Urban agriculture and climate change adaptation: Ensuring food security through adaptation[1]

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1. The impacts of climate change

The current challenge posed by climate change and its interaction with urban poverty and food security is recognised globally. As highlighted in the international conference organised by UN-Habitat (2009*)* 'Cities are a major part of the cause, suffering the most impacts and therefore play a primary role in finding the appropriate solution.' Climate change adds to the existing challenges faced by cities and their urban poor. Many cities are at risk of becoming disaster traps, due to the direct effects of sea level rise, floods or hurricanes or through severe food supply problems caused by droughts, hailstorms or frosts that affect agricultural production in their hinterlands. Indirect effects of climate change include the possibility of increased rural-urban migration.
The United Nations Population Fund (2007) indicates that the impacts of climate hazards disproportionately affect people 'who live in slum and squatter settlements on steep hillsides, in poorly drained areas, or in low-lying coastal zones.' Cities in these zones are at risk from flooding and extreme storm events. While low-elevation coastal zones represent 2% of the world's land mass, they hold 10% of its total population. There are 3,351 cities in such zones worldwide, 64% of which are located in developing regions, with many experiencing rapid expansion (UN-HABITAT 2009).

Food supply problems
Changing rainfall patterns will affect agricultural productivity, especially in African countries. Without the adoption of crop rotation and improved water conservation techniques, agricultural production could decline 10 -25% by 2020 (Herren, Millennium Institute, 2009, pers.comm.). Lenton et al. (2008) state that southern Africa risks losing 30% of its coarse grain output by 2030 while Mozambique, Zimbabwe, and Malawi face as much as a 50% reduction in yields by 2020. In addition, the share of arable land in tropical regions is expected to decrease.
Climate change is expected to put 49 million additional people at risk of hunger by 2020, and 132 million by 2050 (IFAD; http://www.ifad.org/climate/factsheet/e.pdf). Urban economies will suffer as agricultural production in the surrounding countrysides is hit by storms, floods

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or water scarcity. The decline in agricultural productivity will thus not only effect the rural population but also the urban poor. Maxwell et al. (2009) state that 'urban and peri-urban areas are similarly impacted, as natural causes can lead to increased (temporarily or sustained) higher food prices, food shortages, epidemics, and sudden settlement of those displaced by the shock. To make matters worse, natural causes of food crises are often cyclical, repeatedly affecting the same regions or agro-climatic zones.'
While attention to adaptation in urban areas has been grossly inadequate to date, it has been suggested that the earlier that risk reduction and adaptation efforts are incorporated into city investment and development plans, the lower the unit costs will be (Reid and Sattertwhaite 2007).

Urban heat island effect
A significant factor linking food security and climate change is the urban heat island effect**.** Buildings and surfaces, constructed of concrete and asphalt, heating, and transport systems, and, more importantly, the release at night of heat which has accumulated during the day in the fabric of the city (as the bricks and concrete of the buildings act as enormous storage heaters), in conjunction with the human and industrial activities of urban areas, have caused cities to have higher temperatures than the surrounding countryside. The concrete and asphalt of cities increases run-off, which decreases the evaporation rate and further increases temperature. The annual mean air temperature in a larger city (say 106 inhabitants) is often as much as 3-4 °C higher than over open country, with a peak in the built-up core where on a calm, warm day the temperature difference may go up 11 °C (American Meteorological Society 2000). The increased heat within cities causes discomfort and contributes to greater levels of energy consumption, used for cooling and refrigeration purposes, with a side effect of additional pollution.

Other indirect effects
As the effects of climate change may decrease productivity in marginal lands in rural areas, inhabitants will be forced to migrate to urban areas. Climate change could also contribute to current trends in the depletion of biomass energy resources. Reduced stream flows could lessen hydropower production, leading to negative effects on industrial productivity and more difficult and costly management of sanitation, waste disposal, water supply and public health in urban areas.

2 The importance of urban and peri-urban agriculture for climate change adaptation, sustainable water management and building resilient cities

Urban and peri-urban agriculture and climate change adaptation
Urban and Peri-urban Agriculture (UPA) is increasingly recognized as an important strategy for climate change adaptation and mitigation, to a lesser extent. The World Meteorological Organization (WMO) has suggested that urban and indoor farming are necessary responses to ongoing climate change and as ways to build more resilient cities[2]. The Asian Cities Climate Change Resilience Network (ACCCRN), which brings together a number of international organisations in order to develop adequate strategies and action plans for city-level adaptation to climate change, has included urban and peri-urban agriculture as an important strategy to building resilient cities - or those able to respond to, resist and recover from changing climate conditions (Rumbaitis del Rio 2009).
Urban agriculture, include agro-forestry, was also recognized at the International Tripartite Conference on urban challenges and poverty reduction in African, Caribbean and Pacific countries as having high potential for improving the urban environment and urban adaptation to climate change (UN-HABITAT 2009).

[2] "UN Agency calls for urban agriculture" WMO press release December 7, 2007

UPA helps cities to become more resilient by:

1. Reducing the vulnerability of most vulnerable urban groups and strengthening community-based adaptive management through:

    - Diversifying urban food sources, enhancing access of the urban poor to nutritious food, reducing dependency on imported foods and decreasing vulnerability to periods of low food supply from the rural areas during floods, droughts or other disasters;
    - Diversifying income opportunities of the urban poor and functioning as a safety net in times of economic crisis;
    - Being a source of innovation and learning about new strategies/ technologies for high land and water efficient food production.

2. Maintaining green open spaces and enhancing vegetation cover in the city with important adaptive (and some mitigation) benefits including:

    - Reduced heat island effect by providing shade and enhanced evapo-transpiration (more cooling, less smog);
    - Reduced impacts related to high rainfall (by storing excess water) , increased water interception and infiltration in green open spaces and keeping flood zones free from construction, reduction of rapid storm water runoff and less floods downstream and more replenishment of ground water;
    - Improved water quality through natural cleaning in low lying agricultural areas (e.g. natural or constructed wetlands, aquaculture in maturation ponds etc.)
    - CO_2 and dust capture
    - Prevention of landslides by (agro-)forestry on steep slopes (and preventing building on such sites)
    - Conservation of biodiversity, protecting a wider base of plant (and animal) genetic diversity (Santandreu et al. 2002).

3. Safely reusing wastewater and composted organic waste:

    - Adapting to drought by facilitating year-round production, safely using waste water flow and nutrients in water and organic waste[3];
    - Reducing competition for fresh water between agriculture, domestic and industrial uses;
    - Lowering the depletion of certain minerals (e.g. phosphorus, by making productive use of the nutrients in wastewater and organic wastes[4]
    - Reducing landfill volumes and thus methane emission

4. Reducing their energy use and green house gas emissions by producing fresh food close to the city:

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[3] In water-scarce countries (especially in the Near East and North Africa, South Africa, Pakistan, and large parts of India and China) and in densely populated areas, growing competition between industrial, energy and domestic uses of water and agricultural use of water can be observed. When a country faces water scarcity, central and local governments tend to restrict agricultural water use in favour of urban industrial, energy and domestic uses, with important negative consequences for national food production (UN Water, 2007). Meanwhile cities produce increasing quantities of wastewater that to a large extent is routinely disposed in rivers, lakes or the sea, with important negative effects on public health and the urban ecology, including the contamination of groundwater and pollution of fresh water bodies down streams of cities. Along with more efficient water use in agriculture, the productive use of treated urban wastewater and the use of rainwater have been identified as a sustainable way to produce food for the growing cities.

[4] Wastewater, excreta and urban organic waste are an accessible source of plant nutrients, such as phosphorus, nitrogen and potassium. The world's resources of readily available phosphorus are limited and will run out in 25 years (Rosemarin, 2004). Nutrient recycling will reduce the need for artificial fertilisers and the energy needed for producing it.

- Using less energy in transport, cooling, storage, processing and packaging and enabling synergic and cyclical processes between urban domestic and industrial sectors and agriculture (e.g., use of excess heat, cooling water or CO_2 from industry in green houses);
- Reducing the ecological footprint of the city via the energy and water needed to produce and transport the food consumed by it

However, urban agriculture, if not properly managed, may also have some negative impacts on the urban environment. Soil erosion and pollution of ground water may occur, if chemical fertilisers and pesticides are used over an extended period. Ecological farming practices are highly recommended in urban and peri-urban agriculture to prevent such negative effects.

3 The way forward: Building more resilient and food secure cities through urban and peri-urban agriculture

Urban and peri-urban agriculture can play an important role in responding to a range of challenges faced by developing countries when building more resilient cities. The size and urgency of these challenges require innovative solutions and the promotion of safe, sustainable and multi-functional urban and peri-urban agriculture is certainly key among them.

As cities are quickly becoming the principal spaces for planning and implementation of strategies that aim to mitigate or adapt to climate change, there is a growing need for metropolitan, municipal and other local government institutions directly concerned with urban development to play a proactive and coordinating role in enhancing urban food security and cities resilience by including urban agriculture in local climate change adaptation and disaster risk reduction strategies. In order to strengthen climate change adaptation in urban areas, city governments may take measures that include:

- Protecting and stimulating of sustainable urban and peri-urban agriculture in flood zones and wetlands and on steep slopes in order to prevent construction in such areas and to reduce run-off;
- Preferential food procurement from family- and community-based farms located within the city (e.g., government canteens, school feeding programmes) and facilitating direct marketing of fresh and ecologically produced food from regional sources;
- Involvement of urban poor producers in the maintenance of open green spaces such as greenbelts, green fingers, parks and other open spaces ;
- Promotion of agro-forestry in order to reduce the urban heat islands effect and to enhance biodiversity and landscape management;
- Facilitating (safe) reuse of urban wastewater and organic waste in order to reduce waste disposal into open water systems, reducing fresh water use and recycling nutrients

In this context a shift to decentralised and low-cost treatment of wastewater, which would allow the reuse of wastewater and nutrients close to the source (stabilisation ponds, cluster approach, constructed wetlands) needs to be supported in tandem with decentralised collection and (co-)composting of organic waste and excreta. Health risks related to reuse of untreated waste water for production has to be reduced through complementary health risk reduction measures as explained in the new World Health Organisation (WHO) guidelines for safe use of excreta and wastewater (WHO 2006). Urban wastewater can be recycled and applied in a number of irrigation/fertilisation uses including floriculture and fruit crops irrigation, irrigation of forest plantations, combating desertification, providing fuel wood[5],

[5] In many cities attempts to decrease pressure on wood energy (fuel wood and charcoal) by subsidizing gas or electric technologies have not succeeded. The prognostic for many regions, such as in Africa, is that wood energy will continue to be the main source of energy for cooking and heating of the majority of their population.

and turning steep slopes and low-lying lands into urban 'green lungs', that can also be used as recreational areas while creating flood buffers for neighbouring housing areas.

Integration of UPA in urban development and land use plans

Increased access of the urban poor to land and water, and especially enhanced security of agricultural land use, needs to be given proper attention. To this end, the integration of UPA into urban development and master plans, urban land use and zoning plans, as well as active maintenance of the protected agricultural zones against the land hunger of other urban interest groups is crucial. In most cities, there is no real shortage of land, but there is lack of pro-active management policies regarding use of land for food security and sustainable urbanisation. Since land is a valuable resource, combinations of different forms of land use (multi functional land use) for example by combining agricultural land use with recreational, water management / flood protection or other functions may be required.

In addition, various cities have taken innovative measures to enhance access of the urban poor to land including, for example:

- Integration of UPA in social housing and slum upgrading programmes by including space for home gardens or community gardens, street trees for shade and fruits, "productive parks", as in the Villa Viva and Drenurbes housing schemes in Belo Horizonte, Brazil;
- Making municipal land available to groups of urban poor households through medium-term lease arrangements or providing occupancy licenses to the urban poor producing informally on municipal land under the condition that they adopt safe and sustainable production practices (Governador Valadares, Brazil, and Cagayan d'Oro, Philippines). Municipal land that is provided might be land that is earmarked for other uses but not yet in use as such, such as land that is not fit for construction.[6] Such land is given on short- or medium-term lease arrangements to organised groups of urban poor for gardening purposes. Often these contracts with farmers include conditions regarding land, crop and waste management practices and include certain restrictions;
- Fiscal and tax incentives for land owners who lease out vacant private land to groups of urban poor willing to produce on this land (Rosario, Argentina)

Establishment of a Municipal Food Programme

Many cities have started municipal programmes to support the development of safe urban food production and consumption, often with a pro-poor focus. Besides enhancing and securing access to land and water and composted urban wastes, such programmes may focus on:

- Strengthening the organisation of urban producers and their capacity to design and implement projects to improve food marketing systems and participate in local planning activities (see FAO 2007). In Rosario, Argentina, the municipal urban agriculture programme supported the establishment of an Urban Producers Network and helped it link with other various governmental and non-governmental organisations. Peri-urban communities and agricultural cooperatives outside of Beijing are another example of innovative urban agricultural production and marketing projects.
- Providing training and technical assistance to urban producer groups and supporting them in implementation of their production and marketing activities and/or encouraging/enabling local non governmental organisations (NGOs), community-based organisations (CBOs), universities and colleges to do the same. Important topics for training are ecological farming practices, management of health risks, farm development, enterprise management and marketing.
- Support for infrastructure development and access to equipment and inputs.[7] The City of Cape Town for example transferred an old industrial site and building to an NGO supporting 3000 urban producers. The site was converted into a packaging shed for green

[6] These areas include flood zones, land under power lines, buffer zones and land reserves for future use.

[7] Assistance with infrastructure development may consist of storage spaces, packaging sheds, or green houses, while equipments and inputs may consist of irrigation equipment, quality seed, seedlings or young stock at cost or subsidised prices.

vegetables, a demonstration ground for ecological production technologies and a training centre.

- Enhancing access to efficient irrigation systems by delivering a minimum amount of fresh water free of charge to community gardens in slum areas (Cape Town, South Africa), by providing treated wastewater and training to poor producers operating in a peri-urban areas (Bulawayo, Zimbabwe), promoting systems for rainwater collection and storage (Mexico City), or constructing wells and establishing localised water-efficient irrigation systems (e.g. drip irrigation) in urban agriculture.
- Facilitating direct marketing of food products. Municipalities may facilitate marketing initiatives of poor urban and peri-urban farmers by providing them access to existing city markets, by assisting them in the creation of farmers' markets through infrastructure development, licenses, and quality control and by authorising food box schemes and green labelling for safe, ecologically grown urban food.
- Promotion of multi-functional land use. Under certain conditions urban farming can be combined with other compatible forms of land use. Farmers may provide recreational services to urban citizens, receive youth groups to provide ecological education, act as co-managers of parks, etc. In Calcutta, the maintenance of wetlands, agriculture and aquaculture are combined with waste water treatment and reuse. The Municipality of Beijing supports the development of peri-urban agro-tourism. Pretoria, South Africa, in partnership with producers, saves considerable maintenance costs by combining community gardening and recreational activities within municipal open green spaces.

4 Final remarks

The effects of recent crises in surrounding the global economy, food, energy, water and climate change are felt strongly by an increasing number of urban poor people. Adequate responses are urgently needed. Urban agriculture can play an important role in responding to these challenges, if it is incorporated into comprehensive approaches to sustainable urban development characterised by multi-stakeholder involvement, decentralised and flexible approaches, participatory planning and management of spaces and services, pro-poor focus and optimal use of locally available resources (including wastes).

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