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Closing the food-waste-farming cycle: Composting and Urban agriculture in Cameroon and Switzerland

FINAL REPORT

Dschang and Lausanne
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Abstract

Assuming that closing the food-waste-farming cycle has great potential to contribute to climate change mitigation, this interdisciplinary study sought to identify the opportunities and obstacles for urban agriculture using compost from kitchen waste in Dschang (Cameroon) and Lausanne (Switzerland). We found that the widespread knowledge and practice of urban farming and the abundance of compostable waste in Dschang hold promise for the adoption of compost-based urban agriculture but is severely constrained by deficient waste segregation at source and by inappropriate government policies. In Lausanne, by contrast, urban farming is limited, and compost from kitchen waste is scarce because of the adoption of complex waste treatment technologies (i.e., biomethanation). Nevertheless, the rise in urban gardening offers some prospect for closing the cycle through compost-making at the individual and community levels.

1. Executive Summary

The interdisciplinary research project entitled "*Closing the food-waste-farming cycle: Composting and urban agriculture in Cameroon and Switzerland"* aimed to study the opportunities and obstacles of using compost from kitchen waste for local agriculture in the cities of Dschang (Cameroon) and Lausanne (Switzerland) in view of their potential contribution to climate change mitigation and sustainable cities. We used a theoretical framework combining political ecology and social practice theory that allowed us to examine social practices, power relations, institutions, infrastructure and materialities in the food-waste-farming cycle. Based on household surveys and interviews with residents and stakeholders in Dschang and Lausanne, we examined the entire organic waste management chain/cycle from food consumption and waste production, waste management and composting, to compost use in urban farming. This social-science research was complemented by a soil-science assessment of the properties of local soils and the quality of different types of compost. Finally, a North-South comparison between Switzerland and Cameroon has produced policy recommendations and knowledge across contexts highlighting stakeholders' interest in implementing compost-based farming.

Food consumption, waste generation and segregation practices

Food consumption, waste production and segregation differ widely between Dschang and Lausanne. While households in Dschang eat mainly fresh products that come directly from the farms and local markets, the consumption of processed and packaged food is more widespread in Lausanne. This leads to quantitative and qualitative differences in the generation of waste, but in both cities, large amounts of kitchen waste are potentially available for composting.

In Dschang, only 30% of households but most restaurants segregate their garbage to separate waste that is useful to them, for example, for feeding animals, fertilizing fields, reusing, or reselling materials, thus defying standard categories used in 'scientific' waste management. Households mainly use uncovered buckets and plastic bags to store waste on the veranda or in the yard. Unsegregated waste is brought by children, most often by girls, to the curb or to neighborhood collection points for municipal collection.

In Lausanne, about 80% of our respondents (non-representative sample) separate out their organic waste, often motivated by the tax on garbage bags introduced in 2013. Households store kitchen waste in a separate bin, often layered by a plastic bag. The use of non-compostable bags contributes to the pollution of organic waste with micro-plastics. Biodegradable waste is collected by the city from the curb once a week (twice from restaurants) and from designated collection points. However, most of our respondents were not informed about the further treatment of their kitchen waste, leading to suboptimal practices.

Waste management and composting

In Dschang, about 25,000 tons of mixed waste are generated per year of which only 10,000 tons (40%) are collected by the municipality, particularly from the more central and accessible parts. Dschang is one of the rare medium-size cities of sub-Saharan Africa with a municipal organic waste treatment and composting system. Approximately 5,000 tons of waste (20% of the city's total waste production) are sorted and treated annually in two covered plants, co-financed by carbon credits and donor grants.

In Lausanne, a centralized biomethanation plant was introduced in 2017 and treats about 35,000 tons of kitchen and other organic waste from 30 municipalities of the region. Only a few individuals (mostly gardeners) produce compost from kitchen waste; commercial compost producers make it from green waste.

Compost use in urban agriculture

In Dschang, about 70 % of the households practice urban farming, urban gardening, or mixed farming, although urban agriculture is not supported by the municipal authorities. Farmers and gardeners are generally interested in using compost, but they use it mostly in combination with chemical fertilizers, which are heavily subsidized and promoted by governmental agricultural extension services. Home-made and municipal compost is often mixed with manure from chickens and pigs to increase its nitrogen content. With the support of local NGOs, organic farming (for which the use of compost is a necessity) is on the rise in Dschang.

In Lausanne, urban farming and gardening are much less widespread than in Dschang. However, the city promotes urban agriculture through the establishment of community gardens where it also provides composting units to dispose garden waste. Rather than using decomposed material from the community garden, however, community gardeners tend to purchase compost from the central composting plants or from supermarkets. Some of them also make their own compost from kitchen waste. In the longer established family gardens, individuals can rent a plot and very often produce their own compost from a mixture of kitchen and garden waste as chemical product are not recommended.

Quality of composts and soils

In Dschang, soils have relatively good chemical fertility, but a phosphorus deficiency is common. This deficiency can be addressed particularly by the application of compost mixed with manure, which contains high levels of bioavailable phosphorus. Yet, all tested composts had positive physical, chemical, and biological attributes for farming, except for one from one of the municipal plants, where the carbon to nitrogen ratio was too high, probably due to insufficient maturation. The soils in Dschang do not seem to be significantly polluted, but the use of compost presents a risk of eventually bringing (micro)plastics into soils.

In Lausanne, garden soils are very rich in organic carbon and have high levels of all major plant nutrients, probably due to long-standing compost use. Soil contamination with trace metals (zinc, chromium and lead from historical industrial pollution and copper from copper-based pesticides) is significant, but rarely exceeds official limits. The tested composts presented satisfactory physical, chemical, and biological properties. All soils contained microplastics and many composts had visible plastic macroparticles.

Opportunities and constraints

In Dschang, there is great potential for the expansion of compost-based urban agriculture. The daily waste collection system, which can be further expanded, provides fresh organic materials suitable for composting. Technologies have been tested in the local context and good-quality compost is produced for which there is increasing demand from the many local farmers and gardeners, some of whom are switching to organic farming. However, the lack of waste segregation at source presents a major obstacle for the economic viability of composting based on kitchen waste. Moreover, state policies, particularly the promotion of chemical fertilizers, act as a disincentive for the more widespread adoption of compost-based urban agriculture.

In Lausanne, the potential for closing the food-waste-farm cycle through compost-based local agriculture is more limited. Urban farming is less prominent and most of the kitchen waste is treated in biomethanation plants, the products of which are used mostly in commercial agriculture outside the city. Soil pollution is another constraining factor for urban agriculture. However, there is institutional support in Lausanne, particularly for the recently established community gardens, which provide an opportunity for some residents to start producing their own compost and use it on their own plots as has been practiced in family gardens for some time. In order to realize this, the skill levels of the new urban gardeners will need to be improved in each city, and the food-waste-compost-garden cycle needs to become more visible to people.

2. Final Scientific Report

2.1 Initial problem statement

Research rationale

Inappropriate solid waste management and industrial agriculture are both important contributors to global climate change. In turn, appropriate waste management and urban agriculture based on alternative methods have great potential to mitigate climate change. We assumed that the promotion of composting for urban agriculture has great potential to address both issues simultaneously representing a climate-change mitigation measure that can be promoted at national and especially local levels without any need for multilateral agreements or cooperation. Therefore, this research aimed to analyze the opportunities and obstacles of compost-based urban agriculture in Cameroon and Switzerland based on two case studies (Dschang and Lausanne).

Literature review

Uncontrolled decomposition of organic wastes on landfills and dumpsites produces methane, a GHG estimated to be 25 to 28 times more potent than carbon dioxide (Boucher et al., 2009). At the same time, industrial agriculture contributes the lion share of the 10-12% GHG emission by the agricultural sector because of fertilizer application, fuel-based production methods and long distribution chains (Lin et al., 2011). By contrast, urban agriculture shortens food chains and reduces transportation needs, but often relies on chemical fertilizers (Lin et al., 2011).

In Cameroon, smaller towns, in particular, are involved in the intensification of urban farming as food is shipped to big capital cities (Yemmafouo, 2014). In Switzerland, urban vegetable gardens are increasingly encouraged for sustainable food production and consumption (Felipe et al., 2014). In many European countries, community gardens have emerged to feed the city, beautify it and create social ties (Pourias et al., 2012).

While there is an abundant literature on food consumption, solid waste management and urban agriculture in diverse geographical contexts, the literature on the (potential) links between changing food (wasting) practices, municipal (organic) waste management, and urban agriculture is scarce and international comparisons are, to our knowledge, non-existent.

Hypotheses

The feasibility and success of urban agriculture using compost from kitchen waste depend on many interrelated material and social factors**.** First, the quality of the compost is crucial and depends on the "raw material" (influenced by food habits and waste segregation at source), as well as knowledge of composting methods. Second, the scope for composting is dependent on the availability of space and material arrangements at the household or the neighborhood level, as well as at the level of institutional food-waste producers (restaurants, markets, etc.). Not all food wastes may be available for composting due to their use in pig farms, for example. Third, institutional cooperation and coordination will be crucial but challenging as the relevant authorities are departmentalized. Fourth, urban gardeners in Switzerland, most of whom are from environmentally concerned middle classes, will be more inclined to adapt compost-based gardening than their counterparts in Cameroon, who tend to be from lower income groups and pursue farming as a livelihood strategy. In Cameroon, compost will need to be easily available to the farmers and relatively inexpensive to replace chemical fertilizer input.

Methods

The interdisciplinary project was divided in five Work Packages (WPs).

WP1-3 followed the food-waste-farming cycle from (1) food consumption and waste sorting, (2) organic waste collection and treatment to (3) compost use in urban agriculture. For these WPs we applied qualitative and quantitative social science methods.

In Dschang, we conducted a questionnaire survey with 265 randomly selected households from five diverse neighborhoods. The questionnaire covered all topics from WPs 1-3. Furthermore, we carried out semi-structured interviews – nine with representatives of restaurants and markets, six with waste managers, seven with stakeholders from the agricultural sector, 13 with farmers – and four focus groups, one with waste managers, another one with individuals making compost and two with farmers. Primary data collection was complemented by document analysis of policies and reports, as well as the review of master theses carried out in connection with this project.

In Lausanne, we could rely more on existing data on waste generation and urban agriculture. In addition, we collected primary data on food and waste practices at the household level (35 short interviews with residents, 18 responses to an online survey, and 12 in-depth interviews) and from restaurants and groceries (13 semi-structured interviews). Furthermore, we conducted expert interviews, eight on waste management and two on urban agriculture. We also observed family and community gardens and interviewed 14 farmers and gardeners.

For WP4, we drew upon experimental methods from soil science to assess the quality of local soils and different types of compost. In Dschang, soil samples from five sites, as well as samples from four composts, were collected, prepared and sent for laboratory analysis at UNIL. In Lausanne, soil samples from 10 urban family and community gardens and from 2 peri-urban farms were collected. Compost was collected from the same sites, when available, and from two commercial producers of compost. Topsoil, subsoil and compost were analyzed for texture, nutrient content and organic matter, as well as for contaminants (heavy metals, macro-plastics). Soil improvements attributable to compost use were assessed by comparing adjacent plots that were cultivated with different degrees of compost input.

WP5 represented interpretative, transdisciplinary, and policy-oriented research. Comparative analysis of the two case studies and cross-cutting themes revealed through urban political ecology, social practice theories and soil studies. We had planned to do meetings with novel methods for multi-stakeholder participation (Futures Wheels, World Café, etc.), but a lesson learned is how difficult was it to break free from more conventional presentations when working with local stakeholders. Also, we had to adapt to how it is done in Cameroon for the workshop there. In Lausanne, it was challenging to mobilize local stakeholders, particular officials to validate research results, build on and inter-connect key findings.

2.2 Results and analysis

We used Social Practice Theory (SPT) (Evans, 2011) and Urban Political Ecology (UPE) (Heynen et al., 2006) to structure and analyze our data. SPT helped us understand local practices (e.g., waste sorting, using compost) by considering three dimensions, i.e., meanings and social norms, knowledge and skills, and material arrangements. It also led us to highlight the importance of the interdependencies of various practices along the food-waste-farming chain/cycle (e.g., between waste sorting, storage, and disposal or between composting, compost use and cultivation methods). The understanding of local practices was complemented by UPE that allowed us to study social relations, including power relations and institutional arrangements, at larger scales (e.g., governmental support for particular waste technologies or fertilizer applications) and consider the dialectic between political-economic processes and biophysical characteristics (which in the case of soil and compost could be assessed with natural-science methods).

Food consumption, waste generation and segregation

In Dschang, food items supplied by urban markets and farms are mainly vegetables and tubers. About 0.65 kg of organic waste per person is generated daily. This amounts to an annual production of about 60,000 tons of humid household waste and 23,750 tons of dry waste (with a humidity rate of 60% or less). More than 83% of waste is biodegradable. Hence, large volumes of organic waste are produced and potentially available for composting.

We found that food waste in households and restaurants results from poor food preparation and planning, lacking infrastructure for refrigeration and storage, and social norms. For example, households and restaurants tend to cook whatever is available at a given moment. Badly prepared food, especially, is then consumed only partially and children, in particular, tend to waste a lot of food. The problem of food wastage is exacerbated in large households. Furthermore, 52% of the respondents of our questionnaire survey have no refrigerator and therefore no possibility to conserve leftovers. In these households, mostly from the lower social classes, leftovers are thrown out. While the (middle-class) households owning a refrigerator are able to conserve perishables, the tendency to store large amounts of vegetables can also lead to the cooking of too large quantities. Finally, social norms of serving more food than can be consumed, particularly at social occasions, contribute to food wasting. At the same time, eating someone else's leftovers is regarded as unhygienic and socially unacceptable.

Waste segregation at source is not a common household practice in Dschang. Less than 30% of the households sort their waste. People have generally not developed this habit yet as most is anyways biodegradable waste. Furthermore, the municipality has so far not promoted waste segregation at source. However, waste is segregated by households and restaurants when kitchen waste is seen usable (for making own compost or for feeding animals, particularly pigs) or sellable (to animal farmers or informal middlemen). Waste segregation is utilitarian and self-interested, and it does not follow the standard 'scientific' waste categories. In Dschang, where 16% of the households raise pigs, the reutilization of waste as animal feed has been the primary motivation for waste segregate.

In Lausanne, households usually buy their food from the nearest supermarket, appreciating the possibility to buy all needed products in one place and at a reasonable price. Most purchased food is wrapped in plastic and cardboard, although 33% of the respondents prefer unpackaged items. Half of the households shop for groceries every 3-4 days. At home, almost everyone stores perishable food in the refrigerator; a few put it in the cool cellar or at normal room temperature in the kitchen. However, not all have enough storage space: 33% of households reported that they still lack space to store their food. This leads to spoilage. Most households cook their breakfast and dinner at home almost every day of the week. They try to not prepare too much food to avoid wastage. Also, refrigerators are widely available for the keeping of leftovers. Leftovers are avoided or eaten the following day. There is not the same social aversion as in Dschang for not eating leftovers from other people.

Most of our respondents (80%) separate organic waste at home. Stored in a corner of the kitchen or on the balcony, this waste is kept in a bin, often layered by a plastic bag, until it is collected once a week or brought to a municipal collection point. The main motivation for sorting waste is financial; a tax on garbage bags going to the regional incinerator was introduced in 2013. For some respondents, waste segregation is also related to social norms associated with environmental concerns; they aim to limit the amount of waste to be incinerated. A few respondents sort out kitchen waste to make their own compost to be used in their garden. A few respondents (16%) do not separate biodegradable waste because of the smells produced in the house, the lack of compost containers in their apartment building and the absence of municipal

collection points nearby. Some residents stated that they generate an insignificant amount of biodegradable waste that would not make it worthwhile to sort it.

Restaurants in Lausanne sell non-consumed perishable food, snacks, and meals at a low price through the *Too Good to Go* smartphone app and they give them to their employees in order to reduce food wastage. Furthermore, waste segregation at source is a condition that the recycling company mandated by the municipality collects the garbage from the restaurant (twice a week). However, restaurants only separate food waste from non-food waste and do not sort other recyclables indicating that their waste practice is guided by material-institutional arrangements.

Municipal waste collection and treatment

In Dschang, about 25,000 tons of mixed waste are generated per year of which only 10,000 tons (40%) are collected by the municipality, particularly from the more central and accessible parts. To improve collection in other parts of the city, the municipal agency for waste management AMGED introduced 'participatory' pre-collection system in 2016. Three local organizations were mandated that collect about 2,300 tons per year from those households willing to pay a monthly fee (normally CFA 500 or CHF 0.75). Subscriptions and waste collected by means of tricycles have increased substantially since inception of the system. Collection by truck remains free of charge.

Dschang is one of the few medium-sized cities of sub-Saharan Africa with a municipal organic waste treatment and composting system. The daily collected mixed waste is brought to one of the two composting platforms at Siteu and Ngui. Here, waste is first sorted manually on tables; non-biodegradable waste and half-decomposed kitchen waste older than 72 hours are sorted out. This task necessitates almost half of the labor and therefore represents a significant cost of the composting process. In the past, workers would take fresh kitchen waste home to feed their animals; since, this practice has been banned. About 50% of the mixed waste collected is compostable. The covered platforms use the windrow composting method.

In 2022, about 5,000 tons biodegradable waste were used to produce nearly 550 tons of compost. (In 2015, when the project started, only a bit more than 1,000 tons organic waste could be treated.) The compost from the platform at Ngui, where pre-collection waste is brought in by small vehicles (e.g., tricycles), is generally of better quality than that from Siteu, which receives mostly waste from municipal collection by (compactor) trucks that is sometimes already partly decomposed. All compost produced at the municipal platforms can be sold. More than 60% of it goes to large users outside Dschang (see below). However, the income from sales covers only 48% of the production cost. The system is co-financed by an international cooperation project and carbon credits.

AMGED also promoted composting from kitchen waste at the community level. This practice adds only about 22 tons of compost per year and does not fully meet the demand of the participants. The discrepancy in tons of compost produced between the municipal and the community systems is related to the technology used. Community composting is done in containers that cannot hold large quantities of waste. This project was developed as an educational tool. The idea was essentially to encourage urban farmers to adopt compost-based farming and to create additional demand for compost from the municipal platforms since the amount of compost produced is small and households have to buy municipal compost which is produced in large quantities. Furthermore, individual gardening and farming households are encouraged in sorting waste at source to make their own compost from kitchen and yard waste, sometimes adding chicken manure. The production of individual compost cannot be estimated easily.

In the Canton of Vaud where Lausanne is located, 370,026 tons of 'urban waste' were collected in 2020, of which 21% was 'biowaste', according to official statistics. In Lausanne,

organic waste management is integrated in the general solid waste management system underpinned by municipal directives on sorting, collection, treatment, and disposal that are specific to particular waste generators (e.g., household, restaurants) and types of waste. Waste collection is organized by an urban cleaning service according to a defined schedule. Specific containers allow weekly door-to-door collection of organic waste from households. In addition, there are about a hundred of collection points and waste disposal sites distributed over the city and its surrounding, where residents can bring their kitchen waste at any time. Biodegradable waste is collected twice a week from restaurants (once a week in winter) by a private company or by the City of Lausanne, whose service is often seen as less expensive for the owners. These partners collaborate with collection companies and waste transformation and recovery sites, such as the industrial bio methanation centers: Ecorecyclage in Lavigny and Axpo Kompogas in Chavornay, which treat all the bio-waste collected by the City of Lausanne. These centers process food products and produce a form of natural fertilizer, called digestate. In establishments where there is no time to separate organic waste from other waste, the choice of a private company become advantageous, and perhaps the most economical, as the sorting will be done by the collection company. Since garbage is paid by weight or volume, when the city is responsible for collection, restaurant operators are forced to sort organic waste carefully so as not to add to the garbage load. The logistics around waste collection for the grocery stores surveyed are simpler than for the restaurants. They take advantage of dumpsters placed either in front of the building or inside. In these cases, collection is door-to-door, and the dumpsters are often the same as those used by households located in the same building or around the grocery store. The food waste collected by the City of Lausanne is then transformed at the Lavigny and Chavornay sites, where it is also transformed into gas or natural fertilizer (digestate).

Door-to-door collection of biodegradable waste has existed in Lausanne since 1989. Households were supposed to dispose only yard and raw kitchen waste in the green containers that was destined for treatment at the city-operated central composting plant. However, the organic waste management system changed significantly in the 2010s. The introduction of the tax on garbage bags in 2013 altered the waste composition in the green containers toward an increased proportion of kitchen waste that is poorly structured and moist compared to the previously dominant yard waste. To treat this new mixture of biowaste and allow the processing of cooked kitchen waste, too, biomethanation was seen as advantageous over composting. Government authorities also supported this technology because it produces renewable energy. Since 2018, almost all kitchen waste from households in Lausanne goes to a subcontracted private biomethanation plant, which produces energy (from methane), as well as liquid and solid digestate sold to (rural) farmers as 'natural fertilizer'. However, residents are generally unaware of the changed and largely invisible treatment system and do not put cooked kitchen waste in the green containers. Some of these containers are still labelled to be used for raw vegetable waste only, thus leading to further confusion.

Compost use in urban agriculture

Urban agriculture is an important subsistence and commercial activity in Dschang, where about 70% of the households practice urban farming, urban gardening, or mixed farming. However, urban agriculture is not supported by municipal authorities, which claim that high-growth fields represent a security risk, nor through national policies.

Urban farms are generally larger parcels of land (more than one hectare) located mostly at the urban periphery on state land reserves and private lands. Cereals and tubers are the most predominant crops grown, primarily in the wet season only due to limited irrigation

possibilities. 70% of the farmers use chemical fertilizers, which are heavily subsidized by the national government and promoted through the deconcentrated agricultural extension service (which also encourages compost production). When choosing between synthetic fertilizers and organic compost, farmers primarily consider costs and short-term yields rather than product quality and soil conservation. Nevertheless, farmers and gardeners in Dschang increasingly apply chemical fertilizers selectively. For example, they mix it often with organic manure. Furthermore, compost use is on the rise, but many farmers combine it with chemical fertilizers. Farmers have also started to mix compost (75%) with manure from fowl and pigs (25%), locally known as agro-compost and adding much-needed nitrogen (see below). The traditional practice of dumping waste to let it decompose naturally (a form of mulching) continues to be practiced widely. Finally, organic farming is gaining importance as many residents begin to understand the negative health consequences related to the consumption of products grown with chemical fertilizers.

AMGED has developed technical guides, set up demonstration plots and organized field schools to transmit skills regarding proper application of (municipal) compost. Still, many households and smallholders are not knowledgeable regarding compost use and therefore do not make or buy it. By contrast, more than 60% of the municipal compost produced in Dschang is sold to large farms and professionals outside the city who know how to put compost to use. For instance, a corporate banana plantation in the Littoral region ordered 400 tons of compost in 2020. Compost from Dschang was also used in planting carpet grass at a football stadium in Douala. Some has been taken as far as to Kyosi, a border town to Equatorial Guinee. This demand is an indication of the quality of the compost produced from municipal waste in Dschang but also reduces the supply available for local farmers and gardeners. Moreover, compost transported 40km to 60km annihilates the climate mitigation benefits. However, compost sale to corporations seems more lucrative than getting carbon credits.

In Lausanne, we identified three forms of urban farming: community gardens, family gardens and professional farms often located in the urban periphery.

In 1996, the city introduced a number of agricultural policies to promote local food supply, direct relations between farmers and consumers, and the provision of school canteens with organic food from local farms (Mumenthaler, 2019). Lausanne is a pioneer city of urban gardening and claims to be the capital of urban agriculture; it connects with other municipalities to share experiences with farming practices and conducts studies to inform the promotion of local food consumption. The municipality also runs a green city initiative to motivate residents to take up gardening.

Under this general policy, the city of Lausanne has provided allotments for collective gardening in dense urban neighborhoods since 1996. These community gardens cover about 15,000 m^2 and allow 350 citizens to cultivate a few square meters of land (ranging from 6 to 48 m2) within a five-minute walk from home. Demand outpaces supply; plots are given on a 'first come, first served basis and there are waitlists. Plots are rented annually for a symbolic price of CHF 3 per m^2 per year and a registration fee of CHF 20).

The (often new) gardeners of the community plots do not only seek to produce their own food but also enjoy the contact with nature more generally. Often driven by environmental consciousness, they are very motivated to using compost. However, some of them mentioned that they lack knowledge regarding composting techniques, assessing the suitability of compost and its proper application on their plot. Therefore, only a few of them make their own compost from kitchen waste. Furthermore, composting units have been installed in community gardens and are managed by the municipality. However, they cannot be used for kitchen waste but only for garden waste. Moreover, the infrastructure seems inadequate (e.g., water taps necessary for

watering the compost are far from the units), the maintenance and operation by the city is insufficient (e.g., lack of regular compost turning), and users utilize the units more as dumps for all garden waste. Consequently, the compost produced is of inferior quality (as confirmed by our laboratory analysis, see below) and many gardeners do not use it but rather buy commercial compost from retail shops or from central composting plants at the urban periphery.

Family gardens have a longer history in Lausanne than the community gardens. About 600 family gardens operate in eight designated areas across the city. The plots between 100-300 m^2. are bigger than in community gardens and they are mostly used by experienced gardeners, representing 37 nationalities. These plots are in high demand and do not change hands often. The family gardeners have the skills to make their own compost combining kitchen and yard waste on their plot and to apply it correctly.

Finally, compost is also produced in centralized organic waste treatment plants, not from kitchen waste but only from green waste. Different types and qualities of standardized compost are sold directly to the end users. As indicated above, kitchen waste collected by the municipality is treated in biomethanation plants, which produce liquid and solid digestate that is used by professional farmers. While this digestate is rich in nutrients, it lacks organic matter and the favorable physical and biological properties of compost.

The peri-urban farmers cultivate bigger fields (about 8 hectares) and are mostly organic farmers selling their produce in local markets. They use commercial compost but most of them started to make their own, from kitchen and farm waste, to save transportation costs and avoid plastic contamination. Some purchase digestate but find it difficult to spread it on the fields without huge machinery.

Quality of soils and compost

Soils have been formed from volcanic rocks and ejecta in Dschang, whereas they have been built from 'recent' glacial till deposits in Lausanne. This difference in parent material explains some of the observed differences in macronutrient content.[1] Dschang soils have a very high cation exchange capacity[2] and magnesium saturation, which is typical for volcanic weathering products. Soils in Lausanne are young in geological terms and contain limestone fragments, which maintain a high calcium saturation. The difference in parent material also influences trace element content. Dschang soils are notably richer in geogenic trace elements.

Lausanne soils contain more organic carbon than Dschang soils, and despite having a slightly lower cation exchange capacity (CEC), they have essential macronutrient values well beyond the "satisfactory" threshold. The long-standing use of compost or other organic amendment is thought to have contributed to this organic matter and nutrient accumulation. It is known that tropical soils are commonly less fertile than temperate soils. Nevertheless, Dschang soils have a significant CEC and sufficient levels of macro- and micro-nutrients (except P) to have good fertility (see table below).

	Cation exchange capacity	Bioavailable Phosphorus	Bioavailable Potassium	Bioavailable Magnesium	Organic Carbon
Dschang	++	—	+	+	±
Lausanne	+	++	+	+	++

[1] The elements N, P, K, Mg and Ca are among the essential macronutrients, which must be present in relatively large quantities in soils (Weil & Brady, 2017).

[2] Cation exchange capacity determines the soil's ability to hold positively charged ions. It influences soil structure stability, nutrient availability, pH and the soil's reaction to fertilisers and compost.

However, due to the longer soil weathering history, there is a P deficiency in the volcanic soils around Dschang. It would be important to use as an amendment, a compost rich in P: Agro-compost seems to be a solution. This mixture of composts with animal droppings greatly changes the nutrient content compared to simple compost: N, P and K are significantly higher. Adding phosphate fertilizer without considering the needs of the crop in question would not be useful, because up to 90% of the P is fixed 24 hours after application to the soil. However, compost increases the content of other elements in the soil, allowing a greater development of the plant, including its root network, which can thus take more P available in its environment. Overall, Dschang soils have a lower organic matter content and lower available phosphorus than Lausanne soils, and compost applications may be particularly beneficial to these soils. This has been confirmed by the comparison of differently treated soils in Dschang. Topsoil covered with uncomposted kitchen waste (mulch) have lower values in most of variables than soils amended with municipal compost, and much lower values than soils amended with agro-compost.

Regarding contamination, lead, zinc, copper, and chromium are found in greater quantities in all Lausanne soils, with some sites exceeding the limits officially defined in Switzerland. Much of the pollution by trace metals may be old, since several trace elements have been used by humans for several thousands of years (Alloway, 2013), or linked to automobile traffic, and to city development. The lead pollution detected in some of the soils probably finds its source in the historical use of coal, as the lead content was strongly correlated to the number of particles representing coal burning residues. The copper pollution likely originates from the continued use of copper sulphate as a pesticide. Furthermore, more than half of the composts in Lausanne contain excessive amounts of chromium, copper and nickel. Only the municipal compost contained cadmium.

Plastic contamination was widely detected in soils and composts of Lausanne. Four soils (out of ten) showed microplastic content in excess of 1 particle per gram. The microplastic content of soils was correlated with the macroplastic content of compost, suggesting that compost application may be a source of plastic pollution for soils. The accumulation of plastic in soils is an important issue since it has been shown that plastic threatens soil quality, either by leaching toxic compounds such as endocrine disrupters or by sorbing other contaminants, which may subsequently be released to the soil (Bläsing & Amelung, 2018). (We were not able to measure the highly publicized dioxin levels in soils stemming from old-generation waste incinerators of the 1950s and 1960s.)

Dschang soils and composts were globally under the regulatory limits for trace metal contamination except for cadmium, which was found to exceed the limit in Ngui municipal compost and agro-compost. Cd may come from battery present in organic waste before sorting. There were also less microplastics detected in Dschang soils compared to Lausanne and the arbitrary threshold of 1 plastic particle per gram was not reached at any of the sites. Overall, Dschang soils have less contamination than Lausanne soils. More knowledge is needed on individual practices, knowing that plot management can strongly influence the quality and fertility of soils and compost.

2.3 Conclusion and outlook

The study points to a different set of opportunities and obstacles of compost-based urban agriculture in Dschang and Lausanne in view of potential climate change mitigation.

Dschang is one of few medium-sized cities in Sub-Saharan Africa that manages its waste by producing quality compost for agriculture rather than dumping or landfilling it. The experience of Dschang, including its use of carbon credits, is therefore worth to be shared with other agricultural cities. However, Dschang’s system can be optimized particularly by introducing kitchen waste segregation at source to reduce costs of compost production and enhance the quality of the product. This could also reduce the dependence on external funding. An expansion of the daily waste collection system could increase the volume of compostable materials. Yet, it should not replace the informal practice of using kitchen waste for animal fodder that already represents a closed food-waste-farming cycle. Furthermore, the application of agro-compost is promising on the volcanic soil that is poor in phosphorus; municipal compost may be enhanced in a similar way if sufficient chicken and pig manure is available.

The large number of households engaged in farming and gardening represents another opportunity to expand compost-based agriculture in Dschang. Furthermore, the generalized knowledge on agricultural practices is an asset but remains to be complemented with knowledge on the proper use of compost. However, the government subsidies on chemical fertilizers present a bigger obstacle and disincentive for the adoption of compost-based agriculture, because farmers primarily consider costs and short-term yields when choosing between fertilizers and compost. This weighs heavily because the absence of governmental support for composting and urban agriculture. Also, Cameroon is still in the process of developing a policy on organic agriculture while the demand for biological products is on the rise and semi-formal certification processes have been put in place.

In Lausanne, the potential for closing the food-waste-farm cycle through compost-based local agriculture is more limited. Although the proportion of households who segregate organic waste is high, most of the kitchen waste is treated in biomethanation plants and therefore unavailable for composting. Biomethanation is promoted by government agencies as it produces renewable energy, which is in high demand. Furthermore, the natural fertilizer produced through biomethanation is mostly used on commercial farms outside the city. In general, the organic waste treatment system is disembedded from everyday life experiences and invisible to residents. Lack of information on the organic waste change also contributes to confusion and suboptimal waste segregation practices. Another obstacle is that the collection and treatment systems for organic waste in Switzerland vary from municipality to municipality, which creates confusion among new residents regarding the treatment of kitchen waste from the household to the farm.

Farming is generally less prominent in Lausanne because of the economic structure and high urban density. (Historical) soil pollution is another constraining factor. Unlike in Dschang, however, the City of Lausanne provides strong institutional support for urban agriculture. The municipality established community gardens, which provide an opportunity for some residents to start producing their own compost and use it on their own plots. To realize this, however, both the composting infrastructure and the skill levels of the new urban gardeners will need to be improved. The practices of the longer-established family gardeners may thereby be useful inspiration, as well as information on the food-waste-compost-garden cycle.

Coming back to our initial hypotheses, the study confirmed the importance of waste segregation at source for providing appropriate ‘raw material’ to produce quality compost. However, waste segregation at source also proved to be important for the economic viability of (municipal) composting, as exemplified by Dschang. We rightly hypothesized that not all food waste will be available for composting, but the research showed that the diversion of kitchen waste for biomethanation is much more important than for pig farming in the case of Switzerland. Furthermore, compost effectively needs to be easily available to farmers and relatively inexpensive to replace chemical fertilizer input in Cameroon. Finally, lack of institutional

coordination indeed constrains the adoption of compost-based agriculture. In Dschang, for instance, there is a mismatch between national agencies subsidizing chemical fertilizers and some municipalities promoting composting. In Lausanne, there seems to be no links between the service responsible for waste management and the department promoting urban agriculture.

On a more general level, the unconventional comparison across the N-S divide brought to the fore that the simpler waste management system in Dschang allows for very short food-waste-farming cycles (e.g., composting at home, feeding animals with kitchen waste) while the complex and technicized system in Lausanne breaks up and diffuses materials (e.g., urban kitchen waste becoming electricity consumed regionally, as well as liquid and solid digestate distributed on rural fields) and renders processes invisible to residents.

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3. Output and impact report

Scientific publications

The coronavirus pandemic has delayed project activities including the drafting of working papers, but the team members have developed a publication strategy (see below). We do not expect to be able to publish all seven articles but intend to submit at least 3-4 papers by the end of 2022. Apart from the future publications in academic journals and edited books, 11 master thesis were completed in connection with this project and some blogs were published. Furthermore, some field reports have been turned into working papers.

Working papers and publication strategy

- Makamté-Tardy, R., Howarth, H., Véron R. & Sahakian M. (To be submitted by November 2022*).* ***Making kitchen waste visible: opportunities for composting among Lausanne households.*** Worldwide Waste Journal.

- Moye E., Yemmafouo A., Sagne J., Makamté-Tardy, R., Marlyne S., Véron R. (To be submitted by November 2022). ***Challenges in Organic Waste Segregation at Source. An analysis of Practices Among Households and Restaurants in Dschang, Cameroon***. Waste Management Journal.

- Bijedić A., Makamté-Tardy R., Véron R. & Sahakian M., (In preparation). ***Pratiques de tri de déchets alimentaires par les restaurants et commerces : opportunités de compostage à Lausanne***. Journal VertigO.

- Makamté-Tardy R., Véron R., Mumenthaler C., & Sahakian M. (In preparation). ***Compostage et jardinage à base de compost : opportunités et défis à Lausanne.*** Journal Vertigo.

- Véron R., Sahakian M., Makamté-Tardy R., Yemmafouo A., Moye E. (Planned). ***Closing the food-waste –farming cycle: Operationalizing social practices and political ecology.*** Geography Compass journal or C&S.

- Véron R., Sahakian M., Yemmafouo A., Makamté-Tardy R., Moye E. Sagne J., Mumenthaler C., & Grand. S. (Planned). ***Promoting compost-based urban agriculture: Comparative analysis between Dschang and Lausanne***. (Inspired by the final report). *Sustainability* Journal/VertigO.

- Fisher I. Giovannini David, Moundjeu E. Sagne J. & Grand S. (Planned). ***Fertility and quality of soils and composts in Dschang and Lausanne***. International Journal of Recycling of Organic Waste in Agriculture.

Blogs

Véron, R.; de Silva, M.; Fernando, N.; Ghale, Y.; Hollenbach, P.; **Kongnso, M.E**.; Myat, S.S.; Neville, L.; Samarakoon, D.; **Tardy-Makamté, R**.; Tularak, P.; Upreti, B.; Upreti, D.; Vidyaranya, V.; **Yemmafouo, A**. (2020) The Coronavirus Disrupts Waste Practices and Raises Awareness. Blog. Waste Of(f) Life Website.

Véron, R. (2022, August 16). What Swiss cities can learn from solid waste management in an Indian state. Blog. *Nextrendsasia* Website. *Swissnex.*

Master theses

BIJEDIC Amina (2022). Les pratiques de réduction des déchets alimentaires dans l'industrie du commerce de détail et de la restauration à Lausanne : quelles opportunités pour le compostage ? Mémoire de master. Université de Genève.

COIFFIER Yannick (September, 05th, 2022). *L'utilisation du compost en agriculture urbaine au Cameroun : le cas de la ville de Bafoussam*. Mémoire de master. Université de Lausanne.

DJOUGUE Annie (2020) Élaboration d'un web-SIG pour le suivi des acteurs de l'agriculture biologique à Dschang. Mémoire de master, Université de Dschang.

FISHER, Isaline (July 2021) Urban agriculture: soil quality, fertility, and compost quality, in the cities of Lausanne (Switzerland) and Dschang (Cameroon) — a comparative study. Mémoire de master. University of Lausanne.

GATAT N. Hyacinthe Radinovick (2020) Consommation alimentaire et production des déchets dans la ville de Dschang. Mémoire de master, Université de Dschang.

GIOVANNINI David (May 2021). Étude exploratoire sur la fertilité des sols d'agriculture urbaine, la qualité des composts et leurs interactions en ville de Lausanne. Université de Lausanne

HOWARTH Hannah (2022). Using Social Practice Theory to gain a deeper understanding of the practice of separating out organic waste to discover new opportunities for composting. Master Thesis. University of Geneva.

KOUKEM SOGANG Raïssa (2020) Utilisation du compost dans l'agriculture urbaine à Dschang et ses environs (Ouest Cameroun). Mémoire de master, Université de Dschang.

NGOH TITA Russel (2020) Waste management in Dschang, implications and stakeholders. Master Thesis. University of Dschang.

TAILLY Nathalie (2021). Transition vers l'agriculture biologique : intégration et reconnaissance. *Cas de la ville de Dschang, Ouest-Cameroun*. Mémoire de master. Université de Lausanne.

TANGMOUO TSOATA Francis (2020) Agriculture urbaine et intégration dans l'aménagement urbain : Cas de la ville de Dschang, Cameroun. Mémoire de master, Université de Dschang.

Field reports

Fisher I. (2022). *Study report on the fertility and quality of soils and composts in Dschang and Lausanne*. Report.

Yemmafouo and al. (2022). *Synthèse des résultats*, *Dschang*. Report.

Yemmafouo and al. (2022). *Policy brief Cameroun*. Report.

Moundjeu E. (February 2021): Report on soil sampling in Dschang.

Moye E. (September 2020) Data collection via interviews and focus group discussions. Report. Université de Dschang.

Moye E. (September 2020) Fieldwork diaries in Dschang, report.

Tardy-Makamte R. (October 2020), data collection and fieldwork diaries in Lausanne, report.

Tsoata F. Yemmafouo Aristide, Moyé Eric. (4-18 septembre 2020). Rapport des enquêtes de terrain du projet agricom-snis via questionnaire. Dschang, Université de Dschang.

Moye E, Tardy-Makamte (March 2020) Report on the inception workshop in Cameroon. 9- 13th March, 2020, University of Dschang, Cameroon_Campus A Hall: URCLIREN.

Tardy-Makamte, Moye E, All AgriComp team (June 2020). Research Design and field tools on food-waste-farming cycle' SNIS project.

International conferences, panels, and workshops

Online via Zoom, July 18th from 9 am to 11 am CET *"**Decolonizing North-South research collaboration**"*. Gathering *principal investigators, project coordinators, and project leaders from and/or based in the Global North*. The project is a collaboration between the centre for Development and Environment (CDE) and the Commission for Research Partnerships with Developing Countries (KFPE) about Decolonizing North South research collaboration aiming at critically reflecting on the 11 principles and 7 questions. Within the framework of this project, the workshop aims at understanding the current state of North-South research collaboration from a "decolonizing" perspective and at reflecting on opportunities and pathways to decolonization.
Participant: Rolande Tardy

Bern, Switzerland. 28.-29.10.2022. ***Decolonizing Swiss-Africa research collaborations***: 7th Swiss Researching Africa Days organized by the Swiss Society for African Studies. The objective of this biennial convention is to promote the exchange among the community of researchers working on Africa in Switzerland. Panels typically integrate young and established scholars (Master, PhDs, postdocs, professors).

Participant: Rolande Tardy (awaiting confirmation from the organizers). ***Communication: Swiss-Cameroon research project collaboration on the food-waste-farming cycle.***

Berlin, Germany. 5th - 7th of October 2022: V Midterm Conference of European Sociological Association's Research Network 37 (Urban Sociology). The conference general topic is ***"Seeing Like a City / Seeing the City Through".*** The panel focuses on urban nature considering it through the notions of care, sustainability, enchantment, and commodification. The conference hosted by the Georg Simmel Center for Metropolitan Research (Humboldt-University Berlin) in collaboration with Sektion Stadt und Regionalsoziologie, Deutsche Gesellschaft für Soziologie, with a Young Sholars' Pre-Conference Day on October 4. *Participant: Rolande Tardy.* ***Communication: Gardening in the city of Lausanne: between environmental concerns and food production.***

Yaoundé-Nkolbisson, Cameroun. Du 24 au 26 novembre 2021. **Colloque pluridisciplinaire :** *« 25 ans de la Loi n°96/12 du 5 août 1996 portant Loi-cadre relative à la gestion de l'environnement au Cameroun : implications écologiques, juridiques, politiques et socioéconomiques »* CRESA Forêt-Bois.
Communication 1: Local political framework for organic waste management in Dschang, Cameroon. An urban political ecology perspective. *Participants:* Moye Eric Kongsnso & Yemmafouo Aristide, University of Dschang, Cameroon.
Communication 2 : Insuffisances de la loi -cadre de l'environnement dans la promotion de l'utilisation du compost en agriculture au Cameroun. *Participants :* Joël Sagne Moumbe et Aristide Yemmafouo, Université de Dschang.

Impact

Four workshops were organised during the project, starting from the inception workshop in March 2020, then a Zoom mid-term workshop in June 2021 and two final workshops in Cameroon and Switzerland in March and May 2022. Enriched discussions revealed that compost-based urban farming in the dissimilar systems is still to be promoted in each country by the means of diverse and localized drivers including governmental incentives. The following are some academic and general impacts of our project results including the policy impacts

Various publications for a wide audience are out, while academic publications are upcoming. The project has brought about a novel combination of the UPE and SPT and a novel comparative research.

Junior and senior team members participate in collaborative peer-reviewed publications in English and French (see above). These publications contribute to the academic literature on food-waste-farming cycles in the global South and North, and more generally to an urban political ecology of food waste and urban agriculture drawing from social practice theory on consumption and soil science. Furthermore, individual team members are disseminating project findings in national, regional, and international conferences, and through blogs for which other funding instruments are used.

In terms of larger practical and policy impacts, the project has produced diverse outputs through local media including newspapers, social media, and a short documentary to inform general

audiences in Cameroon and Switzerland. Era, the project partner in Cameroon, is preparing a 10-minute documentary for online broadcasting. In Switzerland, these methods serve as a medium for the diffusion of research findings and recommendations to a large audience.

A policy dialogue was organized in each country through personal visits. Stakeholder workshops permitted to raise interest in our research, validate and share results, and draw out policy implications based on the findings across all field sites. During the final workshop sessions, room was given for questions and general deliberations.

In the final workshop in Dschang, the first roundtable had two types of panel participants: councilors from Dschang, Mbouda, Foumban, Bonaléa, on the one hand, and de-concentrated government services including Divisional Delegates from MINADER (Ministry for Agriculture and Rural Development), MINHDU (Ministry for Buildings) and MINEPDED (Ministry for the environment). The second roundtable includes associations and services of waste management (GADD, CIPCRE, HYSACAM) and agriculturalists (Jardin polyvalent de Ntsingbeu, Semences d'avenir, AGRO-ANKH).

It was interesting to see that the example of Dschang council has inspired other councils to adopt composting, adapted to their particular geographical and agro-ecological context.

For example, we had an interesting intervention by the Delegate of the Ministry of Agriculture claiming that MINADER has encouraged compost production and use at the local level. However, nothing is done at the national level in terms of policies Locally, chiefs of agricultural posts have been trained on how to manufacture and use compost. These agents have been extending the techniques to farmers. The delegation has noticed that prices of mineral fertilizers and fowl dung are rising in the market but that of compost is stable. Despite the promotional prices, adoption and usage is timid. So, a lot of sensitizations is needed. In the same line, the MINEPDED remarqued that Compost production should be subsidized in the same manner as mineral fertilizers. Training, education, and sensitization should be improved upon in order to increase the rate of compost use.

In Lausanne, the final workshop saw the participation of almost all team members and students, but also of a few representatives of different services of the city of Lausanne, gardeners, and actors of the waste management service. Some researchers, an international organization member from Neuchâtel, and the SNIS team from Geneva also participated. A journalist from Heidi news covered the event and published a related article.

In general, participation of decisionmakers in Dschang was excellent. In Switzerland, this was more complicated – a lesson learnt - as many stakeholders were not available and the Covid context was not yet that over for more effective in-person participation. However, the connection with the City of Lausanne continues.

The international and multidisciplinary project allowed us, first**,** to communicate with a wide range of people, e.g., through direct contacts with stakeholders, by organizing meetings and conferences, and even through the media.
Second**,** regional representatives in Cameroun have learned a lot from the Dschang city experience with organic waste collection during the stakeholders’ meetings. They showed interest in implementing the process in their respective cities when relevant.
Third**,** some of our master students have pursued their career in the themes of our project. For examples, Mr. Francis Tsoata started a PhD in Canada on urban agriculture in Africa. After

their defense, the two master students from the soil science field were directly engaged in environmental services on soils quality in Switzerland. Furthermore, Amina Bijedic one of our master students from the University of Geneva is setting up a new project on waste recovery on the island of Sainte-Marie in Madagascar, making a link with her work on compost made up of restaurant and grocery waste.

Finally, the project intends to have wider reach and impact through its association with AIMF (International Association of Francophone Mayor). Locally elected councilors are likely to be interested in our research findings, as solid waste management is increasingly perceived as a problem and new approaches are tested. In Cameroon, for example, the Association of Mayors of Municipalities and United Cities aims to collectively promote composting for agriculture.
In Switzerland, the team pursues collaboration with the city of Lausanne through AIMF (International association of Francophobe Mayors).
AIMF runs a knowledge-sharing program on essential services, including solid waste management, as well as an annual workshop of the Commission on Urban Sustainable Development and Environment. We expect to participate in their international workshop on climate change, urban agriculture, and towns. Discussions with the City of Lausanne are in progress regarding the next meeting in spring 2023 and how we could play a role there. Depending on the findings of our research, compost-using urban agriculture may become a future theme of this annual workshop.

The final workshops in Lausanne and Dschang had the Swiss and Cameroon project teams together, national, and local authorities and local actors involved in the promotion of compost-based farming in Dschang and its environs. A policy brief was elaborated subsequently for the respective stakeholders, and we intend to develop it based on our report and to translate it into an AGORA communication project where research meets the public.

Published papers / working papers /book chapters, etc.
Apart from the articles for blogs already available online, the project is yet to publish scientific papers upcoming as indicated above in the list of publications. Three draft manuscripts (on kitchen waste practices by households in Lausanne, on organic waste segregation in Dschang, and on soil studies) are attached to this output and impact report.
The master theses and the other reports are available on request.

4. Final financial report (Separate document).

5. The 'Internal report'

Could the original research planning be followed? If not, where had it to be adapted and why?

Our original research planning was completed, but we had to follow an adjusted timeline. In fact, the coronavirus pandemic resulted in a lockdown for more than three months in 2020, in both Cameroon and Switzerland. This disrupted our original research plan and implied delays in the achievement of milestones. We had to adapt our plan, for example, beginning with desk research and activities we could accomplish remotely. Therefore, our field work as well as in-person workshops were completed months later. In 2021, a remote fieldwork was initiated for compost and soils samples in Dschang, collected by an expert scientist that we recruited. The samples were sent to Switzerland by the local team for lab analysis by soil sciences members at the University of Lausanne. One of our principal members in Switzerland went on her maternity leave from September 27th, 2021, to January 27th, 2022, and the project benefited a co-funding from the Faculty of Geosciences and Environment of the University of Lausanne from January to April 2022.

Fieldwork was delayed but finally completed. These delays, however, have affected the other phases of the project such as data treatment and analysis, which had pushed back the drafting of working papers. Work on WP5 (Analysis integration and Policy) has been completed with a delay. The mid-term and policy workshop in Dschang (originally planned for February 2021) has been postponed given the increased COVID cases in Cameroon and was done in June 2021. The final workshops were done in March and May 2022 in Lausanne and Dschang respectively.

How did the collaboration within the project evolve?

Our team experienced an effective project governance. Regular project meetings were organized by Zoom: 26 February 2020, 26 June, 30 September, 15 December, 30 March 2021, 22 June and 11 December. These meetings involved all team members, including master students. The discussions were on ongoing activities, achievements, and the next steps according to the timeline of the project. Meeting minutes were prepared by our postdocs and shared with the whole team in a timely manner. Meetings in smaller groups (country teams, teams around particular Work Packages) took place whenever required.

As for the three project workshops, a three-day midterm workshop on Zoom was organized on 22-24 June 2021. Then, the four-day final workshop in Switzerland gathered in-person all the principal projects' members of the two countries from 28 to 31 March 2022 where the invited stakeholders participated in the one-day discussions on 29 March. Another final Workshop took place in Cameroun from 12 to 14 May 2022 again with all the principal team members and local stakeholders.
Information and research data were deposited on a (secured) folder on Switch Drive that is accessible for all partners. This ensured full transparency within the international team. It also allowed the team to develop the research design, fieldwork guides and findings in a collective way.
A sign for the strong collaborative spirit of the project, and particularly the high motivation and dedication of the Cameroonian team, is the fact that the team members in Dschang pre-financed

part of the final workshop activities and the expenses as the funds was use for unexpected activities such as remote fieldwork conducted by an expert in Cameroon, that we had to organize due to covid-19 impact delaying our fieldwork for soils and composts collection in Dschang. Hence, the project managed to disburse the last installment of their budget via UNIL, including reimbursement of all the relevant expenses, after the Swiss member were back from the final workshop in Cameroon. The team from Cameroon had great experience observing composting practices in Lausanne and the team from Switzerland had extraordinary visit to Dschang meeting local stakeholders.

How did the interdisciplinary nature of the project shape the results?

Our research team was a mix of junior and senior researchers from Cameroon and Switzerland and from different academic disciplines, including human geography, sociology, urban planning, soil sciences, engineering, and environmental studies, bringing together different analytical dimensions, methods, and perspectives. Approaches from sociology, particularly SPT, usefully brought in microlevel perspectives, which geographers contributed more to macro-level analyses through political ecology. Soil scientist took more of a service function to the overall project, led by social scientists.

In hindsight, what could have been done differently?

A lesson learned is that empirical research design may differ according to discipline like in the social and natural sciences, one beginning the research process with theoretical analysis and the other directly from material sample collection for lab analysis. It is important to consider the methodological differences of disciplines and organize tasks accordingly from the outset, so that no one task overtakes the others, and to ensure complementarity of the disciplines. We also noted how challenge it is to reach policymakers in CH. That would require more time investment.

Any other comments or suggestions.

Another challenge we identified in such interdisciplinary research was to make sure that no discipline or partner lose focus when experiencing any change in the project timeline, could this be related to Covid-19 or not. At crucial stages, a strategy was to recall members how they can contribute from their respective fields.

Research team in Switzerland and Cameroon

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