

Anthropogenic pollutants as limiting factor for urban agriculture strategies

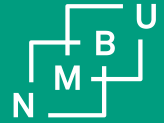
Roland Kallenborn (NMBU)

Faculty for Chemistry, Biotechnology and Food Sciences (KBM)

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Contact: Tel.: +47 67 23 24 97; email: roland.kallenborn@nmbu.no

Urban agriculture

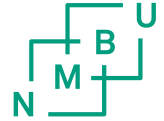


Urban agriculture can be defined as all **farming** activities done in close proximity to a city centre. It can be in the form of industrialized vertical farms, local and small-scale growing systems in restaurants, community plots, rooftop gardens, and so on.

Keywords: Sustainable, green, ecological friendly, high-quality products, home grown



Background



- Urban areas are constantly growing, until 2100 ca 80% of the world populations expected to live in urban areas.
- Provision with food, water and other life sustaining resources will be a major challenge.
- Circular bio economy based recirculation of resources on sustainable renewable energy sources identified as feasible strategy to provide better resources for local usage.
- Urban agriculture is currently launched as a major feature in modern urban development strategies world-wide.





SUSTAINABLE DEVELOPMENT GOALS



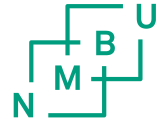
History – Agriculture and Cities



Zürich, 1576; Ref.: Petra Hagen Hodgson et al. (2016)
 Beziehungen: von urbaner Landwirtschaft, Gärten und
 Gesundheit; report, pp 22

- Agriculture integrated in urban development
- Development of economic independent city structures in Europe
- Independent support of city structures
- Safety, Health, quality of life.

Urban agriculture - Today



- Agriculture and Urban life are detached.
- Cities are appearing as “deserts of concrete structures”
- Valuable farming areas unavailable due to urban infrastructures and area requirements for mega city development.
- More than 60% of the global population is living in urban regions today
- Industrial agricultural enterprises rule the global food market.

Ref.: Spiegel report (2018) - guerilla gardening

Today's challenges in modern urban development



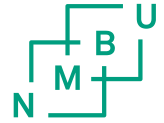
Ref.: nagel-group.com



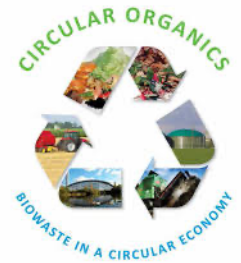
Tokyo today

- Cities are living space for the majority of the human population
- Challenges with access to food, water and other resources
- Balanced and sustainable living conditions for everyone.

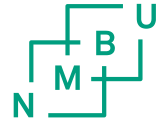
Societal frame



- Sustainable bio-economy priority focus in many society and countries.
- Renewable production (energy and food) is an
- important cornerstone in bio-economy strategies.
- Implementation of UA considered of considerable recreational and even economic value for urban development.
- Food supply for locally restricted urban sections
- **The transfer and presence of anthropogenic pollutants spread as pesticide, contained in ambient air, in urban waters or retained into bio-waste, soil, fertilizers and other UA infrastructures cannot be excluded.**



Visions - Urban strategies and infrastructures



Circular bioeconomy strategies and Urban agriculture actively implemented into new urban development in Europe and Asia.

Adopted large scale technology development (sewage recycling, water reuse, energy neutral buildings) and integrated agriculture as well as green areas

Focus on life quality and smart solutions.

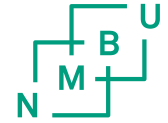
Water separation and sustainable energy access strategy (solar, geo-thermal).



SIEU Green

Sino-European innovative green
and smart cities

Urban resource utilisation



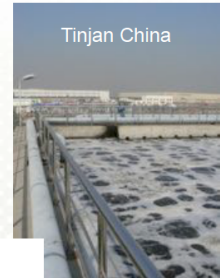
Urban agriculture



Urban agriculture has positive effects on health and happiness and increases food security (Waliczek *et al.*, 2005)

Used water as resource

Conventional wastewater treatment – technically advanced, energy consuming



The water industry is the fourth most energy intensive sector in the UK!

Parliament Office of Science and Technology, Postnote 282, 2007



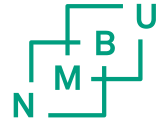
Sustainable daily life solutions



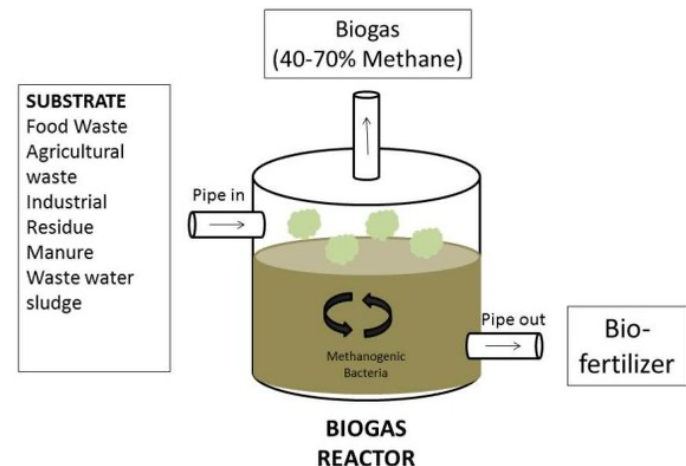
Separation of waste streams



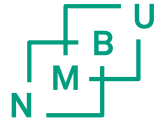
Recirculation of biowastes



- Biowaste is a major feature in sustainable energy production, new building materials, soil amendments and other recirculated products.
- Sewage agricultural-, aquacultural- and food waste resources are utilised as important prerequisite of circular bioeconomy.



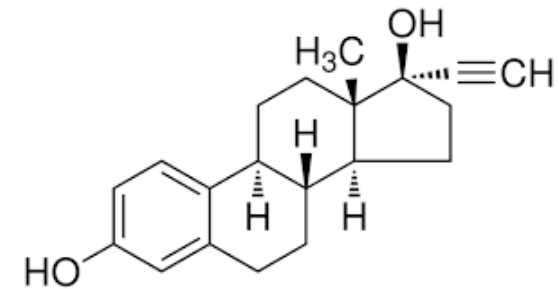
A pollution perspective “Chemical tracers”



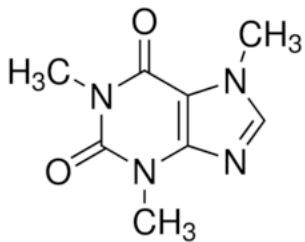
Chemical pollutants in sewage and biowastes - Markers for population size and consumer assessment

- Consumer product ingredients
- Representative for daily usage
- Available for all population groups
- Analytical methods established

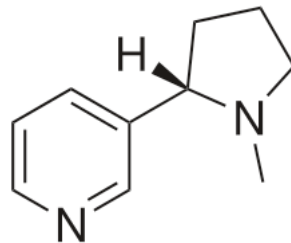
Ethinyl estradiol (EE2)



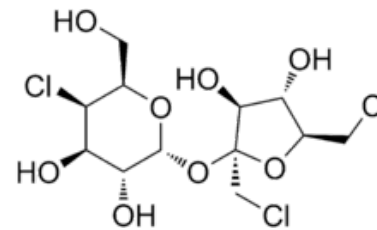
Caffeine



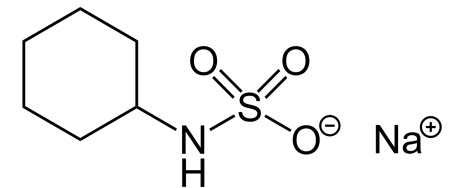
Nicotine



Sucralose



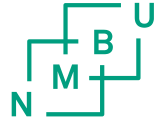
Cyclamate



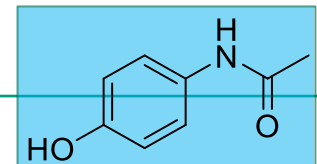
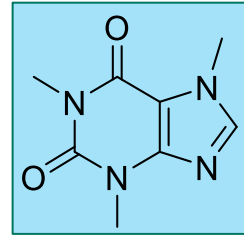
Lim et al (2017) Water 9, 143; doi:10.3390/w9020143

Direct sources:

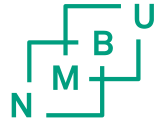
Organic pollutants in biowastes



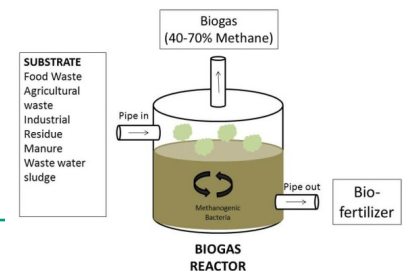
- , Agricultural wastes, sewage and household wastes are identified as main substrates for agricultural applications
- Chemical content and profiles highly source dependent
- Large variety of contaminants identified in agricultural wastes and sewage.
- Little information available on pollutant loads in household wastes, industrial, domestic and agricultural sewage.
- Already applied in large quantities as soil amendment and building materials.
- Consequences and fate (efficacy and pathways) largely unknown.



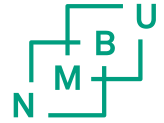
NovelPol Case study in Norway (until 2021)



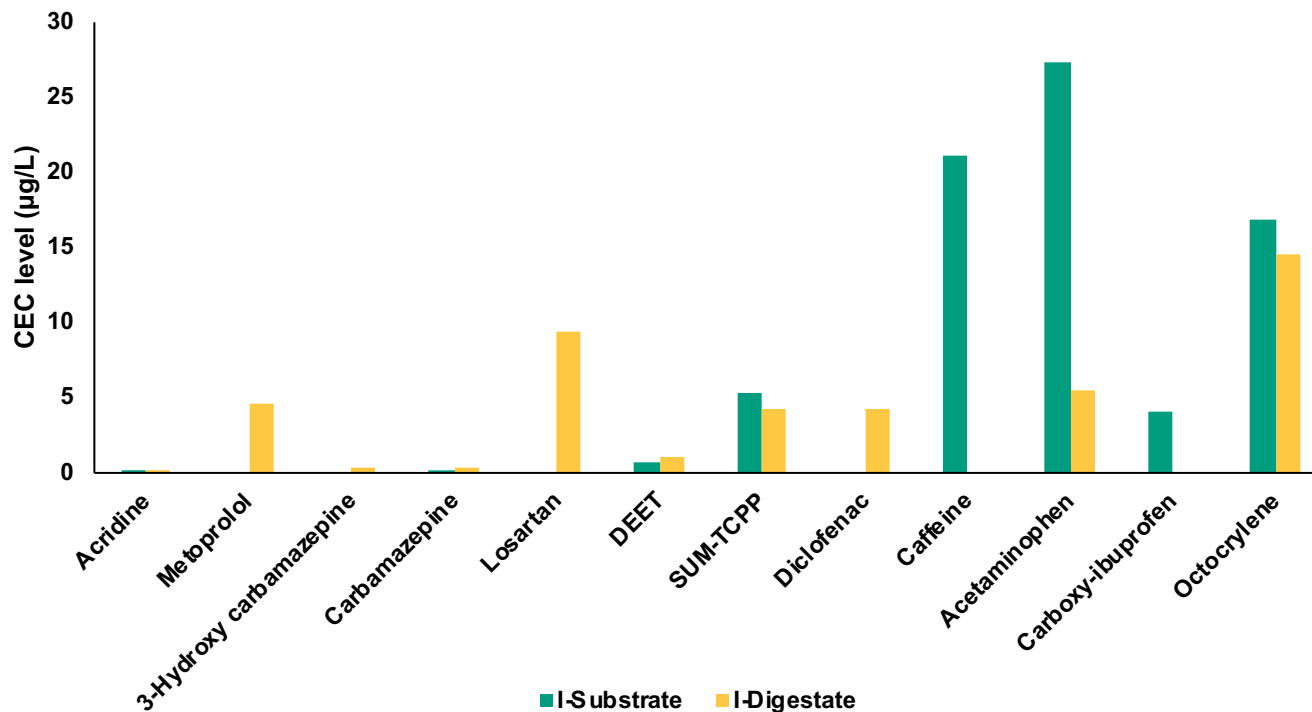
- 12 Norwegian biogas plants contributed substrate and digestate material
- Biogas wastes as indicator matrix for pollutant levels after biogas production.
- Target compounds: Metals, PFAS; PPCPs, POPs, NMVOCs etc.
- Evaluation of uptake potential for legacy pollutants.
- Evaluation of potential exposure risk for human consumers.



Substrate – digestate comparison



Concentration comparison between the target CECs in a substrate (blue - I_{sub}) and a digestate sample (red - I_{dig}) collected from an experimental reactor at station I.



Please note these samples originate from the same production plant but are not produced during the same biogas process.

Comparison with earlier studies



Sample type (country of origin)	CAF (ng/g)	CAR (ng/g)	DCF (ng/g)	TCPP (ng/g)	OC (ng/g)	AMT (ng/g)	LOS (ng/g)	Ref.
Feather meal intended as fertilizer (USA)	<6.0 - 201							10
Fish fillet (USA)		<n.d.- 0.60						12
Sewage sludge (Spain)				429- 912				13
Sewage sludge (Catalonia, Spain)					1060- 9170			14
Whole Fish waste (Spain)	1.6 - 3.3				<n.d. - 30.4			16
Soil, irrigated with reclaimed water (Spain)		0.10 - 8.2				<n.d. - 9.8		17
Soil (UK)			0.14 - 0.21					20
Sewage sludge (Switzerland)					320- 18740			23
Solid digestate (Norway)	n.d .- 210	6 - 90	n.d . - 84	14 - >500	100 - >600	n.d. - 132	n.d. - 76	

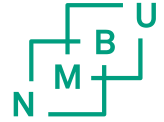
References available upon request

Urban soil pollution

- Urban soil is circulated for centuries
- High pollution levels are documented for organic and organic pollutants in urban soils.
- Utilisation of un-controlled urban soil as substrate for UA is questionable
- No legislation of pollutant control in UA for commercial production in place.



Direct sources - Pollution supporting in infrastructures



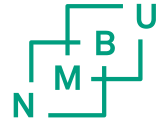
- Chemicals are required for supporting, safety and infrastructure protection
- Introducing pollutions via building materials, technical equipment, insulation and coverage.
- Uptake in vegetation meant for consumption possible
- Currently pollutant control system missing for commercial UA

Specific concern for commercial large scale production facilities.



Ref. Pinterest

Diffusive sources



- Numerous significant direct and diffusive pollution sources identified in an urban environment: *vehicle traffic, domestic combustion, industrial emissions, building materials, garbage, direct release in the gutter, ...*
- Pollution introduces via water, air and soil
- As a part of sustainable strategies, urban pollution issues need to be controlled and monitored.

Consequences for urban agriculture obvious.



Atmospheric pollution

- Elevated annual concentration of inorganic and organic pollutants.
 - Seasonal patterns for many volatile pollutants (highest during Winter).
 - Local sources like domestic heating, combustion engines (traffic), industries and supporting infrastructures (power plants, waste incineration etc.)
 - Frequent smoke and haze events in mega cities covering large areas (SO_2 , NO_x , metals and BTX, VOCs) reported
- Significant source of pollution for UA**



Water pollution

- **Water in urban areas:** Road- and building run off; rain water collectors, ground water; surface water (ponds, creeks), Sewage and rain water overflow
- **Pollution sources:** rainwater contamination, used waters (black, brown water), sewage, industry, domestic waste, vehicle emission, direct domestic emissions,.....

Water usage in UA applications need to be controlled for pollution

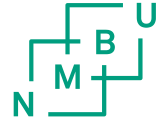


Discussions

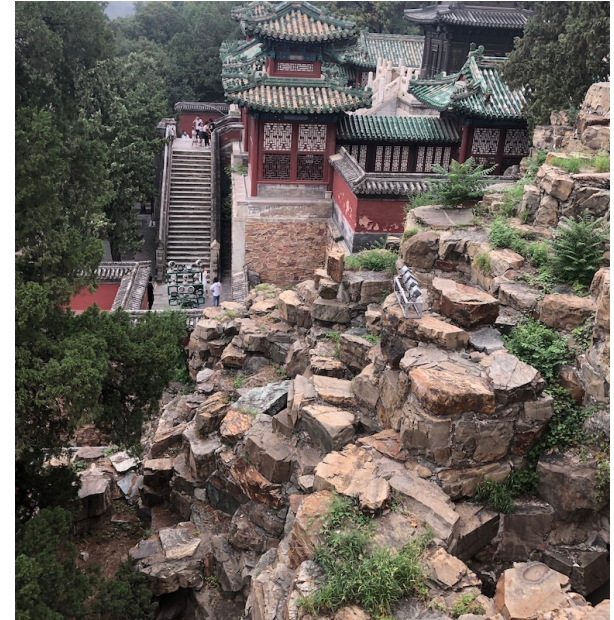


- Urban areas are today considered areas with considerable pollution sources
- The presence of anthropogenic pollutants (metals and organics) is confirmed in a variety of materials and substrates necessary for UA.
- Exposure and distribution patterns of urban pollution is seasonal and area dependent for many pollutants
- Wastes processes contribute to the pollutant patterns in case biowaste are utilized as substrates or soil amendments in UA.
- Potential for up take in commercially exploited vegetation and agricultural products confirmed.
- Pollution control system required for consumer safety.

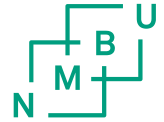
Conclusion



- Urban agriculture (UA) considered as important strategy for future Urban development strategies (mega cities, Citizen livelihood, “green” environments)
- Local UA established and acknowledged as important political focus.
- UA is also considered as contribution to circular bioeconomy transition
- Numerous pollution sources identified and acknowledged
- Urban agriculture and Cities as pollution focus areas is a area of concern
- Suitable and sustainable regulatory frames need to be established for user and consumer production



Acknowledgement



- Thanks NCUA & Trine for the opportunity to present about UA and pollution.
- H7-SIUGreen (Petter Jenssen) for providing supporting information.
- The Research Council of Norway (RCN) supports the *project Novel organic pollutants from recycling of organic waste as risk factors for human exposure* economically.
- The Norwegian Food control authorities (Mattilsynet) and the Farmers association (Bondelaget) actively contribute to the discussion of the presented results.



The background of the slide is a photograph of a large, multi-story brick building with many windows, partially obscured by a large, snow-covered tree in the foreground. The scene is set in winter with snow on the ground and rooftops.

Thank you for your attention!

**Results of the Kahoot
exercise and discussion**