The Influence of the Building Mass Configuration of Settlements around the UNNES Campus on Environmental Carrying Capacity

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Abstract. The impact of the development of the UNNES Campus in Sekaran, a suburb of Semarang City, has become a trigger for the growth of new activities which require the provision of new spaces, especially settlements. This phenomenon shows the growth of settlements that ignore the environment. This study aims to examine the influence of the building mass configuration of settlements around the UNNES Sekaran Campus on environmental carrying capacity as a buffer zone for Semarang City. This study uses descriptive exploratory method which aims to describe the state of a phenomenon in the field. The results of this study are the influence of the building mass configuration of settlements on environmental carrying capacity. The configuration of the building mass that does not pay attention to rainwater infiltration and reduction of sun exposure has an impact on reducing the supporting capacity of the environment and reducing occupant comfort.

1. Introduction
The elements that affect the development of a city are the geographical conditions, site, function of the city, history and culture of the city and the stages of city development [1]. As the capital city of Central Java province, Semarang City is in the highest position in the regional scope and is the center for the development of Central Java's regional development. The development of Semarang City tends to grow from a dense concentration (city center) towards sub-urban areas which are still able to stimulate the growth of new development centers. The rapid urbanization process encourages agglomeration which leads to the transformation of the urban-rural area system and changes in the spatial pattern of urban and rural areas [2]. The pressure of cities to rural areas brings about a change or evolution, especially in their settlements. The evolution of rural settlements is the result of interactions between humans and the natural environment and the long-term development of human society [3].

This is a period of rapid growth and a variety of institutions, namely campuses, hospitals, government units and cultural centers. The growth of campuses in suburban areas creates new cities (satellite cities) that demand the consequences of changing land use from agricultural land to non-agricultural land [4]. Universitas Negeri Semarang (UNNES) develops campuses in suburban areas, administratively into Sekaran Village, Gunungpati Sub-district, Semarang City. Its existence has had a significant influence on the growth of this region since 1990. Currently the settlements around the UNNES Campus are growing rapidly along with the construction of basic infrastructure and public services [5]. The growth
of the campus forms a new mindset for the people who regard the house as an economic commodity that can be developed [6]. This condition causes changes or additional functions of the house, from a single function (residence) to grow into a business house (mixed use function). The growth of existing settlements has shaped the building mass configuration according to the orientation of its space requirements. The factors that influence the existence of settlements are socio-cultural, economic and religious factors [7]. The existence of settlements spatial can be seen from the function and location elements of these settlements which are related to social activities, economic activities and religious activities. [8].

With a variety of different conditions, each city must accurately measure the current situation in order to formulate an appropriate strategy to improve its sustainability better [9]. Urban planning regulations aim to direct development in order to prevent excessive spillage of green areas, and protect rural lands [10]. The success of providing green space effectively will depend on the types of benefits that residents need [11].

Gunungpati Sub-district has an area of 5,399,085 ha. The topography is hilly with varying elevations in almost all regions. Before the construction and development of the UNNES Campus in Sekaran, this area had limited access and transportation. The existence of UNNES in Sekaran Village has more or less triggered regional growth. On the other hand, growth is also supported by the existence of an area that connects Semarang City with Semarang Regency and Kendal Regency.

Figure 1. Location of Research

Based on Semarang City Regional Regulation No. 14 of 2011 concerning Regional Spatial Plans (RTRW) Semarang City Year 2011-2031, Gunungpati Sub-district is included in the BWK VIII (City Area Section) with functions as: (1) Education; (2) Low density housing; (3) Conservation and (4) Tourism / Recreation. The Regulation also mentions policies for developing low density housing. The development of a single residence is permitted to a maximum of 3 (three) floors by considering the environmental carrying capacity. The regulation regulates that Gunungpati Sub-district is included in the area that provides protection for its subordinate areas, namely areas that have a slope above 40% (forty percent) with the function of water catchment areas. Green infrastructure support in order to maintain the existence of a sustainable area is absolutely necessary. The concept of green infrastructure is to form an environment with preserved natural processes, including rainwater management, water quality management, and flood mitigation [12].

According to the Minister of Public Works Regulation No. 06 / PRT / M / 2007 regarding general guidelines for mass planning of buildings and the environment from an environmental perspective, it is explained that: (1) The balance of the planning area with the surroundings; (2) Balance with environmental carrying capacity; (3) Ecological preservation of the area; (4) Area empowerment [13].
Based on this phenomenon, the research problem is what is the influence of the building mass configuration of settlements around the UNNES Campus on environmental carrying capacity?. This study aims to examine the influence of the building mass configuration of settlements around the UNNES Campus on environmental carrying capacity in Sekaran as one of the buffer areas for Semarang City.

2. Methodology
This study used a descriptive exploratory method in collecting and analysing data. This method aims to describe the state of a phenomenon in the field. This research is not intended to test certain hypotheses, it only describes the existence of a variable, symptom or condition [14]. The descriptive exploratory method is carried out based on the facts seen in the field, then mapping and categorization are carried out. The descriptive exploratory method is used to see the development of the spatial structure of the research area by identifying spatial use from an ecological point of view. The research material is the settlements around the UNNES Campus in Sekaran Village, Gunungpati Sub-district, and Semarang City with variables: settlement, infrastructure and climate.

Points of observation area: (A) Setanjung Area; (B) Cempakasari 1 Area; (C) Cempakasari 2 Area; (D) Rambutan Area; (E) Cokro Area; (F) Kalimasada Area; (G) Sirandu Area; (H) Kantil Area; (I) Imam Bonjol Area.

The research stages were carried out as follows:
- Data collection: field survey and documentation of spatial forming elements (exploration stage) with determination of sample points
- Spatial data processing: structuring the mass of the building and its supporting elements according to the existence of the research area.
- Analysis: synthesizing settlement samples with infrastructure and climatic conditions
- Result: determine the results of the synthesis to describe the influence of the building mass configuration on environmental carrying capacity
3. Results and Discussion

The results of the study describe the spatial conditions of the settlements from the nine points of the observation area, namely:

3.1. Setanjung Area (A)
Setanjung Area is on the south side of the UNNES Campus and borders the Faculty of Economics. Permanent and non-permanent buildings develop in a row following the boundaries of the campus land and Jl. Setanjung. The permanent building with 1 - 2 floors and 80% -100% Building Coverage Ratio (BCR). Non-permanent buildings are used as food stalls.

![Figure 4. Setanjung Area](image)

Available infrastructure: paving roads with 3 m wide (some segments have plastered shoulders with 1 m wide), on some sides there are drainage channels, shade trees on campus land and a small part in the yard.

3.2. Cempakasari 1 Area (B)
Cempakasari 1 Area has main access from Jl. Taman Siswa. There are permanent and non-permanent buildings. The permanent building with 1 - 2 floors and 60% -100% BCR. Non-permanent buildings are used for food stalls.

![Figure 5. Cempakasari 1 Area](image)

Available infrastructure: asphalt road with 3 m wide and right-left shoulder with 1 m -1.5 m wide, there are closed drainage channels on both sides with 50 cm wide, shade trees stand in some of the resident’s yards.

3.3. Cempakasari 2 Area (C)
Cempakasari 2 Area has main access from Jl. Cempakasari. There are only permanent buildings with 1 - 2 floors and 70% -100% BCR.
Figure 6. Cempakasari 2 Area
Available infrastructure: paving roads with 2 m wide without shoulders, drainage channels with 100 cm wide, open either on one side or two sides of the road, shade trees stand in several yards.

3.4. Rambutan Area (D)
Rambutan Area has main access from Jl. Taman Siswa. There are permanent buildings and very few non-permanent. Permanent building with 1 - 2 floors and 60% -100% BCR. The non-permanent buildings are used for food and laundry stalls.

Figure 7. Rambutan Area
Available infrastructure: asphalt road with 3 m wide and shoulders at several points with 0.5m -1 m wide, closed and open drainage channels with 30 cm - 50 cm wide on both sides of the road, shade trees stand in some of the resident’s yards and the shoulder of the road.

3.5. Cokro Area (E)
Cokro Area has main access from Jl. Taman Siswa. There are permanent buildings and very few non-permanent. Permanent building with 1 - 2 floors and 70% -100% BCR. Non-permanent buildings are used for food stalls and laundry.

Figure 8. Cokro Area
Available infrastructure: asphalt road with 2.5 m wide without road shoulders, open drainage channels on both sides of the road, shade trees standing in some of the resident’s yards.

3.6. Kalimasada Area (F)
Kalimasada Area has main access from Jl. Student Park. There are permanent and non-permanent buildings. Permanent building with 1 - 2 floors and 70% -100% BCR. Non-permanent buildings are used for food stalls, grocery and laundry.

Figure 9. Kalimasada Area

Available infrastructure: paving road with 3 m wide without shoulders, a drainage channel with 50 cm wide that is open and closed on both sides of the road, shade trees standing in some of the resident’s yards.

3.7. Sirandu Area (G)
Sirandu Area is on the north side of the UNNES Campus and borders the Language and Arts Faculty. Permanent and non-permanent buildings grow in rows following the boundaries of the campus land and Jl. Sirandu. Permanent building with 1 - 2 floors and 80% -100% BCR. Non-permanent buildings are used for food stalls.

Figure 10. Sirandu Area

Available infrastructure: asphalt road with 2.5 m wide (some segments have a dirt road shoulder with 30 cm wide), open / closed drainage channels with 30 cm wide on one side of the road, shade trees stand on the campus grounds and a small part on the yard.

3.8. Kantil Area (H)
Kantil Area has main access from Jl. Sekaran Raya. There are permanent buildings with 1 - 2 floors and KDB 70% -100%. 


Imam Bonjol Area has main access from Jl. Sekaran Raya. This area is on the west side of the UNNES Campus area. There is a permanent building with 1-2 floors and 70% -100% BCR.

Available infrastructure: paving roads with 2.5 m wide without road shoulders, drainage channels with 30 cm - 50 cm wide open on both sides of the road, shade trees stand in several yards of residents. There are several gardens.

Generally, settlement growth is dominated by the addition of new residential functions (boarding houses or rental houses), trading activities and other services. These functions are supported by the addition or expansion of building areas, both permanent and non-permanent buildings. This condition causes the addition of BCR with the consequence that the open space is getting smaller. In addition, the consequences of adding new buildings also cause changes in the land pavement, which previously was the ground into a paved or plastered area. The growth of building groups (BG) forms a new mass configuration of buildings and has an influence on the carrying capacity of the surrounding environment. The condition of available infrastructure also has an influence on this carrying capacity. The two variables are interrelated and influential.

Table 1 illustrates the effect of building mass configuration on the carrying capacity of the surrounding environment:
Table 1: The Influence of The Building Mass Configuration on Environmental Carrying Capacity

| Building mass configuration | Sun exposure influence                                                                 | Rainwater influence                                                                 |
|-----------------------------|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| **A. BG of Setanjung**      | The building mass configuration does not have the same orientation. Configure rows tightly. Almost all the buildings stood right on the road line, so that there was not enough shoulder width. | Sun exposure occurs along the road, in the absence of shade trees. Shadowing occurs on the terraces of permanent buildings (including additional terraces), non-permanent open stalls and campus boundary areas. In this area there are many shade trees that give a cool effect. |
|                             | **B. BG of Cempakasari 1**                                                            | Raindrops fall directly on the paved road surface. Indirect rainwater pouring through roofs and additional terraces of permanent buildings. Rainwater runoff seeps into open land and paved roads, the rest goes to a single drainage channel which is less able to receive large rainwater flows, so there is a risk of flooding. |
|                             | The building mass configuration has the same orientation towards the road. A closed concrete drainage channel can serve as a fairly wide shoulder area. | Generally, sun exposure occurs along the way. Shading occurs on permanent building terraces (including additional terraces), non-permanent open buildings, and shade trees in residential yards. Their presence reduces solar heat and provides a cool effect |
|                             | **C. BG of Cempakasari 2**                                                            | Raindrops fall directly on the surface of the asphalt road and open spaces. Indirect rainwater splash through roofs and additional terraces of permanent buildings, roofs of non-permanent buildings and trees in yards. Rainwater runoff seeps into open land and the remainder into holes in two closed drainage channels. |
|                             | The building mass configuration has the same orientation towards the road. A wide open drainage channel as a road divider and there is no shoulder. | Generally, sun exposure occurs all the way. Shading occurs on the terraces of permanent buildings (including additional terraces) and trees in the yard. |
### Building mass configuration

#### D. **BG of Rambutan**

The building mass configuration has the same orientation towards the road. The drainage channel is small and open as a road divider and there is no shoulder. The random sequence configuration of the building mass has small BCR in several residential areas.

#### E. **BG of Cokro**

The building mass configuration has the same orientation towards the road. The drainage channel is small and open as a road divider and there is no shoulder. Configuration of building mass in tight rows has a large BCR.

#### F. **BG of Kalimasada**

The building mass configuration has the same orientation towards the road. Large drainage channels and partially closed as road dividers and partly as road shoulders. Configuration of building mass in tight rows has a large BCR.

### Sun exposure influence

#### Generally

Generally, sun exposure occurs along the way. Shading occurs on the terraces of permanent buildings (including additional terraces), and shade trees in residential yards. The existence of this tree reduces the sun's heat and provides a cool effect around it.

### Rainwater influence

#### Generally

Raindrops fall directly on the surface of the asphalt road and open spaces. Indirect rainwater splash through roofs and additional terraces of permanent buildings, roofs of non-permanent buildings and trees in yards. Rainwater runoff seeps into open land and the remainder into two open drainage channels with a width of 30 cm.

#### Raindrops

Raindrops fall directly on the surface of the paved roads and open spaces. Indirect splash through permanent buildings (roof and additional terraces), roofs of non-permanent buildings and trees in the yard. Rainwater runoff seeps into open land, paving roads and the rest into holes in two closed drainage channels with 1m wide.
| Building mass configuration | Sun exposure influence | Rainwater influence |
|-----------------------------|------------------------|---------------------|
| **G. BG of Sirandu**       | Sun exposure occurs along the road with a very small scope. Shading occurs in almost all areas due to the presence of shade trees, both in the residential yard and the UNNES campus area which borders the road. Their existence provides a cool environment. | Raindrops fell directly on the asphalt road surface. Indirect rainwater splash through roofs and additional terraces of permanent buildings, roofs of non-permanent buildings and trees in yards. Rainwater runoff from residential areas to an open drainage channel with 30 cm wide, the rest goes to the open campus area to be infiltrated and partly channeled through the campus drainage channel. |
| **H. BG of Kantil**        | Generally, sun exposure occurs along the way. Shading occurs on terraces (including additional) permanent buildings, and shade trees in residential yards. Their existence reduces the heat of the sun and provides coolness to the surroundings, especially large trees with shade reaching the road. | Raindrops fell directly on the surface of the paved roads and open spaces. Indirect rainwater splash through roofs and additional terraces of permanent buildings, roofs of non-permanent buildings and trees in yards. Rainwater runoff seeps into open land, paved roads and the rest into two open drainage channels with 50cm wide. |
| **I. BG of Imam Bonjol**   | Generally, sun exposure occurs along the way. Shading occurs on the terraces of permanent buildings (including additions), open non-permanent buildings, and shade trees in residential yards. The existence of this tree reduces the heat of the sun and provides coolness around it, especially large trees with shade reaching the road. | Raindrops fell directly on the surface of the paved roads and open spaces. Indirect rainwater splash through roofs and additional terraces of permanent buildings, roofs of non-permanent buildings and trees in yards. Rainwater runoff seeps into open land, paving roads and the rest into two open drainage channels with 50cm wide. |
Table 1 describes the building mass configuration with some of their forming elements. Understanding the configuration of space is a form of relationship between humans and space, where the space formed is not an individual/independent space [15]. Based on table 1, it is also explained that building growth is triggered by the increasing need for space to accommodate new functions. Economic service activities are developing rapidly, forming new functions for buildings, namely: housing (boarding house/contract), shops, food stalls, and other services. The growth of new buildings has almost 100% BCR with the development or addition of new buildings, both permanent and non-permanent. This condition is a violation of the BCR regulations that have been determined by The Semarang City government, which is a maximum of 60% BCR for each plot.

This condition indicates the influence of building mass configuration on environmental carrying capacity. The building mass configuration that does not pay attention to the aspects of open space has a negative contribution to the environment carrying capacity. Settlement conditions that are attached to one another do not provide sufficient space for air flow and surface water flow properly. This can also be related to the function of open spaces of residential areas as rainwater catchment areas. The addition of new buildings with up to 100% BCR, makes the catchment area smaller and has an impact on increasing rainwater runoff that is not absorbed into the ground. If the infrastructure conditions are not supportive, it will increase the risk of flooding every time it rains. Field conditions show that several infrastructures have a negative contribution to the environment, namely: paved roads (non-pervasive area), plastered areas (non-pervasive area) and drainage design that is not well integrated with flow sources. This condition requires strict control of the use of open spaces.

Sun exposure generally occurs along roads which have an impact on thermal comfort. However, in some parts of the road, there are shade trees that provide shading of the area around it. Shading by trees and buildings will reduce the environmental temperature by taking into account the factors of the length of sun exposure and the slope of the sun [16]. Sun exposure generally occurs along roads which have an impact on thermal comfort. However, in some parts of the road, there are shade trees that provide shading of the area around it. Shading by trees and buildings will reduce the environmental temperature by taking into account the factors of the length of sun exposure and the slope of the sun [17]. The growth of settlements has also led to the narrowing of open space which hinders the infiltration of water into the ground, both rainwater and wastewater. [18]. Regulation of the Minister of Public Works No. 06 / PRT / M / 2007 in the ecological preservation of the area states that the determination of the size of certain building components (for example plot configuration and building orientation) is responsive to topography by determining the minimum density and size of the plots that can be accommodated, as well as minimizing changes extreme (cut and fill)[13].

4. Conclusions
This study gives the result that there is the influence of building mass configuration of the settlements around The UNNES Campus on environmental carrying capacity. Where that the building mass configuration that does not pay attention to 2 things namely rainwater infiltration and reduction of sun exposure, it will have an impact on decreasing the environmental carrying capacity and reducing the occupant’s comfort. Rainwater infiltration is an important concern where settlement positions are in water conservation areas. Meanwhile, reduction of sun exposure is important to provide comfort for residents and area crossers. This reduction is mainly carried out during the day, where the intensity of sun exposure is very high. Reduction is done by controlling the degree of cover area. The degree of closure can be seen from the existing shading effect, where the wider the area is covered, the wider the area of shadow and sun exposure is reduced. It should also be noted for areas that require direct sun exposure. Efforts to achieve these two things are: (1) Provision of sufficient open space on each residential land; (2) Increasing water absorption by breaking the mass of the building; (3) Integration of roof design for rainwater harvesting and provision of infiltration wells; (4) Design of building openings with the concept of cross ventilation and open view; (5) outdoor area with porous material (paving, grass block ); (6) Adding shade trees and gardens to the available open areas; (7) Provision of potted trees / gardens as street furniture for areas that do not allow direct planting.

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