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Developing a system to improve food distribution in public schools: a case in Mogi das Cruzes

Desenvolvimento de sistema de melhoria de distribuição de merenda: estudo de caso em Mogi das Cruzes

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Abstract: School feeding programs are present in different countries. These programs promote healthy food by purchasing food directly from local food producers, based on familiar agriculture. This paper studied a food supply chain of the school feeding in Mogi das Cruzes city, one of the most important food producer cities in Brazil. The local producers supply food for schools through the National School Food Program (PNAE). Data were availabled by the secretaria da agricultura. Using the locations of the schools and food producers, a spatial analysis of the supply network was conducted in a geographic information system. At last it was possible to conclude that a new distribution point can bring relevant improvements to the logistics operation.

Keywords: logistics, PNAE, school feeding

Resumo: Programas de alimentação escolar estão presentes em diferentes países. Estes programas promovem alimentação saudável por meio de compras feitas diretamente de produtores locais de alimentos, baseados em agricultura familiar. Este artigo estudou a cadeia de suprimentos da merenda escolar na cidade de Mogi das Cruzes, uma das mais importantes cidades produtoras de alimentos do Brasil. Os produtores locais fornecem alimentos para as escolas, por meio do programa nacional de alimentação escolar (PNAE). Dados foram disponibilizados pela secretaria da agricultura. A partir das informações das localizações das escolas e dos produtores de alimentos, análise espacial da rede de escolas foi conduzida em um sistema de informações geográficas. Finalmente, foi possível concluir que um novo ponto de distribuição pode trazer ao sistemas melhorias relevantes na operação logística.

Palavras-chave: logística, merenda, PNAE

Introduction

School feeding programs are a continuing concern to the cities around the world. School-meals provide a protective effect against food insecurity that is known to negatively impact on educational attainment via its influence on learning or school engagement (Harvey, 2016). Researchers have shown an increased interest in school feeding and the food security during childhood (Belik e Fornazier, 2017; Kristjansson et. al.., 2016; López-Olmedo Et. al.., 2018). They can also enhance lifelong health and wellbeing. Effective interventions to improve child nutrition can ensure healthy lives and promote well-being. However, to realize these goals, decision makers need to be able to identify which of these interventions are effective and why, so they also need evidence on their costs, cost per outcome and cost-effectiveness (Kristjansson et. al.., 2016).

These subjects are related to important matters as food security in childhood, food losses and wastes, using of public resources, and different aspects of Food Supply Chains management. However, one of the main obstacles for a good performance of school feeding programs is the transport. The mayoralty purchases directly from farming organizations, including those originating

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from land reform programs and family farmers. From the farmers' side, the new opportunities opened by school meals program procurement disclosed their fragile organization regarding delivery logistics and quality patterns of food provided (Belik e Fornazier, 2017).

In Brazil offers food in schools is an obligation of municipalities that receiving federal investment to provide it. As the country is a continent with crucial social differences, the challenge is higher. In Brazil there are 5570 municipalities (IBGE 2017). In this study we choose Mogi das Cruzes due its importance as a food producer city. The purpose of this study is not offer a solution to all the cities because depend of specific characteristics but is to provide a case study that could motivate the cities in developing similar researches.

Mogi das Cruzes city is considered a very important food producer city in Brazil. There are about 3,000 food producers in the city. Using resources of the Programa Nacional de Alimentação Escolar (PNAE – National Program of School Feeding), the municipal government buys food from 58 local producers that supply for 209 schools located at the city´s area.

Logistics problems are noticed. Costs of transport are expensive. Even so, the transportation company claims constantly for higher prices. The producers take the food to a distribution point that is far from the most of schools. The delivery is made to schools and so quality control is tough. Schools suffer from receiving and storing. Problems are highlighted because the food is bought with public resources. Questions can be raised. Is it possible to improve the operation changing the local of the distribution point? What changes could be implemented to help schools in its logistics issues?

This paper attempts to analyze the school feeding programs and food supply chains that involves schools and food producers in Mogi das Cruzes and proposing a new distribution point aiming for improvements in distribution. Particularly the study will focus in vegetables supply chains. Also, an objective of this study is to propose changes in the operation to help schools in its logistics issues.

The first section of this paper will bring literature review about school feeding programs and studies that investigate distribution and logistics operations. After we describe the method and the results of the investigation. Finally, we conclude that a new distribution point can improve the logistic operation of the Food Supply Chain.

Background

School feeding programs

There is a growing body of literature that recognizes the importance of the food supply chains and the school feeding programs (Chauhan, 2015; Soares e Davó-Blanes, 2017; Torres E Benn, 2017). Also, more recent attention has focused on the food security, food losses and wastes, and the food supply chains (Bislka et. al. colab., 2016; Lebersorger E Schneider, 2014).

Food security is a major concern in large parts of the developing world. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. In developing countries, school feeding is a key factor for food security during childhood.

But, overweight and obesity in children have become a worldwide public health problem. This matter is posing a major challenge. The health and economic consequences are huge, especially when occurring at an early age. Between 42.5 and 51.8 million children aged 0–19 years are obese in Latin America. It is approximately 20–25% of the population. The World Health Organization (WHO) recommends interventions to prevent overweight and obesity. A substantive change can be achieved involving coordinated efforts including schools. .

School feeding programs are widespread. Global estimates show that approximately 370 million children received school feeding in 2012 (Kristjansson et al., 2016).

A study conducted in Jamaica, examined the attendance patterns by region of schools which participated in School Feeding Programs in poor, remote rural areas and determined whether there was a significant difference in attendance over a 10-year period between children who took different lunch types (Jennings, 2016).

The globalization has affected the food supply chains. There has been an expansion of a model of agriculture based on monocultures of food on a large scale. This model has harmed on the small and medium-sized producers, contributing to the exodus and rural poverty. Countries must define their agricultural policies and ensure food supply through local production. Policies that encourage the market of local food from the direct buy of consumer have arisen from this perspective. School feeding programs, present in different countries, promote healthy feeding through direct purchase and sustainable food systems from local farmers. United States, Ghana, Indonesia, Brazil, El Salvador, Honduras, Nicaragua, Paraguay,

Niger, Senegal, Ethiopia, Mozambique, and Malawi have incorporated these policies in school feeding programs (Soares e Martínez-Mián et. al., 2017).

The earliest institutional responses to the problem of hunger and malnutrition in Brazil took place in the early 1940s with the creation of the Serviço de Alimentaçao da Previdencia Social (SAPS - Social Security Food Service), and the only school feeding initiatives existing in Brazil were administered by UNICEF, which, during the 1950s, began to deliver skimmed milk to 350,000 school children in eight states. The national government took its first action in 1955, when following the launch of the First National Plan for Food and Nutrition, a public-school food program was established. In this phase of developmentalism (1945-1964), in which industrialization and economic modernization were the main priorities for the federal government in Brazil, the goal was to centralize the school food system by connecting the existing regional initiatives to supply packed meals to school children with international food aid circuits (Sonnino et. al.., 2014).

The federal Brazilian government encourages a proper nutrition in public schools and the purchase of locally produced foods in small rural properties. The Programa Nacional de Alimentação Escolar (PNAE - National School Feeding Program) provides food and nutritional education of all stages of basic education. The federal government transfers for public schools, financial values as an additional sum in 10 monthly instalments (from February to November) to cover 200 school days, as the number of students enrolled in each school network. The law 11947 guarantees that 30% of the transferred value by the PNAE must be invested in direct buy of familiar agriculture products. The law stimulates economic development and sustainable communities (FNDE, 2018).

The Programa Nacional de Alimentação Escolar (PNAE - National School Feeding Program) provides free meals to over 40 million students. When it began in the 1950 's, the program had the goal of addressing undernourishment. The current diet of most Brazilians is of low nutritional quality. The daily intake of vegetables and fruits is low. The intake of unhealthy foods is high. The increase in overweight among children ages 5 to 9, has become a new challenge of the program (Soares E Martínez-Mián et. al.., 2017).

Many poor children that live in urban and rural areas depend on the school meals to prevent starving. Funds from PNAE buys food from familiar local farmers located in the city of Mogi das Cruzes. The food feeds students of public schools maintained by the municipal government.The PNAE is the oldest social program of Federal, State and Municipal Governments in education area. It has as main goal of supplying the nutritional needs to reduce dropout rates. The city of Mogi das Cruzes handles about 80% of the financial resources. The Federal Government send about 30% of the financial resources for buying food from local producers. In 1994, Law 8913 transferred to municipal governments the responsibility of organizing daily menus, purchasing the ingredients, performing quality control and monitoring the use of resources through the operation of the Conselhos de Alimentaçao Escolar (CAEs - School Nutrition Councils), which were designed to enhance civil society participation in school food policies (Sonnino et. al.., 2014).

Transporting food

Food Supply Chain (FSC) management has been attracting increasing attention from the academics and the practitioners. Much effort has been made to improve the living standard. Though, problems such as high chain cost, food waste, food losses and environmental matters still occur (Li et. al.., 2016).

The management of the distribution of perishable products, like food, needs the perpetual control of the environmental conditions of storage and transport facilities in order to avoid those stresses that may affect their shelf life and quality. Lots of perishable goods are wasted because of inefficiencies during the subsequent transport process. The amount of wastage could be reduced via better planning and control of transport activities (Lin et. al.., 2016).

The perishable food products distribution can be abstracted as vehicle routing problem. It has long been recognized that managing perishable food is a difficult problem, such as vegetables, milk, meat and flowers distribution (Wang et. al.., 2016).

Many types of food are highly perishable and fragile. The added value is low and therefore the transport must be efficient with the lowest possible cost. Cross-docking is increasingly used to reduce inventory holding and the time products spend in the supply chain. It is especially suitable for fresh produce distribution with a short shelf-

life (Agustina et. al., 2014).

Relevant strategic decisions such as the location of facilities are of great importance during the design of the supply chain and its distribution network given the perishable nature of fresh food. However, the subject has not been treated much in the literature, especially due to the difficulty of its modeling (Orjuela-Castro et. al. 2017).

A study has revised operational research models to solve decision problems related to fresh Food Supply Chains. Problems of transport, routing, involving the production and distribution stages attracted attention (Soto-Silva et. al., 2016). This study showed that hub location problems are a field of interest of interdisciplinary researchers.

Another study showed the importance of hubs locations for the distribution of food supplied by local producers. The authors designed a logistic network that eases access through efficient connections between production and consumption sites (Etemadnia et. al., 2015).

Public School Food Procurements are recognized as drivers of food and nutrition security (Filippini et al, 2018). It is relevant studies that improve the logistics of the school feeding programs, due its social impacts.

Methods

The main purpose of this article is to analyze the distribution of food in schools in Mogi das Cruzes, Brazil and investigate how an adoption of a transit point could improve this logistics operation. The city of Mogi das Cruzes was chosen to this study due to the geographic area that difficult the access of vehicles to schools, and the interesting of the mayor in improving the system.

After an extensive literature review, we seek to identify the current distribution procedure, verifying the issue and fails in this system. To this step, we used the QGis 2.18 software. This software performed a geospatial analysis in a geographic information system that allows interpreted the existing situation. We adopted the buffer method, aiming to verify the reaching radius of the new distribution point and the hot spot mapping using Kernel density estimation to identify the schools' concentration.

Buffer method can be used to determine an area of influence in relation to the object of interest. Buffers can be built around any kind of vector geographic object: points, lines, or polygons (Barbosa et. al., 2015). In this study, the buffer represents a circle whose radius is the distance between suppliers and the schools.

The heat map is a method of estimation of density curves. Each point is weighted by distance from a central value. It is possible to determine the pattern of a phenomenon or process analyzed, allowing an overview on the map (Santos et. al., 2009). This method could be applied to, for instance, finding 'hot spots' of traffic accidents, street crimes or leakages in gas and oil pipe lines (Okabe et al., 2009). In this study, the heat map or Kernel density method identified the concentration of schools.

The combination of buffer and kernal methods was frequently used (Barbosa et. al., 2015).

For the delimitation of the city of Mogi das Cruzes in São Paulo state, a vector shapefile format file was used, conforming to a digital range of Brazilian cities, available on the website of Instituto Brasileiro de Geografia e Estatística (IBGE - Brazilian Institute of Geography and Statistics).

Results and Discussion

Mogi das Cruzes is regarded as the most important city of the green belt of the metropolitan region of São Paulo and stands out for the strong presence of family farmers. The city is in the Southeast region of the State of São Paulo in Brazil and has 713.3 km ² and its population is 387,241 inhabitants. The population density is of 542.9 inhabitants per km ². The city lies about 746 meters of altitude, latitude: 23° 31 's ' 29 ' ' South, longitude: 46° 11 ' 14 " West ("Município de Mogi das Cruzes, São Paulo" 2017). The Figure 1 shows the location of the city.

The local government needs supply food in a network with 209 schools. ,Regular food such as rice, beans, sugar are standardized and bought from the regular suppliers. Products such as chard, lettuce, chives, cauliflower, cabbage, endive, escarole, parsley, beetroot, carrot, chayote, and zucchini, need to be provide by family farm producers located in the city boundaries.

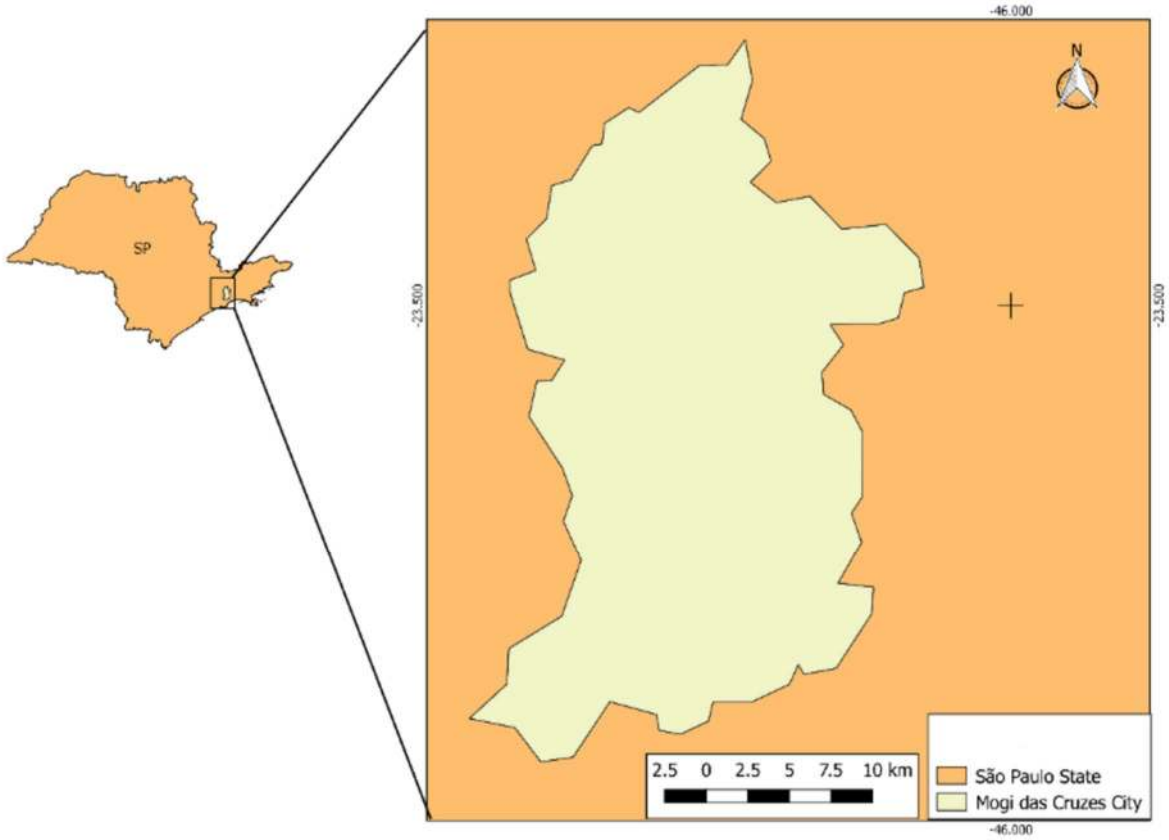

Figura 1. Mogi das Cruzes city. Source: Adapted from Qgis V 2.18

The Brazilian law number 11.947 determines that 30% of products used in the lunch preparation is obliging to buy of familiar agriculture (FNDE, 2018). To motivate the enforcement of law by the municipalities, the Federal Government create the Programa Nacional de Alimentação Escolar (PNAE - National School Feeding Program) for offering federal resources to cities buy products of these families. In Brazil 84,36% of agriculture production is composed by the familiar agriculture ("Censo Agro 2016", 2006).

As mentioned, Mogi das Cruzes is in a green belt of vegetable producers, therefore the mayor develops a cooperative of 58 local food producers that are in a settlement at the neighborhood in the rural area of the city. These producers provide vegetables to local government distribute them in schools.

The local producers send the food to a shed of a producer's association, where two cooperatives members receive, handle, pack, and board the food into 8 urban vehicles with 1,785 kg capacity each, and external dimensions of 5,085 mm of length, 1,740 mm of width and 1,965 mm height. A transport company is hired by the government that pays by kilogram transported and kilometer units.

Logistics issues

The products are sent to the schools with no processing activity, as cutting and repacking in this distribution point. Therefore, the logistics operation shows problems such as a high shipping cost, difficulty in controlling the quality of food supplied and low predictability of delivery schedules. Additional problem is that the limitation of resources in schools like handling and storage equipment are not considered by the producers, because the foods are delivered fresh without any processing such as cutting and packaging in smaller units, that could be suitable for storing and freezing. Big sizes and weights do not fit in schools' refrigerators and the handling is difficult because it is done by women.

One of the most important logistics issues is the location of the current distribution point. The storage area is far from most schools and the quality of the roads is poor. Many of them are not paved providing an extra challenge to the distribution. The Figure 2 presents the map of point of distribution.

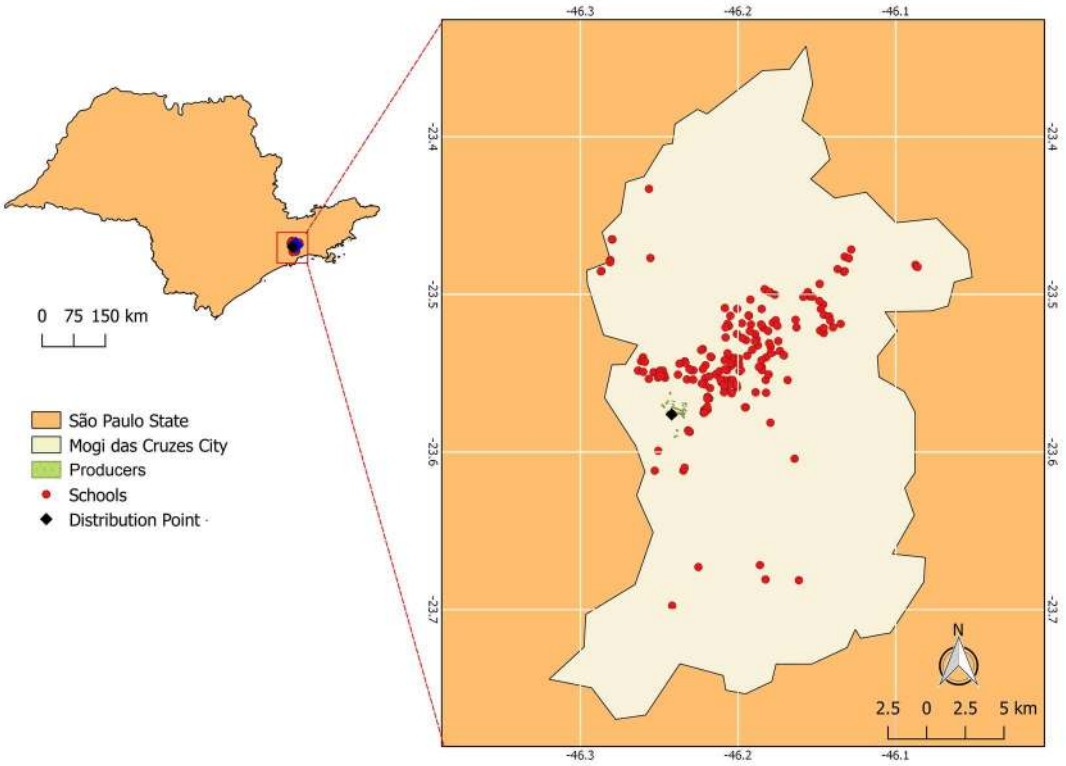

Figure 2. Current distribution point and schools. Souce: Adapted from QGis V2.18

Distribution improvements

The main idea to improve this operation, is locating a new transit point nearer to schools. Thus, vehicles with higher load capacity could send the food from the current distribution point. Shorter routes would be used to attend the supplying network, with a higher quality of pavement and lower losses.

The transit point considered as alternative was the headquarters of the Departamento de Alimentação Escolar (DAE - Department of School Feeding). The address of this department is in an urban area with high concentration of attended schools.

Currently, the DAE manages the provision of school meals maintained by the local government. The number of served meals is about 42,000 every day. At this facility, an industrial kitchen with approximately 300m² of area could process the food received from the local producers. Smaller packages could help handling and storing.

The DAE is the department that takes care of the quality of the purchased food. It is a concerning the quality control of the food bought from the local producers it is sent directly to schools. The DAE has to proceed the quality control. In case of quality problems, the schools report to DAE. The figure 3 shows the schools, the food producers, the current distribution point and the proposed distribution point.

Besides the smaller distances, there are advantages in changing the distribution point. The government owns the property, where there is an industrial kitchen and food could be processed and repackaged. Smaller packages could be better suited at the premises of the schools. For example, chards with high commercial value do not fit in the refrigerator and the schools reject them. Another advantage is that the quality control of the food that could happen on site, before sending to schools. The DAE has this assignment, but schools receive foods and do the quality control through not trained people.

The quantities received could be controlled by the team of DAE that is trained and performs this activity every day. As food is sent directly to schools, control of quantities received is also hampered by distance and decentralization. The new distribution point is in an urban area with paved roads.

We developed a hotspot mapping using Kernal density estimation to analyze the concentration of schools. Unlike point mapping showed in figure 4, which focusses on mapping the location of individual schools, hotspot mapping focusses on highlighting areas which have higher concentration of schools.

The new distribution point is in an area with

higher concentration of schools if compared with the current distribution point. Some schools attended by operation are still far from the distribution point. The Figure 4 shows the schools in the map with Kernal density analysis.

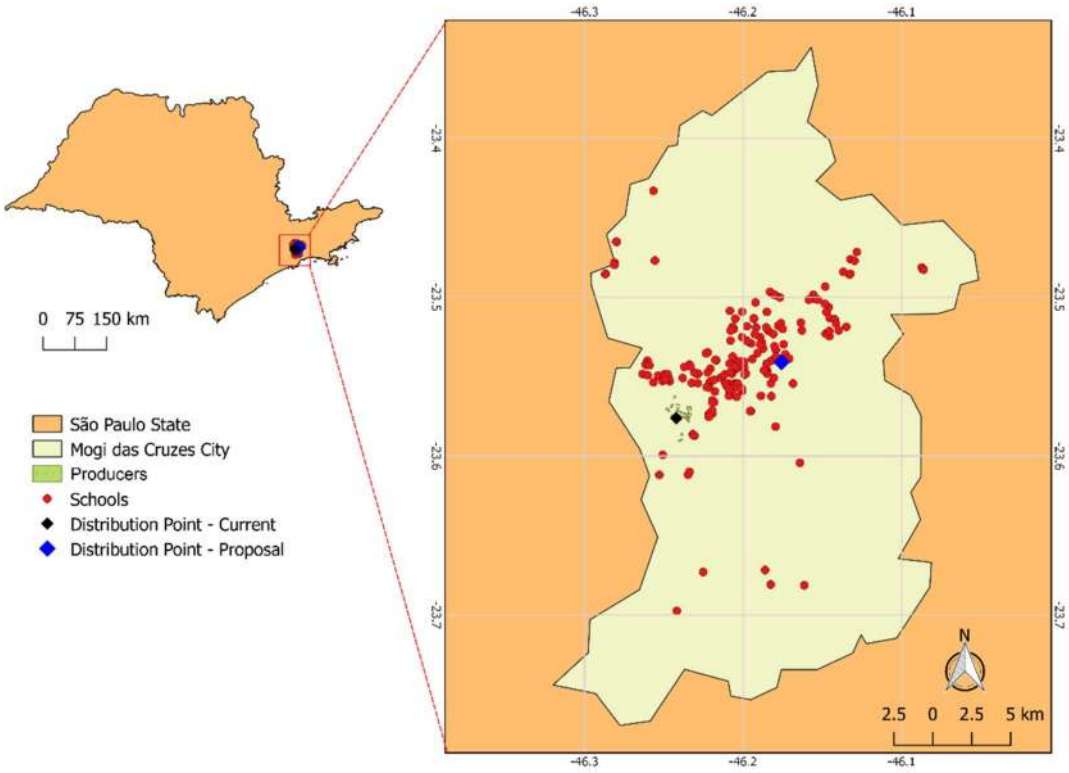

Figure 3. Schools, producers and distribution points. Source: Adapted from QGis V2.18

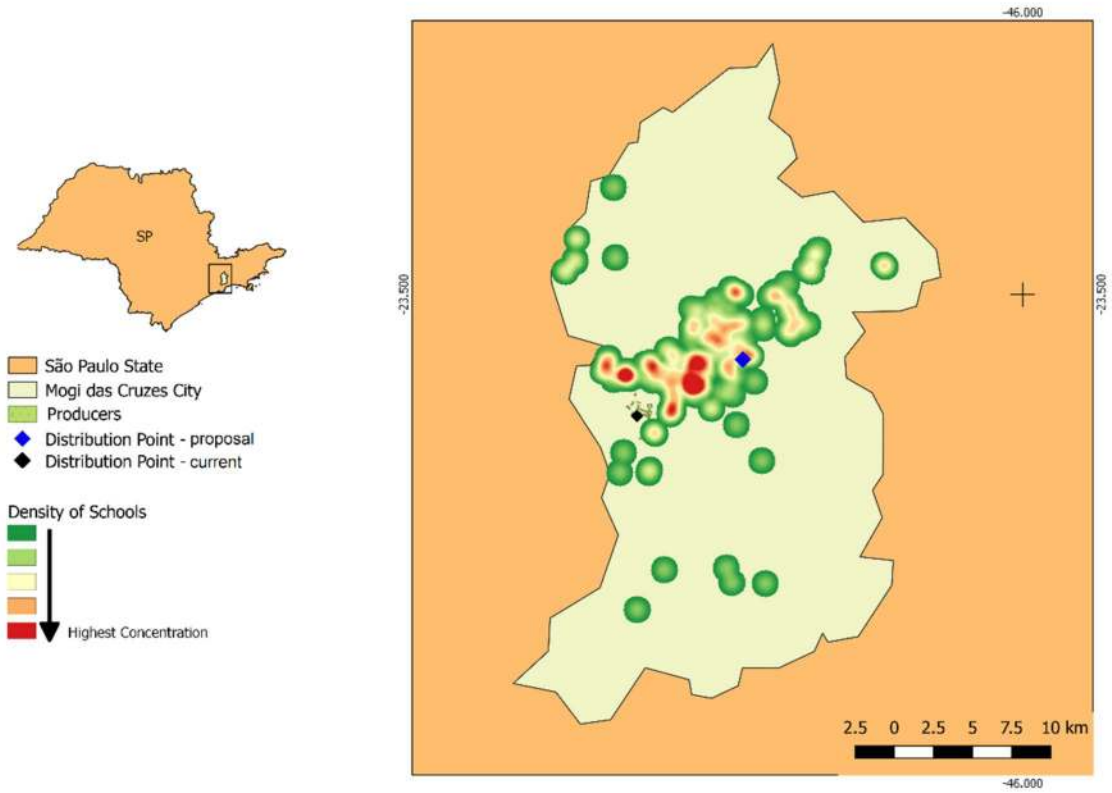

Figure 4. Hotspot mapping. Source: Adapted from QGis V2.18

The map shows that the proposed distribution point is in an area with greater concentration of schools. The red areas concentrate a high number of schools. It is noted that the current distribution point that is located in rural area, is further from the urban area, where most of the schools are located. It is not in the central area, but it is in the western part of the city.

We also used a buffer mapping approach to highlight the smaller distances between schools and the proposed distribution point when compared to the current distribution point.

The buffers show that only 26% of the schools are distant up to 5 km of the current distribution point. But 76% of the schools are located within 5 km far from the proposed distribution point

It is seen that a large number of schools are close to the proposed distribution point, if we consider distances up to than 2 km. The current distribution point is surrounded by the food producers. The Figure 5 shows the buffer mapping analysis.

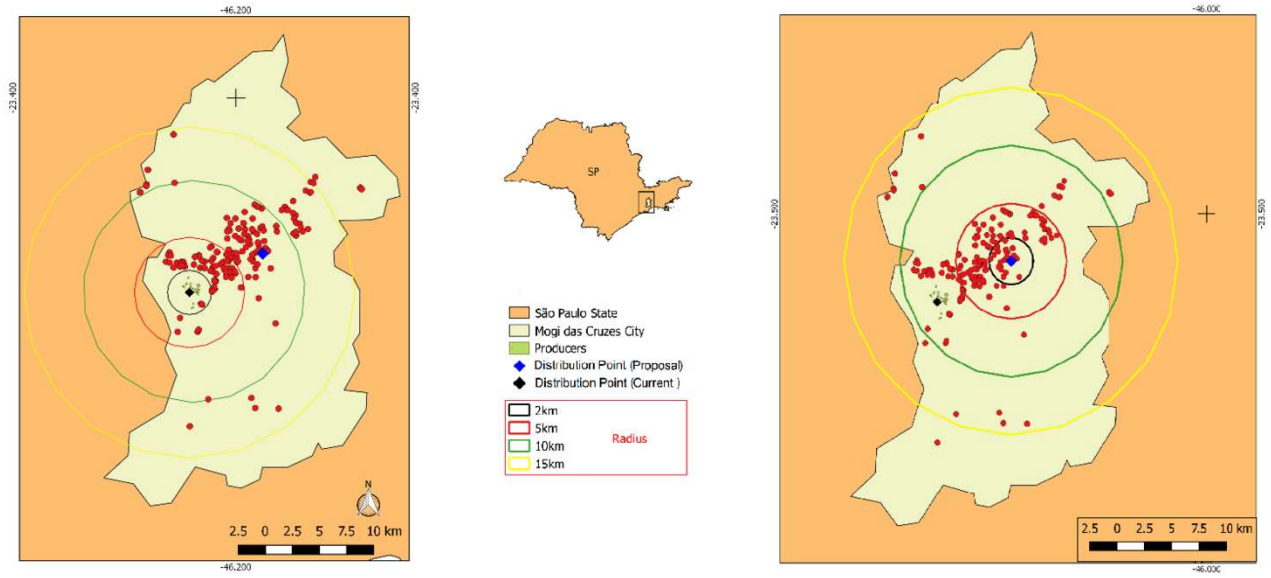

Figure 5. Buffer method comparing the current and the proposed distribution point Source: Adapted from QGis V 2.18

Conclusion

This study intended to bring ideas about a Brazilian food supply chain related to a national school feeding program in Mogi das Cruzes, one of the most important food producer city in Brazil. We identified that 58 small local producers supply food for 209 schools. Improvements are very important if we consider the social impacts.

The local government worries about the high costs and the low predictability of the transport operation. This system feeds about 46,000 children daily and thus cannot fail.

The main goal of the current study was to suggest a new distribution point of the food bought from local producers. We looked for a simpler operation with smaller distances and lower costs. This study has also identified that the quality control is unstable because the food is sent to schools and the department that is in charge. The cookers are not qualified people to make decisions about quality levels of food. The local government highlights this issue during this research as a constant concerning.

The findings of this research provide insights into the improvements in the school feeding in Brazil. Mogi das Cruzes is one of the most important food producer city of the country. More than 3,000 small properties supply food for São Paulo city and cities of the green belt of its metropolitan region. Even with a high number of local producers, there are logistics problems that turn the system expensive and inefficient.

We can conclude cities in general, have operational and logistics issues to solve in the context of school feeding. The present research should prove to be particularly valuable to raise the need for new studies in this area in Brazil.

The information limited the scope of the study because schools were not invited. It will be important to know the problems that schools have to receive, to check, to store and to prepare the

meals. More research is needed to better understand this system. We also suggest an application of a simulation model to verify the distances and the time need to attend the schools from the proposed distribution point.

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