# Mapping vegetables – understanding the food system of greater Bangkok, Thailand: A web-based Collaborative Research Environment

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## ABSTRACT

Urban and peri-urban vegetable production and marketing systems have the potential to contribute to poverty reduction, food and nutritional security, local economic and community development, social inclusion of marginalized groups and women in particular, as well as to enhance urban environmental management by increasing biodiversity and the productive reuse of organic wastes. This project looked at 4 components of the overall food system: Smallholder vegetable producers, community gardeners, markets, consumers and street vendors. To better understand the linkages and importance of each of these components a so-called pilot Collaborative Research Environment (CRE) was developed. The core of the CRE consists of a central, spatially enabled database and a range of associated tools for distributed data entry, for remote and real-time monitoring of the incoming data, for data analysis, and last but not least for data presentation. The tools include the required Geographic Information System (GIS) functionality for spatial analysis and map-based visualization.

In the pilot study the data included in the CRE comprises empirical data from different sources such as questionnaires and surveys, spatial information on production areas in relation to vegetable diversity as well as information on producers, traders and consumers.

Some results of study concerning the different target groups show that: The producer survey shows the importance of market demands and prices influencing the decisions on which kind of crops and vegetables are grown. Other important factors here are farmers' skills and habits as well soil and water conditions. All those are strongly interrelated. Plant diseases and pests as well as climate and weather conditions are identified as major challenges for the vegetable producers. However,

47% of the producers produce more than ¾ of their self-consumed vegetables. For the community gardeners' urban gardening in Bangkok is not about food security in the sense of essential food provision: More than 70% of the interviewees never face difficulties in providing enough food for their family and around 20% rarely do, mainly because of poor harvests. However, a lot of the interviewed people refer to the problem of chemical pollution of market vegetables.

Wholesale markets play a big role for the food security in the Greater Bangkok. About 52% of products from Si Mum Muang Market stay in the Bangkok Metropolitan Area and 85% in the Greater Bangkok Area (including surrounding provinces). Many products come from the North and Northwest of Thailand but a considerable share is also grown in the periurban area around Bangkok. A number of perishable products like e.g. lettuce and kale are mostly grown in the proximity of the megacity. This once again proves the importance of periurban agriculture for food security in Bangkok. More than 70% of the local markets and over 50% of street vendors and restaurants buy at wholesale markets Si Mum Muang and Talad Thai.

Regarding consumption the survey identifies clear differences between men and women. Vegetables are eaten by 65% of male and 80% of female participants. 41% of the male and 51% of the female interviewees eat fruits. For milk products the distribution can be grouped into 32% male and 41% female consumers. 65% of men and 70% of women eat meat minimum every day. Fish/seafood are eaten 24% by men and 28% by women. It is noticeable that women are consuming all food groups more frequently. Other differences get obvious looking at different age groups. It gets clear that food habits are changing. Regarding food purchase and consumption, local markets are of extraordinary importance in Bangkok. The most common challenge for consumers in vegetable usage is the price.

**Keywords**
Biodiversity, Collaborative Research Environment (CRE), food security, vegetable production, community gardens, consumption, marketing, urban and periurban agriculture,

## URBAN AND PERI-URBAN VEGETABLE PRODUCTION

Urban and peri-urban vegetable production and marketing systems have the potential to contribute to poverty reduction, food and nutritional security, local economic and community development, social inclusion of marginalized groups and women in particular, as well as to enhance urban environmental management by increasing biodiversity and the productive reuse of organic wastes. In order to understand the food system, a holistic approach combining quantitative and qualitative methods has been applied in this project. Bangkok's food system comprises of producers, markets, street vendors and consumers, who interact with each other on different spatial and temporal scales. The system is not static but subject to changes and fluctuations depending on external and internal political, socio-economic and geographic drivers.

This project investigated the potential of a GIS-based Collaborative Research Environment (CRE) as an innovative tool to enable researchers, policy makers and the public to find information on a range of factors that affect access to healthy, affordable food, thus, addressing abovementioned constraints. Food mapping has been defined as the process of finding out where people produce, process, purchase and consume food, and what the food needs of local people are. It is a type of needs assessment that aims to identify the geographical areas or communities that have the greatest needs in terms of access to food. Food mapping is one method used to

describe and measure a community's level of food and nutritional security and is therefore not just about producing spatial maps describing physical and economic access to food. The food maps will be able to describe how people feel about local food access, for example, how culturally acceptable and appropriate it is, how convenient it is to access, how appealing it is, how safe it is to eat as well as if people have the skills and confidence needed to prepare healthier food options. Most of this goals where completed, however, an interesting finding of the study is, that so called "food deserts" are non-existing in the context of the target groups in Greater Bangkok. This does not imply, however, that such deserts are not affecting other parts of the Thai society.

The producer system changes e.g. due to rapid land use changes in periurban Bangkok, which can be clearly identified with satellite image time series. But the producer system also responds to consumer demands, new trends and food habits emerging along with the urbanization process. Market processes and political changes (e.g. the opening of the ASEAN market by 2015) may change production pattern dramatically in the future.

In early April 2012, an inception workshop was organised at Kasetsart University in Bangkok, bringing together the main stakeholders of the project, including researchers and students. At this workshop, based on the project proposal, research approach and objectives were specified. Studying the entire food chain from production to consumption from a bottom-up perspective and exploring options for up scaling were important components of the project. The main focus was on farmer communities, wholesale markets, community gardens, as well as consumers and street vendors.

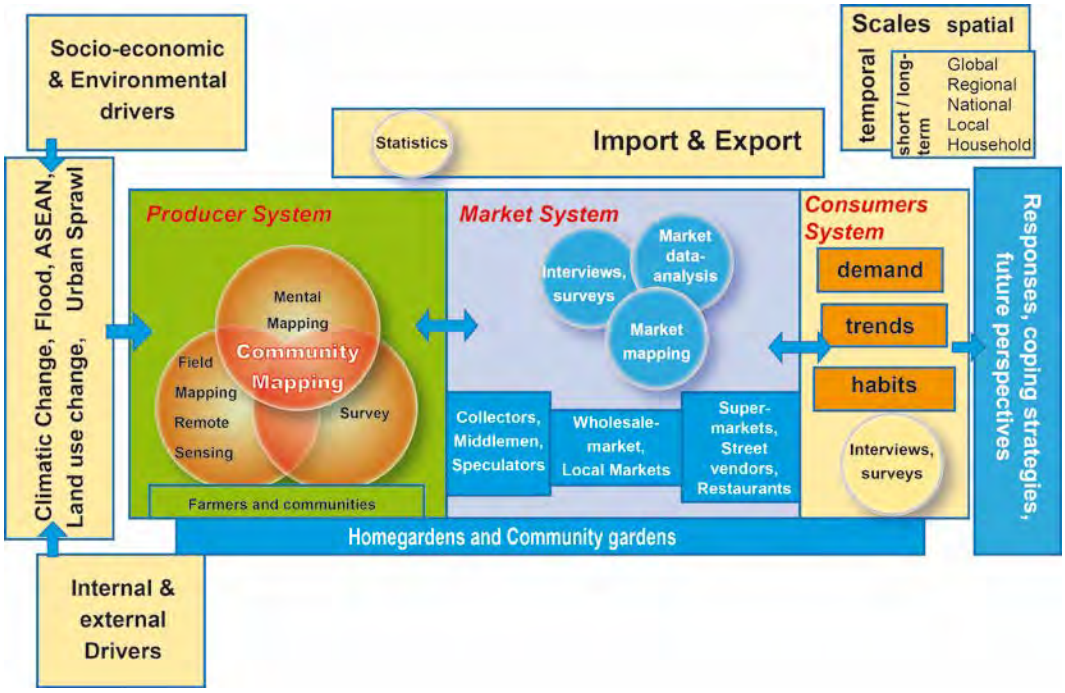



**Figure 1: Conceptual framework of the food system and research approach in Bangkok**

The pilot study was organized in two field campaigns, one in 2012 (April – June) carried out by an advanced group of Master students and another one in 2013 (April – August), carried out by a group of 16 German Master students together with their Thai counterparts. The first campaign was rather an orientation campaign to build the

team, develop and test questionnaires in the field, to learn field and mental mapping, to train Thai and German students, and to adjust the methods to improve the second campaign. In September 2013, a final workshop took place in Thailand, where results were presented to the stakeholders and further action was discussed.

## METHODS

A set of methods was used to capture the food system from different perspectives. The project aimed at gaining quantitative measurable data on food systems as well as qualitative data expressing people's needs, priorities etc. These data are organised in a Geographic Information System along with vegetable production sites that are captured via field mapping to account for the spatial dimension and patterns of food production. In 5 different locations, 30 surveys took place and a total area of about 1.274,000 m² was mapped (Fig. 2).

The data was firstly fed, organized and stored in an internet-based Collaborative Research Environment (CRE) combined with a Geographic Information System (GIS), from where it afterwards was exported into spread sheet and statistical software respectively to a non-internet based GIS for further analysis.

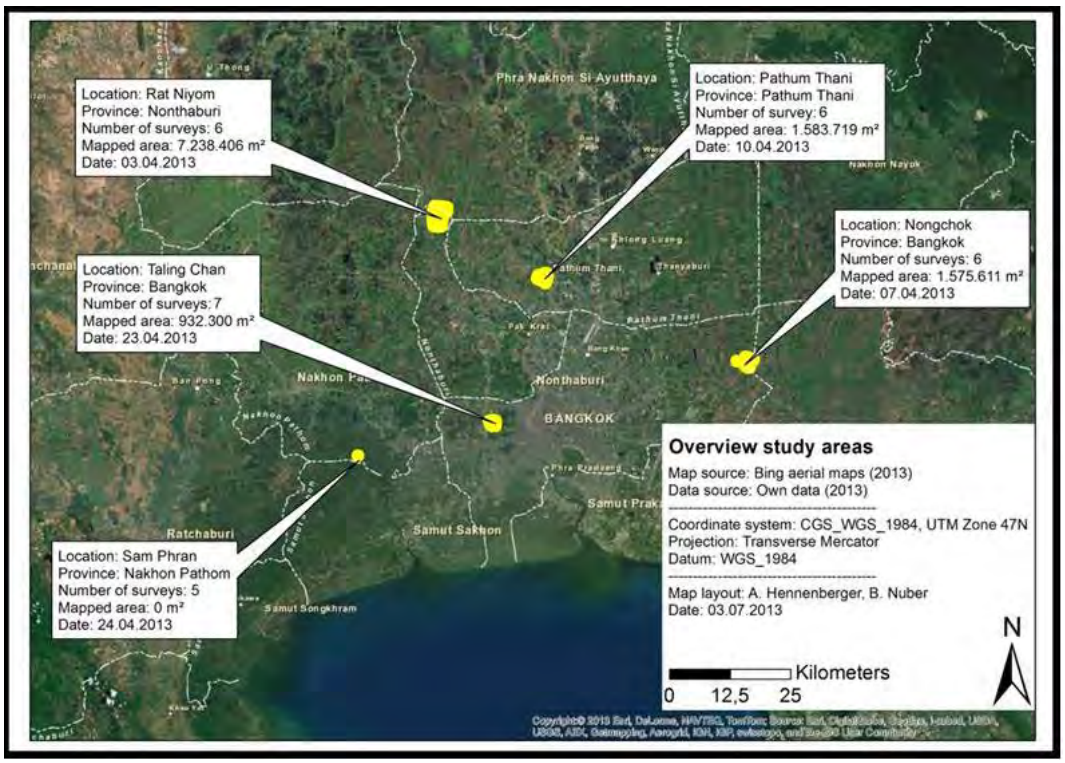


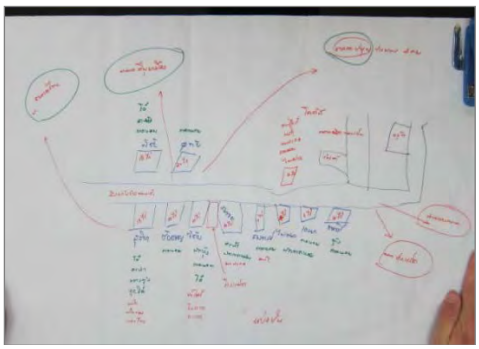

**Figure 2: Overview location and short information study areas**

### Community mental mapping

Community mapping can be defined as "local mapping, produced collaboratively, by local people and often incorporating alternative local knowledge" (Perkins 2007: 127, similar: Parker 2006: 470). It is therefore a strategy worth considering when researchers deal with unknown socio-cultural spheres and spatial contexts. Community mapping aims at gaining qualitative information about the spatial perception of a certain aspect or issue presented to a group of people. Spatial elements and characteristics are considered to be part of individual and collective perception, which can be manifested on a map. It is a method that is increasingly

applied in the scientific community, especially by geographers (Glaser et al. 2007, Perkins 2007, Parker 2006). For instance, Open GIS alternatives such as OpenStreetMap or even the applied CRE of the vegGIS can be viewed as communal mapping projects (Omsrud and Craglia 2003, Kingston 2007). Martinez-Verduzco et al. (2012) conducted community mapping in the context of land use mapping in similar combination of GIS-based methods to separate coffee plantations from natural vegetation. A critical approach shows the implications of community mapping for the re-organization of land use in Northern Thailand (Roth 2006).

In design of this research project the community mapping consists of two different methods: sketch mapping and scale mapping. The two methods are different from each other, since the sketch mapping is conducted on a blank sheet of paper and is therefore not as structured as the scale mapping drawn on a given satellite image. Furthermore, the instructions and the aims of both methods differ: In the sketch mapping the participants are asked to draw everything that comes to mind with regard to their personal and collective food system and their perception of the community as a whole. In addition to the information on the map, there is valuable information to be gained in the discussion between community members. In the scale mapping, the main goal was to clarify boundaries of the community and known ownerships of fields, which are drawn on the sheets individually.



**Figures 3, 4, 5: Mental mapping session and related products (photos: H. Karg)**

As part of the applied methodology, the community mapping aims at gaining qualitative data about the food systems in communities in periurban Bangkok.

Mental maps are cognitive maps drawn by members of the community showing their personal point-of-view perception of their own world. Mental maps provide information on perceived importance of spatial features (e.g. whether they are

drawn at all, or at which size), perceived distances, directions, and in general how people order their space around them.

Community mental mapping takes place in the communities after arranging an appointment in order to gather as many community members as possible. The main activity is drawing a sketch map, i.e. a hand-drawn map on a blank sheet of paper without spatial features indicating scale and location (Fig. 3, 4, 5). After this actual mental mapping session, farmers are asked to indicate their own field on a printed satellite image (A1 format) showing the extent of the study site - referred to as scale mapping. They can also add other spatial features that were subject of the sketch mapping session before (e.g. markets, community boundary, etc.). In addition to the drawn map, information can be extracted from the discussion which takes place while drawing and which should be encouraged by the facilitator.

## Remote sensing and eCognition

Up to now, data on urban and peri-urban agriculture (UPA) is mainly collected through field sampling methods. These methods suffer from manifold practical and economic limitations. This means that spatial and temporal dynamics of UPA must be derived from sparse samples. Furthermore, these ground sampling techniques do not allow the surveillance of continuous measurements of specific variables within a certain area. They are therefore not easily applicable to analyse larger areas in a way that is suitable to support the formulation of sustainable policies for urban resource management.

With the development of ever more sophisticated Remote Sensing (RS) and Geographic Information System (GIS) techniques, the (semi-)automated detection and analysis of UPA is getting more accurate and cost- as well as time-efficient. The temporal and spatial availability of RS data and versatile advancements of the technologies to process and analyse that data makes RS-based approaches increasingly suitable for UPA research.

Up to now, there have been only relatively few attempts to analyse UPA with RS/GIS techniques. One example is the study by Van den Berg et al. (2001) on the spatial distribution of urban agriculture in Bamako and Ouagadougou. By combining visual interpretation of a satellite image and the analysis of GIS datasets, such as streets and water bodies, the authors calculated the likelihood of the presence of urban agriculture in different areas of the cities. Ifatimehin and Musa (2008) investigated on the applicability of geoinformatic technology in evaluating urban agriculture and urban poverty in a Nigerian city. Dongus (2009) investigated the relationship between UPA and the occurrence of mosquito larvae in Dar es Salaam. Even though he applied GIS techniques and the visual interpretation of remotely sensed imagery, a quantification of the agricultural production was not intended.

However, most of the earlier attempts to investigate UPA (e.g. Van den Berg et al. 2001) widely depended on coarse resolution remotely sensed imagery such as Landsat TM and ETM+ with multispectral resolutions of 30 m. As these resolutions are not sufficient to detect small scale UPA in heterogeneous urban environments, high-resolution satellite data was used in this study.

Conventional pixel-based methods that have been applied in the analysis of coarse resolution satellite images such as unsupervised classification and maximum likelihood supervised classification are not necessarily adequate for the analysis of high-resolution remotely sensed images. One reason being that these classification methods fail to incorporate the high spatial content and associated information in the classification scheme (Blaschke and Strobl 2001).

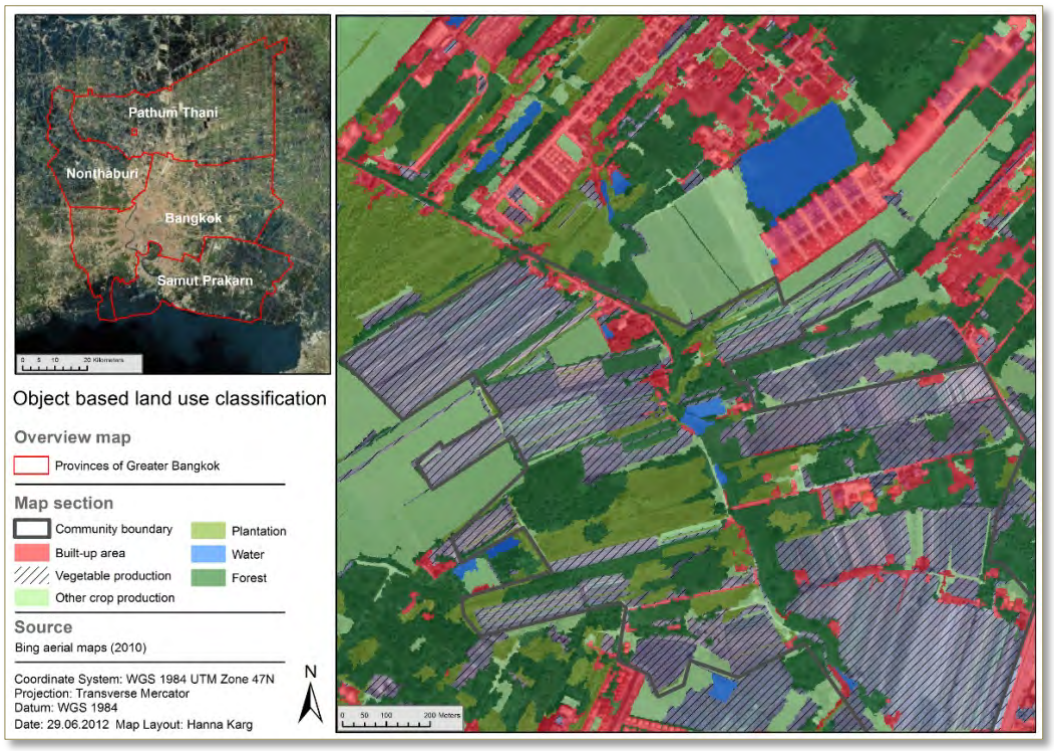



**Figure 4: Object based small-scale land use classification**

Therefore, a different classification was emphasized in this research project. In order to capture areas under cultivation within the city boundaries as accurately as possible, an object-based classification (McKeown 1988) approach was implemented using DefinienseCognition Developer 8.0 software (Fig. 6).

It could already be demonstrated that object-based approaches are much more suitable for the interpretation of high-resolution satellite images than common pixel-based methods. While the latter analyses the spectral characteristics of single pixels, this approach looks at pixel regions as objects or features, evaluating pixels within their context. Therefore other characteristics such as shape and texture play a more important role than just the spectral reflectance. As vegetable production sites usually have distinct spectral as well as textural characteristics that can be easily detected, object-based classification methods proofed to produce highly accurate results in this study. By defining training areas for the segmentation and classification process, the whole classification scheme can be easily scaled up (Fig. 7).

Another advantage of an object-based analysis of high-resolution data in comparison to the common pixel-based methods and coarse resolution data is the accuracy in detecting small-scale agriculture such as backyard gardens. Agricultural production on these small-scale patches tended to be often overlooked due to limitations in spatial data resolutions. However, it plays a crucial role for the food production in heterogeneous urban and peri-urban environments.

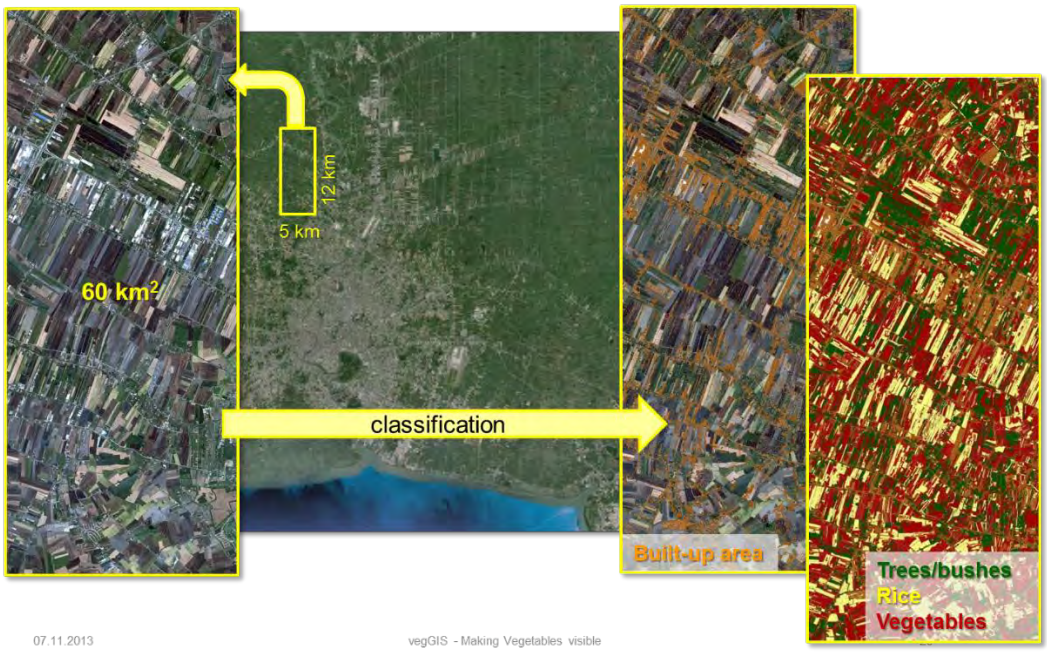



**Figure 5: Object based identification of vegetable fields**

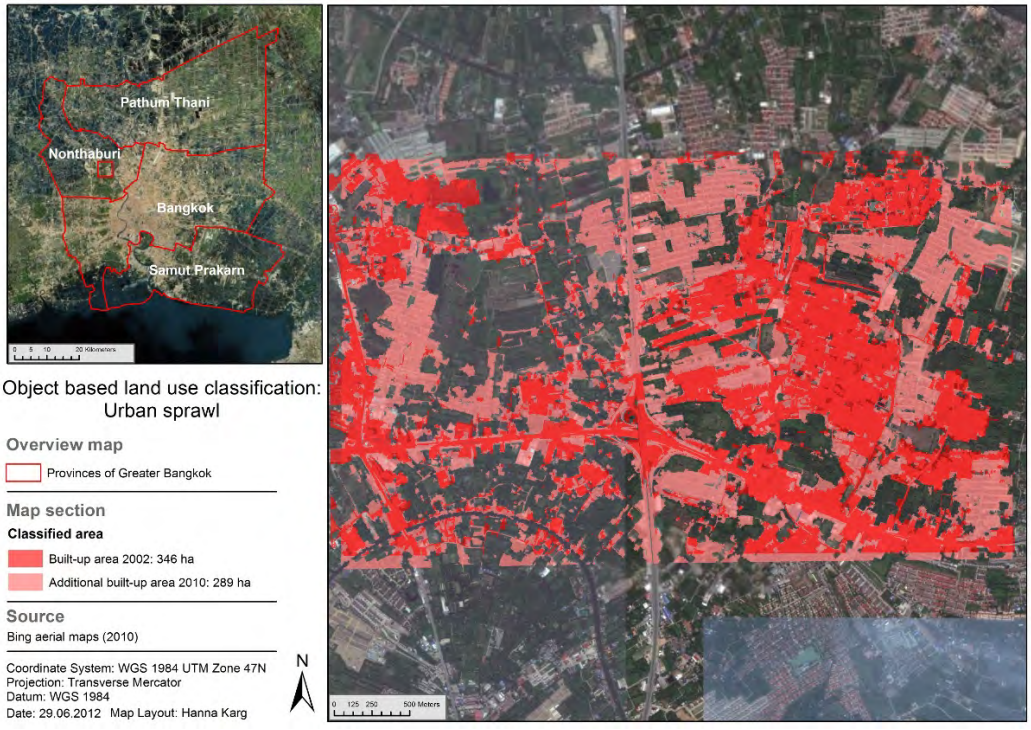



**Figure 6: Object based urban sprawl analysis**

Object-based classification methods implemented with eCognition are also highly suitable for the detection of urban sprawl, a significant feature of Bangkok´s urban and periurban development. Figure 8 shows the increase in built-up area in periurban Bangkok.

Based on high-resolution satellite images, the built-up area was detected for the years 2002 and 2010. The analysis showed that the urban area in this example increased from 346 ha in 2002 to 635 ha in 2010 – an increase of more than 80 % in only eight years.

By applying the same classification schemes on a larger-scale, a cost-efficient and accurate analysis of urban growth and urban and periurban agriculture (UPA) can be achieved.

## MAJOR RESEARCH FINDINGS

### The Collaborative Research Environment (CRE)

The complexity of the research topic demanded a well-organized and transparent data management. As many people were involved in the data collection, a functional and reliable method of managing the collected data was required. While different groups for the different parts of the research project were formed, it was important that all data was stored in a standardized and centralized way, assuring data accessibility and accuracy for all involved people.

For this purpose, a web-based collaborative research environment (CRE) was developed within the project. This web application provides an easy to use and around the clock available data collecting and sharing platform for the project members. In this way, several people were able to work on the same data stock and data exchange between the different research groups was facilitated. Furthermore, data monitoring and backing up could easily be done remotely from the German counterpart while the data was collected and entered in the research location.

While usually – especially when dealing with spatial data – special software and knowledge is necessary for the data handling, our web-based application allows the access requirements for the users to be quite low. Internet availability is the only requirement to participate in the data collection. The web application provides all necessary tools for the collection of spatial and common data. A user and group management allows the definition of roles, tasks and permissions and enables collaborative work on the data. All data is stored in a centralized and spatially enabled database. Data model definitions, where data types and metadata is specified, take care of standardized and validated data. Beside the on-line data monitoring and visualization, the centralized and standardized way of data storing enabled on the fly data conversions in several common data formats for the analysing and further processing with external software. This way, easy data access for all participating people was ensured. Moreover, data protection and long term availability are extremely simplified with this centralized and standardized way of data storage.

In the run of the project, we were able to accomplish the implementation of a functional data management tool with low costs and within a very short time frame.

### Producers

The study shows that food insecurity is currently not an issue for the interviewed farmers in periurban Bangkok. None of the farmers suffered from hunger. Even extreme weather conditions pose only minor challenges to the farmers. This conclusion refers only to the farmers' households in the periurban region and not to the overall population of Greater Bangkok. In the future, however, various environmental changes might endanger the food supply of the urban and the periurban areas, especially regarding vegetables:

- Available arable land in periurban Bangkok is being reduced by urban sprawl respectively by the ongoing development of settlement compounds. Rising prices for development sites might seduce farmers to sell their arable land.
- Global climate change may increase the likelihood of extreme weather events such as higher temperatures, droughts, heavy rainfalls and floods.

- Aging farmers and the unwillingness of the younger generation to work as farmers might cause a different land use of formerly cultivated land.

In general, variables influencing the farming system are household size, age, skills and education of the farmers, economic circumstances, certification and mainly the location of the farms.

The results show that the dynamic and heterogeneous characteristics of the Greater Bangkok area developed different types of communities. The collected data allow a very good understanding of the research sites regarding the spectrum of the cultivation, especially for vegetables, the marketing systems of the farmers, the socioeconomic structures, the agricultural practices, and the influences on agricultural production.

The study shows that the periurban area contributes significantly to the food system of Greater Bangkok by supplying it with fresh fruits and vegetables.

The study provides sufficient data for a classification of small scale land use based on a remote-sensing approach, thus allowing up scaling to larger area.

## Markets

The findings show that wholesale and local markets play a major role for food and nutrition security in the Greater Bangkok Area. The comparison with the results of the producer and consumer survey shows that wholesale markets like Talad Thai and Si Mum Muang are important linchpins in the complex food supply chain as producers deliver their products to Si Mum Muang or Talad Thai and local markets and street vendors buy the products there to sell them again all over the city. The study identified origin of most of the traded vegetables (Fig. 9) and to some extent as well the destination of vegetables within the system.

52% of products from Si Mum Muang Market stay in the Bangkok Metropolitan Area and 85% in the Greater Bangkok Area (including surrounding provinces). Lots of products come from the North and Northwest of Thailand but a considerable share of mostly perishable, leafy vegetables is also grown in the periurban area around Bangkok. This again proves the importance of periurban agriculture for food and nutrition security of a megacity like Bangkok.

According to the merchants one of the most important quality criteria for vegetables is the level of pollution with pesticides. A big problem here is that non-toxic (or less toxic) vegetables can be exported for example to the European Union, whereas highly polluted and toxic vegetables are mainly consumed in Thailand.

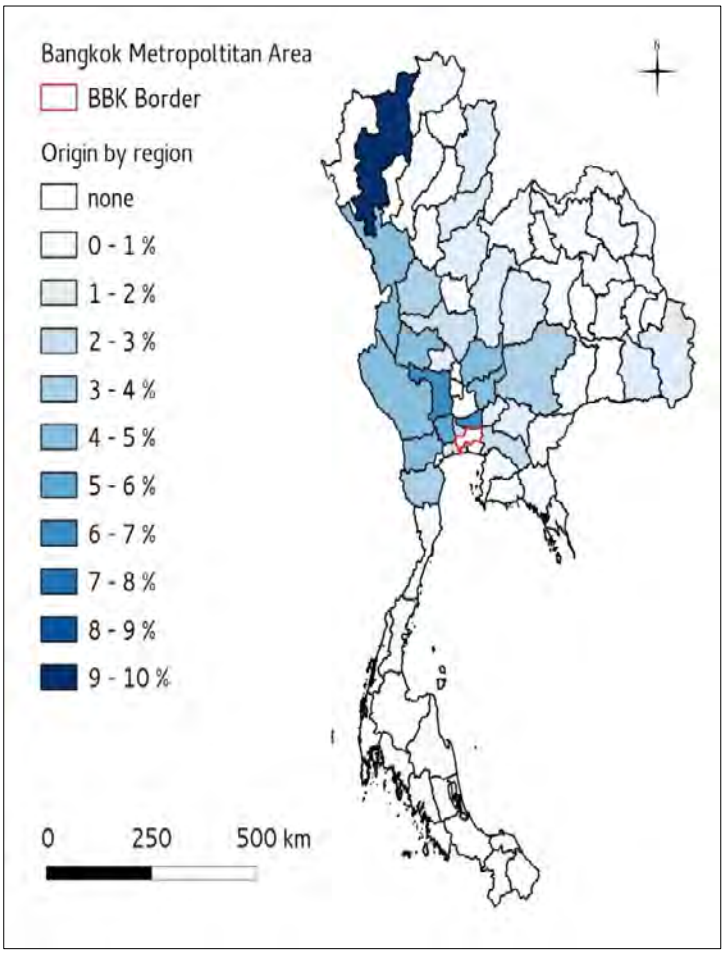



**Figure 7: Origin of all 156 recorded vegetable species by regions of Thailand traded at Si Mum Muang and Talad Thai in Bangkok**

## Community gardens

All gardens examined are based on the principles of mutual aid and solidarity. They are actively supported by specific communities. According to the different forms of support and different origins four types of gardens were identified: 1) district office garden and learning centres; 2) learning centres managed by NGOs; 3) community gardens supported by district offices; and 4) independent community gardens. Whereas the gardens of type 1 and 3 are dependent on district office support, the gardens of type 2 and 4 are self-organized bottom-up initiatives. This typification of the different gardens illustrates that community gardens in Bangkok are not always bottom-up but also top-down initiatives coordinated at district level.

Another important result of the study concerns the aspect of food safety. Vegetables produced and sold in Thailand are assumed to be contaminated to a high degree with pesticides, which is perceived as a health risk by many people. Therefore, the majority of the people interviewed named food quality and the health issue as the main motivation to participate in urban gardening projects. What motivates people to engage in community gardening is not so much food and nutrition security in terms of quantity, but security in the sense of quality and health.

Urban gardening in Bangkok is not a phenomenon among the poorest people in the city but includes the poor. Nearly half the sampled group has to deal with a monthly income significantly lower than the Thai average income. Low-income

groups like housekeepers, retired or unemployed persons as well as students make up about one third of the sample. Higher incomes are found among the officers who represent almost one quarter of the respondents.

Remarkably, most of the people being active in community gardening have a fairly high educational background. Here it becomes evident how profound education from schools, trainings or even universities goes hand in hand with the increased ecological awareness among the interviewees.

Although, urban gardening is not a new activity, nearly half of the interviewees got involved in gardening during the last year, almost a quarter of them have been involved in it for more than five years. Clearly visible in these numbers is a positive trend towards gardening in the city. This is also confirmed by the high demand for trainings regarding urban agriculture and the production of organic fertilizer.

### Street vendors and consumers

By categorizing street food vendors into different categories such as for example age groups, booth types, male and female vendors or by type of sold products it was possible to gain a more detailed and sophisticated view of this business. Street vendors are a typical “urban” phenomenon; they play a much lesser role in peri-urban areas of Bangkok. From the observed 103 street vendors, 30 different vendors are selling fruits, 30 are selling all kinds of dishes and meals and 33 street vendors are selling non-processed vegetables, which are all together embedded and linked with three markets, namely Pak KlongTalad, KhlongToey Market and Mahanak Market. 30 different vegetable species and 12 different fruit species are sold in 10 different locations which have been surveyed. Complicated systems of fee regulations, divided by location, booth types and administrations are hard to comprehend even after the survey.

The important role of street vendors for Bangkok´s food supply has been demonstrated in the consumer survey. Nearly two out of five consumers buy street food for lunch and circa one of three for dinner. But most frequented by consumers - independent on their sex and age - are local markets, though at some local markets street food vendors are selling as well. Most relevant for consumers is “the closest possibility to buy food”, this fact highlights the great local value of street food vendors which are to find all over Central Bangkok.

Vegetables and fruits are essential for Bangkok´s food system. At least three out of four people, regardless of the sex and age, consume vegetables minimum every day. Fruits are eaten by every second consumer at least once a day. Among the most eaten vegetables the majority we find cucumber, kai-lan (Chinese kale), head cabbage, carrot, kangkong (water spinach or water morning glory), pak-choi (leafy cabbage), coriander, tomato and eggplant.

Our data underpin the importance of indigenous vegetables in the local food habits with more than 150 different vegetable species being traded in Bangkok markets. More than one fourth of the respondents grow their own vegetables and fruits. In this way they improve their food and nutrition security even if most of them cultivate on a small scale.

The common challenge for consumers in vegetable usage is assumed to be the price. The major issues concerning positive aspects of vegetables are the freshness, followed by the appreciation of organic vegetables, price, cleanliness and good quality at all. Contrary to the expectation the price would be the fundamental argument for the buying decision, consumer rather prefer fresh and healthy vegetables.

Besides the mere scientific results of the study, this pilot project has influenced a large number of German and Thai students and researchers, trained in getting access to the important question of food and nutrition security and nutrition in a megacity of Southeast Asia. Vegetables have largely been overlooked in the past and one goal of this pilot study was to make vegetables in Thailand more visible.

## ASSESSMENT OF RESEARCH FINDINGS

With Bangkok being representative for rapidly urbanizing Southeast Asia, the innovative methodological approach and corresponding research findings of this pilot project have contributed significantly to make the role of vegetables in a megacity's food system more visible, which are often overlooked in traditional approaches that focus on carbohydrate rich staples only. With the continued population shift from rural to urban areas in Southeast Asia, increasing and changing demands for food will have strong but unpredictable effects on rural and urban livelihoods. In the past three decades, Southeast Asia has achieved significant economic progress, which, however, has not translated into improved nutrition in a number of the countries of the region. While these countries continue to deal with the problems of infectious diseases and undernutrition i.e. deficiencies in energy, protein, essential vitamins and minerals - they are at the same time experiencing an upsurge in non-communicable disease risk factors such as obesity and overweight, particularly in the rapidly increasing urban settings, a phenomenon that is dubbed as "triple burden of disease". To ensure safe, nutritious and culturally appropriate food is available, accessible and affordable year-round is one of the most pressing concerns in the region, a situation that is aggravated by climate change, which poses a major risk for the region and exacerbates existing development problems such as population growth, rapid urbanization, increasing competition for natural resources, and environmental degradation.

Vegetables production in urban and peri-urban areas of Southeast Asia are one of the interventions that have the potential to improve food and nutrition security in the region, generating additional income, contributing to better health, and promoting gender equity. Home and community gardens can provide a wide variety of fruits and vegetables throughout the year, thus contributing significantly to not only a nutritious diet for family members but also offering opportunities for income generation through sale of extra produce. Results show the importance of peri-urban areas to supply nutritious food as well as the major challenges for vegetable producers, namely biotic and abiotic stress factors such as diseases and pests as well as unfavorable weather conditions which can be addressed by the research agenda of AVRDC and its partner agencies. The usage of a GIS-based Collaborative Research Environment (CRE) proved to be essential to understand the complexities of urban food systems, particularly those of mega cities. The use of an object-based classification approach using so-called eCognition software to detect vegetable production sites proofed to produce highly accurate results and has great potential for upscaling.

### Future research needs

In a small pilot project designed to develop appropriate methods, not every aspect of the food system could be highlighted accordingly. Regarding the importance of vegetables for food and nutrition security further research on the provision and quantification of micronutrient flows is needed. The project has shown that mapping of larger vegetable growing areas is possible, but up-scaling still needs to be done. Food safety and hygiene are other factors to look at, especially in the context of street vendors but all along the food chain. Although so far not considered is the aspect of

food losses and food waste from the producers to the consumers and beyond. It is suggested to also include other commodities of the food system into future research, which are often overlooked in traditional approaches, such as fruits, herbs, mushroom and fish.

## SUMMARY

This project looked at four components of the overall food system: Smallholder vegetable producers, community gardeners, markets, consumers and street vendors. In order to better understand the linkages and importance of each of these components a so-called pilot Collaborative Research Environment (CRE) was developed. The core of the CRE consists of a central, spatially enabled database and a range of associated tools for distributed data entry, for remote and real-time monitoring of the incoming data, for data analysis, and last but not least for data presentation. The tools include the required Geographic Information System (GIS) functionality for spatial analysis and map-based visualization.

In the pilot study the data included in the CRE comprises empirical data from different sources such as questionnaires and surveys, spatial information on production areas in relation to vegetable diversity as well as information on producers, traders and consumers.

Some results concerning the different target groups:

The producer survey shows the importance of market demands and prices influencing the decisions on which kind of crops and vegetables are grown. Other important factors here are farmers' skills and habits as well soil and water conditions. All those are strongly interrelated. Plant diseases and pests as well as climate and weather conditions are identified as major challenges for the vegetable producers. However 47% of the Producers produce more than ¾ of their self-consumed vegetables. For the community gardeners' urban gardening in Bangkok is not about food security in the sense of essential food provision: More than 70% of the interviewees never face difficulties in providing enough food for their family and around 20% rarely do, mainly because of poor harvests. However, a lot of the interviewed people refer to the problem of chemical pollution of market vegetables.

Wholesale and local markets play a big role for food and nutrition security in the Greater Bangkok. About 52% of products from Si Mum Muang Market stay in the Bangkok Metropolitan Area and 85% in the Greater Bangkok Area (including surrounding provinces). Many products come from the north and northwest of Thailand but a considerable share is also grown in the peri-urban area around Bangkok. A number of perishable products like e.g. lettuce and kale are mostly grown in the proximity of the megacity. This once again proves the importance of peri-urban agriculture for food and nutrition security in Bangkok. More than 70% of the local markets and over 50% of street vendors and restaurants buy at wholesale markets Si Mum Muang and Talad Thai.

Regarding consumption, the survey identifies clear differences between men and women. Vegetables are eaten by 65% of male and 80% of female participants. 41% of the male and 51% of the female interviewees eat fruits. For milk products the distribution can be grouped into 32% male and 41% female consumers. 65% of men and 70% of women eat meat minimum every day. Fish/seafood are eaten 24% by men and 28% by women. It is noticeable that women are consuming all food groups more frequently. Other differences get obvious looking at different age groups. It gets clear that food habits are changing. Regarding food purchase and consumption, local

markets are of extraordinary importance in Bangkok. The most common challenge for consumers in vegetable usage is the price.

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