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RESEARCH ARTICLE

Understanding Pediatric Health Trends in Papua: Insights From SUSENAS, RISKESDAS, Remote Sensing, and Its Relevance to Prabowo and Gibran's Free Lunch and Milk Program

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ABSTRACT This research endeavors to conduct a thorough investigation into pediatric health in the Papua and West Papua regions of Indonesia, employing a multifaceted approach that integrates data from various sources including RISKESDAS, SUSENAS, and remote sensing indicators such as NDVI (Normalized Difference Vegetation Index) and PDSI (Palmer Drought Severity Index). By amalgamating socio-economic data, health metrics, and environmental variables, the study seeks to achieve a comprehensive understanding of the factors influencing child health. Advanced analytical tools, notably the Generalized Linear Latent Variable Model (GLLVM), are utilized to conduct a dual-analysis of the intricate interplay between health indicators and environmental variables. The incorporation of NDVI and PDSI, derived from remote sensing data, introduces an ecological dimension to the investigation, facilitating a nuanced exploration of the impact of vegetation health and drought severity on pediatric health outcomes. This interdisciplinary research endeavors to unveil correlations, patterns, and potential causal relationships between environmental factors and the prevalence of various health issues among children, including pneumonia, acute respiratory

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infections, diarrhea, underweight, and stunting. The anticipated results aim to not only enrich our understanding of pediatric health in Papua and West Papua but also to contribute to broader discussions concerning the complex connections between health, socio-economic conditions, and environmental variables. By integrating remote sensing data with health and socio-economic datasets, this study provides a comprehensive perspective, enabling a more robust assessment of the determinants of child well-being. The insights gleaned from this research are poised to have significant implications for policymakers, environmental scientists, and public health professionals, informing the development of strategies aimed at enhancing child health outcomes in these regions. Furthermore, this study underscores the importance of initiatives like the Free Lunch and Milk Program proposed by Prabowo and Gibran in the 2024 Indonesian Presidential Election, emphasizing the critical role of holistic approaches in addressing the multifaceted challenges surrounding child health and well-being.

INDEX TERMS Pediatric health, socio-economic factors, RISKESDAS, SUSENAS, remote sensing, free lunch, milk program.

I. INTRODUCTION

Every nation is committed to eradicating hunger within its borders. The Global Hunger Index (GHI) recently published a report identifying countries facing the most severe hunger challenges worldwide in 2022. This valuable information provides a benchmark for Indonesia to guide its ongoing improvement initiatives. Utilized for a comprehensive assessment of hunger at global, regional, and national levels, the GHI derives its score from four critical indicators: malnutrition, stunting, child wasting, and child mortality. The GHI report elucidates a country's hunger situation concerning the fundamental physiological needs of its population, particularly focusing on food and nutrition [1].

This report highlights over 10 countries globally grappling with the highest levels of hunger, offering a valuable assessment tool for the Indonesian government to prevent analogous scenarios. According to the Global Hunger Index Report, Indonesia holds the 77th position among 121 countries, with a Global Hunger (GHI) score of 17.9, signifying a moderate level of hunger. It's worth noting that Indonesia reached its peak GHI in 2007 at 29.1, indicating a severe state of hunger. An elevation in a country's GHI score denotes a deteriorating hunger situation, with the four indicators serving as a representation of a country's nutritional well-being. In 2007, over 19 million Indonesians experienced malnutrition, and approximately 2-3 children per hundred succumbed before reaching the age of 5. Despite a significant reduction, with the hunger index at 17.9 in 2022, it's essential to recognize that Indonesia still contends with a high hunger index within Southeast Asia [2], [3]. Notably, this index is below Laos, which holds the highest hunger rate in ASEAN at 19.2.

Delving deeper into the context of hunger and nutritional challenges in Indonesia, it's crucial to highlight the persistent issue of stunting [4], [5], [6], [7], which has profound implications for the nation's health and development. Stunting, characterized by impaired growth and development in children due to chronic malnutrition, remains a critical concern that demands targeted interventions [8], [9], [10]. The Global Hunger Index report indicates that Indonesia, while making strides in reducing its overall hunger index, is still grappling with significant rates of stunting. Stunting not only affects physical growth but also hampers cognitive development, leading to long-term consequences for the affected individuals and the nation [11], [12]. The prevalence of stunting in Indonesia is often linked to insufficient access to nutritious food during the crucial early years of a child's life. Despite progress, there's a need for comprehensive strategies addressing the root causes of stunting, including improving maternal nutrition, promoting exclusive breastfeeding, and enhancing access to diverse and nutritious diets for children [13], [14], [15], [16].

Government initiatives, NGOs, and international collaborations play a pivotal role in implementing programs focused on eradicating stunting. These programs often include nutritional education for mothers, healthcare access improvements, and community-based interventions to ensure a holistic approach to combat malnutrition [17], [18], [19], [20]. While the Global Hunger Index provides an essential snapshot, it's equally important to recognize the multidimensional nature of these challenges. Factors such as socio-economic disparities, geographical variations, and cultural practices contribute to the complexity of addressing hunger and stunting in Indonesia [3], [21].

This paper explores the Impact and Management of Stunting in Papua, addressing challenges and striving for Sustainable Human Development. Despite its wealth of natural resources, Papua grapples with severe challenges in nutrition and growth, significantly affecting the welfare of its people. Factors such as geographical isolation, limited access to nutritious food, and inadequate health infrastructure present significant barriers to intervention efforts. Moreover, cultural traditions and environmental repercussions from natural resource exploitation are crucial in understanding the complexities of stunting in Papua. Historical factors and conflicts further complicate community well-being and development. Government initiatives in Indonesia, in collaboration with international and non-governmental entities, play pivotal roles in addressing these challenges. Efforts are focused on enhancing health infrastructure, providing nutritional education, and implementing sustainable development programs. Within this context, we explore comprehensive approaches

necessary to address nutritional and stunting challenges in Papua, aiming to make a positive contribution to sustainable human development in the region.

This paper is structured as follows: In Section I, we provide the motivation for this research. Section II delves into the study area in Papua, detailing the data utilized. Section III outlines our method, GLLVM, and spatial Moran's I. In Section IV, we present the results and discussion, focusing on the identification of Optimal Variables for Stunting, the Phenomenon of Kretek Cigarette Consumption and Its Impact on Poverty in Papua and West Papua, as well as the Reasoning behind ARI, Malnourishment, Pneumonia, and Stunting in Papua and West Papua. Section V concludes the paper, followed by Section VI, which covers Practical Implications and Recommendations.

II. STUDY AREA

A. PAPUA PROVINCE

Papua, a province rich in cultural and natural diversity, faces serious challenges regarding the well-being of its children [21], [22], [23], [24], [25]. One of the detrimental health issues requiring serious attention is stunting. Stunting is a condition of failed growth that can have long-term impacts on the physical and mental development of children. This article aims to delve into the factors causing stunting in Papua, its implications for the community, and the efforts that can be undertaken to address this issue. Stunting is a highly dynamic issue for both developing and underdeveloped countries. It is a target of the Sustainable Development Goals (SDGs), specifically part of the second goal, which aims to eliminate hunger and all forms of malnutrition by 2030, ensuring food security [26], [27]. Achieving this ambitious target requires helix collaboration. Helix collaboration refers to a multidimensional and interconnected approach involving various stakeholders, such as government agencies, non-governmental organizations (NGOs), community leaders, healthcare professionals, and other relevant parties, working together in a coordinated manner. This collaborative effort aims to achieve a common goal or ambitious target, often requiring innovative and integrated strategies. In the context provided, helix collaboration involves synergizing efforts from diverse sectors to provide comprehensive steps and solutions for addressing stunting and wasting in children under 5 years old, as well as meeting the nutritional needs of specific vulnerable groups including adolescent girls, pregnant and lactating mothers, and the elderly [28], [29], [30].

Stunting is a major public health concern in low- and middle-income countries due to its association with an increased risk of childhood mortality and other diseases moderating stunting in toddlers [31], [32], [33]. It can have both acute and long-term effects on pneumonia outcomes. During acute pneumonia treatment and recovery, stunted children may have reduced respiratory reserves compared to taller children, increasing their risk of poor outcomes [34], [35], [36], [37]. Additionally, statistically, Acute Respiratory Infections (ARIs) significantly influence the occurrence of stunting. Infections lead to disruptions in body metabolism and the immune system due to inflammation [38], [39], [40]. Besides inadequate nutritional intake resulting from reduced appetite, the connection between infection history and growth disturbances is related to the inflammation mechanisms occurring. Causes of stunting include environmental factors such as poor sanitation, leading to diseases like prolonged diarrhea that can disrupt nutrient absorption during digestion. Maternal factors, such as mothers with Chronic Energy Deficiency (CED) and inadequate nutrient intake during pregnancy, also contribute. Factors related to infants and toddlers, such as Low Birth Weight (LBW), further exacerbate the issue. Nutritional status issues are not just health problems; they encompass social, economic, cultural, parenting, educational, and environmental issues. Contributing factors include poverty, lack of knowledge, parental busyness leading to insufficient time for childcare, inadequate food supply, diseases affecting nutrient intake, and a lack of knowledge about balanced menus and health [41], [42], [43], [44].

Factors influencing nutritional status include maternal factors, child-rearing practices, the child's health condition, and the child's food consumption. Low maternal knowledge is a fundamental factor affecting individuals, families, and communities' ability to manage existing human resources to achieve food, health, and nutrition sufficiency [45], [46], [47], [48]. Parental education also determines how easily someone absorbs and understands the nutritional knowledge they acquire and plays a role in determining food composition patterns and child-rearing patterns. The arrangement of food patterns is closely related to maternal knowledge about food ingredients such as carbohydrates, proteins, fats, vitamins, and minerals. In theory, if mothers have a high level of education, they are more likely to understand nutritional information and tend to create good and healthy eating habits for the family [49], [50], [51], [52], [53].

However, like two sides of a different coin, mothers with high education levels may become the primary breadwinners in the family, replacing the role of husbands in providing for the family, and may not be optimal in overseeing the child's growth and development [54]. There is a tendency for working mothers to have extensive knowledge about toddler nutrition, providing information about toddler nutrition to caregivers at home so that the working mother's job status is no different from that of a non-working mother who can directly care for her toddler [55], [56], [57].

Figure 1 provides a detailed timeline of famine events in Papua, spanning the period from 1982 to 2023. The data, sourced through a Google search, offers valuable insights into the historical patterns and trends associated with famine occurrences in this region. Let's delve deeper into the information presented.The concentration of famine-related tragedies in the months of December, January, and February across different years suggests a recurring seasonal aspect to these events. This temporal pattern could be indicative of adverse climatic conditions during these months, influencing factors such as agricultural productivity, food availability, and

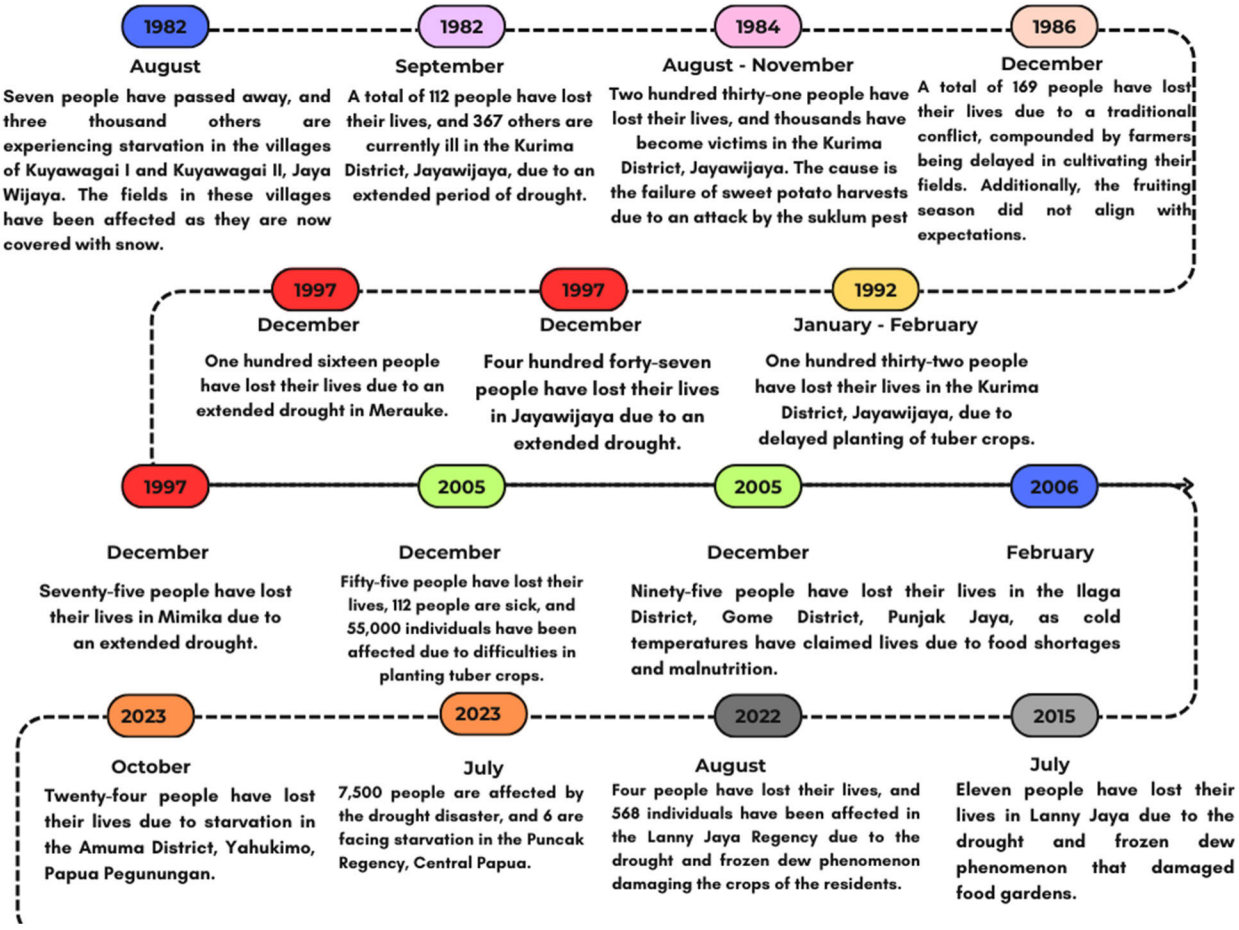

FIGURE 1. Timeline of famine events in Papua.

access to resources. Understanding these seasonal variations is crucial for implementing effective preventive measures and response strategies to mitigate the impact of famines on the affected communities. Equally noteworthy is the observation that a significant number of famine incidents occur in July and August. This could be attributed to distinct climatic patterns during these months, affecting food production, distribution, and overall food security. Analyzing these seasonal trends can guide policymakers, humanitarian organizations, and local communities in developing targeted interventions and adaptive measures to address vulnerabilities during specific periods of the year.

The identified regions most frequently affected by famine events—Jaya Wijaya, Yahukimo, and the Pegununangan area—highlight geographic hotspots where the impact of these crises is more pronounced. Factors such as terrain, infrastructure, and socio-economic conditions in these regions may contribute to their heightened vulnerability. Recognizing these hotspots is instrumental in prioritizing resource allocation, disaster preparedness, and community resilience initiatives. Beyond the temporal and spatial analysis, it is crucial to investigate the root causes of famines in Papua. Environmental factors, such as climate change and extreme weather events, economic disparities, limited access to education and healthcare, and political instability, could all contribute to the vulnerability of communities in the face of food insecurity. A comprehensive understanding of these underlying factors is essential for formulating sustainable, long-term solutions.

B. DATA UTILIZED

In **Table 1**, a comprehensive overview of variable details stemming from the Indonesia Basic Health Research (RISKESDAS) is presented. The data on percentage prevalence rates for various health indicators, such as pneumonia, acute respiratory infections (ARI), diarrhea, underweight, stunting, and malnutrition, has been meticulously sourced from the Papua Barat Province Report RISKESDAS 2018. These specific prevalence rates have been meticulously derived using data provided by the Ministry of Health, National Institute of Health Research and Development. The report, emanating from Papua Barat Province, serves as a valuable resource in understanding the health landscape, offering insights into the health conditions prevalent in the region. The authoritative nature of the information is underscored by the reputable source, the Ministry of Health, which

TABLE 1. RISKESDAS-Reported prevalence rates.

Variable	Definition
u5_pneumonia	The prevalence of children under 5 years old who are diagnosed with pneumonia by medical practitioners (doctor/nurse/midwife) or having symptoms of pneumonia. $\frac{\Sigma\ Pneumonia\ case\ (0-60\ months)}{Total\ sample\ size\ (0-60\ months)} x100$
u5_ari	The prevalence of children under 5 years old who are diagnosed with acute respiratory infection (ARI) by medical practitioners (doctor/nurse/midwife) or having symptoms of acute respiratory infection. $\frac{\Sigma\ ARI\ case\ (0-60\ months)}{Total\ sample\ size\ (0-60\ months)} x100$
u5_diarrhea	The prevalence of children under 5 years old who diagnosed with diarrhea by medical practitioners or having symptoms of dirrhea. $\frac{\Sigma\ Diarrhea\ case\ (0-60\ months)}{Total\ sample\ size\ (0-60\ months)} x100$
u5_underweight	The percentage of children under 5 years old with Weight under Z(-0.2) in WHO 2005 anthropometric standards for toddlers $\frac{\sum_{i=0}^{60} weight_i < Z_{-2.0}}{Total\ sample\ size\ (0-60\ months)} x\ 100$
u5_stunting	The percentage of children under 5 years old with Height under Z(-0.2) in WHO 2005 anthropometric standards for toddlers $\frac{\sum_s \sum_{i=0}^{60} height_i < Z_{-2.0}}{Total\ sample\ size\ (0-60\ months)} x\ 100$ $s = \{male, female\}$
u5_malnourished	The percentage of children under 5 years old with the ratio Weight/Height under Z(-0.2) in WHO 2005 anthropometric standards for toddlers $\frac{\sum_s \sum_{i=0}^{24} ratio_{s,i} < Z_{-2.0} + \sum_{sj} \sum_{j=24}^{60} ratio_{s,j} < Z_{-2.0}}{Total\ sample\ size\ (0-60\ months)} x100$ $s = \{male, female\}$

plays a pivotal role in health research and development at the national level. The data is further solidified by its publication through the Jakarta-based Publishing Institute for Health Research and Development in 2019, adding a layer of credibility and transparency to the findings. This comprehensive approach ensures that the variables and prevalence rates outlined in **Table 1** are not only derived from a reputable national health research initiative but are also bolstered by the specific insights gleaned from the Papua Barat Province, providing a nuanced understanding of health challenges in that region.

The integration of NDVI Mean Scale and PDSI Mean Scale into our remote sensing dataset, as detailed in **Table 3,** serves as a critical component in our endeavor to comprehensively analyze health indicators, specifically Acute Respiratory Infections (ARI), malnutrition, pneumonia, and stunting in Papua and West Papua. The utilization of NDVI Mean Scale holds significance in understanding the potential correlations between respiratory health and environmental conditions, as demonstrated by the continuity index with NOAA-AVHRR-derived NDVI, ensuring historical context reliability. This spectral index, indicative of vegetation health, may shed light on the quality of air and its impact on respiratory well-being, contributing to a more nuanced exploration of ARI prevalence.

Furthermore, the incorporation of NDVI Mean Scale allows for an exploration of how vegetation density influences food resources, contributing insights into malnutrition patterns. The inclusion of these environmental parameters in our dataset, detailed in **Table 2**, aims to provide a nuanced understanding of the intricate connections between ecosystem health and human well-being, transcending conventional health indicators and contributing to a more comprehensive analysis of health dynamics in Papua and West Papua.

TABLE 2. Remote sensing variable.

Variables	Information
NDVI Mean Scale	Normalized Difference Vegetation Index. The MOD13Q1 V6.1 product provides a Vegetation Index (VI) value at a per pixel basis [58], [59], [60].
PDSI Mean Scale	The Palmer Drought Severity Index (PDSI) is a widely used measure in meteorology and climatology to assess and quantify drought conditions [61], [62].

In the SUSENAS dataset, delineated **in Table 3,** Block VI emerges as a pivotal repository of information encompassing migration, birth certificates, and education. Notably, it meticulously outlines the sequence related to the biological mother, underscoring the significance of clarifying her residence status within the household. Furthermore, blocks 609, 610, and 611 delve into the individual's multilingual capacities, probing proficiency in scripts like Latin/Alphabet, Arabic/Hijaiyah, and others such as Javanese, Kanji, or Chinese. Each inquiry contributes to a nuanced comprehension of linguistic aptitudes.

Transitioning to Block VII, this section probes the domains of savings and employment ownership. Question 702 explores a spectrum of activities undertaken in the past week, presenting respondents with options encompassing work, school attendance, household chores, engagement in non-personal activities, or opting for no activity. Question 703 delves deeper, prompting participants to identify the predominant time-consuming activity, whether it be work, school, household chores, or other non-personal pursuits. Finally, Question 705 directs attention to the respondent's place of employment, seeking insights into the primary business field or occupational domain. Collectively, these well-structured blocks and associated questions synergize to form a comprehensive dataset. This dataset, in turn, offers a profound understanding of socioeconomic facets and individual engagements over a specified timeframe.

III. METHODOLOGY

A. GENERALIZED LINEAR LATENT VARIABLE MODEL (GLLVM)

Clustering is a data analysis approach that allows the grouping of objects or data into clusters that exhibit certain

TABLE 3. Suseneas block questions.

Block	Susenas Code	Questions
Block VI. Migration Information, Birth Certificate, And Education	601	Sequence:MotherBiological See Block IV(Fill In 00 If TheBiological Mother Does NotReside In This Household)
	609	Is (Name) Able To Read AndWrite Simple Sentences In Everyday LanguageWith The Latin/Alphabet?
	610	Is (Name) Able To Read And Write Simple SentencesIn Everyday Language With TheArabic/ Hijaiyah Script? 1.Yes 0.No
	611	Is (Name) Able To Read And Write Simple Sentences In Everyday LanguageWith Different Scripts? (Example: Javanese, Kanji, Chinese, Etc.) 1. Yes 5. No
	615	What Is The Highest Degree/Certificate Possessed By (Name)?
Block VII. Information on Savings and Employment Ownership	702	Over The Past Week,What Activities Has (Nama) Engaged In?(The Answer Options Should Be Read Aloud) A. Working B. School C. Household Chores D. Other Than Personal Activities X. Did Not Engage In Any Activity
	703	From The Activities Undertaken Over The Past Week Which Activity Consumed The Most Time? 1. Working 2. School 3. Household Chores 4. Other Than Personal Activities
	705	Over The Past Week,What Is The Main Business Field Or Occupational Area Of (Name)'S Place Of Employment?

similarities [63], [64], [65]. In the context of mapping stunting areas, clustering becomes a highly useful tool for revealing hidden structures and relationships among various regions. This process enables researchers and policymakers to better understand patterns that may be associated with stunting levels in different areas [66], [67], [68], [69], [70]. Several clustering techniques applicable to mapping stunting areas include K-Means Clustering, which groups areas based on average attribute values such as stunting rates. This technique helps identify areas with similar characteristics in terms of child health and nutrition. Hierarchical Clustering forms a cluster hierarchy by merging or splitting clusters based on similarity levels, providing an overview of the hierarchical relationships between areas based on their stunting rates. DBSCAN (Density-Based Spatial Clustering of Applications with Noise) identifies areas with high density as clusters, aiding in discovering patterns of high stunting density in specific regions [71]. Fuzzy C-Means allows data to belong to more than one cluster with different membership levels, useful when there is uncertainty or overlap in stunting data in a particular area [68], [72], [73].

While clustering techniques have significant utility in analyzing and mapping data, there are several drawbacks to consider. Firstly, techniques like K-Means are highly sensitive to variable selection. If the chosen variables do not well represent the actual patterns in the data, clustering results may be inaccurate. Furthermore, K-Means is susceptible to the initial centering of clusters, which can influence the final solution. Other limitations include mismatch for complex or irregular cluster shapes, sensitivity to outliers, and dependency on determining the number of clusters (K) [74], [75], [76], [77], [78], [79]. Additionally, some clustering methods are ineffective in handling data with uneven or skewed distributions. Sensitivity to variable scale is also an issue, where variables with large scales can dominate calculations.

Lastly, some clustering methods assume that clusters are stationary, limiting their applicability to dynamic data. Nevertheless, many of these limitations can be overcome by using more sophisticated clustering methods or through careful data preprocessing before applying clustering algorithms. In this study, we employed the GLLVM (Generalized Linear Latent Variable Model) method, which encompasses a general model that includes GLM (Generalized Linear Model). GLM is a framework used to link response variables to one or more predictors through a corresponding link function and distribution function. GLLVM introduces latent variables into the GLM framework [80], [81], [82], [83], [84].

Latent variables are not directly observed but are considered to have an impact on the response variable. Latent variables provide an additional dimension to the model to capture structure or variability that cannot be directly measured. GLLVM allows the creation of a model that can capture structural dependencies between response variables and latent variables. Additionally, there is a stochastic element that allows for random or unforeseen variability, theoretically aligning with the conditions of stunting in Papua to address situations where observed variables (response) cannot be fully explained by observed variables (predictors), and there are unseen components influencing the relationship between them [80], [82], [83].

This multivariate approach involves an analysis using Generalized Linear Latent Variable Models (GLLVMs) with n rows explaining observations of districts/cities in the provinces of Papua and West Papua. Furthermore, m rows describe the independent variables used, including information on diseases, social factors, and environmental variables as previously explained in the preceding section. For instance, the abundance of each disease j at location i is denoted as y_{ij}. The environmental variables used include NDVI and PDSI, explained as variables in the vector $x_i = (x_{i1}, \ldots, x_{ik})^T$.This

GLLVM model is employed to regress the mean value

$$g\left(\mu_{i,j}\right) = \eta_{ij} = \alpha_i + \beta_{0,j} + \boldsymbol{x}_i^T \beta_j + \boldsymbol{u}_i^T \gamma_j$$

In this model, we describe that β_j and γ_j are disease coefficient vectors explained by covariates and using latent variables. Then, $\boldsymbol{u_i}$ describes the environmental variables used, $\beta_{0,j}$ serves as the disease-explaining parameter and intercept, while α_i represents the province locations in Papua and West Papua, which can be chosen through fixed or random effects $\left(\alpha_i \sim N\left(0, \sigma^2\right)\right)$ [85]. The estimations used can be variational approximation or Laplace approximation, depending on the distribution employed.

B. SPATIAL MORANS I

Changes in global and local spatial disparities can be identified through spatial correlation indices among spatial statistical techniques. This index quantitatively measures the extent of similarity in attribute values of a geographic unit within the study area with the values of surrounding areas. The cornerstone of these indices is Moran's I (Moran, 1948), which is the most used global index. It utilizes the concept of covariances to determine the similarity of values between reference areas and neighboring areas by comparing them with the overall average. The formula is as follows:

$$I = \frac{n \sum_i \sum_j w_{ij} \left(x_i \bar{x}\right) \left(x_j - \bar{x}\right)}{w \sum_i \left(x_i - \bar{x}\right)^2}$$

In the realm of spatial analysis, several crucial parameters come into play. The variable n represents the number of spatial units under consideration, each contributing to the overall landscape. The spatial weight matrix, denoted as w_{ij}, encapsulates the interconnection and influence between these spatial units, forming a matrix that reflects the spatial relationships. Additionally, the environmental weight matrix, denoted as w, represents the sum of environmental weights for all pairs of spatial units where i is not equal to j. This matrix encapsulates the collective environmental impact of neighboring spatial units. The variables x and x_j denote the observations in region i and region j, respectively, representing the data points or attributes associated with each spatial unit. Together, these parameters lay the foundation for spatial analysis, enabling the exploration and understanding of spatial relationships, environmental influences, and observational patterns within a given geographic context. The Moran I value ranges from -1 to 1. The closer all surrounding areas have similar values, the closer it is to the value of 1, indicating that similar values cluster regionally. Conversely, if the values in the surrounding areas are perfectly distributed, it approaches -1.

IV. RESULTS

A. OPTIMAL VARIABLES FOR STUNTING

Understanding the complex interplay between environmental factors, socioeconomic conditions, and health outcomes is crucial in unpacking the multifaceted challenges faced by the regions of Papua and Papua Barat. The pronounced impact of the normalized difference vegetation index (NDVI) on respiratory and diarrheal diseases underscores the significance of environmental health in shaping public well-being. The Palmer Drought Severity Index (PDSI) further adds a layer of understanding, linking prolonged drought to underweight conditions, revealing a potential nexus between environmental stressors and nutritional deficiencies. Beyond the environmental factors, the exploration of poverty as a determinant of health outcomes provides a comprehensive perspective. The high correlation between poverty and adverse health indicators, such as stunting and malnutrition, is consistent with economic theories. Papua and Papua Barat's designation as the provinces with the highest poverty rates in Indonesia aligns with the observed prevalence of stunting in toddlers. The economic vulnerability of households, characterized by a weak economy and a significant percentage of extreme poverty, amplifies the health challenges faced by the local population.

The dynamic nature of poverty in Papua, indicated by a notable 5.02% increase in the percentage of the poor population in urban areas in March 2022, signals an evolving socio-economic landscape. This economic instability can further exacerbate health disparities, emphasizing the need for targeted interventions and policies aimed at addressing both environmental and socio-economic determinants to improve the overall health and well-being of communities in Papua and Papua Barat. The findings from this study provide a valuable foundation for designing effective public health strategies tailored to the specific challenges faced by these regions.

Table 4 explains that statistically, pneumonia is most significant in Papua and Papua Barat. The province of Papua has the highest incidence of pneumonia and diarrhea among children. According to UNICEF and the Papua Provincial Health Office the rate is recorded at 3.5 percent higher than the national average of 2 percent in 2018. Meanwhile, UNICEF data from 2015 indicates that Indonesia ranks seventh globally in child mortality due to pneumonia.

Bronchopneumonia is commonly found in children and infants, as their immune systems are not yet robust, making it easier for viruses, bacteria, fungi, protozoa to enter their bodies. In neonates, infections causing bronchopneumonia are usually due to Streptococcus group B bacteria and Respiratory Syncytial Virus, while in infants, it is caused by Influenza virus, Adenovirus, Respiratory Syncytial Virus, and Cytomegalovirus. In addition to viruses, bronchopneumonia in infants can also be caused by atypical organisms such as Chlamydia trachomatis, Pneumoni, Haemophilus influenza, Mycobacterium tuberculosis, and Parainfluenza bacteria.

Common causes of bronchopneumonia in children include Parainfluenza, Influenza virus, Adenovirus, Respiratory Syncytial Virus, Mycoplasma pneumonia, Pneumococcus, and Mycobacterium tuberculosis. In older children to young adults, causes include Mycoplasma pneumonia, Chlamydia trachomatis, Pneumococcus, Bordetella pertussis, and

TABLE 4. Variable estimation.

	Estimate	Std. Error	t value	P(>|t|)
PC1 : u5_pneumonia	-0.1966	0.0728	-2.6987	0.0105 *
PC1 : u5_ari	-0.0104	0.0716	-0.1452	0.8854
PC1 : u5_diarrhea	-0.1024	0.0738	-1.3890	0.1734
PC1 : u5_underweight	0.0910	0.0742	1.2251	0.2285
PC1 : u5_stunting	-0.0395	0.0713	-0.5535	0.5834
PC1 : u5_malnourished	0.0438	0.0712	0.6148	0.5425
PC2 : u5_pneumonia	-0.0727	0.1460	-0.4980	0.6215
PC2 : u5_ari	0.0435	0.1403	0.3098	0.7585
PC2 : u5_diarrhea	0.2114	0.1363	1.5511	0.1296
PC2 : u5_underweight	0.0487	0.1337	0.3645	0.7176
PC2 : u5_stunting	0.0112	0.1321	0.0851	0.9326
PC2 : u5_malnourished	0.1070	0.1360	0.7870	0.4364
PC3 : u5_pneumonia	0.1474	0.1657	0.8898	0.3795
PC3 : u5_ari	0.1284	0.1824	0.7038	0.4861
PC3 : u5_diarrhea	-0.1107	0.1879	-0.5894	0.5593
PC3 : u5_underweight	-0.0367	0.1526	-0.2405	0.8113
PC3 : u5_stunting	0.0497	0.1439	0.3451	0.7320
PC3 : u5_malnourished	-0.0746	0.1698	-0.4392	0.6631
PC4 : u5_pneumonia	-0.0439	0.2270	-0.1934	0.8478
PC4 : u5_ari	-0.3739	0.2330	-1.6046	0.1173
PC4 : u5_diarrhea	-0.2141	0.2281	-0.9385	0.3542
PC4 : u5_underweight	-0.0899	0.2283	-0.3936	0.6962
PC4 : u5_stunting	-0.0912	0.2137	-0.4266	0.6722
PC4 : u5_malnourished	-0.1299	0.2123	-0.6118	0.5445

Mycobacterium tuberculosis. This information underscores the importance of understanding the specific factors contributing to pneumonia in Papua and Papua Barat, as well as the need for targeted public health interventions to address this significant health issue, especially among children.

Figure 2 visually depicts the interconnectedness of NDVI variables in Papua and West Papua, highlighting its relevance in comprehending the conditions of Acute Respiratory Infection (ARI), Diarrhea, and Stunting. The Normalized Difference Vegetation Index (NDVI) functions as an indicator of vegetation health and photosynthetic activity within the region. Elevated NDVI values signify improved vegetation growth and health. Analyzing NDVI data allows us to establish correlations with public health indicators such as ARI (0.2), Diarrhea (0.17), and Stunting (0.08). For instance, heightened NDVI values may indicate lush vegetation, suggesting a healthier environment and the potential for a lower prevalence of ARI. Furthermore, NDVI data yields insights into natural resource availability and environmental conditions, pivotal factors in understanding the causes of stunting and diarrhea. Thus, exploring the relationship between NDVI and these health variables forms a basis for more precise and effective intervention strategies to enhance public health in Papua and West Papua.

In contrast, the Palmer Drought Severity Index (PDSI) only explains underweight cases by 0.15, indicating its limited impact or relatively low correlation in elucidating the diversity of underweight cases in the region. A value of 0.15 suggests that PDSI does not significantly contribute to underweight variation, implying the existence of other influential factors beyond PDSI in determining underweight conditions in Papua and West Papua. Despite providing insights into the impact of drought on underweight, PDSI may be overshadowed by other variables or complex factors in influencing these health conditions. The significance of Morans I Distance and Distance by neighboring area NDVI and PDSI in Papua and West Papua, as presented in **Table 5** and **Table 6**, further supports these findings. In **Table 5,** the examination of poverty rates using polygons distance does not demonstrate a noteworthy association with public health conditions. Conversely, **Table 6**, employing neighboring area distance, discloses a significant Morans I between elevated poverty rates and unfavorable public health conditions in Papua and West Papua.

This underscores the pivotal role of spatial arrangement in neighboring areas for comprehending the link between poverty and public health outcomes in the region. The results suggest that the influence of poverty on public health conditions becomes more apparent when accounting for the geographic proximity of areas, underscoring the significance of spatial factors in addressing health disparities and devising targeted interventions in Papua and West Papua.Several factors contribute to health issues such as underweight, stunting, Acute Respiratory Infection (ARI), and malnutrition in Papua and West Papua. These include limited access to quality food and healthcare services, unhealthy living environments, economic uncertainties within families, and low levels of education and health literacy among the less affluent. Improving the economic well-being of the community is crucial not only for reducing poverty but also for enhancing overall public health. A holistic approach, addressing education, healthcare access, and economic improvements, can help break the complex cycle between poverty and health.

The statistical model used in our study highlights that common occupations in Papua and West Papua contribute to an increase in pneumonia cases. This might be due to the nature of jobs in the region involving heavy physical activities or exposure to harmful substances, increasing the risk of respiratory infections, including pneumonia and ARI. The significance of variables such as Working, Main Working, High School, Working_agri, illiterate and protein consumption in **Table 5** and **Table 6**, using Morans I, supports these

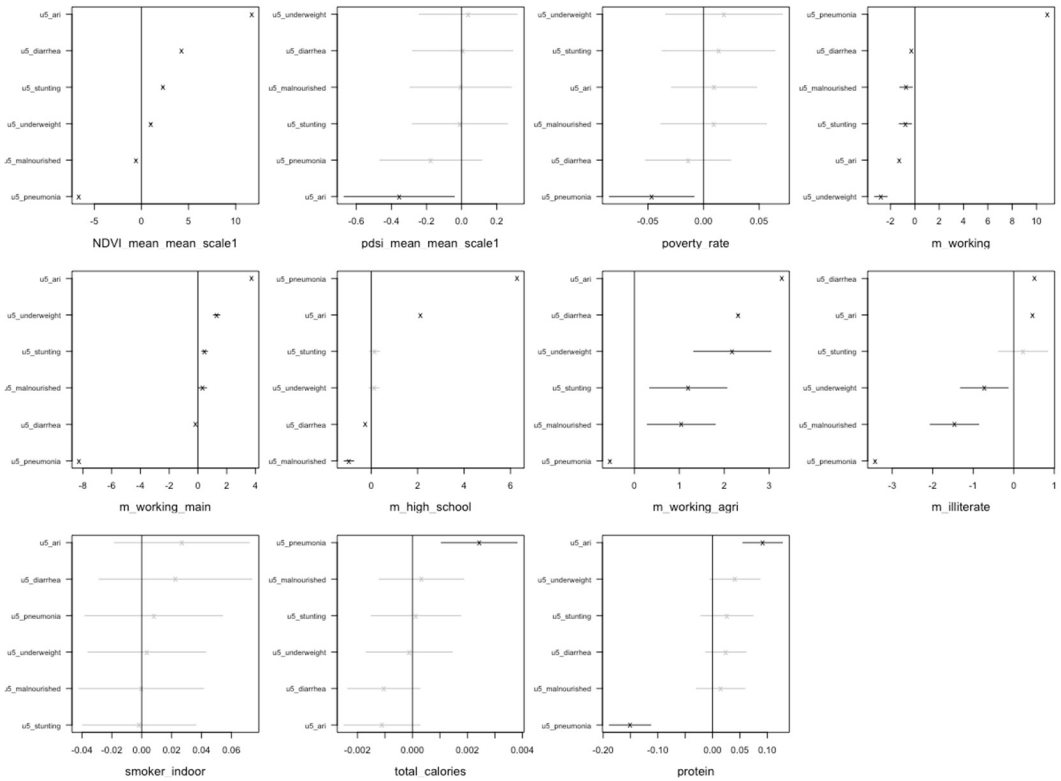

FIGURE 2. **Interrelation of variables' significance.**

results. Our findings also reveal that individuals with higher education levels are more susceptible to pneumonia, with a significant interrelation value of 0.8. If workers frequently travel or live in crowded places, the risk of respiratory disease transmission, including pneumonia, may increase. The literacy level of the population in Papua and West Papua also influences the prevalence of stunting, diarrhea, and ARI. Therefore, it is crucial for parents to understand family parenting practices, particularly in terms of upbringing, care, and nutrition.

In **Table 5** total calories exhibit a slight negative correlation (−0.0143), while protein content demonstrates a stronger negative correlation (−0.0582). These values are compared to the expected Moran's I values of −0.0243 for both variables. The variance and p-values indicate significance for protein content but not for total calories. In **Table 6**, where distance is measured by neighboring areas, similar negative correlations are observed for total calories (−0.0255) and protein (−0.0291). Expected Moran's I values remain consistent with **Table 5**. However, while the variance for total calories indicates no significant spatial autocorrelation, the variance for protein content suggests borderline significance. When Moran's I is significant, it indicates that there is a spatial pattern present in the data that is not likely due to random chance alone. This means that there is a degree of spatial autocorrelation, implying that values in nearby locations are more similar to each other than would be expected under spatial randomness. In the context of nutritional analysis, if Moran's I for protein content, for example, is significant, it suggests that there are spatial clusters or patterns of high or low protein content in the region being studied. This information can be valuable for identifying areas with specific nutritional needs or disparities, which can then inform targeted interventions or policy decisions aimed at improving nutritional outcomes in those areas. Moran's I, a measure of spatial autocorrelation, can be either positive or negative, indicating distinct spatial patterns in data analysis. Positive values signify spatial clustering, where similar values tend to be close together on a map. For instance, a positive Moran's I for protein content would suggest that areas with high protein levels cluster together, as do areas with low protein levels. Conversely, negative Moran's I values denote spatial dispersion, where dissimilar values are close in proximity. For example, if total calorie intake exhibits a negative Moran's I, it implies that areas with high and low calorie intake are dispersed across the region. Understanding these spatial patterns is crucial for identifying localized factors influencing nutritional trends and informing targeted interventions for improved health outcomes.

B. THE PHENOMENON OF KRETEK CIGARETTE CONSUMPTION AND ITS IMPACT ON POVERTY IN PAPUA AND WEST PAPUA

The findings in **Figure 2** indicate a noteworthy association between indoor smoking and several health conditions, including Acute Respiratory Infections (ARI), Diarrhea,

TABLE 5. Moran's I spatial autocorrelation distance based on polygon's centroid.

Variables	observed	expected	sd	p.value
pneumonia	-0.0189	-0.0244	0.0097	0.5742
ARI	-0.0149	-0.0244	0.0163	0.5621
diarrhea	-0.0105	-0.0244	0.0167	0.4076
underweight	-0.0348	-0.0244	0.0168	0.5330
stunting	-0.0382	-0.0244	0.0166	0.4075
malnourished	-0.0094	-0.0244	0.0165	0.3629
NDVI	-0.1435	-0.0244	0.0168	0.0000 *
PDSI	-0.1243	-0.0244	0.0169	0.0000 *
Poverty rate	-0.0253	-0.0244	0.0169	0.9573
working	-0.0417	-0.0244	0.0169	0.3064
m_working_main	-0.0154	-0.0244	0.0165	0.5856
High school	-0.0790	-0.0244	0.0168	0.0012 *
working_agri	-0.0761	-0.0244	0.0169	0.0022 *
illiterate	-0.0632	-0.0244	0.0168	0.0207 *
smoker_indoor	-0.0259	-0.0244	0.0164	0.9281
Total_calories	-0.0143	-0.0243	0.0165	0.5440
Protein	-0.0582	-0.0243	0.01685	0.0446*

TABLE 6. Moran's I spatial autocorrelation distance by neighboring area.

Variables	observed	expected	sd	p.value
pneumonia	-0.0248	-0.0244	0.0013	0.7285
ARI	-0.0236	-0.0244	0.0027	0.7587
diarrhea	-0.0209	-0.0244	0.0027	0.2055
underweight	-0.0279	-0.0244	0.0028	0.1969
stunting	-0.0271	-0.0244	0.0027	0.3245
malnourished	-0.0230	-0.0244	0.0027	0.6101
NDVI	-0.0336	-0.0244	0.0028	0.0008 *
PDSI	-0.0308	-0.0244	0.0028	0.0211 *
Poverty rate	-0.0300	-0.0244	0.0028	0.0440 *
working	-0.0312	-0.0244	0.0028	0.0149 *
m_working_main	-0.0269	-0.0244	0.0027	0.3623
High school	-0.0321	-0.0244	0.0028	0.0054 *
working_agri	-0.0306	-0.0244	0.0028	0.0248 *
illiterate	-0.0297	-0.0244	0.0028	0.0537 *
smoker_indoor	-0.0273	-0.0244	0.0027	0.2689
Total_calories	-0.0255	-0.0243	0.0027	0.6707
Protein	-0.0291	-0.02439	0.0027	0.0834*

Underweight, Malnourished, and Stunting. This suggests that the presence of indoor smoking may play a significant role in influencing the prevalence and severity of these health issues. It is essential to consider the potential impact of indoor smoking on respiratory health, nutritional status, and overall well-being. This information underscores the importance of addressing indoor smoking as a contributing factor in public health interventions aimed at reducing the burden of ARI, Diarrhea, Underweight, Malnourished, and Stunting in the Papua and West Papua.

The primary commodity that takes center stage in understanding the poverty levels in the provinces of Papua and West Papua is filtered clove cigarettes (kretek). Despite not falling under the category of staple food items, cigarettes have a significant impact on the economic conditions and consumption patterns of the communities in this region. According to the Atlas Tembakau Indonesia report, high cigarette consumption is identified as one of the main factors exacerbating the poverty line in this area.

The price of cigarettes, as part of household expenditures, plays a substantial role in the poverty equation. The report reveals that cigarette prices contribute to 11.38% in rural areas and 12.22% in urban areas to the poverty figures. Significant expenditures on cigarettes divert a considerable portion of the community's income, which should ideally be allocated to basic needs or local economic development. Cigarettes not only affect the local level but also contribute to national poverty figures in Indonesia. According to the report from the Center for Indonesia's Strategic Development Initiatives (CISDI), expenditures on tobacco, including cigarettes, led to a 3.23%-point increase in the poverty rate in 2021. This figure is equivalent to around 8.77 million people trapped in poverty due to tobacco spending. With such significant negative impacts, strategies for controlling and reducing cigarette consumption become crucial in efforts to alleviate poverty, especially in Papua and West Papua. Stricter policies towards the tobacco industry, such as cigarette advertising restrictions, increased cigarette taxes, and other legislative measures, can serve as effective instruments to reduce consumption.

Based on **Figure 3A,** it can be observed that regions with the highest percentage of indoor smokers include Mappi (96.98%), Sarmi (96.82%), Asmat (96.59%), and Sorong Selatan (94.53%). This data provides insights into the prevalence of indoor smoking in these areas, which may have implications for public health, particularly in terms of respiratory issues. Moving on to **Figure 3B,** the illustration highlights regions with elevated poverty rates. Deiyai (43.49%), Intan Jaya (42.71%), and Lanny Jaya (40.06%)

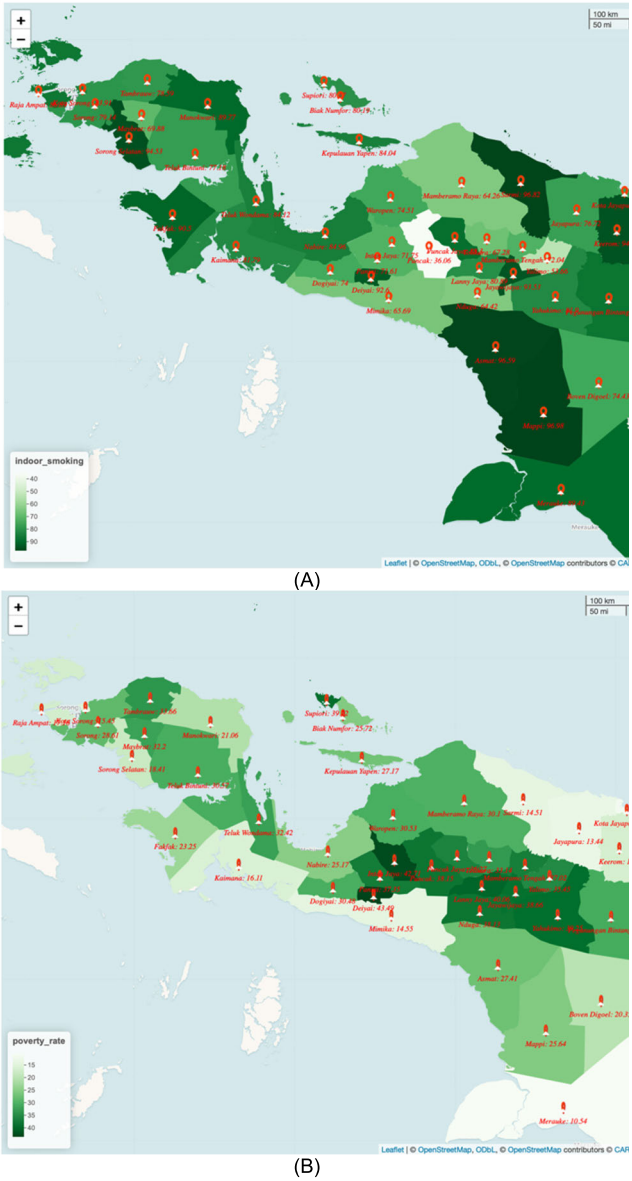

FIGURE 3. Exploring the intersection: Indoor Smoking (A) and Poverty Rates(B) in Papua and West Papua.

are identified as areas facing higher levels of poverty. This information underscores the economic challenges and disparities in income distribution within these regions, emphasizing the need for targeted interventions to address socio-economic factors contributing to poverty. The combined analysis of indoor smoking prevalence and poverty rates can offer a comprehensive understanding of the challenges faced by these regions. It suggests potential correlations between lifestyle factors, economic conditions, and health outcomes. This valuable information can serve as a foundation for tailored strategies and policies aimed at improving public health and socio-economic well-being in Mappi, Sarmi, Asmat, Sorong Selatan, Deiyai, Intan Jaya, and Lanny Jaya.

In addition to regulatory policies, more intensive anti-smoking campaigns are integral to preventive efforts. Increasing public awareness of the health risks and economic impacts of smoking can influence consumer behavior. Education programs targeting various age groups and societal layers can provide better understanding of the risks and consequences of smoking habits.Another crucial step is the development of alternative economies for communities dependent on tobacco production. Economic diversification through skill training programs, investments in non-tobacco sectors, and micro-business development can help reduce dependence on the cigarette industry. This will not only mitigate the social and economic impacts of cigarettes but also enhance local economic sustainability. While these strategies seem logical, there are obstacles and challenges that need to be overcome. The strong influence of the tobacco industry in the national economy hinders the implementation of stricter policies. Lobbying from parties involved in the tobacco industry can pose a serious barrier to significant changes.Addressing the impact of cigarettes on poverty requires synergy among government agencies, NGOs, the private sector, and civil society. This collaboration is crucial to formulate holistic and integrated policies that focus not only on tobacco control but also on rehabilitation and community empowerment efforts.

The steps taken must be sustainable and well-planned. The government needs to involve the entire community in the planning and implementation of these programs. Understanding the needs and sustainability of the local community will help design more effective solutions. Equally important is the need for an effective evaluation and monitoring system. Periodic evaluations of the impacts of the measures taken can provide valuable insights for further strategy adjustments. Transparency in this evaluation process can also build trust in the community and garner support for the implemented policies. Tobacco consumption is associated with a vicious cycle of poverty. Tobacco consumption can increase poverty because the low income of households is spent on tobacco consumption rather than on necessities, which include food, children's education expenses, healthcare expenses, and improving the nutritional status of their children and household members.

The economic conditions of households in both urban and rural areas of Papua and West Papua often involve a significant reliance on daily incremental incomes, with the exact amounts being difficult to determine. Additionally, there is a prevalent practice where individuals seek income mainly to fulfill immediate needs for the next day, lacking long-term sustainability. The following results are also derived from interviews conducted. In urban areas, specific food commodities exert a notable influence on the Poverty Line in the Papua Province. These commodities include rice, filtered clove cigarettes, commercially raised chicken meat, commercially produced chicken eggs, pork, and tuna or bonito. Similarly, in rural areas, there is a tendency for households to depend on daily incremental incomes, and the quantification of these incomes poses challenges. The practice of seeking income primarily for immediate needs without ensuring long-term sustainability is also prevalent in rural settings.

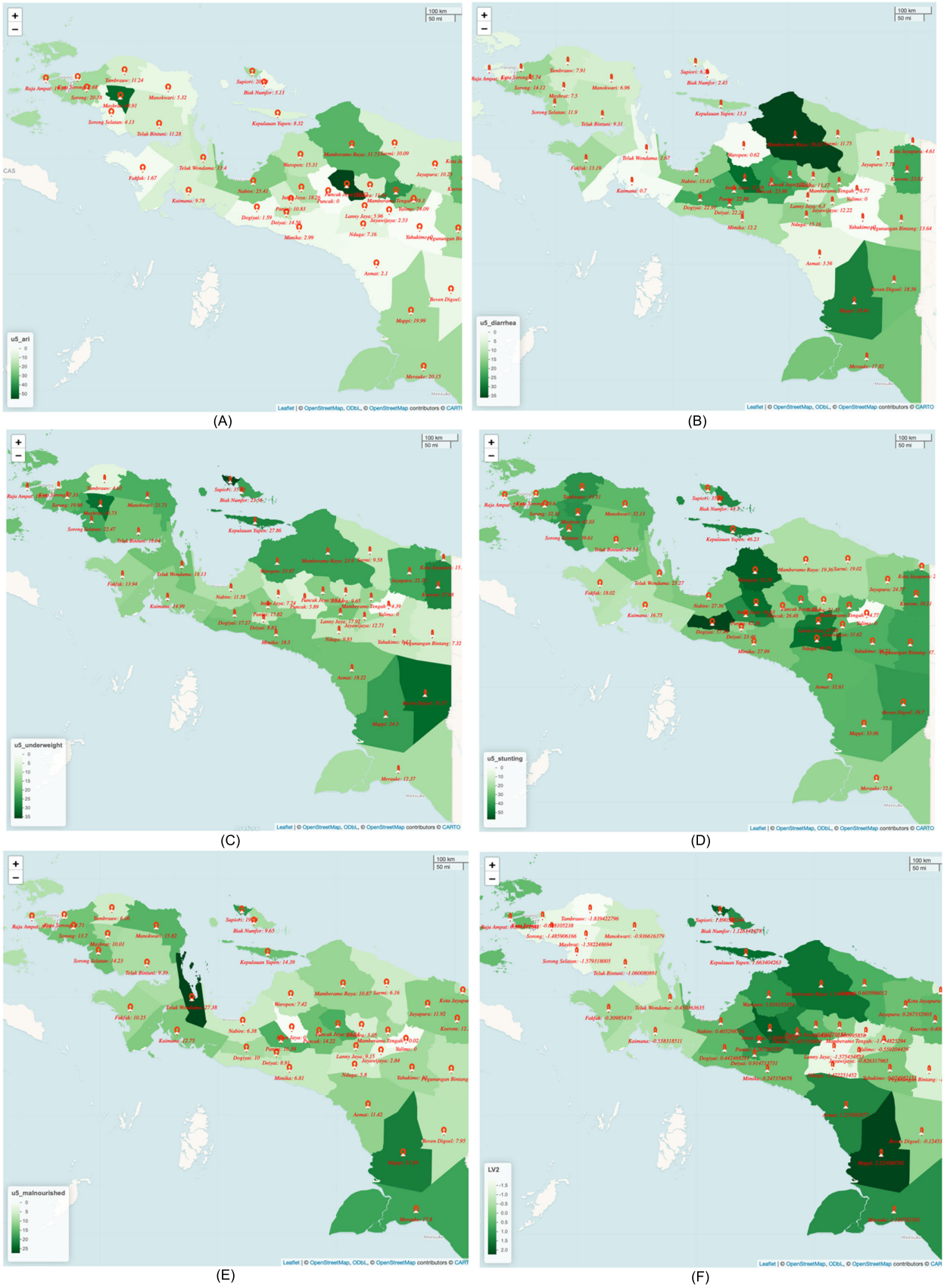

FIGURE 4. Health indicator comparison - ARI (A), Diarrhea (B), Underweight (C), Stunting (D), Malnourished (E), and our Final GLLVM (F).

C. REASONING ARI, MALNOURISHED, PNEUMONIA, AND STUNTING IN PAPUA AND WEST PAPUA

In the vast and diverse landscape of Papua and West Papua, the health narrative unfolds through the critical lenses of Acute Respiratory Infections (ARI), malnutrition, pneumonia, and stunting. This comprehensive exploration seeks to unravel the complexities surrounding these health challenges, delving into their prevalence, distribution, and the intricate web of socio-economic and environmental factors that shape their occurrence. From the pervasive impact of Acute Respiratory Infections to the enduring challenges of malnutrition, the research aims to paint a detailed portrait of the health dynamics in these regions. As the focus shifts to pneumonia, a leading cause of morbidity, and stunting, a manifestation of chronic malnutrition, the investigation aims to not only quantify their incidence but also decipher the underlying vulnerabilities and risk factors. This holistic approach is poised to provide valuable insights for the development of targeted interventions, healthcare strategies, and policy frameworks that address the unique health needs of Papua and West Papua, fostering a future marked by improved health outcomes and community well-being.

Delving into the intricate tapestry of health indicators presented in **Figure 4A**, we discern a compelling narrative of health disparities across Papua and West Papua. The percentages of Acute Respiratory Infections (ARI) reveal not just statistical values but nuanced portraits of the challenges faced by distinct regions. Puncak Jaya, with its 55.32%, is painted as a hotspot, signaling a higher vulnerability to respiratory infections. Maybrat, Mamberamo Tengah, and Mamberamo Raya follow, each portraying a unique facet of health struggles. Figure 4B unveils a critical aspect of health vulnerability — the prevalence of diarrhea. Mamberamo Raya leads this distressing narrative, registering a substantial 36.02%. Intan Jaya, Mappi, and Puncak follow suit, each grappling with significant proportions. These figures transcend mere numbers; they represent the lived experiences of communities, emphasizing the urgency for targeted healthcare interventions.

Transitioning to malnutrition in **Figure 4C**, Supiori and Boven Digoel stand out as regions grappling with high rates, painting a vivid picture of nutritional challenges. These statistics underline the complexity of health issues, highlighting the need for comprehensive strategies that address both infectious diseases and broader socio-economic determinants. In **Figure 4D**, the prevalence of stunting takes center stage, revealing alarming rates in Dogiyai, Waropen, Nduga, and Intan Jaya. These numbers tell a story of developmental challenges, urging a closer examination of the underlying factors contributing to stunting in these regions. **Figure 4E** provides a localized lens, offering detailed insights into malnutrition rates in Teluk Wondama and Mappi. These micro-level perspectives are crucial for tailoring interventions to the specific needs of each community, acknowledging the diversity of health challenges within the broader regional context.

The introduction of the Generalized Linear Latent Variable Model (GLLVM) in **Figure 4F** brings a new dimension to the narrative. This sophisticated model not only identifies vulnerable areas but also unveils hidden connections and interdependencies between variables. Mappi, Supiori, Intan Jaya, and the Yapen Islands emerge as focal points, guiding policymakers towards targeted strategies grounded in a deeper understanding of the complexities at play. Beyond health indicators, environmental factors step into the spotlight. Indoor air pollution and the physical conditions of houses become integral components in the narrative. Housing density, floor type, wall type, and house lighting, as outlined in the study, symbolize the broader socio-economic determinants shaping health outcomes. This holistic approach encourages policymakers to view health challenges as interconnected, requiring comprehensive strategies that address the multifaceted nature of public health issues in Papua and West Papua.

The meticulous exploration of spatial autocorrelation patterns, meticulously documented in previous section, casts a revealing light on the intricate web of relationships governing pediatric health and environmental variables in the regions of Papua and West Papua. When scrutinizing the distance based on polygon centroids, the Moran's I values for pediatric health indicators—pneumonia, ARI, diarrhea, underweight, stunting, and malnourished—unfold a narrative of absence of significant spatial autocorrelation, indicating a dispersed distribution across the geographic landscape. In contrast, the pronounced negative spatial autocorrelation witnessed in NDVI and PDSI exposes a fascinating tale of neighboring areas sharing analogous environmental conditions, particularly in terms of vegetation and drought severity.

The narrative expands further as socio-economic variables take center stage, revealing that certain educational and occupational characteristics, as encapsulated by High school, working_agri, and working, demonstrate discernible spatial clustering. This intricate dance of patterns emphasizes that proximal areas not only echo similarities in pediatric health but also resonate in socio-economic and environmental dimensions. The saga persists when examining the distance by neighboring areas, where pediatric health variables maintain their lack of significant spatial autocorrelation.

Simultaneously, the robust spatial clustering prevails in environmental indicators (NDVI and PDSI), suggesting a landscape where adjacent regions bear resemblance in environmental dynamics. This phenomenon extends to selected socio-economic variables like Poverty rate, working, High school, and working_agri, spotlighting clusters indicative of shared socio-economic attributes. In this narrative, the absence of spatial autocorrelation in pediatric health indicators serves as a canvas upon which the pronounced spatial patterns in environmental and socio-economic dimensions are painted. These revelations hold profound implications for targeted interventions, resource allocation, and policy formulation tailored to the specific needs of distinct clusters within Papua and West Papua. As we weave these insights into the fabric of our understanding, the tapestry that emerges informs a strategic roadmap for bolstering pediatric health and socio-economic well-being in these intricate landscapes.

Our comprehensive approach, integrating datasets from RISKESDAS, SUSENAS, NDVI, and PDSI, unfolds a nuanced understanding of the complex health phenomena of pneumonia, Acute Respiratory Infections (ARI), diarrhea, underweight, stunting, and malnourished in Papua and West Papua. By synergizing health surveys (RISKESDAS and SUSENAS) with environmental indicators (NDVI and PDSI), we've crafted a holistic framework that offers invaluable insights into the interplay between health outcomes and environmental factors.

D. FREE LUNCH AND MILK PROGRAM: PRABOWO AND GIBRAN'S INITIATIVE IN THE 2024 INDONESIAN PRESIDENTIAL ELECTION

The Free Lunch and Milk Program, proposed by Presidential Candidate Prabowo Subianto and Vice-Presidential Candidate Gibran Rakabuming Raka in the 2024 election, stands as a pivotal initiative addressing paramount concerns surrounding nutrition, food security, and social welfare. By providing school children with free lunches and milk, this program not only ensures adequate nutrition crucial for their physical and cognitive development but also contributes significantly to alleviating hunger, especially among underprivileged families. Such a measure not only supports families by easing their financial burden but also promotes equity by guaranteeing all students equal access to nutritious meals regardless of their socioeconomic backgrounds. Moreover, by enhancing educational outcomes through improved attendance, concentration, and academic performance, this initiative aligns closely with the Sustainable Development Goals, notably Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), and Goal 10 (Reduced Inequalities). The free Lunch and Milk Program underscores a commitment to fostering a more sustainable, inclusive future wherein every child could thrive and contribute positively to society.

Ensuring access to nutritious meals and milk for economically disadvantaged communities is essential for promoting public health and well-being. Proper nutrition serves as a cornerstone for physical and cognitive development, particularly among children whose growth and development are still underway. By offering free lunches and milk, the program aims to address prevalent issues such as malnutrition, stunted growth, and other health-related concerns that can have profound, long-term consequences for individuals and society at large. By prioritizing the nutritional needs of vulnerable populations, this initiative not only fosters healthier lifestyles but also contributes to the overall resilience and well-being of communities, aligning closely with broader efforts to achieve sustainable development and reduce inequalities. Moreover, the program contributes to alleviating poverty and reducing socioeconomic disparities. Families struggling to make ends meet often face difficult choices regarding food expenditures, which can lead to compromised nutrition. By offering free meals and milk, particularly to those in need, the program helps relieve financial burdens and ensures that basic nutritional needs are met. This not only improves the quality of life for individuals and families but also fosters social inclusion and equity. Additionally, addressing nutritional deficiencies has broader implications for national development and productivity. Malnutrition can impair physical and cognitive abilities, hindering educational attainment and workforce productivity. By investing in nutrition interventions, such as the Free Lunch and Milk Program, the government lays the foundation for a healthier, more skilled, and more productive population, which is essential for driving economic growth and sustainable development.

Furthermore, initiatives like this can have positive ripple effects throughout the economy. By engaging local food suppliers and catering businesses, the program stimulates economic activity and supports small-scale enterprises, thereby creating employment opportunities and enhancing livelihoods. In a nutshell, the Free Lunch and Milk Program is of paramount importance due to its multifaceted benefits. It addresses immediate nutritional needs, promotes public health, reduces poverty, fosters social equity, enhances human capital, and stimulates economic growth. By prioritizing this issue, policymakers demonstrate their commitment to building a healthier, more prosperous, and more equitable society for all citizens.

The primary concern lies in addressing the possibility of children having allergies to specific foods, necessitating adjustments to provide alternative options that cater to their health needs. Moreover, a thorough evaluation of the funding sources for the program is imperative, particularly if there are intentions to utilize savings from fuel subsidy elimination. While redirecting such savings to welfare programs like the Free Lunch and Milk Program may seem feasible, the potential impact on overall economic stability warrants careful consideration. Numerous media outlets have voiced apprehensions regarding the removal of fuel subsidies, expressing concerns about potential price hikes in food and other essential services. This scenario could exacerbate poverty rates and further marginalize already vulnerable populations. Therefore, conducting a meticulous and comprehensive analysis of the economic implications of reallocating subsidy funds to welfare programs is indispensable.

Concerns have been raised regarding the potential for corruption to undermine the integrity of free school lunch programs, especially in terms of maintaining consistent standards across different regions. This challenge is compounded by significant variations in basic prices, resulting in discrepancies in the quality of food provided. For instance, while 15000 Indonesian Rupiah may suffice for adequate nutrition in Java, it may fall short in meeting nutritional needs in Papua. Thus, there is an urgent need to reassess budget allocations, whether through per capita expenditure or adjusting based on the varying costs of meal portions in different areas. This situation highlights the critical importance of addressing corruption, which directly impacts the consistency and adequacy of food quality and nutritional standards, particularly for vulnerable groups like children.

Corruption undermines the effective implementation of policies aimed at ensuring the availability of safe and

nutritious food for all students. Moreover, the disparities in food quality resulting from regional price differences exacerbate health inequalities and pose significant risks to public health. Combating corruption requires concerted efforts to strengthen governance structures, enhance transparency and accountability in resource allocation, and raise public awareness about adhering to nutritional standards. By addressing corruption and promoting equitable access to quality food across regions, governments can mitigate health risks and contribute to the overall well-being of their populations, particularly the most vulnerable. This comprehensive approach will not only improve public health outcomes but also foster social and economic development nationwide.

Furthermore, we can connect this information with **Figure 2**, where understanding the variations in regional conditions becomes crucial in designing policies for free lunch and milk. Firstly, these programs should not only focus on increasing calorie intake but also pay attention to the macronutrient composition, particularly protein. This is crucial to ensure that the children receiving these meals obtain adequate nutrition for their growth and development. Additionally, the programs should be designed considering the social conditions of the recipients to effectively target and assist those in need. However, more importantly, the figure highlights that the issue of free meals isn't solely about filling stomachs but also about addressing the root cause of poverty. Hence, a holistic and integrated approach is necessary to tackle this issue, including efforts to alleviate poverty comprehensively. Furthermore, improving cultural norms and community habits, such as reducing smoking, should also be considered in fostering broader positive changes within society. By considering all these aspects, free school lunch programs can become more effective in enhancing the well-being of both children and the community.

The selection of milk holds significant weight due to its potential impact on exacerbating obesity, especially with the consumption of high-calorie variants. Despite existing blueprints established by the government and the Ministry of Health to address malnutrition cases, including those affecting children, there remains a notable gap in comprehensive guidelines for managing childhood obesity, particularly concerning the implementation of effective control measures. This gap raises concerns about the unintended consequences of ongoing programs, particularly regarding their potential impact on childhood obesity rates. Without clear and robust protocols to address obesity among children, well-intentioned initiatives may inadvertently worsen this health issue. It is imperative for policymakers to prioritize the development of solid guidelines and control systems to ensure that efforts to combat malnutrition do not inadvertently exacerbate obesity concerns among the younger population. Additionally, at the school level, there is a need to reintroduce screening for food allergies and lactose intolerance profiling among children.

To mitigate potential adverse effects, the government should explore various policy options, including strengthening existing social protection systems, improving food distribution mechanisms, and enhancing budget management efficiency. Engaging diverse stakeholders, such as economists, health professionals, and civil society representatives, throughout the planning and implementation phases of this program is crucial. However, establishing a new ministry may not be the optimal solution. Creating a new governmental body can be time-consuming and resource-intensive, potentially delaying urgent measures to address nutritional and community welfare concerns. Moreover, existing ministries or agencies might already possess the infrastructure and expertise necessary to effectively address these issues. Strengthening and coordinating existing structures can streamline efforts and prevent duplication of resources. Furthermore, establishing a new ministry could introduce bureaucratic challenges and coordination issues between different government bodies. Policymakers must thoroughly evaluate the necessity of establishing a new ministry (agency/institution) and assess its efficiency and effectiveness in achieving their objectives.

V. CONCLUSION

The integration of RISKESDAS and SUSENAS datasets provides a granular view of pediatric health, capturing prevalence rates and socio-economic determinants. Simultaneously, the incorporation of NDVI allows us to gauge the health of the local vegetation, while PDSI unveils the intricate patterns of drought severity. The marriage of these datasets enables us to pinpoint areas where environmental stressors might contribute to the prevalence of respiratory illnesses, malnutrition, and related health challenges. Our findings indicate significant spatial patterns in environmental variables (NDVI and PDSI) and certain socio-economic factors, suggesting localized clusters of vulnerability. This spatial understanding empowers policymakers, healthcare practitioners, and community leaders to devise targeted interventions, resource allocation, and public health strategies tailored to the specific needs of distinct regions within Papua and West Papua. In essence, our approach not only sheds light on the current health landscape but also serves as a proactive tool for anticipating and mitigating future health challenges. By bridging the realms of health and environmental science, our research contributes to a more resilient and responsive healthcare system, ultimately striving for improved pediatric health outcomes in these regions.

VI. PRACTICAL IMPLICATIONS AND RECOMMENDATUONS

In the dynamic context of Papua and West Papua, characterized by distinctive health disparities and environmental challenges, the imperative of fostering a Penta Helix collaboration is elevated. Our approach is intricately tailored to the nuanced conditions prevailing in these regions, emphasizing a culturally sensitive perspective. As researchers, we are devoted to conducting a meticulous and context-specific analysis, recognizing the diverse socio-cultural tapestry, and varied geographical landscapes of Papua and West Papua.

Paramount to our methodology is collaborative engagement with local communities, not only to comprehend their unique health needs but also to integrate indigenous knowledge, enriching the accuracy and relevance of our research outcomes. Acknowledging the rich biodiversity and unique ecosystems in these provinces, our goal is to infuse environmental sensitivity into our analyses. By investigating how remote sensing variables like NDVI and PDSI align with local ecological conditions, we aim to unravel the intricate interplay between environmental factors and health outcomes. The task of addressing health disparities in Papua and West Papua demands a comprehensive understanding of challenges, including limited access to healthcare facilities, transportation obstacles, and the impact of remoteness on health service delivery. Our commitment extends to proposing targeted interventions aligned with the socio-economic context, addressing, and mitigating existing inequities. Non-negotiable, cultural competency is integrated into our research design and implementation. Collaborating closely with local researchers, traditional leaders, and healthcare practitioners possessing cultural insights ensures a respectful and inclusive approach to data collection and interpretation. Integration of insights from SUSENAS Block VI and VII into our research endeavors aims to unravel the economic landscape of Papua and West Papua. This includes analyzing employment patterns, economic activities, and factors influencing health outcomes, informing policies that are attuned to the unique challenges of the region. Our collaborative efforts extend to close cooperation with local and regional governments for the seamless integration of research findings into governance and policy frameworks. Advocating for evidence-based policies becomes pivotal to address the specific health and environmental challenges faced by communities in Papua and West Papua. Simultaneously, our commitment to capacity building within local institutions underscores our dedication to empowering local researchers to take a lead role in ongoing health and environmental monitoring efforts. By tailoring our research initiatives to the conditions in Papua and West Papua, we aspire to make a meaningful and lasting contribution to the well-being of these communities. This approach aligns seamlessly with the principles of the Penta Helix model, fostering collaboration with local communities, government agencies, academia, industry, and civil society to craft sustainable and impactful solutions.

COMPETING INTERESTS

The authors declare no competing interests.

DATA AVAILABILITY

The source code and the material and findings data of this study are openly available in full access by the corresponding author.

DECLARATION OF COMPETING INTEREST

The authors of this article solemnly affirm their unwavering commitment to neutrality and the highest standards of research ethics. They declare that they possess no discernible competing financial interests or personal affiliations that could potentially influence the findings or conclusions presented herein, specifically with regard to any preference for Candidate Pair 1 (Anies Rasyid Baswedan—Abdul Muhaimin Iskandar), Candidate Pair 2 (Prabowo Subianto Djojohadikusumo—Gibran Rakabuming Raka), or Candidate Pair 3 (Ganjar Pranowo—Mohammad Mahfud Mahmodin) in the 2024 Indonesian Presidential Election. Moreover, they emphasize their steadfast dedication to impartiality and integrity in all scholarly pursuits. Each contributor to this article adheres rigorously to the most stringent research ethics codes, ensuring transparency, fairness, and accuracy in our work. They pledge to uphold these principles without compromise, thereby safeguarding the credibility and trustworthiness of their research endeavors.

AUTHOR CONTRIBUTION

Rezzy Eko Caraka conceived the research, constructed the experimental design, participated in the verification and interpretation of data, and finalized the instrument. Rezzy Eko Caraka, Khairunnisa Supardi, Yunho Kim, Syihabuddin Ahmad Mufti, Rung-Ching Chen, and Bens Pardamean managed the project. Rezzy Eko Caraka and Puspita Anggraini Kaban analyzed the data. Rezzy Eko Caraka, Khairunnisa Supardi, Puspita Anggraini Kaban, and Robert Kurniawan drew the study design, carried out data management, and constructed a database. Rezzy Eko Caraka, Khairunnisa Supardi, Puspita Anggraini Kaban, Robert Kurniawan, Yunho Kim, and Syihabuddin Ahmad Mufti wrote the first draft manuscript. All the authors read and approved the final manuscript.

APPENDIX

See Table 7.

TABLE 7. Environmental data analysis.

Name	Use	Sources
R	Programming language	R Core Team [86]
RStudio	Data Analysis	RStudio, Team[86], [87]
Google collaboratory	Data retrieval	Google Research [88]
Google Earth Engine	Data retrieval	Gorelick [89]
QGis	- Polygon preparation - Centroid calculation	QGIS Development Team [90]
gllvm (R-package)	- Generalized Linear Latent Variable Models	Niku, J [81], [82], [83], [91]
Sgeojsonio (R-package)	- Spatial data preparation	Brian Bancroft[92]
spdep	- Polygon neighbor matrix calculation	Bivand, Roger [93]
ape (R-package)	- Moran's I calculation	Paradis[94]

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