CitAgra: The Compact City with Integrated Agriculture and Ecology

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Abstract. The growing problem of urban sprawl – low-density, fragmented, car-dependent development on greenfields – is increasingly serious for both Europe and the rest of the world. It brings with it a number of negative consequences for human health, well-being, social and economic performance, and negative ecological impacts, including emissions, which contribute to climate change. Therefore, in order to improve urban quality of life and address the “20-20-20 strategy” of global objectives, we propose a series of pilot projects that introduce significant planning, managerial and technology initiatives combined to enhance cooperation between European citizens and experts. To increase the extent and health of urban cultivation and maximize the benefits of an urban canopy, cities need an integrated approach and innovations from city planners, engineers, and landscape architects, as well as citizen advocacy and participation along the lines of public-private partnerships. We presume that even if various actors share a common vision, it needs more knowledge for maximum benefits to develop. Our thesis is that urban cultivation can play a significant role as a catalyst for socio-economic sustainability. Comparing benefits from urban forest and agrarian functions, which in many places would compete for the same space, would be necessary. There is now an increasing body of knowledge that several measures of high urban density – including residential, retail, and service density, street-intersection density, and land-use diversity – might have important public health consequences. With more evidence, one can plan neighbourhoods that are more compact and more attractive (thanks to activity-influencing factors such as local services, public transport, leisure, agrarian activities and more), halt invasive sprawl, promote physical activity and social interaction, and shield from environmental and social negatives, such as pollution and feeling unsafe. In this project, the Nature-Based Solutions concept will be applied to improve the impact on quality of life. In this sense, CitAgra would leverage the EU agenda by making the project a form of pilot implementation.

1. Introduction

This paper aims to present a conceptual and organizational basis as well as primary results of the ongoing international project called CitAgra. The main objective of the project is to research and demonstrate the potential of innovative agrarian solutions in regenerating neighbourhoods and enhancing urban environmental services [1]. The ultimate aim is to find operative tools to support urban communities in sustainable improvement of urban environment and wellbeing.

The basic requirement is to increase intensity of underused urbanised land, mostly by means of regeneration, or adaptive reuse of industrial and residential wastelands. In doing so, one needs to enhance green areas and create biologically active surfaces of various types. Urban regeneration brings new opportunities for cities to reconsider their planning strategies in various contexts, such as limited...
available space, deprived areas, or social inequities. Regeneration projects need to consider the interlinkages between urban structure, building culture, design and aesthetics, urban ecology, and its relation to energy and water use. Landscapes that look well cared for discourage anti-social behaviour, and social capital may be nurtured by physical evidence of care [2, p. 27].

The project aims to increase the ability to understand potentials and barriers of regeneration by means of urban ecosystem services development (particularly control of climate, phytoremediation, production of food, and cultural benefits); improve the competence of local experts and municipal officers; and build the capacity for change.

The central thesis of the project is that if employing general rules of sustainable urbanism [3] [4] and specific nature-based solutions [5], it is possible to maintain the city growth, providing new living and work places, and at the same time protect (and even enhance) its blue-green infrastructure, improving the urban ecosystem [6]. Employing innovative greening schemes and technologies have the potential to improve the attractiveness and viability of living in urban centres [7]; retrieve and improve connections between the built and natural environment in the previously disintegrated rural–urban fringe; increase access to locally-grown food [8]; and make important steps toward reducing health inequalities and improving health equity [9]. Simultaneously, proper intensification of urbanised land will limit the pressure on urban greenbelts and villages surrounding the city.

Encompassing local and sub-metropolitan scales, the project aims to establish a new, transdisciplinary approach and explore the feasibility of proposed methods. For this purpose, it includes applied research, limited demonstration, testing and validation on small-scale participatory actions, planning workshops, and pilot activities aimed at showing viability in an operational environment.

This project is an implementation follow-up for the Future of Places, a three-year partnership of UN-Habitat, Project for Public Spaces and the Ax:son Johnson Foundation, its NGO host. The previous project brought together over 1,500 researchers, practitioners, officials and activists, representing more than 700 organizations, 275 cities, and 100 countries from around the world. The forum identified key research in public space creation and improvement, and the implementation tools and strategies required. Among its outcomes was substantial contribution to both the New Urban Agenda and the Sustainable Development Goals, through its partners. In addition, key personnel also participated in the COP21 Climate Conference in Paris, presenting linkages between greenhouse gas emissions, urban form and public space in particular. The follow-on organization, the Centre for the Future of Places, an entity of KTH Royal Institute of Technology, will continue implementing the outcome of the New Urban Agenda, in partnership with a broad network of researchers and research institutions that grew out of the conference series. The disciplines involved (and represented by our university collaborators) include urban design, architecture and landscape architecture, anthropology, sociology, environmental psychology, economics, and public health.

2. Challenges
To address general principles of urban sustainability, one needs to form a metropolitan space (which is usually a mixture of urban, suburban, rural, and semi-natural areas) to be more liveable and productive [5]. It should be done coherently on a multi-scale, strategic level, but with a focus on the distinct character of each community and place that has to be respected.

Since the European urban population has been growing, many cities continue their expansion on greenfields. The common model of development is based on property speculation, gentrification of urban cores, and extensive suburban sprawl, which causes related environmental and social problems. The extensive model of growth despoils the landscape, produces cacophonous detached housing developments, non-functional housing tracts, strip-like shopping centres, and single-use office parks
Widespread car dependency and recent failures in improving air quality, particularly in a number of CEE and Chinese countries, stimulated municipalities’ interest in environmental aspects of growth, but still few towns attempt to revitalise themselves by redeveloping, densification, and a more qualitative approach or innovative means, such as advancement of urban ecosystem services.

Key questions that the project will help explore are: How and to what extent do the forms of ordinary environments, their organisation and identity, interact and how does this interaction support connected and active communities? Can ordinary environments be the prime ground where innovative approaches of new agrarian solutions in regenerating neighbourhoods and enhancing urban environmental services are tested and implemented? Are certain spatial ordinary forms more suited to encourage pro-environmental behaviour (i.e. agrarian urbanism, recycling, water retention and bio processing)? And if so, at what scales is this behaviour most likely to happen (individual plot unit, urban block, clusters of blocks, neighbourhood)? Can urban form encourage pro-environmental behaviour through trade-offs?

3. Materials and methods

The CitAgra system consists of three combined packages, based on three pillars for the common action of experts and local societies:

1) **Environmental Monitoring, Planning, and Design** - which explore natural phenomena, networks, dynamical systems, self-organization, and placemaking respecting local contexts—is applied through a series of participatory workshops. The relationships are investigated between the physical and ecological structure of places, ownership, delivery, and management, along with behaviours.

Animating movement towards agrarian solutions addresses two opposite problems: rapid urbanisation and shrinking cities. The traditional urban system of walkable public spaces defined by mixed-use buildings, completed by blue-green networks, is an important framework to develop and implement, since cities periodically urbanise or de-urbanize [11]. An agrarian city would have the potential to cope better with the unavoidable pulse of growth and shrinkage [12].

The Planning and Sustainable Design package applies nature-based solutions to pilot projects for urban public space improvement. This work is a key implementation action for the New Urban Agenda (outcome document of Habitat III, 2016), the Sustainable Development Goals (adopted by the UN in 2015) and the COP21 framework agreement (adopted by treaty members in 2015), as well as an enhanced implementation of EU environmental policies.

2) The second pillar of the project is **Social Inclusiveness**: The demonstrated solutions will be co-designed, co-developed, and co-implemented by local communities in multi-stakeholder and participatory ways. To do so, innovative methods of communication and tools securing open access, data networking, and knowledge-sharing will be developed, deploying interoperable communication strategies. Charrettes, planning and design workshops, place-making, guerrilla gardening, and communication tools based on SoftGIS, UGC, and VGI will be proposed and demonstrated including 4D-GIS spatial-temporal data management and mining for the dissemination of useful information [13] [14] [15].

3) The third pillar is urban greenery and **Improvement of the Environmental Health of Society**. The project is founded on the principles of Smart Urbanism in general, and particularly: Community-Led Local Development, Blue-Green Infrastructure, Ecosystem Approach, Agrarian Urbanism, Health Promotion and Environmental Justice. The measures proposed must be acceptable to the electorate. Such acceptability is fostered if carbon reduced ways of living are also felt to be wellbeing maximising [16]. The concept of Salutogenesis and System approach to the primary prevention of environmental risk factors has been proposed for the improvement of human health [17] [9]; innovative bioremediation of pollutants is introduced
and will be tested in different urban areas [18] [19]. New agrarian biotechnologies [20] have been introduced for the elimination of pesticide use and production of pollutant-free vegetables. As public space and urban greenery are perceived as valuable resources, the tools need to be provided to assure their availability to all, and not only a privileged part of the society. This need is urgently expressed in cities in transition. Most of the studies on urban ecosystem services have been conducted in Western countries. The influence of that field of studies on city policies is still limited, and in the European context this is clearly visible in cities such as Krakow, Prague, and Warsaw.

CEE countries have not been the area of extensive studies on the role of greenery for city residents’ health, social inclusion, and well-being. Particularly, the modifying role of the social structure on the perception of health and the well-being of citizens – and assigning value to natural areas in the city – has not been widely studied in the CEE region. Choices and preferences of people in Western cities are not directly transferred to post-communist countries. A particular contradiction relates to health, which, as a declared value, has a high position in the hierarchy of values, but in practice, healthy lifestyles and preventive health care are rarely implemented in the policy and developmental strategies of CEE cities.

A transversal supporting pillar is economics and urban management. Agro-urban solutions should be economically profitable from a social perspective and self-sustained. For that reason, the creation of locally based public-private partnerships will be studied as a possible model of management. In such model, public participation and governance will allow for the implementation of self-managed urbanism, which has started to emerge in some of the cities involved in this project, such as Barcelona.

The project methodology is based on the following principles:
- transdisciplinarity,
- problem-solution chain analyses,
- addressing complex problems,
- indicator setting,
- indicator measurement.

Density is a key parameter around which land uses and services that affect the environment and public health are planned and developed. With more evidence, one can plan neighbourhoods that are more compact and more attractive (thanks to the activity-influencing factors such as local services, public transport, leisure, agrarian activities and more) [21]; halt invasive sprawl; promote physical activity and social interaction, and shield from environmental and social negatives, such as pollution and feeling unsafe [22].

The project seeks to create tools to enable sustainable regeneration through small-scale actions, and in doing so, to encourage entrepreneurship and job opportunities for people who do not see starting a business or rebuilding as possible for them. We aim to do this by undertaking a number of pilot actions to test the tools, get practical experience, and build platforms for communicating successes to other towns and cities. Shifting the focus from ecosystem-based to nature-based solutions (NBS), we search for the provision of co-benefits, such as the improvement of place attractiveness, of health and quality of life, and creation of green jobs [23]. Using experience with knowledge platforms such as RAMSES (Reconciling Adaptation, Mitigation and Sustainable Development for cities) [24] and GreenSurge [25], CitAgra is to further acknowledge and assess the value of such co-benefits to guide cross-sectoral policy design and implementation in various geographical contexts. The project also is developing links with ongoing platforms, particularly ThinkNature [26], which enhances the exchange of experiences and supports the presentation of outcomes from recent European NBS demonstration projects; and
EKLIPSE\textsuperscript{1}, which deals with knowledge synthesis methods and social innovation related to NBS. It has developed a holistic framework for assessing and implementing the co-benefits of nature-based solutions in urban areas.

Public participation GIS, User-Generated Content (UGC) and Volunteered Geographic Information (VGI) are applied to support public participation in urban planning, providing data for urban geographical research. Geo-questionnaires \cite{28} are used to research quality of life in chosen areas, perceived quality of urban environments, access to green spaces, participant engagement, and the mobility behaviour of residents. They are adjusted to provide valuable tools for public preference elicitation in land use planning \cite{29}. New PPGIS tools will be also applied to provide information on relationships between urban structure and access to greenery, lifestyle preferences, mobility, PM emissions, and greenhouse gas emissions. Measures integrating non-monetary and monetary valuation methods \cite{30} are being developed to research “hedonic pricing” \cite{31} and value of access to green areas, urban gardens, allotments, water bodies, and other elements of blue-green infrastructure in different cities.

CitAgra started in Krakow as a regional platform for sharing knowledge and experiences in the fields of Architecture and Urban Design and Planning, Civil Engineering, Environmental Engineering, Landscape Architecture, Sociology, Environmental Psychology, Economics, and Public Health. In 2017, several institutions representing European universities and cities from different climate zones joined CitAgra, which today represents the following EU climate zones:

| Climate EU Zone | NORTH | CENTRAL | SOUTH |
|-----------------|-------|---------|-------|
|                 | Steinkjer | Stockholm |        |
|                 | Glasgow | Krakow | Prague | Warsaw |
|                 | Barcelona | Thessaloniki |       |

Additionally, the Chinese city of Wuhan is involved, supported by two strong academic institutions: HUST and Wuhan University.

4. Results and discussions
The topics discussed regarding the improvement of public space using NBS include:

- Affordance (the ability of an environment to afford an action by a user)
- Agglomeration benefits and knowledge spill-overs (the ability of public space networks to promote the exchange of knowledge and innovative economic activities)
- Biophilia (the environmental psychology of natural elements and its restorative effects)
- Capacity-building (the ability of public space occupants to interact and gain knowledge or resources)
- Entry-level economic opportunities (the ability to develop economic enterprises on small scales, especially important for immigrants, the young, the poor, and other deprived populations)
- Resilience (the ability of a population to recover from disruptions, including social capacities)
- Salutogenesis (the generation of higher states of health and wellbeing through design)
- Territorial co-presence (the ability of different populations to occupy different parts of public space without threats or conflicts)

\textsuperscript{1} EKLIPSE, \cite{27}
Many of these concepts are well-developed in the literature, but what is missing is a comprehensive, integrated application of tools and strategies by which they may be deployed [32].

The main results of the work so far might be briefly summarised in the following points:

- To increase the extent and health of the urban cultivation and maximize the benefits of urban greeneries, cities need an integrated approach and innovations from city planners, engineers, and landscape architects [33], as well as citizen advocacy and participation along the lines of public-private partnerships [34]. We presume that even if various actors share a common vision, it needs more knowledge for maximum benefits to develop.
- Urban cultivation can play a significant role as a catalyst for socio-economic sustainability [35]. Urban agrarian strategies should work basically to sustain and grow the benefits of blue-green networks. We would like to compare benefits from urban forest and agrarian functions, which in many places would compete for the same space.
- It is already proven that busy city centres beat suburban living when it comes to human wellbeing, socializing, and walking. Residents of higher-density areas are more active, more socially engaged – and less obese [21]. However, further evidence is needed to identify potential pathways and thereby effectively guide urban policies.
- There is now an increasing body of knowledge that several measures of high urban density, including residential, retail and service density, street-intersection density, and land-use diversity, might have important public health consequences [16] [22] [36].
- On a metropolitan scale, the areas of river valleys, former buffer zones around closed industrial installations, together with agrarian wastelands, form planned and unplanned greenbelts which are of fundamental importance for the city and neighbouring towns. They need to be protected against intensive development, but may be partly utilised for sport and recreational facilities as well as farming, gardening, and energy crops. That enables the implementation of urban agriculture (together with local energy production) on a much wider scale and connects it with the placemaking agenda [37].

The smart city interpretation as “an underlying neoliberal ethos that prioritises market-led and technological solutions to city governance and development” [38, p. 2] is the one which still dominates in many countries, especially the region of CEE. Hollands [39] suggests that there are contradictions hidden in the smart city agenda: serving global/mobile capital and stationary ordinary citizens; attracting/retaining an elite class and serving other classes; top-down, corporatized development and bottom-up, diffuse approaches.

Local, small-scale farming, implemented in forms of both private and community gardens, may be bringing new diversity to urban communities, increasing their social and economic sustainability. Greening strategies as ingredients of urban renewal, upgrading, and revitalization, are too often market-driven endeavours targeting higher income groups sometimes at the expense of less privileged residents [40]. Dispersion of greenery may develop equal access to it and reduce eco-gentrification.

In cities whose real estate market is dominated by speculative capital, each type of space has its own, typical problems:

- Urban areas need to be denser, more intense, more mixed-use, and also much greener.
- Suburban and rural areas (today it is usually a mixture of two) need to be denser, more economically vibrant (more productive) and convivial.
- Semi-natural spaces need to be better protected or regenerated as rural.

There is a need for character enhancement of each type of space. The respect for characteristics of the place in the process of regeneration is necessarily related to the community and the landscape. Being
able to exercise a proactive role in ensuring place responsive development by those inhabiting urban environments is fundamental and has a direct relationship with the physical structure of place, its ownership, and possibilities of management and engagement. This ambition challenges the prevailing tendency to remove users from the conception, production, development, and maintenance of space, and argues for a more inclusive and responsible approach at several urban scales, whereby new operative tools are used to support urban communities in the sustainable improvement of urban environment and wellbeing in different countries [41].

The CitAgra partners aim to further develop the joint research in three dimensions:

- Social (institutions, governance, perceptions, use)
- Ecological (processes, functions, biodiversity, cities as landscape we live in)
- Technical (with special focus on traditional knowledge in agriculture, building and urbanism)

5. Conclusions

In order to improve urban environmental qualities and address Sustainable Development Goals, a feasible model of nature-based urbanism needs to be proposed. The consortium analyses different concepts of combining agricultural interaction with modern society. New academic and practice-based sources provide actionable information for early-stage holistic assessment of agrarian scenarios in various urban contexts [42]. Although their economic feasibility has not yet been adequately assessed, the experiences acknowledge considerable social benefits and overall environmental performance of urban farming [35].

The level of inclusiveness in the process of diffusion of agrarian functions is a necessary condition, but applying the nature-based solutions is needed to employ even more innovative thinking based on the dispersion of ecosystem services. If encompassing food production, clean energy production, and sustainable water management – including new environmental biotechnology – those services can strengthen economic sustainability and improve the quality of life in densely urbanized areas, as well as the continuity and quality of a metropolitan blue-green infrastructure.

CitAgra’s team proposes the following research tasks to be continued: developing recommendations for preferred agronomic plants and biotechnology to cultivate under urban farming conditions; selection of appropriate plant species adopted to the local agro-environmental and economic conditions, and optimizing their agro-technology (such as irrigation, fertilization, and plant protection) in order to obtain the highest quality product standards; examination of the quality of agricultural products originating from urban areas, for food, feed, bioenergy or industrial purposes; developing techniques for converting organic waste, with recommendation for its agricultural use while ensuring environmental safety; rationalization of nutrients and organic matter managements in urban ecosystems through the natural use of biomass produced in urban areas; eco-utilization of the open roofs of multi-floor urban premises for the production of high quality pollutant free vegetables; design considerations and building the prototype of the aeroponic greenhouse system, including energy production.

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