FOOD ENERGY WATER
METER

ROADMAP TO RESOURCE EFFICIENT URBAN AGRICULTURE

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- Polish Allotment Gardeners Association, District Gorzów Wielkopolski / PL
- City of Gorzów Wielkopolski / PL
- AgroParisTech, Paris / FR
- CNRS-IRSTV, Nantes / FR
- ILS – Research Institute for Regional and Urban Development, Dortmund / GE
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Executive Summary

This roadmap identifies policy recommendations for a desirable future for urban agriculture in 2050 based on policy reviews, interviews and workshops. In particular, this work assesses how and to what degree policy can be developed to create synergies between urban agriculture and cities' food, energy and water nexus. This work is based on the existing policies in five city regions in France, Germany, Poland, the United Kingdom and the United States. This report is designed for use by policy makers, public authorities and other stakeholders who want to support a shift towards an urban agriculture in which the nexus between food production, water and energy use, and social benefits is optimised.

To construct scenarios for analysis, seven key factors were identified (from 24 original drivers emerging from analysis) and intersected with three potential trends (positive, negative and a continuation of the status quo). Recommendations in this roadmap are based on the most positive outcomes for urban agriculture, cities, and citizens. Recommendations are given and detailed in the report by key factor and summarized as follows:

Recommendations for key factor 1: Political Frame Conditions

1. Include urban agriculture into local and national political strategies – Policy should communicate and promote benefits of urban agriculture, creating enabling conditions for urban farmers and gardeners.

2. Establish a 'one–stop agency' at city level for information and support of urban agriculture – Support a municipal information point on land access, funding and more to facilitate the start of new projects and initiatives.

3. Develop national food strategies – Food strategies should join up policies and stakeholders that are at present quite fragmented, including for the urban agriculture sector.

4. Integrate urban agriculture into health care schemes and make it eligible for social prescribing – In this way, urban agriculture should become a cornerstone for the prevention and treatment of illnesses such as obesity and mental health conditions.

Recommendations for key factor 2: Economic Regime

1. Develop and push green economy models – ecological principles should be allowed to shape the economic regime which can help small scale urban agriculture become more established.

2. Provide financial incentives through effective fiscal policies – Polluter pays principles and incentives for eco–technologies facilitate the total reuse of waste, including wastewater and food waste.

3. Stop agrarian land speculation – Policy should recognize that agricultural land has a social value rather than only an economic one. Ownership models can shift towards community land trusts.

4. Effective economic valuation of multifunctional benefits – Effective evaluation of ecosystem services should decrease noxious practices of industrial farming.

Recommendations for key factor 3: Urban Growth Dynamics

1. Increase and share the knowledge base about existing urban agriculture activities – Take a census of all types of urban agriculture to increase awareness of its advantages by ascertaining existing capabilities.

2. Create and publish an open access inventory of available land for urban agriculture, including indoor farming – Provide information about location and status of sites, their size, and facilities available to encourage uptake of spaces for urban agriculture.

3. Improve infrastructure in rural areas – The digitalisation of rural regions and increased availability of urban land offers opportunities for new urban agriculture projects in cities, using innovative agricultural concepts.

4. Develop new food hubs – Food hubs provide enhanced opportunities for producer–consumer–interaction and offer a space for alternative food networks which will benefit urban agriculture and urbanites.

Recommendations for key factor 4: Urban Planning Policies

1. Develop a local food strategy – Put food on the local agenda by specifying major goals, target groups, and measures to reduce the environmental impact of urban food production.

2. Include urban agriculture in updated planning regulations and policies – Revised plans should embed crop cultivation, beekeeping and other farming activities in building codes. Building-integrated farming such as rooftop farming should be encouraged.

3. Use urban agriculture as a strategic element in green infrastructure programs – Include urban agriculture in planning for urban green infrastructure.

4. Establish economic models to support the intensification of urban agriculture projects – Ensure that planning policies are coordinated with food policies and enterprise policies for urban agriculture to be strongly rooted in the urban socio-economic fabric.

Recommendations for key factor 5: Land-use Pattern

1. Develop a database of city-owned properties suitable for urban agriculture – This will facilitate access to land for all, including groups and enterprise initiating urban agriculture projects.

2. Recognize and protect urban agriculture in land-use policies – Facilitate land use both in dense and low-density urban areas, making suitable spaces available.

3. Establish procedures to consider the effects of land-use decision for urban agriculture – Urban agriculture should be recognised on equal footing with other land-use types in cities.

4. Provide appropriate land-use tenure contracts and support long term urban agriculture activities – Legislative tools for longer land tenure are needed to encourage the uptake of urban land.

Recommendations for key factor 6: Climate Change

1. Green the cities – Convert parking lots, rooftops and open spaces to adapt to and mitigate climate change.

2. Enable efficient use and re-use of water – Rainwater collection, greywater treatment, innovation in water recycling and efficient irrigation are necessary to improve water efficiency in urban agriculture.

3. Decrease distance between producers and consumers – Urban agriculture shortens the distance between consumer and producer and enables production that matches demand, thus potentially reducing food waste.

4. Support energy-efficient production – Encourage or embed in building codes waste reuse such as waste heat from buildings, wastewater reuse and nutrient recovery from food/organic waste.

Recommendations for key factor 7: Technical Trends

1. Provide incentives for affordable green technologies - This includes pollution taxes and compensations for low competitiveness due to some carbon-friendly technologies. Green technologies must include new food technologies (soil-less, insect farming and lab-grown meat), which are suitable for dense cities.

2. Push technologies for the total re-use of organic waste and wastewater for urban growing – Waste should become a valuable resource and either recycled or re-used.

3. Provide incentives for ICT solutions that connect farmers and consumers locally – This can strengthen consumer-producer networks (making direct distribution easier), while providing new opportunities for urban agriculture.

Introduction

Food, energy and water are key to three of the UN Sustainable Development Goals (2, 6 and 7 respectively) and access to these resources is widely recognized as a human right. Yet, despite extensive scientific evidence on the food-energy-water nexus (FEW nexus), knowledge about policies affecting the FEW nexus in the context of urban agriculture is very limited. Optimising the FEW nexus is expected to improve efficiency, support reimagined resource management, and address social issues, from public health to economic development. We believe that sustainable urban agriculture includes all these attributes. Urban agriculture requires urban resources such as land, water, and energy, but how can policy makers and planners support sustainable urban agriculture? Which governance instruments or policies can promote resource-efficient urban agriculture?

An international research team investigated these questions in the "FEW-meter" project, a Belmont Forum/Urban Europe JPI funded project which aimed at exploring the resource efficiency of urban agriculture in 74 case study gardens and farms in France, Great Britain, Poland, the USA and Germany (for details see FEW-meter Final Report and www.few-meter.org). In five case study areas (London, Nantes, New York City, Gorzów Wielkopolski and Ruhr Area) the team also examined the policy environment in different national contexts and at different spatial scales. Expert interviews in these cities helped identify major factors relevant today or expected to influence the future efficiency of urban agriculture.

Pathways to resource-efficient urban agriculture are complex. They are shaped by the general characteristics of the policy environment and the way urban agriculture is acknowledged or not, e.g., in urban planning policies. Pathways are also influenced by global phenomena such as climate change and economic developments, and they depend on both the availability of space within the cities and the affordability of techniques to improve efficiency, just to name a few of the manifold factors. The FEW-meter team used a scenario-building process to draw from the expert interviews and find a way to unravel this complexity.

The result is a so-called Roadmap to Resource-efficient Urban Agriculture. It aims at policymakers, representatives of municipalities, or stakeholders who are interested in optimizing the FEW-nexus in urban agriculture by shaping the framework conditions. After a brief explanation of the methodology applied, recommendations for future transformation pathways are presented. They were structured along seven key factors of major importance, as identified and analysed in the scenario process. For each key factor, first, we give some context information, then we present most probable trends, transformations pathways and desired futures as results from our research. Last, but not least, for each key factor, hands-on recommendations are summarized.

Background and methods

One of the goals of the policy analysis in the FEW–meter project was to develop a roadmap for expanded, resource–efficient urban agriculture. A roadmap is a strategic plan that defines a goal or desired outcome and includes the major steps or milestones needed to reach it. It suggests pathways to reach this goal based on a description of the current context and supposed trends. We based our roadmap on a scenario building process.

A scenario can be regarded as a story about the way the world might turn out tomorrow. Because there are numerous possibilities of future conditions, a scenario cannot be considered as a specific forecast of the future. It is more a plausible description of what might happen. The process of scenario building should raise awareness of uncertainties, risks and constraints which could be encountered in the future. The awareness of such factors helps to improve strategy development because scenario building facilitates switching mindsets from only one possible future towards thinking about several possible alternatives.

The roadmap and scenario process within the FEW–meter project began in 2020 and was conducted as a five–phase process (Fig.1).

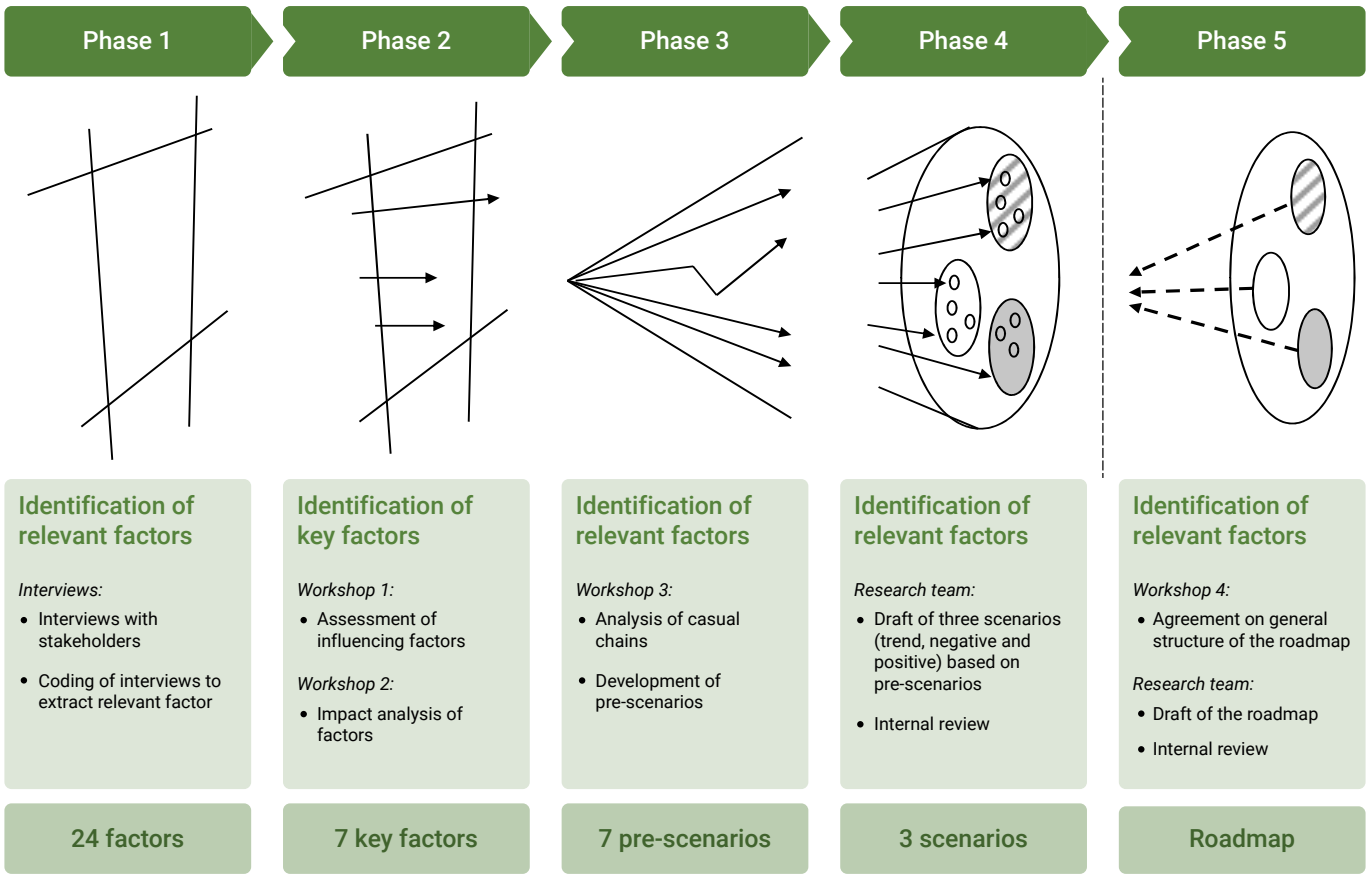

Figure 1: Phases of the scenario building process in the FEW-meter project. *Credits: Authors based on Kosow and Gaßner (2008): 25*

First, in **Phase 1**, we (the authors, led by the team at ILS — Research Institute for Regional and Urban Development, Dortmund) identified and structured the framework conditions for the future development of resource–efficient urban agriculture, based on interviews with stakeholders from municipal governments, NGO´s, scientists and consultants in the five countries involved in the FEW–meter project (France, Germany, Poland, UK and US). After coding and analysing the interviews, we identified a total of 24 factors relevant today or expected to have an influence in the future.

In **Phase 2**, we conducted two workshops with the broader FEW–meter team to identify key factors influencing future scenarios. We (the authors, led by ILS) built the workshops around a structured process of evaluation of the strength and direction of each factor's influence. We identified seven key factors that were included in the next steps:

- Political frame conditions
- Economic regime
- Urban growth dynamics
- Urban planning policies
- Land use patterns
- Climate change
- Technical trends

In **Phase 3**, we determined possible future trajectories of the key factors, resulting in so–called pre–scenarios. For this, we created separate descriptions for each key factor as projections and expansions of the trends identified (so–called future funnels). In a third workshop, the FEW–meter team started the pre–scenario design process. The aim was to identify causal chains that are of central interest for scenario development. The workshop was based on the guiding question: "How can key factor X influence resource–efficient urban agriculture in 30 years?" The scenario concept is based on the assumption that several alternative futures are always possible and that scenarios serve to span the space of possible futures. Often, they are based on a most probable trend scenario in order to compare other scenarios with the perceived status quo. The trend scenarios envisage a future in which no new developments or measures are assumed. However, since unstable conditions must usually be assumed, both positive and negative development opportunities are taken into account in a positive and a negative scenario (Fig.2). The work for completing all pre–scenarios was completed in small writing groups of FEW–meter team members.

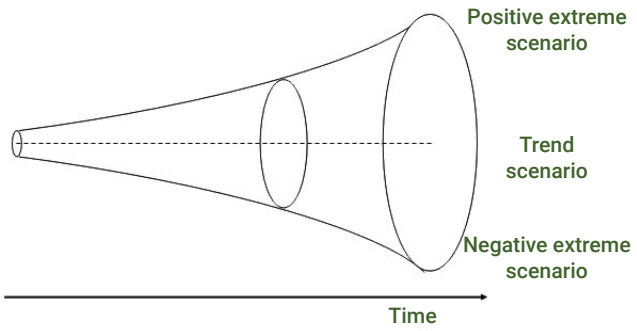

Figure 2: Scenario funnel. *Credits: Graph modified by authors based on: Bernhard Schloss (CC BY-SA 3.0)*

In **Phase 4**, we completed the scenario process with the elaboration of three full scenarios integrating the pre–scenarios for the seven key factors in a negative, a trend, and a positive scenario. The full scenarios are not presented in this roadmap.

Instead, **Phase 5** served to translate the pre–scenarios and scenarios into a roadmap. To facilitate this translation, the FEW–meter team met in a final workshop to explore possibilities for presenting the scenario process for stakeholders including policymakers, community groups and farmers. As the goal of the roadmap is to optimize the FEW–nexus in urban agriculture, we used the positive and the trend scenarios to extract pathways for transformation along the key factors we identified and translate the scenarios into tangible steps to transition towards the positive scenario.

Each section below briefly presents the framing of the key factor explored before discussing possible positive trends and the desired future identified via scenarios. Finally, we identify key actions or turning points which will enable these trends and increase the likelihood of the desired, more sustainable future fueled by urban agriculture.

Key factor 1: Political Frame Conditions

Context

To meet the increasing demand of resources and especially the food, energy and water demands of the steadily growing world population, the political frame conditions need to drive the sustainable consumption of resources, including land, thus leading to resource-efficient urban agriculture. Our analysis revealed that the political frame conditions are a highly active key factor that have a very strong influence on other key factors, such as land use patterns, urban growth, and urban planning policies (Fig. 3). It has a mutual strong relationship of influence with the economic regime. The factors climate change and technical trends are also influenced by the political frame conditions, and they are influencing the political frame conditions in turn. The strengths of these relationships were determined through a structured process (see Background and methods).

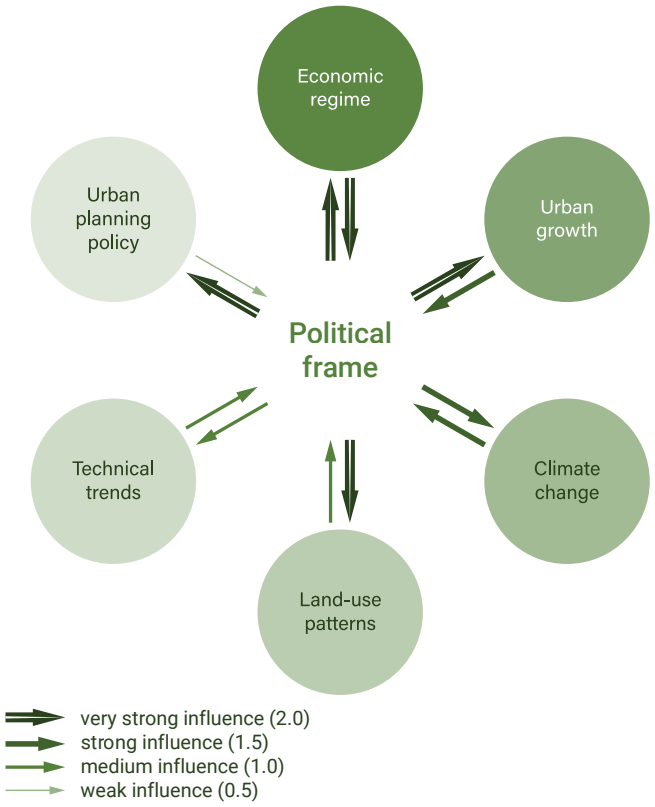

Figure 3: Key factor Political Frame Conditions influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two major trends for the future development of the political frame conditions that can be drivers for transformation:

1. There will be an increase in the political importance of environmental topics along with a higher value ascribed to green infrastructure and increasing recognition for urban agriculture.
2. Increasing problems related to food insecurity or food quality will lead to a stronger political recognition for local food and functioning city–region food systems.

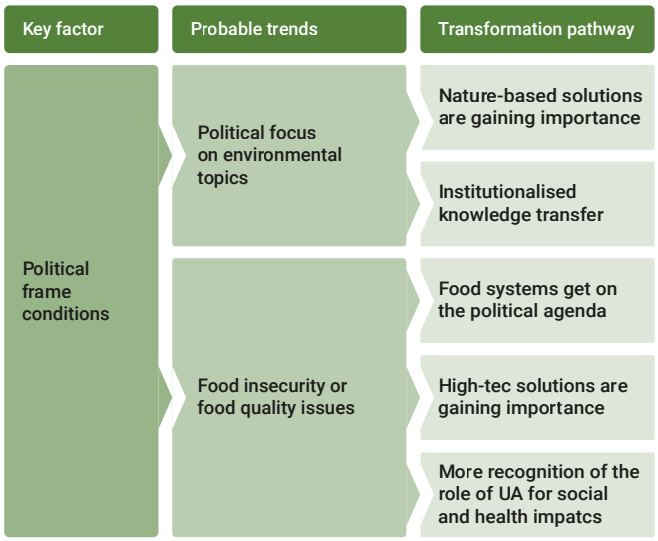

Figure 4: Probable trends and transformation pathways foreseen for key factor Political Frame Conditions.
Credits: Authors

Desired Future

The political frame conditions are strongly driven by principles of justice, as well as by environmental considerations. Functioning city–region food systems will be widely acknowledged and supported by the political frame conditions. Urban agriculture will be prominently placed on the policy agenda and will therefore move from a niche to a mainstream practice. Urban agriculture will be acknowledged as a nature–based solution that supports eco-efficiency and urban agriculture spaces are seen as a permanent and valued urban land use. With this new promotion, urban agriculture will play an increasingly important role as a multifunctional land use in the future city.

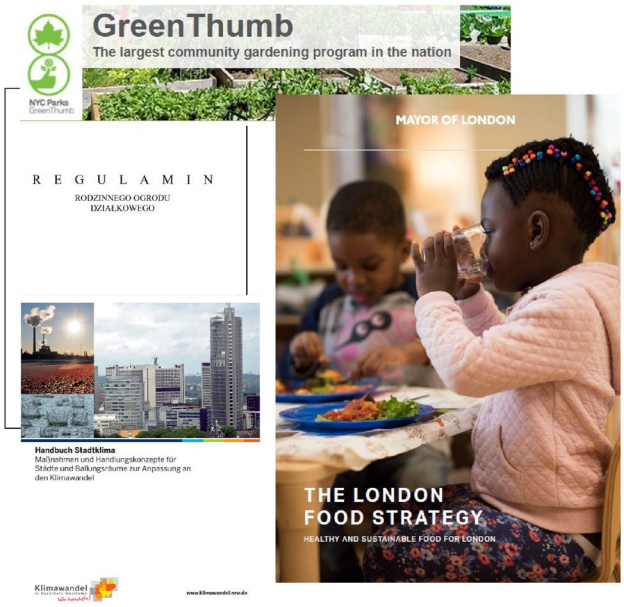

Figure 5: Collage of policies.
*Credits: see **"Imprint"***

Pathways

Recommendation 1

Include urban agriculture into local and national political strategies (e.g., those that address climate change)

Political attention on urban agriculture and active promotion of its benefits can help urban agriculture to flourish and support cities in reaching their sustainability and resilience goals. Amidst accelerating effects of climate change, effective measures need to be implemented. Urban agriculture can be considered as one mechanism, especially as part of a broader political focus on nature-based solutions.

Recommendation 2

Establish a "one-stop agency" at city level for information and support of urban agriculture

In order to have access to detailed and professional advice, there should be a central information point (located at city level) to which people can reach out to if they want to establish urban agriculture projects in their cities. This "one-stop agency" should give support and guidance related to financing, funding opportunities, land access, legal questions as well as provide access to exchange of knowledge and experiences.

Recommendation 3

Develop national food strategies (including strategic points for urban agriculture)

To promote a healthy, equitable, and sustainable food system, national food strategies are urgently needed. Existing strategies are fragmented and inconsistent. So far, food policies are established on different levels and contain a mixture of supranational, national, or local laws, regulations and incentives.

Recommendation 4

Integrate urban agriculture into health care schemes to tackle health problems

Gardening is more and more recognised as a measure to defeat social and health problems. Social prescribing needs to be established as a non-medical option for prevention and treatment of mental health conditions. Urban agriculture can also gain importance as a cornerstone in the prevention of diet-related health problems and address many social problems attached to food poverty, food insecurity, obesity, malnourishment and disparities in access, which have become even more acute during the COVID-19 pandemic.

Key factor 2: Economic Regime

Context

The overall economic regime defines the economic set of rules and norms that can regulate or influence the operation of governments and their interactions with society. Alternative models to the prevailing economic regime could be that of a green economy, de-growth economy or sharing economy.

According to our analysis, the economic regime is an active key factor, that is influencing other key factors, rather than being influenced by other factors itself (Fig. 6). The economic regime has a strong or very strong influence on land use patterns, urban planning policies, climate change or urban growth. The political frame conditions and technical trends are also very strongly influenced by the economic regime, but they also have a mutually strong influence on the economic regime themselves.

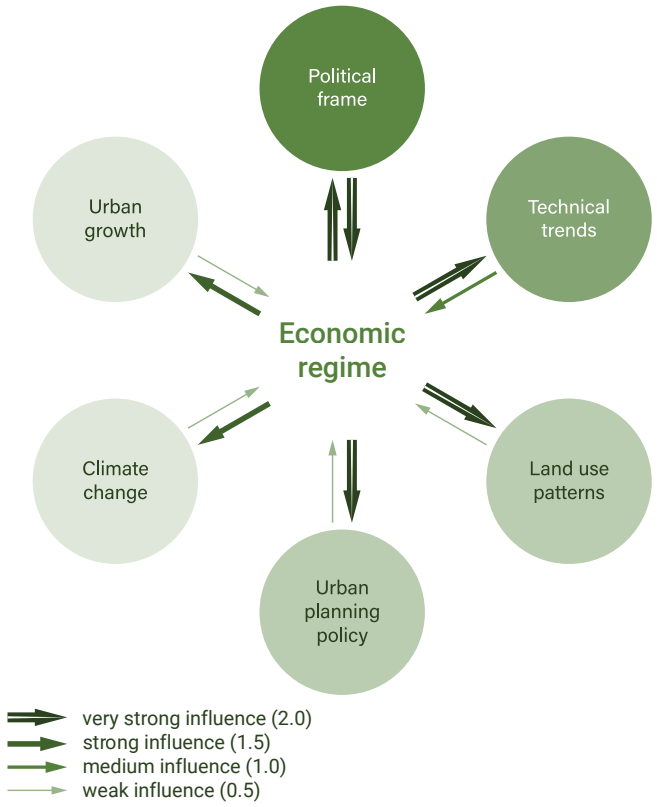

Figure 6: Key factor Economic Regime influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two divergent trends for the future development of the economic regime that can be drivers for transformation:

1. Society retains its current economic structure and regime. Environmental challenges are recognised by many governments and by the civil society as a serious threat to humanity, but nations struggle reconciling effective policies with the neo-liberal economic regime that pushes for deregulation.

2. The economic regime will shift towards a green and circular economy and the state as well as private investors invest in resource-efficiency.

Key factor	Probable trends	Transformation pathway
Economic regime	Continuation of a neoliberal regime	Increasing engagement of civil society
	Circular or green economy on the rise	Increasing adoption of ecological-economic and fair principles
	Think global, eat local movements	Importance of local and regional food production

Figure 7: Probable trends and transformation pathways foreseen for key factor Economic Regime.
Credits: Authors

Desired Future

The economic regime will shift towards a green and circular economy. The policy agenda and the market thereby provide incentives for affordable green technologies. The development in the direction of green economy parallels the rise of conscious consumers in a growing "Think global – Eat local" movement which can be a driver for small-scale urban agriculture or other alternative de-growth models. Along with the ecological principles, fairness is incorporated into policy decision-making. This means that on the one side the principle of polluter pays is firmly established with inefficient technologies being disincentivised while increased investment in eco-efficiency creates more jobs in sustainable industries on the other side.

Figure 8: Local market in New York City.
Credits: Runrid Fox-Kämper

Pathways

Recommendation 1

Develop and push green economy models

Widespread adoption of ecological–economic principles within the economic regime that recognize finite limits of the planet and apply principles of equity (e.g., de-growth economy, circular economy, doughnut economy, etc.) needs to become the mainstream model. Growing investment in green economy models (e.g., by direct investment in small initiatives or provision of micro-credits) can help to increasingly establish urban agriculture, or other types of alternative food networks.

Recommendation 2

Provide financial incentives through effective taxation policies

Increasing taxes for polluting and inefficient technologies on the one side and incentivizing eco–efficient technologies and processes on the other can provide financial support to urban agriculture projects that apply resource-efficient practices. Affordable technologies can enable the total reuse of "waste," including wastewater and food waste, which are reused in urban food growing.

Recommendation 3

Stop the speculation with agricultural land

Land speculation benefits only a few and comes at the expense of the small initiatives and actors in urban agriculture or other types of alternative food networks. It must be widely acknowledged that agricultural land has a societal value and effective policies must forbid speculation with it. A process of rethinking of urban land value ownership models can shift towards communal land management and towards a reduction in land speculation.

Recommendation 4

Provide effective measurement for the economic valuation of multifunctional benefits of urban agriculture

An effective economic valuation of the multifunctional benefits and state investment in services will increase the resource efficiency, urban symbiosis, and health benefits of urban agriculture.

Key factor 3: Urban Growth Dynamics

Context

Ongoing urbanisation shapes urban growth dynamics in and around many cities worldwide and raises questions about options for urban agriculture. While according to our analysis the policy framework and urban planning policies have the strongest influence on the dynamics of urban growth, the factor in turn has a very high influence on urban planning policies and land use patterns (Fig. 7). Urban growth dynamics also shape the political framework and technical trends while it is strongly influenced by the economic regime.

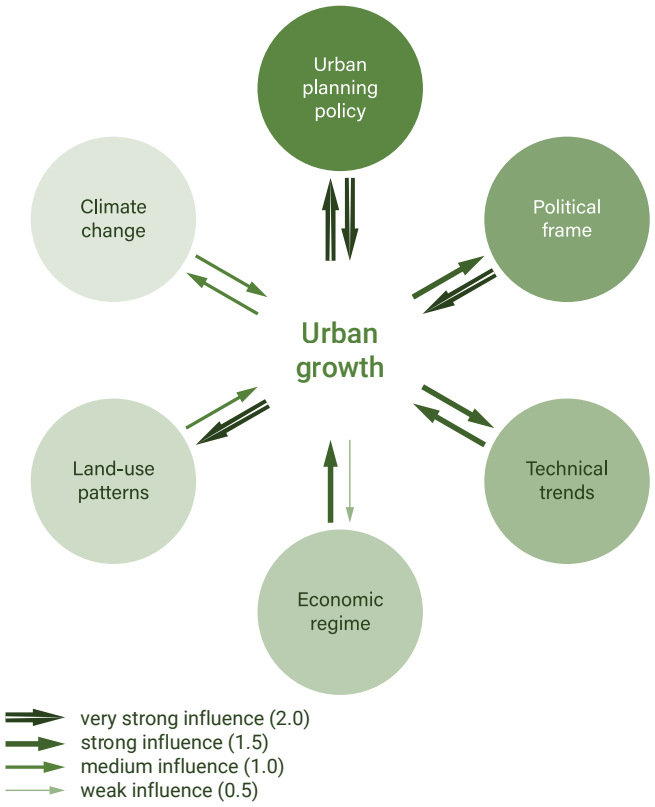

Figure 9: Key factor Urban Growth Dynamics influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two partly contradictory major trends that shape urban growth dynamics and that can be drivers for transformation:

1. Mega-cities and city regions in economically strong regions are supposed to densify and sprawl into their peri-urban surroundings. The ongoing urbanisation will increase land-use pressure, but may also increase awareness of the role of green infrastructure for enhanced people's health and wellbeing, and the liveability of dense urban environments. At the same time, cities in post-industrial cities and the rural hinterland are shrinking or have to cope with vacancies; this may provide opportunities for novel forms of urban transformation, including expanded green infrastructure and urban agriculture.

2. The COVID-19 pandemic has accelerated opportunities for working from remote locations. As a trend digitalisation and flexibilization of work will support a valorisation of rural/remote areas.

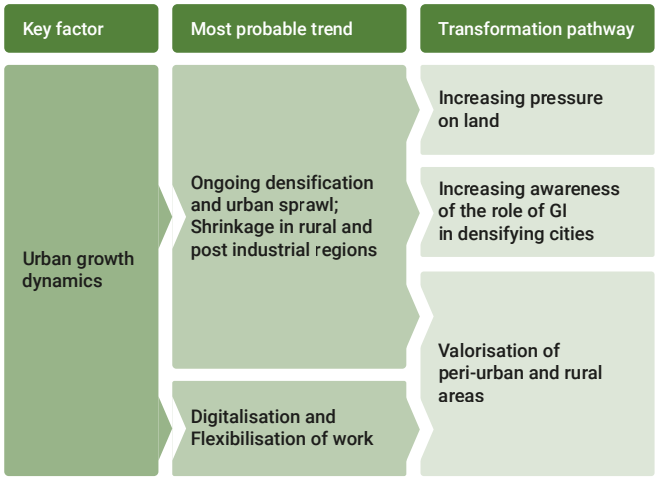

Figure 10: Probable trends and transformation pathways foreseen for key factor Urban Growth Dynamics.
Credits: Authors

Desired Future

Land-use competition and increasing pressure on inner-city spaces can stimulate resource-efficiency of urban agriculture and also offer new opportunities for high-tech urban agriculture.

In a desired future, urban agriculture will be acknowledged as a nature-based solution and thus an integral part of the green infrastructure. In city-regions with decreasing pressure on inner-city spaces, new opportunities for urban agriculture occur.

With the ongoing digitalisation and flexibilization of work peri-urban and rural areas are becoming attractive again and experience a revitalisation of their agricultural sites. This could potentially reduce demand for land to be used for urban agriculture. Local and regional food chains are revalorised.

Figure 11: Indoor farm in Basel.
Credits: Runrid Fox-Kämper

Pathways

Recommendation 1

Increase and share the knowledge base about existing urban agriculture activities

To enable establishing the urban agriculture capacities in each city and increase the general awareness of the diversity of urban agriculture, an online census of all urban agriculture sites is very useful. It could include basic information about allotment gardens, community gardens, commercial farms, school and institutional gardens, such as size, activities and contact dates. Surveys of existing gardens should highlight their multi-functionality and integral role as green infrastructure.

Recommendation 2

Create and publish an open access inventory of available land for urban agriculture including unoccupied properties for indoor farming

Local governments can identify vacant plots, roof-tops or other locations where urban agriculture could be encouraged and make this information publicly available for everyone. The inventory can also include information about abandoned and underutilized spaces, e.g., vacant commercial real estate buildings that can be used for indoor farming. The information about location and status of sites, size, facilities should be displayed on a map.

Recommendation 3

Improve the infrastructure in rural areas

Urban growth dynamics can slow down if living in the countryside and away from metropolises gets more attractive. Digitalisation of rural regions in line with improved public transport options are key technologies to on the one hand decrease pressure from inner cities and offer opportunities for urban agriculture there and on the other revitalise peri-urban and rural areas sites with innovative agricultural concepts.

Recommendations 4

Develop new food hubs

Growing opportunities for urban agriculture need new opportunities for new producer–consumer interactions and alternative food networks. Think about offering (after-work) markets, processing facilities, and online facilities such as food apps to advance them.

Key factor 4: Urban Planning Policies

Context

Urban planning policies are very strongly influenced by the political framework and its agenda as well as the economic regime and resulting urban growth dynamics while land-use patterns, climate change and technical trends have a strong influence (Fig. 12). In turn, urban planning policies very strongly influence land-use patterns and urban growth dynamics. They also have a strong influence on the effects of climate change while their influence on the economic regime and the political framework is weak.

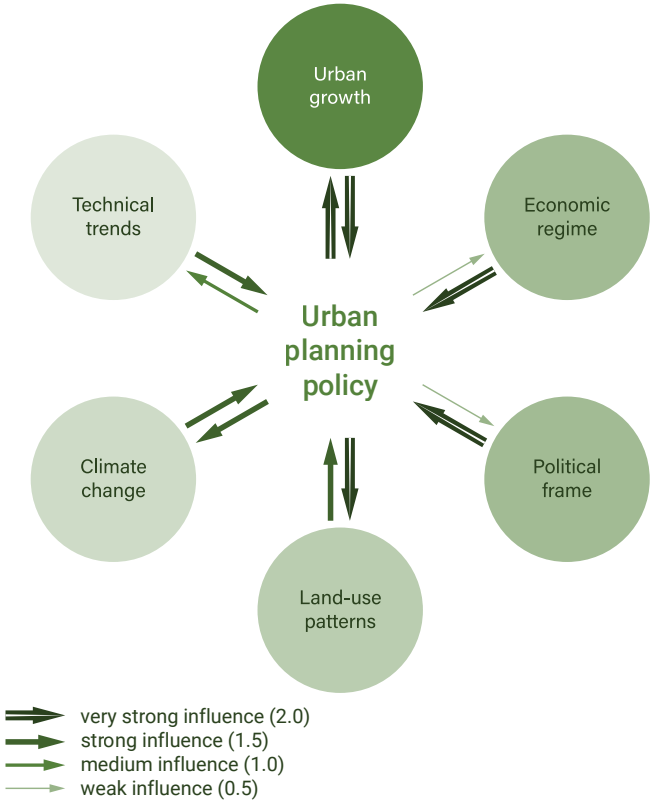

Figure 12: Key factor Urban Planning Policies influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two major trends that shape urban planning policies and that can be drivers for transformation:

1. The importance of local food and city-region food systems is widely acknowledged in urban planning policies. Urban food production is included as a basic need in such policies, including cities´ food strategies, planning frameworks and building codes.

2. Climate adaptation and protection measures are key drivers for urban planning. Urban planning applies a holistic and systemic vision of the city including its region with strong interrelations between economic, environmental, and socio-cultural values. Within this trend, urban agriculture is an integral part of green infrastructure due to its multifunctionality.

Key factor	Most probable trend	Transformation pathway
Urban planning policies	Increasing importance of local food and functioning city-region food systems	Food issues integrated in urban planning
		UA included in urban planning policies
	Climate change protection and adaption on the planning agenda	UA acknowledged as integral part of green infrastructure and for climate adaptation

Figure 13: Probable trends and transformation pathways foreseen for key factor Urban Planning Policies.
Credits: Authors

Desired Future

Urban planners manage to collaborate across sectors and administrative boundaries to overcome silo-thinking in urban planning policies. Sustainable food production in and around cities is acknowledged and included in existing and new urban plans and policies. Urban planning includes a more holistic urban planning view on urban agriculture.

Urban agriculture is acknowledged for its multifunctionality and its ability to contribute to climate change adaptation as an integral part of the green infrastructure.

Figure 14: Commercial farm in Nantes.
Credits: Runrid Fox-Kämper

Pathways

Recommendation 1

Develop a local food strategy

A food strategy helps put good food on the local agenda and create a sustainable food system. It outlines major goals for different sectors (such as food production, processing or distribution and consumption) and/or target groups (such as children, low-income households or underserved neighbourhoods) and promotes measures to reduce the environmental impact of urban food production (e.g., by increasing efficiency or avoid waste).

Recommendation 2

Include urban agriculture into updated planning regulations and policies

Once embedded into land-use plans or zoning plans urban agriculture can be viewed as an integral element of the urban fabric, equal to other kind of land-use, not just a placeholder for future developments. Existing plans should be amended so that building codes legalize crop cultivation, bee-keeping, animal farming, and the like as some existing regulations may prohibit even basic farming activities. Building-integrated farming such as rooftop farming should be encouraged in urban plans.

Recommendation 3

Use urban agriculture as strategic element in green infrastructure programmes

Green infrastructure programmes are set up in many cities to use its benefits and cope with climate change but often do not consider urban agriculture as an integral element, despite its manifold benefits for climate adaptation and beyond.

Recommendations 4

Establish economic models that can support an intensification of urban agriculture projects

If planning policies are coordinated with food and enterprise policies urban agriculture can be strongly rooted in the urban socio-economic fabric which can lead to job creation, higher productivity, and higher share of urban self-sufficiency.

Key factor 5: Land–use Patterns

Context

Land–use patterns are very strongly influenced by the political framework and its agenda, the economic regime and resulting urban growth dynamics as well as by urban planning policies while climate change and technical trends have a strong influence (Fig. 11). In turn, land–use patterns very strongly influence the effects of climate change and strongly influence urban planning policies while their influence on urban growth dynamics and the political framework is medium and weak on the economic regime and no influence on technical trends.

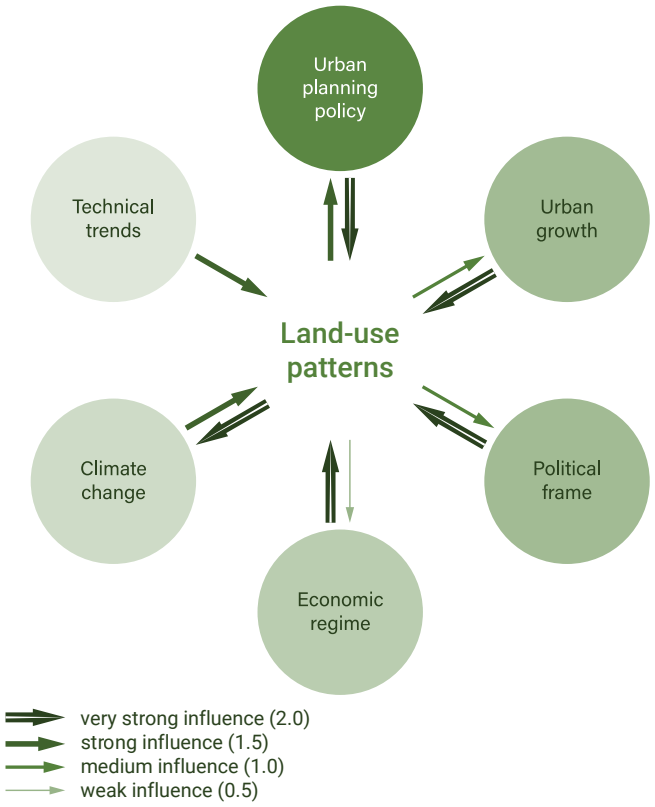

Figure 15: Key factor Land-use Patterns influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two major trends that influence land–use patterns that can be drivers for transformation:

1. Land–use patterns continue to develop in an inconsistent way differing significantly by region and city resulting in fragmented and archipelagic forms of land–use and partly segregated green infrastructure. To overcome this and avoid sprawl, policies aiming at the re–use of land become more and more common. Tailored solutions at all scales consider strategic densification to create multifunctional urban spaces as a way to increase the quality of urban life in increasingly dense cities.

2. In line with the increasing awareness of the effects of land–use patterns on climate adaptation, the role of green infrastructure with urban agriculture as a key component is acknowledged and strengthened.

Key factor	Most probable trend	Transformation pathway
Land-use patterns	Fragmented, archipelagic forms of land-use; varying by region and city	Circular land management policies to avoid sprawl without compensation
		Tailored solutions for regions, cities and borrows including strategic densification
	Increased awareness on the effects of land-use patterns on and the role of green infrastructure for climate change adaption and environmental justice	Emphasis on provisioning green space and infrastructure including UA spaces, for all

Figure 16: Probable trends and transformation pathways foreseen for key factor Land-use Patterns.
Credits: Authors

Desired Future

With widely applied strategic densification policies that consider a diversity of spatial uses public land sovereignty is gaining a key role. Cities are thus enabled to offer new opportunities for urban agriculture to be established on vacant inner–city plots and in abandoned buildings or market gardens in peri–urban regions. Expanding urban agriculture on these sites increases green infrastructure and secures access to urban agriculture for all citizens.

Urban agriculture is acknowledged as a valued and permanent land–use. Participatory land–use decisions allow for maximizing equitable benefits and minimising gentrification threats of green infrastructure.

Figure 17: Gardener in urban agrarian park in Lisbon.
Credits: Runrid Fox-Kämper

Pathways

Recommendation 1

Develop a database of city-owned property suitable for urban agriculture

This will raise the awareness on the role that municipalities have in terms of land-use and facilitated access to land for initiatives. It also demonstrates the willingness of cities to influence land-use.

Recommendation 2

Recognise and protect urban agriculture in land-use policies

Urban agriculture is a flexible land use that can occupy both dense and low-density urbanised areas, inner-city districts as well as peri-urban areas. This can include the identification of suitable types for distinct urban forms/patterns (e.g., z-farming for dense cities, market gardens at the urban fringe).

Recommendation 3

Establish procedures to consider the effects of land-use decision for urban agriculture

Urban agriculture should be treated on an equal footing with other land-use types in the urban tissue. Including urban agriculture issues in standard deliberations processes (e.g., in building permits) will raise the awareness for the consequences of changes in land-use.

Recommendation 4

Provide appropriate land tenure contracts and support long term urban agriculture activities

Insecure land tenure can have important effects on the carbon footprint of gardens and can discourage land managers from implementing expensive, efficient systems. The continuity of urban agriculture activities could be encouraged with appropriate leasing contracts and other incentives which encourage resource-efficient land-use.

Key factor 6: Climate Change

Context

Climate change will influence all areas of living in the predicted future. Urban agricultural production will be confronted with specific challenges, such as the unpredictability of weather conditions, water scarcity, stormwater risks or increasing pressure on efficiency of food production and energy self–sufficiency (Fig. 13). According to our analysis, (changing or remaining) land use patterns are the key factor with the strongest influence on how climate change will play out in cities. Political frame conditions, urban planning policies, technical trends and the economic regime are also strongly influencing climate change. Climate change itself is very strongly affecting the technical trends and is by itself strongly influenced by technical trends.

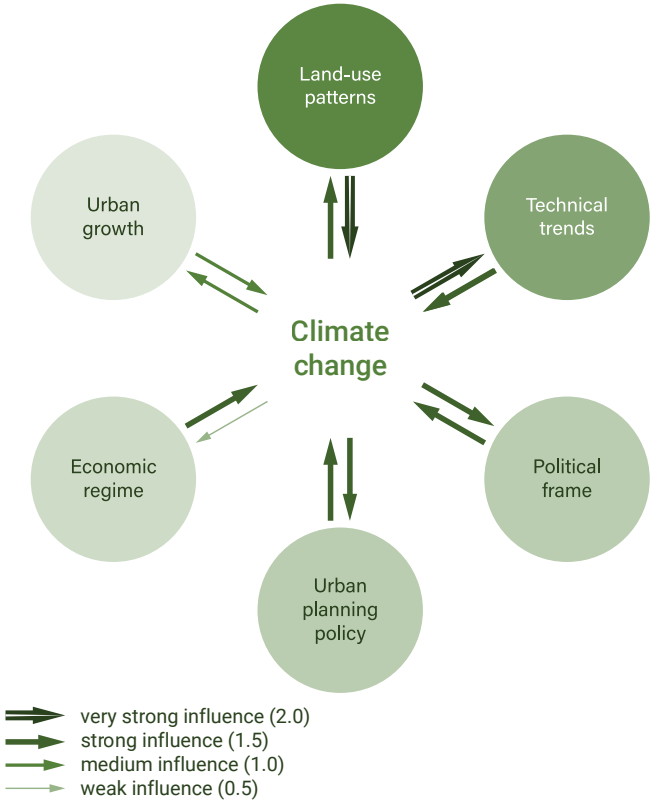

Figure 18: Key factor Climate Change influencing and influenced by the other key factors.
Credits: Authors

Trends

We foresee two major trends that will shape the development in terms of climate change that can be drivers for transformation:

1. Along with the increase in ecological, economic and social catastrophes, large movements in policy and society (e.g., Fridays for future) will make climate change a more urgent topic on the top on the policy agenda. Serious mechanisms will address climate change and thereby focus on the support of nature–based and ecological solutions. In the same line, political preference is given to sustainable food production.

2. Unpredictability in weather conditions will increase the challenges for agricultural production, which drives the development of technical solutions in production.

Key factor	Probable trends	Transformation pathway
Climate change	Impact of climate change movements leads to a turn in policy making	Local and national climate change strategies include urban agriculture (thereby also addressing its resource-efficiency)
	Unpredictability of weather conditions	Support for efficient irrigation and rainwater capture
		Support for technical solutions to improve energy efficiency

Figure 19: Probable trends and transformation pathways foreseen for key factor Climate Change.
Credits: Authors

Desired Future

Civil society is increasingly engaged for social–ecological goals and puts pressure on the decision–makers. With the youth activists of the 2020s becoming leaders of the society, policy and planning decision are strongly driven by the principles of fairness as well as by environmental considerations.

Due to intense action, climate change can be slowed down. and its most significant effects can be mitigated.

Climate adaptation measures are key drivers for urban planning policies. People reduce their car use and chose more environmentally friendly mobility. While parking lots and traffic areas are reduced, green and open spaces can be established all over cities for urban climate change mitigation and adaptation.

Figure 20: Compost collection in New York City.
Credits: Runrid Fox-Kämper

Pathways

Recommendation 1

Green the cities

Providing green and open spaces for climate change adaptation and mitigation can help to slow down the risks posed by climate change. Policy should consider converting a share of parking lots and rooftops every year to green productive spaces. This can go along with the set–up of programmes for building–integrated urban agriculture on rooftops.

Recommendation 2

Enable efficient use and re–use of water

In the face of climate change and the expected rise of temperature in the northern hemispheres, water will become an increasingly scarce resource. To reach a more efficient use of water in urban agriculture, rainwater collection is one solution for more efficient irrigation. More promising options in urban agriculture lie in the closing of water cycles through greywater treatment or the re–circulation of water in closed systems. All these solutions require policy support and approval.

Recommendation 3

Support energy–efficient use and production

Innovative solutions to use waste heat from buildings for heating in urban agriculture (e.g., in urban greenhouses or rooftop greenhouses) can support energy–efficient production at a larger scale. As with water recycling, energy can be used more efficiently by technologies to recover heat that are based on circular systems.

Recommendation 4

Decrease distances from producers to consumers and food miles

Purchasing food from farmers in close distance contributes to reducing food miles (i.e., the distance that the food travels from farm to fork). Re–connecting consumers and producers through farmers markets or ICT–based distribution systems can reduce emissions for transport, cooling and packaging of food.

Key factor 7: Technical Trends

Context

Technological solutions (technical trends) to the environmental crisis are still perceived as the most effective (and desirable) response, capable of finding solutions for sustainability which do not damage economic growth or limit resource exploitation. According to our analysis the key factors climate change and the economic regime have a very strong influence on technical trends (Fig. 15). This key factor in turn influences all other factors on a strong or medium scale.

Trends

We foresee two major trends that shape the development of technical trends and that can be drivers for transformation:

1. The first foreseeable trend is the implementation of large–scale solutions towards a circular economy that considers all types of "waste" as resources. This includes the implementation of circular approaches in the fields of organic waste, wastewater or energy.

2. The second major trend is the digitalisation of farming and local food systems along the entire food chain from production to distribution.

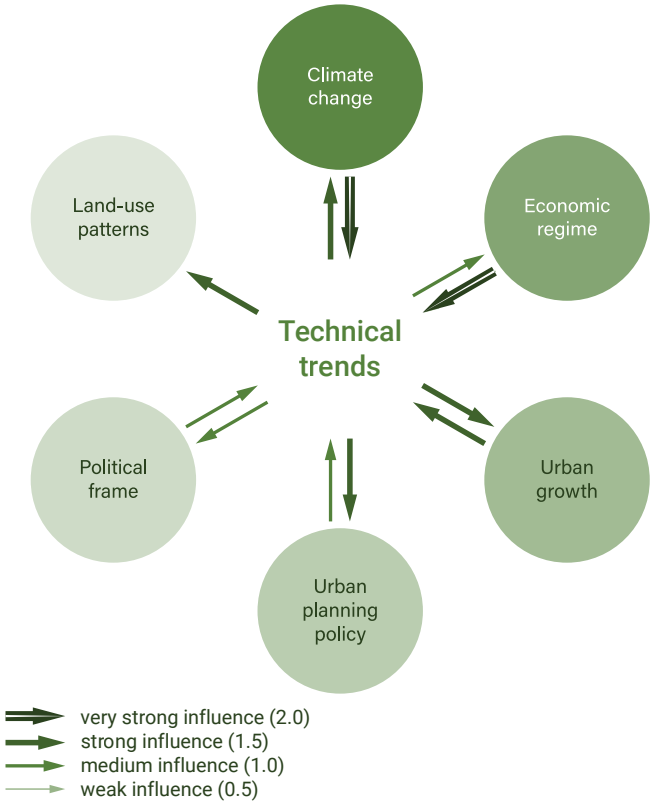

Figure 21: Key factor Technical Trends influencing and influenced by the other key factors.
Credits: Authors

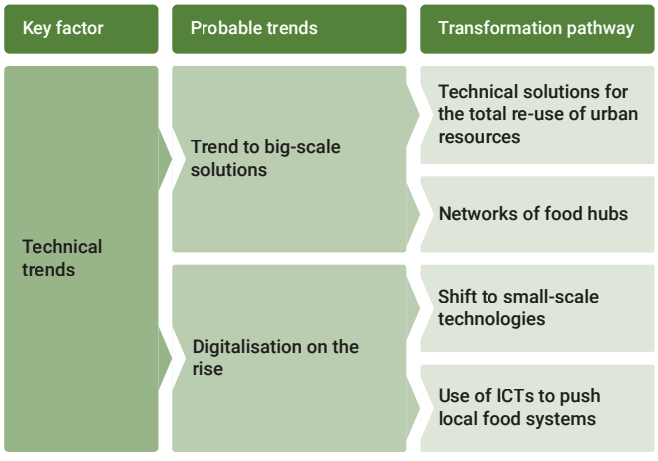

Figure 22: Probable trends and transformation pathways foreseen for key factor Technical Trends.
Credits: Authors

Desired Future

Technical development will shift to technologies that work at local and small scale. Affordable technologies will make small–scale urban agriculture more efficient and enable the total reuse of waste, including wastewater and food waste, which are reused to grow food.

Higher deployment of ICT technologies make distribution easier and push local food systems, and those technologies enable models of direct sale from urban farmers to customers, as well as networks of growers and food hubs. This altogether results in a future with new opportunities for urban agriculture, alternative food networks and stronger producer–consumer interactions.

Affordable technologies will also enable agricultural practitioners to grow new foods indoors or in laboratories (from insects to hydro/aquaponics, to lab–grown meat), which are appropriate for integration into high density cities.

Figure 23: Photovoltaic on urban farm in New York City. *Credits: Runrid Fox-Kämper*

Pathways

Recommendation 1

Provide incentives for affordable green technologies

Incentives must be given to green technologies. This includes financial encouragements to adopt low-carbon and green technologies as well as pollution taxes and compensations for disadvantages that stem from the use of more carbon-friendly technologies. Affordable technologies will also enable to grow new foods indoors or in laboratories (from insects to hydro/aquaponics, to lab-grown meat), which can be integrated into high density cities.

Recommendation 2

Push technologies for the total re-use of organic waste and wastewater for urban growing

Urban resources can be coupled and used in an intelligent and efficient way, while all kinds of “wastes” (e.g., waste heat, wastewater or organic waste) are not considered as “waste” but as valuable resources and are either recycled or re-used.

Recommendation 3

Provide incentives for ICT solutions that connect farmers and consumers on the small scale

Urban consumers can be connected to their local framers through ICT technologies. Such technologies make distribution easier and support direct interactions from urban farmers to their customers. This provides new opportunities for urban agriculture and strong consumer-producer networks.

Conclusion

This roadmap (a strategic plan with main steps to reach an aim) offers guidance to attain and upscale resource-efficient urban agriculture by answering key questions such as: which governance instruments or policies can promote urban agriculture? And how can policy makers support a shift towards an urban agriculture in which the nexus between food production, water and energy use, and social benefits is optimised?

The future is unknown; therefore, scenarios are usually developed as a range of possible directions that future events may take; typically, bad, good and neutral (i.e., no change). In this roadmap, only the positive direction is considered because the purpose of this study is to move towards a desirable future in which urban agriculture is environmentally sustainable, socially beneficial, and materially (i.e. food) productive.

The first key outcome of this scenario development and roadmap is the identification of seven key factors that can determine in the near future an expansion of resource efficient urban agriculture:

- Political Frame Conditions (the ideological and legislative frame determining policy-making in democratic governments);
- Economic Regime (the predominant approach to the national economy and the governance of production, trade and financial markets);
- Urban Growth Dynamics (variations in the demographic composition and number of urban dwellers);
- Urban Planning Policies (frameworks of urban development);
- Land-use policies (including access to land that can be used for farming);
- Climate Change (consequence of ongoing changes on global and local conditions which may push towards higher resource efficiency);
- Technical Trends (technological progress resulting in higher resource efficiency).

Understanding these key factors as leverage points that can strongly influence the future is an important reflection for policy making. More importantly, the roadmap offers pathways to positive change for each one of these key factors, hence pointing towards actions to be taken that will optimise resource use and maximise the benefits and the outreach of urban agriculture.

The second key outcome is the identification of the interconnectedness of such key factors. Diagrams provided at the start of each chapter capture the strength and nature of the links connecting factors, offering a visual representation to better understand the complexity of the issue, and also the possible knock-on effects that the implementation of specific policies for one key factor can have on other factors.

Likewise, diagrams summarising trends and transformation pathways can be understood at a glance and be used as tools for policy makers, exploring how legislative changes in a discrete area, if well designed, can trigger bigger changes.

The third and most important key outcome is a set of recommendations that can be implemented to move towards an environmentally sustainable urban agriculture. These recommendations range from the implementation of stronger ‘polluter pays’ fiscal policies, to an open access inventory to access suitable land, to a recognition of urban agriculture as a fundamental function to be included within urban green infrastructure programmes, to support for longer land tenure contracts that can encourage community groups and enterprises to initiate urban growing activities. Some of these recommendations can be found in literature and are part of the current debate on urban agriculture. The merit of this roadmap is to organise them in a structured fashion, clarifying outcomes and impacts.

This roadmap is a rigorous and important contribution to promoting urban agriculture as a system for not-so-far future environmental and social amelioration. And we hope that policymakers and associations working in this sector will use it when defining or campaigning for policies on urban agriculture.