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Environmental Pollution Control and Sustainability Management of Slum Settlements in Makassar City, South Sulawesi, Indonesia

Batara Surya [1,*], Haeruddin Saleh [2], Seri Suriani [3], Harry Hardian Sakti [4], Hadijah Hadijah [5] and Muhammad Idris [6]

1 Department of Urban and Regional Planning, Faculty of Engineering, University Bosowa, Makassar 90231, Indonesia
2 Department of Regional Economic, Faculty of Economics and Business, University Bosowa, Makassar 90231, Indonesia; haeruddin@universitasbosowa.ac.id
3 Department of Financial Management, Faculty of Economics and Business, University Bosowa, Makassar 90231, Indonesia; serisuriani06@gmail.com
4 Department of Urban and Regional Planning, Faculty of Engineering, University Muhammadiyah, Bulukumba 92511, Indonesia; revplano07@gmail.com
5 Department of Aquaculture, Faculty of Agriculture, University Bosowa, Makassar 90231, Indonesia; hadijahmahyuddin@gmail.com
6 Department of Economic Management, Faculty of Economics and Business, University Bosowa, Makassar 90231, Indonesia; idrismuh1955@gmail.com
* Correspondence: bataraciptaperdana@yahoo.co.id

Received: 26 July 2020; Accepted: 17 August 2020; Published: 19 August 2020

Abstract: The complexity of spatial use has an impact on poverty and the development of slum settlements towards a decrease in environmental quality. In this study, we aim to analyze (1) urbanization and spatial expansion as determinants of spatial dynamics in suburban areas, (2) the effect of spatial expansion, land use change, population increase, and spatial activity patterns on the development of slum settlements, and (3) the relationship between control of spatial planning, handling land reclamation, and improving the quality of infrastructure with improving the quality of the environment and the sustainability of handling slum settlements in the suburbs. We use a sequential explanatory design, which is a combination of quantitative and qualitative research, and data are obtained through observation, in-depth interviews, surveys, and documentation. The results showed that slum settlements in watersheds and coastal areas as well as inadequate support for infrastructure services resulted in excessive groundwater use, soil pollution, and surface water quality pollution resulting in less smooth river flow regulation, lowering of water levels, urban flooding, and disease transmission. Weak control over spatial use, utilization of water catchment areas, and the inadequate fulfillment of slum settlement infrastructure services cause a decrease in environmental quality. These results indicate that it is very important to deal with slum settlements in a sustainable manner, including spatial use and environmental, economic, and social aspects. This study recommends that the handling of slum settlements requires policy support from the government in an effort, to meet the city target without slums by 2030 in Makassar City, Indonesia.

Keywords: spatial dynamics; periphery area; slum settlement; environmental degradation

1. Introduction

The dynamics of metropolitan cities is one of the current global problems. Thus, understanding the components of urban population growth becomes a very important element [1]. Globalization is

the process of integrating the world system as a city, and major cities in Indonesia will have connections to the system [2]. Economic globalization, marked by the increasing volume of global transportation, and urban logistics space is also changing [3]. Urban-agricultural, urban-ecological, agricultural-ecological, and urban-agricultural-ecological space can effectively reduce the impact of human activities and agricultural production [4,5]. Excess urbanization and spatial expansion to meet the needs of the development of socio-economic activities contribute positively to the conversion of productive agricultural land and changes in utilization towards changes in typology and morphology of the periphery [6,7].

The world population that will inhabit large cities and metropolitan areas is estimated to reach 60% in 2030 and 70% by 2050. The number of cities with a population of more than 1 million will reach 450, and more than 20 cities will have megacity status, with a population surpassing 10 million. Rapid urbanization occurs when economic growth and urban job creation are absent in rural areas [8–10]. This perspective refers to the developed concepts of growth poles [11] and economic spatial integration [12]. Urban growth was examined based on a comparison of urban population over time, whereas urbanization refers to the relative comparison of urban population with total population [13,14]. Cities in developing countries including Indonesia have similar problems with their growth process, especially in the development of strategic and economic areas that are generally operated by capitalist sectors in spatial reproduction possession [15–17]. The acceleration of development and spatial expansion of the metropolitan city in Indonesia towards the periphery areas has an impact on reducing land cover, utilization of riverbanks, and water catchment areas for the needs of the construction of socio-economic activities and the construction of housing and settlements.

Urban areas in Indonesia are predicted to increase in population by 2045, when about 220 million people, or more than 70% of the population, will live in cities [18]. Urbanization in Indonesia currently at 56% and will increase to 70%. Every 1% increase in urbanization in Indonesia can only per capita by 1.4%. This figure is much smaller compared to China, where every 1% increase in urbanization creates a GDP increase of up to 3%. Every 1% increase in urbanization in the Asia Pacific and East Asia region, on average, increases GDP per capita by 2.7%. Population growth and urbanization are often seen as threats to environmental quality [19,20]. Indonesia is one of the countries with high population growth in Southeast Asia, which is around 1.45% per year, ranking sixth after Laos (2.3% per year), the Philippines (2.0% per year), Brunei Darussalam (1.9% per year), Malaysia (1.8% per year), and Cambodia (1.8% per year). The combination of typical urban and rural activities has created certain rural–urban transition features as the urban population has continued to notably increase [21,22]. The increase in population due to urbanization for the case of large cities and metropolitan areas in Indonesia, including Makassar City, towards economic growth and urban agglomeration has an impact on increasing poverty, slums, decreasing environmental quality, urban crime, and other urban problems [23,24]

The rapid and revolutionary expansion of Makassar has contributed to the development of slums and environmental degradation. A major challenge for sustainable urbanization policies and strategies is addressing the complexity of urbanization, especially the ongoing growth of informal settlements and slums in developing countries [25]. Slum areas that developed in Makassar occupied 443.38 hectares in 2010 and increased to 740.02 hectares in 2019, representing 66.9% growth distributed in 15 sub-districts. Slums are characterized by a lack of sanitation and public services, inadequate construction conditions, and irregular land tenure, often growing at high rates [26,27]. Slum policies could be shifted from the modernist high-rise slum clearance approach to a more organic, community-based renewal of the slums, in which infrastructure for energy, water, and waste can be created. New technology that fits into community-based governance structures allows such infrastructure to be a viable option, also producing formal economic benefits [28,29].

The spatial physical characteristics of Makassar slums are very different based on their typology and the pattern of use of the built space. These differences indicate that environmental characteristics and variations in community work will require different mechanisms and procedures for handling

them. The composition of the environment and access to employment implies that the relocation program must be carefully designed if it is to improve welfare [30,31]. Increased development activities in the periphery to meet the needs of developing large-scale commercial, industrial, service, tourism, and residential functions in the Biringkanaya and Tamalate Districts have an impact on the conversion of productive agricultural land and changes in spatial use. These changes are positively associated with the development of slums and the inability of the poor to access economic resources and urban land. The impact of spatial expansion affects the periphery, its relationship with the existence of slums, and environmental quality. Slum upgrading requires synergies between community and institutional actors [32].

The focus of this study was answering the following research questions: (1) How are excessive urbanization and spatial expansion working as determinants of spatial dynamics in the periphery of Makassar, Indonesia? (2) How will spatial expansion, land use change, and population increase affect the development of slums in the periphery? (3) Is there a positive correlation between spatial use control, land reclamation handling, and infrastructure quality improvement with environmental quality improvement and the sustainability of slum settlement management in the suburbs of Makassar? These questions were answered through a study conducted in two locations of the periphery: (a) the Biringkanaya district area, which is marked by the existence of seven slum areas, and (b) the Tamalate district area, with the existence of slums distributed in nine village locations.

2. Conceptual Framework for Slum Settlement in Makassar

Makassar's spatial expansion toward the periphery has reduced productive agricultural land and, in line with suburbanization, is characterized by changed spatial use and increasing population. Urban growth occurs in peri-urban areas, which are complex to manage and significantly impact the livability of cities [33]. Local positive and negative correlations exist simultaneously between the density of the spatial distribution and the scale allocation of land use [34–36]. The urban areas changed from a compact city to more dispersed patterns, or expanded in compact areas, a condition which caused changes in spatial structure due to inter-urban connectivity in the periphery [37].

Urbanization, including urban expansion, and demographic changes are some of the most significant and irreversible effects of human population increase [38,39]. The growth of urban areas is frequently disproportionate in relation to population growth in developing countries. This discrepancy cannot be monitored solely using statistics [40]. Growth in the suburbs of Makassar is characterized by the presence of primary service centers, including education centers, industrial areas, airport areas, shopping centers, tourist centers, and health care centers. Rapid and revolutionary spatial physical changes positively contribute to spatial structure changes, spatial pattern, and the agglomeration/deagglomeration of area functions [41].

The rapid expansion of online retailing has raised the concern that shops and shopping centers (evolved or planned agglomerations of shops) may be abandoned and thus lead to a depletion of urbanity [42]. Spatial allocation for trade and service activities dominates along main road corridors with high accessibility. The activity is intended to provide convenient services to consumers. This scale-free behavior of landscape–social relationships challenges the traditional modifiable area unit problem and provides mechanistic insight into the conflicts and compatibilities between human activities and human-induced land use change [43]. The conceptual framework of this study is shown in Figure 1 below.

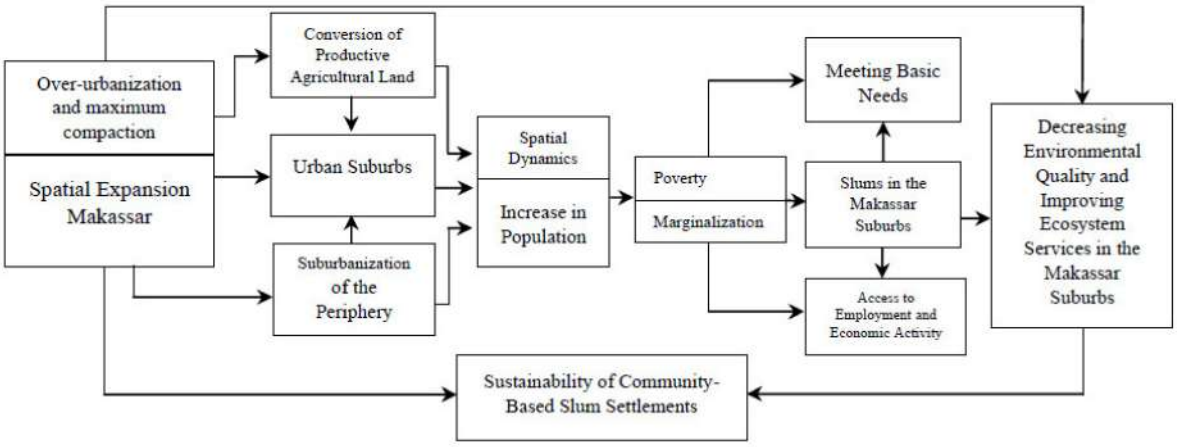

Figure 1. Conceptual framework for slum settlement in Makassar.

2.1. Urbanization, Poverty, and Community Marginality

Urbanization in Indonesia is a demographic process that is different from the conditions in developed countries. Industrialization and modernization of metropolitan city development have resulted in a population explosion, placing pressure on the urban space of Makassar. This population explosion resulted in a decrease in the quality of the environment and impacted economic, social, cultural, poverty, slum, and government services. The process of urbanization has a geographical relationship that continues to change in line with city life [44]. This concept is verified in relation to the spatial expansion of Makassar by the pattern of activities that developed due to excessive urbanization, which will always experience changes and impact changes in people's lives in the periphery. Urban growth is inevitably linked to peri-urban areas, which are the transition zones from rural to urban land uses located between the outer limits of urban and regional centers and the rural environment [45].

Lifestyle changes and an increase in the income of the people of Makassar are marked by suburbanization toward the periphery, and the triggering factors are settlement agglomeration, ease of transportation, and ease of socio-economic facilities services. All cities experience accelerated growth in built-up areas with highly dispersed properties during spatial growth [46]. The impact of suburbanization on the development of settlements emphasizes environmental aspects that need to be addressed in the process of extensive growth of municipalities in suburban regions [47]. The agglomeration of settlements, in line with the increased economic productivity of Makassar, has impacted the formation of community segmentation and differentiation of community work in formal and informal urban areas. In the process of economic urbanization, due to competition among cities, agglomeration and polarization of regional economies occur. The people in urban suburbs are differentiated by differences in lifestyle and ownership of residential facilities toward spatial, economic, and social segregation. Economic segregation is also, to a certain extent, related to race and ethnicity, commuting style, and income inequality [48]. The spatial segregation in the suburbs of Makassar impacts poverty and community marginality. Urban space is socially produced, i.e., it is not provided by nature, but is rather the product of human labor [49].

Community poverty is a condition where people are unable to meet their basic needs and experience difficulties in accessing education services and getting decent jobs. The poor are composed of several groups with different characteristics [50]. Marginality is a condition of a person or group in a marginal position or is in a community or structure and system in which a person or group exists or lives. Indicators of community poverty in the periphery of Makassar are measured based on various indicators: (1) ownership and access to land, (2) low level of education, (3) difficulty in getting decent work, and (4) limitations on education and health services. Therefore, health goals occupy a significant position on the United Nations 2030 Agenda for Sustainable Development [51]. Suburban development,

oriented to the functional development of economic activities and characterized by gentrification, suburbanization, and re-investment, becomes the determinant of changes in space use toward the functions of commercial activities [52–54].

2.2. Slum Settlement Handling Sustainability

The dominant problem facing big cities and metropolitan areas in Indonesia is slums. This slum settlement study basically covered three main aspects: (1) physical condition, assessed on the basis of dense residential buildings with low quality building construction, low-patterned road networks, general sanitation and malfunctioning drainage, and inadequate waste management; (2) the socioeconomic and cultural conditions of the communities that live in slums, assessed based on indicators of low income levels, loose social norms, a culture of poverty, and apathetic attitudes and behaviors; (3) the impacts, which were assessed based on poor environmental health conditions, potential pollution, sources of disease spread, and deviant behavior.

The dynamics of Makassar's development illustrate that residents who are unable to meet their housing needs are classified as low-income and poor people. In this context, individuals and groups of the urban poor are faced with problems related to expenditures required to fulfill their basic needs, including eating, dressing, and medication. That is to say, the first expense to be sacrificed by this group is spending on their homes and residences [55–57]. These hierarchy of human needs consists of five levels: (i) physiological needs, (ii) needs for security, (iii) needs for ownership and affection, (iv) needs for appreciation, and (v) needs for self-actualization [58]. The co-existence of two kinds of modes of production indicates differences in production systems, either in production procedures, force of production, used means of production, and labor skill among the working class at the urban fringe of Makassar [59].

The concept of sustainable development includes three main pillars that are interrelated and mutually supportive as a unified system: (1) to improve the economic welfare of the community, (2) to maintain the sustainability of people's social lives, and (3) to encourage improvements in the quality of the environment through governance of development implementation. The development of sustainable settlements includes 11 principles: (1) sustainable land use; (2) poverty alleviation; (3) productive employment creation and social integration; (4) population and development of sustainable population settlements; (5) an environment with sustainable, healthy, and livable settlements; (6) use of renewable and sustainable energy; (7) sustainable communication and transportation systems; (8) conservation and rehabilitation of historical and cultural heritage; (9) improving the economy in urban areas; (10) the balance of development between residential areas and rural areas; and (11) preventing disaster from occurring, mitigating, preparedness, and the ability to rehabilitate post-disaster [7]. This concept is in line with the 17 goals set in the SDG which is a world development program with the purpose achieving a prospering world community and preserving nature.

3. Materials and Methods

As a research method, we chose a case study. The case study was selected to understand the object under study: slums and the decrease in the environmental quality of the suburbs of Makassar. The aim was to explain the object under study, how it is, and why the case occurred [60,61]. We used case studies because (1) the spatial expansion of Makassar toward the periphery are specifically and complexly arranged, and we wanted to investigate the impact on the development of slums on environmental degradation; (2) the nature of the case has patterns, consistency, and sequences; (3) the context of the case of slums and the deterioration of the environmental quality of the periphery of Makassar area are quite complex; and (4) the nature of the case was aimed at understanding the background or spatial expansion event against the dynamics of the periphery.

We used a sequential explanatory approach, which combines qualitative and quantitative research methods in sequence. The approach was used to present a complete picture of the situations of the slums and environmental degradation in the study object for to explore and clarify the phenomena

in the field. Qualitative methods were used to describe the characteristics of slums, environmental degradation, and the formulation of research hypotheses. Quantitative methods were used to descriptively, comparatively, associatively, and statistically prove the hypotheses. The step was carried out carefully and holistically based on field data and the relationship between the phenomena under investigation [62,63].

3.1. Research Stages

The stages carried out in this study include: (1) The pre-field stage includes: (a) research design, (b) literature review, (c) selection of research fields, (d) selection of research tools, (e) data design, (f) data analysis procedure design, and data validity checking design. (2) Field work stage: In this process, the researcher first understands the background, namely the determinant factor of the spatial dynamics of the periphery of the development of slum settlements. (3) Entering the field: In this process, the researcher will explore and understand the situation, study the situation and background of the existence of the developing slum settlements in the Biringkanaya and Tamalate districts in relation to the socio-economic dynamics of the community. The aim is to improve the relationship between the researcher and the subject under study. (4) Participating while collecting data: In this process, several things were carried out, namely (i) limiting oneself to the entire scope of the research, (ii) recording data using field notes, (iii) remembering data using tools such as recording and video recording equipment if the subject does not object, (iv) examining a setting in which there is a conflict, and (v) field analysis, for the purpose of finding concepts that will be described according to the predetermined focus and research objectives.

The qualitative approach in this study, the main instrument is the researcher himself. Next, the initial action taken was to validate the data. The qualitative approach used is a human instrument, it functions to determine the focus of research, select key informants as data sources. This process was carried out for the purpose of understanding the existence of the people who live in slum areas in the Biringkanaya and Tamalate districts. Thus, researchers act in the process of collecting data, assessing data quality, interpreting data, and making conclusions. Furthermore, the steps that the researcher carried out were to increase sensitivity through interaction with all stimuli from the environment that were thought to be significant in this study. This means that researchers will interpret the spatial dynamics of the periphery areas against the existence of slum settlements.

Furthermore, the research instrument in this study is used for several purposes, including: (1) adjusting to all aspects of the situation for data collection purposes; (2) engaging in the interaction process for the purpose of understanding, feeling, and exploring how the socio-economic conditions experienced by the community by referring to the theories used; (3) making conclusions based on the data collected for the purpose of obtaining confirmation, amendments and improvements; (4) to enhance trust, it is carried out by responding to social phenomena that occur, particularly those related to the socio-economic conditions of the community and the efforts made to meet the needs for shelter facilities and their impact on changing environmental conditions. Thus, data collection in qualitative research is carried out through observation and in-depth interviews and the results are then categorized.

The quantitative approach in this study, the instrument is a questionnaire. The questionnaire is used to measure changes in land use, land reclamation, and infrastructure handling, social relations, social capital, needs fulfillment hierarchy, environmental pollution, and other socio-economic dynamics, in relation to the existence of slum settlements in the Biringkanaya and Tamalate districts of Makassar. Furthermore, the data analysis stage is basically aimed at formulating the basic concepts of research. In this process, the researchers did several things, among others: (1) Organizing the data, from the data that had been collected, including, among others, field notes and researcher comments, pictures, photos, documents in the form of reports, biographies, and so on; (2) the data analysis work carried out, namely arranging, sorting, classifying, coding, and categorizing. This organizing is carried out for

the purpose of finding a theme in order, to become a substantive theory. The stages of data collection and data analysis in this study are illustrated in Figure 2.

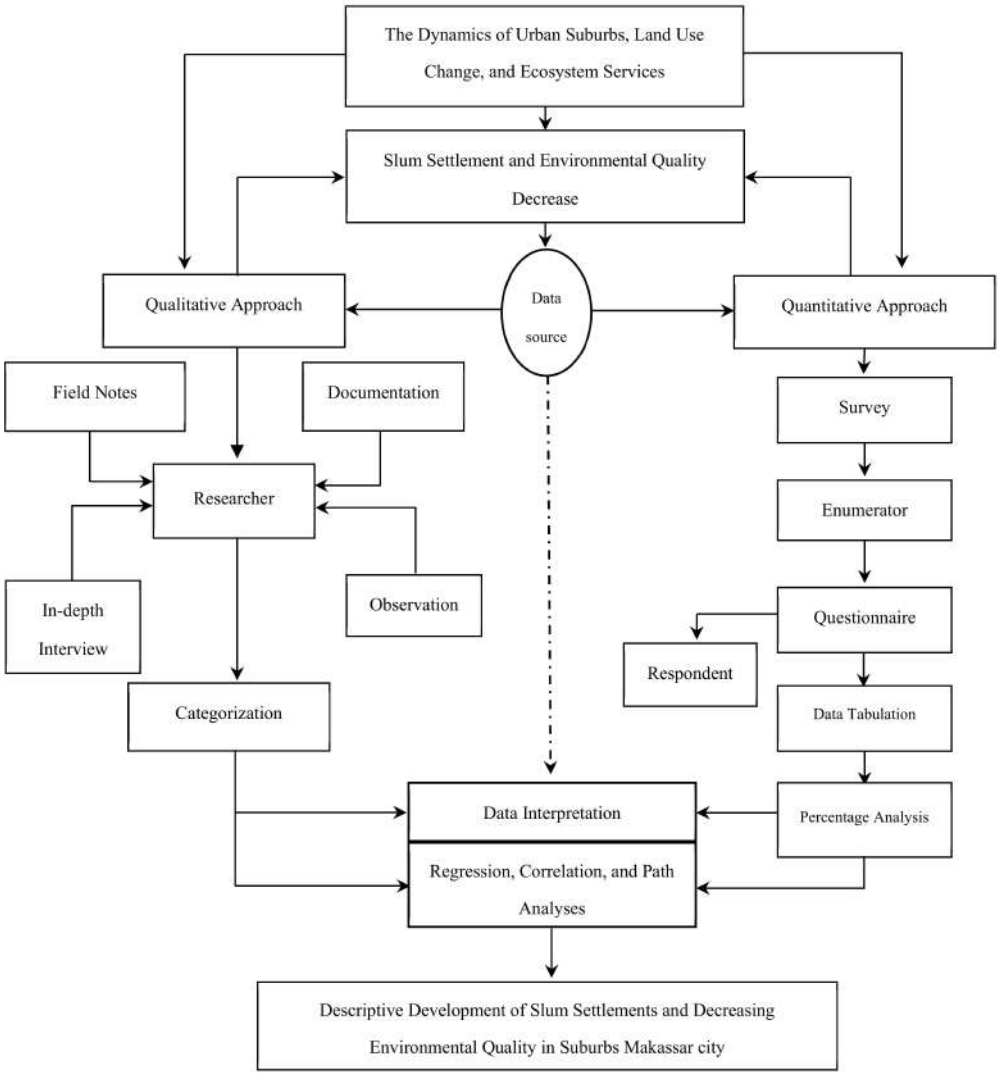

Figure 2. Research process flow.

3.2. Study Area

This study was conducted in a suburb of Makassar. We selected the research sites based on (1) the Biringkanaya and Tamalate districts being centers of economic growth; (2) the slums that develop directly coming into contact with strategic functional areas, including industrial areas, higher education, tourism, and trade centers; and (3) slum areas that develop predominantly being located on illegal land, i.e., on watersheds and coastal areas. Slums in the Biringkanaya and Tamalate districts occupy 43.13 and 177.91 hectares, respectively. Based on type, the areas were divided into three categories: (1) heavy slums occupying an area of 36.04 hectares; (2) medium slums currently occupying an area of 102.28 hectares, and (3) light slums occupying an area of 53.90 hectares. The type of slums development based on spatial characteristics is divided into three categories: (a) slum settlements on water that occupy 42.84 hectares, (b) slum settlements on 122.52 hectares, and (c) slums on lowlands occupy an area of 25.85 hectares. Slum settlements that are above water are slum settlements that are on the body of the river, while slums on the waterfront are slum settlements that are on the border line of the river and the coast. Furthermore, slums in lowlands areas are slums that occupy water catchment areas. Slums in the Biringkanaya district are in direct contact with industrial zones, warehousing, tertiary

education, and trade centers. Slums in the Tamalate district area are in direct contact with the central business zone, marine tourism, watershed (Jenneberang watershed), and the Makassar Strait coastline. The geographical location of the study in Figure 3 and Table 1.

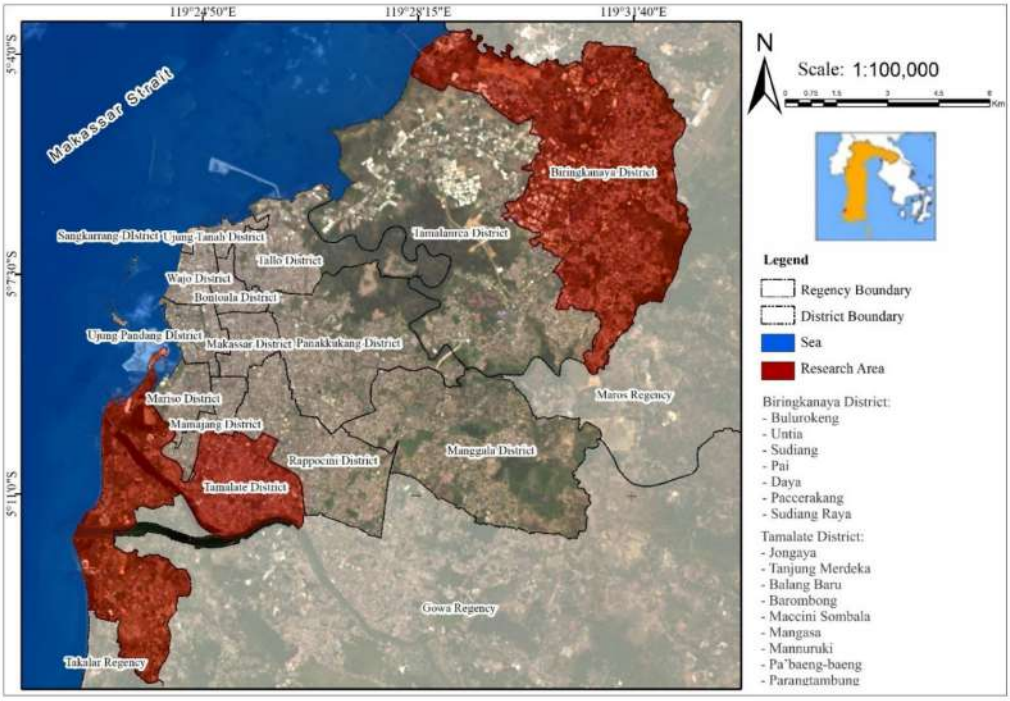

Figure 3. The study objects: Biringkanaya and Tamalate Districts in Makassar.

Table 1. Geographical position and types of slums in the study area.

Number	Slum	Geographical Location	Type of Slum
1	Bulurokeng	119°30′10.665″ E 5°4′35.877″ S	Lowland
2	Untia	119°28′42.518″ E 5°4′14.659″ S	Lowlands and Water Edge
3	Sudiang	119°32′26.908″ E 5°5′32.141″ S	Lowland
4	Pai	119°30′55.501″ E 5°5′23.379″ S	Lowland
5	Daya	119°30′22.264″ E 5°6′28.598″ S	Lowland
6	Paccerakang	119°31′0.479″ E 5°7′13.637″ S	Lowland
7	Sudiang Raya	119°31′48.304″ E 5°6′38.624″ S	Lowland
8	Jongaya	119°24′59.824″ E 5°10′27.819″ S	Lowlands and Water Edge
9	Tanjung Merdeka	119°23′40.14″ E 5°11′2.12″ S	Lowlands and Water Edge
10	Balang Baru	119°24′47.119″ E 5°10′58.134″ S	Lowlands, Water Edge, and Water Above
11	Barombong	119°24′0.744″ E 5°12′32.013″ S	Lowlands and Water Edge
12	Maccini Sombala	119°23′56.456″ E 5°10′2.354″ S	Lowlands and Water Edge
13	Mangasa	119°26′21.032″ E 5°11′8.139″ S	Lowlands and Water Edge
14	Mannuruki	119°25′40.393″ E 5°10′38.858″ S	Lowland
15	Pa'baeng-Baeng	119°25′23.795″ E 5°10′23.996″ S	Lowlands and Water Edge
16	Parang Tambung	119°25′28.153″ E 5°11′22.439″ S	Lowlands, Water Edge, and Water Above

The population and distribution of slums in the Biringkanaya and Tamalate districts of Makassar are in Tables 2 and 3.

Table 2. Distribution of slums, population, and density of Biringkanaya District.

Number	Village	Slum Area (Hectares)	Total Population (Soul)
1	Paccerakkang	603	57,646
2	Daya	472	14,599
3	Pai	-	23,263
4	Sudiang Raya	333	51,736
5	Sudiang	646	40,292
6	Bulurokeng	115	12,546
7	Untia	472	2438

Source: Makassar City Central Bureau of Statistics, 2019 [64].

Table 3. Distribution of slums, population, and density of Tamalate District.

Number	Village	Slum Area (Hectares)	Total Population (Soul)
1	Jongaya	32	15,678
2	Tanjung Merdeka	1719	11,414
3	Balang Baru	1631	8949
4	Barombong	3053	13,276
5	Maccini Sombala	2429	22,584
6	Mangasa	2271	32,042
7	Mannuruki	416	12,082
8	Pa'baeng-Baeng	357	20,731
9	Parang Tambung	4284	42,396

Source: Makassar City Central Bureau of Statistics, 2019 [64].

3.3. Data Collection

Data collection in this study was divided into three categories: First, observations were recorded of the conditions, characteristics, and types of slums in the Biringkanaya and Tamalate districts. For observations in this study, we used field notes, periodic notes, and checklists. The aim was to understand the situation and events related to the research problem. Second, the main subject of this research was the community located in slums in the suburbs of Makassar. Data collected through observation in this study include: (1) spatial use and function of space, (2) characteristics and typologies of slums, (3) land and building ownership status, and (4) environmental quality degradation based on pollution load. The data have a direct relationship with the characteristics of slums in the Biringkanaya and Tamalate districts. Furthermore, the measurement of data obtained through observation uses a nominal scale. The consideration is referring to the characteristics of the data obtained, namely (i) the data is mutually exclusive, and (ii) the data obtained does not have an absolute zero value.

Field observations made by researchers related to two things, namely information and context. This means that the researcher records what happened and relates the incident to the dimensions of time and place. This information and context is used by researchers to reveal the facts and meanings of events observed in the field. Furthermore, the results of observations made by researchers are then linked to the time and place that corresponds to the location of the interview and the distribution of questionnaires to respondents. Among the several images obtained in the field, construction was carried out to reveal the facts and meanings of each event that occurred.

In-depth interviews are used for two purposes: description and exploration. Its purpose is to limit the scope of the investigation. Data collected through in-depth interviews include: (1) people's perceptions of the environmental conditions in which they live, (2) community response to the dynamics of suburban development related to the existence of communities in slum areas, and (3) the ability of the community to adapt to changing environmental situations and the efforts made to ensure the survival of the community as part of the urban system. Data collection is carried out by researchers with the

aim of observing phenomena developing in the field. The instrument used in in-depth interviews is an interview guide made from respondents' answers and is in accordance with the phenomena that are the limitations of the study.

Furthermore, the measurement scale used is the attitude scale. This scale is used to measure people's opinions and perceptions related to social phenomena or symptoms that occur in the dynamics of the people who live in slums in the Biringkanaya and Tamalate districts. The aim is to explain the specific problems experienced by the community. The results are then elaborated through dimensions into sub-variables and determined as indicators in order, to be used as a benchmark for compiling items of questions or statements related to the established research variables.

The questionnaire in this study was used for two functions: description and measurement. Questionnaires were used for tracking data, including goals and motivations of residing in the location of industrial estates, trade, watersheds and coastal areas, educational background, land ownership, work orientation, social and economic relationships that are built, land values, living costs, and the hierarchy of meeting needs, among others. Data collected through a survey include: (1) The condition of basic infrastructure services in settlements, (2) types of community work; (3) hierarchy meeting the needs of the community, (3) community economic conditions related to welfare and income level, and (4) social conditions related to community institutions, community participation, status of land occupied, social status, urban crime, and community behavior towards their residential environment. Data from the survey uses ordinal scale. The consideration is based on the data obtained, namely (i) the data categories are mutually exclusive, (ii) the data categories have logical rules, and (iii) the data categories are determined based on the characteristics and facts that develop in the field to match the questions asked in the questionnaire.

The filling out of the questionnaire in this study was facilitated by an enumerator. The selected enumerators, namely (i) local people who have, the ability to collect data, and (ii) understand the socio-cultural conditions of the respondents in the study area. Before carrying out their duties in the enumerator field, they were first given instructions and questionnaire-filling exercises as well as interviewing techniques for respondents.

The documentation included data on the number of residents obtained from Makassar Statistics Office, urban space patterns and the service center system of the periphery areas obtained from Makassar Regional Development Planning Agency, spatial expansion and land use change obtained from Makassar Spatial Planning and Building Office, and other documents related to the development of the suburbs of Makassar. Secondary data collected to support this research includes the Makassar City development policy 2019, Biringkanaya district and Tamalate district in Figures 2019, and the results of studies on the handling of slums, and Makassar City Spatial Planning. All information obtained in the form of documents were called secondary data.

Data collected through observation, surveys, in-depth interviews, and documentation were then grouped into two types of data groups. First, primary data included data directly obtained by researchers in the field through surveys, in-depth interviews, and observations. Data obtained through surveys were categorized as quantitative data, whereas data obtained through in-depth interviews and observations were categorized as qualitative data. Primary data collected were (1) survey data including types and slum characteristics, community occupancy status, socio-economic relations, income levels, land ownership status, work distribution systems, and the role of institutions in community groups, (2) qualitative data collected through in-depth interviews including reasons for choosing residential location, job differentiation, community work systems and mechanisms, value systems and norms, principles that unite the community, developed economic activities, patterns of relationships and social control, and the factors that cause the community to survive in slums, and (3) qualitative data collected through observation included land use, type, and characteristics of slums, and individual relations within community groups, social stratification, and social status.

3.4. Population and Research Samples

Population consisting of objects and subjects that have certain qualities and characteristics to be studied by researchers, from which conclusions can be drawn. The population in this study included residents of the Biringkanaya and Tamalate districts of Makassar. The number of samples in this study was set to 500 respondents. The sample was determined using purposive sampling according to specific characteristics: residents located in slums with permanent jobs, married, and in slums for five years. The sampling method was performed in accordance with Cochran [65], as follows:

$$n = \frac{N}{Nd2 + 1} \quad (1)$$

where n is the sample size, N is the population size, and d is the error rate (0.5, or 5% of the 95% confidence level). The number of samples defined in this study is presented in Table 4.

Table 4. Number of respondents in the study area Biringkanaya and Tamalate Districts, Makassar.

Slum	Number of Family Heads	Number of Samples
Bulurokeng	3006	25
Untia	530	10
Sudiang	10,002	40
Pai	5494	35
Daya	4406	30
Paccerakang	13,772	45
Sudiang Raya	11,849	45
Jongaya	3932	25
Tanjung Merdeka	2216	15
Balang Baru	4018	30
Barombong	3105	25
Maccini Sombala	5185	35
Mangasa	10,348	45
Mannuruki	3583	25
Pa'baeng-Baeng	5059	35
Parang Tambung	9749	35

3.5. Data Analysis

We conducted two data analysis activities. First, we conducted qualitative research by collecting data through observation and in-depth interviews, which were then analyzed. Second, for quantitative research, we gathered information on research objects using a questionnaire instrument that was filled out by respondents. Then, an analysis was conducted. This second stage was the slightly more dominant method used for analyzing data.

In the first stage, we synchronized the qualitative approach in capturing field data with the results of quantitative data analysis. The technique used was observation, where we observed the situation and conditions of the slums and decreases in the quality of the environment in the study area. Then, we recorded the activities of the people who lived in the slums. We relied more upon qualitative research as a cross-check tool for data collected through questionnaires. In-depth interviews were conducted with informants for the purpose of comparing answers and asking for detailed explanations both from the respondent and from outside the interviewee. For example, the questionnaire questions asked about the intensity of their relationships, especially those directly related to social ties and the principles of values and norms that are still carried together in a community group ties. Through this informant, we asked for a detailed explanation of the frequency of patterns of social relationships and bonds between individuals in a group.

Quantitative research was used to explore information through several questions that were compiled, and alternative answers were given. The questions in the questionnaire were arranged

based on the initial orientation that had been carried out in the field. That is, we attempted to explore the patterns of occupancy and the characteristics of the slums that were developing. Habits are carried out by the community to survive and maintain their existence. The residents selected as respondents were those who were categorized as perpetrators of kinship in one community group.

The collected data were then analyzed by displaying a frequency table to demonstrate the conditions and characteristics of slums in the suburbs of Makassar. Data were analyzed by combining the qualitative and quantitative data. That is, the steps used for qualitative research were also used for quantitative research. For interpretation or analysis, we reduced each datum to categorize qualitative and quantitative data to calculate descriptive statistics. The two data types were interpreted using triangulation. This means that the data obtained from the results of the questionnaire were explored deeper through qualitative and quantitative methods. This merger was performed to strengthen the validity of the results of the analysis. Data were reduced through grouping or categorizing data according to the scope of the study. Likewise, with the questionnaire, all questions referred to the focus of the study. That is, a quantitative approach was used to explain several sections of this study. Thus, this research was first broad, then focused. The stages of data analysis were carried out by combining qualitative and quantitative approaches: domain analysis, taxonomy, componential, and cultural theme analysis.

3.5.1. Domain Analysis

This analysis was carried out after we had visited the slums to determine the social situation including place, actor, and activity (PAA), then we recorded observations, interviews, and made descriptive observations. The next step was domain analysis. The domain in this study was excessive urbanization working as a determinant of spatial dynamics in periphery areas. Domain analysis was used to obtain a general and overall picture of the research object. Excess urbanization, as a research domain, was analyzed and interpreted as a factor that determines the development of slums and decreases in the quality of the periphery. The goal was to analyze the spatial dynamics factors to the existence of slum locations. This process is achieved through preliminary observations at the study site. From preliminary observations, we obtained an indication that excess urbanization is a determinant of the spatial dynamics of the periphery. This process was marked by the development of socio-economic activities and the inability of the community to access adequate housing. That is, the research domain found was used as a foothold to dissect the phenomenon of excess urbanization working as a determinant of spatial dynamics in the periphery.

3.5.2. Taxonomic Analysis

This analysis was performed after finding a domain or category of the social situation of the slum community based on the field data. The domain we chose was determined as the focus of the study, to explore data collection in the field. Data were collected continuously through observation, in-depth interviews, and documentation. Taxonomic analysis, among others, involved determining the domain in detail, including spatial dynamics, spatial functions that developed, and social characteristics of people who inhabited the slums. This process involved observing community social relations, work orientation, institutional functions, and existing social units. The aim was to determine the internal structure of the community based on the developing spatial dynamics. This process was achieved through focused observation of specific items, namely social relations, economic relations, occupancy patterns, and mapping of settlement types.

3.5.3. Componential Analysis

This analysis was the main problem to be organized in the domain. The data were traced through observation, in-depth interviews, and selected documentation. That data collection technique used was triangulation in terms of creating a specific and different-dimension picture for each element found. This stage was performed by (1) determining the specific characteristics of each internal structure,

(2) contrasting each element based on the conditions and characteristics of the developing slums, and (3) observation and selected interviews with contrasting questions to create a picture of the situation.

Cultural themes were analyzed to attempt to find a common thread by integrating existing cross domains [66]. The common thread that was found from the results of domain, taxonomic, and component analyses in formulating social phenomena was excessive urbanization works as a determinant of spatial dynamics in the periphery. The steps followed were (1) establishing the relationship between real domains and integrating across existing domains and (2) structuring the results of domain, taxonomy, and componential analyses to construct the situation of developing slum areas and their impact on environmental degradation. The situation was constructed to examine the effect of spatial expansion, land use changes, and increasing population on the development of slums and decreasing environmental quality in the suburbs of Makassar.

Quantitative analysis was used to determine the effects of spatial expansion (X_1), changes in land use (X_2), spatial dynamics (X_3), increasing population (X_4), spatial activity patterns (X_5) on the development of slums (Y) and environmental quality degradation (Z) in the suburbs of Makassar. Each respondent for each question gave an answer, with the highest score of five, in this case the respondent's response on a five-point scale, with the highest score of five. The second step was dividing the results of research scores with ideal scores. Intervariable correlation test uses the regression method, with the equation as follows:

$$Y = a + b_{1 \times 1} + b_{2 \times 2} + b_{3 \times 3} + \ldots + b_{n \times n} \quad (2)$$

where Y is the dependent variable, X is the independent variable, a is a constant, and $b_{1 \times 1}$, $b_{2 \times 2}$, $b_{3 \times 3}$ are regression coefficients. For the correlation coefficient test, we used the Pearson correlation coefficient (r) considering (i) the research data were interval scale data and (ii) the correlation between two or more variables was linear, meaning that the distribution of the data obtained showed a direct relationship. r is calculated as

$$r_{xy} = \frac{\sum \varkappa.y}{\sqrt{(\sum \varkappa^2)(\sum y^2)}} \quad (3)$$

r_{xy} is the correlation coefficient between variables X and Y, $\varkappa$ is the deviation from the mean for the value of variable X, y is the deviation from the mean for the values for variable Y, $\sum \varkappa$.y is the product of X and Y values, $\varkappa^2$ is the square of the values $\varkappa$, y^2 is the square of the y value. Furthermore, application path analysis was based on the following variables: (i) X_1 exogenous independent variable (slum development), (ii) X_2 exogenous independent variable (land reclamation handling), (iii) X_3 exogenous independent variable (improvement in the quality of settlement infrastructure), (iv) Y endogenous dependent variable (quality improvement environment), and (v) Z endogenous dependent variable (sustainability of slum management). Epsilon (ε) states the amount of residual influence, which is the magnitude of the influence of the independent variables not examined. The path diagram using structural equation is as follows:

$$Y = PYX_1 + PYX_2 + PYX_3 + \varepsilon. \quad (4)$$

Path analysis was used with consideration of (1) interval-scale research metric data, (2) endogenous and endogenous dependent variables for multiple regression models and intermediate variables for mediation models, and combined mediation and multiple regression models and complex models, (3) pattern in the relationship between variables occurring in only one direction, and (4) the causal relationship based on theory, namely, a relationship or correlation between the development of slums, handling land reclamation, and improving the quality of slum infrastructure to improving the quality of the environment and the sustainability of slum management. The application of the multiple regression and path analyses is shown in in Figure 4.

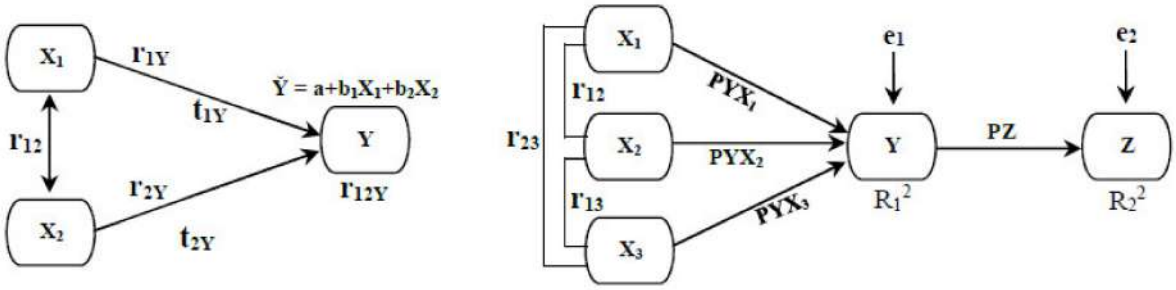

Figure 4. Model of multiple regression analysis and path analysis.

Figure 4 shows the multiple linear regression analysis with explanation Y is the dependent variable, X_1, X_2 is the independent variable, r_{12} is the relationship between X_1 and X_2, r_{1Y}, r_{2Y} is the correlation value between the variables X with Y, t_{1Y} and t_{2Y} are the significance values. In the path analysis model, several things can be explained, including: (1) The magnitude of the relationship is expressed by the correlation coefficient (r_{12}), (r_{13}), and (r_{23}). (r_{12}) shows the correlation or relationship between X_1 and X_2, (r_{13}) shows the correlation or relationship between X_1 and X_3, and (r_{23}) shows the correlation or relationship between X_2 and X_3; (2) The variables X_1, X_2, and X_3 act as independent variables affecting the dependent variable (Y); (3) The independent variable X_1 and the dependent variable Y are connected by the regression coefficient (p_1); (4) The independent variable X_2 and the dependent variable Y are connected by the regression coefficient (p_2); (5) The independent variable X_3 and the dependent variable Y are connected by the regression coefficient (p_3); (6) the magnitude of the direct effect of X_1 on Y is the square of the regression coefficient (p_{12}), the direct effect of X_2 on Y is the square of the regression coefficient (p_{22}), the direct effect of X_3 on Y is the squared of the regression coefficient (p_{32}); (7) The magnitude of the total influence is the coefficient of determination with the R^2 symbol, which is the value of the total effect of the influence of the independent variables under study on the dependent variable: (i) R^2 is the total effect, namely the direct effect + the indirect effect, (ii) ($p_{12} + p_{22} + p_{32}$) is the direct effect X_1, X_2, and X_3 on Y, (iii) (p_1, r_{12}, p_2) is the effect indirect variable X_1 through X_2 on Y, (iv) (p_2, r_{12}, p_1) is the indirect effect of variables X_2 through X_1 on Y, (v) (p_1, r_{13}, p_3) is the indirect effect of X_1 through X_3 on Y, (vi) (p_3, r_{13}, p_1) is the indirect effect of variables X_3 through X_1 on Y, (vii) (p_2, r_{23}, p_3) is the indirect effect of variables X_2 through X_3 on Y, (viii) (p_3, r_{23}, p_2) is the indirect effect of variables X_3 through X_2 on Y. (8) Meanwhile, epsilon (ε) states the amount of residual effect (residue), namely the magnitude of the influence of the independent variables that are not examined.

4. Result

4.1. Determinants of Spatial Dynamics in Suburbs and Slum Settlements

We divided the areas that developed in the periphery into two categories: (a) the dominant type in the Biringkanaya sub-district is lowland slums, occupying 21.69 hectares or 82.13% of the total area, and the dominant slum level is medium slums, with a land area of 26.41 hectares of the total area of slums; (b) the type of the dominant slum settlements in the Tamalate sub-district area is slums on the waterfront, occupying 117.8 hectares or 71.48% of the total, and the dominant slum level is medium slums, occupying 164.80 hectares. These characteristics and types are directly related to the orientation of community work, the potential threat of floods, poverty, helplessness, poor sanitation, limited distribution of clean water services, and the high potential for fire threats. Effective integration of the residents in informal settlements into local governance for water management is urgently needed [67].

The Biringkanaya district (Figure 5) can be characterized as follows. (i) The largest area was located in Sudiang Village with 1349 hectares, whereas the smallest area was located in Untia Village with 289 hectares. (ii) The largest number of family heads was found in the Paccerakkang Village with 13,772 heads of families, whereas the lowest number of family heads was located in Untia

Village with 530 families. (iii) The highest population was located in Paccerakkang Village with 57,646 people, whereas the lowest population was located in Untia Village 2438 inhabitants. (iv) The highest population density was located in Paccerakkang Village with 73 people/hectare, whereas the lowest population density was located in Untia Village with eight people/hectare. The accelerating global population has led to human-made changes of the natural environment to urbanized regions of highly polluted air and densely constructed infrastructures [68].

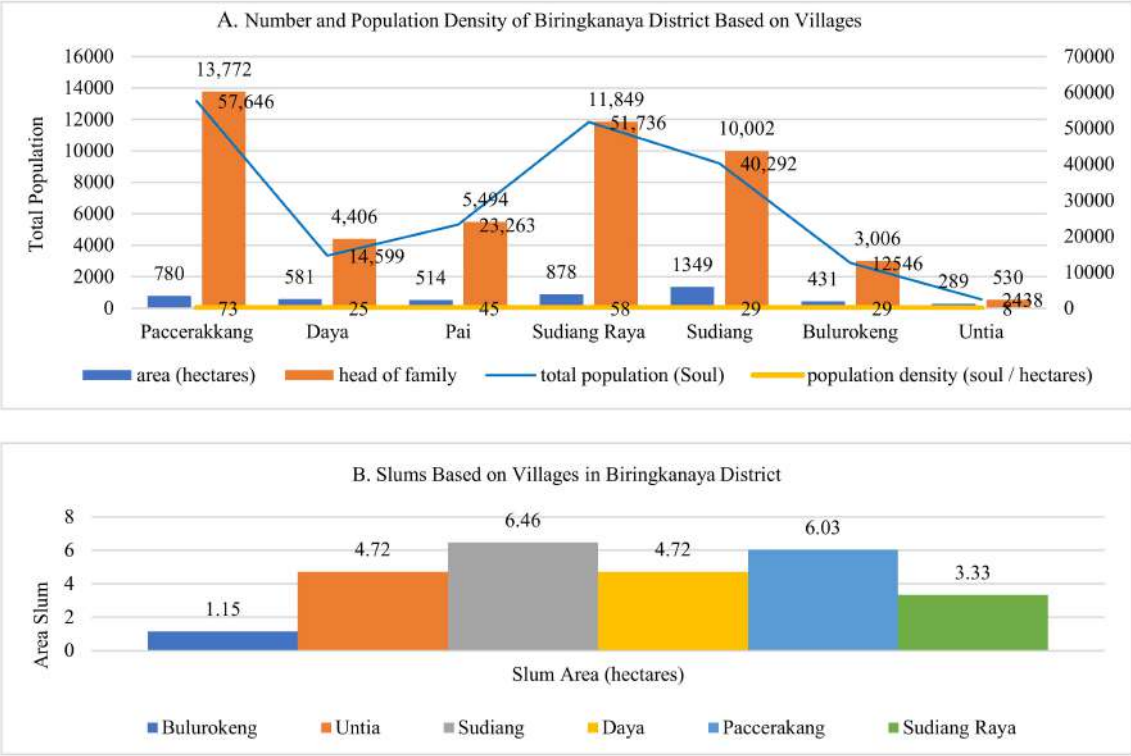

Figure 5. (**A**) Number of slum residents and (**B**) settlements in the Biringkanaya District [64].

Slums located in the Biringkanaya district are distributed in seven urban villages. We found, here, that (i) the dominant type was lowland slums, (ii) the slums were categorized as moderate slums, (iii) slum area was 26.41 hectares, and (iv) the biggest slums are located in Sudiang Village 6.46 hectares, with the smallest located in Sudiang Raya Village at 3.33 hectares. Slum identification studies are driven by the persistence and growth of slums and the emergence of new slums being inexorably part of contemporary urbanization processes and lack of affordable low cost housing and poor planning encourages the supply side of slums [69].

Figure 6 shows the total population in the Tamalate district, Makassar. For this district we found that (i) the largest was 734 hectares (Barombong Village), whereas the smallest was Bungaya Village at 29.0 hectares; (ii) the largest number of family heads was found in Mangasa Village, with 10,348 households, and the lowest number of family heads was located in Tanjung Merdeka Village, with 2216 families; (iii) the highest population was in Parang Tambung Village with 42,396 inhabitants and the lowest population was located in Bungaya Village 8949 inhabitants; and (iv) the highest population density was located in Pa'baeng-baeng Village 391 inhabitants/hectare and the lowest population density was located in Barombong Village with 18 inhabitants/hectare. Public-driven attempts to provide decent housing to slum residents in developing countries have either failed or achieved minimal output when compared to the growing slum population [70].

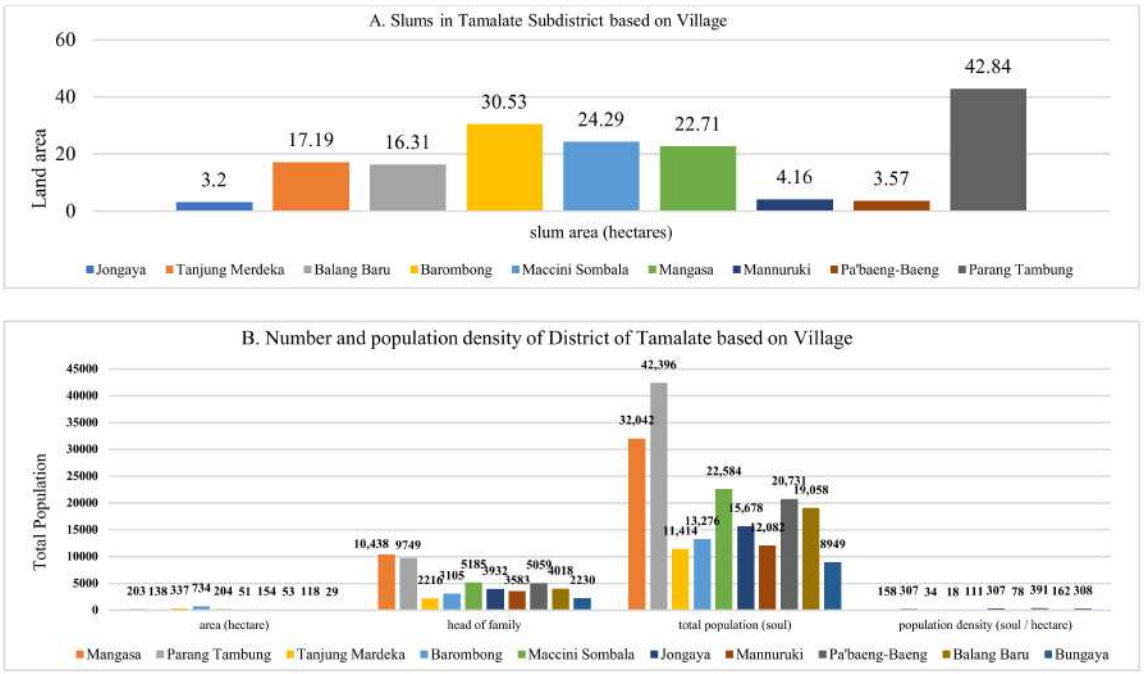

Figure 6. (**A**) Number of slum residents and (**B**) population density in the Tamalate District. [64].

Slums in the Tamalate subdistrict were distributed in nine villages. Here, we found that (i) the type of slum settlements consisted of lowland slums and covered an area of 4.16 hectares, at the edge of water covering an area of 117.8 hectares, and which is located on a river body covering an area of 42.84 hectares; (ii) the slums were categorized as moderate slums; (iii) the total area of slum settlements was 164.8 hectares; and (iv) the largest slum was Parang Tambung Village, occupying 42.84 hectares, and the smallest was Jongaya Village, with an area of 3.20 hectares.

Slums in the suburbs of Makassar will require a treatment program that differ in the physical, economic, and social aspects. The implementation of a Makassar development policy must consider the conditions and characteristics of the community, in this case protecting the existence of poor and marginal communities in the periphery. Good urban governance is a multidimensional concept that focuses on the improvement of the quality of living conditions of local citizens, especially those of marginalized and disadvantaged communities [71].

Figure 7 shows the conditions and environmental characteristics of the slums in the Biringkanaya and Tallo districts. We analyzed three aspects regarding conditions of slums in the study area. First, regarding the level of infrastructure services, residential buildings, and land legality, the indicators assessed included environmental roads, environmental drainage, clean water services, sanitation, waste management, residential buildings, fire protection, and land tenure. Second, regarding the economic conditions of the people, the indicators assessed included the type of work, income level, welfare, and economic business. Third, regarding socio-cultural conditions, we assessed social capital, social relations, land conflicts, urban crime, access to education services, access to health services, social interaction, social adaptation, value systems, and cultural patterns. The results of the field study showed differences in the level of infrastructure services and socio-economic differentiation of people living in the slums. Informal settlement upgrading is widely recognized for improving shelter and promoting economic development, yet its potential to improve health equity is usually overlooked [72].

Figure 7. Examples of the conditions and characteristics of slums in (**A**) Biringkanaya and (**B**) Tamalate Districts in Makassar City. Source: Primary Data, 2019.

Figure 8 describes the slums that developed in the suburbs of Makassar based on the conditions of the infrastructure and economic and socio-cultural services. Our recommendations for handling slums include the following: First, infrastructure services that can be improved by improving the quality of roads with a value of 20.5% of the total area of slums, clean water services 15.9% in the slums in the Biringkanaya district, and 21.3% of road network services and 19.1% of clean water services in slums in the Tamalate district. Infrastructure services that still need improvement in the future include the management of household wastewater, and sanitation and waste systems. The results of the field observations indicated that the implementation of slum settlement infrastructure in the outskirts of Makassar has not been optimized. The solution to the housing problem lies in increasing stakeholders' participation in the provision of housing, where government, non-governmental organizations, multilateral agencies, and the community can play a critical role [72].

Figure 8. *Cont.*

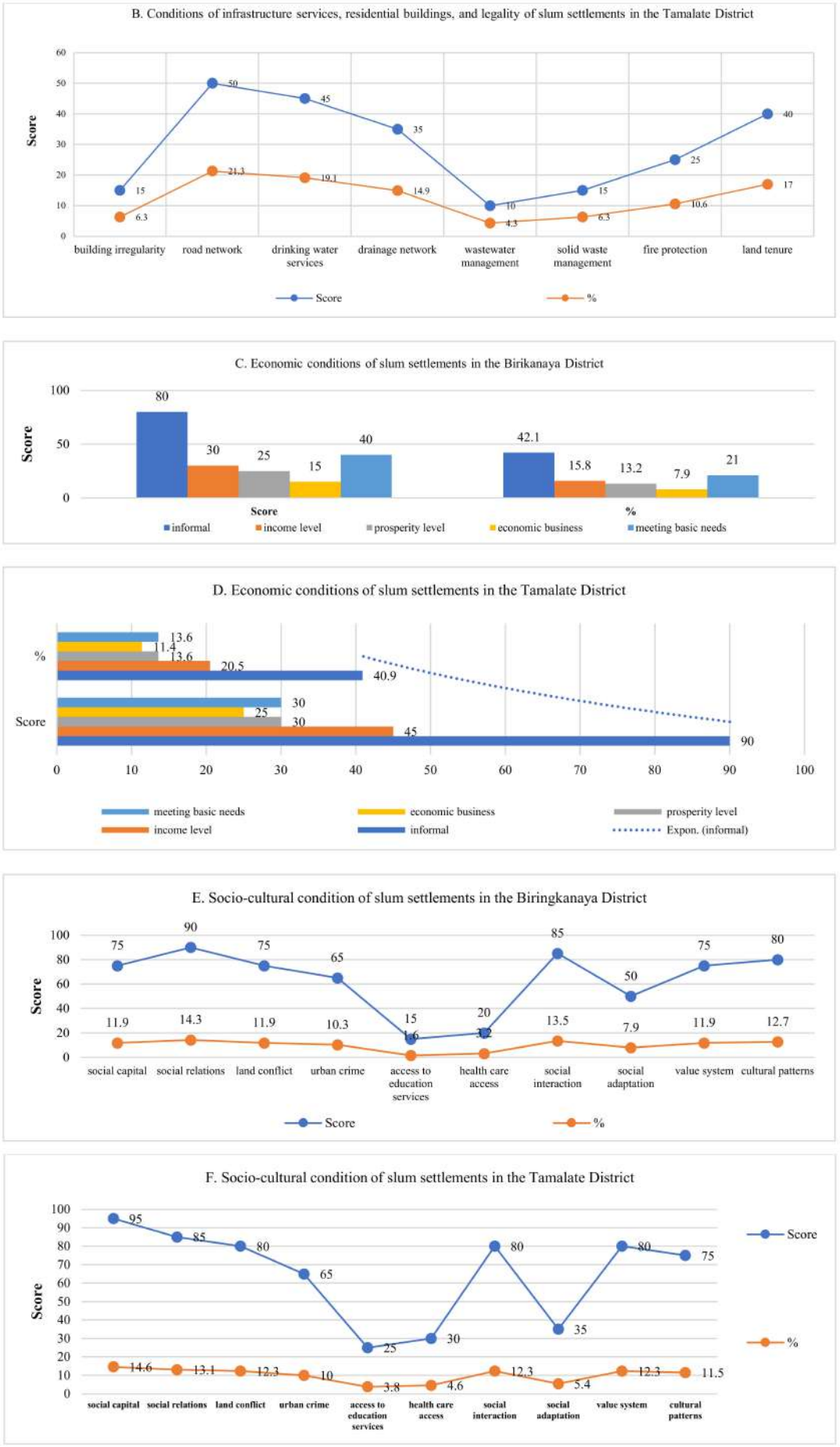

Figure 8. Conditions of infrastructure, economic, and socio-cultural services of slum settlements in (**A**,**C**,**E**) Biringkanaya and (**B**,**D**,**F**) Tamalate Districts, Makassar. Source: Primary Data, 2019.

Second, in the orientation of the economic activities of slum communities in the periphery, the informal urban economic activity stands out, namely 42.1% in the Biringkanaya district area and 40.9% in the Tamalate district area, in relation to the total economic activity of the people who inhabit slums. The results of the field confirmation showed that the community's economic system in the slums is still at a subsistence level; as a result, the residential needs have not been fulfilled independently in relation to the feasibility of residential buildings, including education and health services. Urbanization increasingly means that the poorest and most vulnerable people move into large and highly distressed informal areas. These areas exhibit high levels of poverty and inequality [73].

Third, the socio-cultural aspect of the people of the suburbs of Makassar is quite prominent, showing potential as social capital despite the different origins, cultures, and ethnicities of the people. This condition occurred due to a sense of togetherness in living together and achieving prosperity. Social capital is built as a result, of shared responsibility for the conditions of the environment in which they live. The social relations that are built are symbiotic mutualism, working together, helping each other if there is a need, and agreeing to live together. Thus, social capital is an important element in the process of empowering slums in rural areas. Social capital contributes to resilience by strengthening friendship and cooperation with neighbors and promoting household safety and survival [74,75].

4.2. Effect of Spatial Expansion on Slum Settlements

The spatial expansion tending toward the city periphery, followed by the conversion of productive agricultural land, has changed the characteristics of the environmental ecosystem. The increasing human population in urban areas and the importance of urban functions pose a number the ecological cross-boundary challenges [76]. Thus, the expansion of Makassar to the periphery has exceeded the carrying capacity of the environment. In the majority, of developing countries slums are a defining part of the urban scape. Their supply with energy, basic infrastructure, among others is one of the main challenges of modern civilizations [77]. Excessive use of land resources for meeting the development needs of large-scale settlements, industry, trade and service centers, education, offices, airports, and other socio-economic activities is impacting the deteriorating environmental quality of the periphery. Rapid urbanization is exerting pressure on fresh water supplies, sewage, the living environment, and public health [78]. Field findings showed that spatial expansion has intensified the conversion of productive agricultural land that was initially used by the community for agricultural activities, then underwent a change in the urban industrial direction. Industrialization represents a fundamental shift in how resources and environment are exploited and used, and its typical modes of social production and operation are production mechanization, organization intensification, and mass consumption [79].

Changes in the orientation of community toward industrial urban areas have led to community marginalization. This condition is marked by suburbanization and coexistence of capitalist and pre-capitalist modes of production, which combine to use space in the same location towards a dualistic economic system including the formal and informal economies. Urbanization is a process related to economic growth and expansion of the metropolitan core city towards urban growth in the periphery [80]. Sustainability typically involves the balancing of three major factors: the economy, the environment, and some notion of equity. Though the economy is already a key aspect, the recognition of the informal economy seems to be absent from the many possible permutations of these three [81].

The increasing transfer of the function of agricultural land to non-agriculture, in addition to increasing informal economic activity, also impacts the increasing population in peripheral areas toward the development of formal and informal settlements. Community marginalization has an impact on the urban economy and works as the main mode of generating income for the urban poor to maintain livelihoods [82]. International and nongovernmental organizations (NGOs) often facilitate negotiation rounds from the perspectives of informal sector workers and street vendors [83]. At the regional scale of economic and social activities, the space use is predominantly located in a strategic

area along the main road corridor and connected with the road network system toward the location of formal settlements.

The field findings illustrated that due to the inability of the poor to meet their residential needs due to the high value of land prices, the poor then appropriated land along the river and coastal areas to build and provide housing facilities with uninhabitable building conditions that developed into slums. The expansion of urban slums in the developing world is nothing but a result of informal, illegal, and unplanned urban growth [84]. Slum development is fueled by a combination of rapid rural-to-urban migration, increasing urban poverty, the inability of the urban poor to access affordable land for housing, and insecure land tenure [85]. This confirms that the slums that developed in the suburbs of Biringkanaya and Tamalate districts are not only inhabited by local communities, but also by migrants who are unable to adapt to changes in environmental stimuli. This means that slums in the suburbs of Makassar are inhabited by multi-ethnic communities of different cultural origins.

The results of Table 5 confirm that spatial expansion followed by changes in land use, increasing population, and positive spatial patterns of activity are correlated with the development of slums in the suburbs of Makassar.

Table 5. Summary of associative hypothesis testing.

Correlated Variables	r Count	r Table	Information	R^2
Spatial Expansion with the Development of Slum (ryx_1)	0.42	0.297	Significant	0.176
Land Use Change with the Development of Slums (ryx_2)	0.45	0.297	Significant	0.203
Increase in Population with the Development of Slums (ryx_3)	0.47	0.297	Significant	0.221
Spatial Activity Patterns with the Development of Slum (ryx_4)	0.39	0.297	Significant	0.152
Spatial Expansion, Land Use Change, Increase in Population with the Development of Slums (R)	0.568	$f = 3.22$	Significant	0.320

The field data showed that slums that develop in the suburbs of Makassar have a direct relationship with land reclamation in watersheds and coastal areas and are positively associated with settlement environment inundation during the rainy season. The inundation was influenced by relatively low landforms and reclamation of water catchment areas. Field data illustrated that this condition was exacerbated by suboptimal environmental systems for draining rainwater. Two of the main problems related to urban drainage systems are the frequent flooding events in urban areas and pollution induced by surface runoff in urban areas [86,87]. Slums in the periphery are influenced by two main factors: (i) the building aging process, resulting in building damage, which is dominant in local community housing due to economic constraints, so the quality of housing cannot be improved, and (ii) the process of building compaction, which occurs due to an increase in population and land reclamation as well as the reduction in land cover along watersheds, watersheds, and coastal areas. The use status of reclaimed land and its mechanism should make a critical contribution to sustainable land use planning and policy decision making [88].

Field data shows that standing water in slums is the result of land reclamation along watersheds and watersheds. This condition causes poor regulation of river flows, a decrease in groundwater level, and, during the rainy season, river water and high tides overflow into slums inhabited by poor people. Thus, land reclamation for residential building needs and community behavior causes a decrease in environmental quality. This condition is characterized by inadequate settlement infrastructure systems in terms of services and functions. Thus, slums that develop in the periphery are vulnerable to urban flooding, fire, and infectious diseases, such as dengue fever, diarrhea, and skin diseases. Fecal contamination, as an indicator of low levels of hygiene and sanitation practices as well as poor management of drinking water supply, might increase the risk of waterborne diseases in developing countries like Indonesia [89]. These dwellers in hugely dense slums have no access to safe drinking water, sanitary latrines, proper waste disposal systems, or adequate sewer drainage [90].

4.3. Impairment of Environmental Quality and Hierarchy of Meeting Community Needs

Spatial dynamics and the development of slums in the suburbs of Makassar are producing environmental degradation. Some factors that cause decreases in the quality of the environment include (1) human behavior, influenced by a fairly low educational background, community culture, and community awareness of the environment being low; (2) the quality and limitations of settlement infrastructure, characterized by a suboptimal drainage system for draining rainwater, poor water supply distribution, poor environmental sanitation, and a conventional waste management system; (3) population density and building density, characterized by a non-patterned road network system, very close inter-building distance, quality of residential buildings that do not meet technical standards, and the availability of very limited green open spaces; (4) residential areas that develop in watersheds and coastal areas, marked by the reduction of land cover, damage to mangrove forest habitat, and land reclamation in water catchment areas; and (5) economic limitations, socio-cultural factors, and lack of knowledge, causing the poor to have a low concern for the quality of their residential environment. To tackle multidimensional problems such as ecological destruction, poverty, and inequity, sustainable development is normally characterized by three pillars: environmental, economic, and social sustainability [91,92].

Figure 9 shows the decrease in the quality of the environment of slums in the suburbs of Makassar. We found that (1) the main factors that cause declines in the slum environmental quality are community behavior, population and building density, quality of infrastructure services, land reclamation, and the condition of residential buildings; (2) the economic limitations of the community gave no choice but to use inheritance land granted for generations, even though the land is not suitable for housing. This means that cultural heritage has the potential to be a threat to the sustainability of the urban settlement environment in the periphery if not properly monitored and planned and does not adhere to occupancy eligibility standards; and (3) land reclamation, use of water catchment areas, and settlements that tend to develop along stream areas rivers and coastal areas have the potential to be a threat to urban flooding. Notably, planning should adequately, considering flooding, particularly considering the benefits of keeping natural conveyance systems (rivers) and their floodplains for managing flood waters [93]. Flood control for small-and medium-scale rivers in highly urbanized areas is particularly important [94].

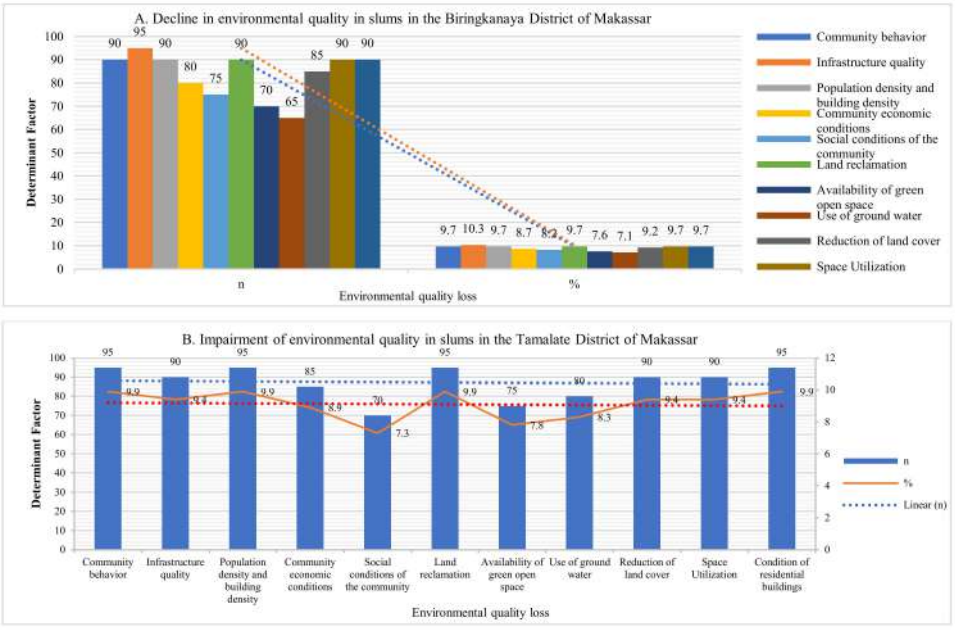

Figure 9. Declining quality of slum settlement environment (**A**) Biringkanaya and (**B**) Tamalate Districts in Makassar. Source: Primary Data, 2019.

Figure 10 shows the relationship between the development of slums, land reclamation, and infrastructure quality with environmental degradation and development sustainability. These results confirmed that controlling spatial use, handling land reclamation, and improving infrastructure quality are positively correlated to improving environmental quality. The concept of a nature-based solution (NBS) was developed to operationalize an ecosystem services approach within spatial planning policies and practices, to fully integrate the ecological dimension, and to address current societal challenges in cities [95].

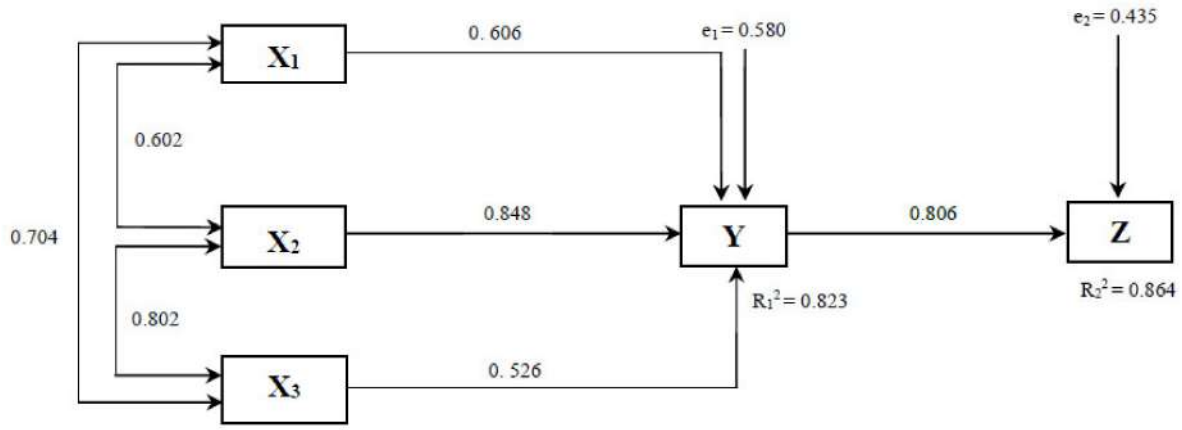

Figure 10. Relationship control of spatial use, land reclamation handling, and infrastructure improvement toward improvement of environmental quality and sustainability of slum settlement management.

The indirect effect of controlling spatial use through land reclamation handling on environmental quality improvement is 0.036 (i.e., 3.6%). The indirect effect of handling land reclamation through controlling spatial use on improving environmental quality is 0.031 (i.e., 3.1%). The indirect effect of controlling spatial use through improving the quality of infrastructure on improving environmental quality is 0.025 (i.e., 2.5%). The indirect effect of improving the quality of infrastructure through land reclamation handling is 0.036 (i.e., 3.6%). The total effect is 0.262 (i.e., 26.2%). The residual influence or residue (the influence of other variables on increasing environmental quality improvement that were not examined) is 0.738 (i.e., 73.8%). The direct effect of increasing environmental quality on the sustainability of slum settlement management is 0.649 (i.e., 64.9%). The remaining influence or residue (influence of other variables on the increase environmental quality not examined) is 0.351 (i.e., 35.1%). The analysis showed that there was a strengthening, namely the influence of X on Y by 26.2%, and the effect of Y (improvement of environmental quality) on Z (sustainability of slum management) by 73.8%. Furthermore, the intervening Y variable strengthened from 26.2% to 73.8% (there was an increase of 73.8% − 26.2% = 47.6%). Per the results of this analysis, the community needs of those located in slums in the suburbs of Makassar must be fulfilled. To achieve a slum-free city, most of the major metropolises are resorting to slum rehabilitation housing [96]. The SDG interlinkages that are specific to each solution were shown to have synergies that can be maximized and trade-offs that can be avoided, which is critical for the allocation and efficient use of limited resources [97].

The spatial dynamics of the periphery showed differences in terms of the hierarchy of meeting the needs of the community. Meeting needs is assessed based on five main categories: (i) physiological needs, (ii) needs for security, (iii) needs for ownership and affection (social relationships), (iv) needs for appreciation, and (v) actualization of self.

The proposed interpretation of the results is shown in Figure 11. First, the relationship between the spatial dynamics of the periphery to the fulfillment of needs shows that only 95.4% of the people in the slums of Biringkanaya district and 90.4% of the slum communities in Tamalate district are able to meet their physiological needs. The dynamics of spatial areas in the periphery showed the inability of the poor to adapt to environmental change stimulus in relation to meeting basic needs and housing facilities. Thus, understanding the variability of space in daily interpersonal activities and examining

individual access to potential urban opportunities will provide specific guidance for reshaping land use and socio-economic policies [98].

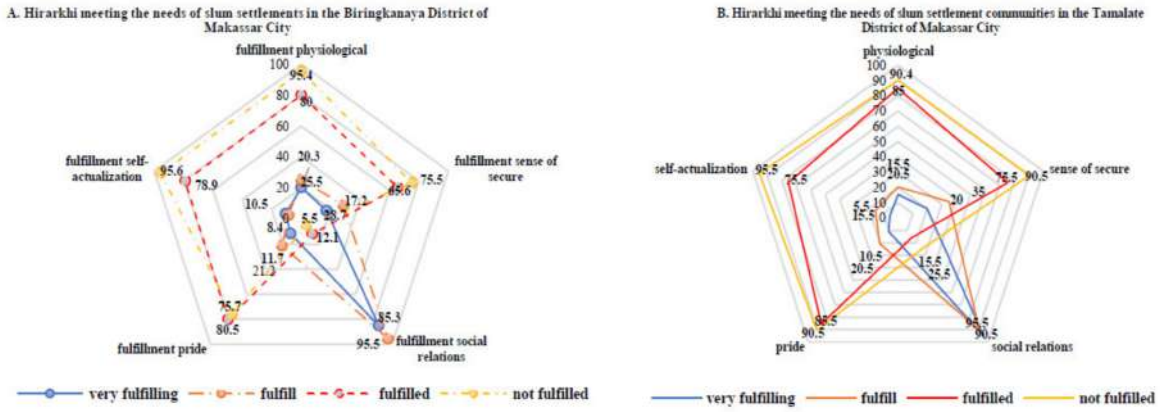

Figure 11. Fulfilling community needs in slums in Makassar suburbs: (**A**) Biringkanaya district; (**B**) Tamalate district. Source: Primary Data, 2019.

Second, the dynamics of the spatial area of the periphery toward the fulfillment of a sense of security for the people who live in slums were obtained by 75.5% of the people in Biringkanaya and 90.5% in Tamalate, indicating the sense of security to settle in their residential location is not guaranteed. This condition showed that the average land occupied by the community in the two districts is illegal. Third, the dynamics of the periphery in relation to the social relations between residents built in the Biringkanaya district area of 85.3% and 95.5% for the people in the slum environment in the Tamalate district area indicate the social relations between residents in the slum environments are strong. This means that the social capital of the community is strong enough to build a life together. The results of the field investigation reinforce this finding in terms of the built social relations being realized by the community through mutual assistance activities, mutual assistance, and social care between individuals and community groups, even though their ethnicities and origins are different. Community capacity and social capital deal with understanding the relationship between community members and with the factors that promote or delay collective activities [99].

Fourth, the dynamics of spatial areas in relation to community pride showed that 17.7% of the people in the Biringkanaya district and 10.5% of the community in Tamalate district feel proud to be in the slum environment. This means that pride as residents in slum areas in both sub-districts is only felt by a small portion of the community. Field results confirm that the existence of capital-intensive community groups has a tendency to use the poor as workers. This means that the communities in the slums in both sub-districts are built through patronage relationships or groups of people who often provide support in the form of living expenses and loans to the community, and these groups often receive government facilities. Although slums typically evoke images of squalor, some slums offer decent living conditions. Some have good access to water; others offer better-quality housing units, and some are physically safe [100].

Fifth, the spatial dynamics of the periphery in relation to the self-actualization of communities located in slums were determined: 10.5% of the people in the Biringkanaya district have the ability to work, develop economic businesses, and then succeed, with this value being 5.5% for the people in the slum environment in the Tamalate district. This means that the ability of the community to respond to environmental situations is strongly influenced by the ability to adapt, externalize, and internalize to achieve prosperity. Factors of environmental adaptation, externalization, and internalization play important roles in the success of individual communities in achieving prosperity [101,102]. The excessive awareness of material and economic problems in the pursuit of happiness involves socio-economic and environmental sustainability by causing "effects of destruction of wealth" [103].

From the five aspects studied, we found that the spatial dynamics of the periphery of Makassar are positively associated with the existence and fulfillment of the needs of the community located in slums in the Biringkanaya and Tamalate districts. Positive contributions were only found in the social relations between communities even though their ethnicity, culture, and origins are different. Four other aspects—physiological needs, a sense of security, the need for appreciation, and self-actualization—related to the spatial dynamics of the periphery of the area tended to be weak or did not have a direct relationship with the hierarchy of meeting people's needs. These results confirmed that the role of the government is important in protecting the poor who are located in the slums in rural areas because a higher level of the plan implementation would ensure the greater sustainability of the slum improvement. Essential lessons can be learned from this real participatory planning, which could be the beginning of the third generation of planning in Indonesia [104,105].

5. Discussion

5.1. Solutions for Slum Settlement in Makassar Suburbs

The development of slums in the suburbs of Makassar in terms of urban problems is complex. One of the solutions that could be implemented to solve the problem of slum settlement is the implementation of land consolidation and vertical settlement development. Strong community social capital, supportive social solidarity, and prominent family ties provide a reference and basis for implementing land consolidation in the slums of the Biringkanaya and Tamalate districts. Land information is one of the basic requirements for land management activities such as land consolidation [106].

Land consolidation is a development model that regulates irregular into regular land lots by providing basic facilities and infrastructure. The purpose of applying this concept is to produce a residential environment with better and standard land use. Implementation of the concept includes (1) giving slums legal status, (2) organizing a justice-based slum environment for orderly land use accompanied by legal certainty of settling, (3) realize effective and optimal land use, (4) anticipating and optimizing the management of the residential environment through the preparation of green open spaces as a forum for community interaction and flood control, and (5) increasing the value of land and property prices. These five aspects need to be supported with policy implementation and community participation. Land inequality is the difference in the quantity and value of land people have access to, the relative strengths of their land tenure rights, and the appropriation of value derived from the land and its use [107,108].

The community housing approach aims to improve and maintain the quality of the settlement environment through providing adequate infrastructure and basic housing facilities. This concept is implemented by building a collective agreement for prospective residents and the planning mechanism is achieved through a process of consultation with the local community and the development is carried out jointly. The implementation of this concept was specifically identified for the slums in the Tamalate district and those located in industrial areas in the Biringkanaya district. The culture of inheritance is still ongoing and is part of the economic sustainability of a family. This culture, if not regulated through government policy and planned well, will create a problem for the community going forward. Slum dweller communities become unable to develop and will even experience declines, in the quality of environmental health, access to education, and economic services. The need to prepare vertical settlements is aimed at (i) communities that have the ability to buy/own livable homes, (ii) increasing land use efficiency, (iii) increasing the capacity, mobility, productivity, and competitiveness of cities, and (iv) preventing the growth of new settlements. Slums in the cities of developing countries cannot be wished away. The challenge is to find realistic and effective methods for addressing this problem [109]. The built environment discomfort is due to the lack of social spaces and poor design of the slum rehabilitation housing [110].

The solution to the handling of slums in the Biringkanaya and Tamalate districts of Makassar is directed at improving the quality of community housing and rehabilitation of environmental quality. Components of the activities that need to be followed up include (i) renovation, in this case, through improving infrastructure service conditions and rebuilding residential locations into habitable settlements through the implementation of land consolidation concepts and vertical settlement development; (ii) environmental rejuvenation, efforts oriented toward creating better settlements to protect the safety and security of the community by first providing a place to live for the community; and (iii) resettlement through the removal of the community from a location that is unlikely to be rebuilt/not in accordance with the spatial plan, or the location is in a disaster-prone area and poses a danger to goods or humans. The concept of resettlement is focused on slums that develop in watersheds and coastal areas. Overpopulation associated with weak infrastructure and low-quality livelihoods make poor slum dwellers highly vulnerable to the consequences of natural hazards [111].

5.2. Management and Control of Environmental Pollution in Slums

The slum environments in the Biringkanaya and Tamalate districts the context are managed by implementing several principles and programs. (i) The use of regulatory and monitoring instruments. The implementation of this program is oriented toward reducing choices for the community as actors who use the environment, including prohibition of activities that will damage the environment, in watersheds and coastal areas by involving the active role of the community. (ii) Economic instruments can be used to change the value of profits relative to losses to be received by actors by providing economic incentives. This incentive–disincentive instrument will generate profit and loss in the form of money and tangible considerations. This program is an effort to build public awareness toward pro-environment, the use of energy-saving devices, environmentally friendly technology, and the imposition of fines for people who commit violations in accordance with established government regulations. (iii) Persuasive instruments can be used to encourage the community and change the perception of human relations with the environment toward increasing profits relative to the losses. This program consists of several activities: education, training, and information dissemination. The aim is to raise moral obligations and change the behavior of people treating environmental conditions.

Slum neighborhood management in the Biringkanaya and Tamalate districts is divided into two categories: (i) environmental administration and (ii) environmental management. Environmental administration is focused on the community related to socio-economic conditions, its long-term nature, policies, and environmental harmony. Environmental management is more focused on environmental management through environmental engineering or rehabilitation. The management of the environment is related to three management channels: (i) managing inputs in terms of managing production, reducing growth, and diversifying products; (ii) managing processes, in terms of managing systems and people through a moral approach; and (iii) output management of the results of waste and recycling. These three aspects will require joint commitment between stakeholders; here, the slum environment is managed using a holistic approach as a unit that is interrelated, dependent, diverse, harmonious, and sustainable. That is, the solution is comprehensive. The next step is setting priorities for the most important factors to implement in environmental management. Next, the stakeholders should sit together to solve common problems. Planning at the neighborhood scale is recognized as essential for achieving sustainable development [112].

The control of slum environment pollution in the Biringkanaya and Tamalate districts of Makassar is more focused on improving settlement infrastructure services. The settlement infrastructure includes, among others, the preparation of wastewater treatment facilities. In this case, local sanitation systems are required. This process is achieved through efforts to build community awareness in relation to reducing the burden of soil pollution and surface water quality (watersheds). Second, clean water services should be provided to reduce excessive use of ground water. This process is achieved considering that the source of drinking water currently used by the community in slums does not meet health standards in terms of quality and quantity. Third, a clean environment culture should be built

in the sense that slums in the two districts require support for the preparation of waste facilities and infrastructure. The current pattern of community waste management is still conventional, meaning it is burned, buried in the ground, and discharged into the nearest drainage and river channels.

Fourth, an environmental drainage system that is integrated with the urban drainage system should be developed to deal with the urban flooding that is experienced every year by people who inhabit slums. This process requires community participation to not use the drainage channel as landfill. Fifth, spatial use should be controlled through the determination of disaster-prone zoning, provision of green open spaces, and close supervision of land reclamation in water catchment areas, watersheds, and coastal areas for the construction of new residential facilities. It is argued that open space tends to act as public land reserves rather than serving the original planning intention of recreation under the current open space planning system [113]. These five things will require consistency in their implementation toward the sustainability of handling slums in the suburbs of Makassar.

5.3. Sustainability of Community-Based Slum Settlements

The failure to date to handle and settle slum settlements is due to the tendency to be partial in the focus on structuring the slum environment, and the tendency to neglect the rights of the community to basic needs in relation to stakeholder responsibilities. The handling of suburbs in the Biringkanaya and Tamalate districts of Makassar in the future should begin with changing slum areas into productive areas and creating an environment with economic added value for the poor, creating social cohesion and changing people's behavior towards sustainable preservation of the environment. The handling of slums in the suburbs of Makassar should adopt the three pillars of sustainable development: economic, social, and environmental sustainability.

Several aspects that can be explained by the findings are related to the sustainability of the handling of slums in the periphery of Makassar (Figure 12): (i) The formulation of urban development policies related to spatial expansion towards the periphery must consider the possibility of slums developing due to limitations and the inability of poor people to access economic activities and adaptation to changes in environmental stimulus. Efforts are needed to protect the community and regulate the zoning of spatial use to avoid spatial use that is incompatible with its function. (ii) The needs for decent housing for the poor and marginal should be fulfilled. Efforts that can be made include (a) land consolidation in slum areas that have legal status, (b) preparation and construction of low-rise housing for slums that have illegal land status, and (c) community housing for communities that have the ability to have adequate housing and is facilitated by the government through funding support from the private sector in the form of corporate social responsibility (CSR). The vital function of cities is providing affordable infrastructure and an institutional environment that enables migrants and other marginal urban communities to contribute to urban prosperity and problem-solving using their skills, networks, and entrepreneurial minds [114].

The handling of slums in the suburbs of the Biringkanaya and Tamalate districts of Makassar is contextualized in three main principles: (1) environmental rejuvenation focused on improving the quality of settlement infrastructure, including road network systems, drainage network systems, sanitation systems and waste water management, waste management, fire protection, and green open space preparation systems, (ii) restoration focused on unsuitable housing conditions through house renovation and building material assistance, and (iii) resettlement focused on communities located on river banks and coastal areas. Programs that can be implemented include the construction of row houses and the construction of rental flats, which are integrated with the conservation of watersheds and coastal areas. Conservation is a key approach for protecting the biodiversity and ecosystem functions [115,116].

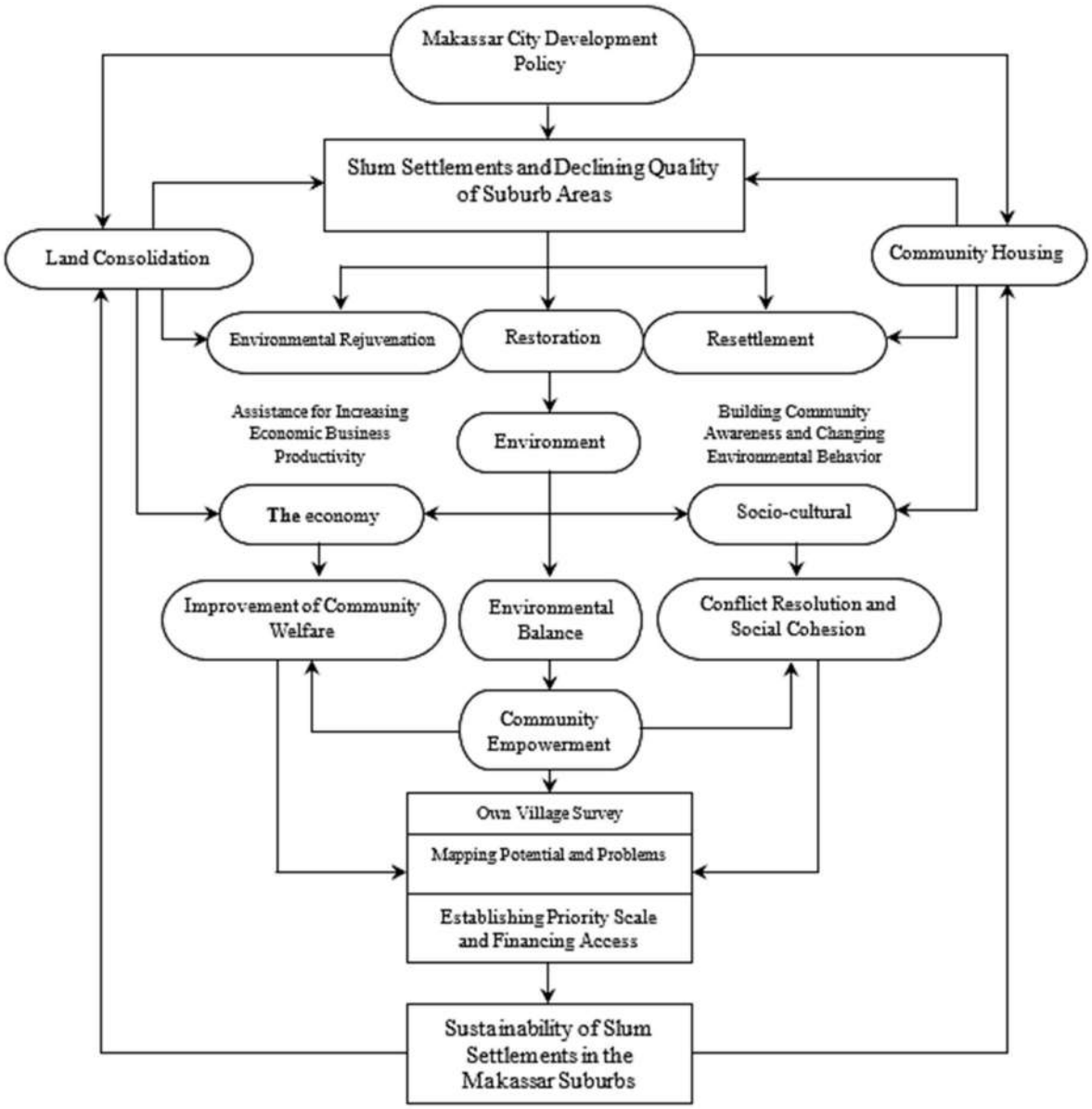

Figure 12. Sustainability of slum settlements in the Makassar suburbs.

Communities can be empowered in several stages, including the facilitation of the community towards increasing economic production. This first stage is focused on economic efforts that have the potential to be developed and facilitate the community during the production process. The implementation is achieved through business training, character selection of business fields of interest to the public, access to finance, business planning, and analysis, marketing plans, strategies for managing business finances, business management strategies, and business sustainability strategies. The second stage is socio-cultural empowerment. This activity is focused on resolution of social conflicts by optimizing the social capital they have in living together towards the creation of social cohesion and changing people's behavior by organizing communities followed by strengthening institutional capacity. This activity is focused on the creation of community independence and enabling and building community capacity toward a better and sustainable direction. Thus, community empowerment developed in the slums of the Biringkanaya and Tamalate districts will provide benefits for the community towards a better life. Empowerment may be viewed on different levels: individual, organizational, or community. In empowered communities, empowered organizations exist, and an empowered organization is reliant on the empowerment levels of its members [117,118].

To achieve optimal results, efforts to sustainably manage slums in the Biringkanaya and Tamalate districts in the outskirts of Makassar should begin with three main things: (i) a village survey administered by the community together with assistants, (ii) mapping potential and problems to identify the potential of the community and the main problems that need to be resolved, and (iii) determining the ranking of program priorities and possible funds that can be used, namely government funds, private funds, funds from donor countries, and community funds. The funding collaboration will accelerate the completion of the handling of slums in the suburbs of Makassar.

6. Conclusions

Overurbanization has led to the expansion of Makassar towards the periphery, positively associated with suburbanization, changes in spatial use, and the formation of highly complex social territory structures. The inability of the urban poor to access land and decent work causes slums to develop, which result in environmental degradation. Slums in watersheds and coastal areas as well as inadequate infrastructure service support result in the excessive use of ground water, soil pollution, and surface water quality pollution, causing the regulation of river flows to be less smooth, water level decline, urban flooding, and contagion. Spatial expansion, land use change, and an increasing population significantly affect the development of slums in the periphery, which requires the control of spatial use, handling land reclamation, and improving the quality of infrastructure to improve the quality of the slum environment.

Management of slums is directed at improving the quality of community residential buildings and the environment. The renovation program should be implemented through land consolidation and construction of vertical settlements. Environmental rejuvenation can be achieved through improving the quality of residential infrastructure. People can be resettled from locations that are not in accordance with the spatial plan or where the settlement is in a disaster-prone area. Environmental pollution can be controlled through the use of regulatory and supervisory instruments, economic instruments, and persuasive instruments. The environment can be managed in the long-term using administrative instruments to create environmental harmony.

Slums can be sustainably handled through environmental rejuvenation, renovation, and resettlement programs. To meet the needs of the community, economic and social empowerment mechanisms can be used based on increasing economic effort, resolving social conflicts, creating social cohesion, and changing people's behavior by organizing communities, strengthening institutional capacity, and creating community independence through collaborative funding for handling slums in suburban area of Makassar.

Author Contributions: B.S. and H.S. compiled the research; B.S., H.S., and S.S. designed the methodology; S.S. processed data; H.H.S. and H.H. contributed materials, methods, and analysis tools; B.S. and M.I. analyzed the data; H.H. contributed to data checking; B.S., H.S., S.S., H.H., H.H.S., and M.I. wrote and revised the concepts. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Government of the Republic of Indonesia through the Ministry of Research and Technology in the form of development research grant assistance.

Acknowledgments: We are thankful for the participation of stakeholders in contributing ideas to this study. Thank you to the Ministry of Research and Technology of the Republic of Indonesia for their support and financial assistance in carrying out this research.

Conflicts of Interest: The authors declare no conflict of interest.

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