Food in space: the spatial organization of food systems

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Abstract: Contemporary food production is facing many challenges. One of these challenges is to re-connect the food system with various public domains, such as spatial planning. Sustainable food planning is a growing domain in planning research. One of the important topics of research concerns the geographical or territorial properties of the food system. This paper addresses the territorial properties of the agricultural system using different spatial concepts. The paper includes a case study of a greenhouse vegetable production system in Venlo, the Netherlands, and its relationships with the regional spatial organization. The assessment allowed to draw some conclusions on the suitability of different spatial concepts to assess the spatial organization of food systems and their potential applicability in supporting the transition toward a more sustainable food system.

Keywords: Spatial organization, food systems planning, land use planning, land management

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1 Introduction

Food systems are defined as the chain of activities connecting food production, processing, distribution, consumption and waste management (Pothukuchiand Kaufman, 1999). Morgan et al. (2006) argue that the conventional, industrial-based food system is far from sustainable. Recent years an increase is shown in consumer concerns, caused by issues such as rising food prices, food security, environmental degradation and malnutrition (food deserts). In the conventional food system the methods of food production, processing, packaging and distribution are no longer attached to traditional farming methods and regional characteristics (Morgan et al., 2006;Morgan and Sonnino, 2010). It has become a global activity focusing on uniformity and bulk production, where food often travels thousands of miles before arriving at the consumer.

The alternative, organic food system aims to restore the link between farmers and consumers. The effort is on re-valuation of regional products, fresh food and shortening the chain between producers and consumers (Broekhof and van der Valk, 2012). However, at present the alternative food movement has a very small share of the food market and the feasibility of feeding the world population by alternative food production is a topic of often-heated debate.

Many scientists argue that producing more food at affordable prices, ensuring livelihoods to farmers and reducing the environmental costs of agriculture will most likely require a full range of alternative, conventional and hybrid systems (Seufert et al., 2012; Broekhof and van der Valk, 2012). This requires acknowledging the role of conventional agriculture, assessing its different components and developing alternatives at the same time (Broekhof and van der Valk, 2012). A key challenge is to re-connect the food system with various related public domains, such as spatial planning (Sonnino, 2009;Wiskerke 2009).Consequently, sustainable food planning is agrowing domain in planning research (Viljoenand Wiskerke, 2012).One of the important topics of research concerns the geographical or territorial properties of the food system.

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This paper describes the territorial properties of a conventional agricultural system in its regional spatial context, using different concepts. The paper includes a case study of a greenhouse vegetable production system in the Netherlands. Section 2 will elaborate on the methods and concepts used, as well as the context of the case study. Section 3 presents the results, while a conclusion is drawn in Section 4.

2 Materials and methods

The methods used in this research involve some selected concepts of food systems and concepts of spatial organization. The selected concepts provided the analytic frame to analyze the case study. This section describes the concepts used and introduces the case study area.

2.1 Concepts of food systems

The analysis of the food system has been structured along two concepts, that of worlds of food (Campbell, 2004; Morgan et al., 2006) and agro-park (Smeets, 2011).

Morgan et al. (2006) describe two competing worlds of food, the conventional agri-industrial food system and the alternative food system. Both systems aim to produce safe and healthy food, but from different perspectives and using different means. The agri-industrial system is founded upon the thought that the environment will benefit from specialized, high-yield farming systems using precision technology, where efficiency and productivity are dominant. The alternative food system includes a multitude of alternative production methods that advocate local and ecologically produced food, starting from quality notions instead of cheap bulk products. Some main differences between both systems are summarized in Table 1.Sustainability is a shared value of both systems and some academics hypothesize common ground for a synthesis of both systems, a 'third way' forward (Broekhof and Van der Valk, 2012).

Table 1 Some main characteristics of the agri-industrial and alternative food system (after Broekhof & Van der Valk, 2012)

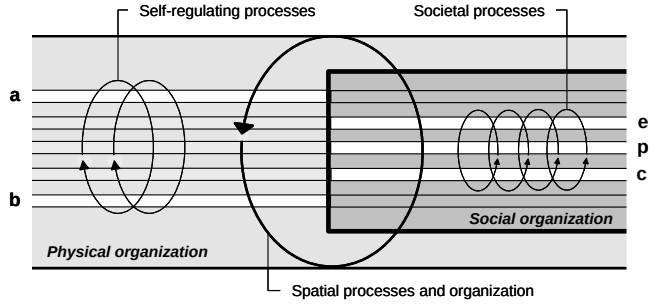
	Agri-industrial food system	Alternative food system
Economic position of farmers	Intensive production 'lock in'	Economies of scope approach
Environmental sustainability	Technical solutions for environmental problems	Closing nutrient cycles at regional scale
Organoleptic quality and diversity	Uniform product, end-of-chain diversification	Created by farmers and/or artisanal food processors
Consumers' trust	Quality and safety assurance schemes	Personal trust based relations
Health	Nutritionally engineered functional food	Fresh food and physical exercise

The concept of agro-park or agribusiness complex refers to the spatial clustering of agriculture and non-agriculture related activities, which is based on the principle of industrial ecology (De Wilt et al., 2000; Van Steekelenburg et al., 2005; Smeets 2011).Agro-parks are part of the development of the agri-industrial food system towards more sustainability. Innovative production, marketing and logistics are located together in agro-parks, allowing to increase efficiency and productivity, together with closing nutrient, water and energy cycles. Several activities can also be integrated in a multi-story building, a so-called vertical farm.

2.2 Concepts of spatial organization

The analysis of the spatial organization of food systems has been structured along three different analytic concepts: the social-physical organization concept (Hidding, 2006), the multi-layer concept (Zonneveld, 2005) and the network concept (Priemus, 2007).

The social-physical organization concept describes the spatial organization of the landscape as the result of intertwining processes between society (the social organization) and the natural landscape (the physical organization) (see Figure 1). The natural landscape is sub-divided in a biotic sub-system (living organisms) and a-biotic sub-system (soil, water and atmosphere). Society is sub-divided in economic, political and cultural sub-systems. The social-physical organization concept is a concept, which accentuates the different relationships between the sub-systems and the spatial organization of the landscape as a result. The structure and dynamics of the subsystems and their spatial implications need to be understood in order to incorporate the socio-economic, political and ecological dimensions of a problem in the planning process (Carsjens, 2009).



(a) a-biotic, (b) biotic, (e) economical, (p) political, (c) cultural
Figure 1 Social-physical organization model (Carsjens, 2009; adapted from Hidding, 2006)

The multi-layer concept emphasizes the rates of change in the landscape, distinguishing three layers, each subject to a different rate of change (see Figure 2). The multi-layer concept as been adopted in Dutch national spatial planning (Zonneveld, 2005). The layers are the physical substratum, the network layer and the occupation layer. The physical substratum includes, for example, soil, water systems, nature and elevation of an area. Major changes in this layer usually take a considerable amount of time, often many decades or even centuries, to settle.The network layer includes the physical infrastructure networks, such as roads, railways and transfer nodes, but also flight paths, pipelines and digital networks. The rate of change in this layer is larger than in the physical substratum, as changes in the network often take decades to settle. The occupation layer includes the human activities and land use, such as residential, industrial and leisure areas and agricultural production. This layer is the most dynamic one, as land use changes usually take no more than a few years to settle. The occupation layer is the result of an on-going process of humans who transform the landscape to their needs.

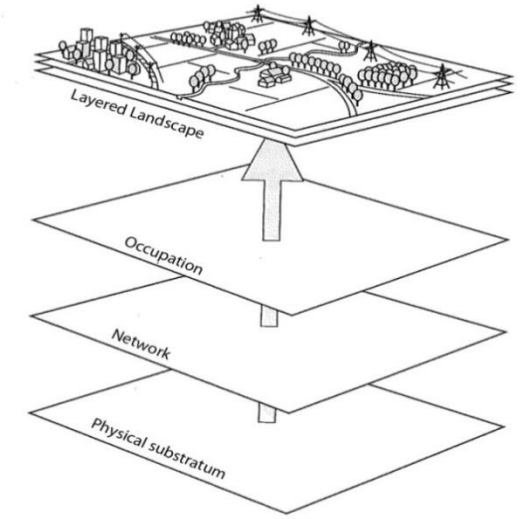


Figure 2 Multi-layer concept (after Hidding, 2006)

The network concept (Priemus 2007) suggests a typology of three spatial networks: (1) the physical networks, such as ecological networks and rivers and streams; (2) infrastructure networks, such as road, rail, air, ICT and utility networks and (3) urban networks, which are the resulting structures of the links between infrastructure networks and occupational patterns. This principle is based on the transport land use feedback cycle of Wegener and Fürst(1999) (Figure 3). Occupational patterns determine the places of human activities: where people live, work, recreate, and so on. Transfers between the different activities should be supported by the transport network and changing it. In turn, changes in the infrastructure network will make areas more or less accessible and therefore more or less attractive for allocating certain activities. And so the cycle begins again (Bertolini, 2010).The concept makes a basic distinction between lines in the network and nodes where people, goods and/or information are exchanged

(Bertolini, 1999, 2010). Both are essential for the functioning of a network.

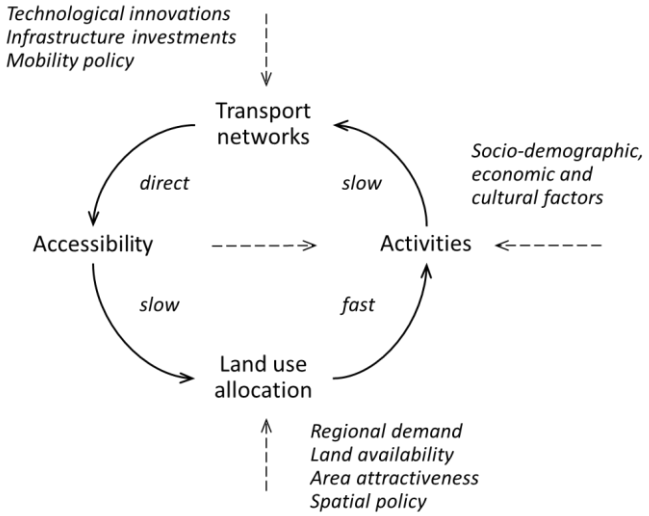


Figure 3 Transport land-use feedback cycle (after Bertolini, 2010; Wegener &Fürst, 1999)

2.3 Case study area

The case study was focused on the greenhouse vegetable production system of greenport Venlo. Greenport Venlo is one of the six important clusters of horticulture in the Netherlands, labeled as greenport by the Dutch national government in 2004. Greenports are agro-parks that accommodate all parts of the horticulture production chain, including primary production, supply, processing, distribution, services, research and education. Greenport Venlo is located in the southeast of the Netherlands, close to the German border. The oldest parts are ZON Fresh Park and the Floriade area (see Figure 4). Existing and new greenhouse and agri-industrial areas are shown in Figure 4. The total planned area of greenport Venlo is 5,400 ha.

Figure 4 Greenport Venlo, master plan 2015-2020

3 Results

The analysis and assessment of the concepts used is a part of work in progress. Therefore, only some preliminary findings are summarized. The analysis of the different agribusiness components of the greenhouse vegetable production system resulted in the scheme presented in Figure 5.The agribusiness components have been differentiated at two scale levels, the spatial organization of the region Venlo and the spatial relationships with activities outside the region. Moreover, the components are arranged in four organizational levels:

supplying activities, primary production, food processing, and trade & distribution. A historical analysis showed that the greenhouse vegetable production system was initiated in the Venlo area by its excellent physical conditions, especially the available groundwater, fertile clay soil and the location of large consumer markets in Germany nearby. The first greenhouses were established as early as 1912. An important impulse for vegetable production was the improvement of farmers' capacity between 1920 and 1940 through agricultural and non-agricultural services, such as extension services, agricultural education and farmers' banks. In time, especially supplying, processing and trade activities that required (daily) exchange of persons or goods were established in the Venlo region. The availability of space and the accessibility of physical networks, such as road and water infrastructure, were conditional for the allocation of these activities.

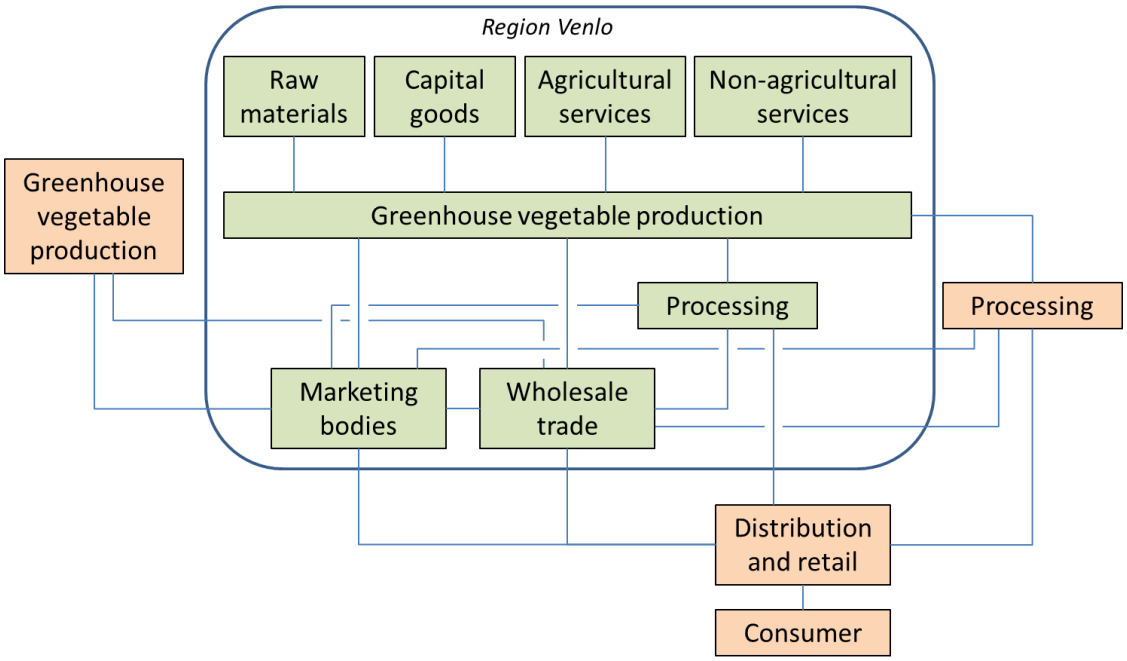


Figure 5 Greenhouse vegetable production system of greenport Venlo, representing activities located within and outside the region Venlo

At present, the region Venlo houses 200 greenhouse vegetable growers (see Figure 6), with an average size of 3 ha, producing 14% of the total production of greenhouse vegetables in the Netherlands. The main products are tomatoes, bell peppers and cucumbers.

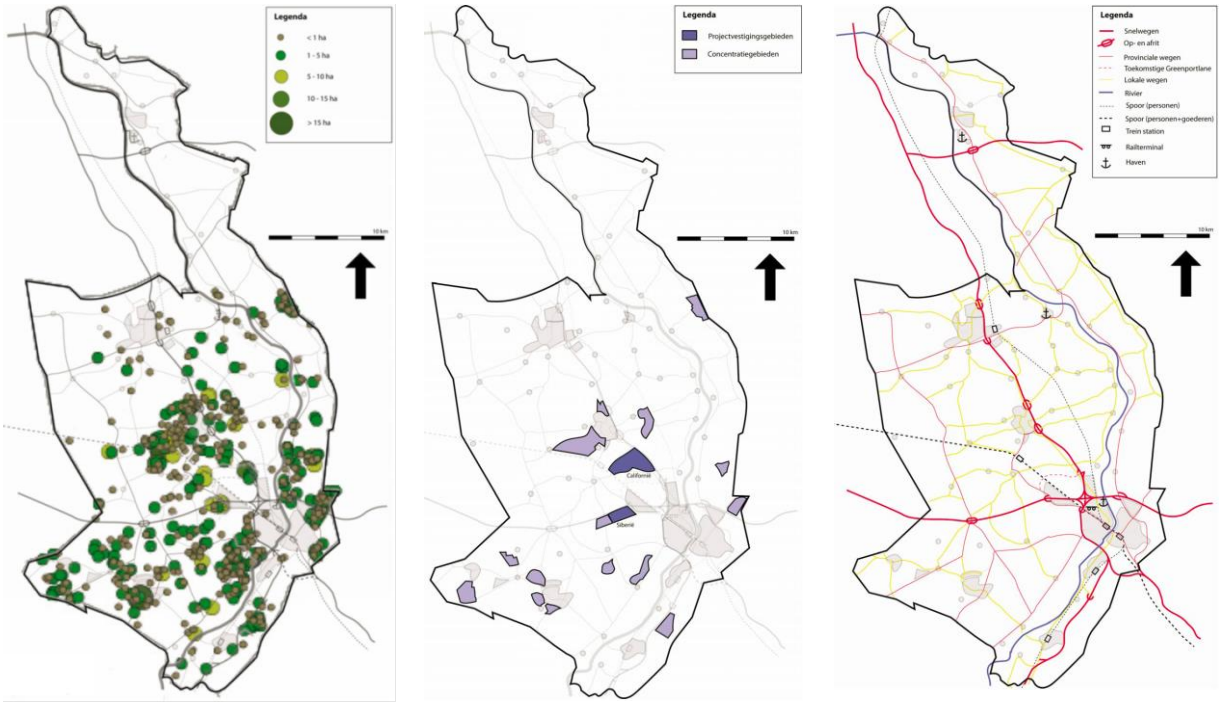


Figure 6 Examples of the spatial analysis of the greenhouse vegetable system, including the location and size of greenhouse vegetable growers (left), designated concentration areas (middle) and regional infrastructure (right)

Since the 1980s the primary production changed to substrate cultivation, reducing the link to the physical conditions of the area, although production is still highly depending on fresh water of good quality (rain and groundwater). Nowadays, greenhouse vegetable production is a knowledge-intensive sector, highly depending on innovation in production systems and processing. The first processing steps are usually done by the vegetable growers themselves, while other processing companies take up some next steps, such as cutting, assembling and packaging. However, the processing companies for greenhouse vegetables are only a small component of the greenhouse vegetable system, since these vegetables are mostly produced for the fresh food market.In fact, the importance of transporting fresh vegetables quickly emphasizes the strong relationship and dependency of the transportation network, especially the road infrastructure since trucks are the dominant mode of transport. Likewise, the marketing and trade components of the system are well established in the Venlo region, given their strong links to the regional and (inter)national transport infrastructure (see Figure 6). These activities are mostly concentrated in the specific designated areas of the Provincial Structure Plan (2011) (see Figure 6). The most important area is the ZON fresh park (see Figure 4). ZON vegetables and fruits are a grower's cooperative, established in the 1920s, and an important mediator between growers, marketing, trade, logistics and retail.The designated areas also housea variety of other supplying, processing and trading companies, with many relationships to other food systems and land use activities.

4 Conclusions

The Venlo case study clearly showed the mutual relationships between the development of primary production of greenhouse vegetables and the conditions and networks of the regional spatial organization. Moreover, the development of primary production in the area triggered the development of extensive supplying and processing industry nearby. On the other hand, the primary production could not have developed at this rate

without the presence of supporting activities and networks. In the process of analysis, the spatial concepts allowed to identify and map these relationships at different spatial scales. The concepts also allowed identifying and mapping the relationships with other systems and landing use activities, enabling the assessment of the complex mutual interactions and the consequences for further development of the greenhouse vegetable system.

However, there are also some clear differences between the spatial concepts. In comparison to the other concepts, the strength of the social-physical organization concept is that it generates a comprehensive understanding of the intertwining processes between different sub-systems. Rather than separating layers, the concept shows their interrelatedness. Although the concept allowed sketching a comprehensive picture of the spatial organization of the greenhouse vegetable system, its abstractness and complexity restricts its usage for quick and basic analysis. The multi-layer concept and the network concept seem to be more suited for this. However, a common pitfall of the multi-layer concept, when separating the different layers, is to overlook the interconnectedness of the layers. A proper analysis with the multi-layer concept does not consist of clear visualizations of the disconnected layers, but is characterized by the integration of the layers. The network concept can help identifying such relationships between the layers, especially from the perspective of specific societal activities, such as the interconnected activities in the food chain. Priemus (2007) argued that if the networks and their mutual relationships can be mapped out and their logic understood it will allow finding conditions for spatial development well-suited to the characteristics of an area. The case study supports this conclusion and as such the concepts can be important planning instruments to guide sustainable spatial development.

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