

A MULTICRITERIA EVALUATION USING THE ANALYTIC HIERARCHY PROCESS AND CORRELATION TECHNIQUES TO ANALYZE THE SUSTAINABILITY OF LAND-USE PLANNING: A CASE STUDY IN PHU QUOC ISLANDS, VIETNAM

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Received: 2 January 2025 / **Accepted:** 22 May 2025

Abstract

Minh V.Q., Dinh L.C., Ngan N.H.N., Dang P.C.: A multicriteria evaluation using the analytic hierarchy process and correlation techniques to analyze the sustainability of land-use planning: a case study in Phu Quoc Islands, Vietnam. *Ekológia (Bratislava)*, Vol. 44, No. 2, p. 196–204, 2025.

The Multicriteria Evaluation uses the Analytic Hierarchy Process (AHP-MCE) technique to analyze and determine factors affecting land-use plan implementation results from 2015 to 2023 to propose a solution to improve the effectiveness of land-use plan implementation. The case study is in Phu Quoc City, Kien Giang Province. The study collects data on the current land-use plans. Statistically, it analyzes the correlation between current land-use plans and implementation results, combining interviews and AHP analysis. The results show that agricultural land has decreased and non-agricultural land has increased from 2015 to 2023. The City has increasingly effectively implemented land-use plans. The study identified four level 1 factors (natural conditions, economy, society, and policy) and twenty-one level 2 factors. Natural conditions have the highest weight ($W = 0.46$), and the level 2 factor of geographical location has the most significant impact (overall weight $W = 0.192$). In addition, the study proposed solutions based on the impact factors to improve the effectiveness of implementing the land-use plan for Phu Quoc City.

Key words: planning, implementation, regression, assessment.

Introduction

According to Dent (1981), land-use planning is a means of helping leaders decide how to use land through systematic evaluation for selecting patterns in land use, in which this choice will meet specific objectives and from there form policies and programs for land use. According to Tri (2010), the goal of planning is defined as “how to make the best use of land and can be divided into specific features of each project. The goal of planning can be summarized in 3 headings: efficiency, equity – acceptability and sustainability”. Nowadays, the social movement process changes rapidly, and the country’s development orientations and policies are increasingly innovated to suit the current land-use needs of the people and ensure that resources are used sustainably and long term.

According to the National Assembly (2018), land-use planning must be consistent with the strategy and plan for socioeconomic development, national defense, and security. Land-use planning must be consistent with the land-use planning of the same level approved by competent state agencies; for provincial land-use planning, it must be consistent with the land allocation and zoning plan in the provincial planning.

Phu Quoc is an island district with development potential with highly diverse and rich natural resources. Phu Quoc’s land from 2015 to 2023 has undergone many substantial changes and has been affected by many factors. According to Resolution No. 1109/NQ-UBTVQH14 in 2020, Phu Quoc became the first island city in Vietnam. To ensure progress and complete development goals according to Decision No. 633/QĐ-TTg in 2010 and detailed regulations on several articles of the planning law of Decree 27/2019/ND-CP, Phu Quoc has had to make efforts in land management, especially in establishing and implementing planning and land-use planning. According to Huyen and Cuong (2021), from 2019 to 2021, the COVID-19 pandemic negatively impacted the socioeconomic situation. In 2023, the City’s economic growth rate was high, reaching nearly 19.6%/year, stable and sustainable. Most socioeconomic indicators increased, and the economic structure shifted in the right direction, rapidly increasing the proportion of trade services and construction industry and decreasing agriculture. Based on the above requirements, the People’s Committee of Kien Giang Province (2023) has approved the 2024 land-use plan. In particular, the land-use plan map, the appendix of project location diagrams, and technical and professional factors must be implemented by the People’s Committee of Phu Quoc City following regulations. In addition,

the remaining area in the land-use plan map must be consistent with the plan approved by the Provincial People's Committee. It requires the implementation of the land-use plan of Phu Quoc City to be managed and monitored so that the implementation results must closely follow the approved land-use plan.

The Analytical Hierarchy Process (AHP) is a multi-objective decision-making method proposed by Saaty (1979). The AHP and Multicriteria Evaluation (MCE) technique applications are widely used in decision-making to solve economic, political, social, engineering design problems, planning, conflict resolution, benefit/cost analysis, and resource allocation (Saaty, 1995).

Therefore, the study assessed the current situation and identified the factors affecting the district's advantages and difficulties in implementing land-use planning from 2015 to 2023. It then proposed solutions to contribute to effectively implementing land-use planning for the following stages.

Methods

The study area

According to the National Assembly (2020), Phu Quoc Island is in the southwest of Vietnam. Phu Quoc is 120 km from Rach Gia and 45 km from Ha Tien. Phu Quoc sea area has 22 large and small islands, of which Phu Quoc Island is the largest with an area of 580 km², 49 km long. The terrain runs gently from North to South with 99 hills and mountains. However, the small island cluster of An Thoi port is wholly separated from the southern tip of Phu Quoc Island by a strait (Fig. 1).

Phu Quoc City has nine administrative units at the commune level, including two wards, An Thoi and Duong Dong, and seven communes: Bai Thom, Cua Can, Cua Duong, Duong To, Ganh Dau, Ham Ninh, and Tho Chau.

The study's procedure

The study was conducted according to the diagram in Figure 2, including steps from data collection, processing for correlation and AHP analysis, and the proposition of solutions. Details of each step are described below.

Secondary data collection

Collect data and information related to Phu Quoc City planning. Land-use planning of Phu Quoc City and relevant official pub-

lished documents and results to support research implementation from the decision approving the 2024 Land Use Plan of Phu Quoc City, Kien Giang province (People's Committee of Kien Giang province, 2023), and Resolution on establishing Phu Quoc City and wards of Phu Quoc City, Kien Giang (National Assembly, 2020).

Expert interview method

The study conducted interviews with nine experts related to the land sector working directly at the Department of Natural Resources and Environment (DONRE) (two experts), the DONRE of Phu Quoc City (one expert), the Land Registration Office (three experts), the Branch of the Land Registration Office of Phu Quoc City (one expert), the Compensation, Support and Resettlement Board of Phu Quoc City (two experts) to identify the advantages and difficulties in the work of formulating and implementing the land-use planning. At the same time, identify factors affecting the results of the implementation of the land-use planning in Phu Quoc City in 2015–2023.

Data processing

By using an Excel program to synthesize and standardize data on planning and current land-use status for 2015–2023 of Phu Quoc City by year, usage type, and administrative unit; and the interviewed data from nine experts.

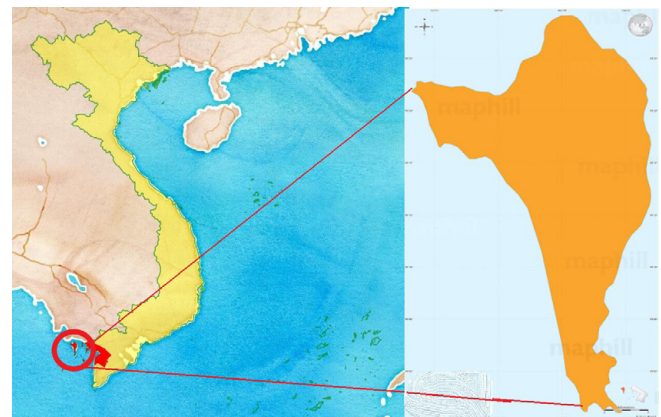


Fig. 1. Map of the study area.

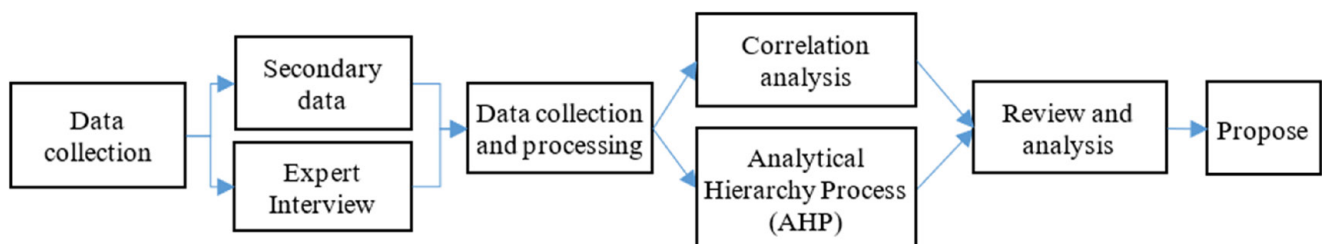


Fig. 2. Diagram of implementation steps.

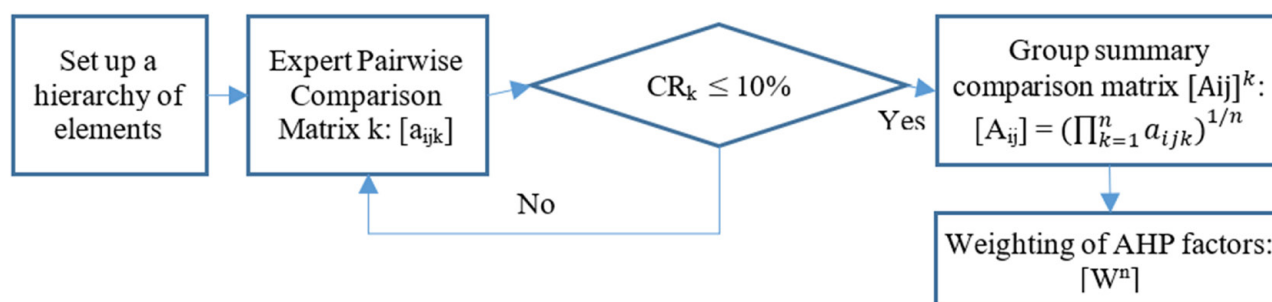


Fig. 3. AHP-GDM in determining factor weights (Source: Saaty, 1979).

Statistical analysis

The topic applies the correlation method to determine the correlation coefficient and evaluate the relationship between the current status and land-use planning in Phu Quoc City in 2016–2023. According to Gomez and Gomez (1984), the correlation coefficient r is evaluated as follows:

Pearson correlation coefficient (r) value	Strength	Direction
Greater than .5	Strong	Positive
Between .3 and .5	Moderate	Positive
Between 0 and .3	Weak	Positive
0	None	None
Between 0 and -.3	Weak	Negative
Between -.3 and -.5	Moderate	Negative

Analytical Hierarchy-Group Decision-Making (AHP-GDM) Method

The AHP is a great option for land-use appropriateness evaluations since the assessment process is considered a decision problem and a traditional procedure that provides a methodical approach to decision-making (Chandio et al., 2013). The AHP weights are the values assigned to evaluation criteria indicative of their importance relative to other criteria under consideration. It implies that the larger the weight, the more critical the criterion is in the overall utility (Drobne, Lisec, 2009; Malczewski, 2006). AHP is widely used in many applications where decision-making is required, and alternatives are available (Vaidya, Kumar, 2006), notably for land-use suitability assessments, because its qualitative qualities may be measured. The distinguishing characteristics of AHP include its consistency in judgment, logical and practical mathematical properties, and straightforward structure (Triantaphyllou, Mann, 1995). Based on the survey results of nine experts, Saaty's (1979) AHP was conducted to evaluate and compare the level of factors affecting the implementation results of land-use planning in Phu Quoc City from 2015 to 2023 (Fig. 3). It supports the decision maker in making the best decision by reducing the decision complexity to a series of pairs of comparisons and synthesizing the results.

Solution proposal method

Based on the research results on the current situation and the level of impact of factors on the implementation results of the Planning and Development Plan of Phu Quoc City, solutions will be proposed to solve difficulties and contribute to completing the Planning and Development Plan implementation in Phu Quoc City in the next phase.

Results and discussion

Assessment of the relationship between current status and land-use planning in Phu Quoc City (2015–2023)

According to resolution No. 1109/NQ-UBTVQH14 (The National Assembly, 2020), Phu Quoc Island District, as Phu Quoc City, has nine administrative units.

Agricultural land

The study determined that the correlation coefficient between the current status and the agricultural development plan has a correlation coefficient of 1% significance (Fig. 4). For 2016–2020, the implementation results closely followed the proposed agricultural development plan. Still, there were many fluctuations due to the impact of factors. In 2021–2023, the implementation results closely followed the proposed agricultural development plan, with most of the correlation values being very high, with r around 0.99**. It may be due to the positive impact of Resolution 1109/NQ-UBTVQH14, which has attracted domestic and foreign investment capital to build non-agricultural works and projects. In addition, local authorities encourage farmers to invest in and develop advanced agricultural production models that bring high economic value and protect the environment, such as ecological agricultural models associated with services and tourism.

Non-agricultural land

The correlation between the current implementation results and the non-agricultural development planning has a correlation coefficient reaching the 1% significance level (Fig. 5), specifically:

- In the period 2016–2020, the implementation results closely followed the proposed agricultural development plan; however, there were many fluctuations as follows: In 2016, the correlation coefficient was high due to the positive impact of the National Tourism Year, which created a good opportunity to promote Phu Quoc to domestic and foreign tourists. In 2017, the correlation coefficient was low due to the slow implementation of the recovery of perennial land, protective forest land, special-use forest land, and other agricultural land. In 2019, the calculated r was 0.938**, decreasing to 0.935** in 2020, showing that in 2020, the non-agricultural situation needed to be more closely following the plan (the implementation results were higher than the plan). Due to the impact of the COVID-19 pandemic in the early stages and the many rising investment capital sources of domestic and foreign enterprises, the progress of construction and development of works and projects using non-agricultural land has shown signs of slowing down. Therefore, the implementation results still need to meet the targets set out in the plan.
- Period 2021–2023: Generally, the correlation coefficient between the current status and the non-agricultural land-use plan reached a significance level of 1%. From there, the implementation results closely follow the proposed non-agricultural land-use plan. The reason is that the positive impact of Resolution 1109/NQ-UBTVQH14 has attracted domestic and foreign investment capital to build defense, security, trade-service projects, and infrastructure development, leading to a high demand for changing the purpose of agricultural land use, etc.

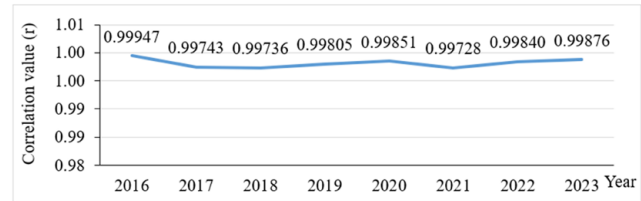
Unused land

Figure 6 shows the high correlation between the current status and the unused land-use planning, with a significance level of 1%. In 2016–2020, the implementation results closely followed the unused land-use planning, which means the unused land was not yet used in the planning. In 2016, r was calculated as 1, decreasing to 0.973** in 2020. In 2020, the area of alluvial land in Bai Thom commune was included in the unused land index according to the instructions in Circular No. 27/2018/TT-BTNMT (Vietnamese Government, 2018). The 2021–2023 period shows that the implementation results closely follow the proposed unused land-use planning. In which:

- In 2021, r is calculated as 1, decreasing to 0.979** in 2022, showing that in 2022, the current implementation status is according to land-use planning. The reason is that the alluvial land along the rivers in Bai Thom commune will still be included as unused land in 2022. Because the land-use planner and implementer have removed this from the commune's implementation plan. Then, the area was low. Therefore, the correlation coefficient in 2022 is lower than that in 2021.
- In 2022, the calculated r is 0.979**, increasing to 1 in 2023. It shows that in 2023, the current status closely follows the unused land-use plan due to the adjustment of the alluvial land area in Bai Thom commune.

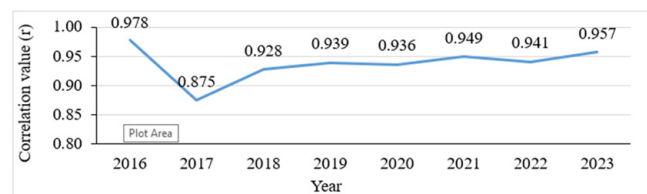
Factors affecting the implementation results of the land-use planning in Phu Quoc City, period 2015–2023

From the results of consulting experts from the AHP-MCE analysis, the study identified four level 1 factors (natural, economic, social, and policy conditions) and twenty-one level 2 factors af-



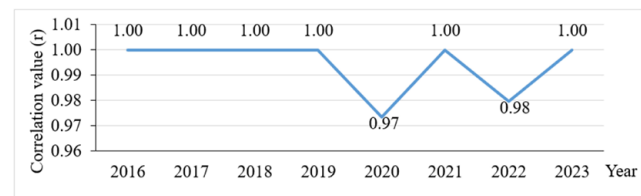
(Significance level 1%: r table (2016–2020) = 0.765, r calculated 2016 = 0.999**, 2017 = 0.997**, 2018 = 0.997**, 2019 = 0.998**, 2020 = 0.998**, n (2016–2020) = 10; r table (2021–2023) = 0.798, r calculated 2021 = 0.997**, 2022 = 0.998**, 2023 = 0.998**, n (2021–2023) = 9)

Fig. 5. Correlation between planning and current status of non-agricultural land (2016–2023).



(Significance level 1%: r table (2016–2020) = 0.765, r calculated 2016 = 0.997**, 2017 = 0.874**, 2018 = 0.927**, 2019 = 0.938**, 2020 = 0.935**, n (2016–2020) = 10; r table (2021–2023) = 0.798, r calculated 2021 = 0.949**, 2022 = 0.940**, 2023 = 0.956**, n (2021–2023) = 9)

Fig. 4. Correlation between planning and current status of agricultural land (2016–2023).



1% significance level: r table (2016–2020) = 0.76; r table (2021–2023) = 0.798; r calculated: 2016 = 1; r = 1; 2018 = 1; 2019 = 1; 2020 = 0.9735**, 2021 = 1; 2022 = 0.9797**;
2023 = 1, n (2016–2020) = 10, n (2021–2023) = 9

Fig. 6. Correlation between planning and current status of unused land (2016–2023).

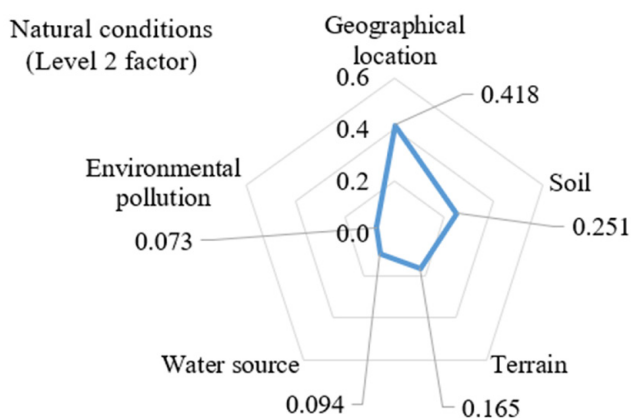
fecting land-use planning (Table 1). It is closely related to the recommended factors from Thong et al. (2021). The impact of each factor is demonstrated below.

Impact level of level 1 factors

The natural condition factor is assessed to have the highest impact level ($W = 0.46$). According to experts, for the implementation results to closely follow the land-use planning, it is neces-

Table 1. List of factors affecting the land-use plan in the study area.

Level 1	Level 2
Nature	Geographical location
	Soil
	Terrain
	Water source
	Pollution status
Economy	State budget
	Production cost
	Consumer market
	Profit
	Financial capacity of the implementing unit
Society	Level, technique, farming means
	Labor force
	Individual households using land
	Team to establish and implement the land-use planning
	The land management and inspection team
Policy	Project investor
	Consistency between policies and laws
	Policy on handling violations of law
	Investment attraction policy
	Tax policy
	Agricultural policy

**Fig. 7.** Weights of level 1 factors.**Fig. 8.** Weights of level 2 factors on natural conditions.

sary to be suitable for natural conditions (Fig. 7). Because Phu Quoc is independent of the mainland (does not receive water from upstream and other areas), the dry season, although short, has caused drought and a lack of fresh water for production and daily life in some areas. In addition, the resources in the area are sensitive to environmental changes, so special attention should be paid to maintaining and protecting them.

Economic factors ($W = 0.329$) are assessed to powerfully impact the results of implementing land-use planning. Typically, in the agricultural production model, for the production unit to gain profit, it is necessary to have a consumption market not only on the island but also on the mainland, so it is necessary to have investment capital and consider the costs incurred during the production process. For the non-agricultural model, economic factors such as reasonable investment capital are essential for construction and development on schedule and ensuring the quality of works and projects.

Social factors ($W = 0.142$) have a medium impact on agricultural and non-agricultural production; gender equality, working age, human resources, and qualifications are of concern in development orientation and social security. Human resources with high professional qualifications are necessary for the land management sector in Phu Quoc City today.

The policy factor ($W = 0.069$) is assessed to have little impact because district officials and people's compliance with land law is improving. Compared to the remaining factors, it has little impact on implementing the land-use plan in Phu Quoc.

Level of impact of secondary factors

According to Figure 8, the natural conditions have the geographical location factor with the highest impact level ($W = 0.418$) due to the distance from the mainland, complex transportation, and limited infrastructure and socioeconomics. Next, the soil factor ($W = 0.251$) takes advantage of the land fund suitable for agricultural development to produce products for tourism (growing vegetables, flowers, fruit trees, etc.) and aims at high-tech agricultural production, increasing the quality and value of products. In addition, the focus should be on protecting forests and green areas to maintain and protect water resources and limit local flooding. The terrain factor ($W = 0.165$) indicates that areas with an elevation < 5 m are often low-lying grasslands distributed along large canals such as Dam Canal, Cua Can Canal, Duong Dong Canal, etc. These areas can be exploited and improved to grow vegetables, vegetables, coconuts, and fruit trees. Areas with an altitude of 5–40 m are usually flat or undulating, suitable for growing pepper, cashew, and fruit trees; the remaining areas, due to high terrain and steep slopes, are suitable for forest development. Climate is also a significant factor that determines land use. Furthermore, the water source factor is considered more important than soil and relief conditions in determining the potential of an area (Koçman, 1993) since it is impossible to ignore the water source factor ($W = 0.094$) because for agricultural production, unlike areas on the mainland, the water source used for agricultural cultivation in Phu Quoc is a problem, especially in the dry season when there is a severe shortage of fresh water.

Finally, there is the pollution factor ($W = 0.073$). The reason experts assess this factor to have a low level of impact because authorities at all levels have a high awareness of environmental protection, so the soil, water, and air environment of the islands

are still quite good. Hence, this factor has little impact on the implementation of the land-use planning in the area.

In Figure 9, the policy with the state budget factor has the highest level of impact ($W = 0.375$) on the implementation of the land-use planning in Phu Quoc City, which is being invested in and developed by sectors and levels to become one of the three special administrative-economic units in the country. The production cost factor ($W = 0.27$) has a substantial impact because the production cost in the area is easily affected by factors such as geographical location, climate change, and development orientation, leading to increased production cost factors to meet needs such as transporting goods, purchasing fertilizers and pesticides for crops, building freshwater reservoirs, digging wells, and investing in production equipment. Consequently, profits in the agricultural land cultivation model decrease. According to experts, the consumption market factor ($W = 0.188$) is assessed to have a high level of impact because it promotes and generates income for the area not only from agricultural land products and ecotourism models. In addition, real estate in the area is also of interest to many investors and consumers. It is impossible not to pay attention to the profit factor ($W = 0.103$) because experts believe that when implementing the planning, unreasonable land-use planning leads to low profits from land use, which people find it challenging to trust in implementing the plan or there is a problem of arbitrarily changing the land-use purpose illegally because the immediate profit is higher. Finally, the financial capacity factor of the implementing unit ($W = 0.063$); the reason experts assess this factor to have little impact because there are legal documents and policies clearly and strictly regulating the investment capital of public service units, so it has little impact on the implementation of land-use planning in Phu Quoc City.

The results of the weighting of the secondary social factors (Fig. 10) show that experts believe that the factor of qualifications, techniques, and means of cultivation is the factor with the highest impact ($W = 0.336$) on implementing the land-use plan in Phu Quoc City. When the consumption market expands, it leads to increased demands not only for agricultural products on productivity and crop quality and but also for real estate developments such as coastal resorts, townhouses, shophouses, etc., in Phu Quoc City, which attract both domestic customers and foreign customers. Therefore, it is necessary to improve and enhance professional qualifications and techniques and to apply advanced scientific and technological methods and modern means. The next factor that experts assess to have a reasonably strong impact is the labor force factor ($W = 0.242$) due to the volume and nature of work in the field of land management in the City. Phu Quoc has many problems and requires high experience and expertise to solve problems such as in the management of records, the number of records for granting certificates of land-use rights and changing land-use purposes is still significant and has not been wholly processed; the rate of handling petitions and complaints is still low, affecting the quality of administrative procedure reform of the City. However, the human resources need to be increased, leading to errors and delays in the planning and implementation.

The survey results of experts show that the factor of individual households using land ($W = 0.17$) is assessed to have a substantial impact. Due to the attraction of high profits, people are willing to change the purpose of using land registered with the manager, encroaching on land, transferring land in violation

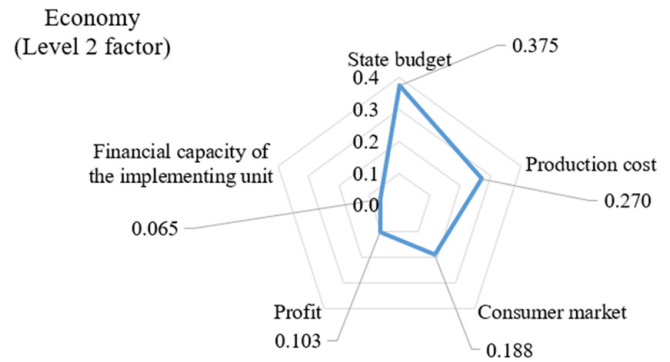


Fig. 9. Weights of secondary economic factors.

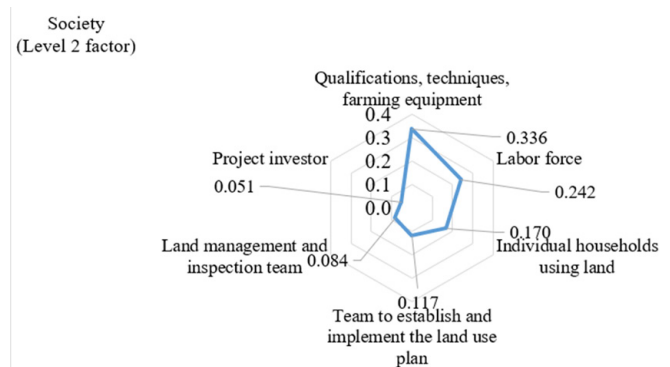


Fig. 10. Weights of level 2 social factors.

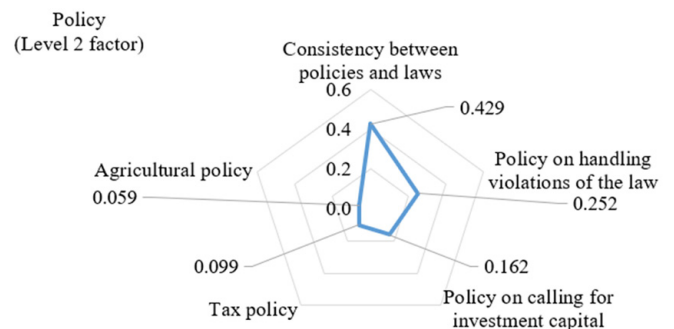


Fig. 11. Weights of level 2 policy factors.

of regulations, using land for the wrong purpose, not fulfilling financial obligations on land, and causing land pollution. It is impossible to ignore the factor of the team establishing and implementing the land-use planning ($W = 0.117$) because the planning and implementation of the land-use planning closely follow reality, meeting the needs of the people and being effectively implemented based on the qualifications and professional skills of the team establishing and implementing the land-use planning. Next is the factor of the land management and inspection team ($W = 0.084$) because illegal land use is a problem encountered

Table 2. Global weights and factors affecting land-use planning of Phu Quoc City.

No	Level 1 factor	Weight (W1)	No	Level 2 factors	Weight (W2)	Overall weight (W = W1 × W2)
1	Nature	0.46	1	Geographical location	0.418	0.1923
			2	Soil	0.251	0.1155
			3	Terrain	0.165	0.0759
			4	Water source	0.094	0.0432
			5	Pollution status	0.073	0.0336
2	Economy	0.329	6	State budget	0.375	0.1234
			7	Production cost	0.270	0.0888
			8	Consumer market	0.188	0.0619
			9	Profit	0.103	0.0339
			10	Financial capacity of the implementing unit	0.063	0.0207
3	Society	0.142	11	Level, technique, farming means	0.336	0.0477
			12	Labor force	0.242	0.0344
			13	Individual households using land	0.17	0.0241
			14	Team to establish and implement the land-use planning	0.117	0.0166
			15	The land management and inspection team	0.084	0.0119
			16	Project investor	0.051	0.0072
4	Policy	0.069	17	Consistency between policies and laws	0.429	0.0296
			18	Policy on handling violations of law	0.252	0.0174
			19	Investment attraction policy	0.162	0.0112
			20	Tax policy	0.099	0.0068
			21	Agricultural policy	0.059	0.0041

every year in any locality, not just Phu Quoc. To limit this problem, it is necessary to closely monitor the current situation to ensure that the land-use plan implementation follows the set plan targets. Finally, the factor of the project investor of the implementing unit ($W = 0.051$), the reason experts assess this factor to have a low level of impact is when the investor registers to implement the project. Still, due to subjective or objective factors, it cannot be implemented; it will affect the results of implementing the land-use plan.

The study determined the consistency ratio $CR \leq 10\%$ of each expert (Drobne & Lisec, 2009), to evaluate CR for each group of level 1 and level 2 factors. Ensuring the consistency of each expert and expert group according to the group of level 2 factors, specifically: CR of level 1 factor is 0.0934 and CR of 4 groups of level 2 factors are respectively: Natural factor group has $CR = 0.0965$; Economic factor group has $CR = 0.0989$; Social factor group has $CR = 0.0933$; Policy factor group has $CR = 0.0832$.

Figure 11 showing the consistency between policies and laws is the most influential factor ($W = 0.429$) because it is necessary to bring about optimal effectiveness from the land-use policies and guidelines set out by the sectors and to prevent violations that take advantage of the inconsistency and lack of synchronization between land legal documents and other legal documents. The policy factor for handling law violations ($W = 0.252$) is the increasing demand for land use; people or officials in the land sector are likely to commit violations, so there must be strict sanctions and deterrence to ensure that land is used effectively and sustainably. The policy factor for attracting investment capital ($W = 0.162$) attracts economic groups and large investors to

serve tourism development and ensure quality and timely implementation of works and projects. Finally, the tax policy factor ($W = 0.099$) is mainly related to incentives on corporate income tax and high-income earners. The agricultural policy factor ($W = 0.059$) is assessed to have a low impact level due to the orientations of coastal urban areas with a focus on tourism service centers and comprehensive marine-island ecology.

Overall weight

The results of determining the overall weight and factors affecting Phu Quoc City's urban planning in Table 2 showed that the three factors with the most significant impact: geographical location was the most dynamically assessed factor (overall weight $W = 0.192$), state budget factor (overall weight $W = 0.123$), and soil (overall weight $W = 0.116$). The results are a scientific basis for managers to propose specific solutions to improve the effectiveness of urban planning in Phu Quoc City in the future.

Proposed solutions to improve the implementation results of land-use planning

Phu Quoc's land from 2015 to 2023 has had many substantial changes. In addition, Phu Quoc also had an important event. In order to ensure progress and complete the development goals according to Kien Giang Provincial People's Committee (2023), Phu Quoc had to make great efforts in land management, especially in establishing and implementing land-use planning and plans. The socioeconomic development status and land-use

status in Phu Quoc City have many fluctuations. The factors affecting the implementation results of land-use planning in Phu Quoc City are mainly natural conditions and economic, social, and policy factors. In addition, natural disasters and epidemics significantly impact the preparation and implementation of land-use plans.

Based on the above results, solutions are proposed to solve difficulties and contribute to the completion of the implementation of the land-use plan in Phu Quoc City. From the results of the AHP analysis, the factors affecting the implementation of the Phu Quoc City Planning and Investment Plan have been identified, with different levels of impact at different levels. The study has proposed several solutions in order of priority to improve the effectiveness of the implementation of the Phu Quoc City Planning and Investment Plan, Kien Giang Province:

- **Natural conditions:** Take advantage of the geographical location (extensive fishing grounds, coastline surrounding the island, etc.). At the same time, the supply chain can be expanded by using an ecological agricultural model associated with tourism and services. Plant and animal varieties are researched, selected, and produced with suitable growth times; they are resistant to salinity, drought, and flooding. Minimize the impact of the greenhouse effect and adapt to climate change; supervise construction to reduce urban flooding; increase forest planting and protection and increase biodiversity; protect water resources to promote economic development and daily life, including fresh water from Duong Dong Lake and saltwater for aquaculture, requiring the construction of irrigation systems serving multiple purposes, strictly controlling treatment activities; complete the monitoring network to allow closer environmental monitoring; and increase the use of equipment and technology to analyze and evaluate environmental factors.
- **Economy:** Maintain capital for the construction of technical and social infrastructure. Ecological and circular agricultural models combine appropriate production technologies to reduce production costs. Connect with businesses to create a system of underwriting agricultural products. Agricultural production is reorganized to restructure the agricultural sector to increase value and sustainable development. Focus on developing a collective economy and large-scale and high-quality commodity production. At the same time, the relationship between production, processing, preservation, and consumption aspects is expanded. Select implementing units with works and projects that are likely to be successful, ensuring the proposed plan.
- **Society:** Organize training courses to improve skills and farming techniques and address issues of concern due to storms and saline intrusion. Community participation must be increased while developing and implementing land-use planning. Train personnel with professional capacity and experience to meet management requirements at all levels to carry out planning and land-use planning, especially in compensation and site clearance. In addition, promptly grasp and thoroughly understand the emerging needs of land use in sectors to adjust planning promptly, land-use planning, and unreasonable land use in each sector to have timely impacts to prevent and limit negative impacts of land-use planning to use land reasonably with high economic efficiency by strengthening inspection and exami-

nation to promptly prevent violations and detect and make recommendations to improve planning. Regularly check the progress of slow-moving projects to prevent encroachment, land disputes, and speculation that wastes land.

- **Policy:** Apply and implement a synchronous policy related to many fields with the highest possible incentives implemented by the government to develop Phu Quoc City. Increase information on the Land Law. Maximize capital mobilization for investment in improving the synchronous socioeconomic infrastructure system. Infrastructure development must be combined with land fund exploitation to reduce the difference in land prices the state invests in. Corporate income tax, value-added tax, agricultural land-use tax, and other tax policies need to be developed and completed to suit the specific conditions of the City.

The method is widely used in many other decision-making applications. Although the study's AHP technique was successful in determining the relative importance of the sets of criteria represented by the weights, its application has been criticized for several flaws, such as unclear questions, fixed measurement scales, and inconsistent results (Song, Kang, 2016). However, the method is still widely used in many parts of the decision-making process. Therefore, the AHP is a great option for land-use appropriateness evaluations since the assessment process is considered a decision problem, and it is a traditional procedure that provides a methodical approach to decision-making (Chandio et al., 2013).

Conclusion

The results of the correlation analysis between the current area of implementation results and the land-use planning in Phu Quoc City in the period of 2015–2023 show that agricultural land and non-agricultural land are highly correlated, and the current status of implementation results closely follows the land-use planning. Four primary and twenty-one secondary factors affecting land-use planning implementation have been identified. In which the main factor of natural conditions and the secondary factor of geographical location have the most substantial impact on land-use planning implementation. The solutions corresponding to the factors affecting the preparation and implementation of land-use planning are proposed to improve the effectiveness of plan implementation in the next period.

References

- Chandio, I.A., Matori, A.N.B., WanYusof, K.B., Talpur, M.A.H., Balogun, A.-L. & Lawal D.U. (2013). GIS-based analytic hierarchy process as a multicriteria decision analysis instrument: A review. *Arabian Journal of Geosciences*, 6, 3059–3066. DOI: 10.1007/s12517-012-0568-8.
- Dent, D. (with Internet Archive) (1981). *Soil survey and land evaluation*. London, Boston: Allen & Unwin. http://archive.org/details/soilsurvey-landev0000dent_t2g8
- Drobne, S. & Lisec A. (2009). Multi-attribute Decision Analysis in GIS: Weighted Linear Combination and Ordered Weighted Averaging. *Informatica*, 33(4), Article 4. <https://www.informatica.si/index.php/informatica/article/view/263>
- Gomez, A.A. & Gomez K.A. (1984). *Statistical Procedures for Agricultural Research*. Wiley Publisher. https://pdf.usaid.gov/pdf_docs/PNAAR208.pdf
- Huyen, B.V. & Cuong D.T. (2021). *Impact of COVID-19 pandemic on Vietnam's socio-economy*. Finance Magazine Viet Nam. <https://tapchitai-chinh.vn/tac-dong-cua-dai-dich-covid-19-den-kinh-te-xa-hoi-cua-viet-nam.html>

- Kien Giang Provincial People's Committee (2023). *Explanatory report summarizing the 2023 land use plan in Vinh Thuan district, Kien Giang province*. https://vinhthuan.kiengiang.gov.vn/Lists/TinTuc/Attachments/5881/3.%20Thuy%E1%BA%BFt%20minh%20KHSDD-2023_VINH%20THUAN.pdf
- Koçman, A. (1993). *İnsan faaliyetleri ve çevre üzerine etkileri açısından Ege ovalarının iklimi*. Ege Üniversitesi Edebiyat Fakültesi Yayınları.
- Malczewski, J. (2006). GIS-based multicriteria decision analysis: A survey of the literature. *International Journal of Geographical Information Science*, 20(7), 703–726. DOI: 10.1080/13658810600661508.
- National Assembly (2018). *Amending and supplementing some articles on 37 laws related to planning (No. 35/2018/QH14)*. <https://thuvienphapluat.vn/van-ban/Xay-dung-Do-thi/Luat-sua-doi-cac-Luat-co-lien-quan-den-quy-hoach-2018-390511.aspx>
- National Assembly (2020). *Resolution on the establishment of Phu Quoc City and wards of Phu Quoc City, Kien Giang Province (No. 1109/NQ-UBTVQH14)*. <https://skhdt.kiengiang.gov.vn/trang/TinTuc/inbaiviet.aspx?nid=1762>
- People's Committee of Kien Giang Province (2023). *Decision on approving the 2024 Land Use Plan of Phu Quoc city, Kien Giang province. (Decision No. 3470/QD-UBND)*. <https://kiengiang.gov.vn/Lists/TinTuc/Attachments/3292/3470-QD-UBND.pdf>
- Saaty, T.L. (1979). *Optimization by the Analytic Hierarchy Process*. Defense Technical Information Center. DOI: 10.21236/ADA214804.
- Saaty, T.L. (1995). *Decisions Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*. Pittsburgh: RWS Publications.
- Song, B. & Kang S. (2016). A Method of Assigning Weights Using a Ranking and Nonhierarchy Comparison. *Advances in Decision Sciences*, 2016(8963214). DOI: 10.1155/2016/8963214.
- Thong, N.M., Phuong, T.T. & Hien P.T. (2021). Evaluation of the results of implementing land use planning of Can Tho city in the period 2010–2020 from the perspective of management staff. *Can Tho University Journal of Science*, 57, 82–90. DOI: 10.22144/ctu.jsi.2021.052.
- Tri, L.Q. (2010). *Land Use Planning Textbook*. Can Tho University Publishing House.
- Triantaphyllou, E. & Mann S. (1995). (PDF) Using the analytic hierarchy process for decision making in engineering applications: Some challenges. *International Journal of Industrial Engineering: Theory, Applications and Practice*, 2, 35–44.
- Vaidya, O.S. & Kumar S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169(1), 1–29. DOI: 10.1016/j.ejor.2004.04.028.
- Vietnamese Government (2018). *Circular No. 27/2018/TT-BTNMT of the Ministry of Natural Resources and Environment: Regulations on land statistics, inventory and mapping of current land use status*. <http://vanban.chinhphu.vn/?pageid=27160&doid=196596>