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*Corresponding author(s) email:
tohasaifudin@fst.unair.ac.id

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Bayesian spatial modeling of poverty: A bayesian geoadditive model

Abdul Karim [1,4], Toha Saifudin [2*], Nur Chamidah [3], Agus Riyadi[4]

1. *Doctoral Programme of Mathematics and Natural Sciences, Airlangga University, Indonesia*
2. *Department of Mathematics, Airlangga University, Indonesia*
3. *Department of Mathematics, Airlangga University, Indonesia*
4. *Islamic Community Development, Universitas Islam Negeri Walisongo, Indonesia*

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Abstract

In this paper, we measure the spatial pattern of the impact of zakah with poverty data in Indonesia and form a zakah cluster in Indonesia using the Bayesian geoadditive model approach. In this study, we collected data from the Indonesian Central Statistics Agency and the National Amil Zakah Agency (BAZNAS) in 2024 respectively to map and model socio-economic and spatial determinants, namely the relationship between zakah and the poverty in Indonesia. We found strong support for our approach to mapping and modeling flexibly to include spatial analysis. Spatial analysis shows a different pattern that shows the effect of zakah variables on the poverty with a significant spatial structure. The resulting mapping can be used to target efforts to receive zakah to reduce the number of poverty people or to explore the relationship between zakah and the poverty. This mapping is a new tool to help policymakers achieve their goal of reducing poverty in Indonesia.

1. Introduction

Spatial data includes information about location and spatial distribution in a geographical area. When the response variable contains spatial information, spatial Bayesian models often capture spatial dependence or correlation between neighbouring locations (Krapu et al., 2023). In spatial Bayesian modeling, the prior distribution is combined with the likelihood function to produce a posterior distribution that reflects prior knowledge and observed data (Geyer et al., 2021; Omre & Rimstad, 2021). Spatial Bayesian models generally use Gaussian or Markov random distributions to account for spatial autocorrelation (Wang, 2022). Spatial Bayesian modeling is preferred over classical linear regression because spatial data tend to violate assumptions such as independence in the data (Kang et al., 2024; Louzada et al., 2021; Zhao & Xu, 2023). Classical linear regression assumes that residuals are uncorrelated and homoskedastic, which often does not hold in a spatial context where neighbouring observations in one region tend to have similar characteristics in another region (Chen, 2016; Dumelle et al., 2023). Spatial Bayesian models have the advantage of flexibility because they allow for spatial heterogeneity (Ling & Le Gallo, 2023).

Tobler explains the first law of geography, namely that the characteristics of a point or area are related to the characteristics of a point or area that is closer together (Goodchild, 2009; Lu & Dong, 2022). This concept is the basis for regional scientific research, sometimes there are dependencies between points or regions (Karim et al., 2019; Karim, Suhartono, et al., 2020). So to overcome this, a regression model was developed using the Bayesian geoadditive model approach. Regional effects (spatial) can occur from one region to another, in spatial data often observations in one location depend on observations in other adjacent locations (neighboring). Spatial modeling is becoming increasingly popular in the regional applied sciences, with its popularity there have been

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challenges and evolutions in thinking about how best to incorporate spatial heterogeneity in models (Amalia & Sari, 2019; Lacombe & McIntyre, 2016; Maulidina & Oktora, 2020).

Adding a Bayesian approach to spatial modeling is one of the appropriate solutions for analyzing spatial data. By incorporating prior distributions and accounting for spatial structure, spatial Bayesian models allow for more flexible data analysis results, especially on data with complex spatial dependencies and effects varying across locations (Congdon, 2021; Lee et al., 2022; Roman & Brandt, 2023). This model extends the traditional Bayesian model by incorporating an additive approach that includes nonlinear effects of covariates and spatial effects, both structured and unstructured (Razen & Lang, 2020). This approach allows flexibility in handling complex data, including nonlinear relationships between covariates and response variables and spatial interactions. Bayesian geoadditive models allow flexibility in the distribution of the response variable. The geoadditive component of the model includes spatial effects with a basis function or Gaussian process approach, which allows the model to capture spatial patterns that are not explicitly observed. In addition, these models often also consider random effects to accommodate variability between groups or hierarchical levels in the data (Moraga et al., 2021).

Measured in terms of the quality of the economy as a whole, based on the 2024 IMD World Competitiveness Ranking (WCR), Indonesia is ranked 27th out of 67 countries and is still below Singapore and Thailand, which are respectively ranked 1 and 25, but Indonesia is still better than Malaysia and Philippines (IMD, 2025). A high level of economic growth is found in most of Java Island, while medium economic growth is found in several provinces in Sumatra and Sulawesi. For other regions, such as parts of Sulawesi and Sumatra, all of Kalimantan, East Nusa Tenggara, West Nusa Tenggara, Bali, Maluku, and Papua, tend to have low economic growth rates. It shows that economic growth in Indonesia has not been evenly distributed and its distribution is still dominated by the island of Java, while other regions support national economic growth after the island of Java.

However, Indonesia's economic growth did not fully provide a positive impact in terms of reducing the wealth disparity. It can be seen in the poverty data of the Central Statistics Agency (Badan Pusat Statistik) in March 2023 that Indonesia's Gini Ratio reached 0.388. This means that currently, 1% of the richest people control 38.8% of national assets. This fact indicates that the distribution of wealth from economic growth that occurs is not evenly distributed and is only controlled by a certain group of groups and regions (BPS, 2024).

As the country with the largest population in ASEAN, based on the results of the 2020 population census, there were 270.20 million people. Currently, Indonesia is entering the era of demographic bonus (Heri Mis Cicih Lembaga Demografi et al., 2021), namely, the productive age population is more than the unproductive age (unproductive age plus unproductive age). This demographic bonus is expected to have an impact on *zakah* receipts in Indonesia (Bilqis & Zaki, 2020; Setiyowati, 2017). Reducing poverty disparities should be able to encourage the growth of *zakah* in Indonesia (Harahap, 2021), in line with the increase in population demographics which is expected to encourage an increase in *zakah* receipts. An important issue in this context is how significant the influence of *zakah* is in reducing poverty in Indonesia. A good distribution of *zakah* is the goal of meeting the demand in the community to reduce the disparity of people's prosperity.

As previously mentioned, there are different approaches that can be taken to diminish poverty. On a broader scale, enhancing economic growth and development, along with ensuring fair income distribution, are crucial factors in alleviating poverty in Indonesia. On a small scale, the resources accessible to households grant them income and impact the extent of poverty experienced. (A. Karim, Utami, et al., 2020; Abdul Karim et al., 2017). Moreover, within the framework of fair economic growth distribution and dwindling data concerning poverty rates in Indonesia, there is a necessity for alternative approaches. In this scenario, zakah emerges as a viable solution to address these challenges. (Qomari, 2017). Zakah, as the third pillar of Islam, entails specific duties for Muslims to fulfill provided certain conditions are met. (Andriono & Hidayatulloh, 2020; Harahap, 2021; Kalimah, 2020). Zakah's primary objective could serve as a means to alleviate a range of socio-economic issues like poverty. (Karim, Mudhofi, et al., 2020; Syari'ah et al., 2017).

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Zakah has a more significant role in poverty alleviation strategies at the micro-level (Aqbar & Iskandar, 2019). Approaches to addressing poverty will depend on the types of resources and rights that households have. *Zakah* is an income conversion right because it is the right of the poverty to the wealth and income of the rich (Ichdayati & Puspitasari, 2021; Jamaluddin et al., 2021). To understand how to use this conversion right to solve the problem of poverty that persistently affects a large part of the population.

At the policy level, it shows that the macroeconomic environment must be improved and *zakah* institutions must be strengthened so that they have an impact on poverty. This requires the integration of *zakah* institutions in the national development strategy. Therefore, the role of *zakah* in poverty alleviation must be studied from the regional perspective of each province. However, to date, very few countries including Indonesia have integrated *zakah* into their development programs. Meanwhile, the government calls for using all alternatives to reduce poverty (Hadiyati, 2019; Herlita, 2017; Sofianto, 2019).

The utilization of zakah as an alternative tool to reduce poverty rates should be maximized. (N. W. Pratama & Purba, 2021; Y. C. Pratama, 2015). Hence, exploring the capacity of zakah in Indonesia is crucial.. (Abdul Karim, Mudhofi, et al., 2020) conducted research on zakah and poverty in Indonesia, employing the local indicator spatial association (LISA) method. The findings of the LISA analysis reveal a noteworthy and affirmative impact of zakah potential on poverty in Indonesia, demonstrating interdependence among adjacent areas in terms of both zakah potential and poverty levels.

Differences in conditions owned by each district/city such as differences in the number of poverty people and economic growth can cause variations in the growth of *zakah* receipts in each region. Differences in regional characteristics that have implications for *zakah* receipts vary. The increase in regional connectivity and or proximity as well as the same characteristics between regions is strongly suspected of having a spillover effect. Therefore, to see the effect of *zakah* based on regional data with the Bayesian geoadditive stochastics model approach is a smart solution in solving the problem of the phenomenon above.

This study highlights the significant benefit of employing flexible modeling techniques to capture region-specific effects, which surpass the limitations of traditional parametric and frequentist methods. For instance, while frequentist modeling leads to redundant parameters for single variables, Bayesian geoadditive models offer the unique advantage of incorporating spatial, nonlinear, and temporal variations of covariates alongside linear effects through appropriate adjustment of smoothness. Moreover, the novelty of this analytical approach holds promise for informing policy formulation, allowing governments to focus on strategies concerning zakah policy. Increasing awareness about zakah initiation may be imperative, extending from provinces to districts and cities.

2. Data and Methods

2.1. Data

A primary repository of extensive national data concerning zakah and the economy lies within the National Amil Zakah Agency (Baznas) and the Central Statistics Agency of the Republic of Indonesia (BPS). Baznas functions as a non-structural governmental entity with a key role in overseeing zakah, infaq, and sadaqah management, among other responsibilities.

The data used in this study is secondary data from the National Amil Zakah Agency (Baznas) and the Central Statistics Agency (BPS) in 2024. The unit of observation in this study is all provinces in Indonesia. This research is the development of a study on the potential of zakah conducted by (Abdul Karim, Mudhofi, et al., 2020) which uses the spatial association methodology with the global moran's and local moran's methods, the difference is that analysis development is carried out in the form of modeling and clustering using the Bayesian Geoadditive Model.

2.2. Bayesian Geoadditive Model

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This section discusses a Bayesian geoadditive approach that aims to estimate fixed effect parameters, unknown smooth functions of metric covariates, and spatial effects of geographic location (Balekelayi, N., & Tesfamariam, S, 2019). This approach is based on fully Bayesian inference using the Markov Chain Monte Carlo (MCMC) technique. The Bayesian method is used to overcome limitations in modeling, such as complex models and unrealistic assumptions. In Bayesian modeling, the parameter θ is treated as a random variable with a certain distribution. The basis of Bayesian modeling is the posterior model, which combines prior information with observed data through the likelihood function. The estimator in the Bayesian approach is the mean or mode of the posterior distribution. Before making an observation, the parameter θ is assumed to have a prior distribution. After observing data, the likelihood function incorporates the observed information to form the posterior distribution.

$$\mathbf{f}(\boldsymbol{\theta}|x) = \frac{\mathbf{f}(x|\boldsymbol{\theta})\mathbf{f}(\boldsymbol{\theta})}{\mathbf{f}(x)} \propto \mathbf{f}(x|\boldsymbol{\theta})\mathbf{f}(\boldsymbol{\theta})$$

with f(θ | x) defined as posterior distribution, f(x | θ) a likelihood function, f(θ) as prior distribution, x as data and θ as parameter. (Soejoeti and Soebanar in Hidayah, 2016) (Safitri, 2010).

Furthermore, in multiple linear regression models cannot accommodate the non-linear influence of independent variables and require strict assumptions about the distribution of data. One method that can be used to overcome these problems is the additive model (Sukarsa, 2001). Suppose we have a set of data $\{y_i, x_{i1}, x_{i2}, \dots, x_{ip}\}_{i=1}^{n}$ where n is the number of observations. Then the additive model can be written as follows:

$$\mathbf{Y_i} = \mathbf{f_0} + \sum_{\mathbf{j=1}}^{\mathbf{p}} \mathbf{f_j}(\mathbf{X_{ij}}) + \boldsymbol{\varepsilon_j}$$

where fj(.) is a single function that belongs to each predictor, p is the number of independent variables, E(ε) has the value 0 and Var(ε) is σ^2.

Additive models (AM) is one of the development methods of linear regression which replaces linear functions into additive functions, AM is used in order to define the relationship between the dependent variable and several independent variables that have non-linear characteristics. (Jamilatuzzahro et al., 2018). The Generalized Additive Model is a development of linear models and the Generalized Linear Model (GLM) which assumes that the independent variables follow the characteristics of an exponential distribution (Shafia et al., 2017). Nonlinear impacts stemming from continuous covariates can manifest within regression models, even when dealing with binary or other non-normally distributed response variables. Echoing the additive models discussed earlier, prioritizing the incorporation of adaptable nonparametric effects for continuous covariates is typically preferred over imposing rigid parametric structures. Techniques for flexible and data-informed estimation of nonlinear effects assume heightened significance in scenarios involving non-normally distributed responses, given that visual aids like scatter plots may not always be viable for grasping the relationship between the response variable and covariates.

Generalized Additive Models are an extension of linear regression by substituting the linear function $\sum_{j=1}^{p} \beta_j X_j$ into an additive function $\sum_{j=1}^{p} f_j(X_j)$. This makes the GAM model more flexible than GLM or Additive Models (AM). GAM can be formulated as follows:

$$\mathbf{g}(\boldsymbol{\mu}) = \mathbf{s_0} + \sum_{\mathbf{j=1}}^{\mathbf{p}} \mathbf{s_j}\left(\mathbf{X_j}\right) + \boldsymbol{\varepsilon}$$

Through the response variable is assumed to be exponentially distributed, and s is a smooth function. GAM and GLM models can be applied in similar situations, but they provide different analytics. GLM focuses

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more on estimation and inference for model parameters, while GAM focuses on nonparametric data exploration (Statsoft in Safriana et al., (2017)).

3. Result and Discussion

3.1 Result

Based on Figure 1, the distribution of the poverty in Indonesia is divided into two groups. The yellow areas show areas with a low percentage of the poverty population ranging from 53 to 1357 (thousand people), and the red provinces show areas with high poverty rates ranging from 1358-4586 (thousand souls). The provinces with a significant population of impoverished individuals are located across East Java, West Java, and Central Java, respectively. Meanwhile, provinces that have a low number of poor people are spread out respectively in East Kalimantan province, Bangka Belitung Islands province, and North Maluku province.

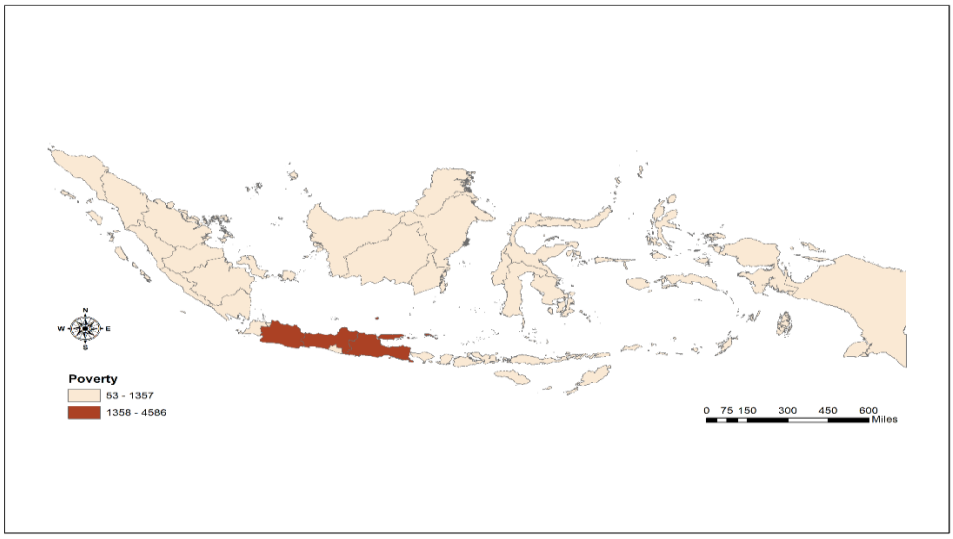

Figure 1 Distribution of the number of poor people for each province in Indonesia (thousands of people)

A confidence interval refers to a span between two points within which the sample mean is precisely positioned at the midpoint. Hypothesis testing on the parameters is carried out using the 95% Probability Confidence Interval approach for each parameter. The 95% Probability Confidence Interval is calculated with the lower limit being the 50% quintile and the upper limit being the 97.5% quintile. The parameter is declared significant if the 95% Probability Confidence Interval parameter does not contain a zero value.

Table 1 Parameter Estimation Results

Variable	Mean	Standard Deviation	95%PCI	Significant
Constant	2804.49	2661.89	3335	-
Zakah	210421	281424	(12665.3,30185.0)	Yes

Table 1 shows the results of fixed effect parameters (non-spatial) in Indonesia. From the table above, it can be seen that the zakah variable has a value of 0 at the 95% Probability Confidence Interval. This shows that the zakah variable has a positive influence on the variable of the poor population in Indonesia with an average of 210421. It can be interpreted that the higher the value of zakah in an area will have a positive effect on reducing poverty levels in Indonesia with an average of 210421.

This indicates that globally zakah provides benefits for the poor in Indonesia. This study is following the research that states the importance of increasing zakah receipts and encouraging people's productivity to

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increase. Currently, it can be seen that individual and corporate productivity will be able to increase zakah receipts. The higher the potential level of zakah, both individuals and corporations, it is strongly suspected that zakah receipts will increase so that it will be able to reduce the level of poverty in Indonesia.

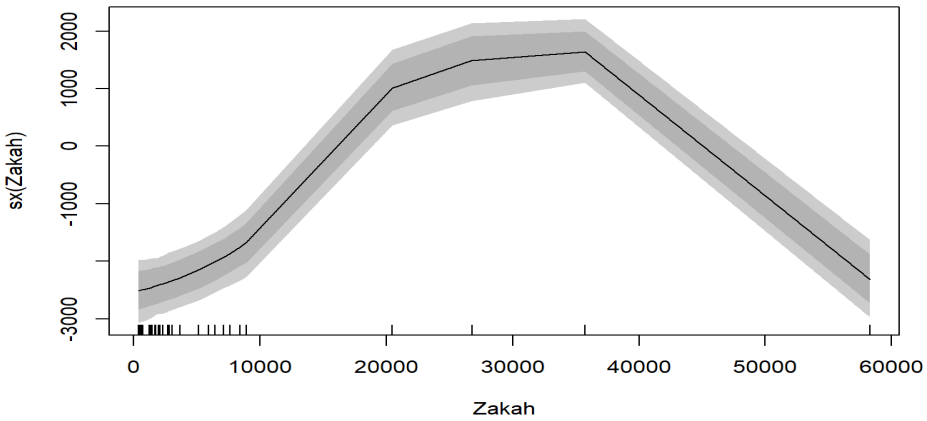

Figure 2. The impact of *zakah* on the poverty in Indonesia

Figure 2 shows the non-linear effect of the predictor variable, namely the zakah variable on the poverty in Indonesia. Figure 3 shows the effect of zakah in Indonesia, such as research conducted by (Kandala, 2006), the effect is in the form of an inverted U graph, the decreasing part shows that zakah tends to have a smaller impact on the poverty in Indonesia. These results indicate that the existing zakah in each province does not spread to the people of the surrounding provinces or it can be said that the growth of existing zakah is not necessarily able to reduce the poverty population in the surrounding provinces.

3.2 Analysis of Spatial Effects on the Poverty

Territories are in most cases not a set of unconnected administrative units. Numerous connections exist among localities, leading to interactions that generate a spillover impact. (Czyżewski et al., 2020; Kim et al., 2021). Among these effects, we can calculate the association for each region.

Thus, when provinces have interacted with each other, the expansion of public goods and services offered by a specific province stimulates economic growth not only within its own political and administrative borders but also throughout the surrounding geographic region it's connected to. This interconnectedness fosters a ripple effect, spreading economic benefits beyond the province's immediate boundaries. (Asmawi et al., 2017; Chai et al., 2021).

In Bayesian inference, Probability Confidence Interval (PCI) is the posterior probability interval used for interval estimation, while in the classical approach the Probability Confidence Interval is obtained from sample data. To find out the specific spatial effects in Indonesia, Figures 3 to 6 show the importance of the observed spatial effects in the form of a posterior probability map. As research conducted by (Kandala, 2006) the level of significance corresponds to the Probability Confidence Interval. The value of Probability Confidence Interval 0 to 317.67 (colored red) shows a significant positive effect, the value of Probability Confidence Interval 0 (colored white) shows an insignificant effect, and the value of Probability Confidence Interval -317.67 to 0 (colored blue) shows a significant negative effect.

Spatial data is data related to location, based on geography consisting of latitude-longitude and area. Spatial data analysis cannot be done globally. This means that each location has its characteristics. Most of the analytical approaches are exploratory data presented in the form of thematic maps. Thematic maps are also

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known as statistical maps or special purpose maps, which produce an overview of the use of space in a particular place according to the desired theme.

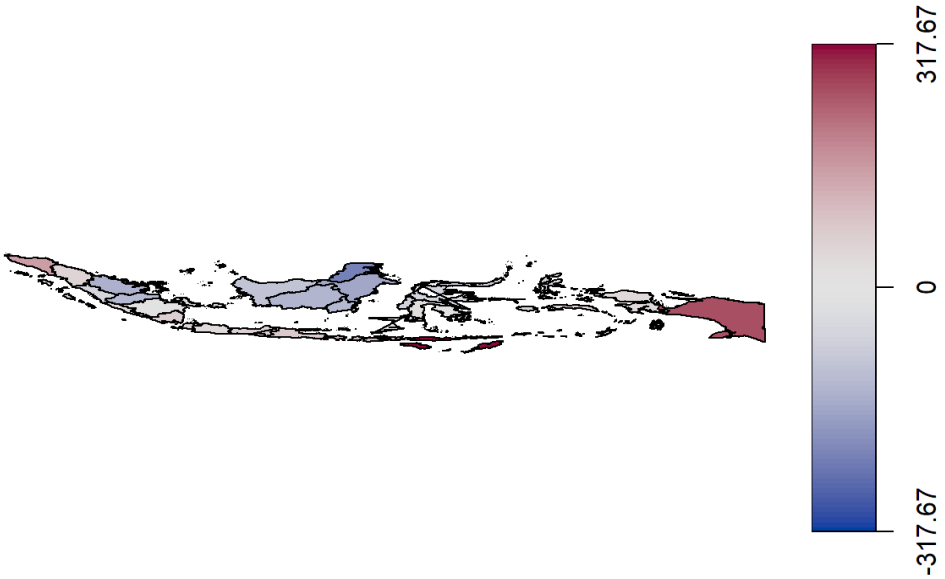

Figure 3 Spatial effects on zakah in Indonesia

To compare the spatial effects, it is presented in Figures 4 to 6 which presents a map showing the effects of the provinces in Indonesia. Figure 4 is Island one (1) the region includes Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, the Bangka Belitung Islands, and the Riau Islands. Figure 5 is Island two (2) consisting of DKI Jakarta, Banten, West Java, Central Java, DI Yogyakarta, East Java, West Kalimantan Province, Central Kalimantan, South Kalimantan, East Kalimantan, North Kalimantan, Bali Province, West Nusa Tenggara, and East Nusa Tenggara. Figure 6 shows island three (3) consisting of North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, West Sulawesi, Gorontalo, Maluku, North Maluku, West Papua, and Papua Provinces.

Several important findings emerged, among which many of these structured spatial effects were significant as shown by the probability maps (figures 4 to 6). The mapping results show a map of the posterior probability of zakah at 95% credible intervals. Provinces in blue show a significant negative spatial effect, while provinces in red show a significant positive spatial effect. Other provinces (in gray) have no significant effect.

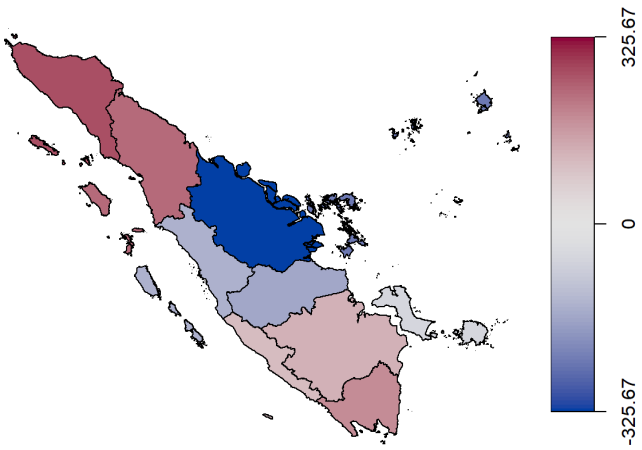

Figure 4. Spatial effect island 1

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The spatial effects of zakah on regions indicate that many variations in the pattern of these relationships still need to be explained in more detail. The model assigns these spatial effects to structured effects depicted in Figures 4 through 6. This is because the pattern for each province tends to cluster or spatial dependencies.

Figure 4 shows the provinces on Island one (1) which are divided into several classifications, for example, Aceh, North Sumatra, Lampung, and South Sumatra, and Bengkulu which are in the positive significant category, indicating the effect of zakah on the poverty population of these provinces is influenced by adjacent areas that have relatively high zakah receipts. This condition causes the poverty in the area to be affected by zakah from adjacent areas. Furthermore, Riau, Jambi, and West Sumatra are in the significant negative category, indicating that the effect of zakah on the poverty in these areas is not influenced by adjacent provinces which have relatively higher zakah receipts.

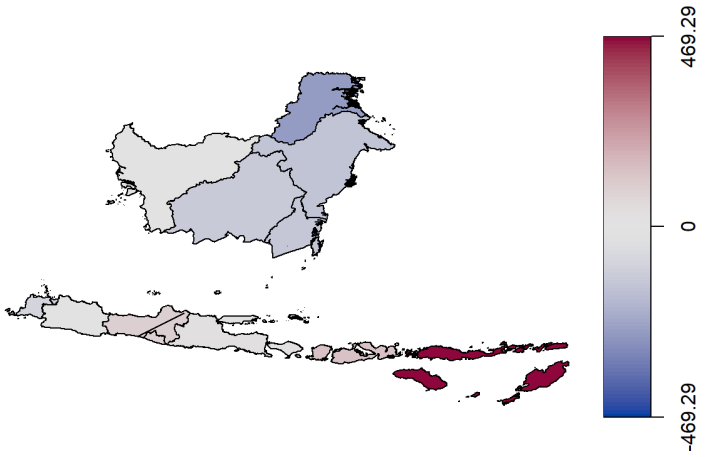

Figure 5 Spatial effect island 2

Figure 5 shows the provinces in island two (2) which are divided into several classifications. East Nusa Tenggara which is in the positive significant category indicates that the effect of zakah on the poverty population of the province is influenced by adjacent areas which have relatively high zakah receipts. This condition causes the area to be affected by zakah from adjacent areas. Furthermore, North Kalimantan, East Kalimantan, Central Kalimantan, and South Kalimantan are in the significant negative category, indicating that the effect of zakah on the poverty in these areas is not influenced by adjacent provinces which have relatively higher zakah receipts. The provinces on the islands of Java, Bali, and West Kalimantan are areas that do not influence or are influenced by other regions in terms of the relationship between zakah and the poverty.

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Figure 6 Spatial effect island 3

Figure 6 shows the provinces on Island three (3) which are divided into several classifications. Papua, which is in the significant positive category, indicates that the relationship between zakah and the poverty of the province is influenced by the fact that adjacent areas have relatively high zakah receipts. This condition causes the area to be affected by zakah from adjacent areas. Furthermore, there are no provinces that are in the significant negative category. Meanwhile, the provinces on the islands of Sulawesi, Maluku, and West Papua are areas that do not influence or are influenced by other regions in terms of the relationship between zakah and the poverty.

Based on Figures 4 to 6, the classification of regional (spatial) influences on the poverty in Indonesia using the Bayesian Geoadditive Regression Models method produces three categories which can be seen in Table 2. Based on the table 2, we can know which areas have spatial dependencies. Regions or provinces that are in the significant positive category indicate that these areas influence each other positively. It means that if the poverty rate in an area is high, the surrounding area will have a high poverty rate as well. However, provinces that are in the significant negative category indicate that these areas influence each other negatively. It means that if the poverty rate in an area is high, the surrounding area will have a low poverty rate. As for the insignificant category, the area does not have spatial dependencies.

Table 2 Classification of spatial effect on the poverty

Categories	Islands	Provinces
Significant Positive	Island 1	Aceh, North Sumatra, Lampung, and South Sumatra and Bengkulu
Not significant		Bangka Belitung
Significant Negative		Riau, Jambi, and West Sumatera
Significant Positive	Island 2	East Nusa Tenggara
Not significant		West Kalimantan, Banten, DKI Jakarta, West Java, Central Java, East Java, Bali and West Nusa Tenggara
Significant Negative		North Kalimantan, East Kalimantan, Central Kalimantan and South Kalimantan
Significant Positive	Island 3	Papua
Not significant		North Sulawesi, Gorontalo, Central Sulawesi, West Sulawesi, South Sulawesi, Southeast Sulawesi, Maluku, North Maluku and West Papua
Significant Negative		-

Source: Analysis, 2025

3.3 Discussion

Poverty in the simplest terms can be defined as the lack of basic needs such as food, clothing, and shelter (Bogaevskaya, 2019; "Rural Poverty and the Nonfarm Sector in Rural Asia," 2024; Satpathy et al., 2023). In other words, the lack of means and money to meet these needs. More than that, the current condition is very worrying where poverty is rampant in Muslim countries. Poverty among Muslims should be able to be suppressed because Islam strongly recommends helping others and encouraging mutual assistance in terms of goodness, especially reducing poverty (Hunjra et al., 2024; Sulaiman et al., 2025; Thalgi, 2024). Many countries in the Muslim world are rich in resources but poverty is beyond normal limits. Somalia and Yemen are examples of how poverty destroys the social fabric. In the past, these two countries were the main exporters of food and livestock in the Region. In addition, Iraq and Libya are two rich countries that have natural resources and many people still suffer from poverty (Abdi Ali et al., 2025; Alnashwan et al., 2021; Samatar, 2025).

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The third pillar of Islam is Zakah, which is mandatory for eligible Muslims (muzakki) to purify their wealth by allocating a portion to those entitled to receive it (mustahik). On a broader scale, Zakah serves not only to cleanse the wealth of the giver but also to address the basic economic needs of the recipients, potentially contributing to poverty alleviation. The Republic of Indonesia, as a unitary state, exhibits diverse characteristics across its provinces. (Shaifudin, 2020). Modernization leads to a contemporary societal setting where individuals exhibit high levels of openness. Muslim communities residing in diverse locales must adopt an inclusive approach, treating one another as siblings in faith, while acknowledging differences in economic status, population demographics, and geographical location. This underscores the necessity for ongoing cooperation among fellow Muslims to alleviate poverty.

Zakah holds significance in reducing poverty, but its effectiveness depends on the efficiency of zakah institutions in collecting and distributing funds. These institutions require a robust governance framework and effective management practices, including transparent decision-making, implementation, skilled personnel, adaptability for innovation, and cost-effective operations. To achieve optimal results, the tasks of fundraising and distributing funds should be distinctly separated. This research confirms that poverty is not only seen globally, and solving its problems requires a multidimensional approach. One part of this research is to examine the role of zakah on the poverty. The results of the macro analysis in Indonesia show that poverty cannot be eliminated without using zakah effectively because it is one of the important roles in reducing poverty.

This research also indicates that certain circumstances are conducive to zakah effectively reducing poverty. Firstly, zakah needs to be supported by robust macroeconomic strategies that foster growth and equitable income distribution to combat poverty. Secondly, the impact on poverty alleviation is most significant when a higher proportion of zakah proceeds is directed towards productive endeavors, necessitating increased collection and efficient allocation. Integrating zakah into broader development agendas requires collaborative efforts and policy enhancements to fortify the amil zakah institution. Presently, governmental zakah collections in many regions are minimal compared to overall receipts, with the bulk directed towards individuals or non-governmental bodies. Such decentralized distribution may not effectively alleviate poverty. Centralizing zakah collection and distribution through public institutions in an organized manner could amplify its impact. Enhancing the efficiency of public zakah institutions in collecting and disbursing funds would instill trust among the populace, encouraging greater compliance with zakah contributions to government bodies. Crucially, the government must demonstrate competence in utilizing these funds effectively and efficiently to benefit target demographics, fostering trust and bolstering compliance.

The findings from the analysis highlight the circumstances wherein zakah can effectively contribute to reducing poverty. Specifically, the findings reveal two main policy considerations concerning the utilization of zakah for poverty alleviation. The first pertains to incorporating zakah into the comprehensive development plan of each region, while the second aspect concerns establishing institutions to enhance the utilization of zakah in poverty alleviation efforts.

Since the majority of macroeconomic policies fall under governmental jurisdiction, the influence of zakah in fostering growth through such policies will be restricted. Nevertheless, amil zakah institutions can significantly impact redistribution initiatives. Their primary objective is to equitably distribute income to aid the impoverished within a society. Zakah's potential contributions to macroeconomic endeavors lie in enhancing human capital and implementing targeted initiatives for the disadvantaged. These initiatives may encompass educational provisions, healthcare services, and social welfare programs aimed at enhancing the well-being of the less fortunate.

Based on the findings above, the policy implications that can be made are as follows: first, poverty in Indonesia has a significant spatial dependence, which indicates that the provincial government should be strengthened from a broader perspective by involving targeted local amil zakah agencies. The implementation of regional economic policies must be based on cooperation with the surrounding area. In particular, the territory of Indonesia which consists of islands must be considered as the main area, and it is necessary to accelerate

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income distribution as a driver of regional economic growth. In addition, the distribution of zakah should not always mean that all zakah is distributed entirely or allocated at 1 USD/day for the reduction of poverty families, the distribution of zakah is intended to empower the poverty. Empowerment is an effort to help those who are vulnerable and powerless so that they can achieve prosperity in their social life.

It's advised that crafting a focused zakah collection plan should take into account local conditions indicated by the clustering analysis. Clustering serves not only to assess zakah potential but also to tailor the collection strategy for each area. Building on the clustering findings, promoting the National Amil Zakah Agency's initiatives in each province via online platforms, governmental bodies, and private institutions can effectively reach communities. This initiative aims to inform the public about zakah payment methods facilitated by digital platforms like e-commerce and banks, simplifying the process. Leveraging online media helps mitigate challenges posed by diverse economic structures, demographics, and geography, making program dissemination more effective. Hence, enhancing collaboration between provincial Baznas and digital platforms is crucial in raising public awareness about fulfilling zakah obligations.

Baznas aims for its outreach efforts in every province to consistently focus on fostering societal transformation. These endeavors should target social and humanitarian issues to align with societal needs, particularly in enhancing conditions amidst prevalent poverty. The core of zakah's framework revolves around initiatives geared towards advancing societal transformation, such as shifting from inequality to equality, poverty to prosperity, and backwardness to progress. Hence, to disseminate zakah funds effectively across diverse provinces, it's advisable to tailor socialization efforts towards promoting values like communal cooperation, mutual aid, and other constructive human principles. These activities aim to cultivate attitudes and consciousness, fostering wise responses to alleviate poverty within each province.

4. Conclusion

The Bayesian geoadditive model has been discussed in this study, with this approach, it is possible to distinguish the influence of the geographic location of the region on the relationship of zakah to poverty. This study describes each province of the region where variations exist. This study uses a powerful method to estimate regression models with structured additive predictors based on the latest MCMC simulation technique. The Bayesian hierarchical model models second-order units as correlated random components that substitute for unobserved contextual factors. This research adopts a versatile method by employing spline functions to handle metric continuous covariates and incorporating geographic random elements to capture nuanced connections between covariates and responses.

We concentrate on Bayesian regularization utilizing conditional Gaussian priors within a structured additive regression model. This framework offers a cohesive approach to statistical modeling and computation. We intentionally exclude methods relying on the Dirichlet process (DP) or similar priors, which represent another prevalent avenue in nonparametric regression. This decision stems from their limited suitability for high-dimensional regression models. Instead, they excel in relaxing stringent assumptions on residual distributions, random effects, or limitations by accommodating greater heterogeneity. Nonetheless, DP-based approaches can complement modeling strategies employing Gaussian smooth priors or adaptive basis function selection.

This study describes the impact of zakah on poverty data in Indonesia. To achieve these outcomes, we conceptualize poverty as a phenomenon incorporating spatial influence, as poverty in Indonesia exhibits non-random distribution. Provinces on the island of Java tend to concentrate larger gaps in the number of poverty people than provinces outside Java. Then, we use the Bayesian geoadditive regression model approach which takes into account the spillover effect to measure the impact of zakah on poverty, while the cluster analysis approach is used to form a potential zakah cluster. The estimation results show, consistently across all specifications, that the impact of zakah has a significant effect on poverty data accompanied by a substantial spillover effect in Indonesia.

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We assess the causal effect of zakah income on the multidimensional poverty gap. This study goes beyond simply establishing that provinces that have more zakah receipts are those that have higher zakah receipts and lower poverty rates, but our results show that provinces that are in the positive significant category indicate that these areas influence each other positively, meaning that if the poverty rate in an area is high, the surrounding area will have a high poverty rate as well. However, provinces that are in the significant negative category indicate that these areas influence each other negatively, meaning that if the poverty rate in an area is high, the surrounding area will have a low poverty rate. As for the insignificant category, the area does not have spatial dependencies.

The study's results also propose various subjects that should be included in the agenda for adjusting and improving the decentralization model. One such subject involves enhancing the zakah collection system to enhance local zakah data, particularly at the grassroots level such as districts or cities, through increased awareness campaigns about zakah contributions. This strategy is anticipated to be most impactful in provinces with significant geographical connectivity to neighboring regions. Provinces with higher zakah potential and greater capacity to boost local revenues are likely to experience greater success in poverty alleviation efforts. Therefore, public policies that strengthen the autonomy of regional amil zakah bodies to develop their programs with responsibilities that are appropriate to the region are encouraged to be included in the agenda.

We discover robust backing for our method of adaptively mapping and modeling various covariates with nonlinear impacts, incorporating spatial analyses as well. Spatial analysis shows a different pattern that shows the effect of zakah variables on the poverty with a significant spatial structure. To evaluate the potential impact of zakah on poverty from alternative policies to strengthen the capacity of local governments through increasing their zakah collection, this study analyzes scenarios of zakah collection strategies. The results of this scenario show that policies targeted at provinces are strongly correlated with their neighbors and with high deprivation rates are more effective in poverty alleviation than national strategies that are uniformly applied to provinces.

Therefore, it is recommended that zakah collection be collected through regional amil zakah institutions, not directly to mustahik. Direct distribution will ignore the aspects of coaching and empowering mustahik especially to accommodate the needs of poor families. The amil zakah institution is an official and professional institution that plays a role in representing mustahik in carrying out this role. The results of the study illustrate the importance of collaboration between the amil zakah agency and local governments to optimize zakah collection which can be used for empowering the poverty, which will later assist the government in tackling poverty in Indonesia. The benefits of zakah are very large, including optimizing the use of government spending in poverty reduction programs.

The existence of institutions related to the collection and distribution of zakah, namely the government, national and regional amil zakah agencies, and private zakah amil institutions, therefore further studies are needed to design information systems between these institutions, as well as information systems for the collection and distribution of zakah so that they can work. effectively. Collection and operation of potential zakah, without overlapping from several amil zakah agencies/institutions.

The resulting mapping can be used to target efforts to receive zakah to reduce the number of poverty people or to explore the relationship between zakah and the poverty. For example, the Bayesian geoadditive regression model can be overlaid with a map of other types of data, say the mapping of zakah potential. The map's visual characteristics can illuminate unanticipated connections often missed in conventional regression analysis. This mapping tool presents a fresh approach to aid policymakers in their endeavor to alleviate poverty in Indonesia.

Finally, we find that the regional effect is highly correlated with the poverty data. These findings indicate that the primary distinction regarding poverty in Indonesia lies not in the divide between urban and rural regions, but rather in the disparities among provinces within Java characterized by higher population densities or proximity to urban centers, compared to those with lower densities and situated farther from cities. These

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results underscore the importance of crafting poverty alleviation plans tailored to specific regions. Policies that address spatial disparities and embrace decentralized approaches accommodating regional diversity are recommended to foster greater social equality. The role of spillover effects has proven to be very important in the design of such policies.

5. References

Abdi Ali, D., Mohamed, N. A., Ismail, A. I., Moahmed, J., & Sahabuddin, M. (2025). Modelling the determinants of rural household poverty: empirical evidence from Somalia. *Cogent Food and Agriculture*, *11*(1). https://doi.org/10.1080/23311932.2024.2445139

Alnashwan, O. S., Alrwis, K. N., Ghanem, A. M., Naji, A. M., & Alaagib, S. A. B. (2021). Studying the phenomenon of poverty in the countryside of the dahhar district in Yemen. *Journal of Experimental Biology and Agricultural Sciences*, *9*(2), 147–151. https://doi.org/10.18006/2021.9(2).147.151

Amalia, E., & Sari, L. K. (2019). ANALISIS SPASIAL UNTUK MENGIDENTIFIKASI TINGKAT PENGANGGURAN TERBUKA BERDASARKAN KABUPATEN/KOTA DI PULAU JAWA TAHUN 2017. *Indonesian Journal of Statistics and Its Applications*, *3*(3). https://doi.org/10.29244/ijsa.v3i3.240

Andriono, A., & Hidayatulloh, A. (2020). Determinan Kepatuhan Wajib Pajak Muslim untuk Membayarkan Pajak. *Kompartemen: Jurnal Ilmiah Akuntansi*, *18*(2). https://doi.org/10.30595/kompartemen.v18i2.7524

Aqbar, K., & Iskandar, A. (2019). Kontekstualisasi Ekonomi Zakat dalam Mengentaskan Kemiskinan: Studi Kebijakan Zakat Umar Bin Khattab dan Perzakatan di Indonesia. *Laa Maisyir*, *6*(2).

Asmawi, A., Sjoraida, D. F., & Anwar, R. K. (2017). MASALAH DAN DINAMIKA IMPLEMENTASI KEBIJAKAN PUBLIK TENTANG TRANSPORTASI (Kajian Di Kota Tasikmalaya, Jawa Barat). *CosmoGov*, *3*(2). https://doi.org/10.24198/cosmogov.v3i2.14729

Bilqis, N., & Zaki, I. (2020). DAMPAK PENGELOLAAN ZIS LAZNAS AL-AZHAR BAGI PEMUDA PADA PROGRAM RUMAH GEMILANG INDONESIA SURABAYA. *Jurnal Ekonomi Syariah Teori Dan Terapan*, *7*(4). https://doi.org/10.20473/vol7iss20204pp659-667

Bogaevskaya, O. V. (2019). National food assistance system in the USA. *World Economy and International Relations*, *63*(1), 75–82. https://doi.org/10.20542/0131-2227-2019-63-1-75-82

BPS. (2024). *Statistics Indonesia 2024*. Badan Pusat Statistik Republik Indonesia.

Chai, J., Hao, Y., Wu, H., & Yang, Y. (2021). Do constraints created by economic growth targets benefit sustainable development? Evidence from China. *Business Strategy and the Environment*, *30*(8). https://doi.org/10.1002/bse.2864

Chen, Y. (2016). Spatial autocorrelation approaches to testing residuals from least squares regression. *PLoS ONE*, *11*(1). https://doi.org/10.1371/journal.pone.0146865

Congdon, P. (2021). Bayesian Modeling of Spatial Data. In *Handbook of Regional Science: Second and Extended Edition: With 238 Figures and 78 Tables*. https://doi.org/10.1007/978-3-662-60723-7_79

Czyżewski, B., Trojanek, R., Dzikuć, M., & Czyżewski, A. (2020). Cost-effectiveness of the common agricultural policy and environmental policy in country districts: Spatial spillovers of pollution, bio-uniformity and green schemes in Poland. *Science of the Total Environment*, *726*. https://doi.org/10.1016/j.scitotenv.2020.138254

Dumelle, M., Higham, M., & Ver Hoef, J. M. (2023). spmodel: Spatial statistical modeling and prediction in R. *PLoS ONE*, *18*(3 March). https://doi.org/10.1371/journal.pone.0282524

Geyer, S., Papaioannou, I., & Straub, D. (2021). Bayesian analysis of hierarchical random fields for material modeling. *Probabilistic Engineering Mechanics*, *66*. https://doi.org/10.1016/j.probengmech.2021.103167

Goodchild, M. F. (2009). First Law of Geography. In *International Encyclopedia of Human Geography*. https://doi.org/10.1016/B978-008044910-4.00438-7

Hadiyati, N. (2019). INTEGRASI PAJAK DAN ZAKAT SEBAGAI SUMBER PEMBIAYAAN PEMBANGUNAN NASIONAL. *Legality : Jurnal Ilmiah Hukum*, *26*(2). https://doi.org/10.22219/jihl.v26i2.7777

Harahap, A. H. (2021). *Pengaruh zakat terhadap pertumbuhan ekonomi dengan pengentasan kemiskinan sebagai variabel moderating di Provinsi Sumatera Utara*.

Heri Mis Cicih Lembaga Demografi, L., Ekonomi Bisnis, F., Nurjono Agung Nugroho Pusat Penelitian dan Pengembangan Kependudukan, D., Jl Permata No, B., Perdana Kusuma, H., & Timur, J. (2021). KONDISI LANJUT USIA DI INDONESIA ERA BONUS DEMOGRAFI. *Sosio Informa*, *7*(2). https://doi.org/10.33007/INF.V7I2.2681

Herlita, J. (2017). Sinergi Pelayanan Zakat dan Pajak Dalam Upaya Mengurangi Kemiskinan. *Alhadharah: Jurnal Ilmu Dakwah*, *16*(32). https://doi.org/10.18592/alhadharah.v16i32.1927

Hunjra, A. I., Arunachalam, M., & Hanif, M. (2024). The Role of Islamic Social Finance in Poverty Eradication. In *Islamic Finance in the Modern Era: Digitalization, FinTech and Social Finance*. https://doi.org/10.4324/9781003366751-3

Ichdayati, L. I., & Puspitasari, R. A. (2021). INTENSITAS PETANI MUZAKI MEMBAYAR ZAKAT PADI (Studi Kasus Kabupaten Indramayu). *Sharia Agribusiness Journal*.

IMD. (2025). *World Competitiveness Ranking*. https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/rankings/wcr-rankings/

Jamaluddin, H., Tinggi, S., Islam, A., & Watampone, N. (2021). REAKTUALISASI FIKIH ZAKAT MENUJU ADMINISTRASI IDEAL. *AL-IQTISHAD*, *1*(1), 72–92.

Kalimah, S. (2020). Pandangan Ulama Empat Mazhab dalam Memutuskan Upah Amil Zakat Guna Meningkatkan Optimalisasi Keprofesionalan Amil Zakat. *Salimiya: Jurnal Studi Ilmu Keagamaan Islam*, *1*(1).

Kandala, N. B. (2006). Bayesian geo-additive modelling of childhood morbidity in Malawi. *Applied Stochastic Models in Business and Industry*, *22*(2). https://doi.org/10.1002/asmb.624

Kang, H. Bin, Jung, Y. J., & Park, J. (2024). Fast Bayesian Functional Regression for Non-Gaussian Spatial Data. *Bayesian Analysis*, *19*(2). https://doi.org/10.1214/22-BA1354

Karim, A., Faturohman, A., Suhartono, S., Prastyo, D. D., & Manfaat, B. (2017). Regression Models for Spatial Data: An Example from Gross Domestic Regional Bruto in Province Central Java. *Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi Dan Pembangunan*, *18*(2), 213. https://doi.org/10.23917/jep.v18i2.4660

Karim, A., Mudhofi, M., & Arwani, W. (2020). ANALISIS SPASIAL POTENSI ZAKAT DAN KEMISKINAN DI INDONESIA. *Ijtimaiyya: Jurnal Pengembangan Masyarakat Islam*, *13*(2), 117–130. https://doi.org/10.24042/IJPMI.V13I2.6853

Karim, A., Suharno, Y., & Arwani, W. (2019). Pemberdayaan Sekolah Islam untuk Meningkatkan Kompetensi Profesionalisme Guru di Kabupaten Semarang. *Jurnal Ilmu Dakwah*, *39*(1). https://doi.org/10.21580/jid.v39.1.4421

Karim, A., Suhartono, & Prastyo, D. D. (2020). Spatial spillover effect of transportation infrastructure on regional growth. *Economy of Region*, *16*(3), 911–920. https://doi.org/10.17059/ekon.reg.2020-3-18

Karim, A., Utami, T. W., Fathurohman, A., Setyowati, C. I., Suhartono, & Prastyo, D. D. (2020). Assessing the indicators of economic growth in Indonesia using spatial principal components analysis. *Journal of Physics: Conference Series*, *1446*(1). https://doi.org/10.1088/1742-6596/1446/1/012051

Kim, Y. R., Williams, A. M., Park, S., & Chen, J. L. (2021). Spatial spillovers of agglomeration economies and productivity in the tourism industry: The case of the UK. *Tourism Management*, *82*. https://doi.org/10.1016/j.tourman.2020.104201

Krapu, C., Stewart, R., & Rose, A. (2023). A Review of Bayesian Networks for Spatial Data. *ACM Transactions on Spatial Algorithms and Systems*, *9*(1). https://doi.org/10.1145/3516523

Lacombe, D. J., & McIntyre, S. G. (2016). Local and global spatial effects in hierarchical models. *Applied Economics Letters*, *23*(16), 1168–1172. https://doi.org/10.1080/13504851.2016.1142645

Lee, S. A., Economou, T., & Lowe, R. (2022). A Bayesian modelling framework to quantify multiple sources of spatial variation for disease mapping. *Journal of the Royal Society Interface*, *19*(194). https://doi.org/10.1098/rsif.2022.0440

Ling, Y., & Le Gallo, J. (2023). Bayesian spatial panel models: a flexible Kronecker error component approach. *Letters in Spatial and Resource Sciences*, *16*(1). https://doi.org/10.1007/s12076-023-00362-8

Louzada, F., Do Nascimento, D. C., & Egbon, O. A. (2021). Spatial statistical models: An overview under the bayesian approach. *Axioms*, *10*(4). https://doi.org/10.3390/axioms10040307

Lu, B., & Dong, G. (2022). GWmodelS: A High-Performance Computing Framework for Geographically Weighted Models. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 13614 LNCS*. https://doi.org/10.1007/978-3-031-24521-3_11

Maulidina, T. P., & Oktora, S. I. (2020). ANALISIS SPASIAL KETERTINGGALAN DAERAH DI INDONESIA TAHUN 2018 MENGGUNAKAN GEOGRAPHICALLY WEIGHTED LOGISTIC REGRESSION. *Indonesian Journal of Statistics and Its Applications*, *4*(3). https://doi.org/10.29244/ijsa.v4i3.690

Moraga, P., Dean, C., Inoue, J., Morawiecki, P., Noureen, S. R., & Wang, F. (2021). Bayesian spatial modelling of geostatistical data using INLA and SPDE methods: A case study predicting malaria risk in Mozambique. *Spatial and Spatio-Temporal Epidemiology*, *39*. https://doi.org/10.1016/j.sste.2021.100440

Omre, H., & Rimstad, K. (2021). Bayesian spatial inversion and conjugate selection gaussian prior models. *SIAM-ASA Journal on Uncertainty Quantification*, *9*(2). https://doi.org/10.1137/19M1302995

Pratama, N. W., & Purba, I. (2021). STRATEGI BADAN AMIL ZAKAT NASIONAL KABUPATEN TUBAN DALAM PENGELOLAAN ZAKAT SEBAGAI UPAYA MENURUNKAN ANGKA KEMISKINAN UNTUK …. *Kajian Moral Dan …*.

Pratama, Y. C. (2015). PERAN ZAKAT DALAM PENANGGULANGAN KEMISKINAN (Studi Kasus : Program Zakat Produktif Pada Badan Amil Zakat Nasional). *Tauhidinomics: Journal of Islamic Banking and Economics*, *1*(1).

Qomari, N. (2017). Zakat: Solusi Pengentasan Kemiskinan. *Iqtishodia Jurnal Ekonomi Syariah*, *2*(2).

Razen, A., & Lang, S. (2020). Random scaling factors in Bayesian distributional regression models with an application to real estate data. *Statistical Modelling*, *20*(4), 347–368. https://doi.org/10.1177/1471082X18823099

Roman, Z. J., & Brandt, H. (2023). A Latent Auto-Regressive Approach for Bayesian Structural Equation Modeling of Spatially or Socially Dependent Data. *Multivariate Behavioral Research*, *58*(1), 90–114. https://doi.org/10.1080/00273171.2021.1957663

Rural Poverty and the Nonfarm Sector in Rural Asia. (2024). In *Reducing Rural Poverty in Asia: Challenges and Opportunities for Microenterprises and Public Employment Schemes*. https://doi.org/10.4324/9781003578345-2

Samatar, E. H. (2025). Social Safety Nets and Their Effectiveness in Poverty Alleviation: Evidence from Banadir Region, Somalia. *Journal of Environmental and Earth Sciences*, *7*(3), 77–87. https://doi.org/10.30564/jees.v7i3.8063

Satpathy, A., Ayyalasomayajula, S., & Srivastava, A. (2023). Predictive Risk Assessment for Homelessness. *29th Annual Americas Conference on Information Systems, AMCIS 2023*.

Setiyowati, A. (2017). Analisis Peranan Pengelolaan Dana ZISWAF Oleh Civil Society Dalam Pemberdayaan Ekonomi Umat (Studi Kasus Lazismu Surabaya). *Jurnal Ekonomi Dan Perbankan Syariah*, *2*(1).

Shaifudin, A. (2020). PENDIDIKAN ISLAM UNTUK KEUTUHAN NEGARA KESATUAN REPUBLIK INDONESIA (NKRI). *El-Wasathiya: Jurnal Studi Agama*, *8*(1).

1st Authhor's Last name et al. / Geoplanning: Journal of Geomatics and Planning, Vol x, No x, year, pp-pp
DOI: 10.14710/geoplanning.8.1.pp-pp

Sofianto, A. (2019). INTEGRASI TARGET DAN INDIKATOR SUSTAINABLE DEVELOPMENT GOALS (SDGs) KE DALAM PERENCANAAN PEMBANGUNAN DAERAH DI JAWA TENGAH. *Jurnal Litbang Provinsi Jawa Tengah*, *17*(1). https://doi.org/10.36762/jurnaljateng.v17i1.784

Sulaiman, A. J., Ahmad, S. N. H. J. N. N., Bidin, Z., Abd Aziz, S., & Ibrahim, I. (2025). Empowering Lives: Unveiling the Impact of LZNK Business Capital Assistance through the MAQASID SHARIAH Lens in Alignment with the Sustainable Development Goals (SDG). *Journal of Information Systems Engineering and Management*, *10*(5), 162–171. https://doi.org/10.52783/jisem.v10i5s.600

Syari'ah, F., Surakarta, I., & Efendi, M. (2017). PENGELOLAAN ZAKAT PRODUKTIF BERWAWASAN KEWIRAUSAHAAN SOSIAL DALAM PENGENTASAN KEMISKINAN DI INDONESIA. *Al-Ahkam Jurnal Ilmu Syari'ah Dan Hukum*, *2*(1). https://doi.org/10.22515/AL-AHKAM.V2I1.679

Thalgi, M. J. (2024). Altruism and Social Cohesion: An Islamic Perspective of Charitable Acts for Sustainable Development. *Journal of Islamic Thought and Civilization*, *14*(2), 42–62. https://doi.org/10.32350/jitc.142.04

Wang, G. (2022). Laplace approximation for conditional autoregressive models for spatial data of diseases. *MethodsX*, *9*. https://doi.org/10.1016/j.mex.2022.101872

Zhao, Y., & Xu, D. (2023). A Bayesian Variable Selection Method for Spatial Autoregressive Quantile Models. *Mathematics*, *11*(4). https://doi.org/10.3390/math11040987