

Assessment of food provider ecosystem services as food security in modern industrial estate planning at Muaro Jambi Regency

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Abstract. This research aims to determine the food carrying capacity and environmental suitability of Kemingking Dalam Village in Muaro Jambi Regency for maintaining food security amidst planned modern industrial developments. Designated as a strategic national area, this village is set to become the first modern industrial zone in Jambi Province. The study employed Geospatial Information System (GIS) methods to assess and map food carrying capacity, particularly focusing on rice production. Findings indicate that the area is currently capable of meeting its food needs. The food provision ecosystem services were categorized into five levels, from very low to very high. The study revealed that 71% (1,874.32 hectares) of the village falls under the "very high" category for food provision. However, a significant portion of the planned industrial area, about 995 hectares or 68.47% of the total, overlaps with these high to very high food provision zones. The policy implication is that areas that have the high-very high category in providing food are not recommended to become modern industrial areas in order to maintain food security.

1 Introduction

Ecosystem services of food provision play an important role in maintaining food security by providing important functions that support food productivity and sustainability [1,2]. These food-providing ecosystem services maintain consistent food production, reduce vulnerability to environmental stress, and support livelihoods in the future [3]. Therefore, protecting and enhancing food-providing ecosystem services is very important to achieve long-term food security. However, industrial development can inevitably disrupt food-providing ecosystem services through changes in land use. When ecosystem services providing food are disrupted, the ecosystem as a food provider can decline, thereby threatening food security. Industrial development Planning of Muaro Jambi Regency, Jambi Province, is a buffer area and close to the capital city of Jambi Province. Kemingking Dalam area is planned to become an Industrial Estate and is a national strategic area [4,5]. The kemingking industrial area is one of the main pillars in economic growth in the region with an investment value of up to 77 trillion rupiah and opening around 147,500 new jobs [6]. Well-developed industries not only create jobs for people, but also increase production and productivity, on national income,

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global competitiveness, and economic development of local communities. Industrial development that is not managed properly can have a negative impact on the environment, such as air and water pollution, damage to natural habitats, and soil quality degradation and even changes in agricultural land use and plantations that are sources of food supply [7–9]. This threatens the sustainability of the ecosystem and reduces the availability of natural resources that are important for agriculture, adversely affecting food security where the majority of Muaro Jambi Regency has livelihoods as farmers both in rice fields and plantations [10]. Therefore, it is important to plan industrial development by considering the sustainability of ecosystem services to ensure long-term food security.

However, in the process of developing an industrial estate plan, it must be based on aspects of food sustainability for local food security [11,12]. The biggest challenge in managing natural resources and the environment is to maintain a balance between humans and their ecosystems, including food provider ecosystem services [13]. On the one hand, humans continue to utilize natural resources for food needs for daily life and must be maintained, but on the other hand, industrial development is needed to promote local welfare and economy. Thus, in planning industrial estates must continue to pay attention to the carrying capacity of the environment based on ecosystem services such as food provider ecosystem Services. Ecosystem services (ES) are those that directly or indirectly improve human well-being. Examples of these services include provisioning (such as food and raw materials), regulating (such as climate and air quality), conserving soil (also known as erosion control), and providing cultural (such as outdoor entertainment and beautiful landscapes) [14,15]. Food providers, namely with the function of providing food which is grouped into food obtained directly from nature [15,16]. Food carrying capacity and carrying capacity are two concepts that are very important in the context of sustainability and sustainability of food systems in the region as food security.

By paying attention to the development of industrial estates that consider the carrying capacity and capacity of food, they can strive to create a food system and industrial development that is sustainable and, that is able to meet food needs in the Kemingking Dalam area and is able to improve the economy. Based on this background, the purpose of this study is to determine the environmental carrying capacity of the providing a physical for food or the ability to serve as food security based on ecosystem services in modern industrial planning areas. Moreover, in this study, A food carrying capacity study is needed to determine the status of food in the Kemiking Dalam Area. Therefore, it is important to find a balance between sustainable industrial development and sustainable food security in industrial planning areas. With wise and proper planning, by knowing the distribution of the carrying capacity of food provider ecosystem services, local governments will know the conditions of the food provider ecosystem, so that food safety policies can be continuously maintained.

2 Method

The research location is in Kemingking Dalam Village, Muaro Jambi Regency, Jambi Province. The location is 41 km from the capital city of Jambi Province and can be reached in 1 hour from the capital city of Jambi. The data used was obtained from secondary data. Secondary data includes spatial data and tabular data which includes; annual land cover data, ecoregion data and spatial planning data obtained from the Directorate General of Planning of the Ministry of Environment and Forestry of the Republic of Indonesia and from the Muaro Jambi Regency Public Works Service for Spatial Planning, Muaro Jambi Regency

Environmental Service. Population data and other data in Kemingking Dalam Village from BPS Muaro Jambi Regency and related agencies.

2.1 Analysis of Food Carrying Capacity

Determination of Food Carrying Capacity status is carried out through population threshold calculations. The population threshold is obtained by dividing availability by energy requirements for food per capita per year. The Food Carrying Capacity threshold is expressed in terms of population size and is determined through a comparison approach of food availability to Food needs. A minus value indicates that the food carrying capacity status has been exceeded, while a positive value indicates that the food carrying capacity status has not been exceeded.

2.1.1 Food Needs

The calculation of food energy needs is obtained through the calculation of the Energy Adequacy Rate (EAR) of the population of Kemingking Dalam Area over a period of one year. EAR is a value for the energy needs of an individual's food to carry out daily activities [17] which in this case the EAR used is only sourced from rice. To calculate the EAR of Kemingking Dalam Area as follows:

$$KB = P \times EAR \times 365 \quad (1)$$

Information :

KB : EAR in Kemingking Dalam Area
P : Number of population in Kemingking Dalam Area
EAR : EAR per capita expectation (kcal)

2.1.2 Food Availability

The availability of food energy in Kemingking Dalam Area uses food production data available in secondary data, namely in BPS Muaro Jambi. The food production of rice is converted from units of weight (grams) to units of energy (kcal) to obtain the energy value of foodstuffs.

2.2 Analysis of Ecosystem Services Food Providers

Data processing is carried out by calculating the service index ecosystem. The calculation of the ecosystem services index is based on the provision of weights and scores on vegetation type, landscape and land cover parameters. In this study, weights and scores that have been set by Indonesian Ministry of Environment and Forestry [15,16]. The next stage is to overlay the food provider ecosystem services map with the industrial area planning map

3 Results and Discussions

3.1 Food Carrying Capacity in the Form of Rice in the Kemingking Dalam Area

Food needs in the Kemingking Dalam Village area are based on the calculation of food energy needs obtained through the calculation of the Energy Adequacy Rate (AKE) of the population over a period of one year. The standard calorie requirement needed by a person

from the staple food of rice is 1075 Kcal. Thus the level of food needs can be determined based on the level of consumption of each person based on the caloric value needed by the body. Based on BPS Muaro Jambi Regency that the population in Kemingking Dalam Village is 2,624 people which means the need is 1,029,592,000 kcal / year. Meanwhile, for the availability of food energy in Kemingking Village, the productivity of rice fields in Kemingking Dalam Village is 2.9 tons / year / ha. Data shows that the area of rice fields based on land use maps amounts to 122.27 Ha which means 1,153,387,582.4 kcal / year.

Determination of the status of Food Carrying Capacity in the Village is carried out through the calculation of population thresholds. The population threshold is obtained through dividing the availability by the per capita food energy needs per year. The threshold of food carrying capacity in the form of rice is expressed in the form of population and is determined through a comparative approach of availability to food needs, for more detail presented in the following table:

Table 1. Status of Carrying Capacity of Food at Kemingking Dalam Area.

Area	Food Availability (Kcal/tahun)	Food Needs (kcal/tahun)	Difference	Status
Kemingking dalam	1.153.387.582	1.029.592.000	123.795.582	not been exceeded

It can be concluded that the carrying capacity of food in the area of Kemingking Dalam can still meet the needs of Kemiking Dalam’s population. If industrial estate planning can change or convert rice fields into industrial areas, there will be a shortage of food in the form of rice so that food security is very vulnerable.

3.2 Carrying Capacity of Food Provider Ecosystem Services

Based on the results of the analysis, most of the Kemingking Village Areas are in the very high food provider ecosystem service class, namely 1,874.32 Ha from 2,630.28 Ha or 71%, while the rest of the categories are very low 381.27 Ha, low 55.78 Ha, medium 91.03 Ha and high 227.89 Ha.

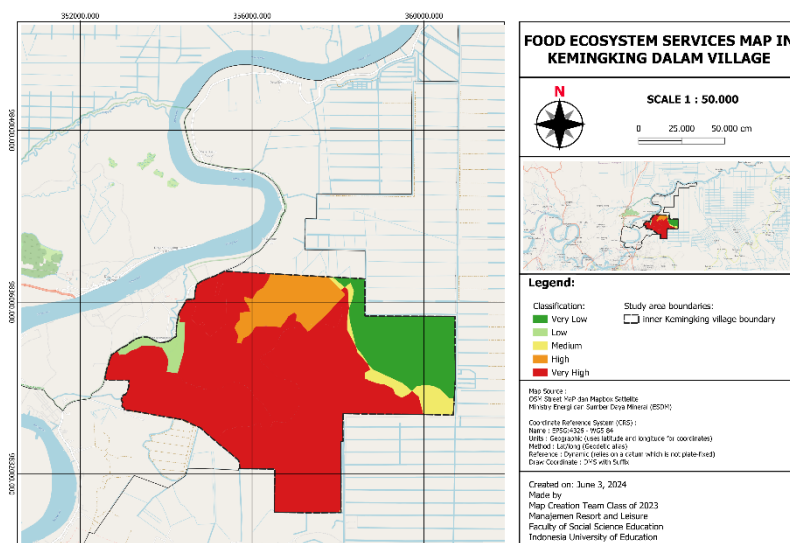


Fig. 1. Food provider ecosystem services at Kemingking Dalam Area.

The ecosystem service of food provider maintains the availability of land, water, sunlight, and plant and animal species as a stock-flow resource [15,16,18], it is clear how ecosystem services contribute to the availability of food. The improved use of ecosystem service delivered by biodiversity describe promise to enhance food security by increasing food availability and crop yield stability [2,11]. This means that the higher the food provider ecosystem services, the higher the food security. Referring to Fig 1., Food provider ecosystem services are dominated by the high-very high category, which indicates that the area has abundant food providers.

3.3 Regional Planning of Industrial Estate in Kemingking Dalam, Muaro Jambi Regency

Planning for the Development of a Modern Industrial Estate in the Kemingking Dalam Village Area covering an area of 1.453 Ha. The area has been designated as a strategic and priority area both from the local level to the national strategic area.

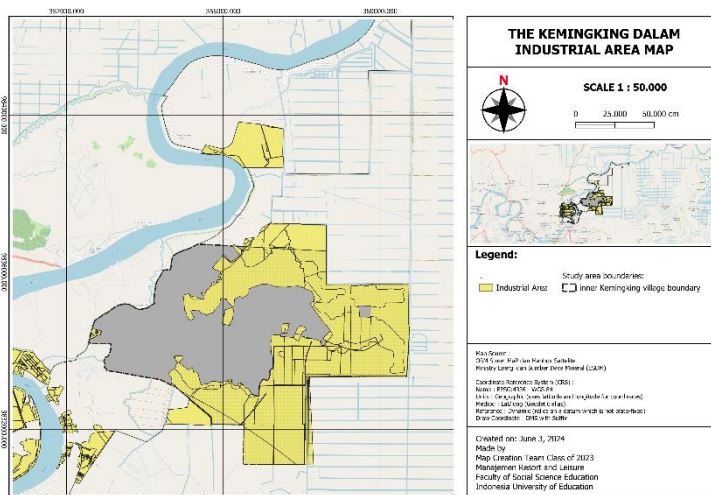


Fig. 2. Industrial Planning at Kemingking Dalam Area.

In this study, an overlay will be carried out between the map of food provider ecosystem services with the planning map of modern industrial estates to find out whether the industrial area to be built is in accordance with its designation and does not reduce food security in the area. The following map can be presented in the picture below

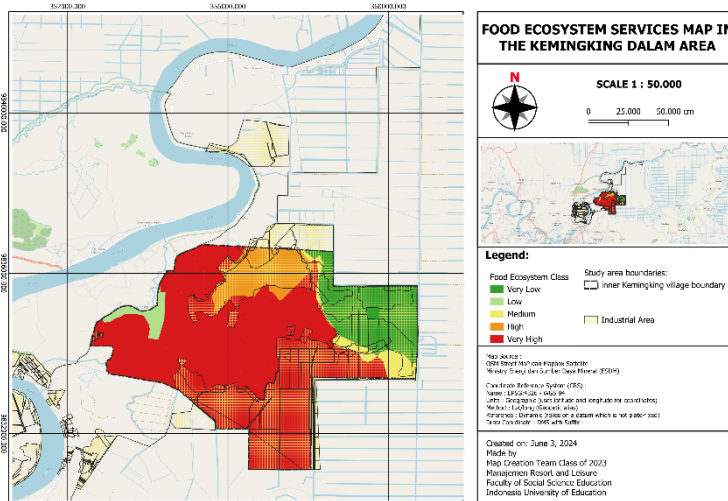


Fig. 3. Overlay Mapping within modern industrial planning and Food provider ecosystem services at Kemingking Dalam Area.

Based on the results of the overlay analysis between the planning maps, industrial areas are located in most of the high-very high ecosystem service areas 995 Ha or 68,47 % from the planned area of the industrial area. According to food provider ecosystem services are indicators of determining industrial estates, the smaller the environmental ecosystem services, the higher the direction to industrial estates [19]. Industrial area planning development directions must be located in medium to very low ecosystem service areas. The policies and alternative recommendations suggested for the development of Industrial Estates to change delineation and moving to very low-medium food provider ecosystem service areas in order to sustain the high food security. Another option, maintaining food security in the industrial planning area can be done by implementing green development infrastructure, low building intensity and high open space area.

4. Conclusions

The food carrying capacity of rice in the Kemingking Dalam Village area is still categorized as being able to meet food needs. However, if this land is converted into a modern industrial area, there will be a food shortage in the form of rice and we will have to import it from outside the Kemingking Dalam area to fulfill it. Furthermore, Kemingking Village is located in a very high food ecosystem service area covering an area of 71% or 1,874.32 Ha, while the modern industrial area planning area is mostly located in a very high food ecosystem service area covering an area of 995 Ha or 68.47% of the planned industrial area. The direction of industrial planning development is to move the location to a medium-very low food supply ecosystem service area and it is not recommended to become a built-up area in a high-very high food supply ecosystem service area.

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