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UTILITY SERVICES POVERTY: ADDRESSING THE PROBLEM OF HOUSEHOLD DEPRIVATION IN MAYOTTE

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Utility Services Poverty:
Addressing the Problem of Household Deprivation in Mayotte

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Abstract:

Access to safe, sustainable and affordable essential utility services, such as electricity, water and sewerage is a key challenge in many developing countries. We define a new concept of utility services poverty (basic utility services deprivation) based on the theoretical capabilities framework of Sen and Nussbaum and on the literature on energy and water poverty. Using a latent class model to evaluate utility services poverty in Mayotte Island, we characterize four household profiles on a scale of utility services vulnerability/poverty. We demonstrate that access to water is more discriminatory than access to electricity in Mayotte. We show that utility services poverty and income poverty are distinct phenomena. Policies should be implemented not according to income but to facilitate water and energy access and improve basic hygiene conditions.

Keywords: Utility services; energy poverty, water poverty, latent class models; poverty; public policies

1. Introduction

The 17 sustainable development goals, also called global goals, were adopted by the United Nations in 2015 and are a global call to action to eradicate poverty worldwide. Among them are the two following objectives: "*ensure availability and sustainable management of water and sanitation for all (goal 6)*" and "*ensure access to affordable, reliable, sustainable and modern energy for all (goal 7)*". Worldwide, 46% of individuals do not have access to safely managed sanitation, 29% lack access to basic hygiene and 26% lack safely managed drinking water. Moreover, one-third of the population uses dangerous and inefficient cooking systems, 759 million people lack access to electricity, and the annual energy efficiency rate is equal to 3% and can be improved[4]. At the microlevel, targeting the most vulnerable households is therefore a considerable challenge for policy makers.
Energy and water are essential utility services for a decent standard of living. Internationally, the UN recognized the right to access to drinking water (and to sanitation) as a "*fundamental human right*" in 2010. This right follows directly from "*the right to an adequate standard of living*". The UN Human Rights Council has also underlined "*that it is inextricably linked to the*

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4 See the webpage : https://sdgs.un.org/goals

right to the best attainable standard of physical and mental health, as well as to the right to life and to dignity". Although the right to water was enshrined in 2010, this is not the case for the right to energy.
In the literature, access to water and access to energy are usually treated independently under the concept of energy-fuel poverty and water poverty. The concept of water poverty was developed in 2000 to consider both a lack of access to clean water and sanitation and the cost of consumption. Fuel poverty in developed countries is a complex phenomenon resulting from a combination of three main factors: low income, energy-inefficient housing and high energy prices (Devalière, 2007; Palmer, MacInees, & Kenway, 2008). These issues are quite different from those identified in developing countries, where energy poverty usually describes situations in which people have inadequate access to modern energy sources. Energy poverty is related to energy deprivation and the lack of adequate facilities. Few studies have treated fuel and water poverty together (Browne, Petrova, & Brockett, 2018; Fankhauser & Tepic, 2007; Laskari, Karatasou, & Santamouris, 2016; Martins, Quintal, & Antunes, 2019; Yoon, Sauri, & Domene, 2019). Some studies have partially addressed fuel and water poverty, focusing mainly on affordability (Fankhauser & Tepic, 2007).

As energy and water are essential needs, it seems relevant to broaden the concept of fuel and water poverty to also address the issue of access to basic utilities in vulnerable territories. In this paper, we propose to expand the concept of fuel and water poverty to the concept of utility services poverty by focusing on the case of Mayotte, a French overseas department (located in the Indian Ocean close to Madagascar). We aim to capture the complex and multidimensional characteristics of utility services poverty. Based on the latest work of Charlier, Legendre, and Ricci (2021), we go further by examining the need not only for domestic energy services but also for all essential utility services to live a decent life.
Although the territory of Mayotte does not fit the definition of a developing country, the characteristics of the territory do not make it a developed territory. The median standard of living of the inhabitants of Mayotte is seven times lower than the national level. A large part of the population lives with very few resources: 77% live below the national poverty line, five times more than in metropolitan France (Direction de l'Environnement de l'Aménagement et du Logement de Mayotte, 2017). According to the OECD definition, 36.5% of the Mahorais households are income poor.
On Mayotte Island, many households do not have the basic utilities needed to sustain their well-being. The fight against substandard housing is a major challenge in Mayotte: six out of ten homes lack basic sanitary facilities (running water, toilets and showers). In fact, 25.8% of households do not have access to water in housing, 83.8% do not have hot water, and 21% do not have access to electricity in their homes (Direction de l'Environnement de l'Aménagement et du Logement de Mayotte, 2017).

The main objective of this paper is to develop the concept of utility services poverty by proposing a definition and a quantification of this phenomenon.
Drawing on the definition of fuel poverty proposed by Day, Walker, and Simcock (2016) and on the theoretical capabilities framework developed by Sen and Nussbaum (Nussbaum, 2003; 2011; 1999; 2003; 2004; 2012; Sen, 1979), we propose a first definition of utility services poverty.
Furthermore, we want to identify the households that are utility services poor. To do so, we employ a latent class model (LCM) (Greene & Hensher, 2003). We accurately assess essential utility services poverty using observable objective characteristics. Assuming that objective multivariate variables describing a set of capabilities are observed, we link these variables to

the following latent unobserved variable: utility services poverty. The advantage of this methodology is that it provides a scale of utility services poverty.
Finally, it is tempting to think of utility services poverty as a problem of income poverty. As the share of income poor households in Mayotte is significant, we can question the independence of the concept of utility services poverty.

The key contributions of the paper are as follows: 1) we advance the first definition of utility services poverty, and 2) we use an original methodology to identify households that are utility services poor. 3) We provide evidence that households that are utility services poor are not necessarily monetary/income poor.

We define utility services poverty as the inability to realize essential "functionings" due to difficulties in access to a set of essential utility services in housing (which could be insufficient access to affordable, reliable and safe basic utility services).
With the LCM, we obtain four distinct household profiles and a utility services poverty scale. We provide evidence that income poor households are not necessarily utility services poor households. In such a context, policies should be implemented not according to income but to facilitate access to water and energy as well as to improve sanitary conditions. We find that households without access to water are more vulnerable than households without access to energy. To reach the development goals in Mayotte, policies could be implemented in two steps. First, to fight utility services poverty, access to water and sanitary facilities should be prioritized. Second, it is necessary to provide access to electricity for everyone.

The article is organized as follows: In Section 2, we propose a definition of utility services poverty. In Section 3, we present data and descriptive statistics on observable characteristics of utility services poverty in Mayotte and present the LCM. Section 4 presents the results, and Section 5 offers some concluding remarks.

2. A proposed definition of utility services poverty

2.1 Theoretical background on fuel and water poverty

In the literature, fuel poverty and water poverty are treated independently. While there have been abundant studies on fuel poverty since the 1980s, the concept of water poverty is more recent and has been inspired largely by the definitions and measures of fuel poverty. We propose to return to those two streams of the literature and show that in a tropical territory such as Mayotte, these two phenomena should be treated together and combined under the term utility services poverty.

a- Fuel and energy poverty literature

The concept of fuel poverty refers to difficulties in obtaining a set of essential energy services in housing. However, there is no consensus on the definition of "fuel poverty". It is difficult to agree on a satisfactory definition, in part because energy is not an end in itself but is a vehicle by which we can use energy services. It is also difficult to specify a simple criterion for determining whether a level of energy services is acceptable. In the academic literature, the term "fuel poverty" was used for the first time in 1983 by Bradshaw and Hutton (1983) to designate households that have difficulty heating their home adequately.

In France, fuel poverty has emerged as a major concern since the 2010s. A legal definition was adopted with the Grenelle 2 law (2010), which defined a person suffering from fuel poverty as *"anyone who encounters, in their home, particular difficulties in obtaining the energy required to meet their basic energy needs due to insufficient resources or housing conditions"*. Many definitions include heating issues as a main component of fuel poverty. Devalière (2007) proposed the following definition: "*One who encounters a social, economic and environmental vulnerability which prevents him from keeping warm and/or paying his energy bills*". The Pelletier report also highlighted this issue (De Quero & Lapostolet, 2009). A household member experiences fuel poverty if he or she "*has difficulty in heating their home because of the inadequacy of their resources and housing conditions"*.

However, Charlier, et al. (2021) showed that the characterization of fuel poverty in tropical territories is different from that at temperate latitudes. Some tropical territories (French overseas territories) do not experience winter cold but nevertheless suffer from domestic energy deprivation. Problems of energy deprivation in the home and the lack of adequate facilities are also commonly described via the term "energy poverty" in the literature. This concept has traditionally been used to capture problems of inadequate access to energy in developing countries, involving a host of economic infrastructural, social equity, education and health concerns (Pachauri, Mueller, Kemmler, & Spreng, 2004). Bouzarovski and Petrova (2015) proposed an integrated conceptual framework for research on and amelioration of energy deprivation in the home to overcome the binary "energy poverty – fuel poverty" problem. They adopted a broader vision of the phenomenon of energy and fuel poverty – in developed and developing countries – that refers to the inability to achieve a socially and materially necessary level of domestic energy services. As shown by Charlier and Legendre (2021), the gap between the two streams of the literature no longer exists when we mention difficulties in access to energy services. The two terms "fuel poverty" and "energy poverty" can therefore be used interchangeably.

While there is a large body of literature on measuring fuel poverty, there is no consensus on either a common definition or fuel poverty indicators. However, the academic literature has recently begun to highlight the need for a unified theoretical framework for analyzing fuel poverty based on Sen's work on poverty. Day, et al. (2016) enlarged the concept of energy poverty and conceptualize the relationship among energy, energy services and capabilities to propose a definition of energy poverty based on the capabilities framework developed by Amartya Sen and Martha Nussbaum (Nussbaum, 2003, 2011; Nussbaumer, Bazilian, & Modi, 2012; Sen, 1979, 2004). The authors defined energy poverty as "*an inability to realize essential capabilities as a direct or indirect result of insufficient access to affordable, reliable and safe energy services, and taking into account available reasonable alternative means of realizing these capabilities*" (Day, et al., 2016).

Charlier, et al. (2021) drew on the work of Bouzarovski and Petrova (2015) and Day, et al. (2016) to capture the complex and multidimensional characteristics of fuel poverty in tropical territories. Like Bouzarovski and Petrova (2015), they showed that in addition to heating issues, fuel poverty should focus on all domestic energy services, including cooling, water heating, and cooking as well as the hygiene, safety and sanitation of dwellings. Moreover, they applied an innovative methodology (LCM) based on the theoretical capabilities framework developed by Sen and the conceptual work of Day, et al. (2016) to identify fuel poor households in tropical regions.

b- Water poverty

The concept of "water poverty" was developed to consider both a lack of access to clean water and sanitation and the cost of consuming water. In 2000, the term "water poverty" was advanced in the literature as an indicator by Salameh (2000). Salameh (2000) described a "*water poverty index*" that was defined as "*the ratio amount of renewable water to the amount required to cover food production and the household uses of one person in one year under the prevailing conditions*". Feitelson and Chenoweth (2002) emphasized the quality of the water used for domestic purposes and defined water poverty as "*a situation where a nation or region cannot afford the cost of sustainable clean water to all people at all times".* As mentioned by Yoon, et al. (2019), those definitions focused mainly on access to potable water, which is appropriate for developing countries but less appropriate for developed countries, where access to water is mainly guaranteed. When referring to water poverty in developed countries, the literature refers mainly to the ability of customers to pay their water and sewerage bill(s) and not their ability to access safe and clean water, as in developing countries. This can be linked to the old concept of associating fuel poverty with developed and energy poverty with developing countries. Similar to fuel poverty, water poverty is due not only to the lack of infrastructure but also to the lack of sufficient purchasing power for households to afford access to the service. This is why water affordability may be an issue in both developed and developing countries. Studies on water poverty have focused extensively on this issue of water affordability and tariffs. Most studies on the affordability of water services have considered a household water poor if its water expenditure related to income exceeds a certain threshold. The World Bank and OECD have suggested that household water bills should not exceed 3–5% of income. Reynaud (2008) defined a "water-poor" household as a household spending 3% or more of its income on water charges. However, this indicator presents a significant problem. In developed countries, not all water consumed by households is used to satisfy basic needs. According to the OECD (2003, pp 37), "*an increasing proportion in some of the more affluent societies is associated with 'luxuries' such as power showers, garden sprinklers, and pressure washers. The percentage of income spent on water for such purposes should be of no particular concern to those interested in social and affordability policies, unless this water demand is met only at the expense of essential use by poorer households*". To overcome this problem, García-Valiñas, Martínez-Espiñeira, and González-Gómez (2010) proposed an alternative way of measuring water affordability in order to consider the cost of water to meet basic needs. Water is a basic right that must be guaranteed to everyone by the public sector. However, basic needs should be distinguished from luxury or superfluous water consumption. The former include water for drinking, personal hygiene, cooking and household cleaning, while the latter includes several outside uses, such as swimming pools, garden watering, and car washing. Instead of considering the total bill of a household (or representative household) for water, the authors suggested that only the amount paid for basic water consumption should be considered, excluding luxury uses. Therefore, they proposed modifying the current water affordability index to consider the theoretical bill for covering basic needs instead of real water bills.

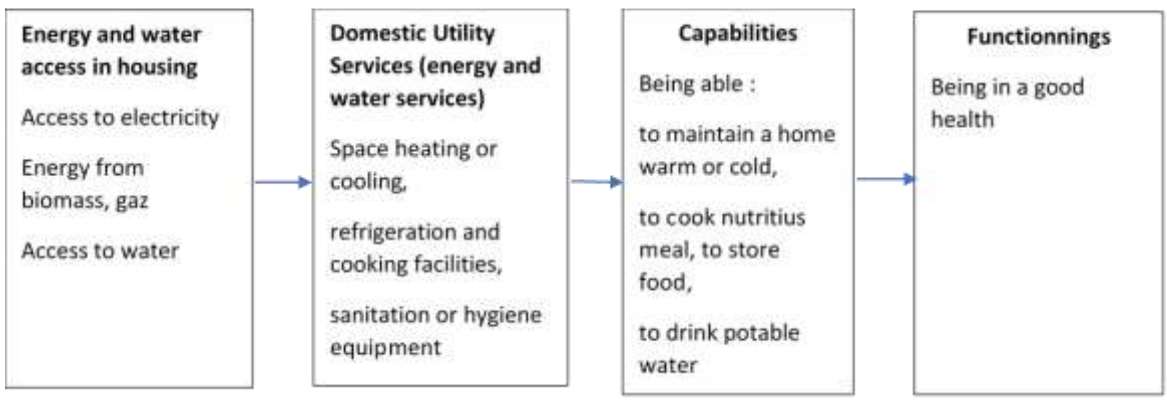
Although access to water and energy are two essential prerequisites for a decent life and for promoting economic development, only a few studies have treated fuel and water poverty together as linked objectives (Browne, et al., 2018; Fankhauser & Tepic, 2007; Laskari, et al., 2016; Martins, et al., 2019; Yoon, et al., 2019). Some of the studies partially addressing fuel and water poverty focused mainly on the affordability issue related to water and fuel poverty (Fankhauser & Tepic, 2007).

2.2 Drawing on the capability framework to provide a definition of utility services poverty

To characterize the broader concept of utility services poverty in Mayotte, we draw on the theoretical capabilities framework developed by Sen and Nussbaum (Nussbaum, 2003, 2011; Nussbaumer, et al., 2012; Sen, 1979, 2004). The capability approach developed by Sen considers human life as a set of doings and beings termed functionings. Functionings vary from escaping morbidity and being in good health to being integrated into a social community, achieving self-respect and receiving recognition for one's work. Sen described functionings in terms of personal achievement, i.e., what a person manages to accomplish or be. The capability of a person is a derived notion that reflects a combination of functionings and the freedom to choose a way of life. According to Sen, poverty can be seen as not having the capability to achieve crucial and valued functionings. This concept of capability deprivation was applied to fuel poverty by Day *et al.* (2016) because it allows a richer comprehension of the phenomenon.

The relevant literature on utility services access and affordability suggests that basic utility services, particularly potable water, improved sanitation and electricity, can impact human health, education, and social interactions as well as women's condition (Howarth, Kenway, & Palmer, 2001; Martins, et al., 2019; Njoh, Ricker, Joseph, Tarke, & Koh, 2019). For instance, access to basic utilities in the home has been recognized as being crucial to prevent social exclusion (the inability of a person or group to participate in daily relationships and activities in several areas based on economic, social, cultural, or political grounds) (Howarth *et al.*, 2001). Moreover, Njoh, *et al*. (2019) recently showed that improving access to basic utilities (potable water, improved sanitation, electricity, and telecommunications) invariably results in reducing mortality for everyone, including children in Africa. Drawing on this literature, we believe that the capability framework developed by Sen is adequate for our study.
While a functioning could be "being in good health", various capabilities are needed to achieve this functioning, including being able to maintain a warm or cool home, being able to cook nutritious meals and store food, and being able to drink potable water. These capabilities require utility services of space heating and cooling, cooking facilities, sanitation equipment, etc., which require access to clean water and electricity (Figure 1).

Figure 1: From utility services access to functionings



Another functioning could be "being integrated into a social community", which might require being able to wash oneself and one's clothes, which are likely to require water and energy services for hot water. It is easily understandable that insufficient access to affordable, reliable and safe essential utility services can result in the inability to realize essential functionings, such as being in good health or being integrated into a social community.

Drawing on the definition of fuel poverty proposed by Day *et al.* (2016), utility services poverty could be defined as follows:

"The inability to realize essential functionings due to difficulties in satisfying a set of essential utility services in housing".

3. Data and descriptive statistics

3.1 Database and variables retained

To carry out this study, we rely on the 2013–2014 Mayotte housing survey. In this database, information is available on the physical characteristics of the housing stock (size, sanitary comfort, heating, outbuildings), the quality of the housing (condition of the dwelling and the building, noise, exposure, location, environment, neighborhood, security, quality of existing equipment, access to electricity and running water, use of clean energy, and household characteristics). Our database has a total sample size of 2058 households.

To measure income poverty, several methods can be used: the local poverty rate at 60% or 50% of the median living standard and the Sen index. The poverty rate is calculated on the basis of annual household income per unit. It is set at 60% or 50% of the local median standard of living, so we have 36.5% of households in poverty, or 751 individuals below the poverty line (with the 60% standard). If we were to use the national poverty line (metropolitan France), we would have 83% of households in Mayotte below the poverty line.
Sen's index was constructed as an index measuring poverty. Its main advantage is that it takes into account two dimensions simultaneously (Sen, 1976): (i) the poverty rate and (ii) the poverty intensity.

Therefore, we use the simplified version of the index, written as follows, since we do not conduct a comparative analysis between countries:

S=T x I = poverty rate x poverty intensity

where T is the poverty rate and I is the average poverty gap (intensity) measured relative to the threshold.

S=poverty rate x ((average income of poor households)/(60% poverty line))x 100

The average Sen index is equal to 13.1%. Therefore, 416 households are below the Sen index.

Thus, based on the *capability* framework, we identify some basic utility services provided by the Direction de l'Environnement de l'Aménagement et du Logement de Mayotte (2017). The classification of basic energy services by the French Ministry and the United Nations (goal for development) combined with the conceptualized relationship between water, energy services and capabilities by *Day et al.* (2016) helps us to identify items that could be observable characteristics of utility services poverty in Mayotte. Using this theoretical framework and the recommendations of the UN, we identify 6 items: access to electricity, access to water, the presence of a cooling system to fight humidity, sanitary facilities (presence of toilets and bathrooms) and the presence of kitchens for cooking with a modern energy source.

3.2 Descriptive statistics

The main descriptive statistics are provided in Table 1. The poverty line was calculated on the basis of income levels in Mayotte and not on the basis of the line that could have been calculated using data from metropolitan France.

Table 1: Summary statistics

	N	Mean	SD	Min	Max
		Utility Services			
Cooling system	2058	0.169	0.375	0	1
Water access	2058	0.741	0.438	0	1
Bathroom	2058	0.436	0.496	0	1
Electricity access	2058	0.943	0.233	0	1
Toilet	2058	0.409	0.492	0	1
Kitchen	2058	0.713	0.452	0	1
Energy for cooking:					
Coal & wood	2058	0.099	0.299	0	1
Butane	2058	0.746	0.435	0	1
Electricity	2058	0.124	0.33	0	1
Oil	2058	0.191	0.394	0	1
		Monetary Poverty			
Income	2058	7050.982	9719.735	0	94125
Monetary poor 60%	2058	0.365	0.482	0	1
Monetary poor Sen	2058	0.202	0.402	0	1
Monetary poor 50%	2058	0.325	0.468	0	1

The results indicate that on average, approximately 25% of the population does not have access to water in housing, and 16.9% of the households have air conditioning in their houses. As shown by Charlier *et al.* (2021), air conditioning is important in tropical territories. The climate in Mayotte in summer is very hot and humid; therefore, air conditioning allows people to fight against mosquito-related diseases. Fifty percent of Mayotte households do not have a bathroom, more than 60% do not have toilets in their dwellings, and 5% do not have access to electricity. We must mention that approximately 20% of households that do have access to electricity are connected to a neighbor’s meter, so those 20% do not have safe access to electricity. Thirty percent of the households do not have cooking installations inside their homes, and approximately 10% use wood or coal for cooking, so this population could be exposed to indoor air pollution.

The average annual income in Mayotte is approximately 7000€ per year. The profile of individuals below the local poverty line is essentially the same as that of those below the Sen index except that poor individuals below the Sen index are even poorer than the others and do not have easy access to the resources and energy needed to live. These statistics show, as Sen pointed out, that poverty is not only a monetary issue but also raises the difficulty of achieving functionings, especially because of a lack of capabilities. We therefore capture more extreme and multidimensional poverty via the Sen index.

As we mentioned in the introduction, it is tempting to think of utility services poverty as a problem of income poverty. As the share of income poor households in Mayotte is significant, we wonder whether monetary poverty and utility services poverty are distinct. Therefore, we examine the data on the non-income poor (Table 2).

Generally, we note that a large number of households do not have the basic resources necessary to achieve well-being and functionings. In fact, many households do not have access to water and electricity in their homes. Very few households can protect themselves from heat (no insulation in the dwelling, no air conditioning). In addition, poor households live in poor sanitary conditions (even worse than other households). However, some disparities exist between monetary poor households and access to utility services. For example, among poor households, the percentage with access to water (48.6%) is almost identical to the percentage without access (51.4%).
In terms of cooking methods, while fewer poor households under the Sen index use propane/butane than nonpoor households (45.2% vs. 68.6%), they use more wood and kerosene (14.9% and 33.5% vs. 4.3% and 12.4%). Poor households also appear less dissatisfied with their housing conditions (43.1% of poor households have a positive perceived situation of their dwelling condition as opposed to 22.3% of nonpoor households).
Additionally, there are no differences between income poor and non-income poor households according to certain housing conditions. For example, 24.5% of the households declared that they had humidity problems. This problem is shared equally among poor and nonpoor households.

Thus, even if the manifestations of monetary poverty seem to be noticeable in the conditions of access to utility services and the quality of living conditions, it seems that the profiles of these households are not strictly identical. We will be able to confirm this intuition with the help of our latent class econometric estimation.

Table 2: Summary statistics by monetary poverty

		Monetary poor 60%				**Monetary poor Sen index**			
	Sample means (n=2058)	**Nonpoor (n=1307)**		**Poor (n=751)**		**Nonpoor (n=1642)**		**Poor (n=416)**	
	%	**%**	**Obs**	**%**	Obs	**%**	Obs	**%**	Obs
	Dwelling characteristics								
Wall material			***1307***		***751***		***1642***		***416***
Sheet metal	33.9	21.5	281	55.5	417	26.9	441	61.8	257
Hard (stone, brick, breeze block)	61.9	73.8	964	41.4	311	68.7	1128	35.3	147
Semihard (coated earth, lime)	3.0	3.7	48	1.9	14	3.2	53	2.2	9
Vegetal, wood, earth	1.5	0.83	17	0.73	15	1.17	24	0.39	8
Floor material			***1300***		***748***		***1633***		***415***
Clay	7.6	4	50	14.2	106	5.9	97	14.2	59
Cement	27.5	24.9	323	32.1	240	26.5	433	31.3	130
Tile	40.6	54.5	708	16.6	124	47.5	775	13.7	57
Plastic coating	24.0	16.6	216	36.8	275	19.8	324	40.2	167
Other	0.3	0.2	3	0.4	3	0.2	4	0.5	2
Roof material			***1300***		***748***		***1633***		***415***
Vegetal	0.1	1.1	3	0.4	3	0.1	3	0.7	3
Sheet metal	58.0	47.7	620	75.8	567	52.7	861	78.6	326
Cement	41.8	52.1	677	23.8	178	47.1	769	20.7	86
Humidity			***1026***		***334***		***1201***		***159***
Yes	24.5	25.0	256	23.1	77	25.0	300	20.8	33
No	75.5	75.0	770	77.0	257	75.0	901	79.2	126
Water infiltration or flooding in the home			***1307***		***751***		***1642***		***416***
Yes	32.4	26.4	345	42.9	322	29.3	481	44.7	186

		Monetary poor 60%				Monetary poor Sen index			
	Sample means (n=2058)	**Nonpoor (n=1307)**		**Poor (n=751)**		**Nonpoor (n=1642)**		**Poor (n=416)**	
	%	**%**	**Obs**	**%**	Obs	**%**	Obs	**%**	Obs
No	67.6	73.6	962	57.1	429	70.7	1161	55.3	230
Cooling system			***1307***		***751***		***1642***		***416***
Yes. entire dwelling	3.3	4.7	62	0.7	5	3.9	64	0.7	3
Yes. just a room	13.6	20.4	266	2.0	15	16.8	276	1.2	5
No	83.1	74.9	979	97.3	731	79.3	1302	98.1	408
Housing condition (as perceived by the household)			***1307***		***751***				
Very good	8.6	10.2	134	5.2	39	4.3	18	9.4	155
Good	37.1	36.9	482	19.4	146	18	75	33.7	553
Medium	36.2	38.4	502	38.6	290	37.7	157	38.7	635
Bad	14.3	9.1	119	21.7	163	22.4	93	11.5	189
Very bad	3.8	5.4	70	15.1	113	17.6	73	6.7	110
	Access to water and sanitary facilities								
Access to water			***1307***		***751***		***1642***		***416***
Yes	74.2	85.5	1117	54.5	409	80.6	1324	48.6	202
No	25.8	14.5	190	45.5	342	19.4	318	51.4	214
Access to hot water			***1117***		***409***		***1324***		***202***
Yes	16.2	20.9	233	3.7	15	18.4	243	2.5	5
No	83.8	79.1	884	96.3	394	81.7	1081	97.5	197
Means of water supply used			***190***		***342***		***318***		***214***
Water intake at a third party	18.1	26.3	50	13.5	46	22	70	12.1	26
Hydrant in the yard	8.5	10.5	20	7.3	25	10.1	32	6.1	13
Public hydrant	38.5	36.8	70	39.5	135	40.3	128	36	77
Hydrant of a family member	17.1	15.8	30	17.8	61	16.4	52	18.2	39
Well, cistern	7.7	5.8	11	8.8	30	5	16	11.7	25
Other (river, water course, etc./)	10.1	4.8	9	13.2	45	6.3	20	15.9	34
Household has a bathroom (shower, bath)			***1307***		***751***		***1642***		***416***
Yes	43.6	57.1	746	20.2	152	50.7	833	15.6	65
No	56.4	42.9	561	79.8	599	49.3	809	84.4	351
Household suffers from water deprivation			***1307***		***751***		***1642***		***416***
Yes, in the dry season	1.4	0.8	10	2.5	19	1.2	20	2.2	9
Yes, in the rainy season	1.0	0.5	7	1.7	13	0.7	11	2.2	9
Yes, in all seasons	9.3	7.9	103	11.9	89	8.2	135	13.7	57
Household has a toilet in the home			***1307***		***751***		***1642***		416
Yes, inside	24.3	54.9	717	16.5	124	47.7	783	13.9	58
No, outside	16.6	31.5	412	53.7	403	35.6	585	55.3	230
No	39.6	13.6	178	29.8	224	16.7	274	30.8	128
	Access to electricity								
Electricity access			***1307***		***751***		***1642***		***416***
Yes	74.3	83.1	836	64.6	485	83.6	1372	60.1	250

		Monetary poor 60%				Monetary poor Sen index			
	Sample means (n=2058)	**Nonpoor (n=1307)**		**Poor (n=751)**		**Nonpoor (n=1642)**		**Poor (n=416)**	
	%	**%**	**Obs**	**%**	Obs	**%**	Obs	**%**	Obs
Yes, connected to another home's meter	18.7	13.2	133	24.6	185	12.8	210	24.8	103
No	7.00	3.7	37	10.8	81	36.5	60	13.9	58
Safety of the electrical installation of the dwelling			***1270***		***670***		***1582***		***358***
Protected installation	44.9	53.8	684	27.8	186	49.4	782	24.6	88
Installation with unprotected wires	47.0	41.2	523	58.1	389	44.1	697	60.1	215
Unprotected installation	8.1	5	63	14.2	95	6.5	103	15.4	55
	Cooking facilities								
Household has a place for cooking			***1307***		***751***		***1642***		***416***
Yes	71.3	49.7	1023	21.6	445	60.0	1235	11.3	232
No	28.7	13.8	284	14.9	306	19.8	407	8.9	183
Kitchen surface area			***755***		***190***		***852***		***93***
Less than 4 m²	23.0	20	151	34.7	66	21.5	183	36.6	34
From 4 m² to 7 m²	36.9	35.5	268	42.6	81	36	307	45.2	42
From 7 m² to 12 m²	25.1	27.7	209	14.7	28	26.4	225	12.9	12
Greater than 12 m²	15.0	16.8	127	7.9	15	16.1	137	5.4	5
Energy for cooking			***1307***		***751***		***1642***		***416***
Butane, propane, tank	74.6	85	1111	56.5	424	68.6	1326	45.2	209
Oil	19.1	10.7	140	33.8	254	12.4	239	33.5	155
Electricity	12.4	15.1	197	7.7	58	12.2	235	4.3	20
Wood	7.4	2.8	36	15.6	117	4.3	84	14.9	69
Coal	2.9	3.3	43	2.1	16	2.6	50	1.9	9

We investigate the link between the presence of a kitchen in the dwelling and the cooking method. Butane/propane gas and oil are the two most-used cooking fuels for all households (with or without cooking facilities). We note that households that do not have a cooking facility use more wood than those that do. More households with cooking facilities use electricity than those without cooking facilities (Table 3).

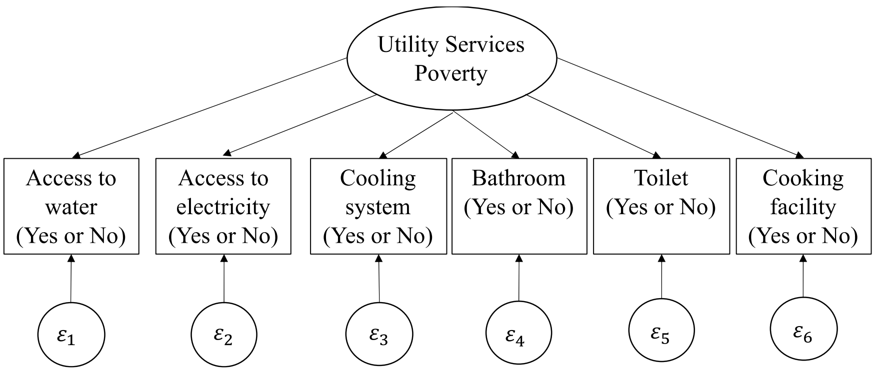
Table 3: Energy for cooking and having a kitchen

		Energy for cooking					
		Butane/propane	**Electricity**	**Wood**	**Coal**	**Oil**	**Total**
Has a cooking facility (open kitchen, gas stove, kitchen utensils...)	**No**	50.5%	6.9%	14.7%	2.9%	28.3%	28.7%
	Yes	84.3%	14.6%	4.5%	2.9%	15.5%	71.3%
	Total	74.6%	12.4%	7.4%	2.9%	19.1%	100%

4. LCM methodology

We want to identify household profiles and know which characteristics are shared by individuals who are utility services poor using latent structural analysis (Lazarsfeld & Henry, 1968). We use an LCM because to date, there is no formal indicator of utility services poverty. Therefore, we are not able to distinguish a person who is utility services poor from a person who is not simply by applying an existing definition and a measurement tool. However, we know, from both the theoretical framework and the UN guidelines, the characteristics of utility services poverty. This person is deprived of his or her capabilities and therefore will not be able to achieve his or her functionings. Indeed, the dependent variable here, the utility services poverty variable, is assumed to be discrete and unobservable, and the latent class methodology categorizes observations into latent classes using observed variables or indicators (Goodman, 2002).
We want to differentiate profiles that are exclusive and exhaustive, where each individual has membership in exactly one category. This is the assumption of conditional or local independence (Masyn, 2013).
The latent classes relate to latent heterogeneity that varies with manifest variables that explain membership in the class. These manifest variables are related to utility services (access to water, electricity, cooling system, bathroom, kitchen facilities, toilet).
These manifest variables should allow latent class *homogeneity* and latent class *separation* (Collins & Lanza, 2009). The model is presented in a path diagram in Figure 1 (Muthén & Muthén, 1998-2011). The methodology is the same as that used in Charlier, et al. (2021).

Figure 2 Path diagram for unconditional LCM of utility services poverty



Using a logit discrete choice model allows us to define in which class an individual belongs. We sort individuals into a set of y classes with $y=0,1,\ldots,r_j-1$. y is the value observed for Y_{it}, the categorical response variable for subject i to item j, with $i=1,\ldots,n$ and $j=1,\ldots, J_i$.
U_i is the discrete latent variable (in our case, the utility services poverty variable) for subject i.

Based on the local independence assumption, the given latent class $U_i=u$, the probability of answering Y_{ij} is independent of the probability of answering Y_{il}, for $j\neq l$; with j,l=1,….,J. The manifest distribution of the response vector Y_i is:

$$P(y) = Prob(Y_i = y) = \sum_{u=1}^{k} \pi_u P_u(y)$$

where π_u is the weight probability that subject i belongs to class u (with u=1,….,k):

$$\pi_u = p(U_i = \xi_u) = \frac{\exp(\psi_{0u})}{\exp(\psi_{0u})}$$

Subject to

$$\sum_u \pi_u = 1;\ \pi_u > 0$$

where ξ is the value assumed by U_i (support point), u = 1; …; k

The conditional probability of answering y, given the latent class u, is:

$$p_u(y) = P(Y_i = y|U_i = \xi_u) = \prod_{j=1}^{J_i} P(Y_{ij} = y|U_i = \xi_u))$$

The number of free model parameters is equal to $\pi_u + p_u(y) = (\mathrm{k} - 1) + \mathrm{kJ}(\mathrm{rj} - 1)$.

The LCM is estimated by the maximization of the log-likelihood:

$$l(\theta) = \sum_{i=1}^{n} \log p(Y_i = y) = \sum_{i=1}^{n} log \sum_{u=1}^{k} \pi_u p_u(y_i)$$

where θ is the vector of free model parameters. The log-likelihood $l(\theta)$ may be efficiently maximized through an expectation-maximization (EM) algorithm. This algorithm is based on the complete log-likelihood written as follows:

$$l^*(\theta) = \sum_{i=1}^{n} \sum_{u=1}^{k} \lambda_{ui} [\log \pi_u + \log p_u(y_i)],$$

where λ_{ui} is an indicator equal to 1 if subject *i* belongs to latent class u and to 0 otherwise. The EM algorithm alternates two steps until convergence in $l(\theta)$: the E-step, which consists of computing the expected value of $l^*(\theta)$ under the current estimates of model parameters, and the M-step, which consists of updating the model parameters by maximizing the expected value of $l^*(\theta)$. The number k of latent classes is not a model parameter, but it has to be fixed a priori. Here, we compare a model with 2 to 3 and 4 classes. The first 2 classes allow us to discriminate between utility service poor households. This first estimate is based on a traditionally binary approach to poverty: some are utility services poor, and some are not. However, such an approach is often criticized because it assumes that the situation of individuals changes once they pass the poverty threshold. However, we know that reality is more complex, and sometimes being on one side or the other of a poverty/precarity line does not radically change the situation. This is why we introduce the idea that there are also one or more vulnerable classes exposed to one or more exogenous shocks of different natures, putting them at risk of poverty. These sources of vulnerability may be different, which is why we test a 3-class model and then a 4-class model.

The final chosen number of classes is based on information criteria such as the BIC and AIC indexes.

After the parameter estimation, each individual i may be allocated to one of the k latent classes on the basis of the highest estimated posterior probability.

$$\hat{\lambda}_{ui} = \frac{\widehat{\pi_u}\hat{p}_u(y_i)}{\sum_{c=1}^{k}\widehat{\pi_c}\hat{p}_c(y_i)}$$

5. Results

In a first step, we ensure the quality of the econometric estimation using 2 classes (to ensure that we measure utility services poverty). Second, we compare the models with 2, 3 and 4 classes using AIC and BIC criteria (see Table 5).

5.1 Results for a model with 2 latent classes

Here, we present the results for a binary-class model of utility services poverty in Mayotte in order to identify who is utility services poor and who is not.

Table 4: Estimated coefficients and predicted probabilities in a model with 2 latent classes

	Class 1 Utility services poor 43.4%			**Class 2 Utility services sufficient** 56.6%		
	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin
0. No access to water	base outcome		0.4568	base outcome		9.07e-12
1. Access to water	0.173	(0.068)**	0.5432	25.426	(0.965)***	1
0. No access to electricity	base outcome		0.1013	base outcome		3.84e-08
1. Access to electricity	2.183[a]	(0.100)***	0.8987	17.075	(7.607)**	1
0. No cooling system	base outcome		0 .9924	base outcome		.06204
1. Cooling system	-4.873	(0.415)***	0.0076	-0.491	(0.076)***	0.3796
0. No bathroom	base outcome		0.9313	base outcome		0.0843
1. Bathroom	-2.607	(0.187)***	0.0687	2.384	(0.144)***	0.9156
0. No toilet	base outcome		0.9678	base outcome		0.1007
1. Toilet	-3.402	(0.207)***	0.0322	2.190	(0.186)***	0.8993
0. No kitchen facilities	base outcome		0.4629	base outcome		0.0569
1. Kitchen facilities	0.149	(0.060)***	0.5371	2.807	(0.179)***	0.9430
Observations	2,058					

Robust standard errors are presented in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Note: [a]The probability of being in Class 1 increases if households have electricity access compared with those without electricity access.

In Class 1, half of the households have water access and 90% have access to electricity. Only 50% of the households have modern kitchen facilities for cooking. This class, which includes 43.4% of the sample, appears to be the utility services poor. For each criterion used to characterize utility services poverty, households in this class are indeed less well equipped than households in Class 2.

Basically, the utility services sufficient households, identified as Class 2, have access to water and energy (100% of the households have access to electricity and water).
This enables us to confirm that there is indeed a utility services deprived class, i.e., a utility services poor class, in which households have common characteristics.

In a French territory such as Mayotte, the standard of living remains lower than in other departments of the country or in other Western countries. Nevertheless, even if the facilities are underdeveloped, a small part of the population has access to elements of comfort similar to what one would find in overseas departments with higher standards of living. The presence of climatization is a good example. Among Class 1 households, 99% do not have air conditioning, while only 62% of Class 2 households do not have air conditioning.

Access to hygiene facilities is represented by the variables of the presence of a bathroom and toilet in the dwelling. The analysis of these variables in our estimations confirms our identification of the two categories of population because again, class one seems disadvantaged compared to class two. This suggests that having dignified access to hygiene is more complicated for the 43% of the population included in Class 1. Indeed, among them, 93% do not have a bathroom in the dwelling, and nearly 97% do not even have a toilet. In comparison, these proportions are much less dramatic within Class 2, as 8% have no bathroom in the dwelling, and 10% have no toilet.

The choice of manifest variables, i.e., variables representative of deprivation in utility services, allowed us to clearly discriminate among households according to whether their situation is precarious.

The clear identification of two classes with very different characteristics and equipment rates attests to the relevance of the manifest variables selected. Nevertheless, as in any analysis of precariousness and deprivation, one can wonder about the limited nature of a binary classification into poor/precarious versus nonpoor/nonprecarious. Such a classification suggests that there is a threshold, even if we do not clearly identify it here. However, the very existence of thresholds is frequently criticized, and rightly so. This is why we explore the possibility of a classification into 3 or 4 classes. Beyond the relevance of such an approach in economic terms, statistical tools may or may not confirm that considering more classes is a good choice.

Using the statistics criterion, smaller AIC and BIC values are better. A higher log-likelihood value (LL) is also preferred. Here, we prefer a model with three classes compared to two classes. According to 2 criteria, the model with 4 classes is preferred to those with 3 classes. A part of the analysis will involve providing materials to attest that it is meaningful to add an additional class and to provide 4 classes in this analysis.

Table 5: Comparison of models

		AIC	BIC	LL	df
Model 1	2 classes	10219.24	10292.42	-5096.619	13
Model 2	3 classes	10009.43	10110.76	-4986.714	18
Model 3	4 classes	9981.925	10117.03	-4966.962	24

5.2 Results for 3- and 4-level latent class models

We now observe what happens if we add a third class, a class that would allow us to identify a scale of utility services poverty (see Table 6).

Table 6: Estimated coefficients and predicted probabilities in 3 latent classes model

	Class 1 Utility services poor 27.8%			**Class 2 Utility services vulnerable** 32.4%			**Class 3 Utility services sufficient** 39.8%		
	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin
0. No access to water	base outcome		0.9143	base outcome		0.0124	base outcome		0.0013
1. Access to water	-2.368	(1.345)*	0.0857	4.377	(0.717)***	0.9876	6.661	(1.080)***	0.9987
0. No access to electricity	base outcome		0.1851	base outcome		0.0165	base outcome		0.0015
1. Access to electricity	1.482	(0.114)***	0.8149	4.088	(1.269)***	0.9835	6.511	(2.833)**	0.9985
0. No cooling system	base outcome		1	base outcome		0.9711	base outcome		0.5992
1. Cooling system	/	/	0	-3.516	(0.302)***	0.0289	-0.402	(0.100)***	0.4008
0. No bathroom	base outcome		1	base outcome		0.7759	base outcome		0.0872
1. Bathroom	/	/	0	-1.242	(0.152)***	0.2241	2.348	(0.269)***	0.9128
0. No toilet	base outcome		0.9632	base outcome		0.9811	base outcome		0.0158
1. Toilet	-3.264	(0.235)***	0.0368	-3.949	(2.400)	0.0189	4.133	(.690)***	0.9842
0. No kitchen facilities	base outcome		0.4507	base outcome		0.4422	base outcome		0.0461
1. Kitchen facilities	0 .198	(0.094)**	0.5493	0.232	(0.092)**	0.5578	3.030	(0.307)***	0.9539
Observations	2,058								

Robust standard errors are presented in parentheses; *** *p*<0.01, ** *p*<0.05, * *p*<0.1

In total, 27.8% of individuals are expected to be utility services poor (Class 1), 32.4% of individuals are expected to be vulnerable to utility services (Class 2) and 39.8% of individuals are expected to be utility services sufficient (Class 3). These results show that a large share of utility services poor households (previously Class 1 in the 2 latent classes model) fall into the second class. When we more closely examine the profiles of individuals in each class, we see that in the poorest class (Class 1), 91% of households do not have access to water, as opposed to 50% in the earlier model with 2 classes. They do not have decent sanitary conditions (no bathrooms and toilets), and in addition, they do not have access to water in housing. In Class 2, utility services are vulnerable; households have access to water and electricity but do not have sanitary facilities (toilets and bathrooms). By opening up this third class, we can better identify the poorest households and those that are vulnerable. Vulnerability here means that even if access is seemingly not a problem, using water or accessible energy is not easy, and so individuals seem to remain deprived of capabilities. Their deprivation is less severe than that of individuals in Class 1. Thus, if we were to prioritize policy targets, we would be better able to do so with a 3-class model than with a 2-class model. Here, doing better means prioritizing the strongest deprivation source: connecting Class 1 households to existing networks and assisting with home improvements for Class 2 households.

Finally, when we add a last class, we note that the utility services sufficient class remains the same, but a new class between utility poor and vulnerable households allows us to identify new profiles (Table 7).

In Class 1 (utility services poor), the profiles of households are as follows: they do not have access to water, they do not have bathrooms and toilets, 25% do not have access to electricity and 60% do not have kitchen facilities. In Class 2 (utility services vulnerable 1), more than 60% do not have access to water, whereas in Class 3 (utility services vulnerable 2), 100% have access to water. The source of vulnerability for individuals in Class 2 clearly comes from limited access to running water. Households in Class 3 appear to be less well equipped, especially in terms of kitchen and toilet facilities within the dwelling. The common denominator of these 2 vulnerable classes is the almost nonexistence of basic hygiene facilities, such as bathrooms and toilets, inside their homes.

Except in Class 1, access to electricity exists. In contrast, our results show that access to running water is the problematic element in both Class 1 and Class 2.

Access to water is therefore more discriminatory than access to electricity in utility services poverty in Mayotte. In fighting utility services poverty, priority should be given first to water access and sanitary facilities.

Households in Class 4 (utility services sufficient) still have access to everything.

Table 7: Estimated coefficients and predicted probabilities in a model with 4 latent classes

	Class 1 Utility services poor 20.1%			**Class 2 Utility services vulnerable 1 – water sanitary** 13%			**Class 3 Utility services vulnerable 2 – energy access** 27.3%			**Class 4 Utility services sufficient** 39.6%		
	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin	Coeff.	Std. Err.	Margin
0. No access to water	base outcome		0.8744	base outcome		.6344	base outcome		0	base outcome		0
1. Access to water	-1.940	(0.491)***	0.1256	-.551	(4.266)	.3656	30.936	(0.494)***	1	31.973	(0.278)***	1
0. No access to electricity	base outcome		0.2495	base outcome		.0272	base outcome		.0101	base outcome		.0022
1. Access to electricity	1.101	(0.602)*	0.7505	3.577	(3.448)	.9728	4.584	(0.899)***	.9899	6.120	(1.108)***	.9978
0. No cooling system	base outcome		1	base outcome		.9830	base outcome		.9734	base outcome		.5966
1. Cooling system	/	/	0	-4.055	(1.548)***	.0170	-3.602	(0.365)***	.0266	-0.391	(0.120)***	.4034
0. No bathroom	base outcome		1	base outcome		1	base outcome		.7429	base outcome		.0746
1. Bathroom	/	/	0	-17.730	(1.704)***	0	-1.061	(0.443)**	.2571	2.518	(1.011)**	.9254
0. No toilet	base outcome		1	base outcome		.8621	base outcome		.9906	base outcome		
1. Toilet	/	/	0	-1.833	(2.256)	.1379	-4.659	(4.877)	.0094	3.931	(1.133)***	.9807
0. No kitchen facilities	base outcome		0.6187	base outcome		.0905	base outcome		.4809	base outcome		
1. Kitchen facilities	-0.484	(1.266)	0.3813	2.308	(1.465)	.9095	0.076	(0.748)	.5191	2.971	(0.296)***	.9513
Obs.	2058											

Robust standard errors are presented in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

5.3 Comparing utility services poverty and income poverty with the 4-class model

If we meet our utility services poor profiles with income poverty indicators, we can see a progression in income level according to the class. Households in Classes 1 and 2 have lower incomes than those in Classes 3 and 4. However, households with utility services poverty and income poverty do not have the same profile (see Table 1 in appendices).

Moreover, according to our 4-class model, we can see that among the households in Class 1 (utility services poor who basically have access to nothing), between 30% and 50%, according to the monetary poverty indicators, are not considered monetary poor (see Table 8). This is problematic in terms of public policy. In fact, many policies to fight fuel and water poverty are based on income criteria; if a household is below the threshold, it is eligible for aid. This means that 33.2% of the utility services poor would not be targeted by the policy if it were based on income criteria. This is also valid among utility service vulnerable households (Classes 2 and 3).

In contrast, we find that among the utility services sufficient (Class 4 in our model), between 6% and 14% are considered monetary poor. Public policies that aim to support only the monetary poor do not solve all the problems of access to utility services. In such a context, policies should be distributed not according to income but according to facilities access and living conditions. Policies could be implemented in 2 steps. First, to fight utility services poverty, top priority could be given to water access and sanitary facilities (fighting disease associated with waste or stagnant water). Second, it could be necessary to provide electricity access for everyone.

Table 8: Results – comparisons of utility services poor and monetary poor (4 classes model)

	Monetary poor 60%				**Monetary poor 50%**				**Monetary poor Sen index**				**Income**	**Total**
	No		Yes		No		Yes		No		Yes			
	Obs	%	Obs	%	Obs	%	Obs	%	Obs	%	Obs	%	Euros	Obs
Class 1 *Utility services poor*	96	**33.2**	193	66.8	105	**36.3**	184	63.7	152	**52.6**	137	47.4	2657	289
Class 2 *Utility services vulnerable 1*	98	37.7	162	62.3	11	43.5	147	56.5	17	66.5	87	33.5	2690	260
Class 3 *Utility services vulnerable 2*	405	61.5	280	42.5	443	67.3	242	36.7	542	82.3	143	21.7	4197	658
Class 4 *Utility services sufficient*	708	85.9	116	14.1	72	88.5	95	11.5	775	94.1	49	5.9	12340	824
Total	1307		751		1390		668		1642		416			2058

6. Conclusion

To characterize the broader concept of utility services poverty, we draw on the theoretical capabilities framework developed by Sen and the conceptual work of Day *et al.* (2016) to propose a definition of utility services poverty. We define utility services poverty as *"the inability to realize essential functionings due to difficulties in satisfying a set of essential utility services in housing"*.
To go further, we mobilize an innovative LCM developed by Charlier *et al.* (2021) to identify essential utility services poor households in Mayotte.
This LCM methodology allows us to accurately assess essential utility services poverty in Mayotte using observable objective characteristics. Assuming that objective multivariate variables describing a set of capabilities are observed, we link these variables to the following latent variable: utility services poverty. We show that restricting utility services poverty in Mayotte to a binary phenomenon could lead to neglect of the complexity of utility services deprivation. Therefore, policy makers should first target the most deprived households (in Class

1) and obtain information about who is vulnerable (Classes 2 and 3). With three and four classes, we highlight a scale of utility services poverty severity. The results show that policies could be implemented in 2 steps. To fight utility services poverty, priority should be given to access to water and sanitary facilities (fighting disease associated with waste and stagnant water), and in a second step, public authorities should provide electricity access for everyone.
One other important result of the analysis is that policies should be distributed not according to income but to facilities access and living conditions for Mahorais households. In fact, we show that utility services poor households are not necessarily income poor households.

The identification of utility service poor profiles does not in itself allow us to determine accessibility or equipment thresholds in order to determine which households are service poor. However, the contribution of this first paper on the identification of the service poor concerns above all the philosophy of the policies put in place. Just as Sen has raised the notion of capability to the level of a true theory of poverty, the monetary aspect is absolutely not sufficient to characterize the vulnerabilities of populations. If public policies continue to be based exclusively on thresholds of living standards, part of the means spent miss their goal. Orienting public policies to directly attack the sources of vulnerability, in this case, the issues of access to energy and running water and in a second phase the issues of equipment and quality of housing, seems absolutely essential.
Finally, the profiles identified through LCM can be adjusted over time (if data are available) and do not depend on constant threshold measurement. Even though the results are specific to Mayotte, it could be interesting to apply the methodology in other territories.

Acknowledgment: We thank Estelle Burnet, research ingenior, for her help with data management.

Annex

Table 1: Summary statistics by utility services poverty

		Utility services poverty			
	Sample means (n=2058)	**Poor Class 1 (n=289)**	**Vulnerable 1 Class 2 (n=260)**	**Vulnerable 2 Class 3 (n=685)**	**Nonpoor Class 4 (n=824)**
Wall material					
Sheet metal	33.9	11.0	10.0	12.4	0.5
Hard (stone. brick. breeze block)	61.9	2.6	2.4	18.8	38.1
Semihard (coated earth. lime)	3.0	0.2	0.1	1.8	1.0
Vegetal. wood. earth	1.5	0.6	0.3	0.4	0.2
Floor material					
Clay	7.6	3.4	1.9	2.3	0.1
Cement	27.5	3.7	3.0	15.5	5.2
Tile	40.6	0.8	1.1	6.5	32.3
Plastic coating	24.0	6.1	6.6	8.9	2.3
Other	0.3	0.1	0.1	0.2	0
Roof material					
Vegetal	0.1	0	0	0.1	0
Sheet metal	58.0	12.5	10.7	23.9	10.8
Cement	41.8	1.5	1.9	9.4	29.1
Humidity					
Yes	24.5	1.1	0.9	7.3	15.2
No	75.5	3.5	3.2	24.3	44.6
Water infiltration or flooding in the home					
Yes	32.4	6.5	55	10.5	9.9
No	67.6	7.5	7.1	22.8	30.1
Cooling system					
Yes, entire dwelling	3.3	0.0	16.0	0.2	3.0
Yes, just a room	13.6	0.0	10.1	0.5	13.0
No	83.1	14.0	3.8	32.5	40.0
Housing condition (as perceived by the household)					
Very good	8.6	0.8	16.0	1.7	5.8
Good	37.1	2.2	10.1	9.1	22.8
Medium	36.2	5.3	3.8	16.0	9.8
Bad	14.3	4.4		5.0	1.4
Very bad	3.8	1.3	16.0	1.6	0.3
Access to water			3.8		
Yes	74.2	0.8		33.3	40.0
No	25.8	13.2	16.0	0	0
Access to hot water			10.1		
Yes	16.2	0	3.8	0.3	15.9
No	83.8	1.1		44.6	38.1
Means of water supply used			16.0		
Water intake at a third party	18.1	7.5	10.1	-	-
Hydrant in the yard	8.5	4.3	3.8	-	-
Public hydrant	38.5	22.6	16.0	-	-
Hydrant of a family member	17.1	7.0	10.1	-	-
Well, cistern	7.7	4.0	3.8	-	-

		Utility services poverty			
	Sample means (n=2058)	**Poor Class 1 (n=289)**	**Vulnerable 1 Class 2 (n=260)**	**Vulnerable 2 Class 3 (n=685)**	**Nonpoor Class 4 (n=824)**
Other (river, water course, etc./)	10.1	5.8		-	-
Household has a bathroom (shower, bath)			12.5		
Yes	43.6	0	0.2	7.3	36.3
No	56.4	14.0		26.0	3.7
Household suffers from water deprivation			3.2		
Yes, in the dry season	1.4	0.5	4.2	0.3	0.2
Yes, in the rainy season	1.0	0.2	0.5	0.2	0.2
Yes, in all seasons	9.3	2.2	0.2	2.4	3.3
Household has a toilet in home					
Yes, inside	24.3	0	8.0	0.1	23.6
No, outside	16.6	0	5.2	0	16.1
No	39.6	7.6	0.9	23.7	0.3
Electricity access			0.1		
Yes	74.3	4.0	12.5	31.4	31.5
Yes, connected to another home's meter	18.7	6.0	0.2	5.0	1.1
No	7.00	6.6		0.1	0.1
Safety of the electrical installation of the dwelling			3.2		
Protected installation	44.9	1.9	4.2	10.0	29.7
Installation with unprotected wires	47.0	6.1	0.5	21.0	11.1
Unprotected installation	8.1	1.1	0.2	35.2	42.4
Household has a place for cooking					
Yes	71.3	2.1	12.5	18.6	38.1
No	28.7	12.0	0.2	14.7	1.9
Kitchen surface area					
Less than 4 m²	23.0	1.0	3.2	7.1	11.8
From 4 m² to 7 m²	36.9	0.3	4.2	6.8	25.6
From 7 m² to 12 m²	25.1	0.1	0.5	2.2	22.2
Greater than 12 m²	15.0	0.0	0.2	1.3	13.5
Energy for cooking					
Butane, propane tank	74.6	3.7	8.0	25.1	37.8
Oil	19.1	5.3	5.2	7.2	1.4
Electricity	12.4	0.4	0.9	3.1	8.0
Wood	7.4	3.4	1.3	2.3	0.4
Coal	2.9	0.2	0.1	1.3	1.1

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