8 The City as Ecosystem
Paul Duvigneaud and the Ecological Study of Brussels

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In 1974, the Belgian ecologist Paul Duvigneaud suggested that “the naturalist” should not only focus on allegedly natural ecosystems such as forests and lakes but also study “man-made ecosystems” (1974a:5). Claiming that about 50–70 percent of humankind was living in urban environments, he argued that the city should become the most important object of natural history and ecology. Duvigneaud put his ideas into practice in a series of field studies, which he conducted with different coworkers in Brussels. These studies touched on climatic conditions, the input and output of energy and matter, air pollution, the pollution of urban waters, and the structure of green-spaces, including the “semi-natural” sites that had survived within the city. Although these studies included elements of descriptive natural history, they represented a most ambitious effort to model the city according to the precepts of quantitative systems ecology.

Duvigneaud was not the only ecologist in this period who became interested in the city. A landmark case in Europe was the work of Herbert Sukopp in West-Berlin, who promoted the study of urban vegetation and urban biodiversity conservation.¹ Already in the 1960s, the American ecologist Abel Wolman (1965) heralded ecosystem analysis as a tool for studying and managing urban ecosystems. Ecosystem analytical approaches were later applied in Hong-Kong (Boyden et al. 1981), Tokyo (Numata 1974), and some American cities (Stearns and Montag 1974) − all studies which were part of UNESCOs’ “Man and the Biosphere Program” (MAB) (see Wächter 2003, Chapter 7).

Historical studies of the rise of ecosystems theory in the 1950s and 1960s (e.g., Kwa 1989; Bocking 1997; Kingsland 2005; Coleman 2010) have rarely touched on urban ecology. In this chapter, I will use the example of Duvigneaud and his coworkers, henceforth the “Duvigneaud group”, to reconstruct the spatio-epistemic process through which urban ecosystem analysis took shape in one particular city.² The focus of the chapter is on the fieldwork and the related intellectual discourses through which the Duvigneaud-group engaged the spaces of their city as objects of knowledge, and through which they redefined what these spaces were and how they should be dealt with in planning practice.
The chapter also provides insights into what historians of urban technology Michael Hård and Thomas Misa (2008) have described as the complementary processes of circulation and appropriation. “Circulation” refers to the exchange of problem definitions, knowledge, and artifacts that links urban experts across distant places, virtually around the world. With “appropriation,” they describe the ways in which such circulating matters get incorporated into the planning discourses and material form of particular cities. Appropriation is always a selective process through which circulating concepts and objects get mixed with locally existing traditions.

The chapter starts with a brief sketch of the appropriation of ecosystems ecology in Belgium and of Duvigneaud’s role in this process. The next part traces how Duvigneaud shifted his focus from forest ecosystems to the city and how this was mediated by local political circumstances. Each of the following three sections zooms into one of three parallel strands of ecological knowledge-making in Brussels: the articulation of a theoretical concept of urban ecosystems, the quantitative accounting of the urban “metabolism”, and the ecological survey of urban spaces.

**Paul Duvigneaud and the Rise of Ecosystems Ecology in Belgium**

Duvigneaud (1913–1991) studied chemistry and biology at the Université Libre de Bruxelles (U.L.B.), where in 1940, he received a PhD in biology. During the German occupation, he worked as a teaching assistant and, after the dissolution of the U.L.B. in 1941, as a researcher at the Brussels-based Institute of National Parks of Congo. At the same time, he conducted his first botanical fieldwork in the Ardennes. In 1947, he started teaching again at the U.L.B (Université Libre de Bruxelles 1947:299), where he became an extraordinary (in 1952), and subsequently ordinary professor (in 1956). Duvigneaud’s early work focused on the systematics of lichen and on phytosociology. Through his fieldwork, he contributed notably to the colonial exploration of the Belgian Congo. When the Congo became independent in 1960, he shifted his interest to the forests of the Belgian Ardennes. It was in the context of these studies that his approach changed from a descriptive phytosociology to the systems ecological approach that he later applied to Brussels. In the late 1950s, his close personal contact to the Ministry of Education and Research resulted in the establishment of a Centre National d’Écologie Générale (CNEG), of which he became director. Ecology, which hitherto had been virtually nonexistent as an academic discipline in Belgium, thereby received a permanent place in the research system.

With systems ecology, Duvigneaud appropriated an approach that circulated widely in the 1970s (Kwa 1989; Bocking 1997; Kingsland 2005; Coleman 2010). It was the British ecologist Arthur Tansley who introduced the term “ecosystem” in 1935, and after WWII, US ecologists such as Raymond Lindemann, and Eugene and Howard Odum built on these ideas. The new
approach took shape in studies of the biological effects of radiation, and was inspired by cybernetics. Its advocates assumed that ecosystems were functionally integrated wholes, which connect organisms with each other and with their nonbiotic environment. Such systems could exist at different scales, ranging from single lakes, rivers, or meadows to entire landscapes or “biomes”. It was the goal of ecosystem research to unravel the mechanisms that keep these systems in a steady state or “equilibrium”. Such mechanisms were food chains, the growth and consumption of biomass, and the circles of energy, water, and minerals. Insights into the functioning of ecosystems were meant to contribute to better management, and help prevent malfunctioning, and optimizing yield. This research agenda reflected the increasing concern in these decades about overpopulation and scarcity of food (see Höhler 2015). In terms of methods, ecosystem science complemented earlier forms of fieldwork observation with experimental practices, mathematical analysis, and computer-based modeling.

According to his former assistant professor Simone Denaeyer-De Smet, Duvigneaud’s reading of Eugene Odum’s (1953) path-breaking *Fundamentals of Ecology* did a lot to kindle his enthusiasm. Around 1960, he had himself become an ardent promoter of ecosystems theory. Together with his assistant professors, he drafted a report on the state of art in ecology for the Belgian government (Duvigneaud 1962). This 130-page text was originally created for biology teachers, but at the time, the report was probably the most substantial programmatic statement for systems ecology in Continental Europe. In the later chapters, Duvigneaud sketched the role of ecology as a unifying science, which would help with the management of the “wealth” of the biosphere in line with human needs for food and industrial exploitation. Duvigneaud appropriated ecosystems theory in his own peculiar way, for example, by introducing Latin names for the main ecosystem types and by using visual renderings that situated schematized ecosystem processes against the background of colorful landscape pictures. Duvigneaud’s magnum opus, the textbook “La synthèse écologique” (1974b), was a revised and extended version of this report.

Duvigneaud’s appropriation of systems ecology was closely linked to, and thrived on the International Biological Program (IBP) (1964–1974) – a research initiative of the International Union of Science. Its theme was “biological productivity” and its relationship to human welfare and well-being. Drawing on ecosystems theory, the participants sought to probe the actual and potential productivity of various “biomes”, such as grasslands, savannahs, and different types of forest and agriculture. In 1963, support from the Belgian state allowed Duvigneaud to host the first meeting of the already operative IBP subcommittee Terrestrial Communities. In this context, the idea of a (state sponsored) Belgian IPB evolved, and was launched in 1968 under the directorship of Duvigneaud.

Duvigneaud envisioned a guiding role for ecology in society, not only for science-based political management of natural resources, but also
in education and through the development of a new ethic. As he put it in 1969, ecology should lead to a “permanent green revolution” (1969/70:IV:12) which would combat hunger in the developing world, and better integrate the industrial society with the cycles of nature. Duvigneaud even claimed that the spread of ecological consciousness, along with genetic knowledge, would lead to a “renewed socialism” (p. 21). Although his political vision was mainly about the management of resources, it also encompassed a concern about “genetic degeneration” (1969/70:IV:21) which resonated with earlier eugenic thinking. 8

The actual research of the Duvigneaud-group was devoted to “ecosystem silva”, Duvigneaud’s term for forest-ecosystems. It was carried out in the Ardennes, a low-mountain region in the South of Belgium that is covered by a patchwork of managed forests, farming areas, and peat bogs. In 1963, the researchers embarked on a seven-year study of a mixed oak forest near Virelle (Duvigneaud et al. 1971; Duvigneaud 1977a:11). The researchers collected data on biomass, productivity, balances of energy and water, and the so-called “turn-over” of organic material. These goals fit directly with the agenda of the IBP, and IBP partners at the American Oak Ridge laboratory drew on the data generated in Virelle to create a mathematical model of forest ecosystems. 9 With the launch of the Belgian IBP, the focus shifted to another site: an area of mixed landscapes in the vicinity of Mirward in the province of Luxemburg (Duvigneaud 1977b). This project ran from 1969–1975, and involved an interdisciplinary group. The main reason for choosing Mirward was its suitability for an internationally comparative study of mixed ecosystems, which the German ecologist Ellenberg had proposed for the IBP (p. 19). In 1966, Ellenberg had already started his own case study in the German Solling mountains (Ellenberg, Mayer, and Schauermann 1986).

The typical pattern of these projects was the concentration of fieldwork over a long period in a selected patch of land over which the researchers could exert a considerable amount of control. The presence of ecologists and their complex observation technology transformed these sites into laboratory-like sites of knowledge making.10 Duvigneaud and his coworkers spent a lot of time at these sites, often staying overnight in a nearby hotel.11 Phytosociological surveying remained important, but it only provided the basic description of the ecosystem. In order to measure biomass, trees and shrubs were cut and sawed and forest litter was collected. The material was weighed, both freshly cut and after drying. To probe the “biogeochemical cycles” of the ecosystem, samples were taken of organic material and soil and then shipped to Brussels for chemical analysis. Measuring devices were installed to measure temperature, humidity, and precipitation. Although similar measurements were also done elsewhere for the IBP, this fieldwork required quite some tinkering and exchange of local skills with researchers at other sites.12

In contrast to many other IBP-projects, the Duvigneaud group conducted its research in a space, which had been molded through forestry, agriculture,
tourism, and the presence of human settlements. The role of humans in natural ecosystems thus also figured prominently in Duvigneaud’s theoretical writings. Following the Russian ecologist Vladimir Vernadski (1863–1945), Duvigneaud claimed that a human-shaped environment, the “noosphere”, had replaced the original “geosphere” and “biosphere” of the planet (e.g., 1969/70, IV; 1974b; 1990). This theme became particularly evident in his work on the city.

The Turn to the City

After 1970, Brussels became the main research object of Duvigneaud’s laboratoire, and its institutional outpost, a newly founded “Center of Urban Ecology.” Although Duvigneaud did not refer much to similar undertakings in other cities, his urban ecology did not develop in isolation. His reception of Vernadsky’s ideas has already been noted. In the context of the IBP, meanwhile, his cooperation partner Ellenberg advocated the notion of “urban-industrial ecosystems” (1973:236). In 1974, Duvigneaud and Denaeyer-De Smet organized an international workshop in Brussels (sponsored by the Brussels Agglomeration), which was devoted to urban ecosystems. Most of the 25 attendees came from French and German-speaking countries, and one each from the Netherlands and Japan (Havelange, Duvigneaud, and Denaeyer-De Smet 1975:1–2). In comparison with his earlier work on the Ardennes, where Duvigneaud had also maintained contacts with British and American scholars, the workshop shows a clear shift of his network towards Continental Europe.13 After the conference, contact was also made with Herbert Sukopp in Berlin.14 Duvigneaud was involved in the preparation of the MAB program, and even if Brussels did not become an official MAB project, his work contributed to this broader agenda.

Notwithstanding the relevance of such transnational knowledge circulation, the actual research dynamic of the Duvigneaud group was embedded in the politics and planning of its own city. Brussels was an agglomeration of about 1 million inhabitants that was formed by 19 independent municipalities. The Belgian language laws of the early 1960s, which divided the country into three unilingual territories (French, Dutch, German), established both Dutch and French as official languages for the Brussels area – a measure to protect the Dutch-speaking minority (Witte 1998). When in 1980, Flanders and Wallonia were created as the two major regions of Belgium, the status of the 19 municipalities remained contested, and it took until 1989, for the bi-lingual “Brussels Capital Region” to be established. In 1971, while the Duvigneaud group conducted its studies, a politically much weaker administrative union of the municipalities had emerged: the so-called “Agglomeration Brussels” (Witte 1998; Vaasen 2008:158–164).

Since the end of WWII, the Brussels area had experienced a rapid population growth, leading both to urban sprawl and to the densification of inner city districts. The Brussels world fair in 1958, the need to create space for
the institutions of the European Economic Community (founded in 1957),
and the unleashing of real estate speculation had led to the destruction of
many historic buildings, and to the development of former green spaces
(Papadopoulos 1996; Heim 2000; Romańczyk 2012). As Alex Papadopoulos
writes, “a planning style, which the more cynical will call nonexistent,
makes the city a palimpsest for developers who with surgical precision can
partially or completely erase the surviving built fabric to make room for
new structures” (1996:15). These developments provoked resistance from
neighborhood activists and critical experts. The concerns of these groups
reached from the gentrification of disadvantaged neighborhoods to nega-
tive effects on the quality of life. In the writings of Duvigneaud, we can
also find critical statements about the transformation of his hometown.
For example, he lamented the proliferation of tower-blocks and parking
lots and blamed “the scandalous exploitation of urban space for mercantile
purposes” (1974a:33). In another publication, Duvigneaud used the term
“Brusselization” (1990:81) to refer to the fatal combination of urban sprawl
and vertical growth, which he considered typical of his city. Even when he
wrote in more generic terms about the “pathologies” of cities (1974a:6–7)
and the need for rational planning, he clearly had his own city in mind.

In contrast to his counterpart, the Berlin ecologist Sukopp, Duvigneaud
did not maintain a longstanding relationship with the local administration
when he turned to urban ecology. However, in the early 1970s, two related
developments opened a window of opportunity for a short period of inter-
action with local planners: the success of the Brussels-based language party
“Front Démocratique des Francophones” (F.D.F.) of which Duvigneaud
was a member, and the establishment of the Agglomeration as a new institu-
tional actor in planning matters.

The F.D.F. was founded in 1964 as a reaction against the language laws,
which guaranteed rights to the Dutch-speaking minority. Protracted con-
flicts about the bilingual status of the 19 municipalities resulted in the party
becoming enormously popular in the early 1970s. When in November
1971, the Council of the Agglomeration was elected, an alliance between
the F.D.F. and the francophone liberals, received 42 of the 83 seats (Vaasen
2008:159). The legitimacy of the council suffered from the fact that candi-
dates with Dutch-language passports had also run for the alliance, and the
latter were able to seize seats that were reserved for representatives of the
Dutch-speaking minority (Witte 1998:20–21). Uncertainties about the con-
stitutional status of Brussels prevented further elections (Vaasen 2008:159);
moreover, the Agglomeration was faced by resistance from the municipali-
ties that limited its envisioned role as a coordinator (pp. 160–161).

Notwithstanding its institutional weakness, the Agglomeration became
an important arena for the articulation of Duvigneaud’s ecology in plan-
ning. This is partly due to the fact that the environment and urban planning
belonged to the few core competences through which the Agglomeration
could assert its coordinative role. Moreover, the F.D.F., which dominated
the Agglomeration, turned out to be relatively open to environmental concerns, and Duvigneaud himself seems to have had some impact on its ecological profile. He participated in party discussions, and coauthored a commentary for the F.D.F. on the federal government’s proposal of a new Belgian nature conservation law (Christel, Duvigneaud, and Rappe 1973).

In the hands of alderman for environment, Pierre Havelange (F.D.F.), the Agglomeration took initiatives to promote green spaces, to combat noise and air pollution, and to establish an environmental documentation center, the *A.S.B.L. Bruxelles Environnement.* It was also the Agglomeration that hosted the international workshop in 1974. In the same year, the Agglomeration created an expert committee on green planning and appointed Duvigneaud and his assistant professor Martin Tanghe as permanent members. Among other things, the committee gave advice on the nature-friendly redevelopment of the valley of the Woluwe-river, and paved the way for the ecological mapping of Brussels. Through the work of Denaeyer-De Smet, the Duvigneaud group was also involved in the Agglomeration’s air pollution monitoring (Denaeyer, Kummer, and Rondia 1978).

Although Duvigneaud’s ecology was closely involved in the establishment of environmental policy in Brussels, his research did not materialize in a major political program. This again is a striking difference to the situation in West Berlin, where Sukopp was able to develop a comprehensive “landscape program.” The Agglomeration proved to be a rather weak institution and suffered from an increasing loss of significance, and in 1984, the replacement of Havelange as alderman for environment distanced Duvigneaud even further from the local planning system.

All this does not mean, however, that urban environmentalism has disappeared from the political agenda in Brussels. The creation of the region in 1989 meant a much more effective structure of governance and also reinvigorated local environmental policy. The “Brussels Institute for the Administration of the Environment” (IBGE), (the successor of *A.S.B.L. Bruxelles Environnement*) achieved a central position in environmental monitoring and policy advice. Although former students found jobs at the IBGE and thereby maintained some intellectual continuity, Duvigneaud himself no longer played an active role in this process.

All this did not prevent Duvigneaud from publishing about urban ecology, even after his retirement. However, by the late 1970s, the period of collective research projects under his direction had come to an end. The lack of resources (the Belgian IBP was not followed by an equivalent program of subsidie) and Duvigneaud’s inability to attract new PhD researchers and assistant professors, had limited the capacities of his research unit. One of his later projects, an ecosystem analysis of the Walloon city of Charleroi, had to be carried out with a group of students for whom this was graduation work (Duvigneaud et al. 1986). Duvigneaud’s own involvement in Brussels politics had meanwhile become limited to some local activism, which he continued with until his death in 1991.
Conceiving “Ecosystem Urbs”

The formation of Brussels as an object of ecological knowledge emerged along three major strands of knowledge-making. The first strand was the formulation of a theoretical model of the urban ecosystem. In 1974, Duvigneaud (1974a) presented a systematic outline of what he (following his earlier habit to label ecosystem types with Latin names) called “ecosystem urbs.” Spatially, Duvigneaud identified the urban ecosystem with the extension of the developed territory: the habitat of the “anthropocenesis”, as he called the living community of human beings. Functionally, he conceived of the city as a set of flows of materials and energy that connects its living communities with the physical surroundings. He considered it the task of ecology to identify and measure these flows and thereby to explain the functioning of the overall system. As Duvigneaud explained, “ecosystem urbs” contained plants, either small natural vegetation which had remained on some lots, or in gardens and flowerbeds created by the human dwellers. He also mentioned dogs and cats, and even the potted plants, aquarium fishes, and caged birds in the interior of human dwellings. It was the predominance of the “anthropocenesis”, Duvigneaud argued which gave this ecosystem its distinct character.

The study of human populations in ecological terms has a tradition that goes back to the Chicago school of sociology. The Brussels geographer Bernard Jouret (1972a) had already used Duvigneaud’s vegetation-ecological concepts to describe human population patterns in Brussels. Duvigneaud extended the concept of the ecosystem beyond such demographic concerns. His interest was in the ecosystems that emerge from the “work of humans” on a given territory (1974a:7). A “developed city” such as contemporary Brussels was thus composed of many subsystems which he described in terms of dominant patterns of land-use: green-spaces, industrial areas, residential areas. These were established spatial categories of urban planners and geographers, which he reinterpreted in terms of ecosystems ecology.

According to Duvigneaud, the predominance of humans in the urban ecosystem had led to a novel kind of metabolism. Whereas natural and semi-natural ecosystems received their energy through the absorption of sunlight by photosynthetic plants, the urban ecosystem depended on the supply of combustibles and electric energy. The same goes for the supply of food, water, and a whole range of other materials that are consumed in the city. Duvigneaud noted that the increasing import of substances and energy is accompanied by an equally excessive output: Waste, sewage, heat, and the various pollutants that are emitted by cars and industrial facilities (p. 24).

As in his earlier studies on forests, Duvigneaud made use of profile drawings to visualize the interplay between these metabolic streams and the elements of the urban ecosystem (see Figure 8.1). His first essay on the city included a profile of Brussels from the West to East, in which he distinguished nine subsystems, and characterized each of them by the preponderance
of specific ecological factors (p. 20). In another version, he added arrows to the profile which represented the various metabolic inputs and outputs of the urban ecosystem (Duvigneaud 1975a:21). Later publications of the profile showed additional metabolic flows (Duvigneaud and Denaeyer-De Smet 1976:130; Duvigneaud, Denaeyer-De Smet, and Tanghe 1976:B3.39; Duvigneaud and Denaeyer-De Smet 1977:589; Duvigneaud, Denaeyer-De Smet, and Tange 1977:40). It was mainly through this profile that ecologists in other countries, particularly within Europe, became familiar with Duvigneaud’s work.26

In their schemes, Duvigneaud and his coauthors described the human dweller, like any other organism, in terms of “biomass” (Duvigneaud and Denaeyer-De Smet 1977:591). At the same time, however, Duvigneaud acknowledged that humans were also mental and social beings (1974a:18). At various points in his publications, Duvigneaud referred to human activities, such as consumption habits or the addiction to the car as a means of transport, as factors contributing to pollution. His core concern was about what he called the “pathologies” of the urban ecosystem: the adverse health effects of pollutants, the density of the city, the anonymity, the industrial working conditions, the overstimulation with information, and the resulting “stress” and “diseases of civilization” (p. 29). Although couched in the

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**Figure 8.1 Model of the urban ecosystem.**
scientific vocabulary of advanced ecosystem-analysis, these were themes that had a long tradition in the criticism of the modern metropolis (see, Lees 1985). Duvigneaud's ecology thereby also resonated with other contemporary discourses, in which terms such as “stress” and “diseases of civilization” had become core metaphors of a scientific critique of modern life (see, Haller, Höhler, and Stoff 2014).

Duvigneaud concluded his pessimistic diagnosis with a program of urban reform which built largely on the functionalist urbanism of Le Corbusier and the Athens Charta (1974a:31). Duvigneaud embraced this program, which aimed at modernizing existing densely built cities through the provision of fresh air, sunlight, and green spaces, and even described the principles of the Athens Charta explicitly as “urban ecological” (p. 32). Although these principles had long been dominant in urban planning, Duvigneaud claimed that they had been badly applied: Instead of renewing existing cities, planners had simply extended the city to the countryside. He also made suggestions for ecological improvements, such as changing from individual to collective transport, the use of the underground for traffic, the creation of pedestrian streets, and the greening of the city with parks and planted facades (p. 33).

Calculating the Metabolic Balance

A second strand of knowledge-making was the calculation of the “metabolism” of the urban ecosystem in terms of input and output of materials and energy, on which the actual numbers in the Brussels scheme were based. In contrast to the Ardennes, where ecologists dealt with manageable patches of land within which they could exert a relatively high amount of control, the metabolic streams of the urban ecosystem were barely amenable to direct observation. What mattered here, were large-scale environmental factors and economic and industrial processes that were not visible or measurable with the usual biological fieldwork practices. In order to account for the urban metabolism, ecologists had to rely on more indirect forms of analysis.

At the international symposium on urban ecosystems, Duvigneaud (1975b) presented a first balancing of the input and output of the most relevant forms of energy and matter in Brussels. He thereby drew on two types of data. The first were parameters which had already been established in previous ecological work, and which he could simply feed into his calculations on Brussels. Examples are the reflection coefficient for sunlight (albedo-coefficient) (p. 47), the primary productivity of trees (p. 52), and the basic physiological parameter of the human metabolism (p. 54). For example, the application of such data would sometimes involve intuitive fine-tuning: Duvigneaud increased the value for the average consumption of human beings because he considered “gluttony” to be widespread in Brussels (p. 50).

The second type of data stemmed from scientific and administrative institutions. The observatory in Uccle provided him with long-term records of the
energy received from sunlight (p. 47). Four meteorological stations recorded the temperature and other climatologically relevant data (p. 48). Municipal registers allowed Duvigneaud to estimate the number of inhabitants and of registered dogs (to which he added his estimation of the number of daily commuters to Brussels and of non-registered dogs) (p. 54). The Institute National de Statistic (I.N.S.) provided data on car ownership (p. 47). Existing reports for the municipality contained data that Duvigneaud used to calculate the production of waste and the various streams (incarceration, landfilling, release of sewage) through which it left the urban ecosystem (p. 56).

As social studies of statistics and accounting have variously shown, the assembling and calculation of quantitative data is inevitably imbued with, often implicit, conventions about what counts as reliable data and how and when data can be treated as arithmetically similar (e.g., Desroisières 1990; Power 1997). Duvigneaud had to rely on data from institutional sources that were very heterogeneous: It was assembled for different purposes and with different methods and covered incoherent spaces of time.

Notwithstanding the piecemeal character of his data, their incorporation in an idealized model of the Brussels ecosystem suggested that they were equally valid parameters. Second, by presenting metabolic streams as intake and output of a spatially bounded ecosystem, Duvigneaud referred to the territory of the 19 communes. In a time when the regional scale of governance was still in the making, his metabolic accounting tended to reascertain the significance of the Agglomeration as a territorial entity. 27

The progress of Duvigneaud’s ecosystem accounting did not overcome the fundamental tension that existed between an almost unlimited need for precise data on the city, and the complexity and messiness of the actual urban processes through which and about which such data could be obtained. As two question marks in his ecosystem model of Brussels show, he even lacked any data on industry-based material flows. When Duvigneaud presented his ratings, he underlined that they were provisional and that they were only meant to introduce a long-term research trajectory (1975b:57). In his later publications, he was able to extend his sources and to slightly adjust his numbers. 28 For example, when estimating biological productivity, Duvigneaud and his coauthors relied on the data they had collected on the size and composition of green spaces in Brussels (Duvigneaud, Denaeyer-De Smet, and Tanghe 1977:30; Perez Mibelli 1978:77). However, Duvigneaud’s original intention to transpose his findings into a “mathematical model” (Tanghe, Duvigneaud, and Jouve-Barbezat 1974:38) of the city was never realized.

**Ecological Surveys in the City**

A third strand of knowledge-making was the ecological mapping and exploration of Brussels’ urban spaces. This happened partly through site surveys, which focused on areas, or sets of areas with a distinguishable physiognomy,
which were identified as distinct subsystems: urban waters, parks, forests, and wastelands. Surveys of urban waters applied chemical analysis to estimate the content of pollutants in the water and in aquatic organisms (Duvigneaud, Lamaye, and Denaeyer-De Smet 1974; Lamaye 1975). Martin Tanghe (1975) conducted a detailed vegetation study and soil analysis in the meadows of the Woluwe valley, an extended green zone in the Eastern outskirts (Tanghe and Duvigneaud 1978). He concluded that the area contained rare vegetation formations, and was worthy of protection, and thereby paved the way for a green space development plan for that area. Practical planning motives were also behind the analysis of the biological composition and the recreation value of parks that Serge Kempeneers (1978) conducted in his graduation thesis. Vegetation and soil analyses were also included in studies of urban wastelands (Duvigneaud 1975c; Huart 1977). However, in contrast to Sukopp’s Berlin, which had been severely destroyed during of the war, Brussels only had a few large wastelands (e.g., a former military exercise ground in the municipality of Etterbeek). In line with Duvigneaud’s interest in metabolism, his studies covered the contamination of the plants with lead, and the productivity of these sites in terms of “phytomass” (that is the biomass of plants).

Another form of survey was the comprehensive mapping of the distribution patterns of ecological phenomena and the delineation of distinct ecological zones throughout the Brussels Agglomeration. Such surveys were meant to inform urban planning, but they also provided a basis for research on urban metabolism. Tanghe, Duvigneaud, and Jouve-Barbezat (1974:43) had already published a simple ecological map of Brussels. A more detailed “Map of Land-occupation and of Degrees of Greenness” was produced with support from the Agglomeration (Duvigneaud, Denaeyer-De Smet, and Tanghe 1977; see Figure 8.2). It was based on existing cartographic material and aerial photographs, but also on infrared photographs that Duvigneaud and Denaeyer-De Smet took from a zeppelin used for advertisement flights over Brussels.29

The map combined two principles of cartographic organization. First, it relied on urbanist land-use categories to distinguish the spatial location and the extent of the various “subsystems” of the city. Second, it represented the same spaces in terms of the density of vegetation coverage, the degree of “greenness” (verdurisation) as the researchers called it. The map thereby was meant to represent the variations of “biological productivity”, which was considered to ascend from the biologically unproductive “grey zone” of the inner city to the “green zone” of the outskirts at the other extreme. In the accompanying report, the authors made suggestions for planners how the greenness of these zones could be increased. The extent to which this mapping strategy was guided by Duvigneaud’s concern for biological productivity and metabolism is remarkable. Whereas, for example, Berlin ecologists based their maps on findings about species diversity and the refugial function of urban habits for threatened species (see Lachmund 2013), these factors remained marginal in the Brussels survey.
Other comprehensive studies derived spatial patterns on the basis of representative sampling sites or transects. These studies were as much about testing these survey methods as about revealing specific insights into the city. For example, Denaeyer-De Smet (1975) monitored air pollution with indicator plants that she placed in 19 sampling points across the Agglomeration. For a phenological study of urban climate, Tanghe, Duvigneaud, and Jouve-Barbezat (1974), recorded the progress of blossoming of trees at 223
“stations.” Other surveys followed the change of ecological parameters along a so-called transect, a method that Duvigneaud had already applied in the Congo. Transects traversed different zones of the city from the central area to the outskirts, such as in Bernard Jouret’s (1972a) population survey and a study of air pollution (Majerus and Denaeyer-De Smet 1974). When Duvigneaud’s student Serge Kempeneers (1976) worked on his graduation thesis, he drove a car with meteorological measuring devices along nine main routes from the central marketplace to the outskirts, thereby covering all cardinal directions in a star-like pattern.

Sampling networks and transects functioned as “technologies of place” (Kohler 2002) which transformed the specificities and complexities of urban spaces into homogenous cartographic data. Although such techniques had already been applied by other field-ecologists, their appropriation in urban space required various context-specific adaptations. When Denaeyer-De Smet distributed her plant samples, she identified the sites by their location at significant buildings and by streets names. She also placed her samples high above the street level to protect them against vandalism (1975b:130), an issue that did not matter in earlier fieldwork in the Ardennes. Kempeneer’s (1976) climatological research thrived directly on the urban infrastructures and practices of automobile traffic. The use of an advertisement zeppelin, as an instrument for aerial photography (Duvigneaud, Denaeyer-De Smet, and Tanghe 1977), is another example of a symbiosis between ecological fieldwork practices and urban practices.

Conclusion

Duvigneaud’s dream to manage the city according to his ecosystem-precepts was never realized. This was due to the weakness of his position in the local planning system, but also reflected the general fate of systems-ecology, which eventually failed with its wide-ranging attempt to control the complexity of nature (Kwa 1989). And yet, the map of “greenness,” and its categories of land classification, survived as reference points for the administrations of the Brussels region. Likewise, the very notion of Brussels as an ecosystem survived in policy papers of the IBGE (BIM-IBGE 1991:14). Last but not least, Duvigneaud’s name is still cited in environmental policy circles in Brussels, even if only as a general reminder of the importance of an ecological approach to urban planning.

In this chapter, I have been interested in the spatial dimension of the processes through which ecosystem theory took shape in Brussels. A first conclusion that can be drawn from this case study concerns the local processes through which the city was opened up as a space of ecological knowledge. As we have seen, ecologists did not only produce generic knowledge about ecological mechanisms of a place-less ecosystem. They also engaged with the concrete geographies of Brussels in locally specific and meaningful ways. This included negotiations with the city administrations to acquire relevant data, to mobilize financial and institutional support, and, to find resonance for practical
proposals. The mundane experience of living in the city also informed Duvigneaud’s understanding of urban ecosystems. In addition to all this, Brussels was a practical working ground where knowledge could be crafted by tinkering with pre-existing methods and the particularities of the urban research sites.

The second conclusion concerns the dynamics of circulation and appropriation in ecology. It has become clear, that Duvigneaud’s work followed broader changes in the international research agenda of ecology. This was the case with his studies in the Ardennes, in which he first adopted an ecosystem approach, and again when he transposed his approach from the forest to the city. This does not mean, however, that Duvigneaud’s work was simply a reflection of a uniform globalized ecological discourse. The spheres of circulation in which Duvigneaud’s work participated followed quite selective geographies. Whereas his work in the Ardennes developed in close exchange with US scholars, the center of gravitation soon shifted to Continental Europe. It was also primarily in Europe, that his work was received and known by other ecologists.

Moreover, ecologists’ negotiations and their engagement with the concrete geographies of the city were active forms of appropriation that articulated systems-ecology in a place-specific way. Although a comparison of the Duvigneaud group with ecologists in other cities is beyond the scope of this study, my occasional references to Berlin have at least revealed some interesting differences. In West Berlin, urban ecology evolved from the background of a long-standing tradition of civic naturalism and nature conservation that focused mainly on nature within the city. This led to a privileging of floristic analysis and biotope protection (Lachmund 2013). The research of the Duvigneaud group, by contrast, was framed by the group’s former experience in the IBP and in the Ardennes. This did not only imply a major focus on “biological productivity” (in contrast to biodiversity), but also on the goal to integrate all specific findings about the city in one overarching system-ecological model. Another difference between the two ecologies reflected the material features of the urban landscape in each city. Berlin had been severely bombed, and reconstruction only proceeded slowly after the war. The massive wastelands that existed in this city became attractive fieldwork sites and foci of civic activism. In Brussels, very few wastelands existed, and so the focus was more on official green spaces and the ecological effects of the built and industrialized core of the city. Brussels’ urban ecology was thus as much an instantiation of internationalized science as it was the product of locally established research practices, and the social and material opportunity structures of a particular place.

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Notes

1 For a detailed analysis of Sukopp’s work in Berlin, see Lachmund (2013). Throughout this chapter, I will refer occasionally to the Berlin case to highlight particularities of Duvigneaud’s work.

2 I use the term “group” here only to underline the collaborative character of Duvigneaud’s research not to make any claims about the actual social cohesion of these collaborations.

3 On Duvigneaud’s biography, see Tanghe (1992), Pierard and Duvigneaud (1992), and Meerts (2013; 2014).

4 Martin Tanghe, email to author, August 13, 2015; Denaeyer-De Smet, Interview with author, August 28, 2015. Until 1966, Duvigneaud benefitted from the support of Fredi Darimont, a biologist who worked as Director General at the Ministry of Research and Education (see also Duvigneaud 1977a:8).

5 Denaeyer-De Smet, Interview with author, August 28, 2015.

6 Most of the pictures were drawn by a former comic designer, Isidore Goedhuys, others by Duvigneaud’s assistant professor Martin Tanghe.

7 75 participants attended, most of them from European countries (Duvigneaud 1977a:8).

8 His idea of an ecological socialism remained vague. It also did not prevent him from a quite elitist biological determinism: According to Duvigneaud, everyone should be informed about their genetic makeup so that they could be realistic about their place within society (1969/70:21).

9 Denaeyer-De Smet, Interview with author, August 28, 2015.

10 On the tensions between laboratory and field, and attempts by researchers to insert features of the laboratory into fieldwork, see Kohler (2002).

11 Denaeyer-De Smet, Interview with author, August 28, 2015.

12 Duvigneaud arranged a visit of two of his doctoral students to the Forstbotanische Institut in Munich where they were to be trained in the use of a measuring device. Letters P. Duvigneaud to Professor Koch, February 25 and 25, 1971, Archive U.L.B. Box 253 PP 0096. Denaeyer-De Smet reports the critical role that the technicians had played in the fine-tuning of the measuring apparatuses (Interview with author, August 28, 2015).

13 It seems that, by 1974, Duvigeneaud had become disappointed about his collaboration in the I.B.P. woodland project. In a letter to David Reichle, program director at Oak Ridge laboratory, he complained about the participation of competing Belgian researchers in the concluding publication and reminded Reichle of the originality of the official Belgian I.B.P that he was directing. He announced that the results of the Belgian IBP would therefore be published in an independent volume (letter Paul Duvigneaud to David Reichle, June 7, 1974, Archive Université Libre de Bruxelles, box 253 pp. 005II).

14 Martin Tanghe, e-mail to author, August 15, 2014.

15 In 1969, architects and critical planners founded the Atral de Recherche et Action Urbaine (ARAU). A bit later, Inter Environment Bruxelles was established, an umbrella organization of various neighborhood initiatives, which had been formed in the previous years (Schoonbrodt, no year). Duvigneaud reacted partly on the same developments as these activists, but there does not seem to have been any significant interaction with them.

16 On the term “Brusselization,” see Romańczyk 2012.

17 Language conflicts were also virulent within the U.L.B. and resulted, in 1969, in its split.

18 Since 1986, many tasks of the Agglomeration were transferred to the emerging institutions of the Region, which in 1989, under the name “Region

19 For example, Tanghe remembers that he and Duvigneaud attended meetings of the F.D.F., at which environmental issues were discussed. Martin Tanghe, e-mail to author, August 13, 2014.


24 Serge Kempeneers, Interview with author, August 28, 2015. Kempeneers himself took a position at the IGBE and later became one of its directors.

25 He participated in a campaign to protect the “semi-natural” site of the Kauwberg, a patch of forest in the well-to-do suburban Brussels municipality Uccle (Duvigneaud 1990).

26 For example, Sukopp (1987) published an adapted German-language version of the scheme.

27 In this respect, Duvigneaud’s work dovetailed with the work of regional geographers who also emphasized the structural integration of the spatially extended Brussels “urban phenomenon” (e.g., Jouret 1972b).

28 The scheme of the Brussels ecosystem that was published in Duvigneaud and Denaeyer-De Smet (1977:589), Duvigneaud, Denaeyer-De Smet, and Tanghe (1976:B3.39), and Duvigneaud, Denaeyer-De Smet, and Tanghe (1977) showed other numbers for some metabolic streams than the version in Duvigneaud and Denaeyer-De Smet (1976:130).

29 Denaeyer-De Smet, Interview with author, August 28, 2015.

30 The work was conducted as a qualification thesis by Majerus, who published the results together with Denaeyer-De Smet (1974; see also Jouret 1972a:83 note 8). The study combined the method of transect with the selection of a network of sampling sites: Samples were taken from tree leaves (whose chemical content was considered an indicator of air pollution) and soil for different “stations” that were all located within the transects.

31 A recent example is the opening sequence of a public lecture by IGEB (https://vimeo.com/83992014, last visited August 20, 2015). Another, is the naming of a center for ecological documentation and education in Brussels after Duvigneaud (Centre Paul Duvigneaud).
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