INTEGRATING GREEN INFRASTRUCTURE ECOSYSTEM SERVICES INTO REAL ECONOMIES

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Erik Andersson, Jakub Kronenberg, Rozalija Cvejić, Thomas Elmqvist , Marina Pintar

Deliverable D4.1

Erik Andersson, Jakub Kronenberg, Rozaljia Cvejić and Crystal Adams
SRC, Sweden; ULOD, Poland; UL, Slovenia

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SEVENTH FRAMEWORK PROGRAMME

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SUMMARY

In 2013, the European Union (EU) launched a collaborative project entitled "GREEN SURGE". Within this project, one of the basic tasks for Work Package 4 "Contributing to the Green Economy" was to review and identify "options for linking ESS provisioning of UGI with economics" drawing on experiences with integrating green space ecosystem services into real economies. This report is the culmination of this task.

Good quality urban green spaces, linked up within urban green infrastructure (UGI), provide the benefit of multiple ecosystem services, and requires investment of capital and work. The goal of turning investments into high quality green space aligns with the goal of a 'green economy'. Here we adopt and build on the UNEP definition of green economy, and in GREEN SURGE green economy is defined as: *An economy that aims to improve human well-being and social equity while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low-carbon, resource-efficient, and socially-inclusive.* GREEN SURGE sets out to explore the connections between green economy, biodiversity, people and green space in urban settings. This report situates UGI within the green economy, aiming to contribute to existing green development strategies and facilitate improved decision-making.

Green economy is best seen as a comprehensive umbrella covering a number of economic approaches and policy/governance strategies, where transitioning to an economy that supports sustainability targets could be achieved using these strategies individually or in combination. Green economy has at least four aspects that connect to UGI: economic competitiveness, business opportunities, economic efficiency (avoided costs) and investment in urban environmental quality. The evidence and support for these connections can be found both in the scientific literature and in the many and diverse projects that have sprung from a widespread, often city-led and initiated by local authorities, interest in urban sustainable development. A strategic focus on the UGI needed for different ecosystem services, not least for services with a direct economic relevance, has been shown to lead to cost savings and new business opportunities. In short, many of the cases are about strategic investment to either avoid costs or to increase benefits, or in some cases both, producing comprehensive value creation.

Decentralisation, outsourcing and an opening up of the "green" sector to new services and connections to society have created new business opportunities and invited new actors to engage with UGI. In this Deliverable we describe the actors involved in the creation and maintenance of UGI. Various UGI governance approaches are discussed from an economic perspective, with a particular emphasis on their green economy context. Several boxes have been used to illustrate the contents of this Deliverable with real-life examples of projects and companies that integrate green space ecosystem services into real economies. These include fundraising schemes, consulting services, food production, storm water management, and horticultural therapy. A more extensive, cross-cutting example of urban forest restoration indicates how a major investment in UGI pays off well.

The present Deliverable indicates several areas for further research that are being or will be investigated within GREEN SURGE. The analysis of integrating green space ecosystem services into real economies can be performed both qualitatively and quantitatively, and we suggest that these two approaches can and should be combined. In addition, it is of key importance to study

not just the rights of different stakeholders with regard to how they use UGI, but also their obligations related to the fact that they have the right to use it. Based on more detailed data on the costs and benefits related to specific urban green infrastructure components, better management of urban ecosystems could be facilitated.

This Deliverable is closely linked to several other GREEN SURGE outputs which are listed in the end of this document. (A dedicated paragraph in the Introduction reviews these linkages.)

1 INTRODUCTION

The project Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy (GREEN SURGE), funded under the EU's 7th Framework Programme for Research, will identify, develop and test ways of linking green spaces, biodiversity, people and the green economy in order to meet the major urban challenges related to land use conflicts, climate change adaptation, demographic changes and human health and wellbeing. One of the tasks (Task 3.4) is to find ways to integrate ecosystem services generated by urban green infrastructure (UGI) into real economies, which is the focus of this report.

UGI, with its emphasis on larger, connected mosaics of different green spaces, invites a different take on ecosystem services to one focusing solely on individual urban green spaces. The combination of different resources, as well as the opportunity to create networks of similar or complementary green spaces, offers both new challenges and opportunities to find synergies and positive effects that go beyond the contribution from the individual green space. Thinking and planning across boundaries require us to take on issues like multiple owners and stakeholders, administrative units and scales, different budgets and interconnections with grey infrastructure and heterogeneous socioeconomic contexts and conditions.

This GREEN SURGE Deliverable 4.1 reviews and discusses ecosystem services derived from green space mosaics (heterogeneous UGI), the stakeholders involved in their maintenance (either as owners/investors or as managers/designers), and case study examples of ecosystem service integration into real economy. It draws on the GREEN SURGE typology for UGI components (GREEN SURGE Deliverable 3.1) to highlight the sometimes unacknowledged complexity UGI planning faces in terms of diversity both in ecological composition and needs, and in ownership and management arrangement. Green economy, defined by UNEP (UNEP, 2011) as "[an economy] *that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*", is here understood as a way towards meeting sustainability targets combining environmental, social and economic objectives. Green economy has bearing on UGI, the core aim being to find, mobilize and make available the resources needed to maintain and restore and create the green spaces we need for the delivery of critical ecosystem services to urban inhabitants. This includes rethinking who should or could invest in UGI. Auxiliary to this baseline, the expansion both of the green sector itself and of the spatial extent of UGIs opens up new business opportunities and models, and thus new ways of making a living.

Although the green economy concept is endorsed by important international organizations, including the UN and the European Union, and is gaining popularity in the broad sustainability discourse, this popularity is not reflected in strategic documents issued at the local level. An analysis of policy documents related to urban green space planning and implementation carried out for 20 European cities representing various environmental management approaches revealed that no document explicitly mentioned green economy (GREEN SURGE Deliverable 5.1 (Davies et al., 2015)). Five documents included similar concepts, such as a sustainable economy or green jobs. Documents issued in Bristol, Amsterdam and Ljubljana attributed highest importance to these issues. Most of the analysed green infrastructure planning and implementation policies included ideas that are consistent with green economy (e.g. formulations about the values of green space and ecosystem services), although the connections were not made explicitly.

This report focuses on the economies associated with UGI, highlighting especially the benefits derived by companies and other economic actors, and the role these take on in maintaining the qualities of UGI and navigating the growing economy around urban greening and the marketing of ecosystem services. Businesses own green space, design green space and quite often manage

the green spaces owned by others; or they may use UGI as the setting and scene for their activities.

Ecosystem services generated by UGI are directly relevant to business and to economic considerations. Regulating services offer opportunities in terms of design, installation and maintenance of UGI components such as bioswales, rain gardens, flood protection etc. and can often be assessed by avoided damage cost and replacement cost methods. Provisioning services often have a direct market value, either as produce/raw material or with added layers of processing, e.g. food production and the delivery of genetic resources. However, long and indirect causal chains often make supporting services less obvious in what and how they may offer economic opportunities, unless there are direct policies addressing them and thus creating markets for companies to explore niches provided by regulating services. As indicated by the introductory remarks this report addresses the broad economic context of UGI. This is different from most discussions on the economic aspects of UGI, which are often reduced to valuation of urban environmental amenities or ecosystem services.

The organisation of the report is as follows: Chapter 2 introduces the intersection of green economy and UGI. Chapter 3 introduces and explores the complexity, needs and opportunities inherent in a mosaic UGI by making use of the GREEN SURGE UGI typology. It offers additional comments on how actors and complex UGI mosaics come together to address different needs, usually by promoting or providing ecosystem services. Chapter 4 provides an in-depth study of the gains to be made by restoring urban forests, meant to serve as an integrative case study. Finally, chapter 5 identifies existing knowledge gaps and points out future directions for research and experimentation, within GREEN SURGE and beyond.

The present report should be read in combination with other GREEN SURGE products and a list of the relevant GREEN SURGE documents is provided in the end of the list of references. The specific linkages are the following:

- ***The present Deliverable is accompanied by a sister document – Deliverable 4.2, which presents a theoretical framework, methodological approaches and case study illustrations for how to think about value as a means to setting up UGI financing.***
- ***The list of actors involved in UGI governance presented in Chapter 3 links to the typology of UGI components (Deliverable 3.1) and the underlying Milestone 23 which featured UGI components inventory.***
- ***A broader discussion of how UGI has been considered in planning and strategic decision making in European cities (including the place of green economy) has been presented in Deliverable 5.1.***
- ***Furthermore, upcoming Deliverable 5.2 will more specifically look at how green economy (and several other GREEN SURGE policy concepts) has been adopted and implemented in policy.***
- ***Deliverable 6.1 looked into the governance of urban green spaces in selected EU cities and provided general background for our present analysis of the roles of different economic actors in the creation, management and restoration of different UGI components.***
- ***Deliverable 6.2 will provide additional angles and more detail on some of the case studies briefly referred to in the present report (adoption of green spaces in Oradea, Romania, and public-private partnership in Lodz, Poland).***
- ***This Deliverable builds on Milestone 30 which presented "Nature as a firm", thus clearly laying the foundation for the review of experiences with integrating green space ecosystem services into real economies.***

Finally, we refer to one example from Malmö, a city that serves as an Urban Learning Lab within the GREEN SURGE project, and to several examples from GREEN SURGE Tier 2 cities, i.e. a group of European cities selected for international comparisons within the GREEN SURGE project. We also use SME partners involved in the GREEN SURGE project to exemplify the diversity of businesses involved in the integration of green space ecosystem services into real economies.

2 UGI AND ECONOMY, BENEFITS OF ECOSYSTEM SERVICES

2.1 UGI and green economy

In GREEN SURGE green economy is defined as: *an economy that aims to improve human well-being and social equity while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low-carbon, resource-efficient, and socially-inclusive.*

Green economy, as related to urban green infrastructure, can be captured by four main objectives or areas, which are particularly relevant to integrating green infrastructure ecosystem services into real economies:

- ***economic competitiveness;***
- ***business opportunities;***
- ***economic efficiency – avoided costs;***
- ***investment in urban environmental quality.***

Figure 1 provides an overview of such interactions, and the following subsections provide more detail and examples of the above areas.

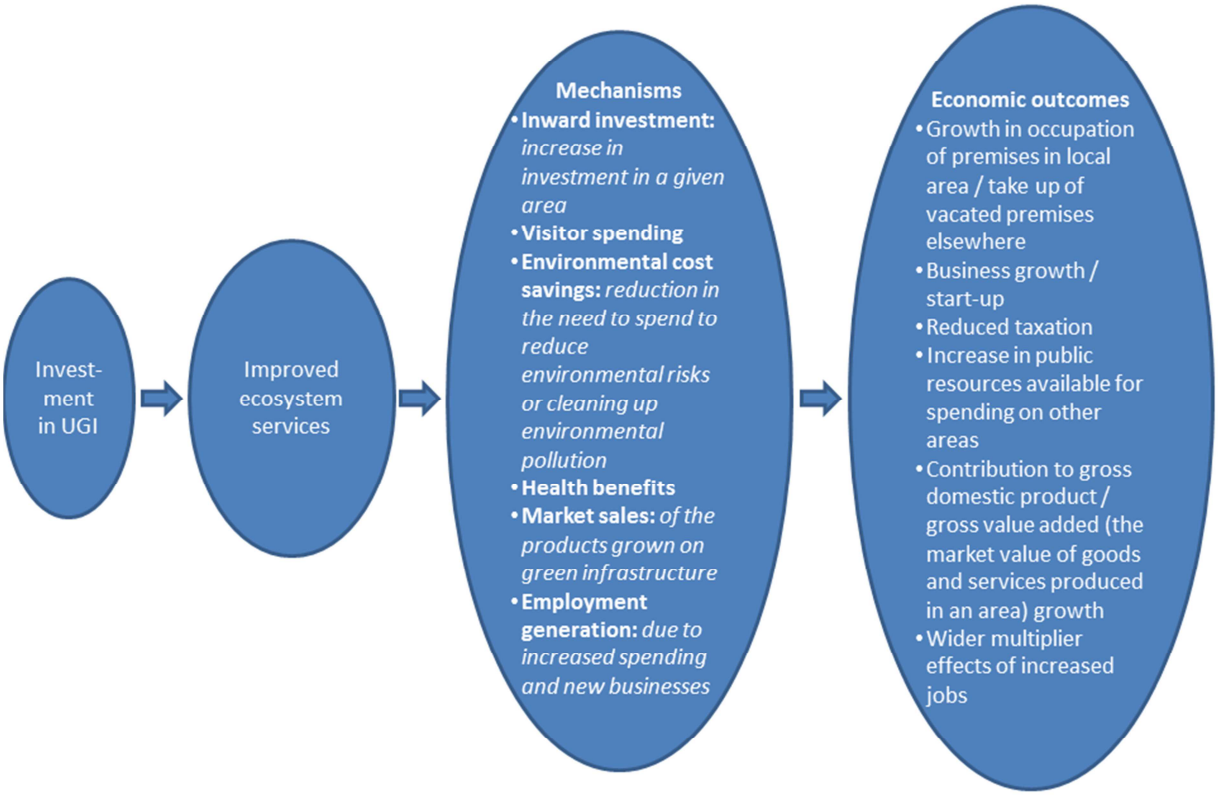

Figure 1: Conceptual model for linking investment in UGI to economic growth (adapted from Eftec and Sheffield Hallam University (2013)).

2.1.1 Economic competitiveness

Attracting inhabitants and businesses

Many methods are available to assess the importance of UGI and green space in general for the inhabitants, which can be translated into UGI attractiveness. Using either questionnaires or observation of people's behaviour, we can find out that people living in greener neighbourhoods and with better access to UGI tend to be more satisfied with their neighbourhood (Skärbäck et al., 2014). This is further reflected in the recognition by some local authorities that UGI improves quality of life and thus can enhance local competitiveness. For example, in Manchester UGI was considered by local planners as "beneficial for quality of place and strengthening the economy, such as promoting a competitive advantage over other locations" (Carter et al., 2015, p. 36).

Furthermore, different urban green spaces have an important place-making potential connected to both innovative regeneration projects (e.g. urban brownfields, see Franz et al. 2008) and to the connection that people feel towards landmark features of local ecosystems (Tidball & Krasny 2014). In both cases people may be attracted to specific locations, either because of the created or innate properties of those locations.

The availability and quality of urban green space tends to be included as one of the important aspects of urban competitiveness (Jiang and Shen, 2010) and it is included in many rankings comparing cities with regard to quality of life and competitiveness, such as the Monocle Magazine's "The Most Liveable Cities Index". Nevertheless, UGI issues are still missing from most mainstream discussions on urban competitiveness (cf. Begg, 1999; Ni, 2012) and the only thing that tends to be considered is environmental quality, broadly understood (Economist Intelligence Unit, 2013). Even the Green City Index, prepared by the Economist Intelligence Unit and sponsored by Siemens, does not explicitly refer to UGI but only to major environmental quality and governance categories (Siemens, 2012). Similarly, quality of living rankings and reports (such as those prepared by the Economist and by Mercer) only refer to general environmental conditions (such as safe and clean environment, institutional capacity to deal with environmental problems, and absence of natural hazards) rather than UGI or green space availability.

Finally, there are also examples showing that companies invest in green spaces to increase the attractiveness of their offices and working environment, with Jubilee Park created in Canary Wharf office development in London at the cost of £6 million as one of the best known case studies (Rolls and Sunderland, 2014). This is also considered in various advisory and labelling programmes for companies interested in enhancing green space in and around their offices and other buildings. One of such examples is the "Image" programme carried out by the Environmental Partnerships Foundation in Poland, which advised companies on how to improve their image by taking proper care of their surroundings, with prime attention paid to the development of UGI (no longer active).

Poverty eradication, inclusiveness and public spaces

It has been shown that greener public spaces attract more people and are used more by residents (Kuo et al., 1998). The same study also showed that residents closer to green public spaces enjoyed more social activities, had more visitors, knew more of their neighbours, and had stronger feelings of belonging. Greening public spaces contribute to greater community cohesion

and social integration (Gobster, 1998; e.g. Kweon et al., 1998), factors that not only have positive effects on physical and mental health but also on economic resilience and productivity (Putnam, 1993). This relationship seems to be particularly strong for disadvantaged people, as community cohesion and social inclusion are linked (O'Connor and Sauer, 2006). Studies show that socio-economically deprived groups tend to live in areas with poorer access to green space, which also relates to health deprivation (Dai, 2011; Gill et al., 2007; Wolch et al., 2014). Cities can counteract these problems by increasing the supply of urban green space in socio-economically deprived neighbourhoods, including using economic incentives to revitalize such areas (Wolch et al., 2014). Properly designed UGI can help achieve both environmental and social objectives, including poverty alleviation and inclusiveness, as demonstrated by multiple case studies (such as the Green Bronx Machine combining urban farming with workforce development, initiated by school teacher Stephen Ritz, and other greening projects undertaken in underprivileged communities by local leaders such as Majora Carter) and systematic studies (Dunn, 2010).

Labour productivity

In general, improving the urban environment has been found to be "good for business and employment" (Werna, 2013). This includes improving air and water quality, curbing the heat island effect etc., all of which can be aided by UGI. Some studies confirm the significant relationship between access to green space in and around workplace and workplace attitude (Lottrup et al., 2013) and reduced stress (Pati et al., 2008; Stigsdotter, 2004). Others highlight the positive effects of protecting wildlife habitat on corporate grounds for employees' job enthusiasm and satisfaction (Kaplan et al., 1996). There is evidence that UGI improves physical and mental health, and it follows that this should also lead to improved labour productivity and reduced worker absence (Rolls and Sunderland, 2014).

Tourism and recreation

The argument for ecotourism and nature-based holidays mainly relates to the benefits gained from "natural" destinations such as national parks and protected areas, but much of the reasoning is fully applicable to UGI and city branding. Urban nature-based holidays may be centred on activities such as walking or cycling, both of which require relatively little expenditure while still being of great value to those taking part. This value may translate into broader economic benefits related to improved health and well-being of those involved. Tourism services can capitalise on consumer demand for recreational or sightseeing opportunities in or near a city, including enjoying beaches, sailing/kayaking, birdwatching, bicycling, golf, or other organized activities.

Parks, gardens and other open spaces can attract tourists both with their attributes (aesthetics, historical background and heritage, landscape) and with their capacity for hosting activities such as music concerts, painting exhibitions and theatre or opera shows (Cianga and Popescu, 2013). Activities and exhibitions related to vegetation (flower fairs, gardening workshops and urban food production) are perhaps the ones that are most in keeping with the specificity of the green spaces (Watkins and Wright, 2007). Finally, a number of international, national and local garden shows demonstrate further tourism opportunities, but also opportunities for enhancing local competitiveness and sense of place. These include perhaps the most famous Chelsea Flower Show organised since 1913, the French garden festival organised in Chaumont-sur-Loire, the Philadelphia International Flower Show, Hampton Court Palace Flower Show, and a number of

garden shows (Gartenschau) organised in Germany, with the important BundesGartenschau organised at the national level.

2.1.2 Business opportunities

Business and economic benefits

UGI can provide connections that link amenities to the city, its neighbourhoods and main streets. Major tourism destinations such as urban forests, big parks and waterfronts attract visitors to neighbourhood districts, local establishments and cultural destinations. Green public spaces and UGI linkages can channel and decelerate transit flows, allowing people to spend more time along transportation routes. A study from the USA found that shoppers across 26 different-sized cities reported being willing to travel further to visit, stay longer once there, and more frequently visit, business districts with trees (Brengman et al., 2012). Green design features incorporating daylight and greenery availability, which include both indoor and outdoor green space, can be linked to positive shopper perceptions and behaviour, less stress among customers and better staff motivations, positively influencing store image and willingness to pay higher prices for goods and services. These issues are increasingly important considering the competition that traditional shopping facilities experience from on-line commerce (see in particular Wolf, 2014). However, integrating greenery into the commercial areas must be designed on a case-by-case basis. Joye et al. (2010) showed that greenery "can potentially reduce access to shops or products, hide shop frontage and advertising, and exacerbate crowding if situated incorrectly".

A growing number of cities allocate public space to farmers' markets, charging nominal fees to vendors selling produce or other farm products there. Cities located near farming districts or interested in promoting urban farms or food production within their UGI may look to facilitate the development of farmers' markets that sell high quality local food. Such markets may cater both to local restaurants and the public (Hammer et al., 2011).

In many European cities the economic contributions of business tourism are at least on par with those from leisure tourism (van den Berg et al., 1994), and the meetings and events tourism market has been explored and pursued by a large number of former industrial cities in the UK, continental Europe, the USA and Australia within their strategies of post-industrial urban regeneration (Law, 1987). While a green image is used to pitch city destinations, it is one of many and the exact relative importance varies (Bradley et al., 2002). However, on the local scale many individual organisers often use the "natural setting" as a selling point.

On an even more elementary level, UGI establishment and management offers multiple business opportunities for various "green entrepreneurs", such as private landscaping firms, arboriculturists, tree nurseries and consultants. Examples of such businesses are discussed in section 3.2.2.

Social entrepreneurship

Social entrepreneurship has been promoted in recent years as an alternative business model that is not only competitive but also works toward societal and environmental gains. This dovetails with the GREEN SURGE definition of green economy, which is an economy that aims to improve social equity and reduce environmental risks. It has even been argued that "green entrepreneurship" is needed (Farninelli et al., 2011), which would drive a green economy through innovation

in technology and management. As we argue above, the presence of UGI affords multiple social benefits like poverty eradication, inclusiveness and recreational opportunities, all of which translate into economic competitiveness. Coupled with ecosystem services, this makes UGI a perfect candidate for social enterprise engagement and investment. Social entrepreneurship is inherently innovative and flexible (Desa, 2012), differs in composition and focus (European Commission, 2013) and uses hybrid business models and various sources of capital to achieve its goals (Battilana et al., 2012). It is therefore well suited to adapting to the complex array of roles and opportunities (discussed in chapter 3) offered by UGI. Furthermore, social entrepreneurship aligns with the goals of innovative UGI governance (see GREEN SURGE Deliverable 6.1) as it involves participatory decision-making, focus on community development and reinvestment of profits (European Commission, 2013).

Box 1. Urban gardening: from cost avoidance to profit making

According to GREEN SURGE Deliverable 6.1, almost all GREEN SURGE Tier 1 cities have green space initiatives where food production is at least one of the main objectives. Although the purpose often was phrased in terms of social cohesion, urban food production also has economic dimensions.

An interesting example for exploring benefits of integrating ecosystem services into real economies is urban gardening. Urban gardening is considered as a marginal economy mainly as a hobby and cost avoidance activity (Černič Istenič et al., 2015), although there are examples where urban gardening was turned into a profit making activity. We compare two economic models of urban gardening in Ljubljana – an avoided costs model (ACM) and a business model (BM) – to exemplify the main differences between the two models. The main difference is that urban gardeners included in BM sell surplus products, which is not the case in the ACM where the produce is consumed and where surpluses are given to members of family and friends or exchanged for other goods, rather than sold.

The ACM highlights the fact that users save money because they self-supply with products from the urban gardening. It is based on the analysis of 127 urban gardeners from Ljubljana (Glavan et al., 2015). The BM refers to the income growers make by selling the urban gardening surplus products to a company. It is based on the analysis of a private company from Ljubljana that buys products from urban gardeners in Ljubljana. The analysis of the BM was done through an interview.

We estimated the production (yield) and the yearly production costs (seeds, seedling plants, fertilisers, plant protection etc.). Multiplying this by the yield per harvested crops/vegetables and average retail price of vegetables we estimated the revenue. Deducting the production cost from revenue we estimated average gross margin for the gardening production per urban gardener in Ljubljana.

The analysis included the average grower with an average size of an urban garden of 102 m^2. Within the BM, the company purchased goods from an average of 30 gardeners. In the period 2014–2015 the company purchased on average 3600 kg of vegetables and wild crops per year for the amount of EUR 4825, for an average retail price of EUR 1.5/kg. An average producer sold 112.6 kg produced surpluses, thus earning (revenue from surplus) EUR 160.8. The costs of production are estimated on the basis of a catalogue of calculations for planning agricultural production on farm. Average costs for an urban garden are EUR 54.7 (Glavan et al., 2015). Therefore the gross margin of surplus is EUR 106.2 per gardener. BM gardeners sell 33.3% yields of the total production. Meanwhile, the ACM urban gardener produced on average 338.42 kg vegetables with a retail price 1.2 EUR/kg and thus saved 246.73 EUR/year.

2.1.3 Economic efficiency – avoided costs

Health

It is widely acknowledged that UGI ensures multiple health benefits related to air quality and humidity, facilitating physical activity, psychological well-being, and the general public health (Tzoulas et al., 2007; Wolch et al., 2014). Access to green space in cities was shown to correlate with longevity (Takano et al., 2002), recovery from surgeries (Ulrich, 1984), reduced stress (Kaplan and Kaplan, 2005; Korpela and Ylén, 2007; White et al., 2013), mental health (Alcock et al., 2014) and self-reported perception of health (Maas et al., 2006; van den Berg et al., 2010), all of which translate into higher well-being. In particular, restorative health, which also includes horticultural therapy, is highly relevant in the context of stressed urban populations (Grahn and Stigsdotter, 2010) and it seems particularly important to ensure visual and physical access to green space for housebound urban residents (Jackson, 2003). The environment improves health directly – offering restorative benefits and alleviating environmental "bads" which negatively affect physical and mental well-being – and indirectly – by providing space for social contact and physical activity (MacKerron and Mourato, 2013; Ward Thompson et al., 2012). Some avoided health costs are associated with the capacity of UGI to contribute to climate change mitigation (Carter et al., 2015). For example, The Trust for Public Land found out that the annual avoided costs of health care related to different levels of physical activity in parks across 10 US cities and counties ranged from $4 million to $69.4 million per year (cited by Wolf and Robbins, 2015).

Several studies highlight the potential of green infrastructure to reduce noise nuisance, including with the use of innovative solutions, such as green walls (Azkorra et al., 2015). Clearly, this also has important implications for health promotion, given the excessive noise levels to which inhabitants are exposed in most urban areas (Stansfeld et al., 2000).

Box 2. Horticultural therapy

The Danish Healing Forest Garden Nacadia is run by the Nature, Health and Design Laboratory (University of Copenhagen) in Hørsholm Arboretum in the north of Copenhagen, the most prominent arboretum in Denmark. Nacadia offers nature-based therapy which is combined with conventional treatment and research (Corazon et al., 2012). The main focus is on treatment for people affected by stress-related illnesses. Therapy starts with a passive stage within which patients regenerate their low resources by simply lying on grass or having a rest in the garden. Once they feel stronger, they undertake gardening activities which strengthen their physical and mental relationship with the environment. Gardening activities follow the rules of permaculture, i.e. farming that imitates the patterns and features observed in nature. This is adjusted to the needs of people with stress problems, who have been found to prefer a wild and diverse environment. The patient's experiences and activities are guided by the therapist. The standard treatment is expected to last 10-weeks and the first patients were soldiers suffering from post-traumatic stress. Nacadia is designed to accommodate eight-person groups at a time on an area of 9700 m^2 of open spaces, forest, water and other habitats (and two buildings). The different habitats and settings are used to create the different "rooms" for different types of activities. Although the idea of horticultural therapy is not new and dates back to gardens in ancient Greece and then medieval monastery gardens, the activity of Nacadia is highly innovative and influential. Indeed, governments in several countries, including Denmark and Sweden formally count horticultural therapy among official stress treatment methods and reimburse the relevant rehabilitation expenses within social insurance.

Insurance value of urban green infrastructure

Greening cities has often been suggested as a strategy for adapting to future climate change and other anticipated but unpredictable changes. Above all, green spaces promote carbon sequestration, water retention and reduce the urban heat island effect. If properly planned, they allow the reduction of energy consumption for heating and cooling buildings. For example, the economic costs of flooding have been increasing over the last several decades, largely due to more people and property locating in hazardous areas (Pielke and Downton, 2000). Brenner-Guillermo (2007) estimated the value of water flow regulation in the urban green space in the Catalan coastal zone (Spain) at US$11 per hectare per year. The avoided costs of flooding can be significant. For example, Kousky and Walls (2014) estimated the average annual avoided costs from flood damages on a greenway along the Meramec River (US) at US$7.7 million per year.

The insurance industry is well positioned to understand the fundamental nature of emerging risks to communities, the global economy, whole industry sectors and its own investments, and is now starting to explore the commercial opportunities in conceiving, developing and rolling out new products and services that address global sustainability issues (UNEP FI IWG, 2007). Potential new markets include insurance for emerging manmade health risks, climate change induced hazards and the protection of natural resources, in particular, biodiversity and ecosystems (e.g. forests) and water.

However, economic approaches to estimating insurance value are "still poorly developed" (Elmqvist et al., 2013), and methodologies for monetizing the insurance value of resilience provided by biodiversity and UGI are in their infancy. Any attempt so far to monetize resilience has required a very high degree of simplification, and – as argued by Mäler (2008, p. 22) – "it may seem overoptimistic to discuss economic valuation of a stock we know so little about".

Box 3. Stormwater infrastructure as an illustration of avoided costs

Stormwater infrastructure is an interesting case as it combines both different UGI component types and different kinds of infrastructure – green, blue and grey. Furthermore, the objectives and aspirations for stormwater management and urban drainage are becoming increasingly multifunctional. Before the 1970s the focus was on quantity and swift reduction of flows, which then expanded to address concerns about quality when the environmental impacts of pollutants on receiving water bodies became more generally recognised. Since the 1990s new designs have been sought that reconcile quantity and quality with recreational and amenity values (Stahre, 2008).

Stormwater infrastructure can be divided into four different classes (Stahre, 2008), with different opportunities to involve business. The first is "source control", referring to small-scale facilities like green roofs, rain gardens or ponds, located on private land. "Onsite control" is the public land equivalent to source control and thus under municipal responsibility. "Slow transport" includes drainage systems (bioswales, ditches, canals) for channelling the stormwater towards the "downstream control" facilities like wetlands or lakes. Large scale structures tend to be the responsibility of the municipality (although design and maintenance is usually contracted to companies within the WSS sector).

Ekostaden Augustenborg (Malmö, GREEN SURGE Urban Learning Lab)

In Malmö, sustainable urban drainage was introduced already in the late 1980s, and the city has been progressive in its work with stormwater infrastructure since. One of the best known examples, with a clear business partner (MKB, a housing company), is Augustenborg. Ekostaden Augustenborg was conceived and launched as an attempt to create a systemic solution to a number of sustainability issues, stormwater management among them. The approach to stormwater management is based on a mosaic of UGI components fitted to flow of water. Source and onsite controls are dominated by green roofs of different kinds, which then feed into a system of canals and retaining ponds. Some of these are located in courtyard areas where they provide additional recreational values and support local biodiversity. Eventually the system connects to the conventional stormwater system. The project has been quite successful, both in terms of preventing flooding and as an example for how private and public actors can work together to make sure that local solutions are integrated and turned into functional infrastructure – it was created and is supported and managed by the MKB housing company that originally developed the Augustenborg neighbourhood in 1948 and local partners in the Fosie District and Malmö city. Additional funding came from the Swedish government's Local Investments Programme for Ecological Conversion and Eco-Cycle Programme, as well as the European Union's LIFE and URBAN programs and a number of other sources both public and private (Stahre, 2008), and maintenance work is jointly funded through the housing company, which incorporates costs into rents, the water board through the water rates, and the city council's standard maintenance budgets.

Selected examples from US cities

According to US Environment Protection Agency (EPA) (2014), Lancaster provided the unit cost of wastewater treatment and pumping (US$0.00125/gallon) and the unit cost for CSO (combined sewer overflows) reduction through grey infrastructure storage (US$0.23/gallon of CSO treated in an average year 4) to arrive at the values below. These values can be compared to the total and marginal costs of implementing green infrastructure within the combined sewer system area. The Lancaster Green Infrastructure Plan assumes that approximately 67% of green infrastructure implementation will occur within the combined sewer system (CSS) area. Assuming that green infrastructure costs are directly proportional to the area of green infrastructure implemented, the total cost of green infrastructure in the CSS area would be 67% of US$141 million (or US$94.5 million) and the marginal cost of green infrastructure would be 67% of US$77 million (or US$51.6 million). (More specifically, for the 25-year green infrastructure scenario, the avoided capital cost of implementing grey infrastructure is $120 million and the avoided operational cost is US$661,000 per year. Within the CSS area, these avoided costs would be achieved at a total cost for green infrastructure of approximately US$94.5 million, or a total marginal cost of approximately US$51.6 million.

In a study from 2002, McPherson and Simpson calculated the stormwater reduction benefits involved impacts on water quality and flood control for Modesto and Santa Monica, USA. In Modesto, water quality benefits were priced based on annual costs for water quality monitoring and education, while flood control benefits were based on local costs for constructing and maintaining stormwater retention/detention basins (McPherson et al., 1999). In Santa Monica, water quality benefits were based on the cost of treating sanitary waste water, while flood control benefits were based on the amount of money spent to control local flooding during a 25-year storm event (Condon & Moriarty 1999). This number is total stormwater benefits, not net benefits. The annual gross value was estimated at US$616,139 for Modesto and US$110,784 for Santa Monica (McPherson and Simpson, 2002).

2.1.4 Investment in urban environmental quality

Taxation

Taxation has been adopted as one of the major strategies for switching to a greener economy. Most directly connected to UGI and urban development are property taxes. These can be used to reduce sprawl and balance pressures on UGI, and lay foundation for future use of neighbouring areas. The impact of these taxes on land use, density and urban sprawl depends on policy choices: what is included and excluded from the tax base, how property value is defined for different classes of property (e.g. residential, multi-residential, farm, commercial and industrial properties), what percentage of the value is taxable, and how effective tax rates vary within and among property classes. Common to such taxes is that land value is taxed more heavily than the buildings on the land.

Reducing the tax burdens on development and redevelopment of urban land could facilitate revitalisation and replacement of obsolete buildings in older central cities. Throughout the OECD, local governments earn the most revenue from property taxes. Housing close to green spaces tends to attract wealthier residents, which in turn increase the tax base. This may seem desirable but is also driving or reinforcing inequalities.

Green accounting

There are many methods available to calculate the value of benefits related to UGI, and surrounding costs, so that they can be included in urban decision-making processes. Several authors have advanced frameworks to this effect, separately looking at the effects of individual projects and broad changes in urban design (Horwood, 2011; UNEP, 2012; Vandermeulen et al., 2011). At the specific level of individual services provided by UGI and typical human-made capital, one can use impact and cost calculation methods such as life cycle assessment and life cycle costing (Wang et al., 2013). To inform decision-makers about the benefits and costs of UGI development and maintenance, Natural England collected microeconomic evidence of benefits related to UGI or green and blue space in general (Rolls and Sunderland, 2014). This report features numerous examples of economic calculations of benefits related to environmental conservation and restoration activities. When considering the broader context of costs and benefits related to urban green space use, one should not underestimate the indirect environmental effects. Management practices themselves come with trade-offs (causing disturbance, emissions, needs in terms of equipment and hence the manufacturing of equipment, etc.), and the use of many ecosystem services provided by UGI is supported by a host of supplementary goods and services with their own environmental impacts (e.g. travel costs and emissions, equipment, infrastructure) (Kronenberg, 2014).

Non-state financing

Given the numerous aims, objectives and actors involved in green economy initiatives a wide range of possible financing sources at different levels may be used alone or in combination with one another for supporting UGI projects, from awareness-raising to stakeholder involvement and hands-on implementation. Public funds are increasingly limited, making it highly desirable for the private sector to play a stronger role in financing UGI. Merk et al. (2012) identified three tools which can be utilized to enable increased private sector involvement: 1) creation of a market (such as the carbon market/carbon financing); 2) introduction of regulative instruments; and

3) corporate social responsibility (CSR). Along with these Merk et al. (ibid) listed a set of existing or potential funding sources: existing partnerships between NGOs and industry (e.g. via CSR and stronger references to the importance of green infrastructure), Public Private Partnerships (PPPs), versions of the "polluter pays principle", Payments for Ecosystem Services (PES), biodiversity offsets and compensation schemes, the introduction of a "green infrastructure benefits tax", which should be paid by the users of green infrastructure benefits (such as tourists), and revolving loans – loans provided by the private sector to cover the high costs that arise at the beginning of a project and can be paid back over the project's lifespan, as benefits accrue.

In addition, costs associated with UGI can be carried more directly by local businesses, for example via business improvement districts (BIDs). Introduced in Ontario, Canada, BIDs have been in use in Europe and the USA since the 1960s. This mechanism facilitates financing and managing improvements to commercial and industrial environments based on the agreement by a majority of businesses (either land owners or tenants) who accept an additional levy. Once a district is established, revenue is available through long-term commitment to capital investment. More examples of how companies can be involved in urban greening are featured in Box 4 on fundraising.

Box 4. Fundraising

Insufficient funds or inappropriate fund distribution are important barriers to preventing urban greening (Kronenberg, 2015). Many innovative UGI funding mechanisms have been developed worldwide, and they can serve as inspiration for other cities and communities. Perhaps the largest diversity and the scale of use of fundraising mechanisms can be found in the USA, where public funds available for public purposes are relatively scarce. Examples of fundraising mechanisms include:

- charity events – on the occasion of balls, galas, award ceremonies etc.;
- charity events – undertaken by organizations or individuals who perform something special to attract attention and funds to a special cause, such as runs, expeditions, taking part in sports events etc.;
- sponsorship – either ad hoc or through long-term collaborations;
- "adoption" of trees or green spaces by companies, institutions and private individuals (see the case study from Oradea, Romania, presented in the end of this box);
- selling contribution certificates that confirm participation in achieving the important social or environmental goal, such as planting urban trees;
- mandatory financing for green infrastructure in urban areas by shopping malls and other companies whose activity contributes to air pollution from emissions of delivery and customer vehicles (such an obligation already exists in several countries, e.g. the USA);
- the so-called "rain tax" paid by real estate administrators based on the volume of surface runoff from their property.

The below list of specific and innovative UGI funding programs reflects the diversity of approaches followed to reduce reliance on public funds for nature preservation in cities, and to increase the share of expenses covered with private funds (Bergier et al., 2013).

- The Heritage Lottery Fund was launched by UK Parliament in 1994 in order to give grants to a wide range of projects that focus on the local, regional and national heritage of the United Kingdom. This includes parks, especially heritage parks, in particular through two programmes established to support "green heritage": "The Landscape Partnerships" and "Parks for People".
- Canopy (www.canopy.org) provides an example of a foundation that carries out multiple fundraising activities in Palo Alto and East Palo Alto: fundraising events, individual contributions, matching grants (within which employers increase donations made by their employees), creating opportunities for community members to support the initiatives.
- In a similar vein, the Toronto Parks and Trees Foundation (www.torontoparksandtrees.org) is a charity dedicated to the promotion of philanthropy, corporate support and community involvement, including an annual fundraising event called Green Tie.
- The University Botanic Garden in Balchik, owned by Sofia University in Bulgaria, is open to the public and collects a small entrance fee from visitors. The garden is also available for hire for weddings, concerts and exhibitions.
- Parks Charge collected from domestic, commercial and industrial properties is a primary source of funding for metropolitan parks in Melbourne (Australia) – this charge is collected once a year and it is included in the water, sewerage and drainage bills of residential and commercial properties and the level of payment depends on property value.
- Rental and leasing of shops, cafés and restaurants provide additional sources of revenue for Mile End Park in London (UK) – shop and café owners are aware that customers tend to spend more money and time in places located in green spaces and are thus willing to pay even higher rents for attractive locations.
- Local authorities in the state of New Jersey, USA have established a special tax, which generates revenues that are used for the purpose of maintenance of public spaces. The property tax level is based on the estimated property value.

Adoption of green spaces by companies in Oradea, Romania

This is a case study from a Tier 1 city analysed within GREEN SURGE Work Package 6 (developed by Éva Gerőházi) – for more detail, see GREEN SURGE Deliverable 6.2: Report on success and failure of governance arrangements across urban Europe, based upon our assessment framework:

"In 2009 the municipality of Oradea decided to follow the experience of some other Romanian cities in letting some smaller green spaces being 'adopted' by private companies. Companies contract with the municipality for one year (that can be extended) on developing and maintaining smaller pieces of green spaces and they are entitled to place their 'name cards' into them. By this means the marginal public spaces are kept in a good condition (thus public expenses are saved), on the other hand the companies obtain a unique opportunity to promote themselves. The demand for such green spaces has increased substantially, currently the companies are queuing for acquiring new places, but there are no more available lands in the project framework. By now 56 pieces of green space were 'adopted', out of which 18 are roundabouts. This practice of the local municipality somewhat fits to the overall policy framework represented by the local decree of 2009 on the development and maintenance of public green spaces in Oradea. According to this decree the land around the premises of different actors (home owners' association, NGOs, institutions, companies) can be managed by the private actors themselves based on a contract between the municipality and the private actors. The municipality is basically responsible for the development of the green area (if it is required) and the private actor is responsible for the management of it."

Non-monetary investment

Volunteerism, social entrepreneurship or different kinds of public-private agreements can by-pass the normal financial set up for green space maintenance. For example, time banks focus on rebuilding the social economy (including strengthening neighbourhood support networks), rather than the conventional economy, and reward time spent participating in voluntary activities in the community, such as green space management activities. Similar initiatives go under different names, e.g. monetary localism (Blanc, 2002) or community currencies (Kubičková et al., 2012; Seyfang, 2004), all referring to the adoption of own means of payment at the local level. Such local currency systems provide a complementary medium of exchange to mobilise informal mutual support, by allowing members to trade goods and services among themselves without using cash, and they represent an attempt by localities to re-claim control over their economies and their neighbourhoods, sometimes offering an alternative development path (Pacione, 1999; Seyfang, 2001). Local development projects featured within such systems often involve urban greening and gardening.

2.2 Scaled to need, the failure of bundles of services

Green economy offers a way of rethinking the financing for UGI, as described in section 3.1, but taking the step from UGI to urban ecosystem services and multifunctionality will need further attention. The connection between investment in UGI and urban ecosystem services may suffer from a problem of scale. Many of the services come from interconnected green spaces, infrastructure, and not from individual sites or green spaces alone (Andersson et al. 2015; also exemplified in Box 3 and further described in GREEN SURGE Deliverable 4.2). However, investment – and often ownership – is usually at the scale of an individual site. Many ecosystem services will need strategic investment in a comprehensively planned UGI and beyond the state there are few actors who act, or at least invest, on the larger scale. Ensuring multifunctionality based on multiple ecosystem services will require coordination of actors and resources. Failure to see interdependencies and to recognize multiple values may lead to inadvertent loss of public goods services where only local ecosystem services are promoted. As discussed in GREEN SURGE Deliverable 4.2, the actual value of a specific site is usually a combination of factors and qualities, and the total value of these is non-linear. For example, the loss of a nearby café may cause some people to stop using a park despite the park remaining the same. Understanding that there are thresholds, and that changes at scales larger than the site itself and among qualities may be a first step for different investors to start to collaborate. Also, a focus on ecosystem services more strongly connected to the infrastructure scale rather than the green space scale will help identify new needs, and possibly new actors, within UGI planning and governance. For example, and as described in Box 3, effective stormwater management is best done at the infrastructure scale where all steps in the source flow and recipient chain can be addressed. Green economy can help restructure economic arrangements for UGI and ecosystem service maintenance. To do this, scale issues need to be considered and the actors that could or should be involved need to be identified.

3 ACTORS AND ROLES CONNECTED TO UGI ECONOMY

3.1 Combining benefits from different components of green space, the value of mosaics

Ideally, engagement with UGI and ecosystem services should address two questions. The first is: What can be done locally? Traditionally, many initiatives and landowners have focused on the internal qualities of different green spaces, the linkages between green space type and quality and the resultant ecosystem services and benefits. However, some ecosystem services will rely on species that require easy access to two or more habitat types (Blitzer et al., 2012), or human access to more than one single area (e.g. long distance running, cycling). Also, actual realization of the potential ecosystem services inherent in different types of green space may be highly context dependent (Andersson et al., 2015). These concerns raise the second question: What kind of landscape and UGI composition will support the local production of ecosystem services? The understanding of landscapes as multifunctional, providing their inhabitants with multiple ecosystem services, has seen considerable progress in the last decade. The backbone to this provisioning in urban areas is UGI and its different components. Urban landscape mosaics are often characterized by small land use patches and high heterogeneity where UGI and other types of infrastructure and built-up areas intermix. Studies in spatial ecology have suggested that spatial structure becomes especially important when for example a certain type of green space drops below a threshold level coverage (e.g. Andrén, 1994). This makes spatial structure and connectivity key concerns in most cities. Moreover, the complex character of urban mosaics means multiple potential pairings and types of boundaries between different land-uses (e.g. Colding, 2007; Gomez-Baggethun et al., 2013), highlighting the need for coordination, collaboration and dialogues about values. As many of the benefits of UGI only been realised by the combination of land-uses, ownerships and infrastructure junctions, there is both a challenge for planning and an opportunity (possibly even mandate) for more actors to engage in UGI governance rather than simply green space management. Engagement with ecosystem services in complex urban landscapes requires a thorough understanding of the origins of the services and their spatial distribution as well as a detailed understanding of the politics, rights and physical limits to access to said services (see e.g. Brandt and Vejre, 2003).

Part of this complicated process is reaching a better understanding not just of the functional properties and interrelations between different green spaces, but also the actors involved in creating and maintaining UGIs – their roles, motivations and spatial distribution. This chapter will present an overview of green space types, presented as UGI components, and the different actors engaged with and creating an economy around UGI.

3.2 The GREEN SURGE UGI typology

UGI is something more than just the aggregation of UGSs. Well-designed, well-managed, and interconnected green spaces are integral to the UGI approach taken within GREEN SURGE. Whilst UGI is often addressed in policy, marketing and economic assessments of value or business opportunities, the actual composition is rarely described or analysed in detail. Green spaces are very diverse, ranging from city parks to green walls and rooftop gardens, from urban forests to allotment gardens. These will depend on different financing, offer different green job opportunities, and different incentive programmes and policy interventions. Because of this diversity, a it is important to understand how green spaces can be functionally connected with each other as

well as with the built environment, thus meeting the criteria for UGI. Accordingly, one of the tasks within GREEN SURGE was to create a typology for UGI and its constituent parts (see GREEN SURGE Deliverable 3.1 for a full description).

In GREEN SURGE Milestone 23, existing inventories of UGSs were combined and refined through a series of internal project meetings and discussions to finally reach the typology presented in GREEN SURGE Deliverable 3.1. While it is unlikely that any one typology can cover all the peculiarities that exist in European cities due to their natural conditions (geomorphological, climatic, biological), historical backgrounds and social demand, the GREEN SURGE typology includes all UGS considered relevant for GREEN SURGE and particularly for assessing the functional linkages between UGI on the one hand and ecosystem services and biodiversity on the other. In addition, no inventory can be final – social initiatives, technological progress, environmental awareness and creativity of city planners, urban dwellers and others perpetually lead to new types of UGS (e.g., community gardens, rooftop gardens, rain gardens, bioswales, constructed wetlands but also mobile backyard gardens or different forms of guerrilla gardening).

A detailed typology will also help in identifying the stakeholders associated with different parts of the UGI, the activities they are involved in, and what their stake is. Maintenance of UGI and associated ecosystem services will be a joint endeavour between many actors and understanding their different roles and interests is one step towards promoting more interconnected UGI. As we will demonstrate, cities differ in their needs and the types of economy set up around UGI. We use the typology and our preliminary insights about its connection to green economy to outline a way of approaching this diversity, so that we can begin to ask questions rather than merely provide generic answers. GREEN SURGE Deliverable 3.1 includes UGI assessments at two different scale levels, which can indicate some of the main differences in focus for UGI, outlined briefly below.

3.2.1 Summary of the GREEN SURGE UGI typology and inventory

The GREEN SURGE UGI typology is based on a review of existing inventories and general literature on urban green spaces, internal project meetings and discussions about how to group and classify different objects, and finally the comments received on a draft circulated within the project. Moreover, several revisions of the database prepared for GREEN SURGE Milestone 23 were included in the final typology presented in GREEN SURGE Deliverable 3.1. Thus, the inventory reflects the needs of GREEN SURGE but can also serve outside needs. The typology is linked to Urban Atlas and Corine land use/land cover, and can thus bridge scales from regional to local. It also supports cross-city comparisons. The typology includes green, partly green and grey as well as blue spaces (waters, wetlands). It also includes several types of green space not usually considered urban, but which can be located close to the city or even within the city itself (like arable land, forests, grasslands, sparsely vegetated areas). Thus, the inventory can also be applied to larger urban regions.

GREEN SURGE Deliverable 3.1 also includes assessments of UGI, availability as well as demand, at two scale levels. At the European scale land use data (land cover data) and demographic data were used to parameterise statistical and GIS models. Land cover data were generated from the European Urban Atlas land cover dataset obtained from (EEA 2010). The data in the Urban Atlas

refer to 301 larger urban zones, which in turn refer to an approximation of commuting zones around cities. Urban Atlas data are based on satellite images with a 2.5 m spatial resolution and provides comparable land use data for all of the European core cities (more than 100,000 inhabitants). The analyses in GREEN SURGE Milestone 23 and GREEN SURGE Deliverable 3.1 focused exclusively on the core cities, which were cities delineated using the administrative city boundaries used to define the core city layer in the Urban Audit (European Commission, 2004). For the ULLs the same analyses were also run at the district level, revealing within- as well as between-city differences. For example, in Berlin districts situated near the city border have higher shares of urban green and notably forest areas, as in the southwest of the city. Accordingly, per capita values are high in these districts. By comparison, the map of the population density shows that density is highest in inner city areas.

In this report we combine the list of UGI elements with information on the economies set up around them; the actors, resources, requirements and how and when these come together in a thought-through approach to UGI planning and management.

3.2.2 Actors and roles

Using publicly available information from the UK we demonstrate some of the ways that different actors may be involved with UGI, using a range of specific examples and including a tentative designation in terms of the GREEN SURGE UGI typology (Table 1). The actor-categories are:

- ***Public authorities;***
- ***Partnerships;***
- ***Business/corporate;***
- ***Investors/funders;***
- ***NGOs;***
- ***Churches;***
- ***Private individuals.***

Our list of actors involved in the economy around UGI is slightly different from the list of actors presented in GREEN SURGE Deliverable 6.1 and we will return to why this is the case in chapter 5. To understand how actors may be involved with UGI, we identify their roles in relation to UGI components. Specific actors' roles vary depending on the capacity in which they are involved in UGI projects, and there is significant crossover between actor-categories and their roles. Moreover, it is not always clear what role actors assume, which suggests a need for further research. However, roles broadly fit into seven categories:

- ***Promotion/advocacy/campaigning;***
- ***Knowledge dissemination;***
- ***Expertise/research/consulting;***
- ***Policy/planning;***
- ***Investment/funding/grant allocation;***
- ***Design/installation/supply;***
- ***Ownership/management/maintenance.***

Table 1: List of actors, specifying sector, role and primary interest in terms of UGI components. The list is exemplified with actors from the UK.

	Actor	Roles	UGI component(s)
Public authorities	Central Scotland Green Network	Planning strategy, grant allocation, advocacy	UGI mosaic
	All London Green Grid	Promoting design and delivery of UGI	UGI mosaic
	Bristol City Council	Owner and manager of parks	Urban parks
	The Landscape Institute	Advocacy, planning, design, management	Various UGI
	Sheffield City Council Trees	Tree monitoring and management	Street trees
	Royal Botanic Garden Edinburgh	Garden management, plant collection, education	Botanic garden
	The City of London Cemetery and Crematorium	Ownership, management and maintenance	Cemetery
	Wild West End project, landowner partnership	Owner, investor, project coordinator	Green corridor
Partnerships	Victoria Business Improvement District	Investor, project coordinator, UGI research	UGI mosaic
	Red Rose Forest PPP	Campaigning, development, management	UGI mosaic
	Walthamstow Wetlands Public partnership	Maintenance (current wetland development)	Urban wetlands
	Cross River Partnership (PPP)	London regeneration projects, funder, developer	UGI mosaics
	The Green Infrastructure Partnership	Knowledge-sharing and policy guidance	All UGI
	Urban Regeneration and Greenspace Partnership	Advocacy, UGI information dissemination	All UGI

	Actor	Roles	UGI component(s)
Business/ corporate	Arup Consultancy	Architecture, planning, technical design services, expertise	Various, usually large, standalone projects
	Ethos Environmental Planning	Green space consultation, GIS surveys, habitat surveys, expertise	Various, institutional green space, green sports facilities
	Tyréns UK	Large-scale infrastructure, landscape architecture, planning, expertise	UGI associated with large-scale urban projects
	Green Infrastructure Consultancy	Planning, design, specification and supervision, GIS surveys, expertise	Living walls, green roofs, rain gardens
	The Ecology Consultancy	Green roof and wall designs, GI audits, ecological appraisals, expertise	Various, including green roofs, walls
	The Next Field	Green space strategy, planning, management, expertise	Public parks, other open green spaces
	Nigel Dunnett	Academic research, design and consultation, expertise	Green roofs, rain gardens, pictorial meadows, bioswales
	Morgan Sindall Group	Large-scale construction and regeneration	Large-scale UGI
	Alumasc Exterior Building Products	Green roof installation	Green roofs
	Thompsons Plant and Garden Centre	Supplies plants, equipment, knowledge and support	Plants
	OCS Group	Vegetation management, grounds maintenance and landscaping	Commercial, industrial, institutional green space
	The Landscape Group	Large-scale arboriculture, landscaping and maintenance	Public-access UGI – parks, cemeteries, institutional green space
	Eden Landscape Gardening	Design, installation and maintenance	House gardens
	Tree Box	Living wall designers and suppliers	Intensive and extensive green walls
	Bedford Estates, London	Owner and manager of restricted-access gardens	Private garden squares

	Actor	Roles	UGI component(s)
Investors/ funders	Private institutional investors	Green bond investment	Unclear – geared toward large-scale renewables
	Green Investment Bank	Funding of green initiatives	Some green space investment, geared toward large-scale renewables
	Heritage Lottery Fund	Advocate and funder of heritage	UGI associated with natural heritage, e.g. historical parks, gardens
	John Laing Group	PPP funding of public infrastructure (private funds)	Green space associated with major public infrastructure
	Church Urban Fund	Church of England funding body	Wildlife and Green Spaces projects
NGOs	UK Green Building Council	Campaigning, research, expert advice	Various UGI, focus on lowering carbon footprint
	Design Council Cabe	Sustainability advocates and architectural design consultants	UGI associated with sustainable architecture
	Neighbourhoods Green	UGI advocate	Residential green space, focus on vulnerable communities
	Groundwork	Social wellbeing and green space projects	UGI associated with community wellbeing
	Royal Horticultural Society volunteer schemes	Schemes supporting volunteer-led community gardening	Small-scale urban gardens, street trees, hedges, flower beds
	Friends of Nunhead Cemetery	Promotes conservation and appreciation of the cemetery	Cemetery
	The Green Flag Award Scheme	National standard for parks and green spaces in the UK	Parks and other public access green spaces
Churches	Saint Michael's Catholic Cemetery, Sheffield	Grounds maintenance using contractors	Churchyard and cemetery
	Arnos Vale Cemetery Trust, Bristol	Grounds maintenance partially by staff, contractors for large-scale operations	Cemetery
	Greyfriars Kirk, Edinburgh	Maintenance by contractors	Churchyard and cemetery
Private individuals	Private homeowner/tenant	Mostly self installation and maintenance, some contracting	Gardens, balcony greens, green walls, green roofs, atriums
	Local resident	Local participation, advocacy, park use, allotment leasing, guerrilla gardening	Allotment/community gardens, street green, green verge

Actors and roles intersect in multiple and complex ways. The nexus between advocacy and policy provides space for projects and partnerships to emerge, and policy frameworks provide a key setting. For example, a green corridor project has been launched in London, dubbed "Wild West End," which is being developed by property owners The Crown Estate, Grosvenor Britain & Ireland, Shaftesbury, the Howard de Walden Estate and The Portman Estate. This industry partnership will create a network of green spaces linking existing parks, and is enabled by London policies promoting green infrastructure. The project is supported by the Mayor of London and the London Wildlife Trust, and is being advised by Arup consultancy, with specialist contractors for construction. In this case, the intersection between policy, advocacy and expertise provides a setting for the private sector to undertake a comprehensive UGI project (see section 3.3 below for further discussion on creating incentives to promote collaboration and 3.4 on business taking the lead).

Similarly, though on a smaller scale, most cemeteries in the UK contract out landscaping and arboriculture. Being publicly accessible spaces, they fall under national and local health and safety policies and so cemetery owners must hire accredited contractors to carry out works (also in order to avoid liability). This applies to local authorities themselves, and accredited contractors must tend street trees and parks. Regional policy settings, combined with advocacy initiatives like the Red Rose Forest in Manchester, which develops and promotes green urban landscapes, provides opportunities for consultants and contractors specialising in UGI. It should be noted that local authorities undertake most planning work in the UK (fitting with the European planning family typology set out in GREEN SURGE Milestone 34) and this will differ significantly in other parts of Europe.

Advocacy also creates opportunities, and in the UK we see many different actors taking on this role. NGOs though, like the UK Green Building Council, are the most important group, driving projects and creating awareness. Due to their heterogeneous nature, NGOs perform a wide range of functions, often acting as advocates and information disseminators, but also owners, managers and investors. Financial investment is another role that can be performed by a variety of actors but is harder to identify, suggesting a need for further research. Those financial institutions whose specific remit is sustainable development, like the Green Investment Bank, have the potential to invest in UGI but focus mainly on large-scale renewables like wind farms (which we mention in Chapter 5 on knowledge gaps and future directions). Other large, institutional investors seem not to show an interest in investing in anything other than green bonds, which are seldom linked to UGI. It can be stated, certainly in the case of the UK, that the bulk of actors benefiting financially from UGI are consultants, architects, developers and contractors, as demonstrated by the list of SME partners involved in the GREEN SURGE project. Consultants are a particularly important and diverse group (see Box 5 below).

Box 5. Consultants

Consultants take diverse approaches to UGI and cater to different needs. Many consultants are actively engaged in activities that connect to green economy as it has been described in this report. The SME partners of GREEN SURGE serve well as an example of the diversity among such companies and the many different entry points for exploring different opportunities to engage with UGI and green economy.

Consultant SMEs (excluding non-profit organisations) within GREEN SURGE

Name	Type of enterprise	Point of intervention	Services offered
C-O-M-B-I-N-E Arkitekter AB	Landscape architecture and urban planning	Planning phase	Urban, landscape and interior design
Ecometrica Ltd	Software developer	Pre-planning and planning phase	Measuring environmental impacts, from carbon, energy and health & safety management all the way through to full supply chain accounting
TISAdoo	Forestry	Management phase	Tree pruning and planting, milling stumps and bushes, biowaste—wood chipping and mulch; urban tree removal
Seebauer, Wefers und Partner GBR	Landscape architecture and urban planning	Planning and development phase	Execution of tasks in the whole field of landscape architecture, landscape planning and urban planning, at all scales
Metropolitan Research Institute Ltd	Urban development, transport, municipal financing, housing policy, social inclusion	Financing, pre-planning, planning, and assessment phase	Inner city regeneration, the problems of large housing estates, urban sprawl, municipal budgeting, urban mobility issues
Profin Service	Financial planning consultant	Financing and marketing phase	Program and project management, financial planning for investment projects that use government funds, business and marketing consulting
Triple E	Financing and planning consultant, communication	Financing, pre-planning, planning, development and assessment phase	Consulting on green space management and governance, as well as on broader environmental protection issues, managing a green space and a cafe (The company is no longer active.)

Box 6. SavATree Consulting Group

SavATree Consulting Group is a US company that presents its focus areas of activity as "Tree Preservation, Planning and Consulting". As the name indicates, the company is at the forefront of arborist services. Its environmental policy, established in 1985, indicates that the company "proudly provides stewardship for over 50,000 properties throughout the Northeast, Mid-Atlantic and Mid-West regions, promoting a sustainable landscape and the unique relationship between people and their surroundings". Alongside broad environmental objectives, the company also declares that it "adheres to Integrated Pest Management (IPM) procedures and promotes cultural, biological and organic program options," and that it "manages land, water, and timber resources in an environmentally sensitive manner". These declarations go beyond what is typically done by other companies offering arborist services, the name obliges. SavATree employees are actively involved in research on urban ecosystem services, and in particular on the importance of urban trees.

The specific services offered by the SavATree Consulting Group include:

- tree inventories;
- landscape evaluation (with a focus on trees, shrubs and plantings);
- tree risk assessments;
- multi-year plans (large-scale landscape architecture projects);
- tree preservation planning during construction at all stages of construction projects;
- tree appraisal (estimating the monetary value of trees for the purposes of property valuation and other business and legal reasons);
- development of bid specifications on behalf of the clients.

Such a comprehensive offer and a focus on environmental responsibility and tree preservation is what differentiates the SavATree Consulting Group from most other companies operating in this market. The company runs its own environmental education program focusing on why and how to manage and protect trees. When presenting the rationale for such activities, the company does not only focus on practical benefits (such as increased property value achieved because of trees), but also on less tangible spiritual, community, and ecological values. The company also understands its own dependence on a healthy urban forest.

SAVATREE®
The Consulting Group

http://www.savatree.com/tree-preservation-about.html.

3.3 Incentives for companies to engage, and modes of engagement (partnerships, contracts, internal)

Urban greening projects are largely implemented by public institutions (Moran, 2007), though an increasing number of community initiatives contribute to greening their neighbourhoods (Krasny et al., 2014). Some researchers observe that companies are also getting involved in such urban environmental management activities more often than in the past (c.f. Moran, 2007). This

is principally so because of the global trend towards privatization and outsourcing of public tasks (Schoenberger, 2003). Having said this, it is also worth noting that there is a contrary trend towards returning of some public services to municipal control by some local governments who have decided that public benefits should rather remain at the discretion of the public authority (Kishimoto et al., 2015).

In line with the dominant trend to engage companies, local authorities create various incentives that are meant to enhance collaboration. The simplest of these refer to creating favourable and flexible approach within the local authority. Working with companies requires some flexibility with regard to how various rules are interpreted. A case study from Lodz, Poland (one of the GREEN SURGE Tier 1 cities) demonstrated such a flexible governance approach for the purposes of Work Package 6 (for more information, see GREEN SURGE Deliverable 6.2). A company that built a new residential estate next to a park suggested that it would like to rehabilitate part of the park adjacent to the estate as compensation for the trees removed from the area where the residence was built. A standard solution would be to plant trees in a quantity agreed with the municipality and in a location indicated by the municipality. Here, the authorities demonstrated a flexible approach and saw benefit in the developer's initiative to use the funds for this specific purpose. As a result a partnership was established through which the developer rehabilitated part of the public park for which the local authorities had no financial resources. Similarly, and often on a larger scale, various public-private partnerships are established to manage urban green spaces in cases within which private investors can see some benefits for themselves.

Local authorities can create financial mechanisms that support private initiatives in the area of urban greening, such as subsidy schemes for greening courtyards or other premises. However, they can also provide information on the importance of maintaining green spaces – as information may also serve as an important incentive. For example, local authorities in London provided incentives for the owners of private gardens to protect those gardens against sealing and other forms of degradation. Information was the most important argument used in this campaign. This campaign's aim was to transform the city's 3.3 million gardens into a "network of mini nature reserves," providing habitat for wildlife and ultimately making London more resilient to climate change.

Payments for ecosystem services (PES) constitute a special type of financial incentives, within which the buyers of ecosystem services pay ecosystem service providers (ecosystem managers) to ensure that they manage ecosystems in a way that maximizes the delivery of the service in question. One of the best known business PES schemes in which business was involved is the case of protecting clean water resources by Vittel (Perrot-Maitre, 2006). In this case the mineral water bottling company created incentives for other stakeholders (local farmers) to protect water resources on which its business activity depended.

Still other incentives include land swaps and various compensation schemes within which companies (and other land owners) are offered alternative plots of land or financial compensation if they do not intend to manage a certain area in line with the requirements of the local authorities. Clearly, when new rules are introduced, e.g. new plans to green an area, landowners should have an opportunity to opt-out. However, keeping the land and conforming to the new regulations should also be associated with the relevant incentives. Such set of incentives was introduced by

The City Council of Aarhus which decided to protect certain areas to ensure access to clean drinking water for the future inhabitants. Land owners were offered opportunities to swap land and also financial and organizational incentives to manage their land in line with the City Council's new regulations. This case study has been developed by Maja Steen Møller within GREEN SURGE Work Package 6 (Tier 2) – for more detail, see GREEN SURGE Deliverable 6.2.

Green public procurement provides a similar incentive, whereby the local authorities commit to purchase goods and services from suppliers that meet selected environmental criteria. These criteria may include urban green space management.

Alternatively, local, regional, national and even international authorities may organise competitions or various award schemes, which are meant to spur competitive spirit among local stakeholders. On an international level, examples include:

- ***The European Green Capital Award – a competition run by the European Commission for cities making a contribution to broadly defined environmental protection;***
- ***European Capital of Biodiversity – a competition organized by Deutsche Umwelthilfe in cooperation with ICLEI and IUCN;***
- ***Entente Florale for the greenest and most floral European town;***
- ***Tree City competition in the USA;***
- ***The growing number of other awards and contests in individual countries.***

Each of the above schemes creates opportunities for inter-sectoral collaborations, and for local authorities competing for a title to involve other stakeholders. An incentive to act for a local authority translates into further incentives for other stakeholders, including companies, neighbourhoods and local communities.

For some companies, information about increased price of a property may also serve as a convincing argument for undertaking urban greening activities. Indeed, benefits from public green spaces translate into various financial benefits (or cash flows) for certain businesses, such as cafes and restaurants located in the green space's vicinity (see GREEN SURGE Deliverable 4.2).

Finally, many leaders from the business sector assume roles that span beyond their companies and most apparent economic interests, and such visionary leaders are also able to involve others. In such cases, personal interests and ambitions serve as the most important incentives and external incentives are not necessary to make them take action in the area of urban greening (and sustainability, more broadly).

3.4 Business taking the lead in thinking big: connecting initiatives at larger spatial scales to create coordinated UGI

Business-led initiatives addressing larger areas or patchwork structures of ownership or land uses are rare, although business are often partners in initiatives led, in Europe, primarily by local to national governments. There is, however, space for industry collaboration, and sometimes these focus on greening and UGI development. One such collaborative entity is the business improvement district (BID), common in North America and increasingly adopted in Europe (mentioned already in section 2.1.4 in the context of non-state financing of UGI). There are more than

1500 BIDs across the world today, including over 200 formal BIDs in the UK and Ireland.[1] BIDs focus on a range of issues, depending on what is important to their local area and business members. As described in GREEN SURGE Deliverable 4.2, BIDs are club neighbourhoods, privately owned areas with specific and potentially exclusionary rights. Greening initiatives often serve the public good but are primarily motivated by increased value return to the owners and investors. BIDs are based on the agreement by a majority of businesses (either land owners or tenants) to pay an additional levy. Once a district is established, revenue is available through long-term commitment to capital investment.

British BIDs reported that the total BID levy income across the UK and Ireland as at 1 April 2014 was £63 million with an additional £130.3 million raised from other sources (British BIDs, 2014). The report shows that BIDs have been successful in attracting other funding, not least through different partnerships, to supplement the BID levy. Particularly in London, BIDs together with the local government have been very active in developing and improving UGI. This work has been guided by a scheme of green audits, pioneered by Victoria (Victoria Business Improvement District, 2013), designed to highlight and improve environmental quality and ecosystem services.

Other kinds of club organisations include the homeowners' associations that govern what are known in the USA as 'common interest developments' (CIDs), and other iterations such as commonhold tenure organisations or cooperatives. CIDs with home owner association governments are typically set up as companies, under company law, where neighbourhood home owners are shareholders of a company that owns, manages and finances collective facilities and services, such as refuse removal, road maintenance, parks and schools (Webster, 2010). Flat owners in a commonhold association have an undivided joint share of the common property and facilities, bundled into the title deeds of their individual homes, while in a co-op the collective entity owns the individual homes as well as the common areas (ibid).

[1] www.britishbids.info, accessed 2015-09-29

4 AN INTEGRATIVE EXAMPLE: RESTORING URBAN FORESTS

4.1 Introduction

The case study of urban ecosystem restoration provides a cross-cutting example of integrating green space ecosystem services into real economies that links many of the issues presented in the previous chapters. Perhaps the most important aspect it highlights is that of insurance value – investment in ecosystem restoration provides urban inhabitants with an insurance against various risks related to external and internal disturbances (such as climate change). This indicates that restoring and conserving urban ecosystems may be economically efficient, and can be studied through the lens of avoided costs. At the same time, ecosystem restoration creates new opportunities to enhance urban attractiveness and quality of life, and in some cases it may also contribute to the development of tourism and sense of place. Urban ecosystem restoration may also help alleviate poverty and solve social problems by creating opportunities for all inhabitants to get involved in restoration projects and to benefit from their results. With such a wide range of potential benefits and beneficiaries, ecosystem restoration offers ample opportunities and arguments for monetary and non-monetary investment. The roles that different actors play in urban ecosystem restoration are diverse, and a range of types of UGI can be subject to restoration, offering opportunities for the involvement of multiple actors. The largest sectors within restoration work are 1) planning, design, and engineering activities and 2) physical restoration—the actual earth moving and site construction, which also involve the suppliers of suitable plant material (catering to many different needs in terms of ecosystem types, local gene pools, tolerance to poor soils and unfavourable conditions). A recent study estimated that the overall economy of restoration activities supports approximately 221,000 jobs in the US, spread out across various industry sectors (BenDor et al., 2015), including the direct, indirect and induced effects (see also BenDor et al., 2015 for a list of the major actors/industries involved).

Having generally outlined above the current status of ecosystem restoration in the context of green economy, we nevertheless acknowledge (as in section 2.2) that a comprehensive view on ecosystem restoration is rare. Most research carried out so far, which we have collected here for the purposes of illustration, focuses on selected types of ecosystems (such as forests) and features only a limited selection of their services (such as carbon sequestration, pollution removal and stormwater reduction). As a result, this example still lacks a fully integrated perspective and illustrates well the failure hitherto to recognize and consider bundles of ecosystem services.

4.2 Benefits of restoring urban forests and associated ecosystem services

In spite of the above long list of economic benefits related to green infrastructure, ecosystem restoration or preservation is often seen as a cost. In cities, which are important nodes of human activity and which are often perceived as centres of economic growth, such activities are particularly unwelcome, at least by some conservative stakeholders. This is because of the seemingly high opportunity cost, i.e. larger potential benefits that could be gained by alternative forms of land use. At the same time, with rapid ongoing urbanization, cities encroach on new green spaces while leaving other spaces idle (especially in the case of shrinking cities and derelict brownfields).

Research in the area of restoration ecology, as well as applied ecology, ecological engineering and many related fields, including recent nature-based solutions, indicates that there are many opportunities to combine urban development with restoration of degraded ecosystems. Even

from the point of view of traditional discussions about urban management, and even using conservative estimates of the most evident values of urban ecosystem services, restoration pays. However, as the benefits of ecosystem restoration extend far beyond those most evident values, the gains are far greater than these conservative estimates.

Here we summarize a recent paper, where we collected evidence on the costs and benefits of urban forestry conservation and restoration projects carried out in 25 urban areas in the USA (20), Canada (1), and China (4) (Elmqvist et al., 2015). Our results indicate that investing in green infrastructure in cities, and the ecological restoration and rehabilitation of ecosystems, such as rivers, lakes, and woodlands occurring in urban areas, may not only be ecologically and socially desirable, but also quite often, economically advantageous, even by the standards of most traditional economic approaches. Indeed, several other recent studies have also highlighted the importance of designing, creating and restoring ecological processes, functions, and services in urban areas (Benayas et al., 2009; Pataki et al., 2011). A very recent study from the USA indicated that the economic benefits of ecosystem services provided by constructed wetlands in Florida outweigh the cost of maintenance by at least two times (Dunne et al., 2015).

The present analysis is based on literature review. We restricted the literature search to studies in which estimates of monetary values of benefits were calculated, based on quantification in biophysical terms (e.g. amounts of C stored/sequestered by trees per hectare per year). The estimates of ecosystem services given in Table 2 are comparable except for those for Beijing, Guangzhou, Hangzhou and Lanzhou (China). The estimates for these Chinese cities are derived from a literature review that was comprised of varying methods used to estimate the value of ecosystem services. The estimates for the remaining cities are based on a standardized data collection and analyses procedure using local field and environmental data. Thus, some differences between estimates for Chinese cities and the remaining cities could be due to differences in methodologies used. Moreover the analysed studies included only five out of many more potentially relevant services generated by urban forest/woodland ecosystems: (1) local pollution removal, (2) carbon sequestration and storage, (3) regulating water flows, (4) climate regulation/cooling effects, and (5) aesthetics, recreation and other amenities.

To standardize values, the values of ecosystem services were first calculated as Local Currency Unit/ha/year using information available in the reviewed articles or finding additional information (by communication with the authors of the original or review publication). Subsequently values were converted into 2013 prices. Finally – when applicable – these latter values were converted into USD using the purchasing power parity-conversion factors. All conversion factors used are based on the World Bank's World Development Indicators database of 2014. Interested readers can find more information on the calculations underlying this overview in the above-mentioned paper (Elmqvist et al., 2015).

Table 2 represents quantification of five services generated in urban woodlands (with variable tree cover): (1) pollution removal (Kg/ha/y), (2) carbon (C) sequestration (tons/ha/y), (3) C-storage (tons/ha/y), (3) storm water reduction (m3/ha/y), and (4) energy savings (kWh/ha/y).

Table 2. Quantification of urban ecosystem services in biophysical units. Amounts presented are per hectare of land area with tree cover (amounts given in parentheses are in units per ha of tree cover).

City or State	Pollution removal *Kg/ha/y*	C seques-tration *Tons/ha/y*	C storage *Tons/ha/y*	Stormwater reduction *m³/ha/y*	Energy savings *kWh/ha/y*	Reference
Beijing	132	-	-	-	1,400	Jim and Chen (2009)
Casper, WY	6.2 (69.9)	0.20 (2.2)	6.2 (69.7)	-	72 (808)	Nowak et al. (2006a)
Chicago, IL	13.5 (74.9)	0.38 (2.1)	10.9 (60.3)	-	317 (1,760)	Nowak et al. (2010a)
Guangzhou	42.4	4.0	25.0	-	14.1	Jim and Chen (2009)
Hangzhou	-	-	-	167	-	Jim and Chen (2009)
Indiana (urban are-as)	13.6 (67.6)	0.59 (2.9)	17.7 (88.0)	-	377 (1,875)	Nowak et al. (2007a)
Kansas (urban areas)	14.6 (104.6)	0.40 (2.8)	10.4 (74.2)	-	253 (1,809)	Nowak et al. (2012c)
Lanzhou	4.1	-	-	-	22.7	Jim and Chen (2009)
Los Angeles, CA	14.7 (71.4)	0.36 (1.8)	9.4 (45.9)	-	653 (3,168)	Nowak et al. (2011)
Minneapolis, MN	18.3 (53.8)	0.53 (1.6)	15 (44.1)	-	1,111 (3,258)	Nowak et al. (2006b)
Modesto, CA	210	18.4	-	390	16.8	McPherson et al. (1999), McPherson and Simpson (1999)
Morgantown, WV	23.4 (59.0)	1.2 (3.1)	34.6 (87.4)	-	1,085 (2,741)	Nowak et al. (2012b)
Nebraska (urban are-as)	32.0 (213.6)	0.40 (2.7)	10 (66.7)	-	455 (3,036)	Nowak et al. (2012c)
New York, NY	19.0 (91.0)	0.48 (2.3)	15.3 (73.3)	-	1,014 (4,851)	Nowak et al. (2007a)
North Dakota (urban are-as)	1.3 (48.3)	0.08 (2.8)	2.1 (77.8)	-	129 (4,768)	Nowak et al. (2012c)
Philadelphia, PA	15.3 (73.5)	0.43 (2.1)	14.1 (67.7)	-	836 (4,020)	Nowak et al. (2007b)
Sacramento, CA	9.3	2.02	66.3	1000	9,800	McPherson (1998), Scott et al. (1998), Xiao et al. (1998), Simpson (1998)

San Francisco, CA	10.7 (66.7)	0.39 (2.4)	14.7 (91.8)	-	-	Nowak et al. (2007c)
Scranton, PA	15.6 (70.9)	0.88 (4.0)	20.3 (92.4)	-	361 (1,639)	Nowak et al. (2010b)
South Dakota (urban areas)	10.3 (60.8)	0.22 (1.3)	5.3 (31.4)	-	237 (1,393)	Nowak et al. (2012c)
Syracuse, NY	15.2 (56.6)	0.77 (2.9)	23.1 (85.9)	-	372 (1,383)	Nowak et al. (2013b)
Tennessee (urban areas)	39.1 (103.6)	1.28 (3.4)	24.4 (64.7)	-	1,843 (4,888)	Nowak et al. (2012a)
Toronto, Canada	29.9 (112.4)	0.73 (2.8)	17.4 (65.3)	-	646 (2,430)	Nowak et al. (2013a)
Washington, DC	23.8 (68.0)	0.92 (2.6)	29.8 (85.2)	-	1,766 (5,045)	Nowak et al. (2006c)
Wisconsin (urban areas)	17.6 (65.8)	1.0 (3.7)	15.3 (57.3)	-	409 (1,530)	Buckelew Cumming et al. (2007)

- = not available.

In Table 3, the benefits provided by urban green space are summarized and the monetary estimates are given as US$/ha/year. In practically all the studies selected for this overview, the monetary values were expressed as economic benefits for the entire city per year. To make the economic benefits comparable between cities, we first calculated the proportion of the green space in the total city area (often given as % canopy cover). To get the value per ha of urban green space per year, we divided the total ecosystem benefit a city derives by the amount (in hectares) of urban green space. In a few cases where the proportion of green space in a given city was not indicated, we approached the authors of the respective studies to provide the missing information (e.g. McPherson and W.Y. Chen, personal comm.). In the case of Chinese cities, all the data (originally given in publications written in Chinese) were obtained from the review by Jim and Chen (Jim and Chen, 2009). Due to the scarcity of data on ecosystem services in urbanized settings it is also possible that benefits of some ecosystem services are overestimated.

Table 3. Average value in US$/ha/y (2013) of selected services provided by urban green spaces.

Service	Average value US$/ha/y*	*Range*
1. Pollution and air quality regulation	647 (n =9)	*60–2,106*
2. Carbon sequestration (annual flow)	395 (n = 5)	*58–702*
Carbon storage (stock value)	3,125 (n = 3)	*1,917–5,178*
3. Stormwater reduction	922 (n = 6)	*615–2,540*
4. Energy savings/ temperature regulation	1,412 (n = 4)	*34–1,908*
5. Recreation & other amenity services	6,325 (n =2)	*2,133–10,517*
6. Positive Health effects	18,870 (n = 1)	*N/A*
TOTAL (excl. health effects and carbon storage)	**9,701 US$/ha/year**	**3,212–17,772**

*) see the original article for details.

The data from the above-cited studies support the finding that the analysed ecosystems provide between US$ 3212 and 17,772 of benefits per ha per year. However, as already indicated earlier, these estimates exclude some very important benefits, such as positive health effects and social welfare related to non-use values, and consequently should be treated as very conservative estimates.

To put the values of the above-mentioned monetary benefits in perspective, we present data on costs of urban ecological restoration interventions, which includes costs for planning, preparation, soil restoration, plant propagation, planting, and management. Even in highly degraded urban areas, restoring ecological structure and functionality is – perhaps surprisingly – often possible (Society for Ecological Restoration, 2004). Urban soils almost by definition are profoundly modified, depleted and often chemically stressful to organisms. Indeed, they are often polluted, compacted, sealed and lacking in microbial organisms important for plant growth. In a restoration context, they must be cleaned up, decontaminated (where possible and cost-effective) and ameliorated in broad terms, biophysically, chemically, and aesthetically (Harris, 2009). Such biochemo-physical remediation or recuperation can however often be highly successful, and organic matter content in particular can be increased through links to urban composting initiatives and through manipulation of vegetation and plant community structure (Vauramo and Setälä, 2010). Thanks in part to innovative uses of organic urban wastes and advances in ecotoxicology and phytoremediation, there are many successful examples of urban ecological restoration and rehabilitation projects, including sites of former landfills, former industrial areas, vacant lots, and other brownfields (US EPA, 2009).

In our analyses we used the following estimates of restoration costs of urban public land in the USA in US$ per hectare (including costs for planning, preparation, modest soil restoration, plant propagation, and planting): meadow/grassland $26,000, and woodland $49,000. Data estimates are means by current landscape architecture workers in New York City (Marcha Johnson, NYC Parks Department), Baltimore (Keith Bowers, Biohabitats, Inc.), Boston (Nina Chase, Sasaki Associates), Los Angeles (M. Sullivan, Mia Lehrer + Associates) and Philadelphia (David Robertson, Pennypack Ecological Restoration Trust).

Given that these restoration efforts took place in urban areas, and involved more infrastructure and more sophisticated techniques than might be needed in extra-urban areas, they tend to be more expensive than most of their rural counterparts. De Groot et al. (2013) scrutinized over 200 peer-reviewed scientific papers from which they identified 94 restoration case studies with meaningful cost data. The benefit–cost (BC) ratios calculated here for urban woodland restoration2, the minimum benefit and maximum cost combination yields a BC ratio of 1.57 and the

[2] We used a term of 20 years and a social discount rate of 8%. We consider this as very conservative as the benefits of restoration can, potentially, last for much longer. The discount rate is also high, adding more weight to the cost than to the benefits. We used these parameters in conjunction with a minimum cost of restoration of US$ 12,098/ha and a maximum value of US$ 40,325/ha. We furthermore made provision for an annual operating cost from year 2 onwards of 5% of the cost of restoration. With respect to benefits, we assumed a minimum value of US$ 14,418/ha and a maximum value of US$ 231,925/ha. This we took from Table 2 adding 25% of the health benefit to the stated minimum value and 75% of the health benefit to the maximum. The benefits were phased in at a rate of 10% (year 2), 20%, (year 3), 40% (year 4), 60% (year 5), and 75% (year 6 and beyond) of the aforementioned levels to respect the fact (1) it takes time for ecosystem values to be restored, and (2) restoring to a 100% level is unlikely. The maximum cost and mini-

maximum benefit and minimum cost combination yields a BC ratio of 14.67. These values compare favourably to the range of BC ratios calculated by de Groot et al. (2013) for nine non-urban ecosystem types, including wetlands, lakes/rivers, tropical forests, woodland/scrubland, coral reefs and grasslands. As shown in Figure 2, those ratios ranged from about 2.5 to 27, with the bulk of ratios falling between 5 and 10.

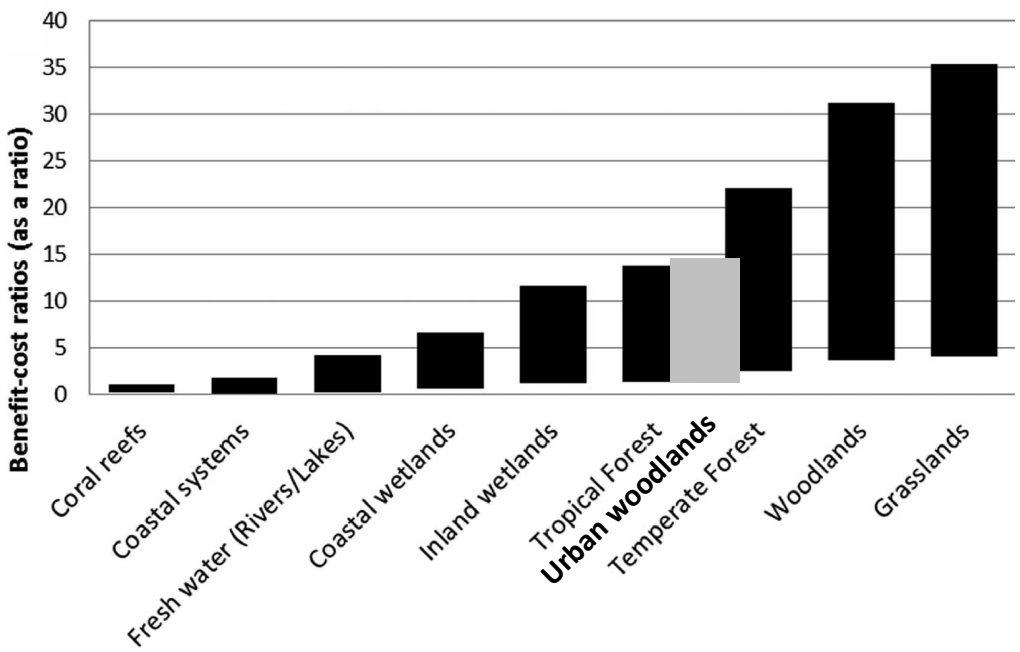

Figure 2: Benefit-cost ratios of restoring urban woodlands (grey) in relation to ratios calculated for 9 different ecosystem types (De Groot et al., 2013).

It is important to note that when any ecosystem undergoes restoration, there is often a time lag of a decade or more before the values as expressed in Table 2 are realized and that a 100% habitat restoration effect is unlikely based on present technology and knowledge base. We therefore assumed a maximum of 75% success rate for all our calculations, based on meta-analysis data for wetland restorations reported by Moreno-Mateos et al. (2012).

mum benefit combination yields a BC ratio of 1.57 and the minimum cost and maximum benefit combination yields a BC ratio of 14.67.

5 KNOWLEDGE GAPS AND FUTURE DIRECTIONS

5.1 Different types of evidence of integrating green space ecosystem services into real economies

Many of the examples and strategies presented in green economy documents or in advocacy for greening and ecosystem service planning are just that – examples or arguments. There is little evidence yet that they are being adopted as more widespread practices. For instance, financial institutions are often pointed out as potential UGI investors, but so far they seem primarily interested in green tech and energy projects where return is more obvious. Some companies may attempt to calculate return on investment in planting trees for publicity purposes (Kronenberg and Mieszkowicz, 2011) and other activities related to UGI creation, maintenance and restoration. Examples might be interesting in themselves, but without strong research or empirical backing their implementation seems uncertain. While the benefits of UGI and ecosystem services are becoming more generally acknowledged their value and thus how they fare in trade-off decisions is less agreed on. More information is needed, and together with it an understanding of the different ways of expressing or calculating value and of ways to combine these. In general there are two types of evidence that can be used to demonstrate the economic benefits related to green spaces and UGI:

- ***Qualitative evidence such as expert judgment, anecdotal evidence or qualitative social research that demonstrates the links between outdoor activity, aesthetics, cleaner air etc. and improvement in human health, reasons businesses state for relocating to greener areas of a city etc.***
- ***Quantitative evidence such as changes in air quality, ambient temperature (reduction in heat island effect for example), noise levels, bird counts etc., numbers of visitors to a new park and any spending they may make while visiting, number of businesses relocating to an area, number of people they employ etc. Typical economic evidence also falls within this category, with examples such as visitor spending, reduction in medical expenditure due to improved health, income from new businesses etc.***

Indeed, sometimes benefits are not directly connected with services and they are 1–2 (or even more) steps removed from them. For example, to a café owner benefiting from increased footfall and economic turnover because of the café location on the route to a large park, the park features attracting visitors (and thus customers) may be less than clear. Not least in these cases, linking benefits to services and thus UGI may require both qualitative and quantitative approaches. While quantitative evidence is often viewed as superior, especially from an economic perspective (because it easily fits into economic calculations), the importance of qualitative evidence should not be underestimated. Qualitative evidence allows a broader group of stakeholders to express their preferences and makes it possible to depict a broader range of benefits. Qualitative evidence may also help in determining the causality of a correlation where quantitative data may not. Revealing benefits in non-monetary terms may be a first step to understanding and acknowledging their input into real economies. We will express these issues further in the forthcoming GREEN SURGE Deliverable 4.3, which will deal more in-depth with theoretical considerations and practical ways for integrating monetary and non-monetary valuation of urban ecosystem services.

5.2 New actors and new challenges for UGI co-ordination

Chapter 3 provides an interesting contrast to the list of actors presented in GREEN SURGE Deliverable 6.1. While Deliverable 6.1 focused on the actors engaged in or at least interested in the planning of UGI and in the discussion about desirable cities, the list here instead highlighted those involved in the maintenance of UGI. This resulted in a shift from a more detailed description of non-business actors to one outlining the diversity within the business sector. The two lists are mostly overlapping, but not totally, and this slight asymmetry could be interesting to investigate further. There are some trends in UGI governance that we expect will influence the future development of UGI, some of them perhaps giving cause for concern. Decentralisation and the outsourcing of maintenance to companies through tendering and procurement have opened up space for companies specialising in installation and maintenance of UGI. Managing the contracting situation in UGI management is not straightforward and requires knowledge about objectives, instruments, and various trade-offs and/or synergies. Presumably contractors are bound by their contracts, but despite specifications in the procurement process an incomplete market will mean you often have to choose from companies who do things "their" way, based on skills, equipment and knowledge. The economic considerations – and slightly different angle on actors involved in UGI management – in this Deliverable will later feed into the WP 6 led task 6.3, "development of guidelines on appropriate and effective governance arrangements for UGI and urban green space".

Although outsourcing was partly beyond the scope of Deliverable 6.1, as the contracted companies were presumed not to have any decision making or governance power, it was still noted that outsourcing might also include citizens through 'adoption' agreements, where use and/or management rights regarding green spaces are granted to a community group. Nevertheless, here we have seen that 'adoption' also works in the case of business because various non-state funding and non-monetary investment opportunities make it possible for virtually any stakeholder to get involved in the creation, maintenance or restoration of UGI and green spaces. Specific opportunities may arise for specialized stakeholders, but the development of these opportunities often needs to be carefully facilitated. The integration of our improved understanding of stakeholders and actors along with the developing insights into biocultural diversity will provide an interesting area of future work. Presumably diversity among actors will promote biocultural diversity, but how and through what means we do not know yet. Different actors both bring in different perspectives on desirable functionality and design, and leave different legacies in terms of cultural artefacts and narratives. An actor lens focusing on interest and sector might be able to move the biocultural diversity studies beyond ethnicity and green space use and thus prove quite valuable.

According to GREEN SURGE Deliverable 5.1, city officials involved in UGI planning and decision making indicated that they would like to see a higher level of participation of business community representatives (approx. 60% of the respondents). Meanwhile, most of the cities complain about the role of the private sector, sharing an almost universal view that private sector stakeholders do not follow the multi-functional approach, i.e. the private actors usually consider exclusively their own interests. This is especially valid if private partners are selected automatically on the basis of the cheapest price offer, which usually excludes the more suitable candidates with proficient knowledge in green space management.

From a policy perspective, these issues could be challenging and they indicate that traditional economic structures may not necessarily favour sound UGI management. An inclusive governance approach that grants a variety of stakeholders the power and opportunity to contribute to a final outcome will prove a better option in the long term. This is in line with the basic tenets of green economy, which is meant to satisfy social, economic and environmental objectives. Finally, it is of key importance to study not just the rights of different stakeholders to have access to and benefit from UGI, but also the obligations that result from these rights. Stakeholders who benefit economically from UGI could be obliged to reinvest in its maintenance. We explore this issue in more detail in GREEN SURGE Deliverable 4.2 on cash flows generated by urban green spaces.

5.3 UGI restoration and ecosystem services return on investment

Chapter 4 provides important insights for further work in the GREEN SURGE project. Restoration goals and results could be calculated for various components of urban green and blue infrastructure (as listed in our urban green space typology – GREEN SURGE Deliverable 3.1). Based on more detailed data on the costs and benefits related to specific urban green infrastructure components, decision-makers could make better decisions with regard to the management of urban ecosystems. Connecting this information to a better understanding of biocultural diversity will be an additional important step for setting future restoration priorities and estimations of actual returns or benefits, which should be helped by the GREEN SURGE WP 2 task to "Developing a typology and database of BCD with urban green infrastructure".

In reality it is of utmost importance to go beyond narrow approaches that focus on individual services or bundles of a relatively small number of services (c.f. GREEN SURGE Deliverable 4.2). The above overview addressed a low-hanging fruit – monetary valuation of services that are relatively easy to depict, quantify and translate into monetary values. However, there are multiple other ecosystem services, whose importance is far more difficult (if at all possible) to express financially. Increasingly more attention is being paid to the non-monetary benefits of ecosystem services (Gómez-Baggethun et al., 2013; Hubacek and Kronenberg, 2013) such as health, aesthetics and education for all ages. A range of additional, more subtle benefits can accrue from restored urban ecosystems such as enhanced social cohesion and trust, human well-being, sharpened sense of place and space-specific values called sense of identity (Casado-Arzuaga et al., 2014; de Groot et al., 2005). Any discussion on the value of urban green space should consider a maximum number of these benefits, to indicate the broader, external benefits related to urban ecosystem conservation and restoration. Indeed, most of these benefits are overlooked in traditional discussions on urban development (or rather urban economic growth), which predominantly perceive the restoration, creation and maintenance of green spaces through the lens of the seemingly high opportunity cost. The two upcoming GREEN SURGE Milestones 25 and 26 ("inventory of functional linkages of different types of urban green spaces for economic use/benefit cost" and "development of multiple-linkage classification scheme for urban green space-ecosystem service-impacts & trade-offs", respectively) should provide additional detail useful for including a more complete of ecosystem services and dynamics in all kinds of valuation.

Finally, ecosystem services provided by urban green infrastructure do contribute to broader urban development objectives and once we depict the multiple benefits into which they can be translated, we will realize that it is the loss of urban green space that creates an extremely high

opportunity cost. UGS are essential for urban quality of life and for urban environmental health, which translate into economic prospects. They serve as an ultimate insurance against various external and internal disturbances, as wisely reflected in the EU Biodiversity Strategy (European Commission, 2011). Correspondingly, we acknowledge the recent commitment within the Convention on Biological Diversity to restore at least 15% of degraded ecosystems by 2020 (CBD, 2011). Also, important connections have been highlighted between investment in urban green and blue infrastructure and the United Nations' agenda on a Green Economy for the 21st century (UNEP, 2011) and the recently adopted Sustainable Development Goals (SDGs).

Although the most general benefits for urban quality of life are the most important, other more specific benefits accrue to various stakeholders. This merits further study, and indeed we make such an attempt in the present Deliverable, looking at how various urban stakeholders contribute to and benefit from various urban green space components identified in the GREEN SURGE typology (GREEN SURGE Deliverable 3.1).

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6.2 GREEN SURGE documents cited in this Deliverable[3]

Deliverable 3.1 – A typology of urban green spaces, eco-system provisioning services and demands

Deliverable 4.2 – Report on cash flows generated by urban green spaces

Deliverable 5.1 – Green Infrastructure Planning and Implementation

Deliverable 6.1 – The governance of urban green spaces in selected EU cities

Deliverable 6.2 – Report on success and failure of governance arrangements across urban Europe, based upon our assessment framework

Milestone 23 – Urban GI Components Inventory

Milestone 30 – Nature as a firm

[3] Only publicly available material. Electronic copies available at: http://greensurge.eu/products/

LIST OF PARTICIPANTS

No.	Participant legal name (and short name)	Country	Organisation type
1	Stockholm Resilience Centre, SRC	SWE	University
2	University of Łodz, ULOD	POL	University
3	University of Ljubljana, UL	SLO	University