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Urban metabolism in practice

The difficult implementation of closing the loop approaches, through the water and food cycles in cities

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Abstract. The global urbanisation, with its pressing socio-environmental challenges and fragmented urban management, is prompting the re-emergence of an urban metabolism (UM) concept that encapsulates integrative and circulating imperatives in its search for sustainability. With water and nutrient cycles being at the same time at the core of the basic needs pyramid and in the throes of the debate on resource depletion, the “closing the loop” approach is flourishing in academic literature. It is also echoed in practical movements recently developed or rediscovered, such as sustainable sanitation (SS) and urban agriculture (UA).

Yet such a holistic concept is confronted with its allegedly vast ambitions when it comes to implementation. The stress on the local context precludes any turnkey solution, especially when considering the number of actors and the urban scales. The dichotomy between the academic and the practical spheres could be seen as another expression of the long-standing cleavage between the green and brown agendas. The latter focusing on local short-term challenges linked to environmental health issues. The former associated to global and long-term issues and tied to ecologically sustainable goals in urban areas.

In order to evidence and understand the gap between theory and practice, this paper reviews some major research programmes explicitly using an urban metabolism framework. It delineates their incentives, then narrows the analysis on the water and food nexus, since it is the most advocated one. The assessment of two recognised programmes – SWITCH and EcoSanRes – through a set of variables combining the main urban metabolism assumptions, demonstrates the various limits and constraints in implementing such holistic approaches. The funding mechanics of international development programmes and the biases of their current expertise-led trend are some of the most critical examples.

Content

List of acronyms

BRIDGE	Sustainable urban plannIng decision support accounting for urban metabolism
CAPS	Center for Advanced Philippine Studies
CFF	Cities Farming for the Future
CLTS	Community-Led Total Sanitation
CREPA	Centre Régional pour l'Eau Potable et l'Assainissement
DFID	Department for International Development
Ecosan	Ecological Sanitation
EcoSanRes	Ecological Sanitation Research
EIA	Environment Impact Assessment
ENPHO	Environment and Public Health Organisation
EU	European Union
FAO	Food Agriculture Organisation
FSTT	From Seed to Table
GTZ	Gesellschaft für technische Zusammenarbeit
HCES	Household-Centred Environmental Sanitation
IWA	International Water Association
IWMI	International Water Management Institute
ICID	International Commission on Irrigation and Drainage
ISSUE-2	Integrated Support for a Sustainable Urban Environment 2
JMP	Joint Monitoring Programme
LCA	Life Cycle Assessment
MDG	Millennium Development Goal
MFA	Material Flow Analysis
Netwas	Network for Water and Sanitation
NGO	Non Governmental Organisation
NPK	Nitrogen Phosphorus Potassium
R4D	Research for Development
RiPPLE	Research-inspired Policy and Practice Learning in Ethiopia
ROSA	Reuse-Oriented Sanitation concepts for peri-urban areas in Africa
RUAF	Resource centre on Urban Agriculture and Food security
SEECON	Society-Economy-Ecology-Consulting
SEI	Stockholm Environment Institute
SFA	Substance Flow Analysis
SIDA	Swedish International Development Agency
SuSanA	Sustainable Sanitation Alliance
SS	Sustainable Sanitation
SUME	Sustainable Urban Metabolism For Europe
SWITCH	Sustainable Water Management Improves Tomorrow's Cities' Health
UA	Urban Agriculture
UDDT	Urine-Diverting Dry Toilet
UHA	Urban Harvest Approach
ULTRA	Urban Long-Term Research Area
UM	Urban Metabolism
UN	United Nations
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
UNU-INWEH	United Nations University – Institute For Water, Environment And Health
UNW-DPC	United Nations Water – Decade Programme on Capacity Development
VIVACE	Vital and viable services for natural resource management in Latin America
WASH	Water Sanitation and Hygiene
WASPA	Wastewater Agriculture and Sanitation for Poverty Alleviation
WHO	World Health Organisation
WSSCC	Water Supply and Sanitation Collaborative Council

1. Introduction

Since the mid-19th century, societies reorganise themselves around cities, concentrating dense population in places of both opportunities and constraints. Opportunities mainly rely on economic aspects. Constraints are revealed in terms of access to basic needs. As urban population growth outpaces the provision of infrastructure and services, the pressure on limited urban resources is reinforced. However, this critical situation often remains clouded by more visible urban issues such as evictions and demolitions, as demonstrated by the coverage of the protests in Istanbul (Taksim Square) (Datu, 2013) and Rio de Janeiro, where the preparations for the 2014 Football World Cup and the 2016 Olympic Games have spurred vivid reactions about 'clean-ups' of favelas and indigenous population displacement (Gibson and Watts, 2013; Griffin, 2014). Such issues are intrinsically linked to major underlying problems mostly ignored by the press. Critical ones are that a seventh of the world population is water- and food-insecure with also rudimentary sources of energy (Hoff, 2011), and an estimated one billion are slum dwellers (UN-Habitat, 2003).

The context of climate change amplifies the multiple socio-environmental urban crises, especially in developing countries where urban poverty and inequality prevail, whilst environmental degradation reaches critical levels. Not only linked to housing and employment, urban poverty lies in the precarious yet vital access to and affordability of water, food, energy and sanitation. The food price crisis, which culminated in 2008, magnified the urban cumulative effect that leads to poverty escalation.

The progressive acknowledgment of such global issues is prompting reflections upon the crucial role of urban areas. It thereby inspires numerous studies on how to keep urban systems balanced and sustainable. The concept of urban metabolism (UM) is gaining momentum in this context, even gaining the ambivalent status of buzzword (Tuhus-Dubrow, 2014), with at least 75 papers published since 1965 according to Kennedy and Hoornweg (2012). As put by Gandy (2004 p.2): "*[…] irrespective of whether the city is celebrated as a dynamic machine or derided as a voracious monster, the metabolic view of the city raises a series of analytical dilemmas concerning the intersection between social and bio-physical dimensions to urban space*".

This paper intends to evaluate the impact of such a holistic theory in practice, by looking at limits and constraints in applying "closing the loop" approaches when it comes to urban water systems and food cycles. It argues that while academic research expands on UM, its application remains constrained by a series of factors, such as the funding mechanics of international development programmes and its expert-led trend.

The literature review (part 2) lays the ground on the notion of UM, before addressing sanitation and food crises and focusing on the specific sustainable sanitation and urban agriculture movements that intend to solve them.

The practice review (parts 4 and 5), on the other hand, delves into the gap between theory and practice, highlighting the fragmentation process at stake in development programmes and the single synergy promoted in the water-nutrient nexus.

Finally (part 6), limits and constraints of closing water and nutrient loops are examined through the assessment of the SWITCH and EcoSanRes programmes, using a combination of criteria inspired from the three main UM approaches.

2. Back to circularity: urban metabolism and closing the loop approaches

2.1 A plural urban metabolism base

Metabolism means *“the chemical processes that occur within a living organism in order to maintain life”* (Oxford Dictionary). It finds its etymology in the Greek word metabole, meaning change. The notion of metabolism therefore refers to a process of changes that keep a system alive, which explains its initial use in ecology and biophysical sciences.

The UM concept applies this analysis of vital changes within a living organism to cities, metaphorically considered as living systems. After centuries of rural predominance, the shift toward urban areas brings along a rupture in the relationship with the biophysical environment. *“Cities have long been viewed as places where nature ends and where urbanism begins, a perspective still prevalent today in many urban policy practices”* (Swyngedouw and Cook, 2009, p.2). Accordingly, UM lies on shared concerns about the human-nature relationship, exploring the links between cities and their hinterland in a quest for urban sustainability (Castan-Broto et al., 2012).

Three perspectives from a wide range of disciplines

From engineering and economics to humanities and social sciences, UM is being theorised according to various assumptions, categorised by Gandy (2004) and Castan-Broto et al. (2011) as the form analogy, the functional analogy and the dialectical approach, also called the hybridized conception (Gandy) or the dialectical production (Castran-Broto et al.).

The form analogy looks at what constitutes the city DNA, focusing on its structuring elements and their interconnection (Rapoport, 2011). In the functional analogy, the focus lies on the organic functions provided by a city and on the flow of inputs and outputs needed to maintain them (Kennedy et al., 2011). Both analogies rely on ecosystem or system theories to condemn the linear processes currently at stake and promote circularity (Girardet, 2010). With arguments largely appealing to common sense, they expose the wastefulness of the disconnected urban management of in and outputs.

The more recent dialectical approach considers the spatial production of the city according to its socio-political and historical aspects, placing the inherently relational social element at the core of the urban entity (Gandy, 2004; Castan-Broto et al., 2011).

The various methodologies and objectives pursued come along with concrete applications for the analogy perspectives. Form analogists deeply inspire urban planning, design and architecture spheres, in both rational and futuristic ways. The rising tendency towards eco-buildings demonstrates this influence and displays a wide range of developments, from eco-houses already constructed to eco-utopian conceptions. The biomimicry movement, for instance, can lead to eye-catching and highly aesthetical architectural projects claiming to solve urban environmental problems through the imitation of nature patterns (Benyus, 2014; Pawlyn, 2011). Along these lines, the architect Vincent Callebaut creates eco-utopian projects such as Lilypad, described as “a floating ecopolis for climate refugees” or Paris smart city 2050, where eight eco-conceived prototypes of positive energy towers are designed to fight global warming (Vincent Callebaut Architectures, 2015).

Functional analogists undeniably influence international policy spheres, disseminating numerous indicators to measure cities’ impact on the environment (Gandy, 2004; Castan-Broto et al., 2011).

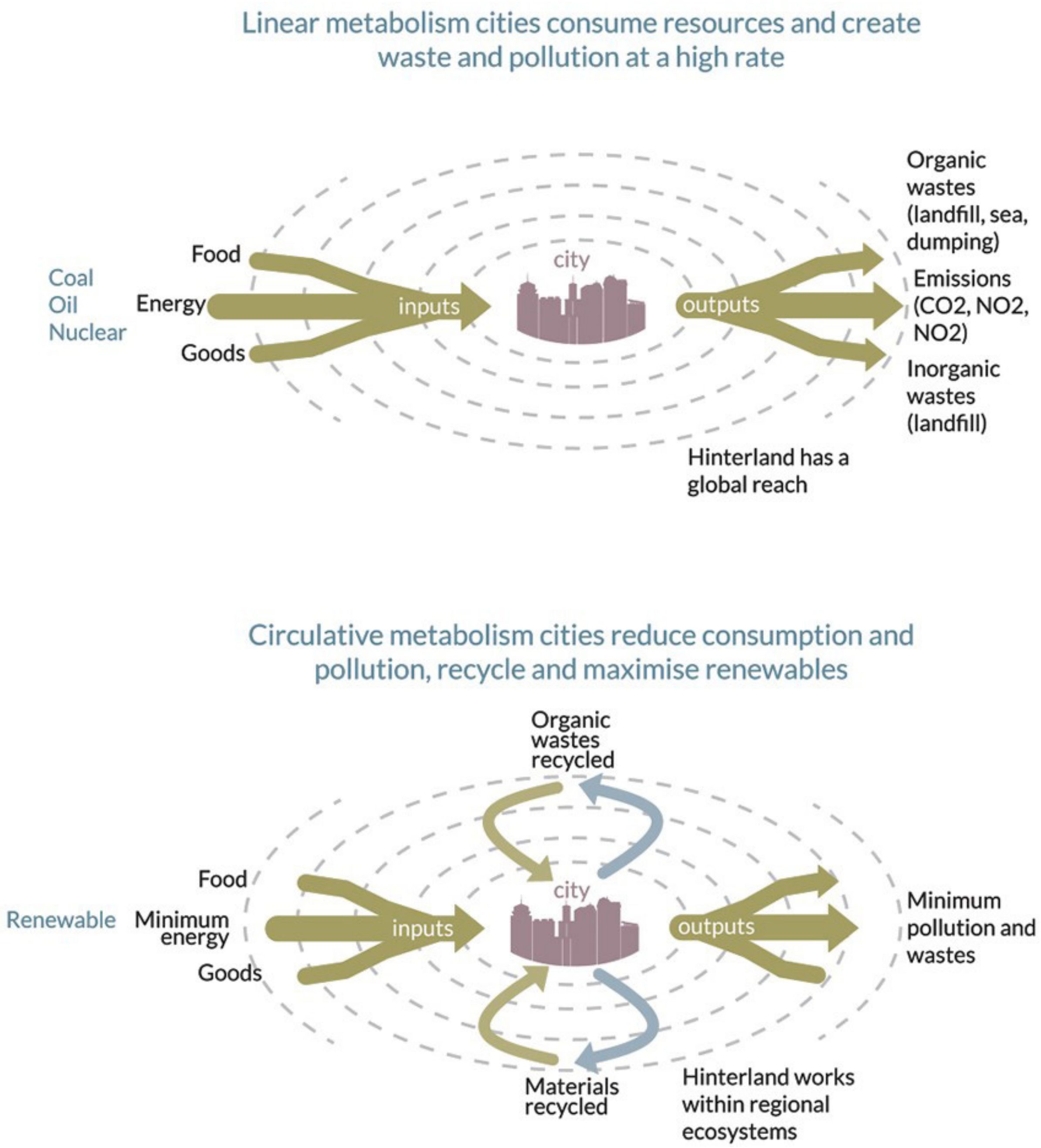
The set of quantitative tools proposed by the functional perspective, such as the Material Flow Analysis, Cities’ footprints or the Urban Harvest Approach, can provide advocating figures to reach enhanced targets and lead to direct improvement schemes by specific group of actors, such as local authorities or environment experts (Holmes and Pincetl, 2012). In the private sector, companies can choose to reduce their environmental footprint by taking resource-efficient measures, since it often results in interesting financial returns.

The surge of these tools also provides useful overviews of the consumption patterns of cities, by looking at resources needed and used, but also at those produced within urban areas. In this regard, they critically underline the prevalent fragmented management of cities resulting in disconnection between resources and waste flows (Kennedy et al., 2007; Esrey, 2001). Instead of considering cities as resources/ nutrient sinks (Cofie et al., 2006; Dreschsel, 2007), they pinpoint urban potential as primary and secondary producer. The notion of cycles is therefore presented as an essential part of the urban equation.

The circular economy (CE) model also derives from this analogy and is currently gaining a broad exposure. On top of asking for policy adjustments, it directly targets the private sector and unfolds the perspective of concrete economic gains. It is mainly advocated for the manufacturing sector, by switching from the linear "extract, use, discard" standard procedures to considering waste as resource, and therefore reconceptualising the initial product design to facilitate longer use, reuse and recycling activities (Andrews, 2015). Furthermore, it advocates for a new economic system where products or services ownership would be replaced by renting and sharing models (Ellen MacArthur Foundation, 2012). Despite this promising potential, up to now CE seems predominantly confined under the waste umbrella.

The narrow focus on flow circularity paradoxically results in another type of linear analysis that cannot escape the critical scrutiny of the dialectical approach (Gandy, 2004). The two main criticisms its proponents address to both analogy perspectives expose the lack of attention to power relations on the one hand - which eludes socio-political inequalities - and the uncontested acceptance of the capitalist prevalent forces driving the urban fabric on the other hand (Swyngedouw, 2006).

Figure 2.1. Linear and circular metabolism of cities. Source: Girardet, 2010



In that sense, the dialectical approach encompasses the main circular assumptions of the form and functional analogies, but crucially adds socio-political cycles to the production of the city. It questions the political nature of any urban context and explores the convoluted game of responsibilities, thus shedding light on what engenders the urban social divide. As put by Castree and Braun (1998, p.34), *"The crucial issue therefore, is not that of policing boundaries between "nature" and "culture" but rather, of taking responsibility for how our inevitable interventions in nature proceed – along what lines, with what consequences and to whose benefit".*

Where both analogies propose hands-on means to improve urban efficiency and sustainability, the dialectical approach advises on the decision-making processes shaping urban areas. It strongly suggests participatory consultations and communities' empowerment to build an inclusive and bottom-up long-term sustainability scenario. Rooted in integration and collaboration imperatives, this approach paves the way to further resilient and environmental justice debates.

Common patterns and pitfalls

Each UM perspective offers a particular angle of examination into the urban complexity, by looking either at cities' flows, the direction of these flows, or who controls their direction, as key elements shaping urban areas. Each analyses the dynamics and changes in and the changes of the urban sphere, through specific lenses such as circularity, interconnection or power relations. Combined, these UM understandings could provide a kind of three-dimensional analysis that would offer a complete diagnosis of the urban process (Castan-Broto et al., 2012).

Despite its different readings, UM appears as a flexible and inter-disciplinary concept allowing new ways of reflecting about the essence and processes of cities (Rapoport, 2011; Castan-Broto et al., 2012; Gandy, 2004, Kennedy et al., 2012). With the notion of integration at its core, it can provide a holistic conceptual framework recognising the inter-dependency of a broad range of actors (Pieterse, 2004). An emphasis on the different timeframes and scales within the city also appears as a fundamental factor to be taken into serious consideration (Gandy, 2004; Pieterse, 2004; Jewitt, 2011).

While each perspective has its own limitations, there is a shared tendency to overlook one aspect to focus on another. Certainly inherent to the complex imbrication of socio-economic-political and environmental layers within urban areas, this results in a common pitfall of looking only at specific parts of the system, or to look at the system as a closed one.

Moreover, the macro-level analysis of UM poses an operationalisation challenge. Particularly, the integration imperative seems to aim above all at a collective long-term vision of the city, which may prove rather difficult to achieve and might reflect a "western" bias in the sense that it presupposes *"(…) a vibrant democratic, accountable and transparent local state that can facilitate a social process of defining a future vision for the territory. (…) an intelligent state that is able to initiate and sustain a participatory strategic planning process that can crystallise a vision for the city that reflects diverse interests and uses it to mobilise resources to initiate selective strategic projects to progressively realise the vision."* (Pieterse 2004, p. 6).

2.2 Brief timeline of historical "closed-loop" and linear urban systems

While the pressing challenges posed by urbanisation trigger active academic research on UM, some papers recall that history is replete with examples of integrated urban management systems. Framed as *closed-loop systems* (Esrey et al., 2001; Bracken et al., 2007) or *regenerative cities* (Girardet, 2010), the focus is set on traditional and past experiences in bridging resources and waste flows. At all times, the first priority of a city should consist of feeding its inhabitants and, to a lesser extent, dealing with the waste generated. Agriculture, sanitation and waste disposal systems therefore represent the main topics addressed.

Pre-industrial cities

Before the expansion of the modern city model around the mid-19th century (Gandy, 2004), the amount of resources needed and waste generated in cities of well-defined boundaries was mostly subject to pragmatic systems. Since urban inhabitants were heavily dependent on natural cycles, it was in their utmost interest to rationalise the vital nutrient cycle. Consequently, traditional reuse of organic waste is frequent throughout humankind's history (Bracken et al., 2007, Jewitt, 2011, Barles, 2007).

Archaeological sources and written archives reveal various illustrations from all over the world. In Celt and Roman societies, urine was valued for many purposes, such as cleansing. Old Sanskrit manuscripts signal the medicinal use of urine practised in Asia. Urban centres in Yemen practised a proper separation of urine and faeces, burning dried faeces as fuel (Bracken et al., 2007). Japan and China share a traditional use of human excreta as agricultural fertiliser, through the night soil practice, for instance, that is still common in China, in areas where sewerage is non-existent (Bracken et al., 2007; Jewitt, 2011). The still fertile Terra Preta soil discovered in the ruins of the Inca Empire contains a mixture of bio-waste, such as charcoal dust, and treated excreta (Factura et al., 2010). The nutrient recovery from human waste for enhancing agricultural production and regenerating soil fertility therefore appears as a common pattern across space and time. It lasted until the mid-19th century in Paris, where human waste, collected in regularly emptied cesspools, was transformed in refusal depots into a popular fertiliser powder (Barles, 2007). The use of London dust-yards as an alternative solid waste management system also provides a lasting example of closed-loop processes (Velis et al., 2009).

Nonetheless, cultural attitudes toward waste also vary in time and space (Jewitt, 2011) and respond to various influences, such as religious or traditional popular beliefs and prevailing health theories (Furedy and Pitot, 2009). Alongside the nutrient value acknowledgement and reuse trend, human waste has also generated negative reactions and social taboos. In other words, they have inspired a "great distaste" (Black and Fawcett, 2008), from widespread disgust to denial (Dellström Rosenquist, 2005). As

Figure 2.2. UM assumptions. Source: Author

Discipline	Normative bases	Type	Focus	Methodology/ Tools	Limits	Authors
Urban Ecology	Ecosystem theory System theory Complex system theory	Form analogy	Anatomical city/ the DNA of cities City's components and interconnections "circularity, balance and order" OR "resilience, self-regulation"	Rely on sciences Biomimicry Landscape architecture *Examples:* Masdar City / archibiotic concept from Vincent Callebaut	City viewed as a closed system Interconnections with hinterland disregarded Lack of socio-political aspects	Girardet Newman and Jennings Benyus Pawlyn
Industrial ecology **Political economy** **Ecological economics**	Bio-physical approach System theory based on the laws of thermodynamics World-system theory	Functional analogy	City functions In and outflows Self-sufficiency Resource efficiency	Dematerialisation / decoupling Closing the loops / industrial symbiosis Circular economy / cradle-to-cradle <u>Tools</u> (details in appendix 1): Carbon cycle Material Flows Analysis (MFA) Substance Flow Analysis (SFA) Cities' footprint Life-Cycle Assessment (LCA) Urban Harvest Approach (UHA)	Rely on technical solutions Lack of socio-political aspects Tools highly dependent on accuracy and availability of data	Baccini Barles Brunner Kennedy Girardet McDonough
Political ecology **Political geography**	Socio-political construction of cities Social metabolism Marx's "metabolic shift" base "Right to the city"(inspired from Lefebvre, emphasized by Harvey)	Dialectical approach	Historical production of cities Socio-political distribution of urban flows Question the prevalent socio-political order	Environmental justice Socio-environmental justice, with the advancement of the "right to the city" concept Resilient cities	No applicable tools Challenge capitalism and neo-liberalism policies without evident replacement solution Advocate for a change of paradigm that might appear as utopian, therefore requiring long-term perspective	Gandy Harvey Heynen Swyngedouw

put by Jewitt (2011, p.4): "[…] *some (faecophilic) cultures tolerate the handling of shit, whereas other (faecophobic) cultures find it abhorrent or ritually polluting and even the words that describe it are deeply offensive to them."* The Akan community in Ghana, for instance, presents a great fear of excreta, materialised in an ambivalent situation where their repulsion prevents them from efficiently deal with their sanitation systems (van der Geest, 1998).

The water shift

Nowadays, repulsive attitudes toward human waste have widely blossomed as the dominant norm. A range of cultural factors influenced the shift from the traditional cesspools, latrines and night soil collector systems to the now widespread flush-and-discharge method. For the poorest in developing countries, however, pit latrines, the drop-and-store method, constitute the main alternative (Esrey et al., 2001).

Deeply rooted in a chaotic context of rural exodus leading to the urbanisation boom and epidemic outbreaks in 19th century Western European cities, the modern city, or bacteriological city (Gandy, 2004), emerged as a successful combination of socio-economic converging interests. While inhabitants were urging for sanitary upgrades, both miasma and hygienist theories flourished (ibid., Bracken et al., 2007; Jewitt, 2011). They successfully lobbied for a "water revolution", which paved the way for the entrance of safe freshwater into the private sphere and of new conceptions around body cleanliness (Gandy, 2004). Water supply and resource became intimately linked to sanitation (Smits, 2005).

This provided at the same time to the young technological and industrial sector some direct markets with the construction of piped water and sewerage networks, while giving to public authorities a new role to play in the public health sphere (Black, 2008). The recovery of nutrients also lost economic interest with the concurrence of cheaper industrial fertilisers developed at that time (Bracken et al., 2007).

This may be the result of the modernisation process, rooted within the Enlightenment ideals around "[…] an eagerness to apply scientific, technological methods to increase material production as well as a desire for institutions and cultural transformation that embody […] efficiency, frugality, orderliness, diligence, punctuality, and above all, rationality in decision making liberated from tradition […]" (Rich, 1994, p. 201). With human aspirations as engines of progress, efforts were directed toward mastering nature for human profit, creating dreams of "exponential growth" (Meadows, 1974) that reinforced the "dominion over nature" (Merchant, 1990).

Henceforth, this anthropocentric system inspired, in a schematic way, the industrial revolution, promising economic opportunities and hope of better way of living in cities. The subsequent rural exodus led to urban outbreaks of epidemic diseases. Human waste and manure, associated with offensive odours, were accused of putting public health at risk. Sanitation became an underground affair, buried from sight and left to specialists (Gandy, 2004).

Under sanitary justifications, the traditional closed-loop systems lost ground to the linear end-of-pipe sanitation model and its intrinsically social excrement-taboo. This change of paradigm required massive investment and institutional regulation over 60 years to be fully operational. Several more decades were necessary to display improvements in terms of public health (Black, 2008). Despite its conception as an emergency solution to a pressing socio-sanitary crisis and its heavy maintenance costs, the water-reliant sewerage model has since been largely disseminated with a clear disregard for local traditions and context (Bracken et al., 2007; Jewitt, 2011). *"The unreflected export of this end-of-pipe philosophy, even to water scarce, poor regions of the South, has however also contributed to the alarming sanitation statistics there […]"* (Bracken et al., 2007, p.6). As Gandy (2004, p.11) explains, water is pivotal in the social production of space while being in parallel a *"brutal delineator of social power".*

2.3 Urban nutrient and water cycles

Mismanagement of water and nutrient cycles can both threaten citizens' health and livelihoods while being of the most vital necessity.

Global sanitation and food crises

The Global sanitation crisis, emphasised by civil society and international organisations for more than a decade, finds expression within the Millennium Development Goal (MDG) 7 "ensure environmental sustainability", Target 7C/10 "access to safe water and basic sanitation". By 2015, it seeks to halve the proportion of the 2.5 billion people lacking sustainable access to basic sanitation.

According to the Water Institute of the University of North Carolina, who recently challenged this figure, the number rises to 4.1 billion people when environmental impacts are taken into consideration (Walton, 2013). With 2008 declared the International Year of Sanitation (UN, 2007) and the World Toilet Day officially enshrined on November 19th[1] by the UN "Sanitation for all" resolution adopted on July 24th 2013, the alarming global sanitation crisis is under the spotlight in order to raise awareness of this harmful taboo (UN news centre, 2013).

It is interesting to note that within UN discourses, sanitation is automatically associated with access to water. The health risk, especially for children and women, appears as the main concern, closely followed by a right to dignity.

However, the sanitation crisis tends to be depicted as a mostly rural issue. The official figures from WHO/Unicef's Joint Monitoring Programme are inclined to portray urban areas as always better than rural ones. This hides a largely underestimated urban situation, where sanitation services often exist while being unaffordable - a factor not considered by JMP – or contingent on obsolete, leaking or malfunctioning sewerage installations (Satterthwaite, 2004). Moreover, environmental and health risks rise with higher urban densities, particularly in informal settlements where communities are less willing to put energy in proper sanitation systems due to land tenure insecurity (Collender, 2011). According to Rosemarin (2005, p.9) *"Half the urban developing world lacks adequate water and sanitation".*

Following the rural figures, NGOs mostly favour rural programmes, where they are the main providers of sanitation services (Banks and Hulme, 2012). This exposes them to suspicion of perpetuating the current *status quo* (Satterthwaite, 2004).

Regarding the food imperative, the fight against food insecurity and hunger is actively lobbied for, as demonstrated by its first position in the MDG list[2].

The global economic crisis has impacted food price volatility and growth, with a direct consequence on the poorest (Cohen and Garrett, 2009). More than 20 countries worldwide have since experienced urban food riots (FAO, 2011). In a cynical historical replay reminiscent of the Roman emperor's motto "bread and circuses", hunger is once again at the source of socio-political instability.

Moreover, food production critically depletes water and nutrient resources. Whilst its largely scrutinised virtual water[3] greed negatively weighs down on cities blueprint[4] (as defined by van Leeuwen et al., 2012), the soil depletion trend feeds growing concerns (Drechsel, 2007; Conradin, 2013). A consensus is thus emerging on the fact that the *"conventional agro-industrial food system is malfunctioning"* (Daniel et al., 2010, p.1).

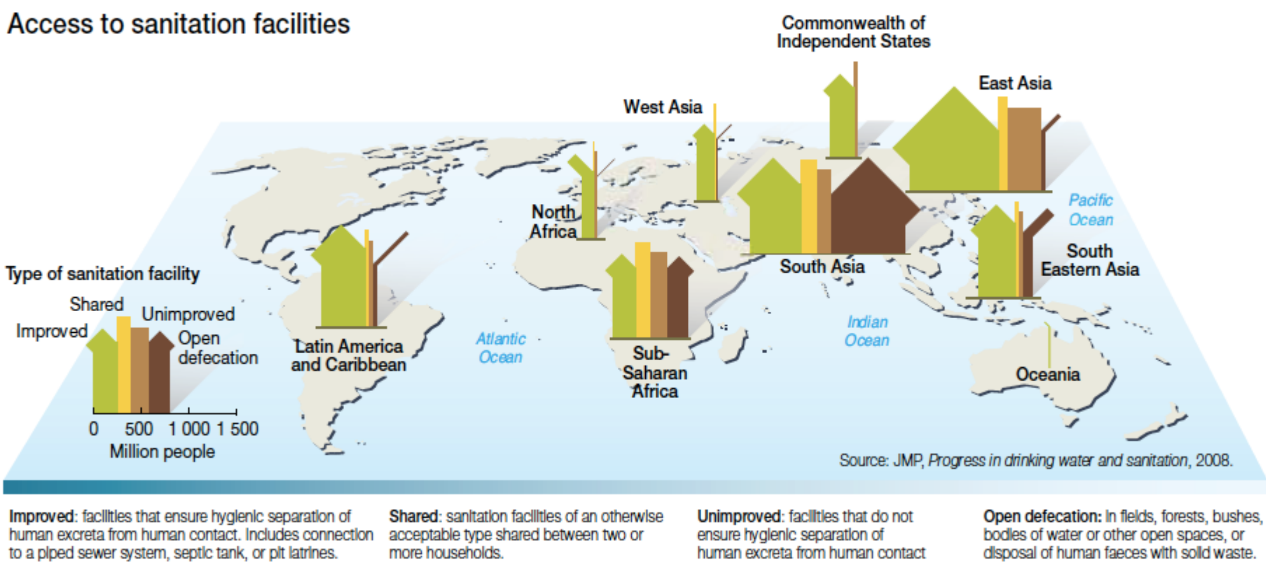
Synergies between urban nutrient and water cycles

Considering the water shortage and pollution chronically experienced in developing countries, the prevision that it will worsen with the pace of urbanisation and climate change (Winblad and Simpson-Hébert, 2004), and the massive challenges posed by soil infertility and increasing food demand, many authors under the UM banner advocate for a sustainable circular management of resources that would be considerate of waste value.

The interconnectedness of water and nutrient cycles is therefore underlined under four main interrelated synergies (Esrey et al., 2001):

- The environmental synergy stresses the positive feedback loop of closing water and nutrient cycles. Alternatives to the water-intensive end-of-pipe sanitation system and reuse of wastewater would indeed decrease overall water-dependency while reducing water bodies and soil pollution and eutrophication of surface-water (Rosemarin, 2010). Wastewater use for irrigation purposes, along with organic waste composting for crop fertilisation, would also ease the industrial fertiliser burden. Finally, recovering nutrients from waste and wastewater reduces the amount of waste to be disposed of in peripheral areas, subsequently decreasing polluting emissions from transportation.

Figure 2.3. Access to and type of sanitation facilities. Source: JMP (2008)



- The economic synergy emphasises how reducing the amount of waste and wastewater to collect, transport and treat would automatically lower management costs for public authorities. In particular, wastewater treatment is extremely costly. Moreover, in areas not covered by public services, waste collection and recycling can generate income. Organic waste and wastewater reuse can lessen the money spent on commercial fertilisers, while urban agriculture reduces money spent on buying food at the household level and on importing it at the city one. Burning waste also provides a cheap fuel, as does biomass in producing energy (Bazilian et al., 2011).

- The rural-urban re-tie, which would reconnect cities with their hinterland, could solve the *"rural nutrient depletion and urban waste accumulation"* issue (Drechsel, 2007). Instead of being considered as two different systems, recognising the rural-urban complementarity as two nodes of a single continuum would trigger an integrated management of food production and water use and reuse (FAO, 2011). Rethinking food-systems often involves new conceptualisations of scale, with examples of calls for de-regionalisation (Donald et al., 2010) and re-localisation (McClintock, 2010).

- Heath improvements rely on a decrease in environmental pollution, since serious disease risks are directly associated with water contamination, waste accumulation, poor sanitation installation and unsafe removal systems. Safe practices of urban and peri-urban agriculture contribute to food security and can considerably improve daily diet, undercutting malnutrition and hunger issues.

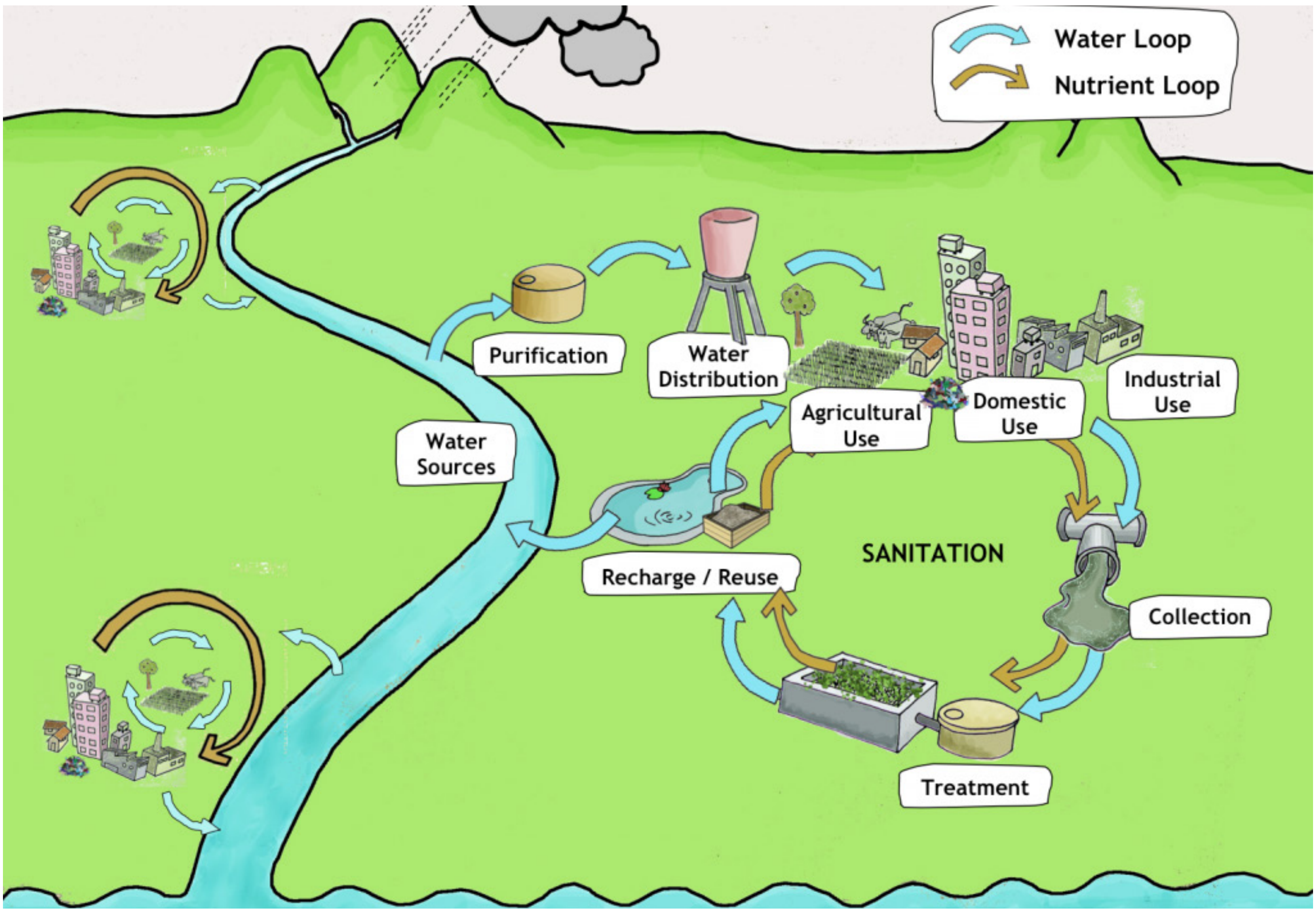
The water-nutrient closed-loop approach could also positively enhance land security, if household and community waste recycling were to be publicly recognised and supported in informal settlements (Hofmann, 2013).

Working on water-nutrient synergies could therefore result in sustainable circular processes.

Sustainable sanitation and urban agriculture

The implementation of circular UM concepts at the city level, however, remains vividly challenging. In the sanitation and food production domains, two concrete alternatives, sustainable sanitation (SS) and urban agriculture (UA), are promoted as innovative and efficient solutions for achieving

Figure 2.4. Simplified water and nutrient loops. Source: Conradin (2013)



closed-loop systems. In theory, as enthusiastically underlined by their proponents, they present most of the water-nutrient synergies. At the forefront is the reuse of organic waste and wastewater for agricultural purposes.

According to the Sustainable Sanitation Alliance (SuSanA, 2011): *"The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources."*

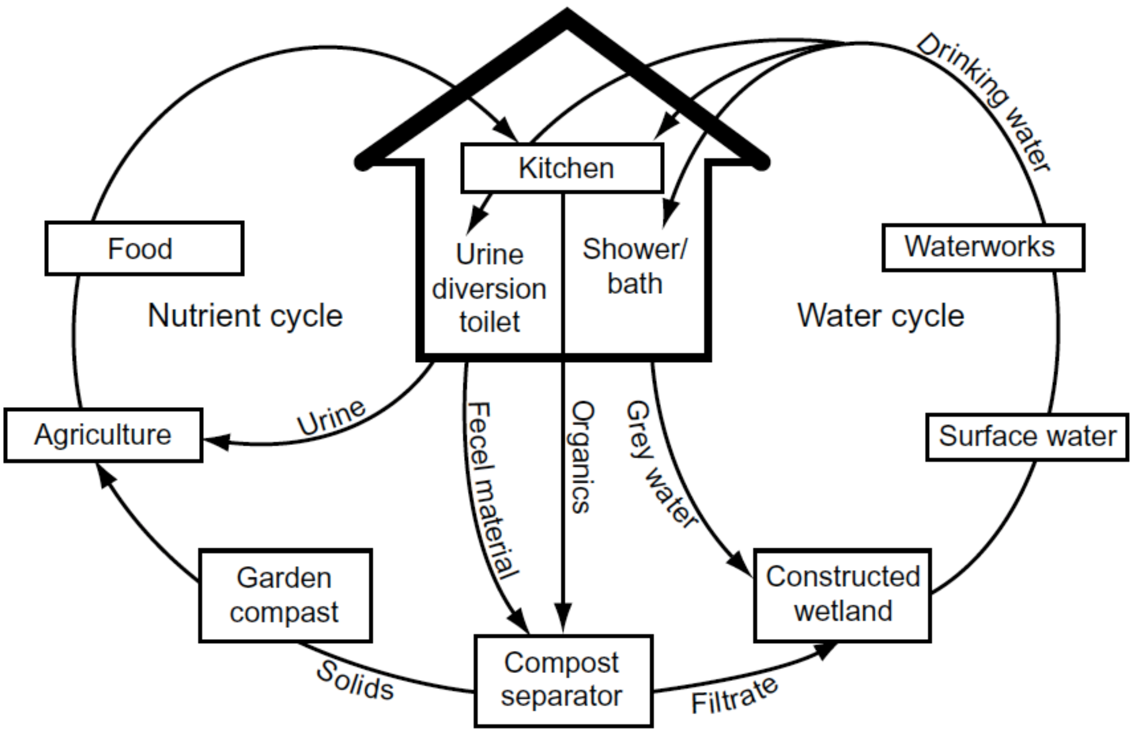
Appreciating the somewhat overwhelming scope of this holistic approach, key safeguards and stepping-stones are provided to lead the way toward sustainable sanitation. As a first reminder, the primacy of local context over technology is crucial. Since SS has to cover the whole sanitation spectrum, from collection to reuse and disposal, it innately compels the use of several techniques and technologies within a community, therefore relying on hybrid systems (SuSanA, 2011).

Deeply interlaced with SS is the ecological sanitation (ecosan) movement, coined as "*[…] a safe approach to recovering nutrients from human excreta, recycling them back into the environment and into productive systems*" (Esrey et al., 2001). Ecosan toilets rely on two kinds of processes, differentiated by urine-diverting (dehydrated) or non-diverting (composting) schemes. Dry diverting methods present the advantage of being the most efficient in killing pathogens (Dellström Rosenquist, 2005). When separated from faeces, urine is stored while faeces are sanitised via one or more processes, such as desiccation, increasing pH or elevating temperatures. In non-diverting systems, "moist" composting processes operate, such as vermicomposting, requiring more time (Esrey et al., 2001; Jewitt, 2011).

On top of being advocated as a low-cost and community-led alternative, ecosan consumes little to no water. However, its implementation often requests a change in individual behaviour, thereby colliding with the generalised dream of water-closet toilets (Jewitt, 2011; Black and Fawcett, 2008). This is reinforced by suspicions of releasing offensive smells (Rheinlander, 2013). Due to mixed returns of experience on ecosan during the last decade, especially in terms of sustainability, the consensus is nowadays rather pointing at SS.

Urban agriculture (UA) refers to *"the sum of food production activities in the city and its peri-urban region"* (Biel and Cabannes, 2009). Some authors enlarge this definition by including wider activities from the food chain, such as processing and sales (Mougeot, 2000). The broad range of the UA typology is widely acknowledged, in terms of land and spaces – for instance back-gardening, vertical or roof production, proper fields in peri-urban areas – but also by type of activity – from survival strategies to market-oriented ones.

Figure 2.5. Closing the water-nutrient loops at household level. Source: Rosemarin, 2005, based on Oldenburg, 2003



UA can play an active role across the social, ecological and economic spheres (Hooten et al., 2006). Its practice reaches several key layers of urban life, with higher potential for positive impacts for the poorest.

Urban agriculture has increased as a survival strategy, especially for the urban poor, as in the case of Kampala, Uganda (Hooten et al., 2006; Lee-Smith, 2010). Despite an internationally ascending wave of interest, its practice remains mostly informal in developing countries. As such, UA is still disregarded by planners and public authorities, with the noticeable exception of Cuba (Premat, 2005) and some much-advocated examples including Rosario, Argentina (Dubbeling et al., 2009; de Zeeuw et al., 2011) and Kampala.

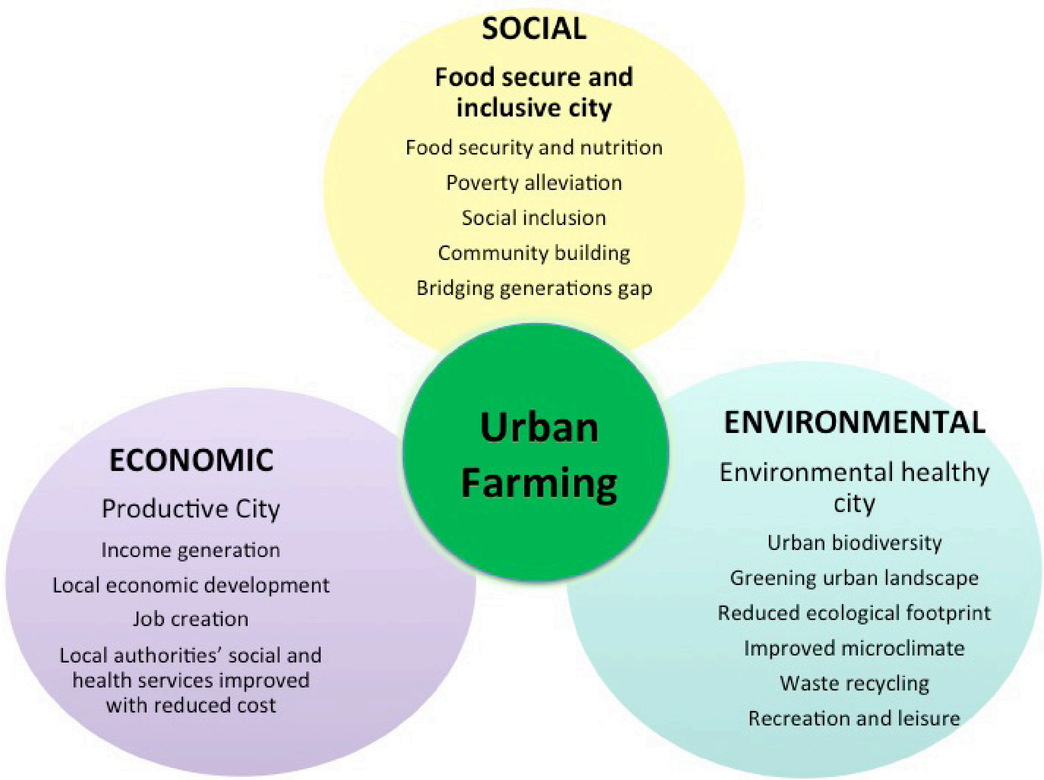
While UA is gaining momentum due to its long-lasting practice in urban premises, SS options still face resistance in most urban settings. Various reasons, such as cultural reluctance, topographic constraints and land insecurity, explain it.

If not properly conceived and implemented, SS and UA raise strong concerns over their threat to public health and environmental degradation, which are then seen as useful justifications for their marginalisation. As pinpointed by Collender (2011), the public health implications of ecological sanitation in urban contexts have not yet been extensively studied.

Nonetheless, numerous guidelines on wastewater and organic waste re-use exist, providing a clear framework for applicative purposes (WHO, 1989 and 2006; GTZ, 2003; Schöening and Stenströem, 2004). For poor urban communities in developing countries, to access them remains an important constraint.

Alongside their shared risks, SS and UA common potentialities and intrinsic correlations, rooted in the water-nutrient synergies mentioned earlier, should act as a beneficial mutual reinforcement, as claimed in numerous papers, especially from the RUAF Foundation (2008) and its UA Magazine.

Figure 2.6. Social, ecological and economic aspects of urban agriculture. Source: Adapted by the author from de Zeeuw



NOTES TO CHAPTER 2

1 The inception of the World Toilet Day comes from the World Toilet Association in 2001.

2. MDG 1 target 1C aims at halving the proportion of people who suffer from hunger.

3. Defined as a measure of the total water used in the production of any commodity.

4. Comprising *"water security, water quality, drinking water, sanitation, infrastructure, climate robustness, biodiversity and attractiveness, as well as governance."* (van Leeuwen et al., 2012, p. 8).

3. Theoretical framework

The above literature review reveals the broad consensus on the global urban crisis and its pressing socio-environmental challenges. The current fragmented urban management is prompting the re-emergence of a UM concept that encapsulates integrative and circular imperatives in its search for sustainability. With water and nutrient cycles being at the same time at the core of the basic needs pyramid and in the throes of the debate on resource depletion, the “closing the loop” approach is flourishing in academic literature. It is also echoed in practical alternatives recently developed or rediscovered, such as SS and UA, which are clearly affiliated to the closed-loop system philosophy.

Yet the holistic nature of the UM concept, which applies for any of its three perspectives, is confronted with its allegedly vast ambitions when it comes to implementation. The stress on the local context precludes any turnkey solution, especially when the scale and number of actors is taken into consideration. This typical trap of macro-analysis on micro-application is also subject to research and for now essentially results in calls to leapfrog discipline boundaries (Castan-Broto et al., 2012; Kennedy et al., 2012).

Nonetheless, the relevance of UM to delve into “closing the loop” approaches remains. Subsequently, this paper intends to normatively draw on the commonalities of the three UM perspectives to critically assess their applicative limits and constraints in successfully closing water and nutrient cycles.

The chosen normative assumptions are, therefore, based on the intrinsic values of the circular, integrated and participative imperatives in meeting urban just sustainability. The critical analysis, on the other hand, will build on the limits of each UM perspective, seen as inherent flaws. Since “closing the loop” approaches are predominantly embedded in the functional analogy, a particular attention will be paid to the criticisms addressed by their detractors, such as followers of the dialectical approach.

The elaboration of a set of five analysis variables, tailored to comprehend both normative aspects of UM and the several limitations expressed by its various detractors, meets this need for an overall critical assessment. The variables are detailed in the following section.

3.1 Analytical framework and methodology

There is currently a gap between the burgeoning research programmes on UM and the still compartmentalised action programmes financed by NGOs and international donor agencies.

Far from these circles, closed-loop approaches can be found in some very localised urban contexts, especially in informal areas where public services are not provided (SuSanA, 2011). In slums, for instance, communities have to organise themselves and tend to find a direct economic interest in bridging water and nutrient cycles[1]. It is precisely in these contexts, however, that the lack of awareness of environmental and health risks increases their chances to occur. When successful and safe on a local scale, these initiatives often become examples advocated by NGOs and research studies.

This dichotomy between the disconnected academic and local spheres could be seen as another expression of the long-standing cleavage between the local short-term brown – linked to environmental health issues – and the global long-term green – tied to ecologically sustainable goals – agendas in urban areas (Satterthwaite, n.d.; Allen, 2009).

In order to evidence and understand this gap between theory and practice, a brief review of some major research programmes explicitly using an UM framework will help in determining their principal discourse and objectives. Delineating their incentives and sources of funding will be key.

The focus will then be set on the most advocated synergy between water and nutrient cycles, namely the reuse of organic waste, including human excreta, and wastewater. An overview of the programmes specifically working in this field will help outline the scale and scope of the actions taken and understand their inherent limits.

In order to identify the limits and constraints of implementing the holistic UM concept and of bridging urban water and nutrient cycles, two specific programmes – SWITCH and EcoSanRes - will be assessed through the set of variables mentioned earlier, as follows:

a. Socio-environmental context, contemplating cultural attitudes toward waste and human excreta and other social factors, such as gender, vulnerability and social impacts; but also environmental and associated health risks;

b. Scale and participation, highlighting who holds the leadership of the projects and to what extent the different layers of urban actors are involved; highlighting also the spatial component of the project, in order to determine its geographical scope;

c. Knowledge and technologies used, with regard to indigenous versus western techniques and appropriateness of chosen systems;

d. Economic component, including the estimated and actual costs, the economic feasibility in terms of supply, demand as well as relevance and access, but also the financial opportunities and constraints and the source of project funding;

e. Scaling-up and governance, comprising informality and institutional frame.

3.2 Limitations

It seems important at this point to highlight the specific limitations of this work. As an ironical mirror of the criticism earlier addressed on UM fragmentation, the wide scope of "closing the urban loop" approaches necessitates narrowing the window of analysis to the more urgent challenges faced by cities. Due to the length and time constraints of the exercise, this paper specifically considers urban back-end water and nutrient cycles.

The analysis conducted in this paper has been mainly conducted on accessible and visible data. This information has been refined by questioning WASH and ecosan forum, such as SuSanA and SanCoP, as well as by conducting some interviews with practitioners (see Appendix 8).

The focus has been set on academic, multilateral and NGOs spheres, with a specific screening of programmes displaying holistic and integrated urban approaches. Therefore, this paper does not pretend to be exhaustive and might have missed some private sector projects using different terminologies, and more discreet civil society programmes.

Official websites, publications and reports from the different programmes considered constitute the main sources of analysis. The general lack of critical sources prevents further crosscutting inquiries.

NOTES TO CHAPTER 3

1. Information derived from a personal analysis of UA in Kampala and from a discussion with Andrew Adam-Bradford.

4. Evidencing the gap between theory and practice

As shown in the literature review, most academic scholars and researchers working on UM and urban sustainability recommend greater circularity, integration and participation. One particular effort is stressed, which is about enhancing cooperation within the urban multi-layered interest groups. While the "closing the loop" approach endorses these imperatives, fragmented and sectorial programmes remain the vast majority of those found in developing countries.

Therefore, the questions raised by Pieterse (2004, p.20-21) remains highly accurate: *"Why would disparate actors, who have to some degree good reasons for operating in a fragmented way, cede their parcels of power to be accountable to higher-order objectives that may expose their failures, or at a minimum reduce their level of authority, influence and control?"*. These might well prefigure most of the crucial hindrances to implementing holistic frameworks.

4.1 The rise of UM programmes

There has undeniably been a nascent trend for research programmes on urban metabolism for the last decade, from the European Union (EU) and the United States (under the ULTRA-Exploratory fund scheme) for instance (Humphries, 2012).

The BRIDGE and SUME programmes, funded by the EU under the Seventh Framework Programme, are both dedicated to UM study. SUME – Sustainable Urban Metabolism For Europe – as its name indicates, considers only the European Union as its geographical area, with a focus on transport and housing (Sume, 2011). BRIDGE, sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism, also works only on Europe, with an eco-systemic approach trying to determine resource optimisation in the urban fabric from a bottom-up perspective (Bridge, 2011). Only one project seems to include UM in its approach toward developing countries, known as VIVACE – Vital and viable services for natural resource management in Latin America. Specifically focused on peri-urban areas of Mexico and Buenos-Aires, the programme emphasises reuse and recycling in natural resources management (Vivace, 2010).

Some international initiatives are also dedicated to UM. For instance, the World Bank Eco2Cities initiative developed in 2009 presents an advocating vision of UM as a sustainable planning framework for developing cities (World Bank, 2013).

Despite a clear reference to the UM ecosystem branch and a consequent focus on resources flows management, the above programmes and initiatives lack a practical component on bridging water-nutrient cycles in cities. Moreover, they appear to remain either at the infrastructural, flows management or policy levels, without proper consideration of socio-economic aspects.

4.2 The international funding issue

Looking at the main international donors priorities might reinforce Pieterse's questions on incentives, as well as provide one crystalline element of answer. Considering the global engagement on MDGs, most of the donor countries are supposedly bound to finance programmes regardless of their urban or rural colour. It seems, however, that the focus on rural issues still prevails, outweighing the financial allocation for urban research and practical projects. This might be the direct result of statistics on poverty, which tend to be underestimated in the same way than the sanitation ones are when it comes to urban areas (as mentioned earlier p.12) (Satterthwaite, 2004). There is little written evidence on the international donors' rural preference, which would merit further in-depth inquiry that is out of the scope of this paper.

As a sampling example, 21% of World Bank and 23% of Asian Development Bank funding were allocated to urban development from 1981 to 1998 (Satterthwaite, 2012). Scrolling through the projects database of the UK Department for International Development (DFID) also tends to indicate a financial support predominantly allocated to rural projects (DFID, 2013). In terms of research projects, the dedicated Research For Development (R4D) database records only eight completed projects when searching under the urban filter, most of which are dedicated to the peri-urban interface.

Furthermore, international donors are setting measurable indicators to assess their progress toward MDGs achievement (Satterthwaite, 2003). When following UM principles, however, the only quantitative option is to rely on the functional-analogy tools. This results in an analysis of resources flows that does not provide concrete answers for bridging urban water-nutrient cycles. Instead, it facilitates funding toward fragmented projects.

Additionally, some argue about the relevance of such financial allocations, in particular in terms of support to local and often informal initiatives. Since international donors have structural difficulties in providing small-scale funds, they tend to support expensive, large-scale infrastructure programmes, disregarding local adaptability and community empowerment (ibid.).

NGOs, for their part, are the main supporters of community-led processes (Banks and Hulme, 2012). Since they mostly rely on international donors' financial help to run their projects, the rural priority directly impacts on the types of projects being conducted. Those who rely instead on private donations, such as Oxfam, tend to present easily marketable projects with a clear storyline appealing to emotions like compassion. Considering the intrinsic complexity of urban projects, especially those calling for integration, this type of project might therefore be left aside (Civicus, 2012).

Combined with our hegemonic and highly competitive system and its intrinsic request for specialisation, NGOs as international agencies are inclined to put forward their comparative advantages, with the perverse effect of fuelling the fragmented aid loop (ibid.).

As a consequence, urban community-led processes present the double burden of requiring tailored small-scale funds, in urban areas still overlooked by the international aid. This might well explain the quasi absence[1] of NGO programmes on closing water-nutrient cycles.

NOTES TO CHAPTER 4

1. An absence confirmed by informal discussions with Water Aid, Oxfam, Human Relief Foundation and Homeless International.

5. Evidencing the single advocated synergy on waste and wastewater reuse

Contrary to the numerous academic papers and the nascent trend of research programmes dedicated to UM or more specifically to urban water-nutrient cycles, finding relevant programmes proved to be a hard task, with less than a handful of positive results that will be reviewed later in this part.

Yet one particular synergy within the water-nutrient loop attracts considerable attention, especially in terms of published articles and forum debates from both academics and practitioners.

5.1 Wastewater and organic waste popularity

Indeed, much has been written about the issue of wastewater and organic waste reuse and recycling, mainly for irrigation and agricultural fertilisation.

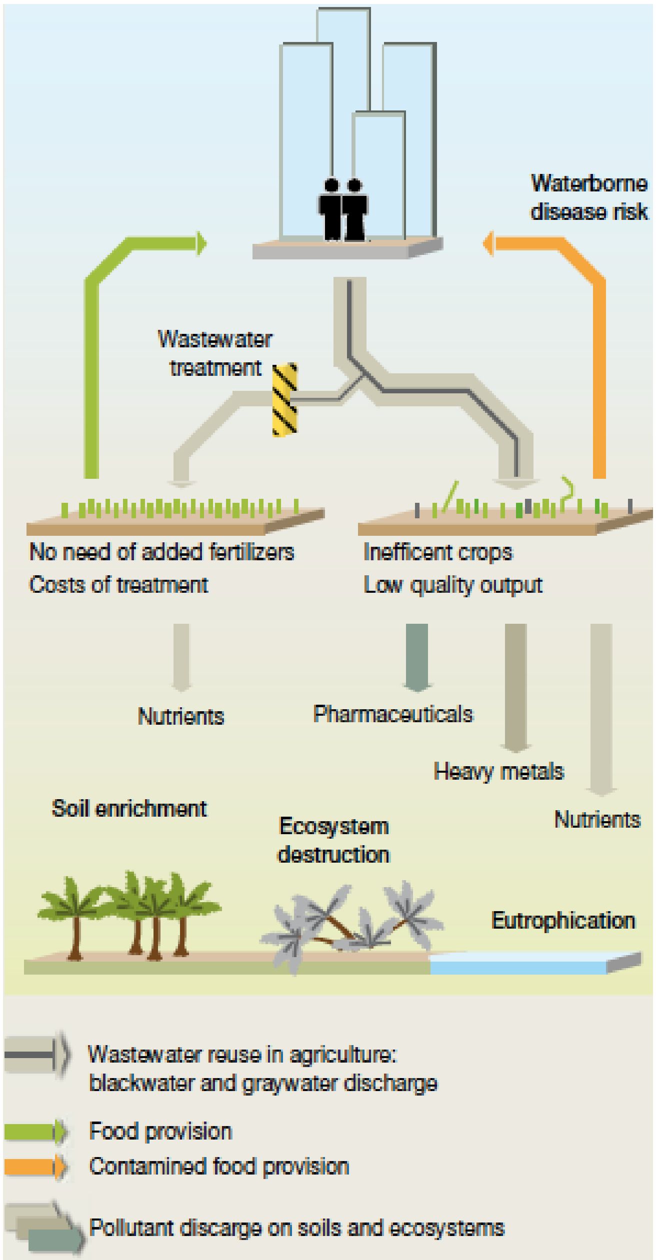
This topic generates a broad range of interest, from general consideration (Smit, 1992; Strauss, 2000; Dulac, 2001; Buechler et al., 2006; Drechsel, 2006 and 2007; Drechsel et al., 2010; Qadir et al., 2008, Corcoran et al., 2010, …) to technical aspects linked to nutrient recovery[1], such as flows of nitrogen (Barlès, 2007; George, 2009) and phosphorus (Rosemarin, 2011). Another related sub-topic concerns the associated health risks of such practices, through pollution of water bodies, use of unsafe sources of water (Appendix 9) such as untreated municipal sewage, industrial pollution contained in wastewater, waterborne diseases and diseases linked to livestock manure and human excreta (non-)management. This triggered the publication of the international guidelines previously mentioned (see part 3c, p. 17), to which the Guidelines on Municipal Wastewater treatment from UNEP/WHO/UN HABITAT/WSSCC can be added.

Overall, this particular segment of water-nutrient cycles is under the spotlight because of its wide practice all over the world for centuries, whether in safe or unsafe ways. Due to this de facto status, most holistic approaches, including SS and UA projects, devote a specific component of their programmes to this aspect.

5.2 Programmes with reuse components

The multi-disciplinary UrbanFood[Plus] network, conducted by the German Federal Ministry of Research and Education, proposes an African – German partnership "*to enhance resource use efficiency and improve food security in urban and peri-urban agriculture of West African cities*". The eight sub-projects tend to demonstrate a fragmented approach centred on innovative hybrid technologies

Figure 5.1. Wastewater in UA – Resource or threat. Source: Drechsler et al., 2009



in wastewater irrigation and organic waste recycling for urban purposes. Sanitation systems are, however, never explicitly mentioned (UrbanFood[Plus], 2013).

The FAO multi-stakeholder Food for Cities network, initiated in 2001 and still very active nowadays, also dedicates one sub-thematic group to water use and reuse in UA. Their main answer is to lobby for better-integrated water management systems, especially at the policy level (FAO, 2013).

More recently, a UN agencies consortium led by UN-Water[2] launched in November 2011 a Capacity Development[3] Project on the Safe Use of Wastewater in Agriculture. Finished in May 2013, phase 1 of the project focused on capacity building at the individual/organization level and provided several interesting lessons. The main capacity needs identified by the participants were on "Health risk assessment", "Economic and financial considerations" and "Monitoring and system assessment". Additionally, participants highlighted their difficulties in implementing the WHO Guidelines and the lack of good examples or models to follow (Liebe, 2013). As for the FAO network, this project reflects a common characteristic of the UN system, namely a policy focus on national, regional and global scales.

Funded by the EU Asia Pro Eco II programme[4] from 2005–2008, the Wastewater Agriculture and Sanitation for Poverty Alleviation Project (WASPA) followed holistic and sustainable principles applied to the entire wastewater continuum. It was implemented in Rajshahi, Bangladesh, and Kurunegala, Sri Lanka, in order to address the agro-reuse of untreated wastewater situation. This project generated little documentation and operated at a very localised scale (Evans et al., 2010).

The RUAF Foundation, specialising in UA and food security, seeks to provide training, technical support and policy advice to all levels of involved actors and dedicates whole components of its programmes[5] on safe reuse of urban organic waste and wastewater. Particularly concerned with urban farmers empowerment, in a perspective of urban poverty alleviation, they promote education and knowledge-sharing activities. Interestingly, they are also part of the single project found that clearly works toward linking sanitation and UA (RUAF, 2013).

In terms of NGOs' projects, it is worth mentioning the Dutch WASTE and its ISSUE-2 and ROSA completed projects. While predominantly oriented toward sustainable integrated sanitation systems and management, WASTE noticeably advocates for a closed-loop approach that finds its echo in a reuse and recycling component (Waste, 2012). With the usual exception of agro-reuse of wastewater and nutrient recovery, there is however no clear link with UA.

Despite the fact that each of the mentioned projects and initiatives looks at water-nutrient cycles through a specific narrow-angled window, one could say that, all together, they form a resourceful pool of accumulated knowledge that could be tapped into in order to develop further the other synergies of the "closing the loop" approach. In this sense, they could constitute a solid practical cornerstone of the UM philosophy.

5.3 EcoSanRes, SWITCH and the Dutch WASH Alliance project.

It is striking to note that only one project has been found that is explicitly dedicated to bridging sanitation with UA. Under the Dutch WASH Alliance coordination, the RUAF Foundation, the Dutch NGO WASTE and the local NGO RiPPLE[6] - Research-inspired Policy and Practice Learning in Ethiopia – settled to work together in Hararghe and Dire Dawa, Ethiopia, on a project labelled as "Linking sanitation and hygiene (Urban waste management) to Urban Agriculture". The project began in January 2012 and should have been completed in May 2015 (Dutch Wash Alliance, 2013). However, an external audit of RiPPLE in 2013 resulted in all partners of the project withdrawing their support to RiPPLE, thus ending it. (Klaver et al., 2015).

In order to clarify the reasons why only one of the water-nutrient cycles synergies is being considered at the moment, this section delves into two particular programmes that present a thorough closed-loop claim, namely EcoSanRes – Ecological Sanitation Research – and SWITCH – Sustainable Water Management Improves Tomorrow's Cities' Health.

Both programmes were chosen due to their important impact and recognition -SWITCH won IWA's Sustainability Award 2012 for *"innovation in the practical realization of sustainable urban water management"*; EcoSanRes lasted ten years and played a critical advocacy role for the sanitation cause, especially at the UN level – as well as for the availability of sufficient documentation.

The main sources consist of the general information displayed on each programme website and the ample documentation produced, e.g. final reports. The main critical ones are the SWITCH analysis from Evans et al. (2011) and the global evaluation of EcoSanRes (Nilsson et al., 2011).

While SWITCH was conducted by an implementing consortium of 33 partners from 15 countries in 12 implementing cities (Appendix 2), EcoSanRes was directly managed by the Stockholm Environment Institute, who appointed eight regional nodes worldwide (Appendix 2), involving various local partners.

Furthermore, SWITCH was specifically an urban programme, when phase 2 of EcoSanRes operated in rural, peri-urban and urban areas, enlarging the urban focus of phase 1.

Both programmes were completed in 2011, which allows us to compare their main discourse, methodology and outcomes as presented in their official final reports and websites.

Some general remarks arise from this comparison.

Firstly, the UM philosophy underlies the discourse of both programmes, claiming either an integrated and holistic framework or an eco-systemic one.

However, each programme intends to close only one loop, the water cycle in the case of SWITCH and the sanitation one for EcoSanRes. In this sense, the agro-reuse of waste and wastewater remains a secondary component in both programmes, with no clear statement on bridging water or sanitation loops to UA at a wider extent. Despite their holistic pretention, both have worked on specific aspects with different sub-groups dedicated to particular topics.

In the case of SWITCH, six research areas are covered, including Planning for the Future, Engaging Stakeholders, Water Supply, Stormwater, Wastewater and Decision-Support Tools. Each cluster comprises several focuses

Figure 5.2. Comparison of SWITCH and EcoSanRes main characteristics. Source: Author

	SWITCH	EcoSanRes
Type	Action research programme EU funded - €20m 2006-11	Action research programme SIDA funded - $10m for the phase 2 Built on SanRes programme - 1992-2001 Phase 1 2001-05 - Phase 2 2006-11
Discourse	Socio-technical transition towards Integrated Urban Water Management (IUWM) paradigm.	Ecosan viewed as part of an ecosystem-based society, seeking to close the water and the nutrient cycles.
Focus	To embrace the whole urban water cycle, from water supply, wastewater (with evaluation of ecosan, diverting system and UA nutrient recovery) and stormwater to water services.	Closing the Loop on Sanitation for improved livelihoods around the world.
Objectives	"To catalyse change towards more sustainable urban water management in the 'City of the Future'" To improve the scientific basis for the development and management of urban water systems.	Phase 2: "To develop and promote pro-poor sustainable sanitation in the developing world through capacity building and knowledge management."
Approach	"Learning by doing and doing by learning" Grey to green approach	
Methodology	Propose an holistic framework based on 2 principles: demand-led research and "Sustainable, robust and flexible technologies" Implementation in 12 cities, including 8 in developing countries.	Phase 1: *dedicated to urban areas* Communications and networking, Capacity building, Research and development, Implementation through pilot projects. Phase 2: *covering rural, peri-urban and urban areas* Capacity development through 8 regional knowledge nodes, focus on training, policy development and implementation.
Outcomes	"SWITCH Approach" based on: - Learning Alliances - City-level strategic planning - Transitional framework - Action research - Demonstrations - Training toolkit	Production of reports, including guidelines on safe use of urine and faeces; Generating knowledge through production of factsheets; Animation of central forums and online libraries on ecosan; Creation of regional knowledge nodes; Supporting small demonstration projects to demonstrate alternative techniques; Awareness-raising on sanitation.

(see Appendixes 3 and 4). As shown in the case of wastewater, each implementing city chooses its priority, which could demonstrate a commitment to the demand-led imperative while de *facto* fragmenting the process.

For EcoSanRes, each knowledge node was specifically asked to provide a basic capacity building package in five areas, related to toilet and collector system design, management, health and hygiene, gender and social acceptance and agro-reuse of nutrients (see Appendixes 5 and 6). This methodology could, in theory, lead the programme to reflect on society ecosystems from the knowledge gathered in each cluster, either at the node or at the general level. However, this has not been the case, which tends to prove that in practice, the holistic theory was not pursued to its end.

Finally, SWITCH and EcoSanRes display significant knowledge-oriented outcomes, thus indicating a prevalence of research over practical results, as you would expect from action research programmes. Integrating their specific focus in the wider urban system, or less ambitiously closing the loop within the food-water nexus, only appears in one objective for EcoSanRes (objective 3 – see Appendix 5). The number of publications from practitioners and researchers confirms the predominance of research over implementation, as it is often the case in action research programmes where the learning process is a much more achievable outcome. SWITCH, in particular, promotes associated MSc and PhD theses. Additionally, the process of collecting and disseminating knowledge triggered more critical external reviews than any other achievement.

NOTES TO CHAPTER 5

1. Mostly NPK (Nitrogen, Phosphorus and Potassium), the main chemical components needed in plant growth and contained in industrial fertilisers.
2. The consortium comprises FAO · WHO · UNEP · UNU-INWEH · UNW-DPC · ICID · IWMI.
3. Defined as "(…) the process by which individuals, groups, organizations, institutions and societies increase their abilities to: i) perform core functions, solve problems, define and achieve objectives; and ii) understand and deal with their development needs in a broad context and in a sustainable manner."(UNDP, 1998)
4. Grants provided for EU-Asia cooperation projects improving environmental performance and technology specifically in the field of the Urban-Environment.
5. Such as Cities Farming for the Future (CFF) and From Seed to Table (FSTT).
6. RiPPLE was originally a research programme founded by DFID, which turned into the formation of a local Ethiopian NGO in April 2012.

6. Assessing limits and constraints in closing urban water and nutrient cycles through SWITCH and EcoSanRes

In order to evaluate the ratio of UM assumptions to its main flaws, the set of variables will be applied to SWITCH and EcoSanRes. This assessment intends to depict the overall limits and constraints found when implementing holistic approaches, without diminishing the overall value and success of both programmes.

6.1 Socio-environmental context

Contemplating cultural attitudes toward waste and human excreta and other social factors, such as gender, vulnerability and social impacts; but also environmental and associated health risks

SWITCH:
The programme is undeniably concerned about environmental and sustainability issues, both appearing in the first eight (of nine) key objectives (See Appendix 4). Moreover, the assessment criteria of success are based on these objectives, meaning that ecological considerations are truly a determining factor (Howe et al., 2011).

For instance, in terms of stormwater management, the programme does not hesitate to criticise the usual end-of-pipe system, and proposes more ecological alternatives such as eco-hydrology and green roofs. However, these alternatives are usually not adopted in unplanned settlements, where flooding particularly affect slums dwellers.

Social factors appear overlooked, with no reference to gender or pro-poor filters in any key objective. The ecological alternatives proposed are therefore often useless if not addressing beforehand informality and land tenure issues, among others. The only exception relates to the diverting ecosan technology experience, which has been thoroughly studied through two surveys (SWITCH, 2009). It took into consideration the perception of users, of related product users and of government, briefly mentioning psychological, religious, gender and age aspects (Ibid).

EcoSanRes:
Since SS is strongly linked to poverty alleviation and environmental security, and even to food production, in the strategy set for phase 2, both environmental and social factors are well considered (SEI, 2006). It is certainly the programme's main strength, even if it has been nuanced as a positive outcome under a knowledge development umbrella (Nilsson et al., 2011).

Socio-environmental aspects specifically appear in five of the 12 strategic aims (See Appendix 5). Gender mainstreaming is specifically looked at; there is also consideration of age and cultural norms. Attitudes toward human excreta seem often included, which is complemented by an emphasis on what people expect and value.

The programme used a *"systems analysis and livelihoods and vulnerability assessment approach"*[1] in order to evaluate both positive and negative social, economic and environmental impacts of ecosan (SEI, 2006, p.25). The immediate environmental conditions, as well as the potential impacts of the proposed ecosan alternatives, are therefore usually incorporated.

Due to the narrow focus on the sanitation loop, however, there is no explicit consideration of the water cycle, such as water bodies' management and other wider-scale aspects.

6.2 Participation and scale

Highlighting who holds the leadership of the projects and at what extend the different layers of urban actors are involved; highlighting also the spatial component of the project, in order to determine its geographical scope

SWITCH:
Participation appears to be a SWITCH leitmotiv, as claimed in their official discourse. The specific "Engaging stakeholders" cluster tends to support this idea. However, the spatial focus on the formal city conveys a planning assumption that does not cover the informal city in many cases. The only exception seems to be in Bogota, where the Governor worked toward the inclusion of slums in urban planning.

SWITCH strongly advocated its Learning Alliance platforms, defined as "*[…] innovative participatory processes that aim to maximize the impact of research on policy and outcomes.*" (Evans et al., 2010).

The donor-funded aspect nuances this outcome. The lead organisations, convinced of the intrinsic validity of setting Learning Alliances, might consequently neglect the initial needs assessment phase. This somewhat contradicts the demand-led objective (ibid.). Besides, setting up these participatory platforms is particularly time-consuming and resource-intensive, raising the question of better allocation of funds for implementing activities (ibid.).

Moreover, when looking at what is achieved per cluster, communities are not always visibly involved despite the Learning Alliance component. In *Planning for the Future*, only Alexandria, Belo Horizonte and Accra present some level of community inclusion and participation. In *Wastewater*, it appears to be the case only in Lima. In *Stormwater,* there is no apparent community inclusion.

In terms of scale, the programme considers both the river basin and the city levels, which accurately responds to the stress on the whole water cycle.

EcoSanRes:
EcoSanRes advocates integrated participation and even community-led paths (SEI, 2006). For this purpose, baselines on regional or national stakeholders and practices involving ecosan were developed. However, practical implementation generated mixed results. While some regional nodes are run by local participative organisations, like CREPA in West Africa and ENPHO in Nepal, others are either branches of international organisations (SNV in Bolivia, NETWAS in Uganda) or academic organisations (CAPS in Philippines). None seem truly community-led. Nevertheless, in the case of Bolivia, the multi-sectorial approach succeeded due to the inclusion of local enterprises, municipal and ministerial authorities and local communities (Nilsson et al., 2011, appendix 10).

There is some local authority involvement when it comes to health and advocacy, but urban planning issues are either poorly considered or failed, like in the Burkina Faso case where none of the projected “commune sanitation plan” were developed. In the Southern Africa node, the expected “urban community of practice” could not be set due to lack of participation (Nilsson et al., 2011).

The overarching leadership remains quite academic, when considering the knowledge-generation direction of most outputs.

In general, small and localised scale predominated, especially for the demonstration projects, where household and communal solutions, such as housing estates and schools, were preferred (ibid.).

6.3 Knowledge and technologies used

With regard to indigenous versus western techniques and appropriateness of chosen systems

SWITCH:
SWITCH stated its technical-oriented preference from the beginning: “*Key outputs and deliverables of SWITCH are newly developed equipment, methods and techniques […]*” (SWITCH, 2007, p.1).

The emphasis on innovation and alternative technologies is reinforced by a focus on their efficient inclusion in existing water system of cities and in strategic planning, which lets aside the unplanned part where most of the problems occur. It tends to suggest that only minor attention is given to traditional knowledge and raises suspicions of an engineer-led programme, especially with no local consideration of the "*replication of new ideas and methodologies*" (Howe et al., 2011, p.118).

EcoSanRes:
EcoSanRes advocated for ecosan toilets, a technology often perceived as a western one in developing countries. Ecosan advocacy, development and demonstration constituted the underlying motivations for launching phase 2 (SIDA/SEI, 2006). Despite a mid-term acknowledgement of the limits of ecosan, especially in terms of sustainability, and a formal switch to the SS frame, Urine-Diverting Dry Toilets (UDDT) predominated during the whole programme at the expense of other options (Nilsson et al., 2011). It is stated for phase 2 that “*[…] the whole area of trying to make mixed sewage systems more sustainable is well beyond the scope of this programme*” (SEI, 2006, p.15).

Some other technologies, such as Arborloo and Fossa Alterna[2], are derivations of indigenous practices and are acknowledged as such. Adapted from Southern Africa, they are mostly appropriate for rural areas due to the space they require. Promoted in one popular publication of the programme (Morgan, 2007), they were nonetheless not implemented (Nilsson et al., 2011).

Furthermore, despite the urban localisation of the pilot projects, the urban specificity was left aside, outweighed by the technological orientation. Only one of the 19 factsheets (See Appendix 7) is dedicated to peri-urban contexts (EcoSanRes, 2010, Factsheet 14); it merely looks at what others are doing by assessing the viability of codified approaches, especially the urban-oriented Household-Centred Environmental Sanitation (HCES) and Community-Led Total Sanitation (CLTS).

6.4 Economic component

Including the estimated and actual costs, the economic feasibility in terms of supply, demand as well as of relevance and access, but also the financial opportunities and constraints and the source of project funding

SWITCH:
Comprised in the Planning for the Future cluster, the economic component includes cost-benefit analyses, life-cycle costings and economic and financial decision-

support tools (SWITCH, 2011). The examples provided by van Dijk (2011, table 6, p. 13) underline the prevalence of research- and decision-oriented methods.

The complexity of the developed models, however, prevents an easy use in developing countries and suggests expert-led approaches more suitable for developed ones (ibid., p.29).

The proposed tools, based on technology evaluation, gave little consideration to context, particularly the institutional one (ibid., p.30).

Finally, the focus on water prevented linkages with other economic dimensions, such as food and energy cycles or livelihood and affordability at household level. For instance, the market value of agro-reuse of nutrients was considered in terms of farmers' demand only (Howe et al., 2011).

EcoSanRes:
Economic considerations figured as one of the strategic aims (SEI, 2006). Their optionality within the capacity building programmes design suggests another reality, confirmed by the evaluation, which concludes about their negligence (Nilsson et al., 2011, p. iv).

Demonstration projects and training do not seem to include financial sustainability, such as cost recovery from end users. In this regard, the approach remains oriented to traditional supply-led WASH. Moreover, training builders without adding business planning or marketing abilities hinders the replication of acquired skills in the long run. The evaluation therefore recommends "*[...] to ascertain whether sanitation marketing and people-centred design approaches can be utilised to lower the production costs of ecosan facilities and encourage the marketing and sale of these products through sustainable local market mechanisms*" (ibid.). Recommendations also suggest UDDT cost-reduction and promotion of less expensive ecosan technologies. In the same line, the economic impacts of ecosan are analysed at household scales, but not at the wider city level.

Finally, there is a general lack of private sector involvement, reinforcing the programme's subsidy-driven character (ibid.).

6.5 Scaling-up and governance

Comprising informality and institutional frame

SWITCH:
By specifically working on strategic planning, scaling-up and governance are encompassed amongst SWITCH key successes (Howe et al., 2011).

However, the main results primarily show the development of guidelines, manuals and policy briefing notes that supposedly enable cities to make more informed and sustainable choices, such as a review of the theory and practice of good governance (Green, 2007). In this sense, the production of policy tools allows city authorities to enhance or reform their existing systems. In the case of Lima, the only outcome was the adoption of guidelines on safe reuse of wastewater, without informing on their actual implementation (Howe et al., 2011).

Learning Alliances can be useful in order to understand the prevailing institutional context and governance framework. They also provide a dialogue opportunity for stakeholders with often radical views. Institutional mapping was also developed as a second step and the utility of such tools remains valued (Sutherland, 2011).

Wastewater irrigation for agriculture typically implies crosscutting city-level departments, such as agriculture, land tenure, water provision, health and hygiene and strategic planning. It necessitates at the same time going beyond spatial boundaries within policy and planning spheres. When confronted with non-uniform decentralization processes, the implementation of wastewater reuse therefore becomes highly complicated. In Accra, Ghana, responsibilities are dispatched in such ways that wastewater management and the use of land and water resources for agriculture are made at the city level, whilst certain sources of water remain under the jurisdiction of sometimes decentralized water or power utility (Evans et al, 2010).

EcoSanRes:
Considering the subsidy-driven character of the programme, as explained in the economic variable, the post-EcoSanRes viability of the nodes mainly relies on the strength of each host organisation (Nilsson et al., 2011, p.22).

The stress on knowledge production, training and dissemination means that many resources are still in use, and some nodes still seem to operate as focal networking or knowledge points in their areas. Measuring their concrete impact has proven difficult, and some have been absorbed within other running programmes. In the Burkina Faso case, for instance, the node "*was never properly established or recognised as a separate institution, thus has no life outside of its specific project funding and activities*" (ibid., p.8).

Sustainability, replication or expansion considerations appear overlooked for the nodes and the pilot projects. The evaluation points at weak institutional and multilateral interactions, like under-consideration of existing governance systems (ibid., p.22). Added to the financial unsustainability, the durability of the nodes' activities remains uncertain.

However, some outstanding outcomes are recognised in terms of governance with "*the inclusion of sustainable sanitation principles in the Manila Declaration*", and "*gender guidelines and national guidelines for ecological sanitation*" in Bolivia (ibid., p.13).

In addition, the programme was instrumental in the creation of SuSanA (ibid., p.17), which inherited its knowledge-sharing and networking functions.

6.6 Summing up

Intrinsically, SWITCH and EcoSanRes are research-oriented programmes, which explains their UM theoretical perspective. Holistic views, however, remain at the stage of ambitions underpinning a final goal rather than practical guiding principles.

In compliance with the ecosystem branch of UM imperatives, each programme has strategically set comprehensive and crosscutting objectives, whilst narrowing integration and circularity to a single specific loop.

Facing realistic limitations, in terms of funding sources, constrained budgets and expertise, some achievable targets have been prioritised. Raising awareness of sustainable technologies and underscoring participatory processes, knowledge gathering and dissemination were therefore more likely to be successful, as they mostly were. In addition, both programmes were subject to a limited timeline, usually lasting five years (the length of each EcoSanRes phase), which might explain the lack of longer-term perspectives.

Interestingly, lessons from EcoSanRes led to new research areas within the Stockholm Environment Institute, such as Productive Sanitation (Gensch, 2008) and the water-energy-food nexus (Granit et al., 2013). The latter is also comprised in the "strategic topics and opportunity areas" of the "SuSanA joint roadmap 2014 to 2018 - towards more sustainable sanitation systems". It explores the security synergies of the nexus (SuSanA Forum, 2013).

NOTES TO CHAPTER 6

1. This assessment method has been specifically developed for Environmental Impact Assessment (EIA).

2. Arborloo consists in planting a tree in a full shallow pit. Fossa Alterna relies on alternating pits, using one when the other serves for composting (Morgan, 2007).

7. Conclusion

In developed countries, "closing the loop" arguments tend to arouse consensus and positive attitudes, especially in the academic spheres as the rise of urban metabolism studies demonstrates. With the widely advertised context of climate change, it now seems almost instinctive to lessen the burden we place on our environment, especially if there is a potential economic gain. Paradoxically, it seems as intuitive to get rid of our faeces as quickly and invisibly as possible, and this is not as easily discussed.

Modernity undeniably brought along health and some social improvements, while disconnecting people from their natural environment, and in the process from their own body. Our inherited end-of-pipe scheme symbolises the main flaws of our dominant system. Managed in a linear and fragmented way, it runs negative feedback loops in terms of nutrient waste, soil and water contamination and drains fresh water as much as economic resources, especially for maintenance purposes. Intrinsically unsustainable, current sanitation management consequences are amplified when linked to similarly broken water, food, land and energy loops.

The extent of environmental degradation and high levels of urban injustice and poverty could be seen as direct consequences of widespread accumulative systems, as stressed in urban political ecology. While this alarming situation has triggered academic reaction, acknowledgement from multilateral organisations, new approaches such as sustainable sanitation and urban agriculture and some level of policy commitment from developed countries – e.g. the MDGs and SDGs – the recent integrated and circular alternatives remain hampered by centuries of constructed habits.

Moreover, the promotion of sustainability, elsewhere referred to as the green agenda, can be globally confronted by social aspirations associated with the modern model. While the poorest areas might witness some local initiatives successfully bridging water and nutrient cycles, the underlying incentive is often immediate profit or impending need. If an upgrade opportunity occurs, however, communities could well decide to switch their small-scale sustainable practices for socially more prestigious systems, such as flush-and-discharge ones.

Despite the newly accepted logic of "closing the loop" approaches in international aid, practitioners find themselves contingent to ingrained patterns of fragmentation and specialisation, in terms of funding and expertise.

While some nascent, broader lines, such as the water-energy-food nexus and the renewed interest in resilient and regenerative cities[1], demonstrate positive attempts to cope with the quest for sustainability and integration, the embedding of functional analogy and its inherently fragmented implementation still prevails. Thus, the diverse processes through which injustices are created and reproduced remain disregarded.

Without challenging, at some level, the pre-established order and institutions' routine, only a restricted number of synergies can be touched upon. As a matter of fact, this "poverty versus inequality" dilemma has divided the international community in the SDG debate. Despite the interesting advances in research trends, mostly reflected in research-led programmes, practical implementation remains contingent to the ruling forces. In other words, effects are attacked without tackling the underlying causes.

Recurrent threats on international aid budgets and the global economic constraints tend to lead, as a side effect, toward more cross-disciplinary and joint projects. Calls for partnerships and coordination between partners to ensure participation and long-term success also support such merging approaches.

More than discourses or last-resort choices, systemic urban approaches need to be embedded both in strategic aspirations and in practical actions, by tackling both effects and causes.

The partnership effort displayed when considering some urban nexuses could be the first step in overtaking classical fragmentation, if it manages to reach out of its academic premises. The other way around could be to make the best use of the growing momentum about the circular economy rhetoric - currently implemented by the private sector - in the "aid-founding countries" to trigger meaningful systemic actions.

NOTES TO CHAPTER 7

1. It was the main objective of the Future of Cities Forum, held in Hamburg, Germany, on 4-7 September 2013; of Habitat 3 in 2016, and found a strong echo in the COP21 held in Paris in December 2015.

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Appendices

Appendix 1: Some tools from the functional analogy

MFA /SFA

Definitions
"Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time" (Brunner and Rechberger, 2004).

"The sum total of technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste" (Kennedy et al, 2007).

Content
MFA looks at water, biomass, energy, construction materials and nutrients flows (Baccini, 1997).

Since *"Cities at present are mainly linear reactors: their metabolism consists of inputs, stocks, and outputs and no cycles. Thus cities are vulnerable and depend completely on their hinterlands for both supply and disposal"*, MFA allows measuring their durability (Bruner, 2007).

Limits
Criticism pinpoints the availability and accuracy of data needed to achieve such an analysis. The static image resulting from MFA has also been criticised for its linearity (Gandy, 2004).

SFA has the exact same implications, but is focused only on one type of substance, such as phosphorus.

Life-cycle assessment (LCA) or Cradle to Grave analysis

Definition
"A systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle", according to ISO 14040.2 Life Cycle Assessment - Principles and Guidelines.

It is a useful tool to measure the quantifiable aspects of urban "consumerist" life.

Criticism in form of "boundary critic to system thinking", relying on accessible data, questioning their accuracy and availability.

Moreover, *"Life cycle assessment (LCA) model is frequently applied to evaluating urban solid waste management methods."* (Qu et al, 2012).

Cities footprints

According to Barlès (2010), it is possible to measure several kind of footprint, such as environmental footprint, water footprint and food-print.
Each one aims at measuring a selected city's impact.

Ecosystem services:

Definition
"Ecosystem services are the benefits people obtain from ecosystems" derived from:
"*Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors (Daily 1997b:3).
Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions* (Costanza et al. 1997:253)." (UNEP, 2005).

Multi-sectorial approach based on four steps: provisioning, regulating, supporting and cultural aspects, according to the United Nations 2005 Millennium Ecosystem Assessment.

The focus on economic value is seen as an important bias (Cornell, 2011, Baker et al., 2012).

Urban Harvest Approach

Proposes three strategies to achieve self-sufficiency and resilience in urban areas: demand minimisation, output minimisation and multi-sourcing (Agudelo-Vera, 2013).

The starting point could be similar to an MFA; UHA recognises different spatial-temporal scales and promotes innovative technologies.

Some other definitions consider UHA as only looking at outputs of the system: *"The urban harvest approach is based on closing the resource cycle on the output side of a linear system."* (Rovers, 2007)

Appendix 2: SWITCH and ESR principal locations

SWITCH

Cities

- Accra – Ghana
- Alexandria – Egypt
- Beijing – China
- Belo Horizonte – Brazil
- Birmingham – UK
- Bogotá – Colombia
- Cali – Colombia
- Hamburg – Germany
- Lima – Peru
- Łódż – Poland
- Tel Aviv – Israel
- Zaragoza – Spain

EcoSanRes

Nodes

- Burkina Faso
- Uganda
- Southern Africa (South Africa, Namibia, Zambia)
- Central America (Nicaragua, Honduras, El Salvador, Guatemala)
- Bolivia
- China
- Philippines
- Nepal

Appendix 3: The 6 research areas of SWITCH with their specific focuses

1. Planning for the Future
Focus 1: Strategic approaches to urban water management
Focus 2: Strategic planning and Sustainability indicators
Focus 3: Transitioning to More Sustainable Systems

2. Engaging Stakeholders
Focus 1: Learning lessons from city experiences
Focus 2: Application of the learning alliance approach
Focus 3: Governance research
Focus 4: Social inclusion

3. Water Supply
Focus 1: Managing Water Demand
Focus 2: Water Security through Re-use
Focus 3: Water Quality from Natural Treatment Systems
Focus 4: Use of rainwater

4. Stormwater
Focus 1: Stormwater control technologies and risk
Focus 2: Design and urban integration of stormwater BMPs
Focus 3: Decision support tools
Focus 4: Institutional analysis
Focus 5: Stormwater as a resource in IUWM
Focus 6: Stormwater Best Management Practice Principles

5. Wastewater
Focus 1: Situational analysis (in Lima, Beijing, Accra and Hamburg)
Focus 2: Adoption and operational performance
Focus 3: Treatment processes for pharmaceuticals
Focus 4: Agricultural use of nutrients
Focus 5: Best practice and decision support systems
Focus 6: Institutional change

6. Decision-Support Tools
Focus 1: City Water – A comprehensive DSS designed to assess the urban water cycle as a whole
Focus 2: Additional SWITCH DSS tools for more detailed investigation of urban water cycle components
• SUDSloc – GIS based approach to selecting stormwater management solutions
• Eco.SWM – Life Cycle Cost Assessment (LCCA) tool: Calculation tool to carry out life cycle cost assessments of stormwater management solutions
• COFAS – Comparing the Flexibility of alternative Solutions: Tool to calculate the flexibility of different water management solutions
• "Jericho" Decision Support System – evaluates options of water resources allocation under conditions of scarcity and potential for wastewater reuse, using sustainability indicators
• SETNAWWAT – Selection tool for natural wastewater treatment systems
• SOMA – the "SWITCH Organic Micro-pollutants Assessment" tool facilitates the design and operation of Bank Filtration systems in the reduction of selected groups of OMPs
Focus 3: Case studies on selecting approaches and technologies for urban water cycle management

Appendix 4: The nine key objectives of SWITCH

1. Improve the scientific basis for long-term strategies for sustainable urban water management, equipped to resist negative effects of global change.

2. Achieve a switch in urban water management practices, towards sustainability in the SWITCH demonstration cities.

3. Develop an overall strategic approach to achieve sustainable urban water management in the city of the future.

4. Increase impact and visibility by dissemination to stakeholders through a learning alliance approach, wide dissemination and teaming up with other international initiatives.

5. Develop effective stormwater management options in the context of the hydrological cycle at urban and river basin level.

6. Provide effective water supply services for all at minimum impact on water resources and the environment at large.

7. Develop effective sanitation and waste management options based on the principles of 'Cleaner Production'.

8. Integrate urban water systems into the ecological and other productive functions of water at city and river basin level.

9. Develop innovative, effective and interactive institutional arrangements covering the entire urban water cycle in the urban and broader river basin setting.

Appendix 5: EcoSanRes strategic aims and specific objectives

Overall Strategic Aims of the EcoSanRes Programme
1. To develop and introduce sustainable, innovative approaches to help improve sanitation services in needy communities in the South

2. To advance knowledge on sustainable sanitation systems for livelihood improvement and sustainable development

3. To advance integrated strategies that link sustainable sanitation to management of water, land, food systems and socio-economic development

4. To work with and within the authorities, organisations and businesses that are responsible for sanitation in urban and rural settings in selected regions

5. To integrate ecological sanitation into the mainstream sanitation by finding useful entry points and linkages

6. To communicate more effectively about sustainable sanitation

7. To emphasise in the public forum the advantages of ecosan in terms of health and environmental protection, water savings, simplicity, reliability and linkages to agriculture – elements that would allow sanitation to pay for itself

8. To create centres of competence in selected global regions and to assist in building capacity in the area of sustainable sanitation

9. To promote sustainable sanitation and to help coordinate the international efforts within similar programmes

10. To support the development of policies and regulations that will allow for sustainable approaches to sanitation in developing countries

11. To promote gender aspects in sustainable sanitation

12. To ensure that the following building blocks are part of the ESR Programme:

a.capacity building, regional node development and demonstration projects
b.normative knowledge development
c.communications and networking

The four specific objectives of the Programme are:
1. Effective capacity development through nodes at regional and/or national levels for the promotion and development of sustainable sanitation

2. Strategic knowledge developed, based on demand and analysis of needs, for the enhancement of sustainable sanitation

3. Catalytic global communications, networking and knowledge management for the promotion and development of sustainable sanitation

4. Effective ESR2 programme governance and management for capacity development, knowledge development and communications

Appendix 6: Phase 1 and pilot projects of EcoSanRes

Phase 1 three components
Outreach: Promotion, Networking and Dissemination
Capacity: Methods Development, Studies and Training
Pilot Projects: Asia, Africa and Latin America

Pilot project
In Asia, Africa, and Latin America.

Logical Framework
• initial contacts taken to identify targets, possible collaborators and institutional ownership
• organisation of courses, seminars and workshops to consolidate interest, build capacity, transfer expertise and plan activities
• planning and funding development
• pre-feasibility study for regional pilot project
• detailed planning phase
• implementation of pilot project
• monitoring and evaluation

Criteria for Pilot Projects
• optimise dissemination factor
• gender impact
• appropriate knowledge
• political support
• right people
• strong local ownership
• inclusion through reference group

- training & local research
- build on what is already on-going
- where - rural or urban?
- clear objectives

Appendix 7: Factsheets produced by EcoSanRes

Base Factsheet: The EcoSanRes Programme, Revised for 2009
Factsheet 1: The Sanitation Crisis
Factsheet 2: The Main Features of Ecological Sanitation
Factsheet 3: The EcoSanRes Programme for Improved Livelihoods Around the World
Factsheet 4: Closing the Loop on Phosphorus
Factsheet 5: Guidelines for the Safe Use of Urine and Faeces in Ecological Sanitation Systems
Factsheet 6: Guidelines on the Use of Urine and Faeces in Crop Production
Factsheet 7: Open Planning of Sanitation Systems
Factsheet 8: Introduction to Greywater Management
Factsheet 9: Norms and Attitudes Towards Ecosan and Other Sanitation Systems
Factsheet 10: A Review of Sanitation Regulatory Frameworks for Sweden, Mexico, South Africa and Uganda
Factsheet 11: Sweden-China - Erdos Eco-Town Project - Dongsheng, Inner Mongolia
Factsheet 12: An Ecological Approach to Sanitation in Africa: A Compilation of Experiences
Factsheet 13: Toilets That Make Compost
Factsheet 14: Adapting Planning Tools to the Peri-Urban Setting
Factsheet 15: Work of the 3 African Knowledge Nodes in Burkina Faso, Uganda and South Africa
Factsheet 16: Work of the 2 Latin American Knowledge Nodes in Honduras and Bolivia
Factsheet 17: Work of the 3 Asian Knowledge Nodes in Nepal, the Philippines and China
Factsheet: Improving Food Production and Sustainable Livelihoods in Sub-Saharan Africa

Appendix 8: List of practitioners contacted in 2013

In-depth interviews
Rémi Kaupp
International programmes officer at Homeless International (HI) (until 2014)
Programmes Officer at WaterAid

Madeleine Fogde
Senior Project Manager (Director of EcoSanRes phase 2) at Stockholm Environment Institute (SEI)
Arno Rosemarin
Senior Research Fellow (Research & Communications manager during EcoSanRes) at Stockholm Environment Institute (SEI)

Andrew Adam-Bradford
Emergency Response Coordinator at Human Relief Foundation

Email exchanges and informal discussions
Yves Cabannes
Chair of Development Planning Unit (DPU) at University College London (UCL)

Niels Lenderink
Adviser on urban environment and development at WASTE

Tim Forster
HSP-PHE Capacity building, coordination and innovation at Oxfam GB

Andy Bastable
Public Health engineering coordinator at Oxfam GB

Louisa Gosling
Programme Support Advisor at Water Aid
Sue Cavill
Research Manager, SHARE at Water Aid

Tarah Friend
Research Uptake Manager at Department for International Development (DFID)
Helen O'Connor
Climate and Environment Adviser at Department for International Development (DFID)

Sudha Shrestha
Act. Chief Technical Advisor / GSF Project Manager at UN-HABITAT

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