, 2017; UNISDR, 2015; Birkmann et al., 2013).

Implications of Land Use Inconsistency for Disaster Risk

The conversion of protected land into built-up areas reduces infiltration capacity, alters surface runoff patterns, and weakens slope stability. These changes increase the susceptibility of protected areas to environmental hazards such as flooding and landslides. The spatial pattern identified in Figure 3 confirms that land use deviation follows accessibility-driven development trends. This indicates that areas with higher accessibility are more vulnerable to uncontrolled land conversion, which may further intensify disaster

risk if spatial planning regulations are not effectively enforced. In the long term, this condition may reduce the effectiveness of protected areas as ecological buffers, thereby weakening the overall resilience of the urban environment.

Identification of Internal and External Strategic Factors

Strategic factors influencing the integration of disaster education into RTRW implementation were identified through stakeholder assessment and structured questionnaires.

Table 2 Summary of internal and external factors

Factor Category	Average Score	Weight	Rating	Score
Strengths (S)	3.35	0.25	4	1.00
Weaknesses (W)	2.80	0.25	3	0.75
Opportunity (O)	3.40	0.25	4	1.00
Threats (T)	2.95	0.25	3	0.75
Total	-	1.00	-	3.50

Table 2 indicates that both internal and external conditions support the integration of disaster education into RTRW implementation, as reflected by the relatively high total weighted score (3.50). Strong institutional frameworks and supportive policy environments provide favorable conditions for strengthening land use control.

Among the internal factors, the highest scores are associated with the availability of spatial planning regulations and the commitment of local government institutions, which reflect strong governance capacity in supporting the RTRW implementation. Meanwhile, key external opportunities include increasing policy support for disaster risk reduction and growing public awareness of environmental issues, which further enhance the feasibility of integrating disaster education into spatial planning. These dominant factors reinforce the strategic potential for implementing proactive and education-based interventions in land use control.

Strategic Position Based on IE Matrix

Based on the IFE and EFE total scores, the study area is positioned in Cell I (Grow and Build) of the Internal–External (IE) Matrix. The position of the IE matrix is shown in Figure 4.

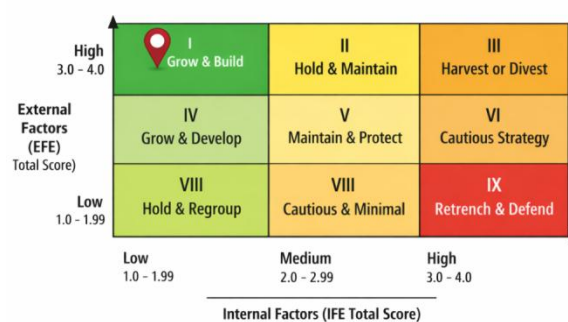


Figure 4 Internal–external (IE) matrix position

As shown in Figure 4, the strategic position of Salatiga City falls within Cell I (Grow and Build) of the IE Matrix. This position indicates that proactive strategies focusing on capacity building and institutional strengthening are appropriate.

Figure 4 presents the results of the IFE and EFE matrices, which quantify the relative importance of strategic factors influencing the integration of disaster education into RTRW implementation. The IFE results indicate that strengths such as the availability of spatial planning regulations, institutional support, and government commitment have higher

weighted scores compared to weaknesses, suggesting moderate internal capacity. However, weaknesses such as low public awareness and limited enforcement remain significant constraints.

The EFE results show that opportunities, including policy support for disaster risk reduction and increasing awareness of environmental issues, outweigh external threats. Nevertheless, threats such as urban development pressure and economic interests continue to challenge the effectiveness of spatial planning implementation. Overall, the combined IFE and EFE scores place the study area in the growth strategy category, indicating that proactive strategies should be implemented by utilizing existing strengths to maximize available opportunities, particularly through strengthening disaster education and improving spatial awareness.

Priority Strategy Formulation Using Quantitative Strategic Planning Matrix (QSPM)

The SWOT analysis reveals that the integration of disaster education into RTRW implementation is influenced by both internal and external factors. Strategies are categorized into four groups SO, WO, ST, and WT, each reflecting different strategic approaches based on the interaction between strengths, weaknesses, opportunities, and threats. Among these, SO strategies are considered the most dominant, indicating that leveraging institutional strengths to capitalize on external opportunities provides the most effective approach for improving spatial compliance. Priority strategies based on the QSPM are shown in Table 3.

Table 3 Priority strategies based on QSPM

Rank	Strategy Code	Strategic Focus	Total Attractiveness Score (TAS)
1	SO1	Disaster education based on RTRW zoning and spatial evidence	6.42
2	SO2	Integration of spatial technology into disaster education	5.87
3	SO3	Multi-stakeholder collaboration in spatial education	5.33
4	SO4	Development of conservation-based education centers	4.95

Table 3 demonstrates that Strategy SO1 achieved the highest Total Attractiveness Score (6.42), indicating its priority over other strategic alternatives. This result suggests that disaster education grounded in RTRW zoning and spatial evidence is the most effective approach for strengthening land use control in protected natural areas.

The QSPM results further indicate that the highest priority strategy is strengthening the integration of disaster education into RTRW implementation through community-based spatial literacy programs and stakeholder collaboration, with the highest TAS. This suggests that strengthening disaster education through community-based programs and spatial literacy initiatives is the most effective approach to improving compliance with spatial regulations. This finding confirms that education-based interventions are not only complementary but also play a central role in bridging the gap between spatial policy and land use behavior.

The findings reveal a persistent gap between formal spatial planning regulations and actual land use practices in protected natural areas of Salatiga City. Although the RTRW provides a regulatory framework for environmental protection, its effectiveness is constrained by limited public awareness and compliance. The occurrence of built-up areas within protected zones indicates that regulatory enforcement alone is insufficient, particularly under increasing development pressure driven by accessibility. This supports previous studies that highlight the limitations of regulation-centered spatial governance in rapidly developing urban areas.

From an ecological perspective, land conversion within protected areas reduces key environmental functions, including water infiltration, runoff regulation, and slope stability,

thereby increasing disaster vulnerability. These findings reinforce earlier research emphasizing the strong linkage between land use change and disaster risk, particularly in peri-urban environments where ecological boundaries are increasingly contested.

The strategic analysis offers a more integrative perspective by identifying disaster education as a priority intervention within RTRW implementation. The “Grow and Build” position in the IE Matrix indicates favorable conditions for proactive strategies, while QSPM results confirm that education based on spatial zoning and empirical evidence is the most effective approach. This aligns with recent studies suggesting that knowledge-based compliance enhances community participation and strengthens environmental governance.

Compared to prior research that primarily emphasizes regulatory enforcement and institutional control, this study highlights the role of disaster education as a mechanism to bridge policy and behavior. This finding extends spatial governance theory by demonstrating that effective land use control requires not only formal regulations but also behavioral transformation through improved spatial literacy.

In addition, the findings underline the importance of participatory governance. Disaster education facilitates community engagement, enabling stakeholders to better understand spatial regulations and contribute to monitoring land use practices. This supports resilience-based approaches that view community participation as essential for adaptive governance in environmentally sensitive areas.

Finally, integrating disaster education into RTRW implementation offers a preventive approach to disaster risk reduction. Unlike reactive strategies, education-based interventions influence land use decisions at an earlier stage, aligning with sustainable resilience frameworks that prioritize preparedness and risk-informed planning (UNESCO, 2017; Shaw et al., 2022). From a policy perspective, this integration also encourages stronger collaboration between planning agencies, educational institutions, and communities, thereby enhancing the long-term effectiveness of spatial governance.

This study provides both theoretical and practical implications. Theoretically, it contributes to spatial governance literature by integrating behavioral and educational dimensions into spatial planning frameworks. Practically, the findings highlight the need for policymakers to incorporate disaster education into RTRW implementation as a non-structural strategy to enhance public compliance. This includes strengthening spatial literacy, community participation, and institutional coordination. Furthermore, the results suggest that spatial planning effectiveness cannot rely solely on regulatory instruments but must be supported by continuous education and awareness-building initiatives. This finding emphasizes that spatial planning effectiveness depends not only on regulatory enforcement but also on behavioral compliance supported by education and awareness.

CONCLUSION

Land use in the protected natural areas of Salatiga City is not fully aligned with the RTRW, as indicated by the presence of built-up areas within ecological protection zones. This reflects early-stage land use deviation driven by development pressure, which may reduce ecological capacity and increase disaster risk. These findings highlight the limitations of regulatory-based control and the need for more adaptive and participatory approaches. Strategic analysis using IFE, EFE, IE Matrix, and QSPM shows that integrating disaster education into RTRW implementation is a priority strategy. The grow and build position supports proactive measures, while QSPM results emphasize education-based interventions to improve spatial awareness and influence land-use behavior. This study positions disaster education as a bridge between spatial policy and community practice, enhancing spatial literacy and compliance. However, limitations include a limited number of expert respondents, constraints in spatial data quality, and potential subjectivity in expert judgment. Future research should expand data sources and apply more objective approaches to strengthen reliability.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, ENA and H; methodology, ENA and H; formal analysis, ENA; investigation, ENA; data curation, ENA; writing-original draft preparation, ENA; writing-review and editing, H, EB, RH, and ES; supervision, H; validation, EB, RH, and ES.

AI DISCLOSURE STATEMENT

The authors used an artificial intelligence-based writing assistant during manuscript preparation for language editing and organization. After using the tool/service, the author thoroughly reviewed and edited the content as needed and takes full responsibility for the content of the publication.

ACKNOWLEDGMENTS

The authors would like to express sincere gratitude to Universitas Negeri Semarang for academic support during this research. Special appreciation is extended to Hariyanto for supervision and academic guidance throughout the research process. The authors also thank Eva Banowati, Rahma Hayati, and Erni Suharni for their valuable evaluation, suggestions, and academic feedback. Appreciation is further extended to the stakeholders and respondents in Salatiga City who contributed important information and participated in the data collection process.

REFERENCES

- Asian Development Bank. (2018). *Strengthening spatial planning for disaster risk reduction*. Asian Development Bank. <https://doi.org/10.22617/TCS189655>
- Banowati, E. (2018). Perencanaan wilayah dan pengendalian pemanfaatan ruang perkotaan. *Jurnal Geografi*, 15(1), 1–10.
- Banowati, E., & Hayati, R. (2019). Implementasi kebijakan tata ruang dalam pengendalian pemanfaatan lahan perkotaan. *Jurnal Wilayah dan Lingkungan*, 7(2), 85–98.
- Birkmann, J., Cardona, O. D., Carreño, M. L., Barbat, A. H., Pelling, M., Schneiderbauer, S., & Welle, T. (2013). Framing vulnerability, risk and societal responses: The MOVE framework. *Natural Hazards*, 67(2), 193–211. <https://doi.org/10.1007/s11069-011-9824-5>
- BNPB. (2021). *Indeks risiko bencana Indonesia*. Badan Nasional Penanggulangan Bencana.
- Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster resilience indicators for benchmarking baseline conditions. *Global Environmental Change*, 20(4), 598–606. <https://doi.org/10.1016/j.gloenvcha.2010.07.005>
- Djalante, R., Thomalla, F., Sinapoy, M. S., & Carnegie, M. (2013). Building resilience to natural hazards in Indonesia: Progress and challenges. *Natural Hazards*, 69(1), 1–25. <https://doi.org/10.1007/s11069-013-0706-0>
- Guneralp, B., Reba, M., Hales, B. U., Wentz, E. A., & Seto, K. C. (2021). Trends in urban land expansion. *Nature Sustainability*, 4(3), 184–193. <https://doi.org/10.1038/s41893-020-00672-2>
- Hariyanto. (2017). Peran rencana tata ruang wilayah dalam mitigasi bencana di wilayah rawan longsor. *Jurnal Geografi*, 14(2), 101–112.
- Hayati, R. (2020). Implementasi RTRW dalam pengendalian pemanfaatan lahan kawasan lindung. *Jurnal Tata Ruang*, 12(1), 45–57.
- Irwansyah, A. I. (2021). Integrasi pendidikan kebencanaan dalam perencanaan tata ruang wilayah. *Jurnal Tata Ruang*, 13(2), 67–78.

- Juhadi. (2018). Dinamika perubahan penggunaan lahan dan implikasinya terhadap lingkungan perkotaan. *Forum Geografi*, 32(1), 1–12.
- Kurniawan, E. (2020). Pendidikan kebencanaan sebagai instrumen pengurangan risiko bencana berbasis wilayah. *Jurnal Pendidikan Geografi*, 25(1), 45–56.
- Lee, S., & Kim, J. (2023). Strategic spatial planning and decision-making tools in urban management. *Sustainability*, 15(4), 3121. <https://doi.org/10.3390/su15043121>
- Lestari, P., Ramadhaniyanto, B., & Wardyaningrum, D. (2018). Komunikasi kebencanaan dalam masyarakat berisiko. *Jurnal Ilmu Sosial dan Ilmu Politik*, 22(1), 1–15.
- Li, X., Zhou, Y., & Eom, J. (2022). Urban expansion and transport accessibility. *Landscape and Urban Planning*, 222, 104395. <https://doi.org/10.1016/j.landurbplan.2022.104395>
- Mardiatno, D. (2019). Pengurangan risiko bencana berbasis tata ruang dan masyarakat. *Jurnal Kebencanaan Indonesia*, 5(2), 75–88.
- Mensah, J. T., Adu, G., & Amoah, A. (2022). Urban land-use planning challenges. *Land Use Policy*, 112, 105804. <https://doi.org/10.1016/j.landusepol.2021.105804>
- Muta'ali, L. (2015). *Teknik analisis regional untuk perencanaan wilayah, tata ruang, dan lingkungan*. Badan Penerbit Fakultas Geografi UGM.
- Nugroho, A., & Pramono, R. (2021). Kesesuaian pemanfaatan lahan terhadap RTRW di kawasan lindung perkotaan. *Jurnal Perencanaan Wilayah dan Kota*, 32(1), 23–35.
- OECD. (2020). *Land-use planning for resilient cities*. OECD Publishing. <https://doi.org/10.1787/eea7c9a8-en>
- Oliveira, E., & Hersperger, A. (2021). Governance in spatial planning. *Progress in Planning*, 145, 100436. <https://doi.org/10.1016/j.progress.2019.100436>
- Pelling, M., O'Brien, K., & Matyas, D. (2021). Adaptation and resilience. *Global Environmental Change*, 68, 102253. <https://doi.org/10.1016/j.gloenvcha.2021.102253>
- Rahman, M. M., Hickey, G. M., & Ford, J. D. (2021). Participatory planning and resilience. *Climate Risk Management*, 33, 100324. <https://doi.org/10.1016/j.crm.2021.100324>
- Republik Indonesia. (2007). *Undang-Undang Republik Indonesia Nomor 26 Tahun 2007 tentang Penataan Ruang*. Lembaran Negara Republik Indonesia Tahun 2007 Nomor 68.
- Saputra, R., & Nugroho, A. (2020). Kesesuaian pemanfaatan lahan terhadap RTRW di kawasan lindung. *Jurnal Perencanaan Wilayah dan Kota*, 31(3), 211–223.
- Setiawan, B. (2018). Tata ruang dan mitigasi bencana di wilayah perkotaan Indonesia. *Jurnal Wilayah dan Lingkungan*, 6(2), 89–102.
- Seto, Karen C., Güneralp, B., & Hutyra, L. R. (2020). Global forecasts of urban expansion. *Proceedings of the National Academy of Sciences*, 117(13), 7194–7200. <https://doi.org/10.1073/pnas.1904882117>
- Shaw, R., Takeuchi, Y., & Shiwa, K. (2022). Disaster education and resilience. *International Journal of Disaster Risk Reduction*, 75, 102970. <https://doi.org/10.1016/j.ijdr.2022.102970>
- Suharini, E. (2019). Pengendalian pemanfaatan ruang sebagai instrumen mitigasi bencana wilayah. *Jurnal Perencanaan Wilayah dan Kota*, 30(2), 101–112.
- Sugiyono. (2019). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.
- Surono. (2016). Pendidikan kebencanaan sebagai bagian dari mitigasi bencana. *Jurnal Pendidikan Geografi*, 21(2), 89–98.
- UNESCO. (2017). *Education for disaster risk reduction and resilience*. UNESCO.
- UNISDR. (2015). *Sendai framework for disaster risk reduction 2015–2030*. United Nations.
- World Bank. (2019). *Integrating disaster risk management into spatial planning*. World Bank.
- World Bank, & GFDRR. (2021). *Urban resilience and land-use planning*. World Bank.

AUTHOR PROFILES



Name: Elsa Nur Aida

Email: elsanuraida064@students.unnes.ac.id

Affiliation: Master's Program in Geography Education, Faculty of Social and Political Sciences, Universitas Negeri Semarang, Semarang, Indonesia

Expertise: Spatial Planning, Land Use Control, Disaster Risk Reduction, Geography Education

Google Scholar: Elsa Nur Aida

Orchid: <https://orcid.org/0009-0006-8159-3355>



Name: Hariyanto

Email: hariyantogeo@mail.unnes.ac.id

Affiliation: Master's Program in Geography Education, Faculty of Social and Political Sciences, Universitas Negeri Semarang, Semarang, Indonesia

Expertise: Rural Environment, Geography of Urban and Rural

Google Scholar: Hariyanto

Sinta: 6012187

<https://sinta.kemdiktisaintek.go.id/authors/scopusanalysis/6012187>



Name: Eva Banowati

Email: evabanowatigeografi@mail.unnes.ac.id

Affiliation: Master's Program in Geography Education, Faculty of Social and Political Sciences, Universitas Negeri Semarang, Semarang, Indonesia

Expertise: Social Geography, Community Empowerment

Google Scholar: Eva Banowati

Sinta: 5985538

Orchid: <https://orcid.org/0000-0002-7012-1778>

<https://www.scopus.com/authid/detail.uri?authorId=57195296290>



Name: Rahma Hayati

Email: rahmahayati72@mail.unnes.ac.id

Affiliation: Master's Program in Geography Education, Faculty of Social and Political Sciences, Universitas Negeri Semarang, Semarang, Indonesia

Expertise: Urban Planning, Coastal Management, Agricultural Geography, Food Security

Google Scholar: Rahma Hayati

Sinta: 6011500

<https://www.scopus.com/authid/detail.uri?authorId=57377214500>



Name: Erni Suharini

Email: erni.suharini@mail.unnes.ac.id

Affiliation: Master's Program in Geography Education, Faculty of Social and Political Sciences, Universitas Negeri Semarang, Semarang, Indonesia

Expertise: Disaster Management, Geomorphology, Disaster Education

Google Scholar: Erni Suharini

Sinta: 5977973

Orchid: <https://orcid.org/0000-0003-1793-6596>

<https://www.scopus.com/authid/detail.uri?authorId=57204144187>