Innovation Characteristics for Sustainable Metropolitan Agriculture

Spatial-Functional Perspectives for TransForum Innovative Projects

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SUSMETRO Phase 1 Final Report
(Definition, Spatial Vision and Outlook)
- Full Report -

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1. Introduction

1.1 Research context and project objectives

The proposed research project SUSMETRO attempts to assess the social, economic and environmental impacts of TransForum's vision for metropolitan agriculture on sustainable land use primarily in the Netherlands, but also in similar Northwest European regions. The need for undertaking sustainability impact assessments derive from both national [quote] as well as European legal requirements. The project is hence designed to upscale selected TransForum findings to the national level and to examine the expected impacts on sustainability in the context of the most recent European studies on future land use change scenarios. TransForum results will serve both as a benchmark for an innovative, bottom-up strategic approach towards agricultural renewal as well as a test case for the adequacy and reliability of current EU top-down assessment procedures. SUSMETRO is expected to provide targeted input by (1) developing spatially explicit definitions of metropolitan agriculture based on TransForum principles, (2) running future scenarios for metropolitan agriculture linking TransForum's trans-disciplinary KOMBI approach with existing state-of-the-art EU Impact Assessment Tools for sustainable land use; and (3) presenting a variety of design proposals for metropolitan regions by means of graphic and digital visualization techniques. The project will largely draw upon selected TransForum Innovative Projects, recent national research on the rural-urban context and on European integrated projects.

Two large-scale EU-funded Integrated Projects (IPs) belonging to the recent generation of initiatives stand out:

- SENSOR (Helming et al. 2008), a project linking macro-economic and sector models (e.g. CAPRI for agriculture) to assess policy-driven land use changes and their social, economic and environmental impacts in European regions, and
- SEAMLESS (Van Ittersum et al. 2008), a project developing a computerized and integrated framework for assessing how future alternative agricultural and environmental policies affect European agriculture and whether and how such policies contribute to sustainable development at large.

Since the Dutch involvement in these IPs and EU projects is significant (conceptual guidance, tool/software development, field and farm modelling and scaling methods) offering access to various Intellectual Property Rights on the one hand, and a strategic European research position on the other hand (also facilitated through Alterra's role within PEER[3]), a close liaison with TransForum appears not only timely, but also imperative:
In addition, the EU project FARO (led by Alterra) on developing foresights for Europe's rural areas and the project LUPIS (led by LEI) on 'Land Use Policies and Sustainable Development in Developing Countries the project will adapt integrated assessment tools for sustainable development to be applied by scientists in a selected number of developing countries. Attention will be given to both natural and agricultural ecosystems.

[3] PEER = Partnership for European Environmental Research, a network initiative including leading European research partners such as UFZ (Germany), Cemagref (France), CEH (United Kingdom), JRC-IES (European Commission, Italy), SYKE (Finland), NERI (Denmark), see also www.peer-initiative.org

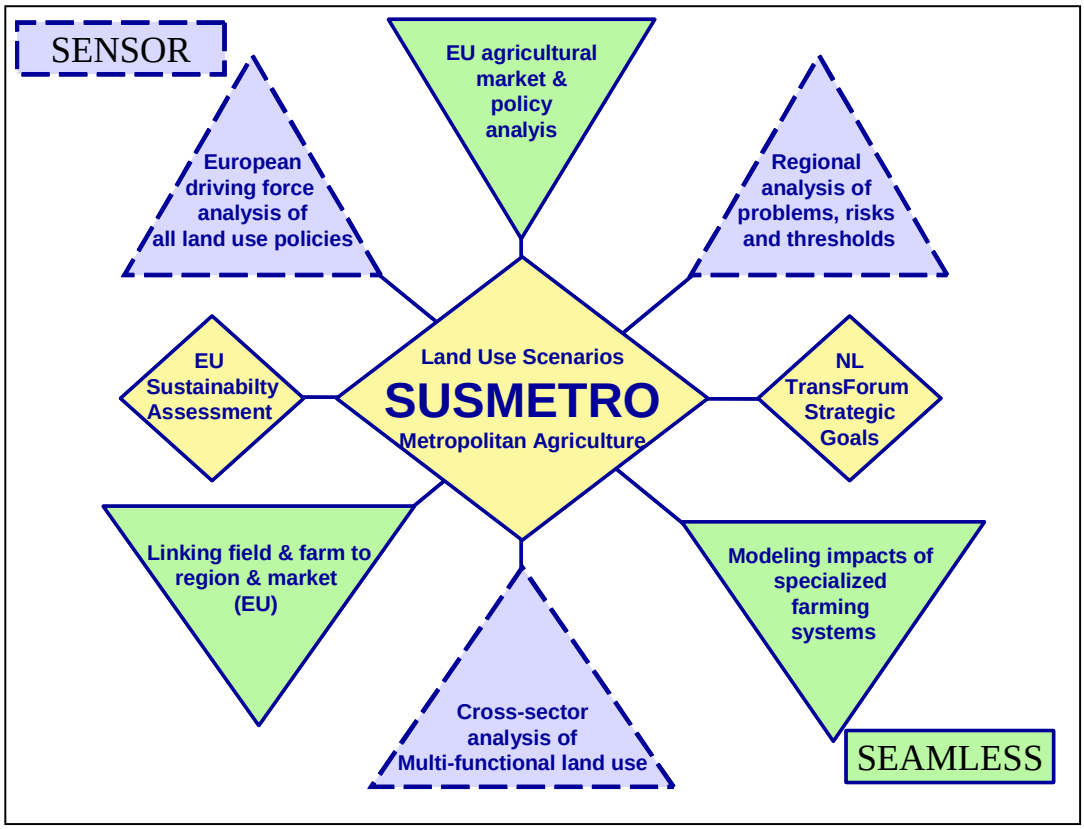


Figure 1: Key research contributions of the IPs SEAMLESS and SENSOR to TransForum in the light of EU sustainability assessments and the special role of metropolitan agricultural regions.

The objective of TransForum's scientific program is threefold; (1) it addresses research questions raised in the innovative projects; (2) it investigates the need for system-innovations and the way in which they can be realized; (3) it designs research projects to test the 5 main working hypotheses of the program. More specifically, SUSMETRO is meant to assess TransForum's national strategic goals by targeting and applying recently developed European tools while at the same time providing input to the current knowledge infrastructure (KIS) at both the national and international level. SUSMETRO is hence set up as a complementary and synergistic project that supports TransForum's strategic goals at various levels:

(1) Vital clusters: in order to overcome the segregation of different agro-sectors and their associated societal structures, the concept of so-called 'vital clusters' has come to life by proposing agro-parks that act as technological, infrastructural and economical hubs. The proposal's focus on metropolitan agricultural landscapes of delta-regions provides the adequate spatial and scientific context when testing policy cases and simulating sustainable options for the future. The EU project SEAMLESS offers a range of scaling methods, to link analyses at field, farm, region and market (EU) scales to support TransForum's goals;

(2) *Regional Development*: in essence, this strategic goal mirrors the EU's recent reform of the Common Agricultural Policy by putting much emphasis on multi-functional land use objectives for rural development. Especially the EU project SENSOR thrives upon a strong regional research component in which the simultaneous performance of various land use functions is key to the strategic approach. Regional sustainability thresholds,

regional forms of landscape governance and regional spatial reference frameworks belong to the innovative set of tools that shall be further developed towards their application for metropolitan agricultural areas.

(3) *International Agro-food Networks:* the strategic goal of fostering the Dutch role as an international knowledge broker and organiser in the agro-sector can only be achieved if a coherent view on European and national sustainability is backed by assessment criteria (indicators) and design principles (policies) that take into account aspects such as the ecological footprints and the wider context of the international market (WTO). Both SEAMLESS and SENSOR are based on modelling capacities that can measure macro-economic trends as well as regional dimensions of land use changes, e.g. through a range of state-of- the art quantitative models. The analytical capacity of individual research tools and their integration in the SEAMLESS and SENSOR impact assessment frameworks will be used to identify new pathways of sustainability as part of the TransForum strategic spectrum.

By focusing on metropolitan agricultural land use of delta regions (typical for the Netherlands, but also relevant in similar zones inside and outside of Europe) SUSMETRO thrives to fill an important gap in the sensitivity spectrum of current state-of-the-art Sustainability Impact Assessment tools at the European level. By doing so, new functional linkages and synergetic processes will be identified for further developing the knowledge infrastructure for the agro-sector at both the European and national level.

1.2 Background: recent trends in Dutch agriculture

When looking at the future of Dutch agriculture, several things should be noted. Agriculture it is the main land use for the Netherlands using more than 50% of the space (CBS, 2009a). Changes to agriculture therefore have an incredible impact on the landscape (Holtslag, 2009).

Several problems emerged during the last two decennia (1990-2009). One of the problems is the succession of farmers. The number of people willing to take over a farm is declining (CBS, 2009b) and will lead to a further reduction of farms. The land owned by these farms can either be bought by surrounding farmers who want to enlarge their company, or will be used for other developments. Therefore it can be expected that in the future less and bigger farms remain. A second problem for the agriculture is the high land prices in the Netherlands. Agrarians have a hard time raising funds for new land when scaling up to remain competitive, especially when the land is in vicinity of the city. Often these grounds are purchased by property developers trying to cater to future spatial development or the government buying ground for nature, water detention or recreation purposes. A possible solution lies in the combining of several functions, or the intensifying the land use on a smaller area (Hidding & Brink, 2006).

Because of the changes in other land uses and trends within the agricultural sector, three developments can be observed: One towards large-scale agriculture. Clusters and Greenport's are developed to reduce transport kilometres and thus reduce costs. Also combining research facilities and processing industry leads to synergy within production processes (Holtslag, 2009). A highly efficient, intensive and large-scale agriculture should be able to compete on the world market (Greenport(s) Nederland, 2006; Smeets et al., 2007). A second possibility is the specialisation on regional or biological production. The last possibility is the development towards combination of multiple land uses. Besides farming

these could be recreation, healthcare, childcare, education etc. All three forms can be implemented in parts of the ISPDB plan (ISPDB, 2009).

1.3 TransForum's Vision of Metropolitan Agriculture

As a world leader in the development and establishment of agricultural production systems, the specific geographic and socio-economic characteristics of the Netherlands as one of the global Delta-Metropoles with a large area of peri-urban landscapes pose both challenges and opportunities when setting targets for sustainable development. During the last years, Dutch agriculture has been exposed to a series of challenges at the social, economic and environmental front: severe cases of swine-fever, air and water pollution by excess manure production and disposal as well as decline of traditionally managed landscapes including the associated recreational and biodiversity values. TransForum has been established to accompany the process of Dutch agricultural restructuring with innovative and forward looking strategic support. While TransForum succeeded in launching and supporting a series of Innovative Projects pursuing these goals, the midterm review recognized a certain fragmentation of efforts. The projects' diversity in terms of scale and contents makes it difficult to understand what impact they will have in terms of sustainable spatial development. Yet, by putting forward the concept of metropolitan agriculture, other contemporary perceptions of Dutch landscapes are being challenged. Has the influence of metropolitan agriculture already changed the associated landscapes to a degree that they themselves must be considered as metropolitan? When examining TransForum's project history and mission statements, it becomes clear that the notion of *metropolitan agriculture* though central to the TransForum's vision, has not yet been established in a transparent and broadly understandable – let alone scientifically robust – way. TransForum considers metropolitan agriculture as "*a deliberately designed system of intelligently connected* [agricultural] *production sites that uses the available resources, conditions and infrastructure in metropolitan areas to produce material and immaterial demands for the same metropolitan area* "(Latesteijn 2008). This description suggests:

(1) spatial-functional entities with boundaries which are determined by system integration at the production level thereby defining what constitutes a metropolitan area;
(2) sustainable principles, namely the limitation of agriculture's ecological footprint by promising to use only those resources, conditions and infrastructure that are available in the same area of demand;
(3) a multifunctional approach by covering society's material as well as immaterial demands (commodity and non-commodity goods and services).

Given that virtually all agricultural production systems within the European Union – and certainly those in The Netherlands – are extremely dependent on external resource input (e.g. fossil energy, nutrients and soya-based food stuff for livestock to name just the most prominent), and given that most metropolitan areas are widely recognized by characteristics such as peri-urban settlement structures, accessibility to centres of higher education, hospitals and cultural facilities, and by the presence of leisure and nature parks, TransForum's vision must be considered as rather hypothetical or even virtual – or as mainly a business model. The vision is 'hypothetical' because the above principles are not yet applied and can be considered 'virtual' because such metropolitan areas only exist as logistic and process-dependent configurations without clearly defined spatial boundaries and are not

necessarily perceived as such by the occasional visitor or non-expert. At the same time, the above definition does not adequately address the wider international aspirations of Dutch agriculture, namely those projects which target international food chains or the establishment of large-scale 'vital clusters' in the form of Greenports. These TransForum projects go beyond the respective spatial-functional entities considered as metropolitan areas, but seek to link up with the supra-regional and global food market (Nassauer and Wascher 2007).

On the other hand, current trends in Dutch agriculture indicate that tremendous changes have already occurred in the wider countryside around metropolitan centres and that it would be ignorant not to acknowledge that the rural areas as we know them from the past ceased to exist decades ago. The influence of the city on surrounding agricultural production landscape has steadily increased in many ways. In the Netherlands, with the traditional segregation between nature conservation on the one hand (spatially manifested in the implementation of the Ecological Main Structure) and highly intensive agricultural land use on the other hand (manifested by extremely high livestock densities, large-scale glasshouse productions and by high-tech and high-input farm management), certain elements of TransForum's vision such as concentration, segregation and modernisation are indeed already recognizable since quite some time. But TransForum's vision goes beyond the achievements of the past. Especially in the Southern provinces of the Netherlands such as Limburg and North Brabant, the new trends towards more multi-functional agricultural land use become visible. Here the transition away from mono-functional intensive pig farming towards multi-functional landscape services targeting at rapidly expanding urban populations has created the types of building blocks for TransForum's metropolitan vision.

But before exploring the spatial attributes of this vision, we first will make an effort to better understand the phenomenon of metropolitan agriculture by reviewing the notion of system innovation in the light of the triple-P-concept, thus People, Planet and Prosperity. The underlying motivation for doing so is that if metropolitan agriculture is meant to become a widely recognizable concept for understanding, managing and planning the production of agricultural goods and services in and around cities, it will require a clearer definition in terms of its spatial and operational boundaries.

2. Characteristics of Metropolitan Agriculture

2.1 The Role of the City

Outside the Netherlands, and even within various Dutch expert networks and interest groups, the term 'Metropolitan Agriculture' is not very much established at all and evokes only a vague understanding of the underlying meaning. In contrast, the concept of 'urban agriculture' is rather well known and immediately understood as different forms of citizens' engagement in producing food in community or allotment gardens of different types (Anderson, 2009)

Comparisons across different urban centres of the world show, that the phenomenon of urban agriculture is (1) expanding in terms of area percentage and number of actors, (2) is sometimes associated with the stigma of socio-economically under-privileged neighbourhoods, and (3) is receiving increasingly institutional support from public and private sources. While the general perception of urban agriculture is more or less along the above lines, relevant sources address urban agricultural in a clearly wider context:

"*An industry that produces, processes and markets food and fuel, largely in response to the daily demand of consumers within a town, city or metropolis, on land and water dispersed throughout the urban and peri-urban area, applying intensive production methods, using and reusing natural resources and urban wastes, to yield a diversity of crops and livestock.*" (UNDP)

Urban agriculture can be defined as the growing of plants and the raising of animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs, and the processing and marketing of products. Urban Agriculture is located within or on the fringe of a city and comprises of a variety of production systems, ranging from subsistence production and processing at household level to fully commercialised agriculture (van Veenhuizen 2006)
(http://www.idrc.ca/openebooks/216-3/)

The above definitions are clearly expanding the notion of urban agriculture economically towards 'fully commercialised agriculture' and spatially towards the wider peri-urban regions outside cities. Given the substantial differences between the essentially small-scale, inner city and subsistence-oriented initiatives and the more commercial, high-tech and (supra-)regional dimensions it seems not only justified, but very reasonable to set the two phenomena apart by calling the first 'urban' and the latter one 'metropolitan' agriculture. It seems that metropolitan agriculture could include urban agriculture, but not vice versa. The principal attribute of metropolitan agriculture is a specific combination of highly intensive (both land bound and land-independent agricultural production systems) and fragmented patches of low-input farms with recreational and environmental values in the context of dense (peri-) urban, infrastructural – or *metropolitan* – landscapes.

Table 1: Characteristics of Urban vs. Metropolitan Agriculture

	Urban Agriculture	Metropolitan Agriculture
Location-extend	Inner-city or direct urban fringe, any city (example: Wageningen, Antwerp, Cologne)	Urban fringe, surrounding peri-urban regions forming larger metropolitan areas (sometimes cluster of cities) as well as spatially remote farmland(clusters), functionally connected with metropolitan centres (examples: Randstad, Brabantcity, Ruhrgebiet, Antwerp-Brussels)
Mission/purpose	• Providing high-quality (fresh) food for low prices • Social responsibility and networking • Support and training for handicapped • local/regional opportunities for linking rural with urban populations; • Create added value • Create close ties with conscious, critical and committed consumers	• Largely commercial production, processing and marketing of products. • Focus on innovative, high-tech, efficient production systems; • Logistics, communications and infrastructure are key • aiming at large consumer groups/distributers;
Type and character of farming	• Focus on small-scale farming; • Vegetable & fruit production dominates • Changing production schemes • Direct consume • small lots and small amounts • Season- and region-dependent, but most of the year • Labour intensive • Often organic, always based on sustainability principles • Largely visible and accessible (though backyard farming less) • If commercial, generally small scale, characterised by niche production, rather than mass market production	• Wide range of agricultural products, in fact all supermarket products where there is demand for; • Includes intensive conventional farming, including large-scale diary farming ('megastallen'), glasshouse cultivation, vital clusters/greenports • Highly diverse in terms of product, specialization and niche function • Labour extensive • Metropolitan context not immediately clear (footloose, indoor, markets unclear)
Actors	• Urban dwellers, neighbourhood initiatives • Co-operations • Interest groups (NGOs) & social initiatives • Farming animators, • Environmentalists • Government: municipal, state, and/or national	• Little, but highly specialized (trained) workforce • Entrepreneurs, engineers, horticulturists, managers • Farming lobby/associations • Government/landscape protection agencies
Business dimension	• Generally low ambition (frequently subsistence) • Link between restaurants and farming – new networks and business opportunities; • Farmer's markets as a trendy urban phenomenon;	• Generally high ambition (international competition, profit oriented) • Seeking cooperation with equally big commercial partners (e.g. supermarket chains, energy companies) • Experimental, science-oriented

Land use and landscapes	• Open (abandoned/'in-waiting') lots within cities; • Allotment and community garden (frequently park landscapes) • Backyard/private gardens • Poor neighbourhoods/outskirts of large urban agglomerations (sometimes ghetto-style) • Developing spontaneously, unplanned	• Open agricultural landscapes around and within peri-urban surroundings • All levels of intensities (crop, grassland), including footloose production systems • Cultural landscapes that are managed to serve urban needs.
Sustainability	• Multi-functional urban land use (thereby addressing PPP aspects) • Reducing ecological footprint (focus on regional products, direct consumption) • Local wildlife support • 'Greening' of the city	• Multi-functional peri-urban or quasi-rural landscapes • Energy landscapes (biofuels, wind- and sun energy installations) • Integration of social (care farms), recreational and ecological qualities • Highly controlled design principles • Greenports and other clustering models reduce agricultural footprint and can be energy-neutral
Institutional dimension	• In Europe only occasional governmental support • Tradition of allotment gardens build into some national legislations (e.g. Germany's "Kleingartengesetz)	• National (spatial) planning agencies • Financial sector (banks, investment funds) • Regional stakeholders from private enterprise and governance

Given the substantial differences laid down in Table 1, one might be tempted to raise the question whether this is not a comparison between 'urban agriculture' with conventional agriculture. Or, taking land cultivation history into account, whether urban agriculture does not simply stand for an evolutionary earlier, more primitive phase of farming after humans had abandoned their existence as hunters and gathers and experimented with first farming activities. However, this would not pay justice to the societal functions and levels of sophistication in which urban farming is being practiced, nor does it acknowledge the key attribute of metropolitan agriculture, namely the vision of *sustainable and largely self-supportive system-networks* at the scale of larger metropolitan regions.

Figurer 1a schematically illustrates the fundamental differences between urban and metropolitan agriculture in terms of labour intensiveness, economic-operational area coverage and size of the associated consumer group. As one can see, the two are rather opposite of each other and therefore partially complementary. As mentioned earlier, the metropolitan agricultural system as laid-down in TransForum's definition and described in Table 1 still does not exist in reality and therefore we lack empirical information on such figures. It is very likely, that metropolitan agriculture will – at least for a long period of time not be able to take up the role that is being described in Figure 1 and that conventional agriculture as we know it from the presence will continue to play a dominant role. Figure 2 projects the same metropolitan agricultural vision in the context of the current and future role of conventional agriculture. According to this scheme, conventional agriculture – understood as of large ecological footprint due to external resource dependencies in terms of access food-stuff, nutrients and transport energy import - is going to be substituted by the concept metropolitan agriculture. The role of urban agriculture is not examined here in further detail.

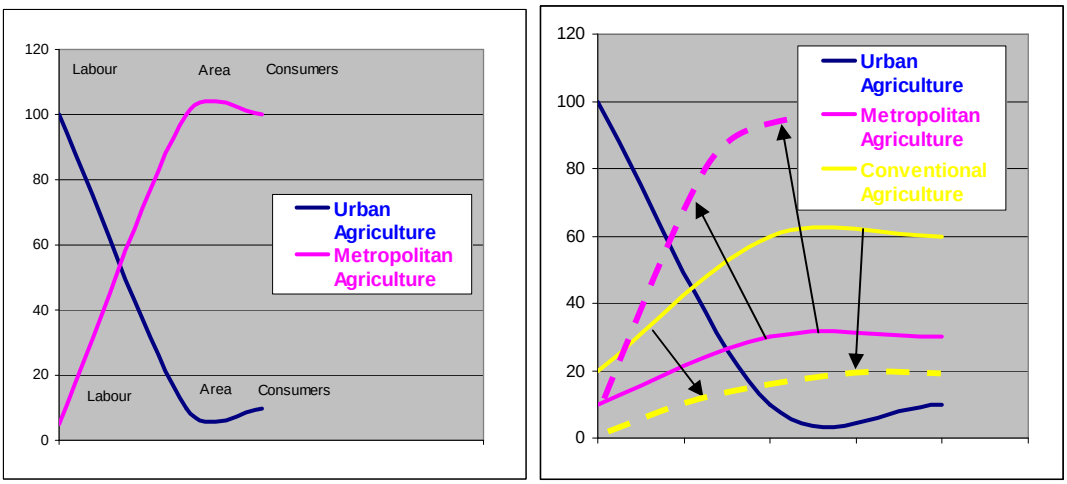


Figure 2a) schematic comparison of Urban with Metropolitan Agriculture in terms of labour force, area coverage and consumer numbers as approximations (result vision); Figure 2b) same comparison with inclusion of conventional agriculture, indicating expected changes when implementing Metropolitan Agriculture (trend vision)

As the focus of this project is on metropolitan agriculture, we are not going to further examine aspects of urban agriculture. As mentioned earlier, the two concepts can be easily – and possibly ideally – envisioned in combination.

In this respect, the following observation requires special project attention:
The official *profiling* of the goal setting is visionary in terms of scale, spatial design, technological innovation, and international model function. The projects – in contrast – are rather heterogeneous with emphasis on stakeholder-driven processes in regional portfolio, and Greenports as vital-cluster approach. With regard to the science context, the focus is on images and inventions of sustainable development, and on cooperation between actors (stakeholders/) and the behaviour of these same actors.

2.2 Multifunctional vs. Industrial Agriculture

Multifunctional land use has been heralded as one of the sustainable alternative to industrial agriculture. It is based on the idea of simultaneously producing commodity and non-commodity outputs, thus services for non-marketed landscape goods such as recreation, education, environmental conservation, buffering and mitigation of pollution. On the other hand, industrial agriculture is considered to focus entirely on commodity outputs and to have severe negative effects on ecological and social systems (Horrigan et al. 2002).

Regarding the origins of the multifunctional land use concept, the summary report on the Conference on the Multifunctional Character of Agricultural Land in Maastricht (IISD 1999) refers to Chapter 14 of Agenda 21, the 1992 United Nations Conference on Environment and Development (UNCED) and more specifically at the establishment of a framework for the consideration of integrated land management and sustainable agriculture and rural development (SARD). Later OECD (2001) and the European Commission (CEC 2003) took

up the concept of multi-functionality, however strictly with reference to agricultural land use. Wiggering et al. (2006), stressing the need for societal and monetary valuation for non-commodity outputs, sees a close link between multi-functional agriculture on the one hand and multi-functional landscapes on the other hand, thereby defining landscape per se as a multi-sectoral phenomenon. In this interpretation, shortages with regard to non-commodity outputs (e.g. biodiversity, aesthetically pleasing landscapes) create a new "market potential" for farmers receiving financial (though mainly public) support when offering multi-functional land use.

In the SENSOR project implementation, the concept of functions was initially presented as a paper by Hein & de Groot (2005), outlining the possible adaptation of ecosystem function as developed for the Millennium Ecosystem Assessment (Hassan et al. 2005) to become the blueprint for landscape functions. However, given the discrepancies with the anthropocentric approach to multifunctionality and in the absence of scientifically stable alternative concepts rooted in landscape science, SENSOR adapted a pragmatic solution by identifying 9 key *land use* functions (see Table 2). Though in essence anthropocentric, this land use based approach offers the opportunity to engage in a stakeholder-friendly, quantitative, fact-finding assessment on the simultaneous provision of functions associated with different land use types. This allows SENSOR to deliver operational solutions in the assessment of multi-functional land use, a field that has yet been largely dominated by theoretical or site-specific research activities. A further achievement is the broadening of the multifunctional approach to include also other sector than agriculture. In fact, each sector is meant to be scrutinized regarding the multi-functional performance on the land.

Table 2: SENSOR's 9 Land Use Functions (Perez-Soba et al. 2007)

Functions Mainly SOCIETAL	**Functions Mainly ECONOMICAL**	**Functions Mainly ENVIRONMENTAL**
Provision of work Employment provision for all, according to activities in relation with natural resources ; quality of jobs, lack of job security, localisation of jobs (constraints / commuting)	**Residential and non land based industrial and services** Space where residential, social and productive human activity take place in a concentrated mode. The utilisation of the space is mainly irreversible due to the high concentrations of the buildings	**Provision of abiotic resources** Space used for infrastructures that determine changes which are irreversible
Human health & Recreation (spiritual & physical) Access to health and recreational services and factors that influence services quality	**Land based production** Human productive activities that determine changes which are mainly reversible (agric, for, natural energy sources, land based industry -mining).	**Support & Provision of habitat (biodiversity, gen pool)** Factors affecting the capacity of the land to provide biodiversity, from the genetic diversity of organisms to a diversity of habitat in the landscape that are in suitable ecological condition.
Cultural (Landscape identity (scenery & cultural heritage) Factors influencing the	**Infrastructure**	**Maintenance of ecosystem processes.**

appreciation of landscape aesthetics quality and local culture valorisation	Space used for infrastructures that determine changes which are irreversible	Capacity and factors affecting to vital processes such as water purification, nutrient cycling, etc…)

Since Transform aims to make a substantial contribution to the transition towards more sustainable development of Dutch agriculture, multi-functionality must be considered as one of the assets of innovation. However, one of TransForum's strategic goals, namely the establishment of so-called vital clusters aims at new forms of industrial agriculture – though also addressing sustainable objectives. What both concepts hence have in common is that they are both focused on innovative ways of integrating agricultural production into metropolitan systems. At the same time, both concepts have very different characteristics (Table 3) and are based on a different set of value propositions and sustainable principles. The concepts appear to be, at least spatially, incompatible.

Table 3: Different characteristics of Industrial Metropolitan Agriculture and Multifunctional Metropolitan Agriculture

	Industrial Metropolitan Agriculture	**Multifunctional Metropolitan Agriculture**
Principles of production	Innovation, Efficiency, interlinking flows, highly productive, large scale	Creating added value, combining functions, meeting consumer demands, highly productive
Spatial characteristics	Clustering / concentration of production flows	Interdependence of urban & rural land uses; contrast between rural and urban characteristics. Highly accessible for consumers
Scale of production	Preferably large scale	Often small scale
Spatial requisites	Accessibility, Transport	Identity; direct links with consumers; landscape values
System	Closed / protected	Open – rural-urban interaction is essential
Starting point	Production process	Regional characteristics; consumer-producer relation
Producer – consumer relation	Anonymous. Market = Agro-food business	Direct, Personal. Market = (urban) consumers
Agricultural production	Primarily (food) production (mono-functional), intensification	Provision of multiple goods and services; multifunctionality
Importance of landscape	Not important	Very important – an asset for creating added value
Vision on current agriculture	Dispersed, inefficient, pollutant, obstructing alternative functions (nature, relation)	Too mono-functional; Decoupled from society;
Chains	Interlinking different chains	Short: Producer – Consumer; Multiple chains
Transform concept	Vital cluster	Regional development
'Licence to produce'	Innovation, sustainability, high-productivity	Multifunctionality, meeting demands of society, sustainability
(Claims on) sustainability	Innovative; closed & interlinked chains of food, residuals, energy; efficiency	Short chains, organic production, multifunctionality; meeting consumer demands; maintaining the landscape
Origin / mostly encountered	Netherlands – Asia	USA
Other characteristics	'Footloose'? Rural is of no importance?	Co-evolution of the urban and rural

Examples (see links below)	The concept of Agro-business parks (Peter Smeets)	The concept of Urban Edge Agricultural Parks that provide fresh food, as well as educational, environmental, and aesthetic amenities for nearby urban and suburban communities.

According to TransForum, an example of industrial metropolitan agriculture (the vital cluster idea) is the concept of agro-business parks (Smeets et al., 2007), while the concept of urban fringe agricultural parks (the regional development idea) exemplifies multifunctional metropolitan agriculture. However, this categorization of metropolitan agriculture can be further detailed. For instance, no definition of the geographic extent of a metropolitan area is provided and the question arises whether the metropolitan regions are situated just within a certain distance of the city and, if so, what is this distance? Or are there some other criteria? Industrial agriculture, both close to metropolitan areas and in rural areas, is very strong in the U.S. and other Western countries. In less developed countries, such as many in Asia, Central America and Africa, there is a large amount of subsistence agriculture, both in rural and metropolitan areas. Perhaps the key to understanding TransForum's sense of metropolitan agriculture is realizing it applies mainly to Dutch agriculture.

Searching the literature for other definitions of metropolitan agriculture turned up a few late 1980s studies of the U.S. situation. Lawrence (1988) used metropolitan agriculture as a term meaning agriculture near cities. He stated that metropolitan agriculture was subject to different influences than agriculture in rural areas, such as pressures of urban expansion resulting in farm fragmentation, absentee ownership by speculators, and increasing land prices because of real estate speculation. This is being echoed by a recent presentation by the former Dutch National Advisor for Landscapes, Dirk Sijmons, who demonstrated the close link between metropolitan landscape trends and land prices [quote > Herman]. Another study reported that 16% of the United States land area was metropolitan and 29% of all farms and nearly 20% of harvested cropland was included in this area (Heimlich, 1989). Heimlich found metropolitan agriculture to be characterized by smaller farms, more intensive production, a focus on high-value crops and livestock, and more off-farm employment as contrasted with rural agriculture. The degree to which metropolitan agriculture shared these elements was related to the length of time that the metropolitan counties had been affected by urban pressures, with older metropolitan areas having more adaptations in farm characteristics.

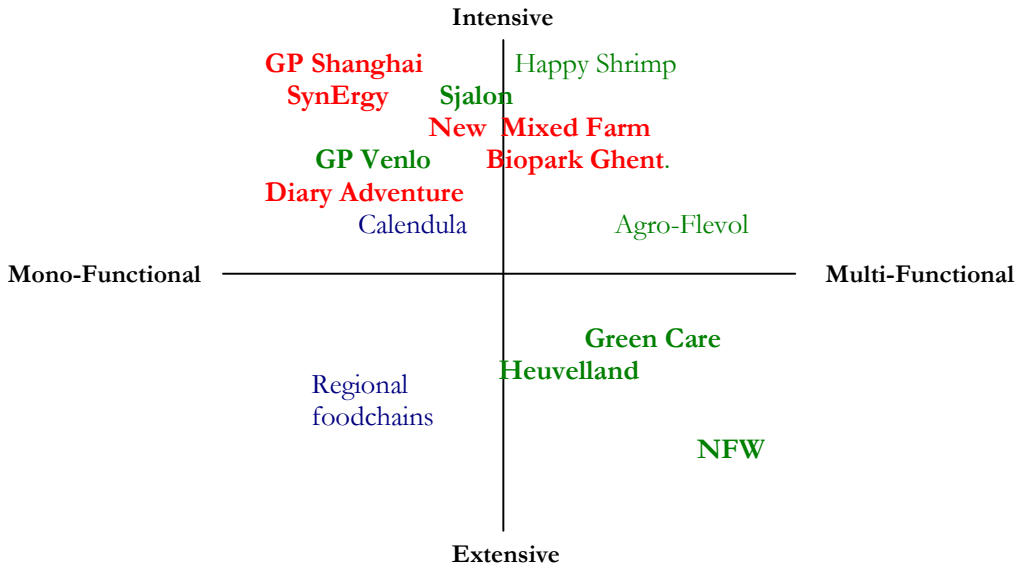


Figure 2: TransForum IPs according to land use intensity vs. extensity and mono-functionality vs. multi-functionality.

Furthermore, the fact that both concepts are based on a rather different understanding of rural-urban dynamics or 'logic' implies that co-existence is not all that obvious. On the contrary, the understanding and support of Metropolitan agriculture will require (political) discussion and choices as to which type of Metropolitan Agriculture is most viable at what location. The TransForum projects of New Mixed Farms, Biopark Ghent-Temeuzen, Greenport Shanghai, SynErgy, Healthy Pip Fruit Chains, and Dairy Adventure (www.transforum.nl) are all examples of the vital clusters concept under industrial metropolitan agriculture.

2.3 System Innovation and Metropolitan Agriculture

The basic meaning of innovation is understood as something which is new or original in a way which improves upon the existing. The European Commission (2009) defines innovation as:

> *The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relation. The minimum requirement for an innovation is that the product, process, marketing method or organisation/method must be new (or significantly improved) to the firm.*

TransForum defines innovation as "implementing a new value-proposition by means of a new, unique value chain" (Latesteijn et al., 2008). When the process involves innovation at a larger scale, in a system with multiple actors, it is known as system innovation (Porter, 1990). As Porter stated, a country's competitiveness is a result of its industries' abilities to innovate and upgrade. Innovation has also been described as applying knowledge to produce new

knowledge and requiring systematic efforts and a high level of organization (Drucker 1993, cited in Johannessen et al., 1999). In the late 1990s, the concept of system innovation was developed in innovation studies, which widened the perspective of innovation to encompass not just individual organizations, such as business firms, but also networks of organizations (Geels, 2004). System innovation is a non-linear learning process, that is, the process occurs in a manner which builds in feedback loops which enables constant re-evaluation and revision. This is a fundamental change from the formerly prevalent top-down model of knowledge transfer from scientific experts to practitioners.

Through some 60 practice, scientific and learning projects, TransForum has identified three stages of value formation which happen in sequence: value proposition, value creation and value capturing. A true innovation cannot stop at the first stage but must go through at least two consecutive phases to produce a concrete result.

For the purposes of this paper, we would like to place system innovation in the realm of metropolitan agriculture – through a general understanding of how innovations are adopted and specifically how system innovation takes place in agriculture. To understand the essential elements of innovation as applied to metropolitan agriculture, characteristics of innovation for selected TransForum vital clusters and regional development projects are listed in Table 3 and further specified in Table 4 and 5.

Table 3: Checklist of TransForum IPs regarding innovation characteristics such as spatial effect, land vs. non-land-bound characteristics ("foot-loose"), linkages with the urban market and society, contribution to multi-functionality objectives and the degree to which they offer sustainable solutions. [+ present, - not present, +/- partly present, ? unclear, ~ not relevant]

Business model	Spatial impact	Foot-loose	Urban link	Multi-functional	Sustain-able	Science-Practice link
Vital Clusters						
Greenport Shanghai	+	+	-	-	+/-	+
Biopark Ghent-Terneuzen	-	+	-	-	+	+
Healthy Pip Fruit Chain	+	-	-	*	+/-	+
Mainport Aalsmeer	*	*	+	-	-/+	-
New Mixed Farm	+	-	-	-	+	-
SynErgy	-	+	+	-	+	+
Dairy Adventure	+	-	~	+	+	-
Regional Development						
Business	**Spatial**	**Foot-loose**	**Urban link**	**Multi-**	**Sustain-**	**Science-**

model	impact			functional	able	Practice link
De Sjalon	+	-	-	-	+/-	-
Green Care	-	-	+	+	+	-
Northern Frisian Woods	+	-	?	+	+	-
NMVC Heuvelland	?	-	+	+	+	-
Greenport Venlo	-	+	+	-	-	+
Brackisch Agri on Texel	+	-	?	+	+	+
International Agrifood Networks						
Business model	**Spatial impact**	**Foot-loose**	**Urban link**	**Multi-functional**	**Sustain-able**	
Flor-i-Log	-	+	+	-	-	-
Quest for Golden Egg	-	+	+	?	+/-	?
Int. Livestock Coord.	-	+	?	-	-	-
Calendula	-	+	?	-	+	+
Sustainability Retailing	-	+	+	-	-	-
Health Oats	-	-	?	-	+	-
More about Food	-	-	+	-	+	-
Regional Food Chain	-	~	+	-	+	-

The adoption of innovations has been studied by sociologists and an adoption/diffusion model was developed by Rogers (1983). Basically the adoption/diffusion model attempts to describe how innovations diffuse throughout a community. Individuals' adoption behaviours are predicted through their personal characteristics, the element of time elements and the qualities of the innovation (Padel, 2001). Four phases, or adopter types, occur in the adoption/diffusion model. The first people to adopt a new product or method are called innovators and they tend to be cosmopolitan in their relationships, in communication with other innovators and are not always respected, well-integrated members of the social system. Next are early adopters who are more connected to their local community and, in fact, are often opinion leaders, along with having good connections with information sources. Early and late majority adopters adopt an innovation after it has been made acceptable by the early adopters, the main difference being the time element. Finally, laggards adopt much later, if at all. Though the model has gathered criticism, especially for what has been seen as its pro-innovation bias and the neglect of the institutional nature of agriculture, it has continued to be used by researchers for its utility in describing innovation process. The adoption/diffusion model is relevant to the selected projects in Table 3 with the exception of Greenport NL because that project has a large spatial impact involving many stakeholders and applying the model would be too complex to be useful.

Pannell carried out an analysis of research about agricultural innovation adoption (1999), with a focus on farmers switching to more ecologically-oriented farming. In the analysis, four qualities were found necessary for farmers to adopt a new system: awareness of the innovation, believing that trying the innovation is feasible, believing that the innovation is worth trying, and believing that the innovation supports the farmer's objectives. Pannell stated that, for developed countries, innovations can face obstacles of how to develop more profitable systems, proving profitability, and conquering uncertainty about the innovation. The critical challenge with successful and lasting innovation adoption seems to be convincing the farmer that the innovation has a clear advantage over the existing technology, system or approach. Farming systems are complex and it is probably necessary to consider not just individual farmers but also the range of stakeholders varying from rural communities to the global food system. Pannell's study seems quite useful for consideration of the selected projects. Especially for the projects directly involving farmers, but perhaps more generally for the other projects as well, understanding the possible barriers to innovation adoption and important qualities for innovations to be successfully adopted can supply useful information and guidance for metropolitan agriculture projects.

A paper on the adoption of more sustainable practices through innovations stressed the twin nature of technical and societal changes which need to happen more or less concurrently for innovations to be adopted (Elzen and Wieczorek, 2005). Unlike incremental processes, system innovations, also known as transitions, are characterized by this dual nature of technical change coupled with society undergoing changes that allow and promote the adoption of technical changes. Understanding transitions means grasping this interrelatedness and the mutual dependencies of technological and socio-cultural changes. Then, for more sustainable transitions to be encouraged, issues such as policy formation by governments and learning processes of actors and networks need to be understood. These ideas are particularly applicable in the case of the Northern Frisian Woods project since the project involves many technical practices, i.e., manure management improvement for the benefit of pasture birds or the mapping of pasture birds' nest sites, coupled with social factors, such as the inclusion of urban recreationalists, such as birdwatchers.

A study of organic farming in Quebec examined the role of innovation and found that location of farms in urban fringe areas was associated with the development of organic agriculture as an innovation (Beauchesne and Bryant, 1999). The researchers propose that urban fringe areas induced more adoption of organic practices over other rural areas through the presence of positive aspects of the urban fringe, such as market access and the availability of specialized services, through the presence of dynamic actors, and through positive local forces, such as agriculture being valued by the community. Negative aspects of agriculture at the urban fringe were also discovered, such as land speculation, incompatibility of urban and rural land uses, lack of leadership, and negative attitudes about agriculture in the community. Urban fringe areas with concentrations of organic farming were found to provide more positive than negative factors favouring this type of innovation. This study seems relevant for two of the selected projects, Greenport NL and Green Care farms. With both of these projects, location adjacent to an urban centre is essential because of the involvement of urban populations for purposes of marketing(for Greenport NL) and health care centre involvement (for Green Care farms).

Pearson (2007) reviewed studies in parts of Europe, New Zealand and North America which compared the profitability of organic vs. conventional agriculture. For various crops in Western Europe, the 22% to 37% higher production costs of organic agriculture were more than offset by price premiums. Three trends of increasingly metropolitan areas favour a shift to organic agriculture: less tolerance for negative environmental impacts of agriculture, such as pesticide drift, in areas where farmland and residential areas are adjacent, more value placed by society on relationships between urbanites and farmers, such as pick-your-own operations and other opportunities for consumers to purchase food directly from farmers, and more prospects for urban agriculture as urban areas spread and conventional farming faces increasing difficulties in peri-urban areas. Pearson wrote that a blend of farmer-oriented information, public property management changes, and legislation is probably best. It's difficult to say how this study could be applied to the selected projects since so many factors are involved. Focusing just on the issue of organic farming's profitability, the study is most useful for the three vital clusters projects (Greenport NL, New Mixed Farms, and Dairy Adventure) and the regional development project of Greenport Venlo. Generally this is because of strong sustainability emphasis of these projects and the direct involvement of organic farmers.

3. Identification of Suitable TransForum IPs

3.1 Introduction

The projects commissioned and accompanied by TransForum must be considered as the fundamental, practical knowledge base when developing spatial-functional perspectives for a metropolitan agricultural vision. More specifically, SUSMETRO is meant to provide targeted input on developing sustainable approaches for metropolitan agricultural landscapes – a Dutch domain in the international context – to the current knowledge infrastructure (KIS) at both the national and international level.

The interface with European projects such as SENSOR offers the opportunity to create synergy between the Dutch and the international research efforts (1) by feeding regionally specific experience and criteria of sustainable land use (e.g. on metropolitan agriculture) into the European approach, and (2) by making use of the state-of-the-art sustainability assessment tools when implementing TransForum's vision. SUSMETRO is meant to assess TransForum's national strategic goals by targeting and applying some of the recently developed European tools while at the same time providing input to the current knowledge infrastructure (KIS) at both the national and international level. The project will address the following research questions:

- *What are the conceptual, design and learning principles of metropolitan agricultural landscapes and how do they fit into other geo-references, such a landscape typologies or a future Dutch AHS (Agrarische Hoofdstructuur = Agricultural Main Structure) ?*

- *Which decision-support tools can provide stakeholders and decision makers with the means for measuring the potential impact of TransForum's metropolitan agricultural vision on sustainable land use objectives (PPP) at the national and international level?*

- *How does TransForum's metropolitan agricultural vision translate into spatially explicit design proposals at the landscape level, taking into account the variety of ongoing national and international approaches towards 'green and blue service' around cities?*

Transform itself has stated that it is complicated to clearly identify initiatives of Metropolitan Agriculture and that there is a need for a new 'set of glasses'; meaning a new perspective and set of criteria in order to recognize true Metropolitan Agriculture. Given the diverse interpretations of the concept of Metropolitan Agriculture, we argue that these glasses ought to be multifocal in order to be able to understand and deal with two very distinctive concepts of Metropolitan agriculture.

According to TransForum, different types of Metropolitan Agriculture are both possible and needed in order to stimulate the transition of Dutch agriculture and its surroundings towards more sustainable production systems. However, although it might be theoretically possible that different types of Metropolitan agriculture co-exist at a national or regional level we argue that it is very unlikely that the concepts of Industrial Metropolitan Agriculture (such as Vital clusters) and Multifunctional Metropolitan Agriculture (represented by Regional Development initiatives) are (spatially) compatible at a local level, due to their distinctive needs and characteristics.

3.2 Innovation Characteristics as Spatial Design Principles

On the basis of the above discourse on urban vs. metropolitan and industrial vs. multi-functional agriculture, a set of six characteristics for system innovation have been developed. In order to be implemented within an Innovative Project (IP) all or most of these characteristics are supposed to be objects of the so-called 'New-Value-Proposition' deriving from a Mode2 science-policy-stakeholder interface. Hence none of the below design characteristics of the IPs are meant to be put into place by just a single societal player.

Box 1: SUSMETRO Innovation Characteristics

Spatial impact

Does the innovation affect a large area in the direct surroundings, such as a region? A plus symbol indicates that it does. However, being innovative is not always connected with having a large spatial impact. An innovative project could have a relatively small spatial impact but, because of the high degree of other innovative characteristics, would be considered innovative. Also, the spatial impact can be positive or negative, depending on the way an innovative project is implemented and integrated.

Foot-loose production

The term 'foot-loose' refers to the innovation not requiring a direct link to the land. For instance, a business park would be foot-loose as it could be located almost anywhere. However, a green care farm requires a close location to both environmentally diverse and attractive rural landscapes and proximity to urban populations so it cannot be foot-loose. The topic is somewhat related to the previous, as a foot-loose innovative project is not expected to have more indirect spatial impact beyond its own area coverage, e.g. the increase of commuting and transport traffic in the closer regional surroundings; but also the land use change impacts in remote areas due to food-stuff import. Being considered as foot-loose shifts the dependency of an innovative projects from the bio-physical to the socio-physical parameter – e.g. infrastructure and accessibility.

Urban-rural link

This characteristic indicates a direct relationship between an urban population center and the metropolitan agriculture project. The innovative project needs to be connected to the urban center for such elements as skilled employees or consumer markets. There are of course many indirect and concealed links with the urban context; here we consider the more obvious and spatial links (see section 2.1 of this report)

Multi-functional land use

This term represents the concept that more than one function, or purpose, is provided by an innovative project. For example, an agricultural area (e.g., farmstead) could also offer recreational opportunities, such as hiking or bird-watching, in a multi-functional innovative project. Other forms of multi-functionality exist as well, namely at a larger spatial – e.g., regional – scale, thus not necessarily by one land use type, but distributed across a larger area (see also section 2.2. of this report)

Sustainable development objectives

Sustainable means that the "three P's" of sustainability (planet, people and prosperity, otherwise known as environment, social and economic factors) are met in a rather balance way by an innovative project. The European Union considers emissions of greenhouse gases, new antibiotic-resistant strains of some diseases and, potentially, the longer-term effects of many hazardous chemicals, loss of bio-diversity and transport congestions in urban areas as the unsustainable trends – many of which related to intensive forms of agricultural land use (CEC, 2001).

Science-practice link

The science-practice link denotes a relationship between research and application of an innovative project. This is ideally an iterative process in which science informs practice and vice versa so that both realms are improved by the mutual feedback. The closer the link in terms of time and space, the more effective the science-practice link.

3.3 Description of selected TransForum IPs

Vital Clusters/Industrial Metropolitan Agriculture

New Mixed Farms is a TransForum vital clusters project which will start operations in 2009 near Horst in Limburg province. The project brings together a pig breeding farm, a chicken farm and an installation company in a shared location with a bio-energy plant. The combination of a high level of animal welfare standards, high energy efficiency, low environmental burden, and lower production costs make this a unique and innovative vital cluster. Through spatial clustering and waste flow exchange, more sustainable agriculture is to be achieved. A small business school specializing in sustainable development is also being started here. Another innovation of *New Mixed Farms* is the active involvement of many stakeholders – entrepreneurs, researchers, politicians and non-governmental organizations, as well as public discussion of the environmental impacts of the project's enterprises.

A second vital cluster project, *Dairy Adventure*, seeks to implement innovations in technical aspects of dairy farming, such as stable design, pasture systems, fertilizer processing, landscape management and the creation of additional added value. Along with these technical themes, the social theme of cooperation is pursued to bring business efficiency and harmonious relationship with the environment together. This project is being developed in three regions: in Groningen, a feed supply and fertilizer sales business cooperates with farmers for mutual benefit; in Southwest Friesland, five businesses are clustered for efficiency and profitable operations; and in Gelderland, a business focuses on production within a small-scale landscape. Knowledge creation in the technical areas and social realm can help the Dutch dairy industry develop new strategies to meet the challenges of reduced and possibly eliminated European support mechanisms.

Greenport NL is a prospective vital clusters project which applies the basic concept of the agro park to the Netherlands, similar to *Greenport Shanghai* only brought into the Dutch metropolitan landscape.

Regional Development/Multifunctional Metropolitan Agriculture

In contrast with industrial metropolitan agriculture, multifunctional metropolitan agriculture is often on a small scale of production, has direct and personal producer-consumer relations with the market usually being urban consumers, provides multiple goods and services and thus is multifunctional. TransForum projects of regional development include *Greenport Venlo*, *Northern Frisian Woods*, *and De Sjalon*, brackish agriculture on Texel, *Green Care*, *New Markets and Vital Coalitions Heuvelland* and *Streamlining Greenport Venlo*.

Venlo GreenPark is a regional development (multifunctional metropolitan agriculture) project which incorporates six innovative elements. Venlo is a municipality and city located in the province of Limburg in the south-eastern part of the Netherlands. The Venlo area lies at the centre of the most comprehensive agribusiness region of the Netherlands and, together with the Niederrhein area of Germany, counts as one of the largest European agricultural areas. *Venlo GreenPark* is the first innovative element. The business park is a core for research, development and knowledge transfer among agricultural companies. Partnerships between businesses and knowledge institutions promote the development of food and horticultural

products. Pure and applied research is pursued and is fundamental to the strength of *Venlo GreenPark* as a knowledge hub.

Table 4: Innovation Characteristics of selected Vital Clusters IPs

Business model	Spatial impact	Foot-loose	Urban link	Multi-functional	Sustainable	Science-Practice link
Greenport NL	+ Distinct, large, enclosed business-park-style area, Concentration vs. widely dispersed, intensification in wider surrounding landscapes	+ Close to logistic hubs, (not entirely footloose but logistics / infrastructure /accessibility as the main organizing principle	- Max of 150 km distance to urban centres, Instructural links, Employment recruited from cities, City is the market	- Negative MF: itself mono-fuctional on agri-production, possibly positive effects on surrounding landscapes by adding additional income sources	+/- Improving the ecological footprint; Possibly energy producing; foodstuff (soya) supply still unclear	+ Mode1&2?
New text needed						
New Mixed Farm	+	- Needs existing farms	-	(-) Bio-energy plant	+ Small business schools, Gelderscale small scale approach	- Stakeholder involvement,
Agropark. Government regulation determines the speed of the innovation process. Entrepreneurs are now setting up small scale business school on sustainable development.						
Dairy Adventure	+ Landscape management	-	-	+ "additional added values"	+ Landscape management	- Technical innovation
Three regional specific experiments with dairy farming beyond the scale of family farms, characteristic for NL. Application of knowledge and experiences from Dutch emigrants who started large dairy farms. International Community of Practice. - Dairy production regions as a organizing principle - Innovative / highly productive / large scale enterprises as a organizing principle						

Table 5: Innovation Characteristics of selected Regional Development IPs

Business model	Spatial impact	Foot-loose	Urban link	Multi-functional	Sustain-able	Science-Practice link
Streamlining Greenport Venlo	+/- 'Beacon of Innovation', Confined to urban development	+ Gateway Europe, Transport hub	- educated employees	-	+/- Cradle-to-Cradle GreenCampus	+ Mode2, transparent knowledge centre
Agropark. Strongly building on network of New Mixed Company. Innovative combination of Knowledge Institutes, Entrepreneurs, Governmental and Non-governmental organizations working is pre-dominating problem. No agricultural production 'on site' or programmed.						
Green Care	- moderate	- Specific environmental & urban needs	+ Directed towards Amsterdam	+ Agri & health care	+ highly sustainable according to PPP	- Social science & health care systems linking up with agro-

						business;
Developing of a cooperation of Care Farms and Educational Farms, in collaboration with care organizations and schools. The cooperation, now consisting of 20 farmers, has been recognized by the national health insurance.						
Northern Frisian Woods	+ 700 farmers, territorial approach, landscape-oriented	-	? Indirect, services directed towards urban needs	+ Is a goal – broadening of scope of agricultural practices	+ Support increased biodiversity by connectivity and manure improvements for pasture birds	- Close link with WUR, specific contact person, various research projects
Supported the farmers' organisation NFW in their aim for self regulation in environmental and landscape management. A 'regional contract' was developed and space for experiments created.						
NMVC Heuvelland	?	-	+	+	+	-
New Markets and Vital Coalitions. New value propositions and coalitions were developed. Important lessons were learned about regime aspects. 'Red' is taking responsibility for what is 'green'.						

The second *Venlo GreenPark* innovation is the region's adoption of the *cradle to cradle* principle. Venlo is the first region in the world to adopt this principle. The cradle to cradle concept means that products must be made in manner that allows them, after their useful life, to be biologically degraded or to serve as the foundation for new products of similar high quality. This principle is currently being applied in a range of projects in the Venlo region. The third innovation is *Venlo GreenPark's* strategic location as a *Gateway to Europe* for highly educated workers and markets. The GreenPark is placed at the intersection of several fast motorways and has four international airports within an 80 km radius, so that products can be quickly and efficiently distributed worldwide. Approximately 30 million consumers live within just an hour's drive. Fourth, Venlo GreenPark has InnovaToren, a tower of offices and businesses that bridges the A73 motorway. InnovaToren is known as a physical landmark, a *Beacon of Innovation,* and the region's innovation hub. Through being situated in the InnovaToren, businesses can easily network and exchange knowledge developments and thus achieve more than if they were isolated from each other. The fifth innovation is that InnovaToren is part of a *green campus* which focuses on attracting innovative companies with strong research departments and commitments to sustainability. Lastly, the business park has a *transparent knowledge centre* which serves as a symbol of the need to make knowledge accessible: "a clear head in a clear building". *Venlo GreenPark's* role aims to be a place of knowledge transfer for agricultural products. Students and workers in agriculture can gain by the theoretical and practical knowledge created in the GreenPark. As an example, in 2012, 2 million visitors from around the world are expected to come to Venlo for Floriade, an international trade show, to learn about the latest developments in agriculture and horticulture. This will be an opportunity to showcase Venlo GreenPark as a green business park utilizing innovation and sustainability as key components.

As an example of sustainable development through a regional approach, the *Northern Frisian Woods* project creates new value propositions for marketing the landscape. Collectively, 750 farmers and the provincial authority are working to jointly develop agriculture, safeguard the landscape and ecological features, and assure an adequate income for farmers in the region. This regional cooperation seeks to increase biodiversity and recreational opportunities within an actively farmed landscape.

A third case of a regional development project of multifunctional metropolitan agriculture is the *New Markets and Vital Coalitions Heuvelland* project. In areas where agriculture is decreasing, the loss of the rural landscape is a concern. To retain the rural character of the typical hilly south Limburg landscape, new economic activities are being developed, such as recreation, hotels, restaurants and catering facilities, and health care. Vital to the success of these new enterprises is a cooperative approach where new product-market combinations are developed collaboratively among entrepreneurs, municipal and regional authorities, and knowledge institutions. This innovative collaboration links new players, i.e., farmers together with banks, project developers, healthcare insurers, and hospitals. This project is an example of the red, that is urban areas, taking responsibility – in a cooperative way with rural areas - for that which is green, or environmental, for mutual benefits. Results so far include new value propositions of post-operative rehabilitation facilities in Orbis (the Maasland hospital), Château St. Gerlach and the Heuvelland Hotels (www.helendehellingen.nl) and MosaeGusto, a fine food market recently opened in Maastricht (www.mosaegusto.nl). In order for these cooperative ventures to work, three conditions have been found to be important, according to TransForum: "1) The transition from an agricultural area demands cash-rich and enterprising entrepreneurs. The challenge, therefore, is to reel in the SMEs [small and medium-sized enterprises]. 2) Each cooperative arrangement demands its own unique approach. 3) An authority operating on an integral basis is an important precondition for innovation (www.transforum.nl)."

Another example of a regional development project of multifunctional metropolitan agriculture is the *Green Care* project around Amsterdam. This project exemplifies a way in which city and countryside can be integrated in a new relationship. The innovative character of this relationship is how farmers are cooperating with health care organizations and insurers to provide care and shelter for people with psychological problems and to recovering addicts. The project is also innovative in how institutions and parties who did not previously know how to find each other are linked up. A professional arrangement of care, agriculture and landscape creates a new value proposition which integrates the green space around urban areas with the needs of the urban population. This innovation reinforces the city-countryside connection by strong economic and socially valued support mechanisms.

4. Developing a Spatial Vision for Metropolitan Agriculture

4.1 Spatial references for applying innovation characteristics

The concept of metropolitan agriculture implies a deliberate (re)design of agricultural production systems in metropolitan areas in order to meet the future material and immaterial demands of this same metropolitan area.

The introduction of new forms of metropolitan agriculture needs to take into account existing regional spatial characteristics, both in terms of a suitable sustainable choice space as well as their expected future impacts. It is hence imperative to first develop spatially explicit definitions of metropolitan agriculture in the context of different agricultural production systems and their real as well as virtual boundaries. The following three dimensions require attention (1) the bio-physical environment (*stock*), (2) the supra-regional socio economic forces (*drivers*) and (3) the intra-regional land use change dynamics (*flows*). On the following, we will briefly illustrate which types of data sets are relevant for providing spatial references and how they can be used. It should be noted that the selection of these datasets is based on a longstanding experience (and tradition) of working with spatial assessments. One of the key considerations has been the question whether the relevant data sets exist also as European versions. In general, European data as provided by European institutions such as the European Environment Agency, the European Statistical Office and other expert centres such as Alterra is coarser and less reliable than the equivalent national datasets (Wascher 2000; Wascher 2005). However, the advantage of these data sets is their universal availability and consistency across borders – a clear asset for projects such as SUSMETRO.

On the other hand, existing Dutch national data can provide valuable additional information. For instance, cultural data such as on heritage, landscape preferences, recreational qualities etc is hardly available at the European level, but must be considered as important at the regional and national level.

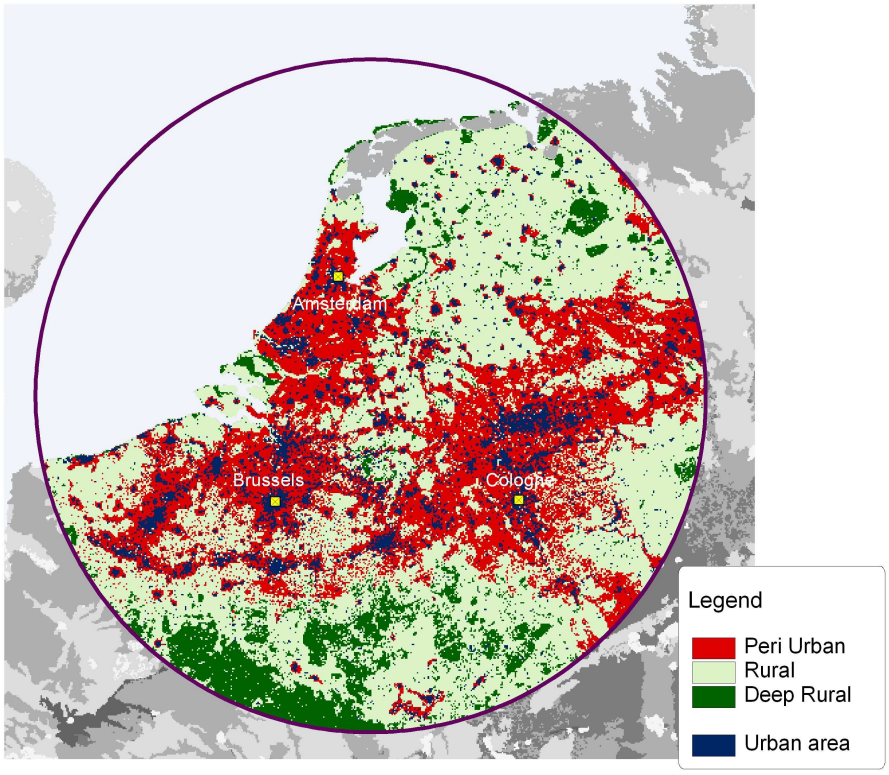
The future spatial development of metropolitan agriculture in the Netherlands raises three key questions:

- How are metropolitan agricultural production systems linked to landscape character (multi-functionality)?
- How do parameters of stock and flows affect the chances for rural transformation and innovation processes (bottom-up)?
- How do driving forces such as policies, demography and market mechanisms affect spatial planning at the national level (top-down)?

In the following, we will present those datasets which are considered as relevant when developing a spatial vision of Dutch metropolitan agriculture in the context of its international environment. The ABC-Region (Amsterdam-Brussels-Cologne) serves the central geographic reference for this assessment. For the purpose of this assessment, we selected only the region surrounding The Netherlands with parts of Lower Saxony and North Rhine-Westphalia in Germany as well Belgium in the South and Luxembourg.

The bio-physical environment: *stock*s

When it comes to agricultural land use, the bio-physical environment provides a very crucial reference framework: soils, water quality and availability, but also climate and geomorphologic structures (e.g. slope) determine the type of farming potentials. In addition, most of the negative impacts that are being reported upon go on the account of farm management types that are conflicting with these bio-physical factors – e.g. drainage of wetlands, soil erosion due to habitat destruction, etc. Though the environment and certainly the cultural landscapes associated with them are constantly changing, their spatial distribution is in principle considered as static. Land developers and cultivation experts might see opportunities in even very hostile locations, but the distribution of soils, water and vegetation still plays an important role when planning at the large scale and for the long-term. These factors are hence considered as 'stocks'.



Map 1: Rural Classification for the European Union (van Eupen, 2008)

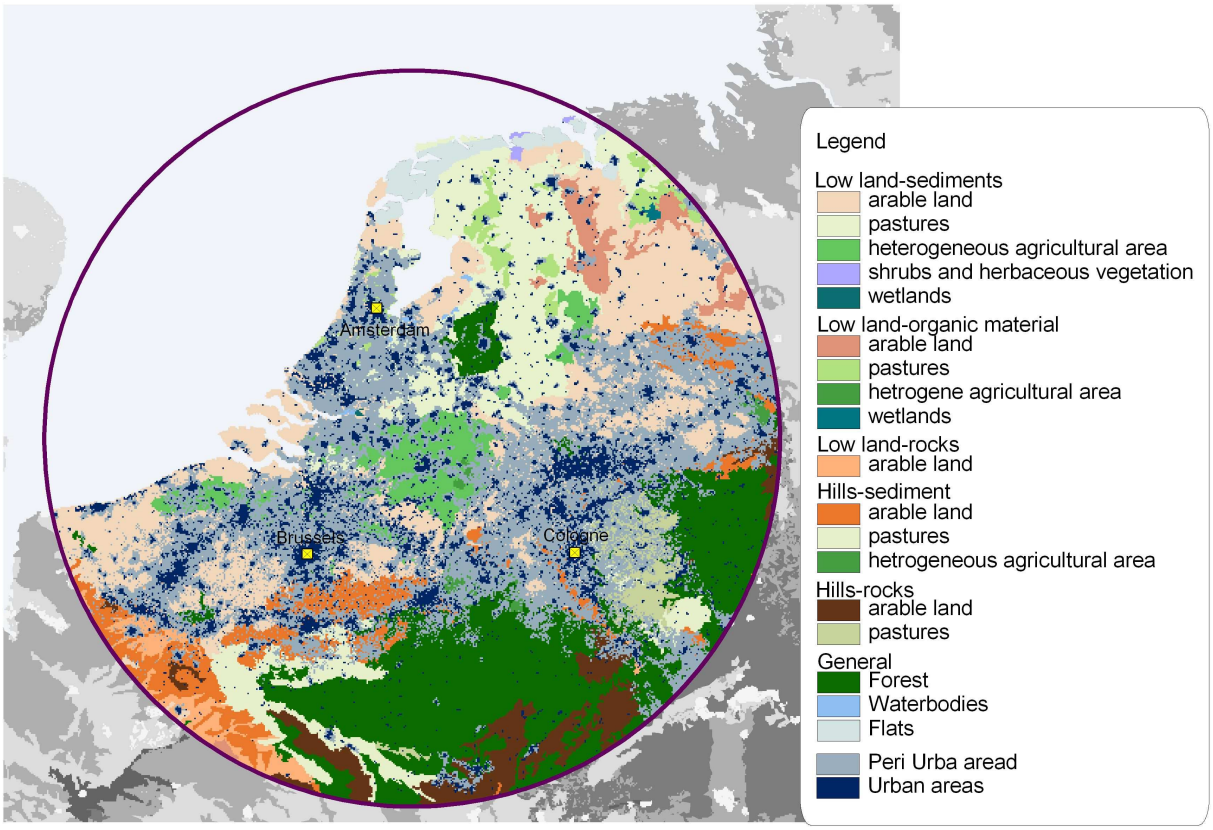
Rural vs. Urban Areas

The Rural Classification for the European Union (van Eupen, 2008) is classified based on average economic density and accessibility per Environmental Zone (Metzger et al. 2005). This is giving a meaningful division for European regions with comparable environmental conditions. However, when a region is taken out of the European context and compared with itself, the same can be done on a low level. The Rural Classification for the Netherlands (source: van Eupen, 2009) is using the same basic datasets for economic density and accessibility, but it is classifying these datasets according to the Dutch average and standard

deviation. For the Netherlands the averages are higher than the average of the Atlantic Environmental zones, in which the Netherlands are situated, and the standard deviation is much narrower. This is logically resulting in a more differentiation of the 9 rural-urban classes within the Netherlands.

Landscapes

Rather than compiling a series of environmental maps it seemed to be more 'user-friendly' to offer a cartographic framework in which most of the relevant aspects are already spatially integrated. At many national levels, such integrative frameworks can be found in the form of landscape maps (Wascher 2005). In The Netherlands, a variety of landscape typologies has been developed and is being applied for different purposes. Because of the reasons stated above, the cross-boundary character of this project suggested the application of an international landscape map which would allow recognizing similar landscape types in the neighbouring countries as same legend units.



Map 2: excerpt of LANMAP2 (Mücher et al. 2006)

A first initiative to produce a pan-European landscape classification using state-of-the-art technology started at Alterra in 2002 (Mücher et al. 2004). The European landscape map should provide a practical and easy tool for communication between scientists and others interested in European landscapes and for European policy implementation, which forms a major challenge. The European Landscape Map (LANMAP2) has been produced on the basis of state of the art technology and four core data layers with a high spatial resolution; i) climate, ii) altitude, iii) parent material and iv) land use. This resulted in a classification at a scale of approximately 1:2M, with a minimum mapping unit of 11 km^2 and more than 14.000

mapping units. It covers an area of approximately 11 million km^2 (Mücher et al. 2006). The European Landscape Classification is a hierarchical classification. Level one is based on climate only and has 8 classes. Level two is based on climate and altitude and has 31 classes. Level three is based on climate, altitude and parent material and has 76 classes. Level four is based on all four data layers and is the most detailed level and has 350 landscape types (Mücher et al. 2006). By integrating soils, topography and land cover into one spatial reference framework, LANMAP2 can be considered as a bio-physical approximation. We also decided to slightly amend the legend of the map since its top layer – namely the environmental classes (in this case a differentiation between the Atlantic and Continental part of this region) – were not considered as necessary.

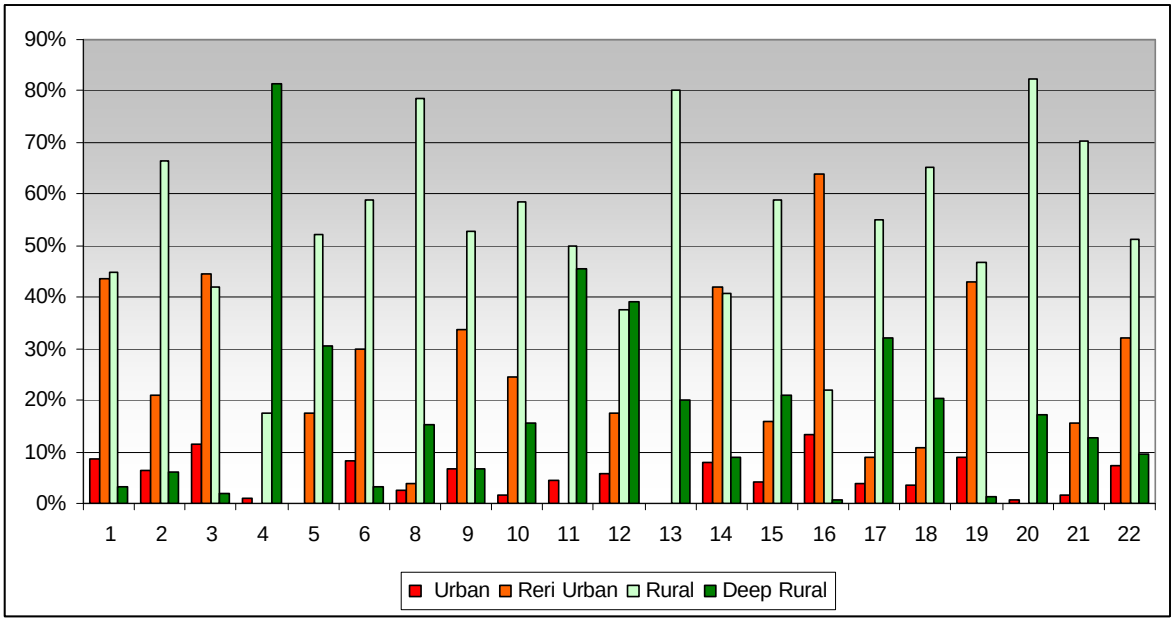
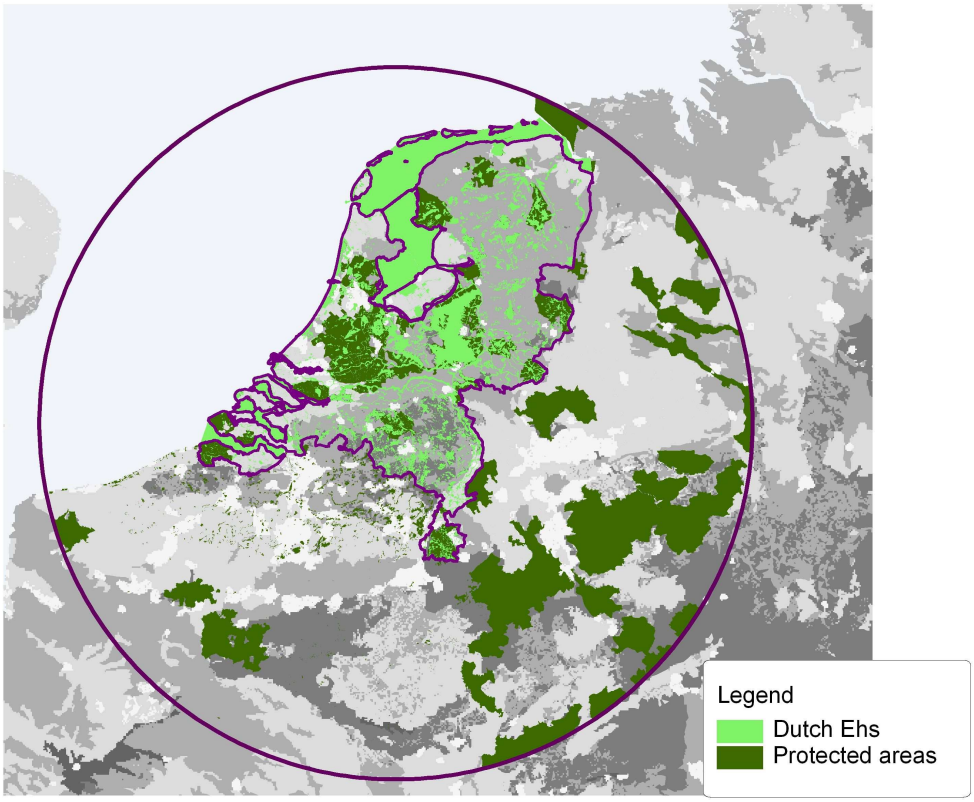


Figure 3 Distribution of LANMAP2 landscapes (Mücher et al. 2006) by FARO-region (van Eupen, 2008)

Lowland-Sediments		Area (km2)	***Hills-sediment***		
1	Arable land	45794	14	Arable land	14002
2	Pastures	16383	15	Pastures	5913
3	Heterogeneous agriculture	10098	16	Heterogeneous agricultural	1747
4	Shrubs & herbaceous veg.	119	17	Forest	9983
5	Wetlands	23	***Hills - rocks***		
6	Forest	2480	18	Arable land	6796
Lowland-Organic materials			19	Pastures	4391
8	Arable land	2710	20	Forest	967
9	Pastures	3175	***Mountains***		
10	Heterogeneous agricultural	123	21	Forest	3983
11	Wetlands	88	22	**Grand total**	131716
Lowland-Rocks					
12	Arable land	2931			
13	Lowland-Rocks-Forest	10			

Nature and Landscape Protected Areas

Obviously, such an approximation does not allow in-depth interpretation of its related environmental parameters, such as biodiversity. Since such information must be considered as rather important – agricultural development plans are likely to stand clear of high value nature areas – the existing information on protected areas (National Parks, but also National landscapes) and in the case of the The Netherlands, the location of the Ecological Main Structure (EHS) forms part of the second reference map addressing important stocks. The data derives largely from national sources, but has been compiled in a European data base managed by UNEP and WCMC.

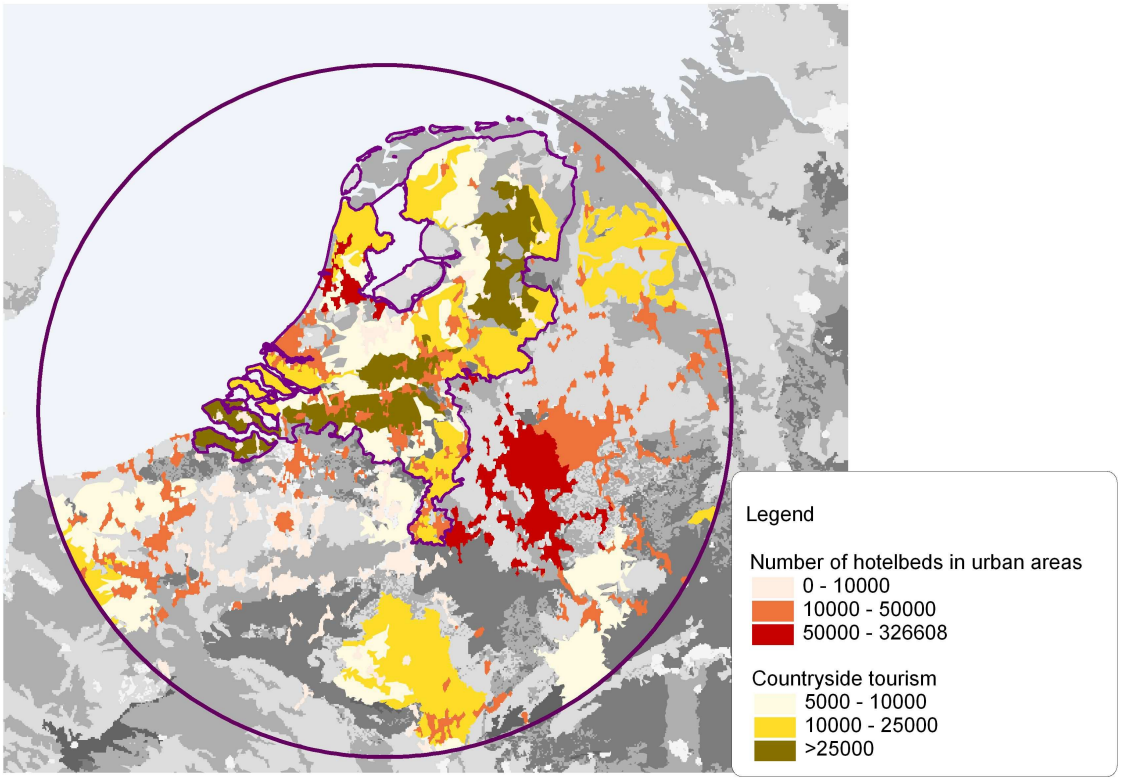


Map3: Protected Areas (Nature and landscape conservation) and EHS in the The Netherlands

Leisure and recreation

The work on landscape indicators undertaken by Konkoly et al (2006) as part of the sustainability impact assessment of the SENSOR project was one of the first European-wide approaches linking tourist data and landscape aesthetic assessment. LANMAP2 has been used as an overall reference framework for depicting tourism and leisure activities at the European level. The main target group of the Map of *European Leisurescapes* are authorities and stakeholders concerned with leisure and tourism as a driving force of landscape change, with both opportunities and risks, at a regional, national and international scale. The map will form part of an advisory to the Council of Europe and to national authorities. Making us of national statistics on the number of hotel beds in urban areas (2 classes) as well as number of camping beds (23 classes) as compiled by Eurostat and ESPON (2007), Map 4 shows the

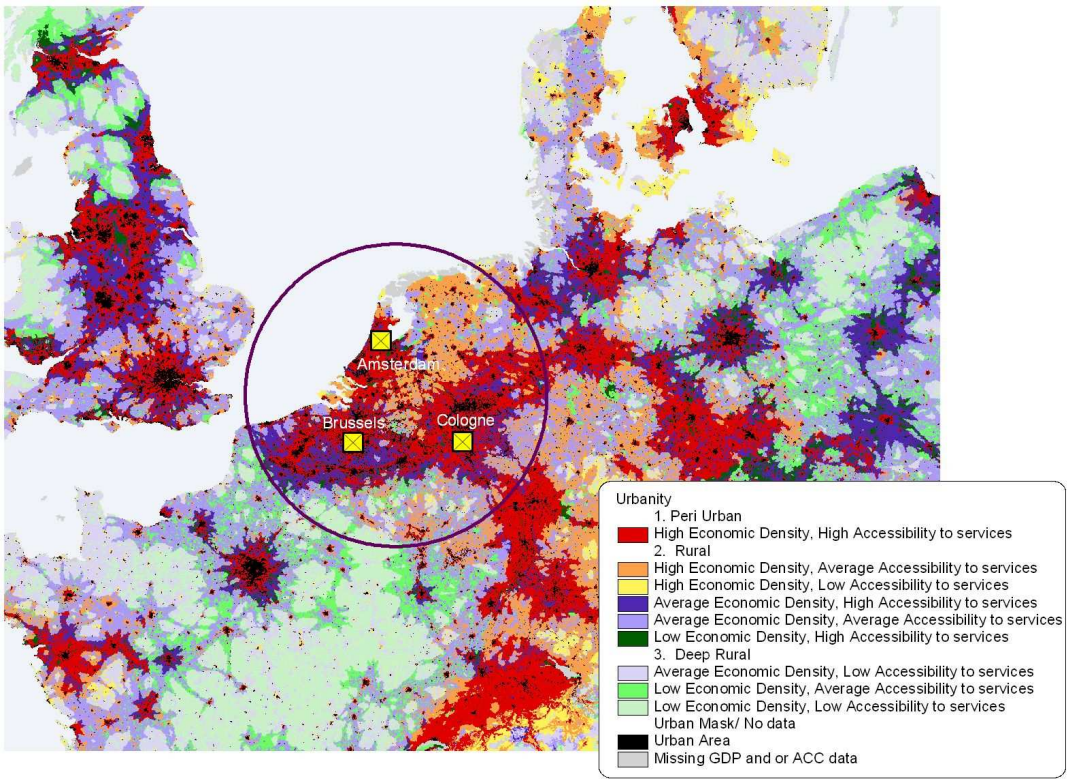
distribution of these leisure activities. This information deems necessary when assessing potential development areas for Dutch agricultural business.



Map 4: Leisurescape at the European level (Wascher et al. 2008)

Supra-regional socio economic forces: *drivers*

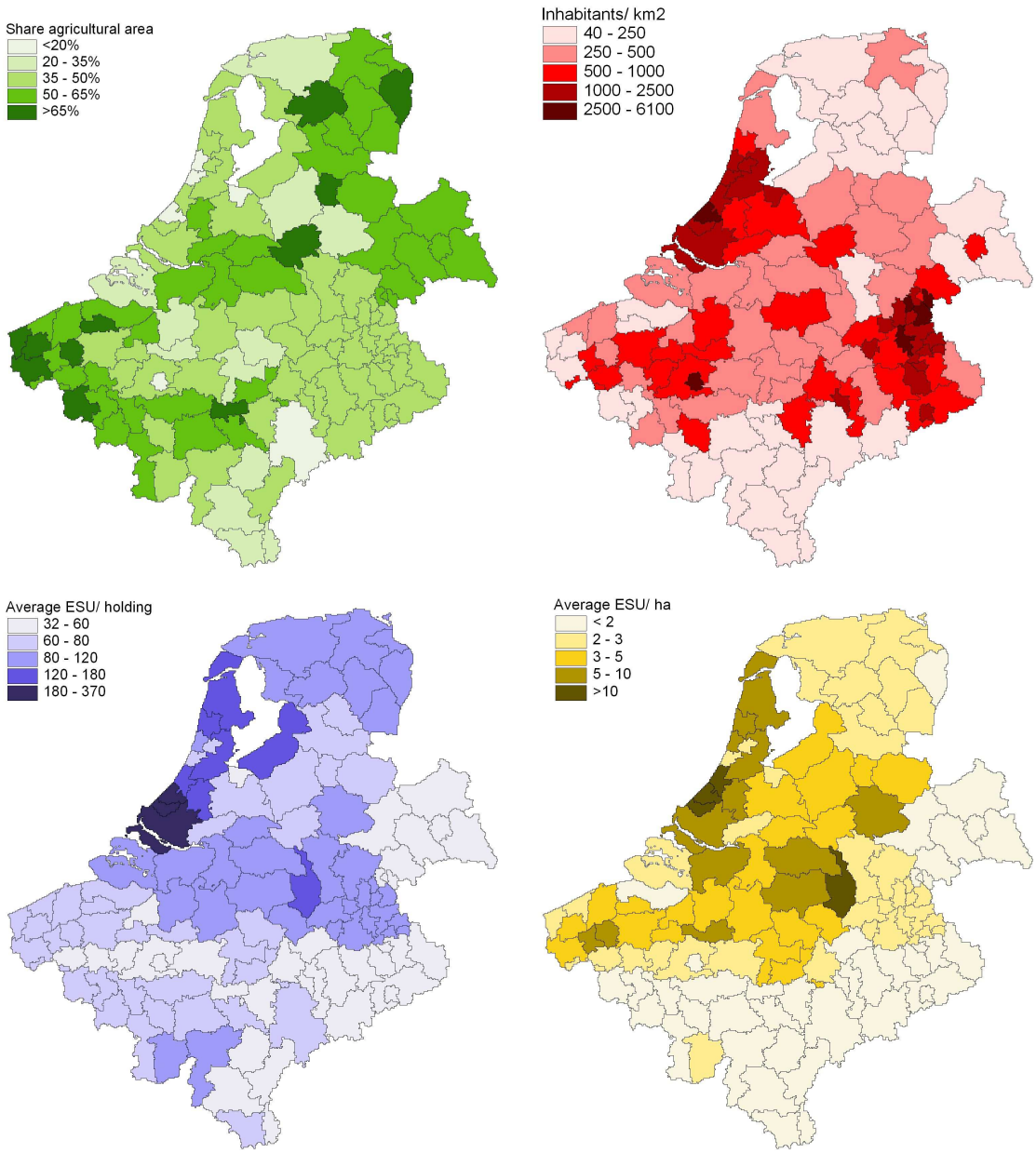
Land use change is depending on the dynamic relationship between the rural and urban, between different sectors such as forestry and agriculture and between different production systems. These dynamics are based on *drivers* in terms of people (traffic, settlements, and recreation), money (ground prices, investments, subsidies) and sector-specific land use trends affected by regional, national and international economic trends. The area of interest is quite naturally the region and when analysing these trends, regional economic profiles can be detected (Briquel and Collicard, 2004). Some basic indicators when characterizing drivers, like population or unemployment rates, or even GDPs (when available; it depends on the manner the region has been defined).



Map 5: Economic performance and accessibility to services (reference!)

Besides these key figures, a regional economic profile can look like a general summary of main data and indicators that characterize the region in various socio-economic domains, or can focus only on the domains that are the most in link with development main issues. For instance, one can find non-essential to give information about transport networks or flows where accessibility or mobility is not considered as a major issue. One constraint is that the information must be concise and carry a clear message about the region. Data or indicators that compare a region with another region or with a country help to precise what is worth pointing out for the region.

Maps 5a-d all show driving forces that dominate the agricultural sector. Map 6a 'share agricultural area' indicates the percentage agricultural area per NUTS region, a low percentage is caused either due to nature area or due to urban area. Map 6b gives the urban area based on the population density, it indicates the urban pressure per NUTS region. In general a high agricultural share means a relative low population density. A high population density or high urban pressure, results in a lower share agriculture area.

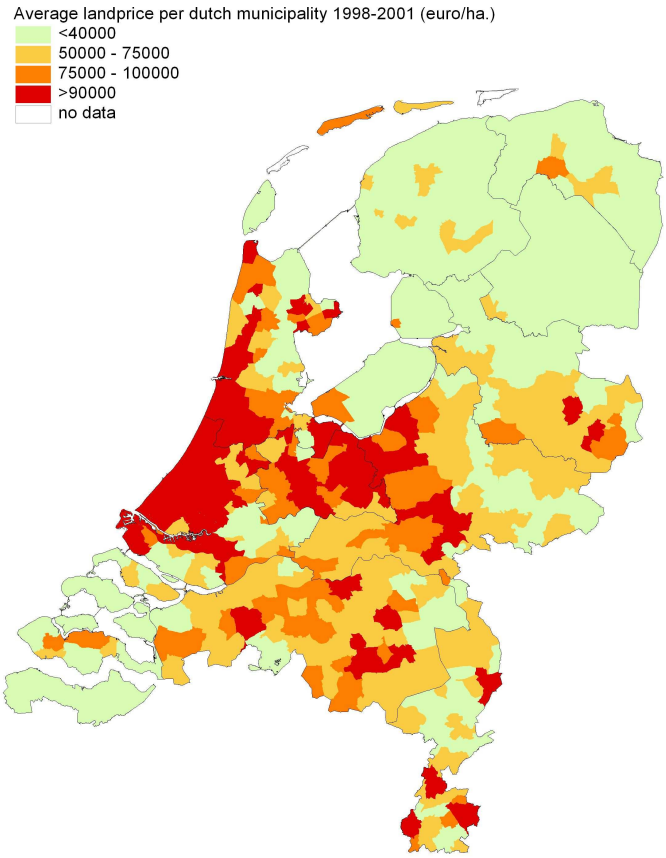


Map 6a-d. Driving forces for agriculture for NUT3 regions.

Map 6c and 6d indicate the economic basis of agriculture per NUTS region. The average ESU/ holding are given as indicator for competitive strength of holdings on international food markets. Nuts regions with a low average represent areas with many small holdings. These are the areas of minor significance for agricultural production. Areas with high average ESU/ holding are highly competitive on international food markets.

The map with average ESU/ha gives the intensity of agricultural production, indicating the competitive strength of agriculture on the regional land market. Areas with intensive agricultural production or more competitive. On the other hand, as shown in the map with

population density, these areas often have a high population density. Especially in the Netherlands areas with high urban pressure tend to have a more intensive production.



Map 7: Land prices at average value between 1998-2001 for the Netherlands

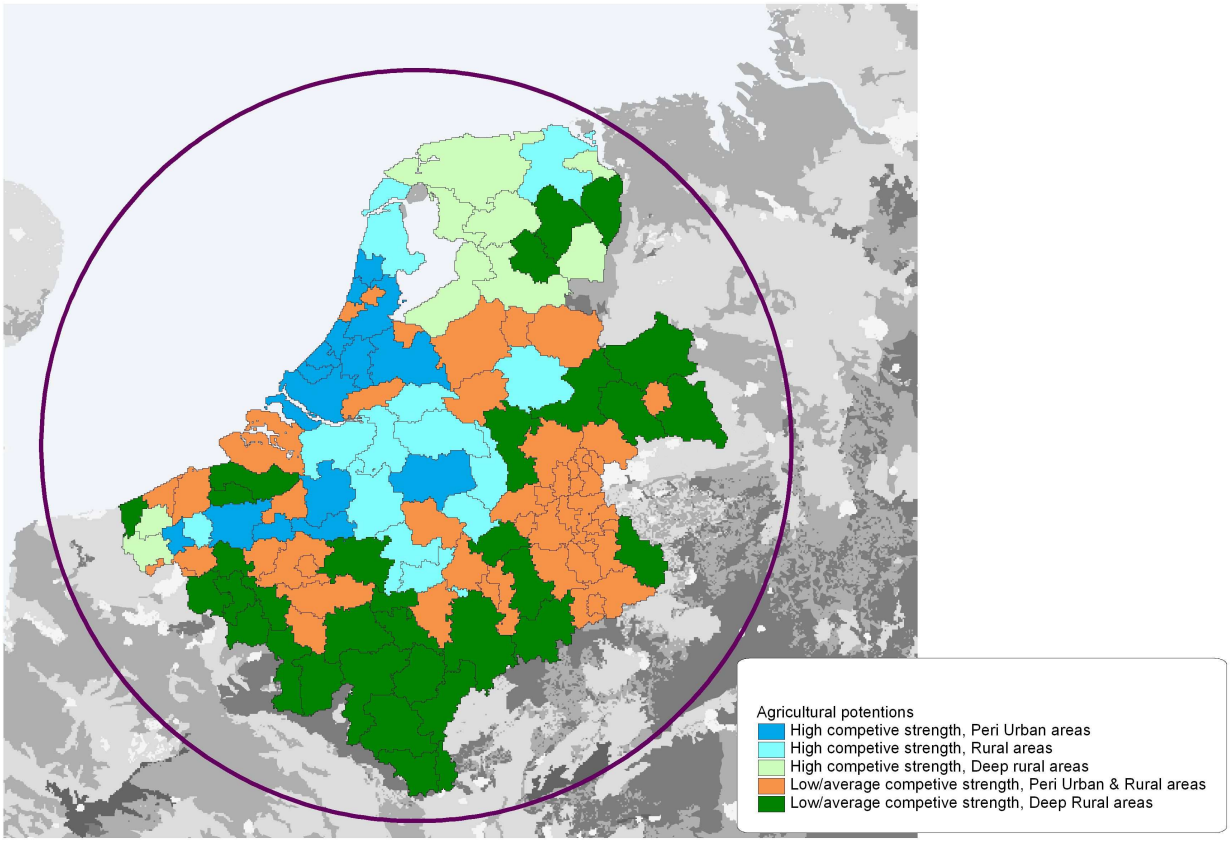
Land prices

One of the key driving forces for the value of the land is urban development and the quality of the soils. In competitive, free-market societies, these drivers have substantial impacts on the land prices which themselves can act as driving forces. High land prices are always a result of both existing land use trends and speculations. They are hence vulnerable to larger economic trends.

In areas where agriculture is competitive and urban pressure is low, there seem to be more options for ground based agriculture. By means of policymaking these regions come insight for locations of intensive agricultural production. Regions with low competitive strength of agricultural in combination with high urban pressure have little potential for agriculture. In these regions actual agricultural use tends to a transition to other non agricultural functions of the rural parts.

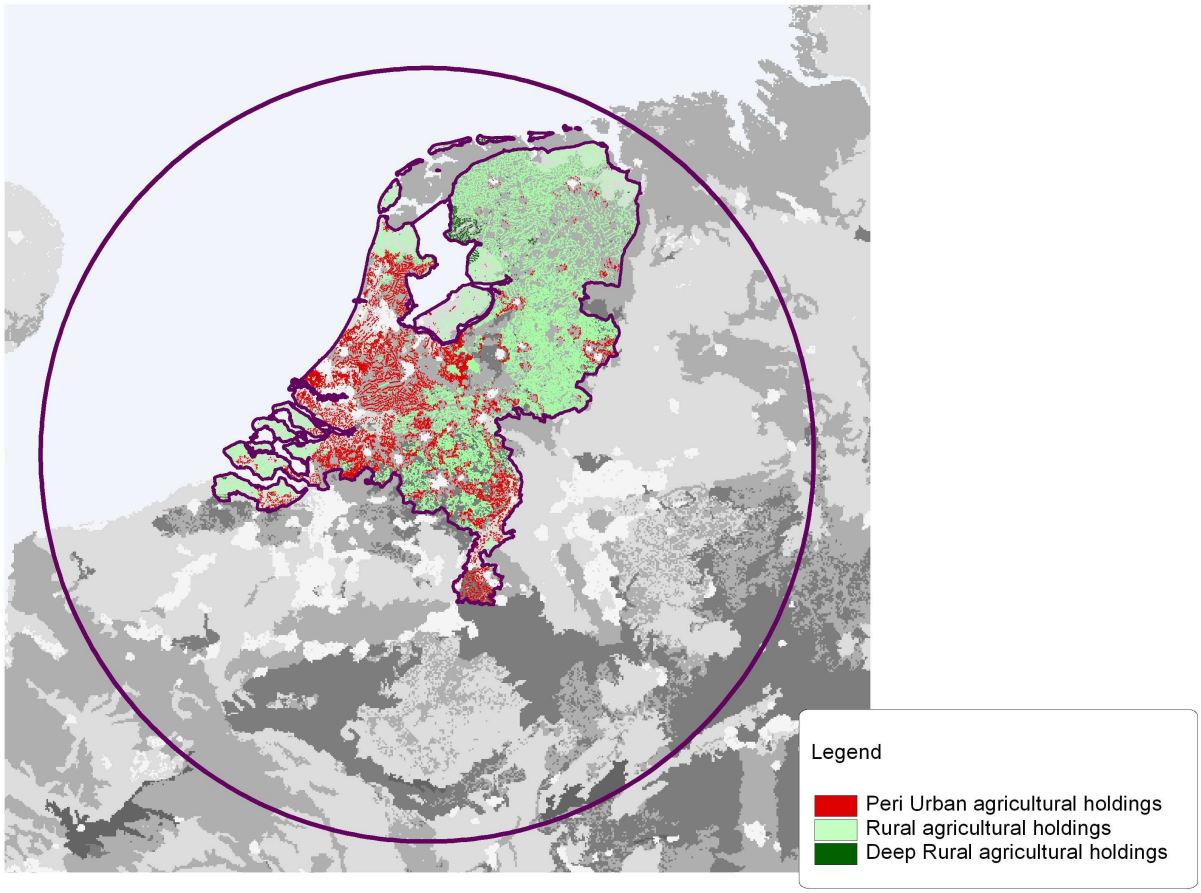
Intra-regional land use change dynamics: *flows*

Combination of the maps of urban pressure and competitive agricultural strength, gives understanding of agricultural potentials of regions, where high urban pressure and low competitive strength can be seen as push-factors. It means in areas with high competitive strength of agriculture and high urban pressure there is a trend of intensifying agricultural production. This autonomous trend can be tense with goals of policy makers to keep open areas close to the cities, a real and possibly increasing conflict that is the case already in several parts of the Netherlands.



Map 8. Potentials for agricultural production for NUT3 regions

Though Map 8 is largely building upon the data compiled in the category 'driving forces' (see Maps 5a-d) its results are more of a dynamic and prospective nature. It clearly shows that high competitive agricultural regions with strong peri-urban characteristics are located within the ABC-triangle between Amsterdam – Brussels – Cologne. The lower competitive regions coincide very much with the forested and mountainous regions. Of interest are also the high competitive communities in North-Holland, East-Gelderland and Groningen.



Map 9: Dutch agricultural holdings, based on the FARO typology (European threshold)

Table 6.Number of Agricultural holdings and distribution of the Dutch agricultural area

	Number of agric. holding	%	Agricultural Area (ha)	%
Peri Urban	31893	40%	573470	31%
Rural	46464	58%	1240494	67%
Deep rural	1206	2%	40563	2%
Grand Total	79563	100%	1854527	100%

Table 6. shows only 2% of the holdings and 2% of the agricultural area in the Netherlands is in a deep rural area. Next to that these holdings are mainly concentrated in the North-west region and therefore strongly influenced by local circumstances. To make a more clear analysis of characteristics between rural and per-urban agriculture the holdings in the rural and deep rural area in the next tables are no longer considered as separate groups.

Table 7. Share of agricultural area per sector

	Peri urban	Rural+Deep Rural
Arable farming	20%	26%
Dairy farming	38%	44%
Non dairy cattle farming	18%	14%
Mixed farming	11%	10%
Horticulture	10%	4%
Intensive meet production	3%	3%
Grand Total	100%	100%

Table 7. shows relatively more agricultural area is used in peri urban area by horticulture and non dairy cattle farming. The horticulture holdings can be character sized as industrial agricultural production while the non dairy cattle farming are mainly small holdings with extensive use of land.

Table 8. Average size of holdings (area and economic production) and average intensity of production.

	Av. area (ha/holding)	Av. economic production (nge/holding)	Av. Intensity (nge/ha)
Peri Urban	18	112	6.2
Rural/ Deep Rural	27	78	2.9
total	23	92	3.9

Table 8 shows that holdings in the peri urban area on average are smaller but much more intensive. The average (economic) production size per holding in the peri-urban area is 43% higher then the average size of farms in the rural/deep rural area. Important is to notice that it is likely that the high average economic size of holdings in the peri urban area is caused by a part of really big holdings. Table 5 proofs this assumption

Table 9. Distribution of agricultural area in relation to economic size of holdings

	Peri Urban	Deep rural +rural
< 70 nge	32%	25%
70-100 nge	18%	17%
>100 nge	50%	57%
Total	100%	100%

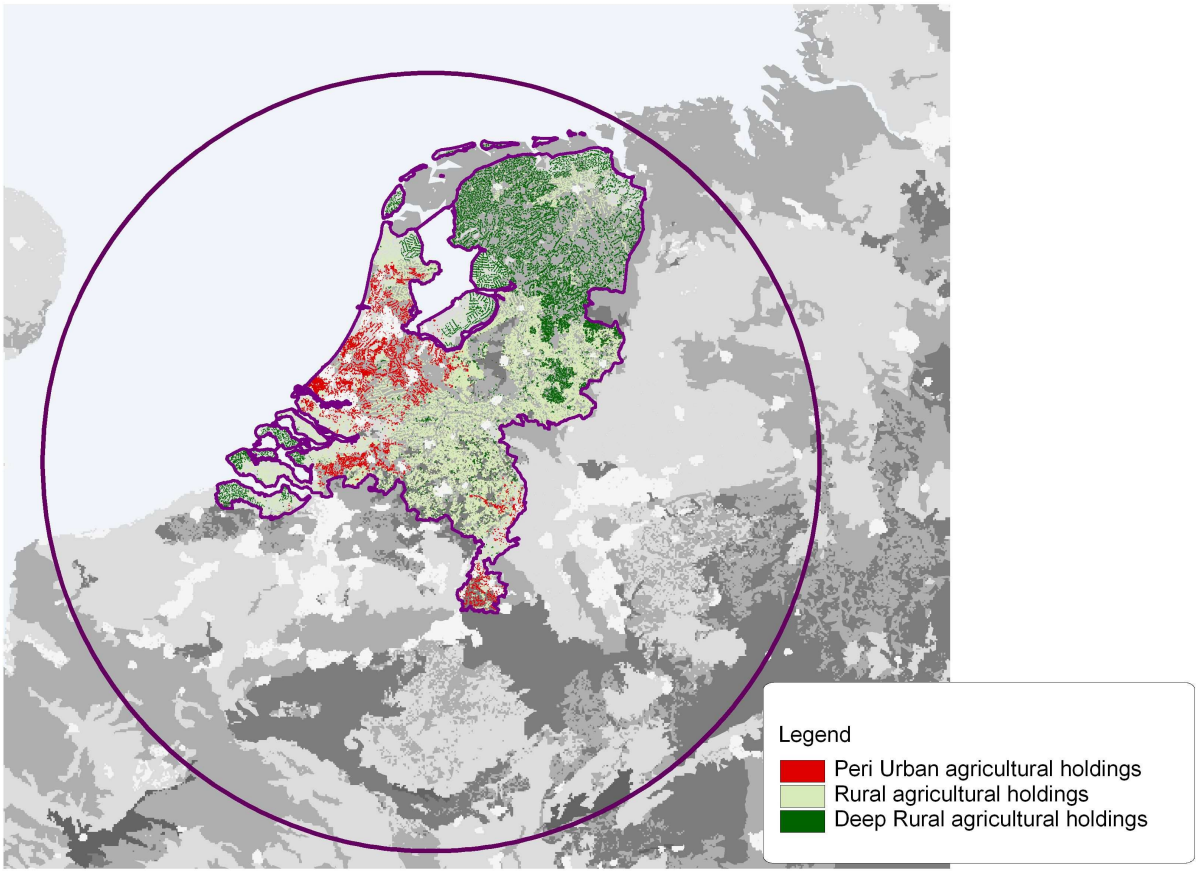
Table 9 shows for the peri urban area that relatively more land is used by small holdings. It means the high agricultural production in the peri-urban area is being realized on a relatively small area. A large part of the agricultural area in peri-urban areas is in extensive agricultural use.

Because the peri-urban area has more small farms its likely to have a higher share of multifunctional agriculture. Table 6 shows the share of multifunctional holdings

Table 10. Share of holdings with multifunctional agriculture

	Peri Urban	Deep rural +rural
Nature and landscape conservation	8.2%	8.3%
Use or production of sustainable energy	5.8%	7.6%
Sale of products	4.2%	2.9%
Recreation	2.6%	3.3%
Processing products	1.1%	0.7%
Care farming	0.7%	0.7%
Biological production	1.4%	1.5%

For most types the share of multifunctional agriculture is not higher for the peri-urban area. Sale and processing of products is found more often in the peri-urban area



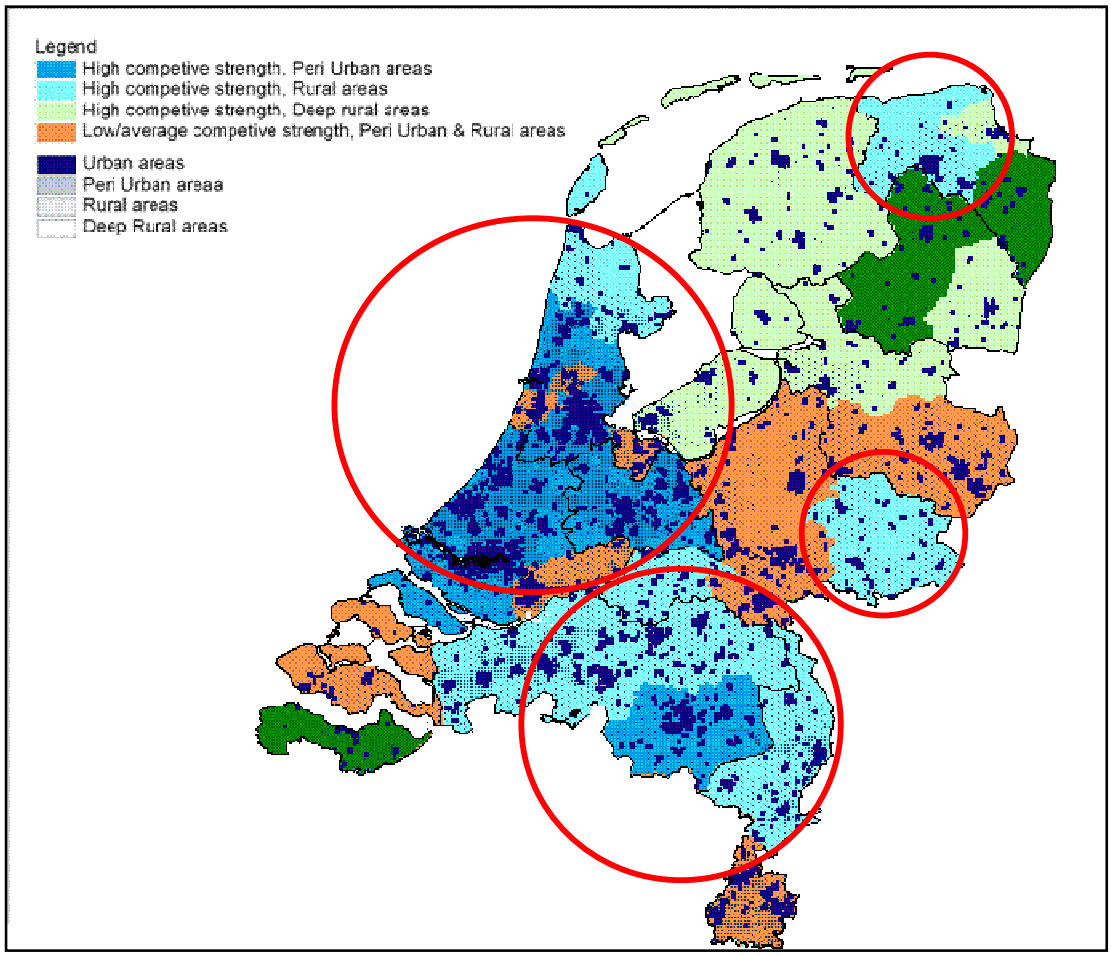
Map 10. Dutch agricultural holdings, based on the FARO typology (Regional threshold)

The Rural Classification for the European Union (van Eupen, 2008) is classified based on average economic density and accessibility per Environmental Zone (Metzger et al. 2005).

This is giving a meaningful division for European regions with comparable environmental conditions. However, when a region is taken out of the European context and compared with itself, the same can be done on a low level. The Rural Classification for the Netherlands (source: van Eupen, 2009) is using the same basic datasets for economic density and accessibility, but it is classifying these data sets according to the Dutch average and standard deviation. For the Netherlands the averages are higher than the average of the Atlantic Environmental zones, in which the Netherlands are situated, and the standard deviation is much narrower. This is logically resulting in a more differentiation of the 9 rural-urban classes within the Netherlands (see Map 10).

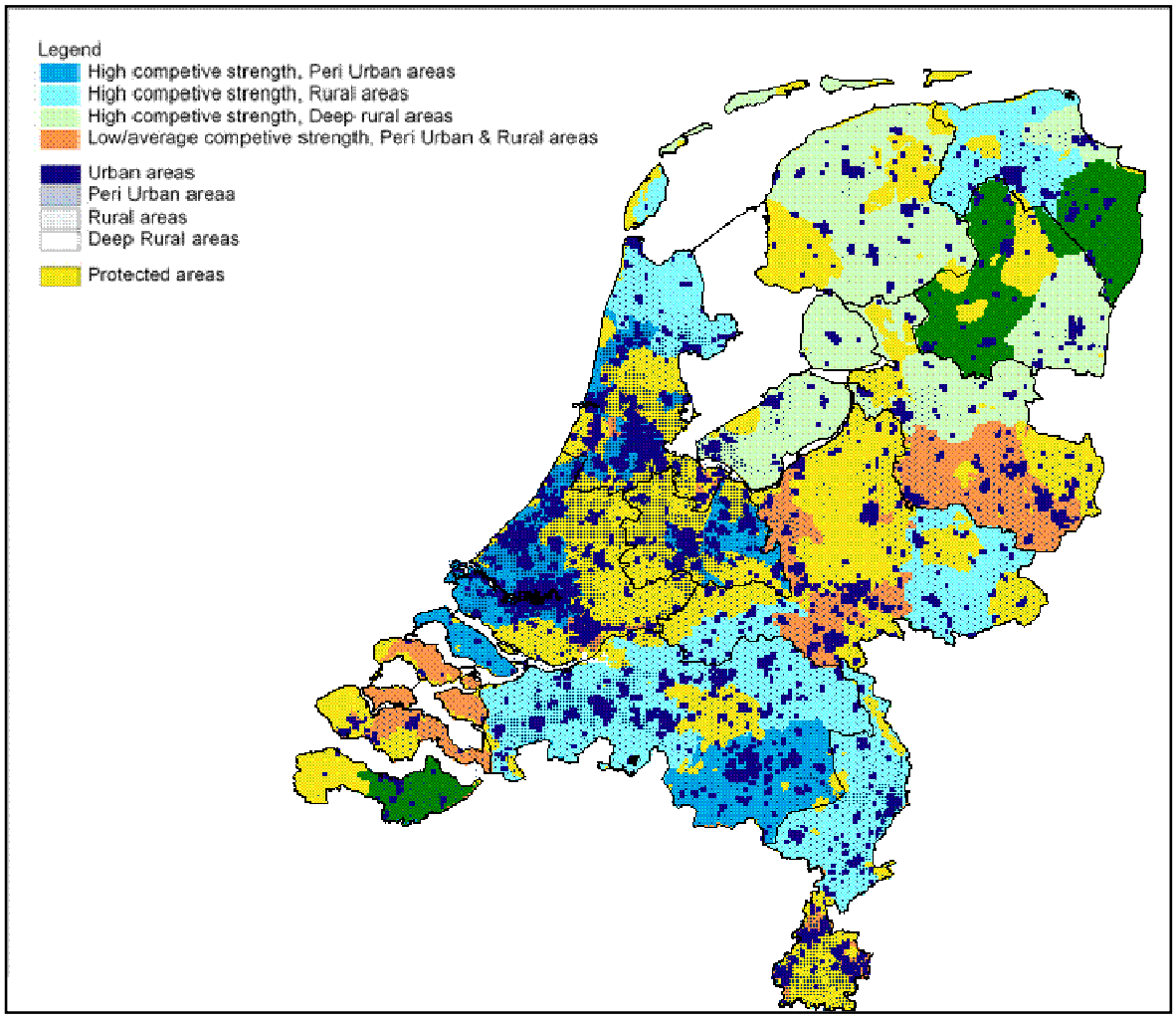
4.2 Spatial visions for Dutch metropolitan agriculture

A thorough analysis of the above spatial characteristics associated with metropolitan agriculture in the Netherlands and their direct cross-boundary surroundings provide the possibilities of exploring the existing and potential realms of agricultural development. By selecting the information on Dutch agricultural potentials based on competitiveness and population density data (Map 8) in combination



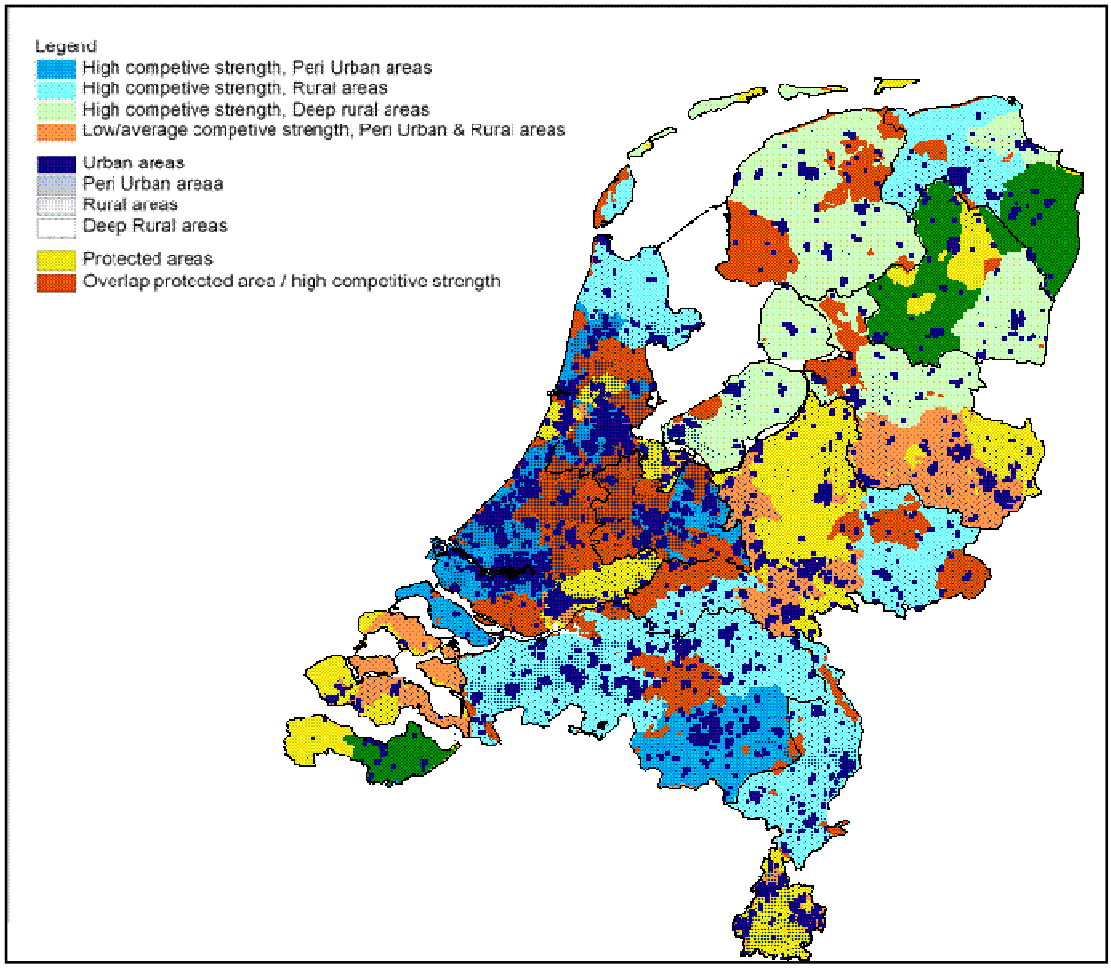
Map 11: Dutch agricultural competitiveness compared to urban-rural situation. The circles indicate metropolitan agro-potential priority zones

with data on urban vs. rural agricultural areas, Map 11 allows interpretations for how TransForum Innovative projects could possibly be placed or up-scaled into suitable rural and peri-urban spaces. With the help of the Innovation Characteristics (Box1) it should be possible to develop the necessary decision rules for spatial allocations, safety distances, landscape planning principles but also data management processes and stakeholder discussion when developing strategic plans for IPs in Dutch metropolitan landscapes. Map 12 shows the same areas but in the context of the larger protected areas of the Netherlands which are being considered as 'natural' boundaries for the expansion tendencies of Dutch innovation programmes – but also as potential multifunctional regions to host those IPs which are targeted at the more integrative dimensions of agricultural innovation. The last map (13) facilitates the interpretation of the previous ones by showing the overlap zones (possible conflict or integration zones) as highlighted areas.



Map 12: Dutch agricultural competitiveness compared to urban-rural situation and protected nature and landscape sites.

Assessing perspectives for Dutch both industrial as well as multi-functional metropolitan agricultural land use in terms of potential expansion areas as well as 'red tape' zones (reserved for pre-dominantly no or only extensive forms of agricultural as portrayed in Maps 10 to 12 can rightfully be considered as possible building blocks for a Dutch Agricultural Main Structure or *Agrarische Hoofdstructuur* (AHS). An indeed, the research commissioned by TransForum included an exploration on the question whether such an AHS can be identified as part of the spatial vision for Dutch metropolitan landscapes, thereby establishing something like a complimentary structural to the Ecological Main Structure (EHS). The question is not new. Since the establishment of the EHS, the agricultural and also other sectors felt challenged to also develop their own spatial planning approaches in a more



Map 12: Dutch agricultural competitiveness compared in the light of urban-rural situation with special attention to the overlap with protected areas

explicit way. Despite the fact that nature and landscape has continuously been marginalized by agricultural intensification – resulting among other in a substantial loss of biodiversity and cultural landscape values (Wascher & Rössler 2005) - the EHS was rapidly seen as thread to agricultural interests. Since this time, the establishment of an AHS is object of a critical debate between different stakeholder groups. It hence does not come as a surprise that the Dutch 'Council for Rural Areas' (Raad landelijk gebied - RLG), a body with a clear nature

conservation orientation, declared an AHS as not desirable: "The Council states that a national AHS represents a concentration zone for footloose and/or large-scale ground-dependent agriculture and is as such not adequately fitting the diversity of the Dutch landscape characterized by a mosaic of functions and variation of production types. Such an AHS can result in a substantial degeneration of nature, landscape and recreational functions. The diversity and fine-grain aspects of the Dutch landscape with its wide coherence of different interests does not require a segregate and exclusive, but an integrated territorial approach." (RLG 2007).

4.3 Conclusions

Rather than considering the concepts and cartographic materials produced for this report as blueprints for the "segregate and exclusive interests" of industrial agriculture, we feel that this information can offer the type of integrative tools which the RLG is rightfully requesting. Though a wide range of fine-grain natural and cultural aspects are certainly not included in this assessment – due to scale and scope of the exercise – it becomes clear that the type of landscape assessment techniques applied in this research offer the opportunity to prepare the ground for a wide set of varied and targeted measures in line with sustainable and multi-functional land use requirements. In order to do so, the six Innovation Characteristics developed in this report (see Box 1) can serve as operational tools when analysing the future impacts of TransForum IPs on sustainability along the triple-p approach.

We hence put forward the following concluding statements:

- Building upon TransForum's **definition of Metropolitan Agriculture** (MA) the report offers a comparison with the concept of Urban Agriculture (UA), a term that is more widely used and acknowledge in both literature and public debate. While UA is frequently used as an umbrella term for a rather wide range of farming activities in and around cities, the recently emerging trends towards new forms of 'commercialised agriculture' in the wider peri-urban regions outside city boundaries deserve to be clearly set apart from it. Given the substantial differences between the essentially small-scale, inner city and subsistence-oriented initiatives and the more commercial, high-tech and (supra-)regional dimensions we propose to set the two phenomena apart by calling the first *urban* and the latter *metropolitan* agriculture.

- At the more **fine-scale level**, Heimlich (1989) found metropolitan agriculture in the US to be characterized by smaller farms, more intensive production, a focus on high-value crops and livestock, and more off-farm employment as contrasted with rural agriculture. The degree to which metropolitan agriculture shared these elements was related to the length of time that the metropolitan landscapes had been affected by urban pressures, with older metropolitan areas having more adaptations in farm characteristics. In the Netherlands, the latter is be expressed by the co-existence of rather intensive, high-tech farming (e.g. glasshouse production) next to extensive, low-income traditional farms in the direct proximity of urban centres.

- We further observe that the innovative character of existing Metropolitan Agriculture – as manifested in the TransForum **portfolio of Innovative Projects (IPs)** – sets

MA apart from conventional and other forms of agriculture. This is mainly due to the vision of a full-fletched *triple-p-sustainability in the configuration of largely self-supportive system-networks* at the scale of larger metropolitan regions. However, it must be stressed that the type of self-supportive system networks (TransForum's 'Vital Cluster') do not yet exist or are – in terms of functions and area coverage – only very partially realised. In this context, TransForum IPs can be understood as 'live' test laboratories for the type of future MA.

- Another important differentiation within the Metropolitan Agricultural domain as defined in the previous sections is the **co-existence of mono-functional industrial** on the one hand (namely 'Vital Cluster') **and multi-functional forms** of MA (namely 'Regional Development'). What both concepts have in common is that they are both focused on innovative ways of integrating agricultural production into metropolitan systems. At the same time, both concepts have very different characteristics and are based on a different set of value propositions and sustainable principles. The concepts appear to be, at least spatially, incompatible.

- One of the corner stones of TransForum's conceptual approach is **the role of System Innovation**. System innovation is a non-linear learning process, that is, the process occurs in a manner which builds in feedback loops which enables constant re-evaluation and revision. This is a fundamental change from the formerly prevalent top-down model of knowledge transfer from scientific experts to practitioners. Through some 60 practice, scientific and learning projects, TransForum has identified three stages of value formation which happen in sequence: value proposition, value creation and value capturing. According to TransForum, true innovation cannot stop at the first stage but must go through at least two consecutive phases to produce a concrete result.

- On the basis of the discourse on urban vs. metropolitan and industrial vs. multi-functional agriculture, SUSMETRO developed a set of **six characteristics for system innovation**: *spatial impact, foot-loose production, urban rural link, multi-functional land use, sustainable development objectives, and science-practise link*. For the selection of proper IPs for the future up-scaling process (SUSMETRO Phase 2) all IPs have been rated on the basis of simple assessment rules addressing the presence of non-presence of these characteristics. It should be kept in mind that these characteristics are supposed to be objects of the so-called 'New-Value-Proposition' deriving from a Mode2 science-policy-stakeholder interface.

- Though performed for the IPs across all three TransForum categories (vital clusters, regional development and international agro-food networks), the selection process focussed only on the first two categories as agro-food networks lacked the type of direct spatial dimension that was considered as key to the SUSMETRO research. The **selected projects** were: Greenport NL, New Mixed Farms, Dairy Adventures, Streamlining Greenport Venlo, Green Care, Northern Frisian Woods, and NMVC Heuvelland. These projects have mainly been selected on the basis of their clear spatial impacts and specific ways of linking innovation with sustainability objectives. All selected projects have been described in the context of innovation in more detail

- The objective to develop a vision for (Dutch) metropolitan agriculture requires taking into account the Innovation Characteristics in the context of different agricultural production systems and their real as well as virtual boundaries. When undertaking a spatial-functional assessment, the following **three dimensions of a spatially explicit vision** require attention (1) the bio-physical environment (*stock*), (2) the supra-regional socio economic forces (*drivers*) and (3) the intra-regional land use change dynamics (*flows*). One of the key considerations of the SUSMETRO approach has been the question whether the relevant data sets exist also at the European level. The advantage of European data (e.g. by the European Environment Agency, the European Statistical Office and other expert centres) is their universal availability and consistency across borders – a clear asset for projects such as SUSMETRO that want to link up with other international research. The ABC-Region (Amsterdam-Brussels-Cologne) serves hence as the central geographic reference for this assessment.

- The **three main research questions** to be addressed through the cartographic assessment when identifying spatially explicit development perspectives for metropolitan agriculture in the Netherlands, are:
  - How are metropolitan agricultural production systems linked to landscape character (multi-functionality)?
  - How do parameters of stock and flows affect the chances for rural transformation and innovation processes (bottom-up)?
  - How do driving forces such as policies, demography and market mechanisms affect spatial planning at the national level (top-down)?

- The **principle spatial data sets** that has been selected is as follows. With regard to the bio-physical environment (*stocks*): the Urban-Rural classification developed by the EU project FARO (van Eupen et al. 2008), here specified for the Dutch context; the European Landscape Classification LANMAP2 (Mücher et al. 2006); Nature and Landscape Protected areas (WCMC/UNEP 2008; LNV 2008); and the map of Leisure and Landscape (Wascher et al. 2008). For the supra-regional economic forces (*drivers*): economic performance and accessibility to services (FARO); Share of agricultural areas – Inhabitants/km2 – Average ESU/holding – Average ESU/ha (FADN/LEI 2008); and land prices of the Netherlands. For the intra-regional land use change dynamics (*flows*): potentials for agricultural production at NUTS level (FADN); Dutch agricultural holdings based on FARO typology.

- A **final integrated cross-analysis** based on targeted selections among the above data sets illustrates Dutch agricultural potentials based on competitiveness and population density in combination with data on the distribution of urban vs. rural agricultural areas. A further analysis allows to further narrow down the spatial 'windows of opportunity' for future agricultural innovative projects by projecting the results against the larger protected areas of the Netherlands which can be considered as 'natural' boundaries for the expansion tendencies of Dutch innovation programmes – but also as potential multifunctional regions to host those IPs which are targeted at the more integrative dimensions of agricultural innovation.

The methodological tools and criteria as well as the spatial concepts developed by SUSMETRO allow interpretations for how TransForum Innovative projects could possibly be placed or up-scaled into suitable rural and peri-urban spaces. With the help of the Innovation Characteristics (Box1) the necessary decision rules for spatial allocations, safety distances, and landscape planning principles can be developed. At the same time, these characteristics will become part of the data management processes and the object stakeholder discussion when developing strategic plans for IPs in Dutch metropolitan landscapes. Facilitating the interpretation of the spatial opportunities and challenges, the integrative assessment (Map 13) shows overlapping zones between metropolitan agro-potentials and socio-political claims in form of multi-functional land use and territorial policy designations. Many of these overlap zones – like for example the Green Heart – are likely to become crystallisation points of metropolitan agriculture where innovative concepts are needed to ensure sustainable life and living.

5. Up-scaling, Impact Assessment and Visualisation – the next steps

SUSMETRO Phase 2 will build upon both the findings of the Phase 1 report in terms of (1) the identified data and modelling requirements, (2) national and international (EU and US) research and policy initiatives in the field of metropolitan agriculture and (3) the feedback of TransForum as the essential stakeholder. Since this feedback still needs to be provided, we just list here the main lines of actions that are being envisioned.

5.4.1 Identify the key components (data and models) of the European projects on land use change scenarios for sustainability impact assessment that should feed into SUSMETRO

Making use of the results of Phase 1 and the stakeholder feedback, the SUSMETRP Phase 2 will undertake a targeted effort to exchange with researchers and desk officers responsible for European Integrated Projects such as SENSOR, SEAMLESS or PLUREL, as well as related projects such as SCENAR, FARO or EURURALIS to inform about possible ways of cooperation and data exchange for incorporating SUSMETRO output into their work and vice-versa. One of the criteria for identifying the components shall be their potential role of the visualisation. Establish a list of options for integration between SUSMETRO and the different EU project (table) to be circulated among the TransForum Programme Team and KOMBI Stakeholders.

5.4.2 Develop detailed conceptual approach linking Phase 1 Innovation Characteristics and the spatial-functional analysis to guide a systematic up-scaling process of TransForum IPs o.

Building upon TransForum's vision as well as on its innovative project results and taking into account the SUSMETRO project proposal and findings under Phase 1, develop a sound conceptual approach in which the relationships, activities, logistics and data-operations under Phase 2 are presented in a transparent way.

5.4.3 Develop a time and (contra-)funding plan for Phase 2 in which activities and product development that affects the work of finalised or running European projects are scheduled.

The contra-financing plan is largely secured by the existing research link with the academic instructions in LAR 60318 during the period 1 and 2 in 2009 with prospects for further support out of EU project such as Geoland2. Regarding the approximate time schedule for Phase 2, please see table at the end of Annex 4.

5.4.4 Establish a Phase 2 project team (implementation) and a scientific committee (advising).

The project team for Phase 2 will partially build upon researchers that have been involved in Phase 1. On the other hand, the different types of activities will require

new expertise. In addition, the scientific committee will be recruited out of those projects and project components that are playing a key role. The question to which degree and in which way KOMBI partners should become members of a special committee needs to be discussed with TransForum.

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Annex 1: TransForum IPs

Business model	Spatial impact	Foot-loose	Urban link	Multi-functional	Sustain-able	Science-Practice link
Vital Clusters						
Greenport Shanghai	+	+	-	-	+/-	+
Agropark. Strongly building on network of New Mixed Company. Innovative combination of Knowledge Institutes, Entrepreneurs, Governmental and Non-governmental organizations working is pre-dominating problem						
Biopark Ghent-Terneuzen	-	+	-	-	+	+
Agropark. Second, final phase almost concluded. Implementation of enterprise will start in 2008. Tuning of process flows and business models between different enterprises proofs very difficult.						
Healthy Pip Fruit Chain	+	-	-	*	+/-	+
Introduction of cis-genetic modification to speed up race development in fruits. Efforts concentrate on technical innovation, which gives the project the character of a scientific project instead of an innovative practice project.						
Mainport Aalsmeer	*	*	+	-	-/+	-
Regional approach to accessibility of Greenport. Formulating “Problem as conceived by all stakeholders” is major effort in first phase. Result of successful co-operation between TransForum and Transumo.						
New Mixed Farm	+	-	-	-	+	-
Agropark. Government regulation determines the speed of the innovation process. Entrepreneurs are now setting up small scale business school on sustainable development.						
SynErgy	-	+	+	-	+	+
Learning network on Energy in Greenhouses. Created a learning network now evolving into a Community of Practice. Strong emphasis on communication with early adapters via seminars. Successful programming of scientific projects.						
Dairy Adventure	+	-	^^	+	+	-
Three regional specific experiments with dairy farming beyond the scale of family farms, characteristic for NL. Application of knowledge and experiences from Dutch emigrants who started large dairy farms. International Community of Practice.						
Regional Development						
Business model	**Spatial impact**	**Foot-loose**	**Urban link**	**Multi-functional**	**Sustain-able**	**Science-Practice link**
De Sjalon	+	-	-	-	+/-	-
The development of a large scale arable enterprise in the NoodOost Polder, by merging arable farms in collaboration with dairy farms and chain partners. A business plan has been developed						
Green Care	-	-	+	+	+	-
Developing of a cooperation of Care Farms and Educational Farms, in collaboration with care organisations and schools. The cooperation, now consisting of 20 farmers, has been recognized by the national health insurance.						
Northern Frisian Woods	+	-	?	+	+	-
Supported the farmers’ organisation NFW in their aim for self regulation in environmental and landscape management. A ‘regional contract’ was developed and space for experiments created.						

NMVC Heuvelland	?	-	+	+	+	-
New Markets and Vital Coalitions. New value propositions and coalitions were developed. Important lessons were learned about regime aspects. 'Red' is taking responsibility for what is 'green'.						
Greenport Venlo	-	+	+	-	-	+
A network of entrepreneurs and local governments is supported who are developing the 'Greenport Venlo' a dynamic region in Northern Limburg, on 'food, feed and flowers'. Focus on learning processes by organising and facilitating Communities of Practice.						
Brackisch Agri on Texel	+	-	?	+	+	+
Experiments and research of new Brackish Crops both in laboratory and field circumstances. Focus on plant properties and cultivation techniques, product and market development. Field experiments have been started						
International Agrifood Networks						
Business model	**Spatial impact**	**Foot-loose**	**Urban link**	**Multi-functional**	**Sustain-able**	
Flor-i-Log	-	+	+	-	-	-
Dutch flower auctions and wholesalers are looking for new organisational and logistic models to maintain the Dutch leading position in the international floricultural sector. Goal is to seriously diminish unnecessary transport of floricultural products.						
Quest for Golden Egg	-	+	+	?	+/-	?
System innovation in the table egg sector. The actual laying hen production systems still have many veterinary, environmental and animal welfare problems.						
Int. Livestock Coord.	-	+	?	-	-	-
Transforming the entire livestock farming chain into sellers of knowledge and services in international markets. The aim of the project to develop a strategy to exploit this knowledge has not been obtained in this project.						
Calendula	-	+	?	-	+	+
Start of a new company ' "Calendula Oil BV" that will bring Calendula Oil on the market. FEM-Business Magazine recently selected Calendula Oil BV as one of the 25 'most promising' start ups.						
Sustainability Retailing	-	+	+	-	-	-
Find out whether a pull strategy through retail can speed up the transition towards a more sustainable agro food production and how a transition approach of strategic stakeholder partnership works out in practice.						
Health Oats	-	-	?	-	+	-
A new chain of high quality products on the basis of guaranteed gluten free oats. Gluten free oats will contribute to the reduction of an important social healthy problem of a growing group of celiac patients (2% of the population).						
More about Food	-	-	+	-	+	-
can find production information to easily compare sustainability performances of various food products. The consumer information thus generated can be used by participating industries and retailers for new, sustainable value propositions.						
Regional Food Chain	-	^^	+	-	+	-
Primary producers are also responsible for merchandizing their products in the retail to the consumers. In this project the hierarchies in the chain are changed; analysed both for supermarket and for producers.						

Annex 2: LANMAP x FARO areas (km2)

Lowland-Sediments	Total (km2)	% Urban	% Peri - Urban	% Rural	% Deep Rural	Total
Arable land	45794	9%	44%	45%	3%	100%
Pastures	16383	6%	21%	66%	6%	100%
Heterogeneous agricultural areas	10098	11%	45%	42%	2%	100%
Shrubs & herbaceous vegetation	119	1%	0%	18%	82%	100%
Wetlands	23	0%	17%	52%	30%	100%
Forest	2480	8%	30%	59%	3%	100%
Total	**74897**	**8%**	**38%**	**50%**	**4%**	100%
Lowland-Organic materials						
Arable land	2710	2%	4%	79%	15%	100%
Pastures	3175	7%	34%	53%	7%	100%
Heterogeneous agricultural areas	123	2%	24%	59%	15%	100%
Wetlands	88	5%	0%	50%	45%	100%
Total	**6096**	**5%**	**20%**	**64%**	**11%**	100%
Lowland-Rocks						
Arable land	2931	6%	18%	37%	39%	100%
Atlantic-Lowland-Rocks-Forest	10	0%	0%	80%	20%	100%
Total	**2941**	**6%**	**17%**	**38%**	**39%**	100%
Hills-sediment						
Arable land	14002	8%	42%	41%	9%	100%
Pastures	5913	4%	16%	59%	21%	100%
Heterogeneous agricultural areas	1747	13%	64%	22%	1%	100%
Forest	9983	4%	9%	55%	32%	100%
Total	**31645**	**6%**	**28%**	**48%**	**18%**	100%
Hills - rocks						
Arable land	6796	3%	11%	65%	20%	100%
Pastures	4391	9%	43%	47%	1%	100%
Forest	967	1%	0%	82%	17%	100%
Total	**12154**	**5%**	**22%**	**60%**	**13%**	
Mountains						
Forest	3983	**1%**	**15%**	**70%**	**13%**	100%
Grand total	131716	**7%**	**32%**	**51%**	**10%**	100%

Annex 3: SUSMETRO Poster (January 2009)

SUSMETRO*

Spatially explicit assessment of Metropolitan Agricultural Landscapes

* Phase I of the TransForum Project SUSMETRO (Vision, Assessment and Design for Sustainable Metropolitan Agriculture)
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"Metropolitan Agriculture is a deliberately designed system of intelligently connected production sites that uses the available resources, conditions and infrastructure in metropolitan areas to produce material and immaterial demands for the same metropolitan area" (TransForum).

1. What are Metropolitan landscapes?

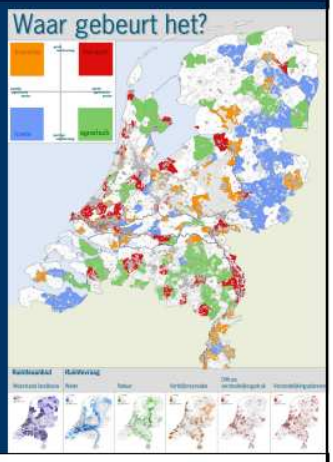
- Can rural-urban indicators represent different degrees of 'metropolitansm'?
- Which Dutch landscapes can be considered as metropolitan?
- Is there a general trend / evolution towards metropolitan agriculture?
- What are the main (spatial) drivers / obstacles for this transition?
- Which public goods and impacts are associated with metropolitan agriculture?
- How does the Dutch situation relate to European case?

2. What are (spatial) characteristics of different types of Metropolitan Agriculture?

Mono-functional industrial agriculture (large-scale, incl. Vital Clusters)	Multi-functional modern agriculture (mainstream-marketing, city-oriented)	*Traditional and organic agriculture* (alternative marketing)
'Footloose'	Close to urban areas (cycle distance)	Land-based
Clustering of activities and integration of production chains	Based on Consumer – Producer relation	Integration of red and green elements
Strategic position in Transport networks (harbours / highways etc.)	High potential for combinations with other functions (food production, recreation, nature conservation, water storage)	Not too many other spatial claims (enough space for growth / reconstruction)
At infrastructural 'hot-spots'	Possible in areas with high landscape / heritage values)	Not in areas with high ecological value
Outside areas with high ecological / heritage / landscape values	Open / interactive system	Strong, existing production systems / networks
Closed / protected system		
Other? ***Centres of International Agri-food networks***	*Other?* ***Linked with International Agri-food networks***	*Other?* ***Parts of alternative marketing networks***

3. How does Metropolitan Agriculture relate to (existing) regional dynamics and characteristics?

- What are existing regional dynamics in Dutch metropolitan areas?
- What are the basic characteristics ('Kernkwaliteiten') of these different areas?
- How strong is the need / demand for a transition of agriculture?
- How does the spatial allocation of metropolitan agriculture affect sustainability?
- Is there a need for a Dutch Agricultural Main Structure to guide further planning?
- Which tools will help stakeholders to get engaged?



ALTERRA WAGENINGEN UR

TRANSFORUM

Annex 3: SUSMETRO Phase 2 Specifications (tentative)

2.1 Up-scaling of TransForum principles

Based on the selected innovative projects identified in Phase 1, (1) undertake a national up-scaling exercise by means of GIS and KOMBI methods in which the likely distribution of TransForum-style measures, plans and land use trends are being identified (using LGN); (2) undertake a simplified approach for the wider NW-European region (using CORINE LC); and (3) initiate and guide experts for undertaking a similar effort for a metropolitan agricultural region in Michigan, USA.

2.1.1 National up-scaling exercise

Methodology: making use of best available international (FARO, LANMAP2, FADN) and national data on land use (GIAB, LGN) further develop and apply the Phase 1 Innovation Characteristics for up-scaling methodology for the selected TransForum innovative projects. The result shall be a series of thematic maps of the Netherlands displaying the different up-scaling results and one conclusive map in the context of the AHS and metropolitan landscape hierarchy.

2.1.2 Transfer TransForum upscaling principles to NW-European regions

Methodology: Perform a simplified approach on at the European level of the whole of the NW-European regions or selected (metropolitan) sub-regions, making use of the tentative AHS. The result should show possible locations of TransForum-style approaches towards innovative metropolitan agriculture in similar NW-European locations.

2.1.3 Transfer TransForum upscaling principles to Michigan, US

Methodology: Perform a similar approach on at the American level for the wider Detroit region in Michigan, US, making use national/regional data sets. The result should show possible locations of TransForum-style approaches towards innovative metropolitan agriculture in the wider Detroit metropolitan area.

2.2 Scenarios for assessing TransForum's impacts on sustainable land use

Making use of the KOMBI-approach when interpreting the results of up-scaling exercise for TransForum's agricultural innovation strategies, develop (1) assessment criteria based on landscape functions and services; (2) benchmark scenarios for showing the impacts on the current situation; and (3) high-growth/low-growth scenarios to inform about the likely impacts in the light of different framework conditions.

2.2.1 Introduce the key data sets deriving from the baseline / high-growth / low-growth scenarios of the European projects on land use change scenarios to TransForum's upscaling results (2.1).

Methodology: develop spatially accountable storylines of sustainable development for TransForum goals and vision on the basis of data and criteria compiled in Phase

1. Making use of landscape functions and services, develop criteria for Sustainability Impact Assessment that are specific for metropolitan landscapes – link up with existing international methods and procedures.

2.2.2 Apply the TransForum KOMBI meetings at different phases of the implementation in which the assessment criteria as well as the framework conditions and scenario results are tested and further developed (iterative process).

Methodology: present the spatially accountable storylines of sustainable development for TransForum vision in the context of the up-scaling results to TransForum stakeholders (KOMBI-approach) as well as to EU stakeholders.

2.2.3 Organise an international meeting to present SUSMETRO results and to put forward the special case of metropolitan agriculture as a sensitive area by assessing the role of TransForum's innovative agricultural strategies in terms their environmental and socio-economic impacts (recreational/aesthetic).

Methodology: Exchange with EU project coordinators to develop and test the new assessment approach. The meeting should be organised at the premises of the Dutch representation in Brussels to draw international attention to the results. The meeting needs to be professionally facilitated (expected participants: 30 – 50 people)

2.3 TransForum Sustainable Design Solutions

Develop sustainable design-solutions for TransForum visions taking into account local/regional conditions in the Netherlands, Northwest Europe, and Michigan (US) by means of (1) landscape architectural design studios developing graphic solutions; (2) digital 3d-visualisation and (3) compiling all relevant project results in an educational/promotional DVD. The development of sustainable design concepts will draw upon the values and value chains that are surfacing out of the KOMBI approach in 2.1 and 2.2.

2.3.1 For three selected metropolitan agricultural regions in the Netherlands, North-western Europe and Michigan, US, use contrasting TransForum future visions to illustrate their impacts on PPP in a site-specific context.

Methodology: In cooperation with regional and national stakeholders, project coordinators and other relevant experts, brainstorm and develop the principle design for the selected/proposed (see Part 2.3) approaches to TransForum.

2.3.2 Make use of both landscape-atelier design capacities as well as digital computer animation techniques to develop high-detail, multi-perspective visualisations.

Methodology: Illustration needs to involve both landscape architecture based atelier work to develop a variety of artist impressions and computer-aided digital design based on state-of-the-art visualisation techniques to illustrate future TransForum spatial design concepts for metropolitan agriculture.

2.3.3 Interim and final Project Report with all technical details Produce and a DVD to showcase SUSMETRO results including the visualisation of sustainable design for the above regions.

Methodology: this is a largely technical procedure for capturing the results of Part 3.2 on film with audio comments. The DVD should contain all relevant information, graphs, and publications in the context of metropolitan agriculture, also beyond TransForum results.

Timetable 2009-2010

	2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1	2.3.2	2.3.3
Jul	d								
Aug	D								
Sep		d					d		
Oct		D M					d	d	
Nov			d					d	
Dec			D						
Jan				d			d		
Feb				d			d	d	
Mar				D M	d	d		d	D M
Apr					D	d			
May						D M			
Jun							d		
Jul							D		
Aug								d	
Sep								D M	
Oct									d
Nov									d
Dec									D M

d – work
D – Deliverables
M – Milestones