

Waste colonialism and metabolic flows in island territories

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Abstract

Islands are tightly connected to globalized material flows, with specific constraints and vulnerabilities. They are not closed metabolic loops of consumption, production, and waste, favorable to the circular economy. Small islands allow the observation of the material outcomes of circulation, from overflowing dumpsites to marine debris washing up on the shore. We argue that islands are key territories for better understanding the Capitalocene, precisely because of the ways in which they are connected to (rather than isolated from) globalized material flows. This article is a comparative geographical analysis of waste realities in three French island territories: Ndzuwani (Comoros), Réunion, and New Caledonia. It builds on metabolism analysis and waste studies—in particular waste colonialism—to address the different perspectives that these approaches open up for the study of island territories. The long-term sociohistorical context of each island helps to explain contemporary waste management policies and practices. A material flow analysis makes it possible to sketch out metabolic profiles that show the contribution of prevailing mining and agricultural industries to waste generation. The comparison of current situations regarding household waste discourses and economies shows how these territories are characterized by waste accumulation.

Key words: waste; waste colonialism; territorial metabolism; islands; political ecology

Résumé

Les îles sont étroitement liées aux flux de matières mondialisés, avec des contraintes et des vulnérabilités spécifiques. Elles ne sont pas des boucles fermées de consommation, de production et de déchets, favorables à l'économie circulaire. Les petites îles permettent d'observer les résultats matériels de la circulation, des décharges qui débordent aux débris marins qui s'échouent sur le rivage. Nous soutenons que les îles sont des territoires clés pour mieux comprendre le Capitalocène, précisément en raison de la manière dont elles sont connectées (plutôt qu'isolées) aux flux matériels mondialisés. Cet article est une analyse géographique comparative des réalités des déchets dans trois territoires insulaires français : Ndzuwani (Comores), la Réunion et la Nouvelle-Calédonie. Il s'appuie sur l'analyse du métabolisme et les études sur les déchets - en particulier le « colonialisme des déchets » - pour aborder les différentes perspectives que ces approches ouvrent pour l'étude des territoires insulaires. Le contexte sociohistorique à long terme de chaque île permet d'expliquer les politiques et pratiques contemporaines de gestion des déchets. Une analyse des flux de matières permet d'esquisser des profils métaboliques qui montrent la contribution des industries minières et agricoles dominantes à la production de déchets. La comparaison des situations actuelles concernant les discours et les

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économies des déchets ménagers montre comment ces territoires sont caractérisés par l'accumulation des déchets.

Mots clés: déchets; colonialisme des déchets; métabolisme territorial; îles; écologie politique

Resumen

Las islas están estrechamente conectadas a los flujos de materiales globalizados, y tienen limitaciones y vulnerabilidades específicas. No son circuitos metabólicos cerrados de consumo, producción y residuos. El estudio de las islas pequeñas permite observar los resultados materiales de la circulación, desde los vertederos desbordados hasta los desechos marinos en la costa. Sostenemos que las islas son territorios clave para comprender mejor la época del Capitaloceno, porque están conectadas a los flujos materiales globalizados (y no aisladas de ellos). Este artículo es un análisis geográfico comparativo de las realidades de los residuos en tres territorios insulares franceses: Ndzuwani (Comoras), Reunión y Nueva Caledonia. Se basa en el análisis del metabolismo y en los estudios sobre los residuos -en particular el colonialismo de los residuos- para abordar las diferentes perspectivas que estos enfoques abren para el estudio de los territorios insulares. El contexto sociohistórico a largo plazo de cada isla ayuda a explicar las políticas y prácticas contemporáneas de gestión de residuos. Un análisis de los flujos de materiales permite esbozar perfiles metabólicos que muestran la contribución de las industrias mineras y agrícolas a la generación de residuos. La comparación de los discursos y las economías de los residuos domésticos muestra cómo estos territorios se caracterizan por la acumulación de residuos.

Palabras clave: residuos; colonialismo de residuos; metabolismo territorial; islas; ecología política

1. Introduction

Waste has been studied through many different prisms, one of which sees waste as circulating matter (Moore, 2012). The nature of waste is such that it only becomes a problem when it is not desired at a certain time, in a certain place: the aim is to get rid of inconvenience by moving it elsewhere for storage or transformation. Thus, in addition to waste prevention, one of the main issues in waste management concerns the steering of waste flows. Notions of circularity and circulation, along with that of proximity, have become structuring principles that are supposed to govern waste management. Waste management, therefore, raises issues of socio-spatial justice, as evidenced by the first international laws on waste—the Basel Convention of 1989—which regulated transboundary waste circulation in order to eliminate hazardous waste dumping from so-called "developed" countries to "developing" nations. Analyses of waste flows highlight the economic and political issues behind socio-environmental injustices and question the responsibilities at stake; as such, they fall into the remit of political ecology, participating in a "renewed interest in material flows" (Bryant, 2015: 3).

Islands are restrictive systems, meaning waste cannot be endlessly stored or pushed back. The circular economy paradigm theorizes that isolation and distance could be overcome by closed loops of production and consumption. But more often than not, these challenges cannot be met, so that islands risk becoming dystopian cases or waste treatment and management. One of the most extreme cases is Thilafushi, the trash island of the Maldives (Magnan and Duval, 2020). Islands are directly connected to globalized consumption and waste flows, which is why most of them are far from implementing self-contained metabolisms of production and consumption. We believe that islands are crucial spaces for exploring waste issues in what authors including Malm (2017), Haraway (2015), and Moore (2016) have referred to as the Capitalocene, namely the current era of global changes that derive from capitalism.²

As European colonization wreaked havoc on island ecosystems in the nineteenth century, colonized islands were among the first cases studied of ecological catastrophes (Ferdinand, 2019; Ferdinand *et al.*, 2020). Our proposal is to test the hypothesis that island territories can be studied as witness-spaces of the Capitalocene,

² The notion of the Capitalocene is one of the many alternative concepts that have emerged as a critique of the now popular notion of the Anthropocene, reframing the responsibilities it entails. Other notions have emerged such as the "Plantationocene" (Haraway, 2015) or the "Wasteocene" (Armiero, 2021).

by comparing waste flows in Ndzuwani (Comoros), Réunion, and New Caledonia. While these islands are diverse regarding their colonial links to France, their size, their demography, and their wealth, they share interesting similarities as far as waste is concerned. All three islands are import-dependent and rely on economies that produce a lot of unplanned waste which accumulates in more-or-less managed dumpsites. All three islands engage in recycling efforts, mostly by exporting recyclable waste, because economies of scale are hard to implement. All three islands depend on the exportation of a mono-industry, be it sugar, nickel, or ylang-ylang (*Cananga odorata*, a tree that produces perfumed essential oils), which has direct and indirect impacts on the final flows of waste and the generation of waste. This article builds on the concept of island metabolism, which is a research tradition "for systematically studying the biophysical stocks and flows of material and energy associated with societal production and consumption," according to which "the impact of global environmental change on small islands is disproportionate and grips them in a spiral of increasing metabolic risk" (Singh *et al.*, 2020). Following the perspective of sociopolitical ecology (Cole, 2012; Gössling, 2003), we engage with the study of island metabolism in order to track the often-hidden corollary of material flows such as waste flows.

Our data is drawn from fieldwork and studies conducted on Ndzuwani (Bahers *et al.*, 2019), New Caledonia (Bahers *et al.*, 2020, Rocher *et al.*, forthcoming), and Réunion (Manglou, 2021). Here, we compare our cases in order to identify the relationships island territories have with waste. The comparisons draw on metabolic flow analyses, case studies of waste management policies and practices, and analyses of waste as a discourse and as a public concern, leading us to suggest a critical perspective on institutional solutions.

In the first section, a literature review addresses the different perspectives that island studies, metabolism analysis, and waste studies—in particular waste colonialism—have opened up for the study of island territories and, conversely, the different ways in which these territories may challenge these research fields. The second part of this article provides a general background by presenting the sociohistorical context of each island as well as the resulting contemporary waste management policies and practices. In the third section, we endeavor to depict the metabolic profile of each island in broad strokes, paying special attention to the waste flows generated by prevailing mining or agricultural industries. The last section of the article goes into finer detail by comparing specific situations regarding household waste discourses and economies on each island.

2. Metabolic analyses and waste studies: what perspectives for island territories?

Our research experiences converge on the idea that island territories can provide a fresh perspective on globalized waste flows and their political implications. The literature on which this article is based highlights the points of contact between metabolism studies, island studies, and waste studies.

The literature on social metabolism offers insight into the implications of waste flows. Metabolic analyses study the extraction, production, and consumption of resources, from atmospheric emissions to the accumulation of waste in nature. Some analyses build on the Marxist concept of "metabolic rift" by exploring its socioeconomic dimensions (addressing the commodification of the environment), its individual dimensions (looking at the exploitation of nature as a source of alienation), and finally its ecological dimensions (coming to terms with the production of urban and industrial waste that is not reintroduced into biogeochemical cycles) (Foster, 1999; McClintock, 2010). At the intersection of political ecology and ecological economics, the metabolic flows under study are linked to the emergence of environmental conflicts and of severe social inequalities, as the richest countries in the world consume three-quarters of the world's resources and produce much more waste than poorer countries (Görg *et al.*, 2019; Martinez-Alier *et al.*, 2016). Studies also show that such consequences do not stop at territorial borders: metabolic hinterlands (Brenner and Katsikis, 2020), which are home to mining and waste burial practices, bear traces of the Capitalocene. The advent of capitalism marked the beginning of a great acceleration in the consumption of materials and energy (Görg *et al.*, 2019), which continually increases with the extraction of fossil fuels and minerals, and the accumulation of waste on a global scale (Malm, 2017; Moore, 2016). This prompts us to research what we refer to as "capitalocenic metabolism." In this article, we look specifically at how this notion applies to the case of island territories, not as impermeable spaces but in relation to global materials markets. Islands have proven to be compelling

research fields for the study of territorial metabolism, that is, the material and energetic flows produced by the socioeconomic processes that feed and structure a territory. Indeed, clear geographical boundaries make it relatively easier to identify and measure flows of matter and energy, particularly regarding imports and exports. Recent literature on socio-metabolic research focuses on islands (Singh *et al.*, 2020). Island metabolism studies bear witness to the considerable constraints regarding the circulation of resources, including hazardous materials or materials that become hazardous as waste, with a particular emphasis on vulnerabilities and environmental conflicts (Harrison and Popke, 2018; Author 2, 2019).

Following Malcolm Ferdinand's invitation in *A Decolonial Ecology* (2019), we take into account the link between the history of the colonization of the world from the fifteenth to the twentieth century, based on the overexploitation of the land as well as human and non-human beings, and the genealogy of the current socio-ecological crisis, which we examine through the prism of globalized waste flows. Island territories have something to teach us about the globalized economy that is inherited from this history, about the limits that we see emerging today, and about the alternatives that will have to emerge. As Guillaume Blanc (2020) pointed out in *The Invention of Green Colonialism*, former colonies that boast pristine nature are often expected to enthusiastically endorse more environmentally friendly practices such as recycling and conservationist policies, even though crises such as deforestation and mass extinction have had much to do with colonization, and even though former colonies seldom have the power to refuse to participate in the predatory dynamics that fuel Western economies. Such a discrepancy can be found in the way islands are commonly depicted today.

Indeed, there is a long-standing fantasy, with deep colonial roots, that paints islands as ideal research laboratories and, more recently, as isolated microcosms in which to study and imagine sustainable development (Taglioni *et al.*, 2011). Yet social scientists have warned us against overestimating the specificity of insular territories, instead emphasizing their diversity and deep connections to the rest of the world and fueling "relational and archipelagic turns in island studies" (Pugh, 2018). More specifically, when island territories depend on the metropolises, they have little power to become "laboratories" in any way that might challenge the economic and political dynamics that mark their dependency. The current take on colonialism in France frames colonization as mainly a nationalist issue: it is commonly believed, particularly in mainland France, where debates on colonization are fraught with tension, that there are no colonies to speak of since all colonies have undergone processes of decolonization. Yet this narrative is challenged internationally, as New Caledonia for instance is part of the UN's list of territories to be decolonized. Statistics on the socioeconomic situation of French overseas territories (when they exist) also speak for themselves: they still differ so widely from the national average that most of the time these territories are not included in national studies so as not to bias them.

As waste is a major good in global exchanges, geographical studies of it have contributed to highlighting the spatial, social, and political dimensions associated with metabolic flows. Analyses of materials that are emblematic of contemporary globalized recycling circuits, such as e-waste (Lepawsky, 2015), have shown the situations of social injustice induced by the movement of waste (Davies, 2012). While informal work stands as "the most common area of scholarship on waste in the Global South," Millington and Lawhon (2019) argue that "studies of waste in the Global South would benefit from expanding their gaze beyond questions of poverty and development." They point to several ways in which researchers could go beyond "north-south empirical and intellectual dichotomies" in waste studies. In particular, they recommend further "research on the multiscale governance of wastescapes, including work on the relationships between the legacies of colonial governance and contemporary processes of privatization." Instead of seeing Northern waste policies as a model to replicate, Cavé *et al.* (2020) suggest that Southern practices, which combine lower consumption, more intense reuse of goods and materials, and unconventional forms of waste collecting, should be taken seriously as desirable models of sobriety.

If the first reference to waste colonialism originated in the drafting of the Basel Convention, which regulates transboundary movements of hazardous waste, waste colonialism realities go far beyond the disposal of waste in poor or ill-equipped countries (Liboiron, 2018, 2021). They are rooted in access to land and operate through models of waste management, as promoted by discourses, exemplary practices, regulatory norms, and standards. Drawing on this definition of colonialism, Liboiron (2018) encourages us to engage with disposability in and of itself as a form of colonialism that researchers need to expose:

The exaction of oil and natural gas from Land to create plastic and paper disposables is colonialism. Recycling, incineration, and other waste managements that 'take care' of waste so that the extraction and access to Land can continue is colonialism. Exporting these models to other places and then blaming the local people for not properly managing colonial sinks is colonialism. Seemingly helpful and logical solutions to waste that involve access to Land for beach clean ups, to educate people, and to build incinerators is colonialism. They are all premised on settler access to Land for settler goals, even when those goals are well-intentioned.

We argue that there is an interest in challenging the current nationalist framework regarding colonization, and that the analysis of French overseas territories can contribute to overcoming this North-South dichotomy. Their insularity and the colonial relationships that these territories maintain with France are two characteristics that we assume to be decisive in the way waste issues are framed there. Looking at island territories through the prism of political ecology reframes environmental crises like waste production as socially produced crises with their roots in colonial legacies. We look at waste production as a problem of distribution and of economic and political power, raising the question of responsibilities: What are the social and environmental costs of the current situation of economic and political dependency that binds these island territories to mainland France? Who benefits from the externalization of environmental costs? Drawing on the political ecology of waste metabolism, we seek to explore what waste colonialism might mean in French island territories.

As demonstrated by Heynen *et al.* (2006), a political ecology framework assumes that the way in which we engage with material flows is never apolitical; rather, power relations tend to frame which questions can be asked and what solutions can be brought forward. Using a political ecology perspective, we look at the historical and current power relations that condition the way waste has become an issue on specific islands, by paying particular attention to the material cost of overconsumption that underlies waste production. We also keep a close eye on the dominant narratives and discourses that underpin power relations.

Our aim is to conduct a comparison between three island territories that were all colonized by France but that today present very contrasting situations in terms of their status vis-à-vis the metropole, their level of development, and the current exploitation of endogenous resources. We seek to understand how waste manifests itself in these three cases, from a double perspective. On the one hand, this analysis explores the connections between situated metabolic flows and long-term colonial contexts. Our hypothesis is that the metabolic reading of current flows cannot be understood without fully confronting the exploitation of resources (mining, agriculture), which still determines the economy—and the generation of waste—in these territories. On the other hand, we try to understand how these island territories position themselves in global waste flows: What conditions are favorable to closed loops of waste management, and what conditions favor their extraversion? In her attempt to characterize research approaches to waste and its mobility, Davies (2012) identifies mapping flow exercises, material approaches consisting in following 'things' and identifying commodity chains, as well as the study of illegal mobilities or the impacts of the accumulation—immobilities—of waste. Our study combines two of these approaches: flow analysis, for a general understanding of island metabolisms, and the observation of waste management practices. We seek to understand what allows their circulation or, by contrast, their accumulation.

3. Réunion, Ndzuwani (Comoros), and New Caledonia: Situating waste production in different colonial contexts

Three colonial histories

When Réunion was colonized by France in the seventeenth century, it first served as a granary en route to the East Indies: settlers, slaves, animals, and seeds were shipped to the virgin, unoccupied island to produce food for merchants on their way to India. This arrangement mostly served private interests, as the French administration initially took little interest in the island. The sugar industry boomed in the nineteenth century, profoundly transforming the landscape and population of the island and attracting growing political and

economic interest from France. Typical colonial metabolic flows ensued: Réunion sent heavy flows of sugar to mainland France, while France sent back boats full of commodities. Réunion became a French *département* in 1946, and a European ultraperipheral region in 1992. In the 1970s, a series of development policies ensured the arrival of mass consumption on the island, which manifested itself through a massification and diversification of metabolic flows: on the one hand, European subsidies, and now French subsidies, have ensured that the island still produces and exports sugar to mainland France and other countries despite fierce global competition; on the other hand, tons of goods have been making their way to the island, so much so that, by the 1980s, waste had become a very visible issue. This newfound prosperity in Réunion has affected its 855,000 inhabitants unevenly. There are 341 inhabitants/km² but only 51% of them are formally employed. The GDP per capita (US\$24,295) is below the national average for France, but above that of the surrounding nations, and on the same level as the other European ultraperipheral regions. The economy is mainly service-oriented: market services (tourism, transportation, the digital economy, etc.) account for 39% of local growth, and non-market services (health, education, social work) account for another 35%. Sugar cane farming, which takes up a lot of the land and is mainly export-oriented, contributes to 1% of total employment and 3% of GDP.

Ndzuwani (Anjouan in French) is part of the volcanic archipelago of the Comoros located in the Mozambique Channel, colonized by the French in the nineteenth century for agricultural exploitation through slavery. The Comoros is composed of four islands—Ndzuwani (Anjouan), Ngazidja (Grande Comore), Mwali (Mohéli), and Maoré (Mayotte)—of which only the latter is not part of the Union of the Comoros, which gained independence in 1975. Indeed, Mayotte has repeatedly voted to remain a French territory (Taglioni, 2008), including in the most recent referendum in 2009, in which 95% voted in favor of becoming a French overseas *département*, obtaining this status in 2011. However, in 1975 the United Nations recognized the Union of the Comoros as being composed of the four islands of the archipelago. Thus, in the eyes of the government of the Comoros in particular, Mayotte is still occupied by the former French colonial power. The Union of the Comoros is classed as one of the Small Island Developing States (SIDS), a group of countries that are particularly vulnerable to the effects of climate change. With a GDP per capita of US\$1,445, the Union of the Comoros has one of the lowest nominal GDPs in the world and is classified by the UN as a Least Developed Country, with an economy mainly based on food production and the exploitation of export products such as the ylang-ylang plant. The population of Ndzuwani was approximately 332,466 in 2015 (UN estimates), making it the most densely populated island in the Comoros (784 inhabitants/km²). It is also the poorest island in the archipelago according to the World Bank (Belghith *et al.*, 2018) and the closest to Mayotte, making it a departure point for illegal migration for economic, family, or health reasons (Peccia and Meda, 2017). The sea between the two islands has become an infamous maritime graveyard, with between 10,000 and 20,000 deaths over the last twenty years (Tchokothe, 2018).

The religious and commercial colonization of the archipelago of New Caledonia (*Nouvelle-Calédonie* or *Kanaky*) by Europeans began at the end of the nineteenth century. In 1853 it was officially annexed by the French, who made it a penal colony and gradually evicted the Kanak populations from the cultivable land of the main island. The discovery of nickel in 1864 "set the scene for further 'accumulation by dispossession', elevating the island's geopolitical importance" (Batterbury *et al.*, 2020). Nickel mining and processing was initially provided by French capital, before opening to outside capital and labor during the twentieth century. Nickel exports support an economy that was generally prosperous from 1960 to 2010, very extroverted, but also very dependent on fluctuating world nickel prices since 2010. The GDP per capita (US\$34,932 in 2019) is partly the result of transfers from metropolitan France (about 17% of GNP) and nickel mining, which in 2017 accounted for up to 7% of total GDP (Ris *et al.*, 2017). Control over this strategic resource is central to the political power struggles surrounding the status of this territory and its decolonization (Batterbury *et al.*, 2020; Demmer, 2017). Tourism is a marginal activity, while the exceptional environmental and marine wealth (the lagoon is a UNESCO World Heritage Site) is a factor of both attraction and fragility, especially considering the heavy environmental impact of nickel mining. Two-thirds of the 271,400 inhabitants counted in 2019 live in the Nouméa urban area, while the rest of the territory is very sparsely populated.

The episodes of violence in the 1980s between Kanak independence fighters and the French police led to a reform of New Caledonia's status and its territorial and political organization. Under the Nouméa Accord (1998), New Caledonia is no longer an overseas territory but a *sui generis* collectivity, with its own government

and broad powers, while the state retains jurisdiction only in matters of sovereignty (defense, foreign affairs, currency, law and order, and justice). A referendum process on full sovereignty under the Nouméa Accord began in 2018 and the third referendum, boycotted by most independence supporters due to a COVID-19 outbreak leading to mortality and imposing customary mourning, was in December 2021. Because of this unresolved status, New Caledonia, without being part of the European Union, is attached to it as an "overseas country and territory." According to the UN, it is still a colonized country (on the UN's list of Non-Self-Governing Territories).

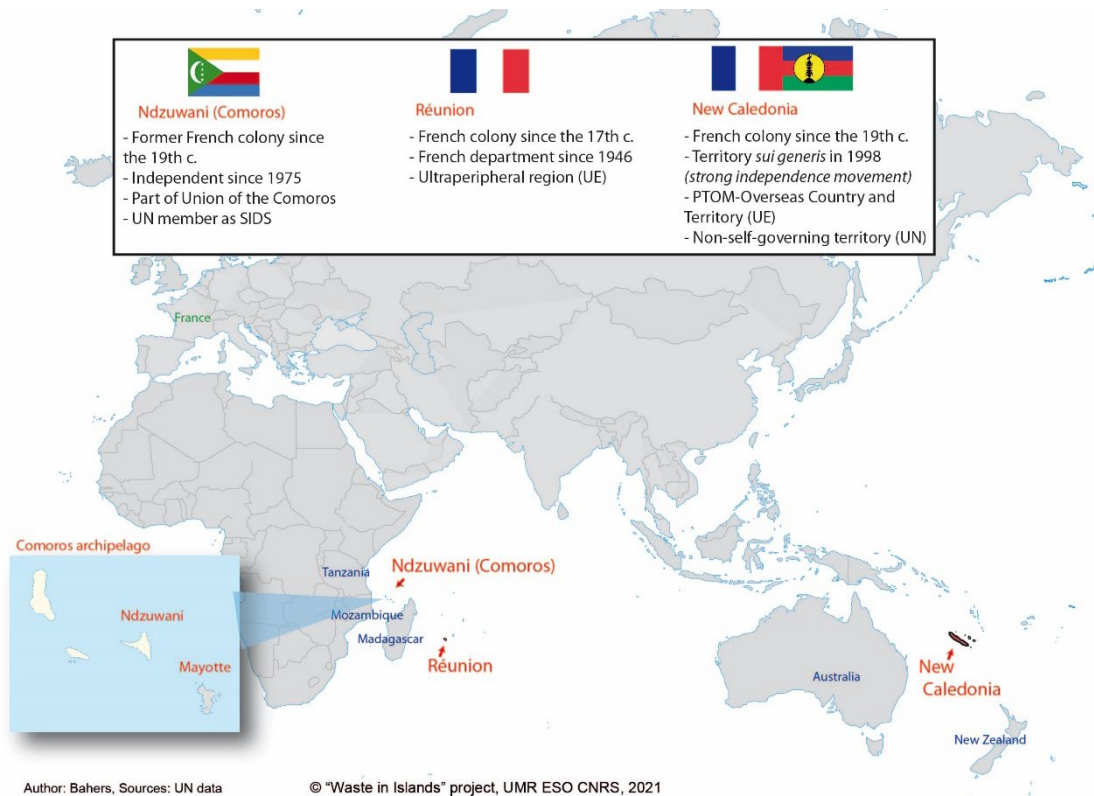


Figure 1: Ndzuwani, Réunion, and New Caledonia: location and status. Source: Authors

Waste management policies and practices: The French model in perspective

These three territories have very different profiles from every point of view: demographic, spatial, economic (Table 1). However, they share a colonial history and an ongoing relationship with France, even if their current dependency status varies. Political status is more or less stabilized in two cases, with further instability and negotiations possible for New Caledonia. The volumes of household waste produced in each of these territories is more or less known, and shows great difference. In Réunion, the waste collected in 2017 corresponded to 598.5 kg/inhabitant/year. According to an empirical study (Fouquet, 2014), the Anjouanese produce around 146 kg/inhabitant/year of household waste, 80% of which is organic waste (Bahers *et al.*, 2019). In New Caledonia, household waste generation amounts to 438 kg/inhabitant/year in the most urbanized South Province (ADEME, 2017), but lower in rural areas. The waste management context varies, directly correlated to the level of wealth and the ability of municipalities to raise a tax to collect finance and install treatment systems. In fact, the actual management of waste, and the resulting social, political, and spatial arrangements, are very different in each of these territories. However, the forms of organization and the objectives inscribed in local policies are quite similar, and they appear directly or indirectly prescribed by

French regulations and policies. In each of these islands, ongoing reforms are reflected in projects for storage or incineration facilities, with an official discourse framing these as ways to improve health and the environment.

In Réunion, the emergence of waste as a problem is intimately linked to the decolonization process that took place after 1946, when Réunion ceased to be called a colony and officially became a French *département*. Living standards failed to improve, which fueled growing discontent. A communist movement rallied more and more support, demanding independence and, later, political autonomy. As a political response, the French government vowed to make Réunion (and the three other overseas *départements*) a "showcase of successful development" (Debré, 1994). This was achieved by making mass consumption available to the inhabitants of the island, by massively investing in import infrastructure, and by creating a new middle class of public servants who went from being 23% of employees on the island in 1954 to 70% by 1974. This new middle class wanted to live and consume just as any other French person, spurred on by the advertising industry and by the presence of people from mainland France who were encouraged to come and live in Réunion. Supermarkets grew like mushrooms.

Sudden access to mass consumption in the 1970s was used to calm down the growing discontent that followed the disappointing "departmentalization" process. Waste thus became a rapidly growing problem, mainly in the form of dumps. Waste management policies, which were deeply inspired by the French model, were implemented from the 1980s onward, facilitated by the fact that French norms and regulations on waste management fully apply in the island, with a few exceptions such as additional time to apply national laws. The aim of these standardization policies was to put an end to informal landfills, to bring formal landfills up to standard where necessary, to enable recycling, and in particular to replace overflowing landfills with incinerators, which still represent the virtuous horizon of French-style waste management. Waste incineration has been on the cards since the 1980s without ever materializing, as proposals have repeatedly sparked protests (Manglou, 2021).

From 2018 to 2021, as the island faced an alarming lack of land to expand its overflowing landfills, local intercommunal syndicates and a private multinational company were supported by the French government to push for the construction of two waste-to-energy power plants, which are currently being built. Some local researchers have argued that waste-to-energy facilities are ill-adapted to the island's context for many reasons (Hatik, 2012; Manglou, 2021), because they create new toxic waste out of household waste, they emit toxic fumes that have not been correctly monitored in past cases, and they do not encourage the reduction of waste production, since incinerators need to be fed set quantities of waste to keep on working.

The Comoros is gradually adopting legislation aimed at making municipalities responsible for the collection and treatment of waste, which is most often thrown into the sea or rivers, and sometimes burned. Plastics, scrap metal, vehicles, textiles, medical waste, and packaging are found on the beaches and in illegal dumping areas. Formal recycling is nonexistent, although there are informal practices of salvaging metals, organic waste for animal feed, or construction materials for embankments or buildings, which are difficult to quantify (Bahers *et al.*, 2019). Others are buried in unsuitable sites, which has triggered social conflicts on the island. In addition, the project of a controlled landfill is on the horizon but is going through a complex decisionmaking process.

In New Caledonia, the institutional organization of waste management, despite the government's autonomy in these matters, is very closely based on the French model, which has served as the horizon for a so-called modernization for the past fifteen years (Rocher *et al.*, forthcoming). The opening of compliant landfills and the implementation of separate collection systems are considered a priority, with the aim of closing down uncontrolled landfills and stopping the burning of household waste. Land availability and low density are the reason why the use of multiple landfill sites is preferred to incineration in a single centralized plant. Yet certain waste products (such as used oil) are co-incinerated in nickel plants. While waste overflow is less critical than in Réunion or the Comoros, waste collection and transportation throughout the territory represent growing organizational and financial challenges, fueled by greater consumption. The territory is equipping itself with recycling facilities, but the recovery of recyclable materials is struggling to find an economic balance: as

explained in Section 3, the volumes of recyclable materials collected are often insufficient to be recovered both locally and for export.

	Réunion	Ndzuwani (Comoros)	New Caledonia
Population	855,000 inhab.	332,466 inhab.	271,400 inhab.
Density	341 inhab./km ²	784 inhab./km ²	15 inhab./km ²
GDP per capita (2019)	US\$24,295	US\$1,445	US\$34,932
Waste generation	Household waste: 598.5 kg/cap./year Industrial waste: 1,770 kg/cap./year	Household waste: 146 kg/cap./year Industrial waste: 140 kg/cap./year	Household waste: 438 kg/cap./year Industrial waste: 790 kg/cap./year Mining waste: 35,720 kg/cap./year
Basel Convention	1991 (via France)	1994	1991 (via France)

Table 1: Country profiles and waste data.

3. Metabolic profiles based on material and waste indicators

Metabolic analysis: A comparison

A first metabolic approach consists in mapping the flows of materials, energy, and waste in the three islands under study. The aim is to compare material metabolisms and the socioeconomic functioning of these territories, as well as to confront existing data with field observations. The method consists in measuring the input and output balances of material, energy, and waste covering all economic sectors (extraction, industry, agriculture, households) in each territory, based on data collected by the authors (Bahers *et al.*, 2019; Bahers *et al.*, 2020) and other experts (Cornéus *et al.*, 2016). These balances provide indicators of material demand, material consumption, and emissions per capita, which gives a basis for comparison.

The three profiles show significant similarities in terms of material flow balances. First, we can note the significant role of imports, which correspond to about 30% of material inputs (Imports/Total inputs) (Figure 2). This implies a low island autonomy in terms of material needs (construction materials in particular, but also food). It should be noted that a large proportion of these imports are manufactured goods, such as electrical equipment, clothing, household appliances, and durable goods. However, there are no local treatment channels for these products when they reach the end of their life, which leads to the dumping of toxic elements such as the hazardous substances in electronics, plastics, and metals. These imports therefore have a major impact on the generation of hazardous waste in these islands. Second, we can observe the importance of the extraction of minerals and biomass, which does little for domestic consumption, as it is mainly export-oriented (Exports/Extraction) (see Figure 2). This includes nickel mining in New Caledonia and the extraction of agricultural products (ylang-ylang in Ndzuwani and sugar cane in Réunion). Concerning outputs, Figure 2 shows the predominance of industrial and economic waste, which is for the most part waste from the extraction processes presented above. Atmospheric emissions come mainly from the combustion of fossil fuels, used for industrial processes (smelting in New Caledonia), electricity production, intra-island transport, and also in part for waste landfilling and incineration. Finally, it can be observed that household waste and recycling remain at very low levels compared to the rest of the circulation of flows.

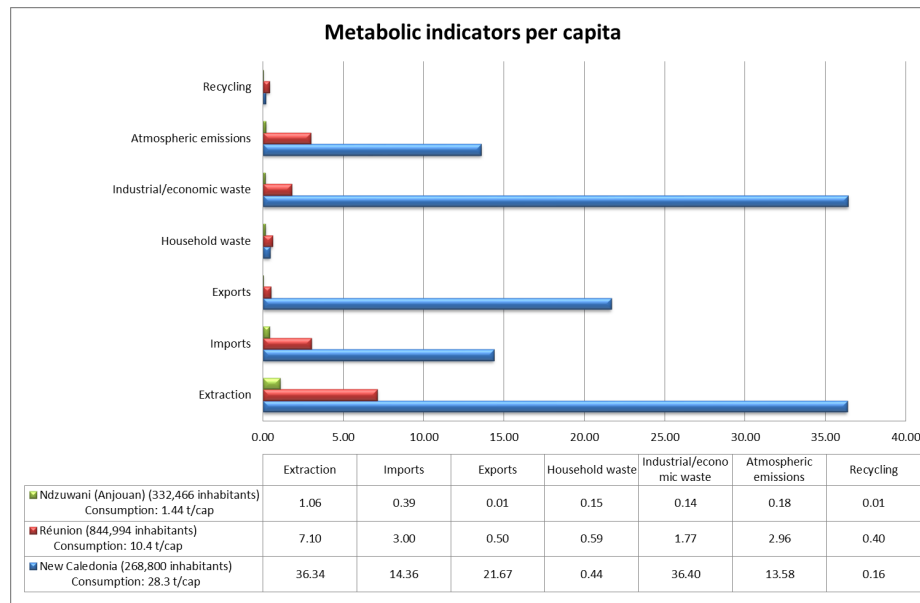


Figure 2: Metabolic indicators per capita for Ndzuwani, Réunion, and New Caledonia. Source: Bahers *et al.*, (2019, 2020); Cornélus *et al.*, (2016)

Extractivism, exportation, and the accumulation of waste

In New Caledonia, the export of nickel involves an enormous amount of metal ore extraction and a large amount of imported fossil energy to feed the metallurgical industry, concentrated in three nickel smelters. The accumulation of hazardous slag and the resulting greenhouse gas emissions are the consequences of this metabolic rift. Slag is not quantified nor labeled as waste, yet it is carried by, and accumulated in, waterways, altering natural metabolisms and transforming urban landscapes (Sellier *et al.*, 2021). Slag from the Nouméa nickel plant, Doniambo, has long been used as filling material for the city's peninsular growth and continues to be distributed to the inhabitants as a substitute for rubble. This solid slag is accompanied by hazardous liquid waste from the metallurgical process, which consists of a mixture of water, solvents, and inerts. This hazardous waste is very poorly managed and has led to leaks of sulfuric acid into rivers from the southern Goro plant, notably in 2009 (Le Meur, 2010), 2012, and more recently in 2014.³ Finally, these extractive activities, which are made visible by the analysis of metabolic flows, are largely obscured in public discourse, in which the focus is almost exclusively on household waste.

In Ndzuwani, capitalocenic metabolism takes shape through the export of ylang-ylang oil, which is the pride and economic backbone of the island, and from which it draws a large part of its economic resources. However, the externalities of this production are rarely mentioned. The production of essential ylang-ylang oil is obtained by stills, which results in increasing deforestation in order to extract wood fuel, as well as significant withdrawals of river water, which dries rivers out and makes the water milky. Heavy rainfall contributes to obscuring the issue, which has not made it onto the public agenda, focused as it is on household waste management.

In Réunion, sugar cane accounts for 60% of exports, although the economic added value is very low. It represents one-third of extraction (in tonnage) and corresponds to 69% of the use of arable land. European and French subsidies finance this otherwise unprofitable sector. Sugar cane monoculture results in significant crop residues (with a ratio of 12t/ha/year and 40% waste per ton of sugar cane produced) and high land erosion. Part

³ See <https://www.lesechos.fr/2014/05/nouvelle-caledonie-un-nouvel-arret-qui-tombe-mal-pour-lusine-vale-302621>.

of these residues (bagasse) is used as fuel—an argument that is overused to assert the ecological modernization of the sector, even though these volumes do not substitute for the coal burned by the island's thermal power plants. Coal is soon to be replaced by wood imported from the United States, in order to abide by the LTECV law demanding that 100% of the island's energy should come from renewable sources. For the past thirty years, the cultivation of export-oriented food crops, particularly award-winning Victoria pineapples, has been based on an intensive agricultural model that generates more unexpected waste: plastic. Some 1,500 tons of agricultural plastics are imported each year, although no treatment channel is available to collect them once they are used, and landfills are reluctant to receive them: many farmers plow the tarpaulin (a plastic mulch film) into the soil to prepare the next harvest. In both cases, plastic ends up mashed up in the soil, headed for the sea. This is also the case in other French overseas territories such as Guadeloupe (Gontard and Seingier, 2021).

The observation of these metabolic profiles illustrates the outdated nature of preconceived ideas that see islands as isolated, remote places. These are highly exploited territories with production systems geared toward the export of products that often symbolize island identity, and that lead to significant extractivism. Other research confirms this as a common pattern where extractivism accompanies continued colonial exploitation of SIDS (Mallin, 2018). The extractive nature of island metabolisms includes minerals and fossil fuels. The similarities that emerge from our comparison depict island metabolisms as the embodiment of waste colonialism, unfolding in capitalocentric situations: past and present situations in which human activity is structured by and for a capitalist mode of production (involving extraction, accumulation, and export). Extractive activities took root during colonization and have been continued, evidenced by ongoing environmental and social harms within the island territories we have discussed. Exploitative actions brought about by colonization are therefore the main cause of insular environmental imbalances.

4. Waste in situ: a comparative approach

On the overrepresentation of individual responsibility

A major tendency in the media and in public discourse is to focus attention and communication efforts on everyday household waste at the expense of residues related to industrial activities. This is not particular to the island territories under study, as this tendency has been observed worldwide (Hird *et al.*, 2014; Hird, 2015). In the cases studied here, we observed an association between waste management, the importance of cleanliness in public and natural spaces, island identity, and the making of a "sellable" territorial image for tourism. For example, one of the first awareness campaigns on waste sorting in Réunion was organized by the local tourism board, using the slogan "La Réunion, c'est proprement beau" ("Réunion is 'cleanly' beautiful"), which was printed on food packaging to encourage consumers to throw it away properly. The publication of a comic strip⁴ by the environmental agency of New Caledonia enjoined inhabitants to "adopt the right behaviors" concerning waste sorting but also illegal dumping or burning. In New Caledonia again, the application "Gardons notre île propre" ("Let's keep our island clean"), set up in 2015, invited inhabitants to geolocate illegal dumps and report them to the authorities.⁵ In Ndzuwani, waste encroachment is such that it is presented by local actors as a factor hindering the island's tourism development (according to an interview with the public agency for territorial development). The tension between waste and tourism activity, which can be very acute in some island areas such as Phu Quoc in Vietnam (Kerber and Kramm, 2021), is less obvious in the cases presented here. However, in each case we note discourses linking household waste, island identity, and cleanliness, the latter always being associated with a behavioral problem on the part of island inhabitants.

The propensity of certain social groups to "keep the island clean" emerges as a racial present in the discourse of elites and in the media. The Réunionese for example, who, according to local authorities, are said to not sort their waste as well as those in mainland France, are declared to have "behavioral problems." The problem is said to "always come from the same slice of the lower social stratum", affected by unemployment

4 See "Un caillou bien net", at: <http://tice.svt.free.fr/spip.php?article1672>.

5 See <https://gouv.nc/actualites/10-12-2015/gardons-notre-ile-propre>.

and exclusion (stakeholder interviews). It is "always the same" people, that is to say, Mahorais immigrants in Réunion, who are regularly accused of illegal dumping on social media. These discourses are echoed in the supposed proximity between the dirty and the poor that social science researchers have highlighted: poor and/or racialized people are perceived as being close to garbage, a perception that justifies distancing, and which means discriminatory treatment (Hill, 2006; Sundberg, 2008). Such representations—as well as critiques thereof—are vivid in Réunion and New Caledonia, where distinct (ethnic, local, metropolitan) population groups coexist. "The Kanak population is often made out to be very dirty [...] but the behavior I see in the tribes is often more respectful of the environment than what I see in Nouméa. [...] Nature comes before man in rural Kanak life and that is obvious" (interview with a journalist, New Caledonia).

While the prescription of behaviors toward waste is deployed as recycling channels are set up, the public authorities tend to ignore vernacular practices of reuse through the transformation or repurposing of objects, for example in New Caledonia or Ndzuwani. This brings us back to the question raised by Cavé *et al.* (2020) which is whether the sometimes-illusory recycling systems of affluent societies are relevant to subsistence and near-subsistence societies.

The overrepresentation of individual responsibility in the way that waste production is depicted contributes to downplaying other much more significant types of waste, such as that produced by mining, agriculture, or the construction industry. It also fails to take into account the responsibility of private companies in waste production. In Réunion for instance, when two local dairy factories took the unilateral decision to change their packaging from a highly recyclable material to single-use plastic packaging. This shift had such an impact on collected recyclable packaging that local recycling infrastructures brought it before the French National Assembly, to no avail. This puts into perspective the considerable amount of energy expended on educating individuals on how to properly sort their waste, while polluting industries—who fund these campaigns—are rarely the subject of such scrutiny.

Waste that fails to flow: Islands as places of accumulation

These island economies import Western consumption models, supported by expatriate populations and the emerging local middle class with strong purchasing power. Although imports are supervised by the customary authorities, the resulting waste—especially packaging waste—does not fall within their area of responsibility. The incoming objects will sooner or later become waste stocks, destined to accumulate or to be exported. While the generation of waste is broadly overlooked as far as imports are concerned, there are nonetheless some signs of emerging awareness, especially concerning plastics. In 2019, the Congress of New Caledonia adopted a law banning the sale of various plastic products. This law, which aims to develop alternative and local channels, for the first-time addresses waste from the perspective of products imported and distributed in the territory. As a result, single-use plastic shopping bags, disposable tableware, cotton swabs, and plastic food trays are banned from distribution, while both bio-based and non-bio-based shopping bags have an import ban. In July 2021, in the final declaration of the 5th France-Oceania Summit, the French President outlined the unjust nature of the consequences of plastic pollution: "Noting plastic pollution's disproportionate impact on the Pacific Ocean and Pacific Island Countries in general, particularly considering they do not extract fossil fuels nor produce plastics and their additives, we support a decision to launch intergovernmental negotiations of a global plastic binding agreement at the second session of the fifth United Nations Environment Assembly."⁶

In Réunion, where 80,000 single-use trays are used every day, such measures must be implemented in accordance with French regulations (Law n° 2020-105 on waste and the circular economy). The application of this law has been postponed due to the COVID-19 health crisis, during which uses of single-use plastic have increased dramatically (Patrício Silva *et al.*, 2021). These efforts to regulate single-use items are for the moment incidental. They cannot stop the growing spread of various consumer goods, food and others, including in rural areas where there are significant closed loops of production and consumption from agriculture, fishing, and

⁶ <https://www.elysee.fr/en/emmanuel-macron/2021/07/19/final-declaration-5th-france-oceania-summit>.

hunting, as shown by surveys conducted in New Caledonia among Kanak tribal areas (Bouard and Sourisseau, 2010; Zugravu-Soilita *et al.*, 2021). Although not surveyed, self-consumption is common in Ndzuwani, but FAO studies (FAO, 2018) show a decline of subsistence agriculture and fishing (provisioning) in the face of ever-increasing food imports. According to the head of a local NGO, "there is no involvement of the government in agriculture. It is only people that are trying to get by." In Réunion, only 15% of grocery shopping is locally produced.⁷

In addition to the arrival of commercial consumer goods, island areas are particularly exposed to the stranding of waste carried by marine tidal flows. Because of their favorable geographical location, none of the cases presented here face the seasonal mass stranding of external waste known as the "trash season" (Kerber and Kramm, 2021), but the fragility of the marine environment contributes to putting this issue on the agenda, particularly in the South Pacific. Evidently, island territories' conversion to mass consumption and their difficulties dealing with the resulting waste has meant that they participate in the flow of waste that ends up in the ocean. The Réunionese artist Richard Riani, who grew up in Tanambo, a former slum in the south of the island, remembers his awe the first time he noticed the nearby river carrying so many goods to the sea during a cyclone, when his community was still living in dire straits. In Ndzuwani, the sea's ebb and flow brings the waste discarded in the waterways back to the coastal area. The result is that beaches are littered with cheap items (such as poor-quality flip-flops that break quickly) and lots of other plastic residues.

Apart from a few attempts to cut the import of single-use plastics, the main solutions envisaged to remedy this invasion have to do with the creation of sanitary landfills, presented as an indispensable operation for effective waste management. Waste is thus allowed to accumulate in fragile areas, where occupation density is sometimes high, while the arrival of consumer goods is increasing and attempts to change this situation appear derisory. Following Liboiron's definition of waste colonialism (2021), we argue that the unplanned mass production of waste that results from these islands' import-oriented economies, and the hardships it creates, demands that the very notion of "disposability" be reassessed: on smaller islands in particular, there is no "away" to speak of, and the question of land is crucial. The very possibility of mass consumption in island territories rests on the invention of waste as an acceptable, legal category that sanctions a particular transformation of the land so as to build landfills and incinerators, and to organize collection networks, etc. By observing waste colonialism in island territories, we see waste not as an unplanned by-product of the economy, an inconvenient afterthought, but rather as a highly organized social construct that enables it to keep ticking over. In this system, not all residues are destined to remain *in situ*.

Islands in the midst of globalized waste flows

Islands are far from being isolated from globalized waste flows, although their remoteness and small size condition the way they participate in them. As far as globalized waste flows go, only hazardous waste falls under the international regulation (Basel Convention) that requires specific reports from public authorities. Réunion and New Caledonia abide by the Basel Convention (1991), and so do the Comoran islands (1994). Thus, hazardous waste must be tracked in terms of its nature, volume, and destination. In the absence of suitable infrastructures, hazardous waste generated in islands tends to be shipped over long distances. This results not only in high costs but also has many undesirable consequences. In Réunion, hazardous waste is shipped all the way to mainland France. Organizing the export of used batteries for recycling has been a major challenge for the local authorities: costly disposal used to cause recurrent litter issues, and when the rise in lead prices made recycling batteries economically possible, the authorities had to deal with "theft." Reliance on long-distance transportation contingencies may result in waste accumulation. In 2021, local state authorities in Réunion allowed extended storage of hazardous waste at the port, because shipments, which were already running late because of the COVID-19 crisis, were further affected by the blockage of the Suez Canal. As a PTOM (overseas country and territory), New Caledonia abides by European norms and forbids the import of hazardous waste

⁷ See <https://www.lequotidien.re/actualites/thematiques/societe/une-impossible-autonomie-alimentaire-a-la-reunion/?fbclid=IwAR1gCNvxRLteH0mU45C-1LEU91-MxdbFezFpPmF5cxOCndiROUE3wwU0rC0>.

for disposal. In the meantime, industries and households generate hazardous waste that is treated abroad. According to registrations in respect of the Basel Convention, hazardous waste (from batteries, WEEE, metals, oils, waste from hospitals) varies from one year to the next, from 3,700 tons in 2015 to 12,500 tons in 2020. Over this period, exports to New Zealand have constantly increased (from 68.2% of hazardous waste in 2015 to 94.6% in 2020) (Haut Commissariat de la République en Nouvelle-Calédonie-Direction de l'industrie, des mines et de l'énergie, 2020). The rest is shipped to South Korea, Australia, and Europe, although decreasingly so.

Unlike hazardous waste, recycling mainly relies on market opportunities and is subjected to very little scrutiny. This is partly because recycling continues to be portrayed as the most virtuous waste management solution, although it has often been criticized. Crang *et al.* (2013) showed that globalized flows of recyclable goods lead to socio-spatial inequities that have not yet been properly accounted for, such as practices camouflaging waste dumping as recycling. Looking at waste through the prism of islands highlights another limit of recycling as a universalized model. In Ndzuwani, Réunion, and New Caledonia, public authorities endeavor to improve waste management, using French policies as the main template: waste is to be collected from the whole territory, and specific channels are to be organized, some for disposal and others for recovery. Yet these islands are having difficulties participating in globalized flows of recyclable goods.

First of all, local valorization of sorted materials is a challenge. In Réunion, local recycling infrastructures have proven economically unsustainable. Furthermore, the amount of waste collected for recycling is relatively limited, making the valorization of exports a major challenge. The situation has worsened since 2014, when China decided to close its borders to the world's trash. Most Asian countries have followed China's lead and grown more and more demanding as to the quality of recyclables they allow in—a "Green Fence" against the world's trash. Réunion is now struggling more than ever to export plastic: most plastics have to be buried on site. Still, the island is able to export other recyclables all over the world, so much so that waste ranks as the second most exported good on the island after sugar (Cornélus *et al.*, 2016). Glass is sent to South Africa or Tanzania, cardboard to Thailand, Vietnam, India, Indonesia, or China, some plastic is still sent to Pakistan, France, Malaysia, or Hong Kong, metals are shipped to India, Singapore, Vietnam, Malaysia, Turkey, etc. In reality, it is difficult to map such flows as they change regularly, sometimes in a matter of a couple of months, depending on opportunities and commercial contracts.

In New Caledonia, several recycling channels based on the principle of extended producer responsibility have been set up in recent years for oils, batteries, tires, e-waste, and end-of-use vehicles. Sorting practices and recycling infrastructures have been developed to accommodate these materials. However, their final destination is highly problematic, as there are no outlets for their local recovery. Paper and plastics were once exported to Australia and various Asian countries. But the cost of transport proved to be prohibitive due to the small volumes involved, and some of these sorted materials ended up in landfills.

In Ndzuwani, although some metals are conditioned for export, the cost of conditioning and collection remains dissuasive. According to the manager of a scrap metal recycling company, "the freight is too expensive, and we cannot export scrap metal every month. Then we are completely dependent on the fluctuations of the market price." Meanwhile, the boats leave the port empty. . .

Thus, the recovery of waste from these islands is confronted with the full force of a recycling economy that requires a massification of flows that can integrate long-distance circuits. The circular economy model, as it is translated into extended producer responsibility channels, condemns potentially valuable waste—as well as hazardous waste, and everything else (waste with no potential economic value)—to accumulate in landfills or open dumps (see Figure 3). When local recovery is envisaged, it is most often in the form of energy recovery: through incineration or co-incineration. Closed-loop virtuous circuits in the islands appear to be a very distant prospect, and this gives food for thought about the ecological nature of recycling and the relevance of a universalized model in the light of diverse colonial histories.



Figure 3: a) Waste on a beach in Ndzuwani (Source: Bahers, 2018); b) Open dumps in New Caledonia (Source: Rocher, 2018); and c) Landfill in Réunion. (Source: Manglou, 2019)

5. Conclusion

The comparative overview of three island territories provides several avenues for reflecting on the complex relationships between waste, insularity, and colonialism. Far from being ideal sites for the realization of the circular economy and closed-loop material flows, islands appear in many respects as anti-models of sustainable development. They are characterized by their geographical isolation and at the same time by their hyper-connection to a globalized economy, unable to regulate the waste they generate. The geographical isolation of these territories does not spare them from these dysfunctions; on the contrary, they seem to be particularly exposed and vulnerable.

Island metabolism shapes and is shaped by material flows linked to the extraction of materials and the circulation and disposal of waste. Tracing material flows and hidden waste flows helps us to unpack past and present colonial relations illustrative of capitalocenic situations. Metabolic data and analysis account for major trends of material and waste movements and allow us to follow their evolution over time. In particular, the quantitative analysis of material flows makes it possible to relate the waste flows themselves to those of consumption, energy, and those relating to economic activities. On the scale of a small island territory, such data are very significant and complementary to empirical observations in order to understand the way waste circulates and accumulates, as well as to identify the differentiated attention it receives. While public discourse focuses on household waste and the importance of inhabitants' good behavior in maintaining a clean and tourist-friendly island, metabolic data show that the most important residual flows are linked to the extractive, mining,

and agricultural mono-activities that characterize these island economies, and to the import-oriented system that supports them. Extractivist economic profiles are directly linked to the colonial history of these territories. When confronted with environmental studies and field observations, these residues are often revealed to be sources of major pollution and landscape transformation. The visibilization/invisibilization of waste, often highlighted in the literature on waste, is a striking feature of these island realities. A first step toward decolonizing waste-producing economies and waste management policies is to fully engage with this reality.

Fueled by the recent development of Western consumption patterns, household waste generation raises specific problems in islands in relation to their colonial history, and perpetuated today as a form of neocolonialism. Although the current political and institutional situations are very different for each of the islands studied here, we note that management policies are very heavily inspired by the French model, a fact that Liboiron (2021) sees as a form of colonialism. Over time, this waste management model has evolved from equipping territories with sanitary infrastructures such as landfills, to their replacement with so-called circular economy facilities, such as recycling and waste-to-energy plants, with particular urgency for islands facing land pressure. One common observation is an emphasis on the responsibility of inhabitants and efforts to install recycling, while sorted materials are condemned to be exported far away, or to stagnate *in situ* due to incompatibility with the constraints of the globalized recycling economy. The French model relies on the presupposition of fluid circulations, which prove unrealistic for islands where shipping costs and insufficient volumes prevent sorted materials from reaching recycling markets. As a result, waste ends up stagnating and accumulating in overflowing landfills and dumpsites.

At the same time, the regulation of *imports* is barely considered as a means of waste prevention, except for emerging restrictions on single-use plastics. We argue that the decolonization of waste production cannot be achieved without identifying that, for these island territories, waste production starts at the very least with importation, and ideally even earlier in the production chain. However, none of these characteristics are taken into account in management schemes, which would benefit from being developed independently of the metropolitan or Northern model (Millington and Lawhon, 2019). Only islands' exposure to coastal stranding is beginning to alert local and international actors and institutions. In these places, the dominant (Northern) pattern of waste management results in waste accumulation, be it within legal infrastructures or not. Accumulation appears as a corollary manifestation of long-distance circulations of goods and end-of-life products. With this in mind, efforts to map waste mobilities as well as immobilities (Davies, 2012) prove more necessary than ever in order to decolonize waste management practices in island territories.

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