The measurement of food and nutrition security situation in Indonesia

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Abstract. An appropriate analysis of the food security situation influences the decision-making and even planning of targeted intervention. Considering Indonesia's vast area and different characteristics of each region, information on the food security situation for each region is needed for policy intervention. This paper conducted a composite analysis to obtain the food security situation of 416 districts in Indonesia. The weighting approach of nine indicators represented the three subsystems of food security, namely food availability, food access, and food utilization, was used for food security situation analysis. Of 416 districts, 81 were classified into food vulnerable region-based on a set of cut-off points used for districts classification. These vulnerable food regions were mainly characterized by the ratio between food production and normative consumption, the percentage of people living under the poverty line, and the prevalence of stunting. The information on vulnerable food regions and their underlying factors can be used as a basis for program intervention and policy formulation for food security in Indonesia. The program designed for food vulnerability alleviation should be located in the vulnerable food area and targeted to reduce those three underlying factors causing food vulnerability.

1. Introduction

Food security is a complex and multi-dimensional situation [1,2], and therefore food security evaluation requires comprehensive measures involving different aspects of food security, namely food availability, food access, and food utilization. Information on the food security situations will benefit various actors ranging from a government institution to targeted communities. Therefore, an appropriate evaluation of the food security situation is needed to support food policy decisions and targeted intervention [2,3].

Food security evaluation at the global level, such as the Global Food Security Index (GFSI) by the Economist Intelligent Unit and Global Hunger Index (GHI), was published, which compared food security situation among countries using a different set of food security indicators. Although, in general, the Indonesian food security situation improves, as indicated by the increase in GFSI rank [4], Indonesia still suffers from severe hunger according to the 2018 Global Hunger Index [5]. While the GFSI focused on the contributing factors to food security, the GHI focused on the outcomes of food security, such as the prevalence of undernourishment, child stunting, child wasting, and child mortality.

Since the index is a country measure, it is less relevant to assess the regional situation of food security. Considering that Indonesia consists of 34 provinces and 514 districts/cities, it is then important to develop a tool for regional food security assessment. For that purpose, the food security situation measurement, covering 416 districts but excluding the 98 cities, was performed to provide information.
on the status of food security and the underlying factors causing the vulnerability situation of each district. The cities were excluded since they have different characteristics as districts, and therefore, they need a separate analysis. Moreover, mapping of the analysis result is needed to facilitate the interpretation of the regional food security situation. Besides serving as a platform to assess regional food security, the information can be used by related institutions and other stakeholders involved in the food security and vulnerability sector for policy decisions and targeting programs and interventions.

2. Materials and Methods
The measurement of food security situation was initiated in 2005 by World Food Program in collaboration with the Agency for Food Security [6] Since then, the measurement evolves and the approach used in this paper was also employed in writing the food security and vulnerability atlas [7]. The main challenges in measuring food and nutrition security are determining the indicators and developing analysis methods. Selecting universal indicators for measuring food security is not an easy task [8]. The ones considered suitable for measuring global food security must be reliable, repeatable, and available for the majority of the countries [9]. Therefore, several indicators suitable for measuring regional food security status were considered in this manuscript. Of many prospective indicators, nine were selected because they are available yearly.

The weighting approach was used for developing the composite food security score since the indicators were obtained from different categories. Therefore, seven experts with food security and nutrition backgrounds were asked for their opinions on the weight contribution of each indicator to food security. The weightings are also context and regional-specific since different regions have their challenges along food security pathways [9]. For comparison in this paper, we used the same weighting approach for all regions. The selected indicators and average weight used in this paper were: a. food availability (0.30): 1) ratio between per capita normative consumption and net availability of rice, maize, sweet potato, and cassava productions. The normative consumption is set at 300 gram/day rice equivalent, which contributes to 50% of the required dietary intake; b. food access (0.30): 2) the percentage of people living under the poverty line (0.15), 3) the percentage of households with food expenditure proportion is more than 65% (0.075), 4) the percentage of households without electricity access (0.075); c. food utilization (0.40): 5) the average length of study for a woman above 15 years old (0.15), 6) the percentage of households without access to clean water (0.10), 7) ratio between health worker and total service area (0.05), 8) prevalence of stunting (0.05), and 9) life expectancy at birth (0.05).

2.1. Materials
The data used for developing each indicator were obtained from the National Agency for Statistic/Statistic Indonesia (Susenas 2018-Data of the poverty line, food and total expenditures, access to electricity, access to clean water, length of study of a woman above 15 years old, and life expectancy at birth), Ministry of Agriculture (2018 Cereal and tubers productions), and Ministry of Health (2018 Basic Health Survey and number of health worker).

2.2. Methods
The raw data was prepared and corrected according to the requirements of each indicator. Before the indicator and cut-off points were used for composite analysis, they were standardized consecutively using z-score and distance to scale (0–100). The individual and composite scores were later calculated using the following equation 1:

\[ Y_i = \sum_{i=1}^{n} a_i X_i \]  
\[ Y_{com} = \sum_{i=1}^{n} Y_i \]  

(1)

where \( Y_i \) is the score of indicator i, \( a_i \) was the weight of indicator i, \( X_i \) was the value of indicator i, and \( Y_{com} \) was the composite score obtained from the summation of all \( Y_i \).

The cut-off points of each indicator were assigned using the distribution of the previous data set. These individual cut-off points were used to classify each indicator and were also used later to calculate the composite cut-off points. The composite cut-off points were later used as a basis to rank and classify
a district into one of the six priorities of food security status, namely very food vulnerable (≤41.52; priority 1; dark red); food vulnerable (>41.52–51.42; priority 2; medium red); slightly food vulnerable (>51.42–59.58; priority 3; light red); slightly food secure (>59.58–67.75; priority 4; light green); food secure (>67.75–75.68; priority 5; medium green); and very food secure (>75.68; priority 6; dark green). The data of each indicator and the inverted composite value (index) was used to create the food security map using Quantum GIS (QGIS) version 2.18.

3. Results and discussion

Figure 1A showed the result of the composite analysis for the situation of food security. Of 416 districts in Indonesia, 26 districts were classified as very food vulnerable (priority 1 - dark red); 21 districts were food vulnerable (priority 2 - medium red); 34 districts were slightly food vulnerable (priority 3 - light red); 47 districts were slightly food secure (priority 4 - light green); 137 districts were food secure (priority 5 - medium green) and 151 were very food secure (priority 6 - dark green). Most of the food vulnerable areas, as indicated by light to dark red color, were concentrated in Papua Island. In smaller number, the area was also found in Maluku, North Maluku, Sulawesi, Kalimantan, Sumatera and East Nusa Tenggara.

![Figure 1. Map of 2018 situation of A. food security status of Indonesia region and B. ratio between per capita normative consumption and net availability.]

| Table 3. The average value of each indicator and the calculated composite scores (the year 2018). |
|-------------------------------------------------|-----------------|-----------------|
| **Indicators**                                  | **Food vulnerable** | **Food secure**  |
| Ratio between per capita normative consumption and net availability | 3.92             | 0.83            |
| Percentage of people living under the poverty line | 23.19            | 12.08           |
| Percentage of household with food expenditure proportion more than 65% | 45.74            | 40.15           |
| Percentage of households without electrical access | 26.45            | 3.03            |
| The average length of study for a woman above 15 years old | 6.95             | 7.79            |
| Percentage of households without access to clean water | 50.08            | 42.16           |
| Ratio between health worker and total area | 23.91            | 5.26            |
| Prevalence of Stunting | 33.72            | 32.21           |
| Life expectancy at birth | 65.38            | 69.03           |
| **Food availability score** | **21.97** | **85.10** |
| **Food access score** | **55.41** | **76.36** |
| **Food utilization score** | **53.94** | **64.89** |
| **Food security score** | **44.79** | **74.40** |

The average score of the food vulnerable region was 44.79, far below the score for the food secure region of 74.40 (Table 3). Each district had different causal for its food vulnerable status, but in general food vulnerable region was indicated by i) high ratio between normative consumption and net
production; ii) high prevalence of stunting; and iii) high percentage of people living under the poverty line. Considering that the average score of some indicators in Table 3 did not differ between food vulnerable and food secure regions, the inclusion of those indicators might be reviewed. The use of individual-level indicators for food utilization, such as individual food intake, and also other indicators reflecting the stability dimension might also be considered to improve the analysis. Indonesia is also prone to disaster, and the use of indicators describing the effect of natural disasters on food security is also of interest.

3.1. Food availability

The ratio between per capita normative consumption and domestic food production of most districts in Papua Island, some of the districts in Kalimantan, Sumatera, and Sulawesi Islands, and in North Maluku province was above 1.5, as indicated by dark red color in the map (Figure 1B), meaning that the demand for consumption was higher than the capacity of those regions to produce food. On average, the food vulnerable region had a ratio between per capita normative consumption and net cereals and tubers production of 3.92, which was far above the ratio of food secure region of 0.83 (Table 3).

Note should be taken that the classification was based on the ability of domestic production to fulfill the demand of the population, which is known as domestic food self-sufficiency. It is widely known that food availability is supplied from domestic production and import [1], as well as domestic stock. However, only certain cereals and tubers’ domestic productions were considered in the current setting. Although in actual condition food trade between regions exists, it was excluded in the setting due to complexity in data collection and the possible disruption by certain natural, physical, social and economic problems, which in turn affect the regional food availability. Moreover, the ideal proportion of cereals consumption is 50% of the total calorie consumption. Thus, considering only production and consumption of the main cereals and tubers were deemed sufficient for the purpose. Other commodities like sago and taro could also be considered since both are the staple food in some regions in Indonesia. Furthermore, including other commodities, such as animal food, is also of interest to accommodate the change in the future food demand.

3.2. Food access

The food vulnerable region (light to dark red color, Figure 2A) had on average 23.19% of people living below the poverty line, which was almost double in comparison to the proportion in the food secure region (Table 3). This result was in line with previous studies that reported a strong correlation between poverty and food insecurity [10,11]. We also noted that besides having a high percentage of poor populations, some of these provinces also relied on their cereals supply from other provinces, making them even more vulnerable to price shock and commodities shortage.

A high percentage of households with high food expenditure (>65% of the total expenditure) was found on every island (Figure 2B). Similar to poverty, populations with high food expenditure might be susceptible to food price changes, which eventually affect their calorie intakes. However low correlation
was found between poverty and food expenditure data \((p=0.00)\), meaning that districts having a high percentage of populations living under the poverty line did not necessarily have a high percentage of households with food expenditure > 65%. This could be linked to the fact that free food, which was obtained either from gifts, social safety net, or taken from nature and their land, was not counted as part of population food spending. So, keeping the food expenditure remains low.

Access to electricity opens an opportunity for economic access through increasing productivity, enabling new job creation, and reducing household workloads [12]. Other studies also reported that rural electrification increases the propensity of women to work outside the home [13] and affects the ability of children to keep up with their education [14]. Although the average percentage of households without electrical access in the food vulnerable regions was still categorized as slightly good, the lack of electricity in some districts, such as in East Nusa Tenggara and Papua (Figure 2C), might limit their population access to income-generating activities.

### 3.3. Food utilization

Access to clean water was still a substantial problem in Indonesia (Figure 3A). Previous studies suggested that child undernutrition was closely related to water, sanitation, and hygiene [15,16], as tropical enteropathy, an abnormality of small bowel structure and function associated with mal-absorption, was high in stunted children [17]. Therefore, improving access to clean water could improve hygienic practice in food vulnerable area, which in turn decrease children malnutrition.

![Figure 3](image.png)

Figure 3. Map of 2018 situation of food utilization: A. Access to clean water; B. Percentage of life expectancy at birth; C. Ratio between health worker and total area; D. Length of study of a woman above 15 years old; E. Prevalence of stunting.

Higher life expectancy at birth could be attributed to several factors, such as rising living standards, improved lifestyle, better education, greater access to the high quality of health service, as well as other factors of better nutrition, sanitation, and housing [18]. The life expectancy at birth was also projected to increase in industrial countries due to among others decline in death from children and adult infections, improved childhood and adolescence nutrition and expanded access to primary and secondary health services, and lower in countries having high levels of young adult mortality, major chronic disease risk factors and less effective health system [19]. In food vulnerable regions, one health worker was in charge of on average 23.91 km², while in the more food secure regions one health worker worked for the area-w-es = of 5.26 km². The provinces in Papua and Kalimantan Islands had fewer health workers compared to other smaller provinces in Java, Bali, Nusa Tenggara, Maluku, and Sumatera Islands (Figure 3C). This could be one of the reasons behind the low life expectancy at birth.
in some districts in Papua Island, although this was not the case for other districts on the same island and Kalimantan Island (Figure 3B).

Ensuring household nutrition security through food and non-food practices is the domain of women [20]. The nutrition education given through health service was not only suggested to improve caregiver knowledge and feeding practices [21,22], but also decrease the prevalence of stunted growth in an area where access to food was not limited [23]. Although the government of Indonesia requires its young generation to have formal education for a minimum of 9 years, less education time was still observed in many parts of the Indonesian island (Figure3D). While formal education is expected to improve literacy, it only leads to small reductions of stunting rates in high burden countries unless additional curricula on health and nutrition are added [24]. This also in line with our analysis that the correlation between the average length of study for a woman above 15 years old and the prevalence of stunting was relatively small (p=0.00).

Stunting remains one of the challenges in food security (Figure 3E) since it has a multidimensional relationship with child nutrition characteristics, dietary diversity, household marital status and education level, family garden and livestock asset, environmental factors, and policy on food production [25]. A previous study suggested that food insecurity (or vulnerability) is a predictor for stunting [26]. Since stunting is the outcome rather than the contributing factor to food security, there was confusion over its use as one of the indicators to evaluate the food security situation in Indonesia. Thomas et al. [3] suggested that to have a good assessment of the actual food security and nutritional status, GFSI is used in conjunction with other indicators of food consumption and the nutritional status of the population, such as stunting. Therefore considering stunting as one of the indicators in our analysis will provide a more comprehensive picture of the food security situation in Indonesia.

4. Conclusions
The food security situation in Indonesia was portrayed using 9 selected indicators, representing the three subsystems of food security, availability, access, and utilization. Of 416 districts, 81 were classified as food vulnerable, mainly determined by the high ratio between normative consumption and net production, high prevalence of stunting, and a high percentage of people living under the poverty line. The result can be used as a basis for program intervention as well as policy formulation. The analysis could be improved by considering other factors more relevant to food security and the inclusion of other commodities in the food availability indicators or other indicators reflecting the stability dimension. Moreover, the inclusion of transitory and perhaps seasonal food security aspects, such as natural disasters, drought, cropping patterns, might be of interest to improve future food security analysis.

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References
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