Title: Is the analysis scale crucial to assess energy poverty? Analysis of yearly and monthly assessments using the 2M indicator in the south of Spain

Authors:

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Abstract:
Energy poverty has been addressed as a global problem. Many studies have been conducted, and several indicators have been established to detect energy poverty. However, most analyses have been performed at a yearly level without considering the differences throughout the year. This study performed a sensitivity analysis to determine these differences using the 2M indicator in 36,230,400 case studies in the south of Spain, which is a warm zone with great energy poverty, as well as vulnerable to climate change effects. The results showed that monthly assessment could increase energy poverty situations in the months with greater climate severity, compared to yearly assessment. That increase in winter and summer months raised energy poverty cases over 20%, with these months being those with greater vulnerability due to cold and heat waves, respectively. The results also showed that variations were independent of both the technical characteristics of the dwelling and the use of HVAC systems. Energy poverty cases were reduced only in the summer months with the adaptive approach, which considers thermal adaptation. The use of the 2M indicator in monthly scales can detect vulnerable family units that cannot be detected by yearly studies, so monthly scales are crucial for governments to adopt energy poverty policies and strategies.

Keywords:
Energy poverty; assessment scale; sensitivity analysis; kappa; built environment; Spain

Highlights:

- Over 20% of energy poverty cases increase with monthly studies.
- Monthly variation is independent of dwellings' technical characteristics.
- Users' behaviour pattern does not affect monthly tendencies.

1. Introduction

Household energy services are essential to have an acceptable life level [1,2]. This aspect is included in the sustainable development goals. However, the current situation is the opposite. Most world population lives in energy poverty (EP) situation [3] because of both technical factors [4,5] and social and economic aspects [6,7]. EP should therefore be understood as a multidimensional problem, taking place in all countries, although differently [8]: in developing countries the main problem is installation availability [9,10] and energy access [11,12], whereas in developed countries the main problem is the difficulty to tackle energy expenditure [9,13]. However, combined situations could be placed in the two typologies of countries because energy access could also be something of a challenge in developed countries [14]. Moreover, the importance of EP should be understood at different scales because of its influence on users' health [15,16], young people's future expectations [17,18], and the fight against climate change [19].

EP has recently become important in developed countries. Constant economic crisis and price inflation are leading to an increasingly complicated situation in households to pay energy bills, i.e. EP is a problem related to affordability [20]. Recent events such as Covid-19 lockdown [21] and the war in Ukraine [22,23] have led to more EP cases.

Consequently, Spain's situation is worsened [24], a crucial aspect considering the delicate EP situation of the country before COVID-19. In this sense, EP in Europe was a major and acknowledged problem even before COVID-19 and the energy crisis, which is evidenced by the creation of the Energy Poverty Advisory Hub (EPAH). Several studies had already stressed that situation. First studies were published in 2012, reflecting that over 30% of unemployed households allocated more than twice the median of the energy expenditure to pay energy bills [25]. Likewise, households in EP situation increased over 140% in less than 5 years. Subsequently, 11% of households in the country had problems to keep thermal comfort [26]. These data were complemented by other regional studies performed in several zones of the country. A study by Sánchez-Guevara Sánchez et al. [27,28] showed the significant gender gap in family units in EP in Madrid, as well as the predominant percentage (over 20%) of population in EP situation in the region.

As a result, the Spanish Government has established a roadmap, i.e., the National Strategy against Energy Poverty 2019-2024, to reduce EP in the country [29]. The goal is to reduce EP cases up to 50%. For this purpose, 4 indicators are used to assess the situation from various perspectives [30]: (i) inability to keep home adequately warm; (ii) high share of energy expenditure in income (2M); (iii) hidden energy poverty (HEP); and (iv) arrears on utility bills. Except HEP, all indicators are also monitored by the EPAH [31] and allow a traceability with the assessments conducted by the European Union to be obtained. Monitoring is useful to adopt measures that reduce energy cost. Likewise, the goal is to reduce building energy consumption (building energy renovation [32,33]) and to give economic aids (e.g., aids to pay the electricity bill [34]).

The national strategy's action plan is clear, but there are some limitations. The first limitation is the quantification of possible Spanish family unit's EP situations. Most EP analyses are based on yearly scales. Table 1 compiles most studies on EP, as well as the analysis scale used. Family units are quickly assessed by a yearly scale, which is significant considering the many family units that are estimated to be in EP situation. However, the actual family units' situation could not be included in this analysis. Recently, Bienvenido-Huertas et al. [35,36] showed the changing nature of EP by assessing certain case studies. Their results showed that EP could vary throughout the year, so family units could be some months in EP situation. However, these studies were limited because only energy saving measures were analysed. Consequently, there is a knowledge gap to determine the actual need for assessing family units' EP situation monthly. This study therefore performed a sensitivity analysis among the expected concordances by yearly and monthly assessing the EP situation. The goal was to know the differences between assessments at different scales. The results of this study therefore aimed to quantify the similarities and limitations of the currently most used scale (annual scale) in comparison with a shorter scale (monthly scale). The 2M indicator considered by the National Strategy against Energy Poverty was used. The study sample was a parametrized dataset of 36,230,400 cases.

Table 1. Analysis scales used in the studies on EP.

Indicator	Country	Analysis scale	Year	Reference
2M	France	Yearly	2015	Legendre and Ricci [13]
	United Kingdom	Yearly	2015	Roberts et al. [37]
	Greece	Yearly	2016	Papada and Kaliampakos [38]
	Spain	Yearly	2018	Sánchez-Guevera Sánchez et al. [39]
	Spain	Yearly and monthly	2021	Bienvenido-Huertas et al. [36]
LIHC	France	Yearly	2016	Imbert et al. [40]
	China	Yearly	2020	Lin and Wang [41]
	Turkey	Yearly	2021	Dogan et al. [42]
	United Kingdom	Yearly	2022	Galvin [43]
HEP	Belgium	Yearly	2018	Meyer et al. [44]
	Italy	Yearly	2020	Betto et al. [45]
	Poland	Yearly	2020	Karpinska and Smiech [46]
	Mexico	Yearly	2022	Soriano-Hernández et al. [47]
IVH	Spain	Yearly	2018	Castaño-Rosa et al. [48]
	United Kingdom	Yearly	2020	Castaño-Rosa et al. [49]
	Spain	Yearly	2021	Alba-Rodríguez et al. [50]
FFPRI	Chile	Yearly	2018	Pérez-Fargallo et al. [51]

LIHC: Low Income High Costs; IVH: Index of Vulnerable Homes; FPPRI: Fuel Poverty Potential Risk Index

2. Methodology

2.1. Case study

The analysis was limited to the existing characteristics of the built environment, as well as to the socio-economic characteristics of the family units in the south of Spain, a region with warm climate characteristics. This region was chosen because of two reasons: (i) its high prevalence of EP; and (ii) its climate characteristics, with greater prevalence of cooling demand [52], an aspect that will be more important in future climate change scenarios [53]. Moreover, EP significantly impacts this region [54], where there are greater percentages of EP cases than the national mean and cooling energy demand is the most predominant. A huge dataset was used to include most typologies in that built environment. A social building with a geometry that represents most buildings in the region was therefore selected (Figure 1). The building has 51 dwellings, each with 2 or 3 bedrooms. The useful surface area of dwellings is up to 90 m^2. The building was modelled in DesignBuilder and validated according to the ASHRAE Guideline 14 [55]. The validation was included in previous studies [56,57]. The technical characteristics of the building did not allow most of the built environment of the region to be included, so the model was parametrized (Figure 1). The process consisted in using the geometry of the model to combine it with the variables included in Figure 1: (i) thermal transmittance of façade, roof and floor, with variations between 0.1 and 2.0 $W/(m^2K)$ and intervals of 0.1 $W/(m^2K)$; (ii) thermal transmittance of windows, considering 3 typologies; and (iii) HVAC system performance, considering 17 typologies according to the values of both the energy efficiency ratio (EER) and the coefficient of performance (COP). The HVAC system was a heat pump because of its prevalence in the buildings of the region.

As a result of the parametrization, both buildings with great energy efficiency (i.e. low values of U-value and high performance in heat pumps) and buildings with poor performance (i.e. high values of U-value and low performance) were included. Dwellings on the ground, middle and top floor were simulated. Dwellings on the second floor were used because of their small difference in energy consumption in comparison with middle floors. Dwellings were configured for the air-conditioned mode, so there were no limitations associated with the height of the floor. A total of 37 dwellings of the original building was used.

As for the family units' operational pattern, the hypothesis of using static operational patterns (i.e. fixed setpoint temperatures) and adaptive operational patterns (i.e. variable setpoint temperatures) was considered. In this sense, the complexity to predict adaptive behaviour in the social, economic and environmental context [58,59] was assumed in this research study through the adaptive thermal comfort approach. For this purpose, the approaches established in EN 16798-

1:2019 for both patterns were used [60]. Table 2 summarises the values of each operational pattern by establishing 3 categories. Adaptive setpoint temperatures varied according to the running mean outdoor temperature, as the standard establishes.

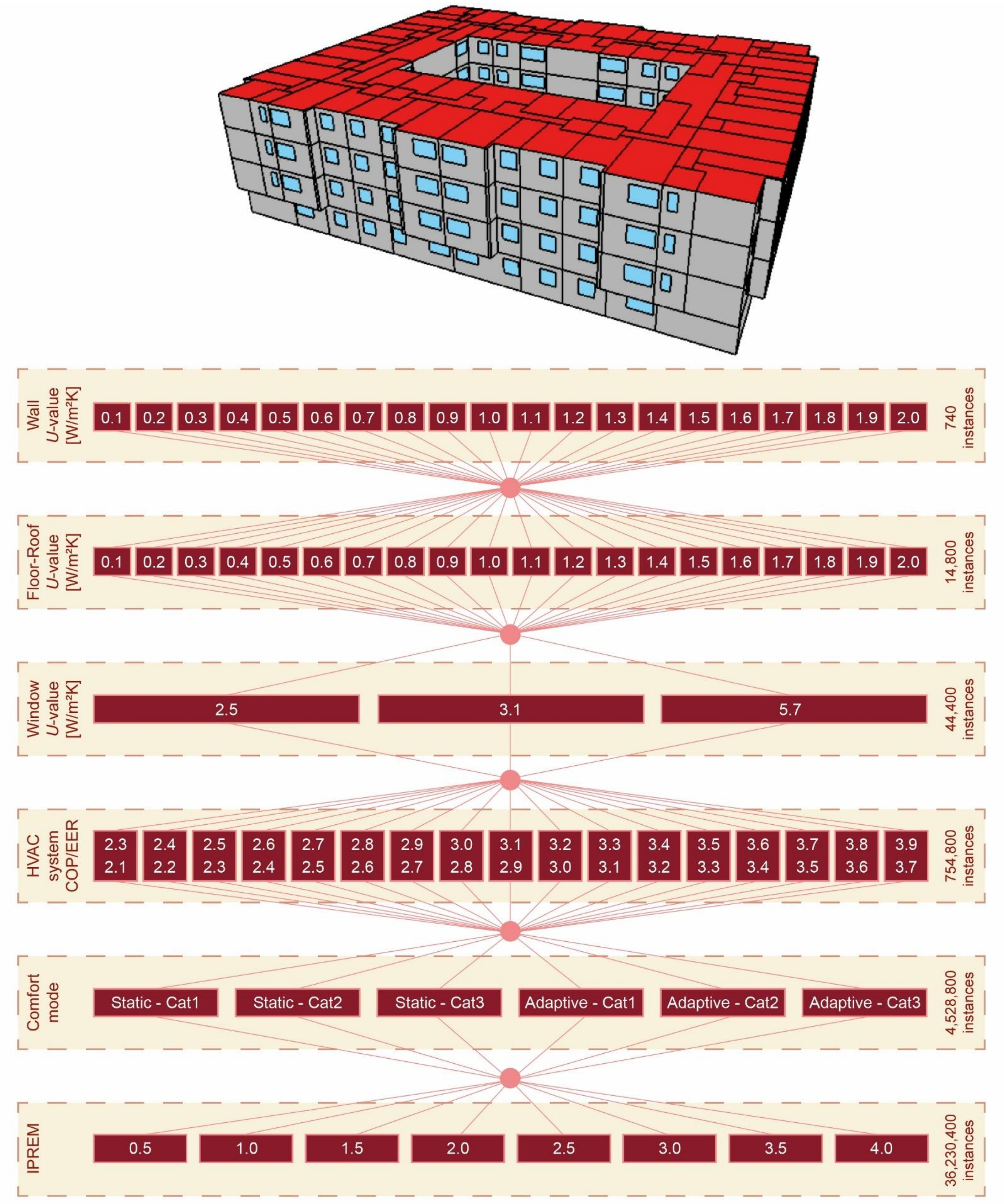

Fig. 1. Variables parametrized in the dataset generation.

Table 2. Setpoint temperatures established for each operational pattern.

Mode	Category	Cooling setpoint temperature (°C)			Heating setpoint temperature (°C)		
		T_{rm}: (-∞,10)	T_{rm}: [10,30]	T_{rm}: (30, ∞)	T_{rm}: (-∞,10)	T_{rm}: [10,30]	T_{rm}: (30, ∞)
Static mode	1	25.5			21		
	2	26			20		
	3	27			18		
Adaptive model	1	24.1	$T_{rm} \cdot 0.33 + 20.8$	30.7	19.1	$T_{rm} \cdot 0.33 + 15.8$	25.7
	2	25.1	$T_{rm} \cdot 0.33 + 21.8$	31.7	18.1	$T_{rm} \cdot 0.33 + 14.8$	24.7
	3	26.1	$T_{rm} \cdot 0.33 + 22.8$	32.7	17.1	$T_{rm} \cdot 0.33 + 13.8$	23.7

T_{rm}: Running mean outdoor temperature

Envelope, systems and operational pattern were combined to perform the energy simulations in EnergyPlus. Seville's climate file was used because of the great impact of EP in the city [61]. Hourly energy consumption results were obtained in all the combinations. EP was also assessed in each case by using the 2M indicator, one of the most used indicators to assess EP. The EPAH and the National Strategy against Energy Poverty in Spain use it. It is also widely used in the state of the art [62,63]. The 2M indicator compares the fraction of both energy expenditure and family units' income with the national average energy expenditure. Family units with an expenditure/income fraction greater than twice the national average will be in EP situation [64]. The expenditure/income fraction was therefore obtained in each case, calling it energy poverty ratio (EPR):

$$EPR = \frac{EC}{I} \cdot 100 \quad [\%] \qquad \text{(1)}$$
$$Case\ in\ energy\ poverty \quad \text{if} \quad EPR \geq 2M$$

Where EC is the energy cost of the household [€], and I is the household income [€].

The threshold of 10% reported by Sánchez-Guevara Sánchez et al. [30] for Spain was used for the 2M value. Likewise, certain conditions were fixed for income thresholds and family units' energy bill to determine EPR. As for the income threshold, 8 types of family units were considered for each combination of dwelling (envelope and systems) according to the income level. The combination of dwellings, operational patterns, and family units generated a dataset of 36,230,400 cases. In this study, the socio-economic factors are based on income data. Specifically, the public income indicator of multiple effects (IPREM in Spanish), which was used to establish the income thresholds of each family unit. This indicator is widely used in Spain to assess economic aids, such as the electrical social bond, that could be given to needy family units [65]. A total of 8 typologies of family units were therefore considered according to the IPREM. For this purpose, factors of 0.5 were applied to the IPREM value, in a range from 0.5 to 4.0. The IPREM basis of 2019 was used. Table 3 summarises the yearly and monthly income values of IPREM. It is worth stressing that the yearly value refers to 14 salaries, whereas the monthly value includes both the monthly net income of the family unit and the sharing of salary bonuses.

Table 3. Income combinations according to the IPREM considered in the study.

Acronym	Factor applied to the IPREM for the hypothesis of the family unit's income	Yearly net income [€]	Monthly net income [€]
IPREM 0.5	0.5	3,759.80	313.32
IPREM 1.0	1.0	7,519.59	626.63
IPREM 1.5	1.5	11,279.39	939.95
IPREM 2.0	2.0	15,039.18	1253.27
IPREM 2.5	2.5	18,798.98	1566.58
IPREM 3.0	3.0	22,558.77	1879.90
IPREM 3.5	3.5	26,318.57	2193.21
IPREM 4.0	4.0	30,078.36	2506.53

Energy cost (EC) was determined by applying the electricity price of the voluntary price for the small consumer (PVPC in Spanish) to the energy consumption obtained in simulations. PVPC is the price available in Spain that is regulated by the government [66]. This price is very related to low-income family units as it is essential to obtain social aids, among other aspects [24,67]. The EC of each case is obtained by summing several variables that consider dwelling consumption and other concepts (Eq. (2)).

$$EC = ET + PT + ElT + EMR + VAT \qquad \text{(2)}$$

Where ET is the energy term, PT is the power term, ElT is the electricity tax, EMR is the rent of measurement equipment, and VAT is the added value tax.

ET is the amount of the kWh consumed. It is obtained by applying the price of kWh of the PVPC to the energy consumption of the dwelling (Eq. (3)). Its price hourly varies throughout the year, so the prices established in 2019 were used. PT corresponds to a fixed price that family units should pay to have the required power in their installation. The amount is obtained by applying the number of billing days and the prices of both marketing margin (0.010959 €/(kWday)) and grid access (0.104229 €/(kWday)) to the contracted power (in this case, 4.6 kW) (Eq. (4)). ElT is obtained by applying a tax of 5.1227% to the amount of ET and PT (Eq. (5)), whereas VAT is obtained by applying a tax of 21% to the sum of the remaining concepts of the bill (ET, PT, ElT, and EMR) (Eq. (6)).

$$ET = Energy\ consumption \cdot Price\ of\ electricity\ in\ kWh \tag{3}$$
$$PT = 4.6 \cdot ND \cdot (0.104229 + 0.010959) \tag{4}$$
$$ElT = 0.051127 \cdot (ET + PT) \tag{5}$$
$$VAT = 0.21 \cdot (ET + PT + ElT + EMR) \tag{6}$$

This study aimed to assess yearly and monthly differences, so the EPR was assessed 13 times in each case (1 for yearly, and 12 for each month of the year).

2.2. Sensitivity analysis

Assessments given to family units according to the analysis scale were compared by a sensitivity analysis through the kappa coefficient (K), sensitivity, and specificity. Likewise, K is used to assess the concordance of measurement instruments whose result is categorical (2 or more categories) and represents the agreement proportion observed beyond chance with respect to the maximum agreement (Eq. (7)). If K has a value of 0, it is related to poor concordance force as it is considered acceptable from 0.21 and almost perfect from 0.81 [68]. The concordance among the responses given by yearly and monthly scales was checked by valuating K. This analysis was performed for each month of the year.

$$K = \frac{P_0 - P_e}{1 - P_e} \tag{7}$$

Where P_0 is the proportion of observed agreements (Eq. (8)), and P_e is the proportion of expected agreements (Eq. (9)).

$$P_0 = \frac{NEP_{Yearly-Monthly} + EP_{Yearly-Monthly}}{N} \tag{8}$$

$$P_e = \frac{NEP_{Yearly} \cdot NEP_{Monthly} + EP_{Yearly} \cdot EP_{Monthly}}{N^2} \tag{9}$$

Where $NEP_{Yearly-Monthly}$ are the dwellings that are not in EP according to the yearly scale and are classified as dwellings that are not under poor energy conditions with the monthly scale; $EP_{Yearly-Monthly}$ are dwellings in EP according to the yearly scale and classified as dwellings in EP with the monthly scale; NEP_{Yearly} is the total amount of dwellings that are not under poor energy conditions according to the yearly scale; EP_{Yearly} is the total amount of dwellings in EP according to the yearly scale; $NEP_{Monthly}$ is the total amount of dwelling that are not under poor energy conditions with the monthly scale; $EP_{Monthly}$ is the total amount of dwellings in EP with the monthly scale; and N is the total amount of dwellings.

Likewise, the analysis assessed sensitivity and specificity. Sensitivity is the probability of classifying a dwelling as not being under poor energy conditions with the two analysis scales (Eq. (10)). Sensitivity varies from 0 to 1 (from 0 to 100%). As greater the numeric value, greater the concordance in dwellings that are not under poor energy conditions according to the two analysis scales; and (ii) specificity is the probability of classifying a dwelling in EP with the two analysis scales (Eq. (11)). Specificity varies from 0 to 1 (from 0 to 100%). As greater the numeric value, greater the concordance in dwellings in EP that were valued by the two analysis scales.

$$Sensitivity = \frac{(NEP_{Yearly} \,\&\, NEP_{Monthly})}{(NEP_{Yearly} \,\&\, NEP_{Monthly}) + (NEP_{Yearly} \,\&\, EP_{Monthly})} \tag{10}$$

$$Specificity = \frac{(EP_{Yearly} \,\&\, EP_{Monthly})}{(EP_{Yearly} \,\&\, EP_{Monthly}) + (EP_{Yearly} \,\&\, NEP_{Monthly})} \tag{11}$$

3. Results and discussion

3.1. Differences in yearly and monthly EP assessments

The first step of the analysis was a descriptive study of the differences between yearly and monthly EP assessments. For this purpose, the EPR distributions were first analysed. The results of static and adaptive behaviour patterns were separately assessed because there were differences in the results. EPR values varied according to the analysis scale. The point clouds in Figures 2 and 3 show this aspect. The abscissa axis is the monthly value, and the ordinate axis is the annual value. Values close to the abscissa axis indicated greater values in the monthly results, while values close to the ordinate axis indicated high values in the annual results. To simplify assessment, the results of the family units with incomes of 0.5 times the IPREM were only represented. Monthly assessments generally varied EPR values. According to the month of the year, EPR values increased or decreased in comparison with the yearly results. All months generally obtained cases where EPR values increased in comparison with yearly assessment, although they decreased in some spring and autumn months (March, April, May, and October); however, February and November obtained results like yearly results. It is therefore expected that the results obtained with the 2M varied throughout the year for a same family unit, having lower EP risk in some months. Likewise, EPR values significantly increased in the months with greater climate severity (January, July, August, and December).

There were no differences in the behaviour of the EPR values per month between static and adaptive patterns, except the lower EPR value range related to adaptive behaviour patterns, resulting from their energy saving. The EPR value range of family units with incomes of IPREM 0.5 was 90% with static patterns, and 72% with adaptive patterns. Behaviour tendencies were the same, but EPR values were not so high with adaptive patterns in the summer months. Although EPR values increased in comparison with yearly assessments, increases were not so significant as in the winter months. The reason was the great potential of adaptive patterns to reduce energy consumption in the summer months as their percentage of application was greater in summer. The months in which EPR values increased more with adaptive patterns were therefore January and December.

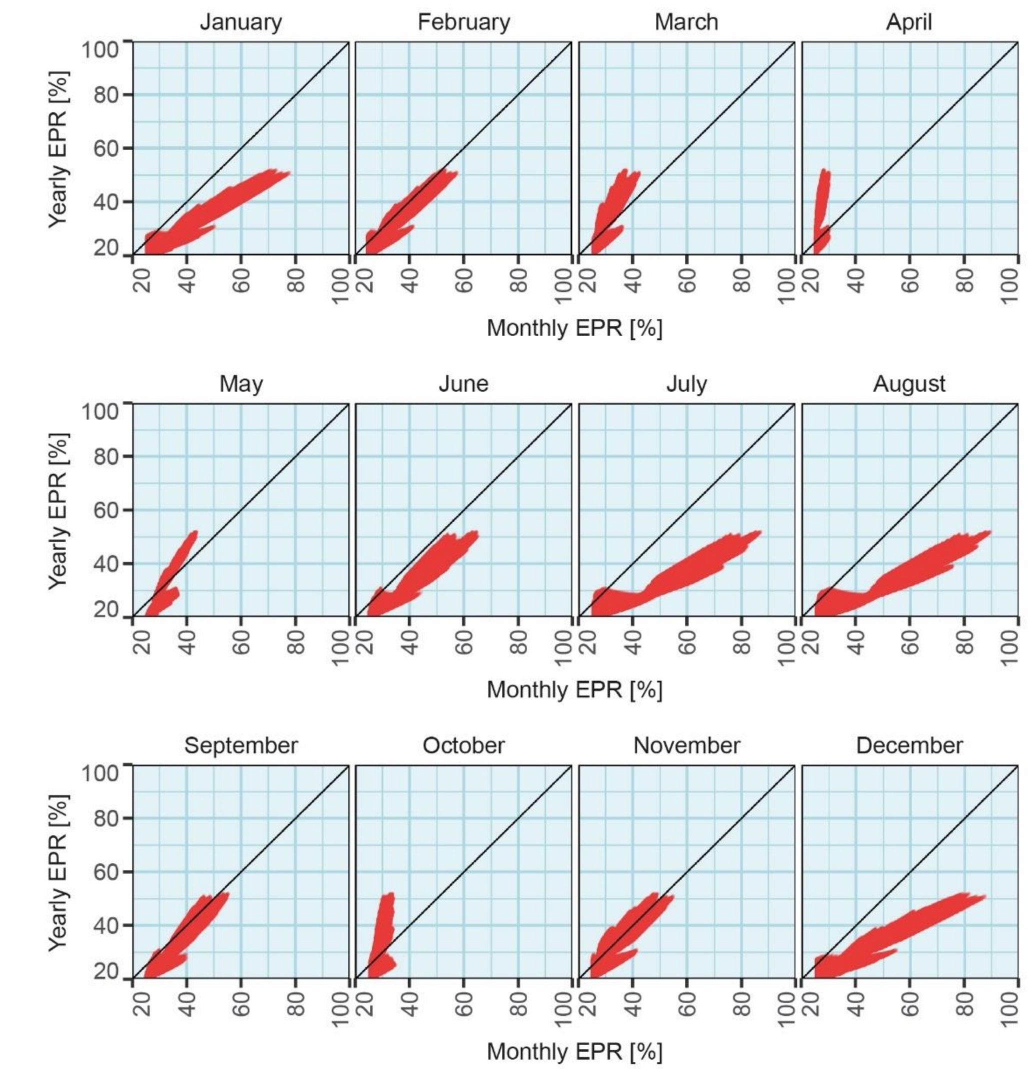

Fig. 2. Point clouds of the differences between yearly EPR results and monthly EPR results. EPR results obtained with static operational patterns for family units with incomes of 0.5 times the IPREM.

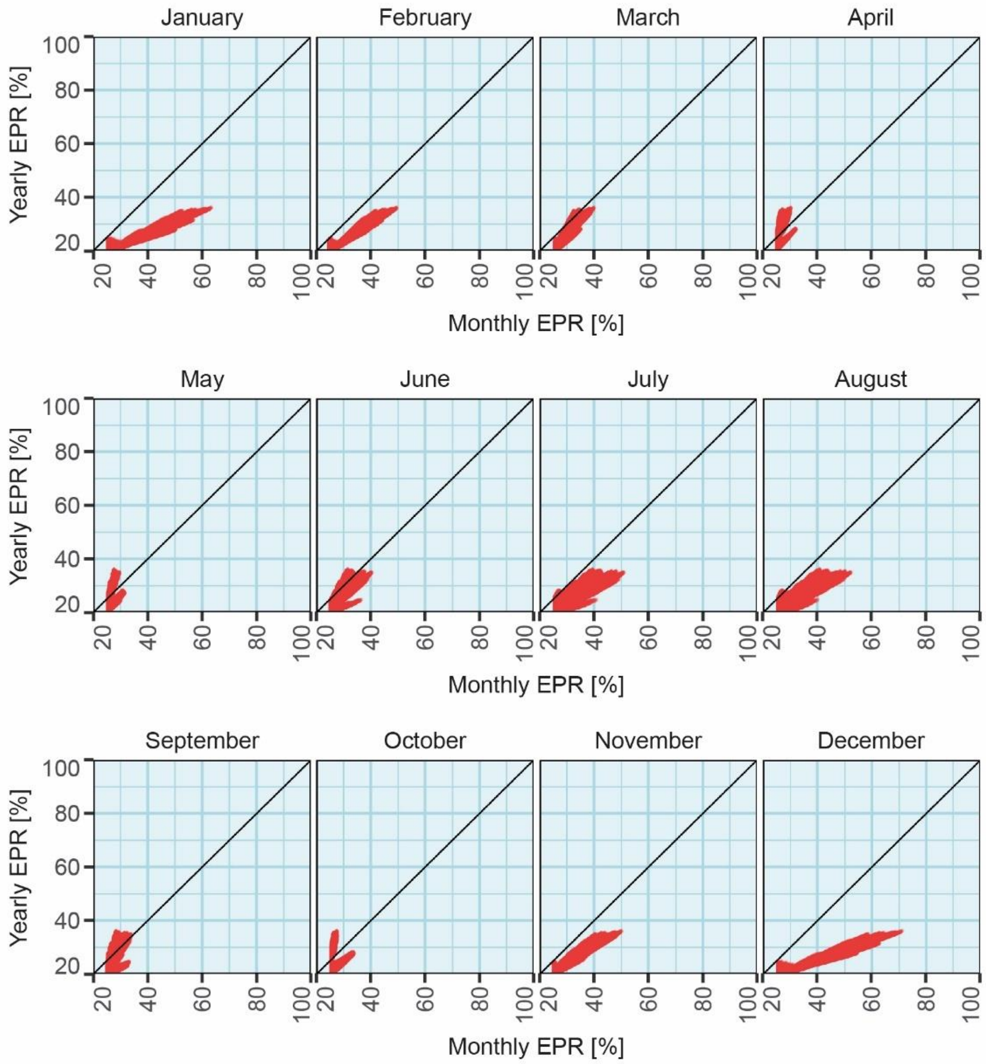

Fig. 3. Point clouds of the differences between yearly EPR results and monthly EPR results. EPR results obtained with adaptive operational patterns for family units with incomes of 0.5 times the IPREM.

3.2. Different distributions in yearly and monthly EP assessments

Despite the differences in the EPR results, the analysis was complemented by assessing their difference distributions. Figures 4 and 5 represent the distributions of the differences obtained by the two behaviour approaches. The positive distribution values showed an increase in the monthly EPR value in comparison with the yearly results. As for the static pattern, difference distributions between yearly and monthly scales showed the tendencies in the point clouds. As for January and December, quartile distribution values showed an increase in EPR values in comparison with the yearly scale: (i) IPREM 0.5 obtained quartile values between 8.1 and 16.7%, with maximum values of 36.7%; (ii) IPREM 1.0 obtained quartile values between 4.1 and 8.4%, with maximum values between 13.5 and 18.3%; and (iii) family units with incomes equal or greater than 1.5 times the IPREM obtained quartile values between 1 and 5.6%, with maximum values between 3.4 and 12.2%. Similar results were obtained in the summer months, although increases were greater, as quartiles showed: increases between 6.2 and 11.6% in IPREM 0.5, between 3.1 and 5.8% in IPREM 1.0, and between 0.8 and 3.9% in IPREM 1.5 or greater. This tendency was also observed in the maximum values of the summer months, with increases between 1.6 and 11.3% in comparison with the winter months. These results were consistent with the climate characteristics used for the parametric analysis because the southern zones of Spain are characterized by greater cooling energy demand. The greatest EPR values in the distributions were obtained by the increase in the energy bill due to the consumption of building cooling systems. Distributions presented negative quartile values in April, May, and October: between -10.1 and 1.2% in IPREM 0.5, between -5.0 and 0.6% in IPREM 1.0, and between -3.4 and 0.4 in family units with incomes equal or greater than IPREM 1.5.

Likewise, tendencies in the increase distributions of EPR at a monthly scale were similar with adaptive patterns. In January and December, quartile values increased between 10.6 and 18.9% in IPREM 0.5, between 5.3 and 9.5% in IPREM 1.0, and between 0.1 and 6.3% in incomes equal or greater than IPREM 1.5. Greater EPR values were obtained in the monthly analysis in the summer months, but the increase was not significant as with static patterns. The static pattern obtained greater EPR values in the summer months, whereas the adaptive pattern obtained greater EPR values in the winter months. Winter months therefore obtained a difference between 0.3 and 10.4% in comparison with the results of summer months. As previously mentioned, the characteristics of the adaptive approach (which significantly reduced cooling energy consumption) could imply that family unit's vulnerability was lower in the summer months, although this analysis was performed with warm climate characteristics. Nevertheless, EPR values increased in the summer months in comparison with yearly assessments, so family units could be in EP situation in these months. Finally, there were increase and decrease oscillations in the quartiles in the months with lower climate severity (April, May, and October). The variability of climate conditions in these months therefore led to 3 possible modifications: an increase, a decrease, and equal results in the EPR values.

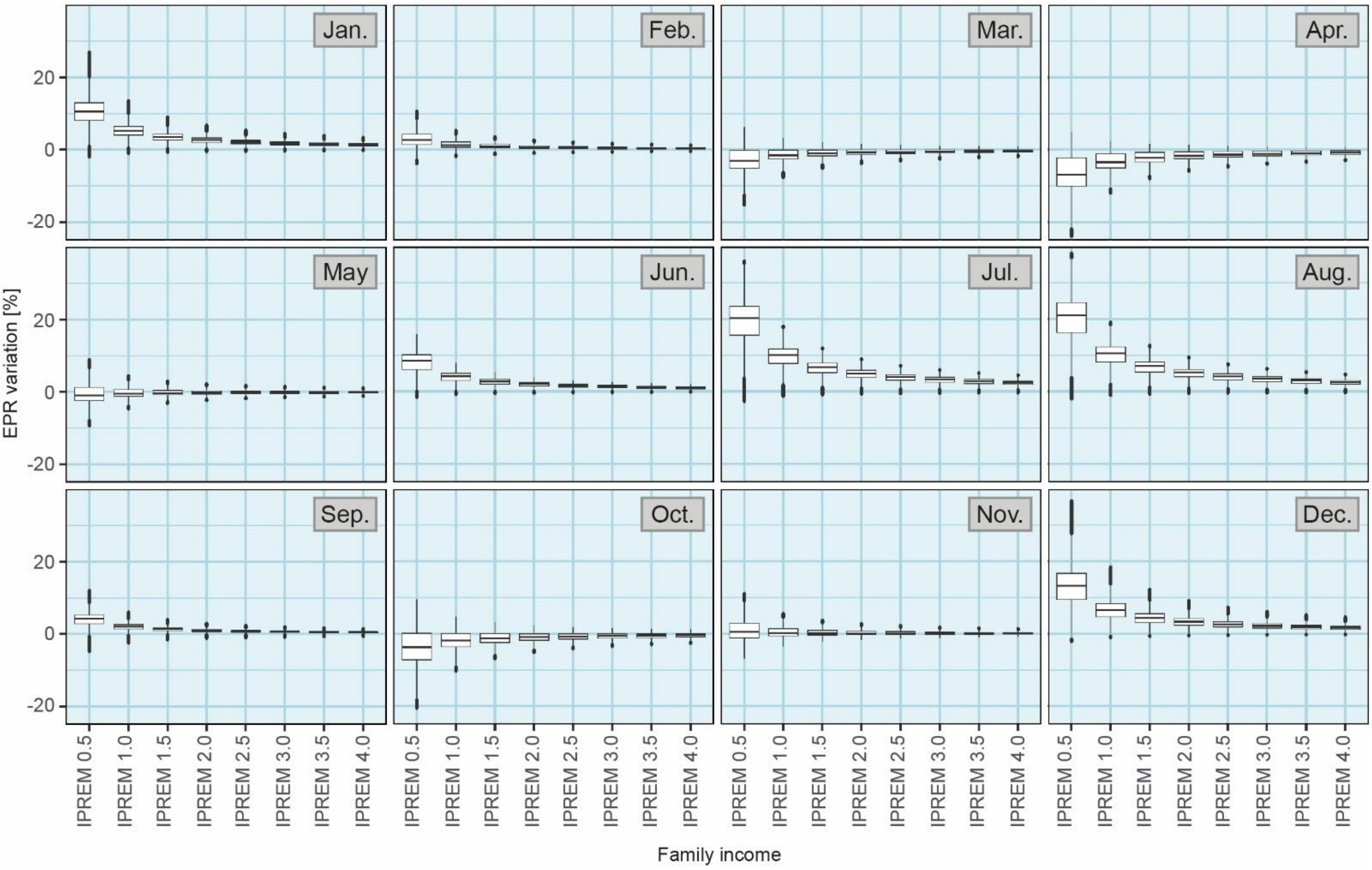

Fig. 4. Distributions of the EPR variations (yearly vs monthly) for the various combinations of months and incomes analysed in family units with static operational patterns.

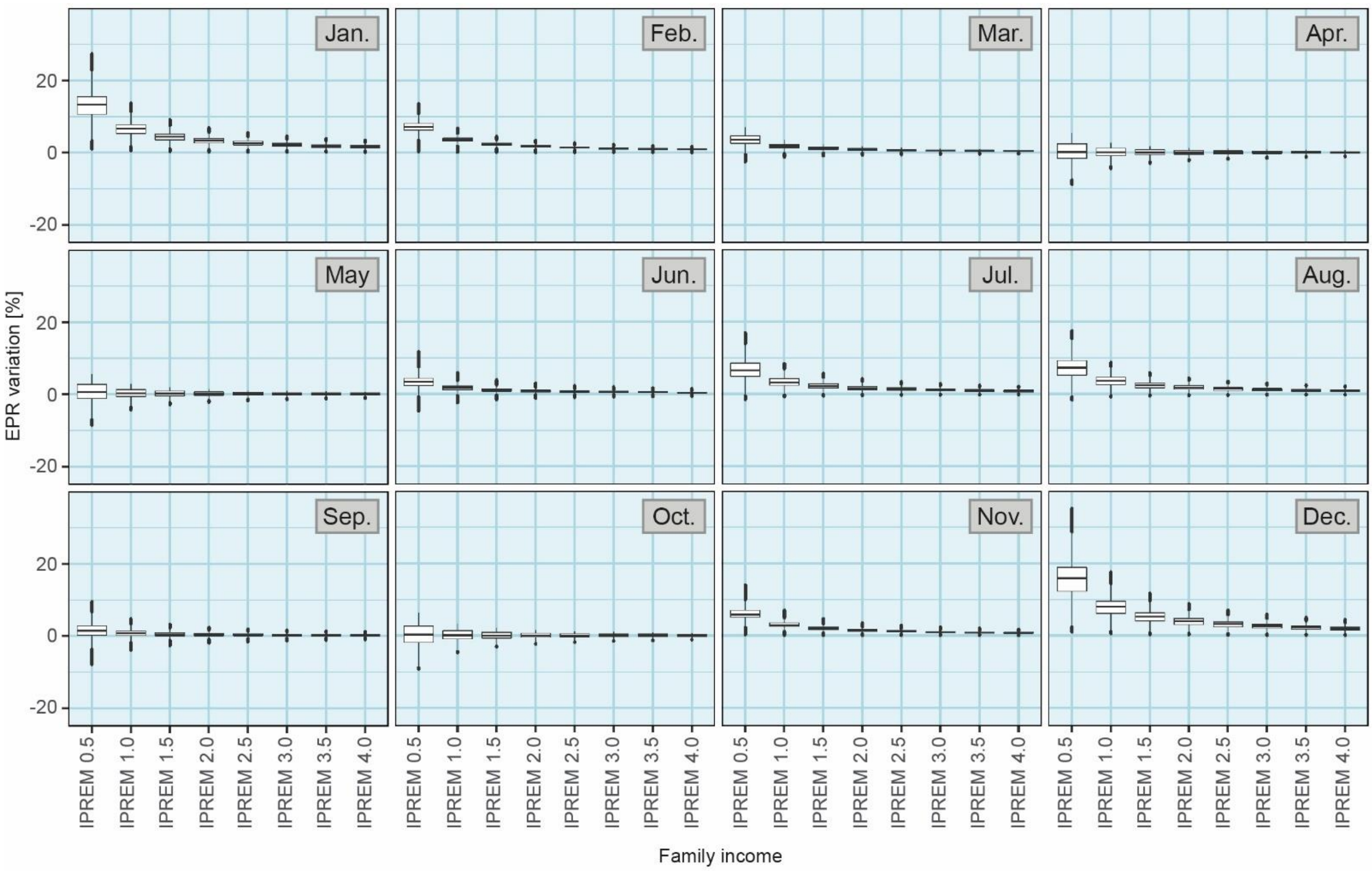

Fig. 5. Distributions of the EPR variations (yearly vs monthly) for the various combinations of months and incomes analysed in family units with adaptive operational patterns.

These results therefore showed that the monthly analysis of family units' situation could vary. EPR was characterized by significant increases in the months with greater energy demand by using both static and adaptive patterns. This became significant in low-income family units because their percentage increase values were greater. Yearly analyses did not show the reality of the family units throughout all months. Nonetheless, using only EPR was not useful to know whether family units were in EP situation. For this purpose, the 2M indicator was used with the characteristic threshold of each country (10% in the case of Spain).

3.2. Sensibility analysis of yearly and monthly EP assessments

As mentioned in the Methodology section, a sensitivity analysis of monthly and yearly assessments was performed. Concordance was assessed through the kappa coefficient, as well as sensitivity (coincidence capacity in cases with no EP) and specificity (coincidence capacity in EP cases).

Figure 6 shows the results obtained by static behaviour patterns for all family units, and Annex A includes the results per family units' income level. A total of 18,115,200 cases were used for static patterns. The sensitivity analysis showed that EP assessments presented differences in the two analysis scales. Kappa values oscillated between 0.55 and 0.95. These results showed a good concordance in the results (because many cases were coincident with EP assessments in the two scales), but they also showed that many family units were not included in the analyses. Moreover, the lowest kappa values were the months with greater severity (January, July, August, and December). EP cases increased in these months. This aspect could be assessed through specificity. It was 0.74 and 0.69 in January and December, respectively, so that 2 million cases were considered in EP with the monthly analysis, whereas they were not considered in EP by yearly assessment. Sensitivity in assessments of family units which were not in EP was always 1 (i.e. monthly and yearly assessment coincided in these family units). Specificity was lower in July and August (0.57 and 0.55, respectively), resulting in that over 4 million cases were in EP in these months. Over 20% cases would therefore not been considered in EP situation in these months by yearly assessment. As for the assessment of not EP in the yearly scale, monthly assessment was almost coincident. As for April and October, decrease tendencies of EPR values decreased EP cases. Lower sensitivity values were obtained in these months (0.87 in April, and 0.90 in October), so the monthly analysis considered many cases of family units that were not in EP: 1,708,283 cases in April, and 1,330,400 cases in October. These results were in accordance with the variations in the EPR distributions (Figure 4). Nonetheless, the lower number of cases in assessments in April and October was not so significant as the increase in the months with greater severity. Yearly assessments obtained similar results in EP cases in most months, but the most significant differences were observed in the months with greater severity. This aspect became important considering that family units' health would be exposed to greater risks during these months because of cold and heat waves. It is worth stressing that differences depended on the family units' income level, as Annex A shows. In this regard, family units with incomes equal or lower than IPREM 1.0 were always in EP. As for the remaining income levels, family units' EP situation varied according to the analysis (monthly or yearly). Even family units with the greatest income threshold (IPREM 4.0) were in EP situation in the summer months: between 3,107 and 6,999 cases. The results obtained with a monthly scale therefore showed a clearer vision of the EP situation in family units with high, medium-high, and medium-low incomes, with low-income thresholds being always in EP situation.

January

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	9,644,697	2,233,407
	EP	0	6,237,096

Kappa	0.75
Sensitivity	1.00
Specificity	0.74

February

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,307,298	570,806
	EP	4,560	6,232,536

Kappa	0.93
Sensitivity	1.00
Specificity	0.92

March

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,822,851	55,253
	EP	756,865	5,480,231

Kappa	0.90
Sensitivity	0.94
Specificity	0.99

April

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,878,097	7
	EP	1,708,283	4,528,813

Kappa	0.78
Sensitivity	0.87
Specificity	1.00

May

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,757,184	120,920
	EP	258,747	5,978,349

Kappa	0.95
Sensitivity	0.98
Specificity	0.98

June

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	10,231,033	1,647,071
	EP	73	6,237,023

Kappa	0.81
Sensitivity	1.00
Specificity	0.79

July

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	7,843,358	4,034,746
	EP	54	6,237,042

Kappa	0.57
Sensitivity	1.00
Specificity	0.61

August

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	7,645,612	4,232,492
	EP	30	6,237,066

Kappa	0.55
Sensitivity	1.00
Specificity	0.60

September

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,215,364	662,740
	EP	5,988	6,231,108

Kappa	0.92
Sensitivity	1.00
Specificity	0.90

October

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,866,405	11,699
	EP	1,330,400	4,906,696

Kappa	0.83
Sensitivity	0.90
Specificity	1.00

November

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	11,650,499	227,605
	EP	250,713	5,986,383

Kappa	0.94
Sensitivity	0.98
Specificity	0.96

December

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	9,022,525	2,855,579
	EP	0	6,237,096

Kappa	0.69
Sensitivity	1.00
Specificity	0.69

Fig. 6. Dispersion matrices with the classification of family units (in EP and not in EP) with monthly and yearly analyses. Results correspond to static operational patterns.

The same analysis was performed by using the adaptive pattern. Fig. 7 summarises the results obtained in the sensitivity analysis for population (18,115,200 cases), whereas Annex B includes the results per income thresholds. The results followed the same tendency, with an increase in EP cases in the months with greater energy demand. However, the increase was not the same because the summer months obtained a lower increase in EP cases: January and December obtained a specificity of 0.62 and 0.58, respectively, whereas it was 0.74 for both July and August. The increase in EP cases with the static pattern was greater than 4 million in the summer months, but it was less than 2 million cases with the adaptive approach. This aspect showed the effectiveness of the latter to reduce energy consumption in these months. Likewise, there was a great concordance between yearly and monthly assessments in the months with lower severity (March, April, May, September, and October). Kappa values oscillated between 0.93 and 0.97, sensitivity between 0.99 and 1.00, and specificity between 0.90 and 0.99. Moreover, the relationship between the differences in yearly and monthly assessments and family units' income level should be again stressed. Similarly to the static pattern, there were variation tendencies according to the income level (Annex B). Low-income family units were in EP situation, whereas family units with incomes equal or greater than IPREM 3.5 did not obtain EP cases. Family units without presenting EP situations could reach income thresholds of twice the IPREM according to the analysis month. Greater deviations obtained with the adaptive approach between yearly and monthly assessments were therefore related to family units with medium-high and medium-low income thresholds.

January

		Monthly	
		Not EP	EP
Yearly	Not EP	10,665,853	2,796,839
	EP	0	4,652,508

Kappa	0.66
Sensitivity	1.00
Specificity	0.62

February

		Monthly	
		Not EP	EP
Yearly	Not EP	11,849,634	1,613,058
	EP	0	4,652,508

Kappa	0.79
Sensitivity	1.00
Specificity	0.74

March

		Monthly	
		Not EP	EP
Yearly	Not EP	12,942,775	519,917
	EP	195	4,652,313

Kappa	0.93
Sensitivity	1.00
Specificity	0.90

April

		Monthly	
		Not EP	EP
Yearly	Not EP	13,406,092	56,600
	EP	176,717	4,475,791

Kappa	0.97
Sensitivity	0.99
Specificity	0.99

May

		Monthly	
		Not EP	EP
Yearly	Not EP	13,407,408	55,284
	EP	176,748	4,475,760

Kappa	0.97
Sensitivity	0.99
Specificity	0.99

June

		Monthly	
		Not EP	EP
Yearly	Not EP	12,975,078	487,614
	EP	21,639	4,630,869

Kappa	0.93
Sensitivity	1.00
Specificity	0.90

July

		Monthly	
		Not EP	EP
Yearly	Not EP	12,027,979	1,434,713
	EP	0	4,652,508

Kappa	0.81
Sensitivity	1.00
Specificity	0.76

August

		Monthly	
		Not EP	EP
Yearly	Not EP	11,856,667	1,606,025
	EP	0	4,652,508

Kappa	0.79
Sensitivity	1.00
Specificity	0.74

September

		Monthly	
		Not EP	EP
Yearly	Not EP	13,384,840	77,852
	EP	111,579	4,540,929

Kappa	0.97
Sensitivity	0.99
Specificity	0.98

October

		Monthly	
		Not EP	EP
Yearly	Not EP	13,395,821	66,871
	EP	176,748	4,475,760

Kappa	0.96
Sensitivity	0.99
Specificity	0.99

November

		Monthly	
		Not EP	EP
Yearly	Not EP	12,146,180	1,316,512
	EP	0	4,652,508

Kappa	0.83
Sensitivity	1.00
Specificity	0.78

December

		Monthly	
		Not EP	EP
Yearly	Not EP	10,072,361	3,390,331
	EP	0	4,652,508

Kappa	0.60
Sensitivity	1.00
Specificity	0.58

Fig. 7. Dispersion matrices with the classification of family units (in EP and not in EP) with monthly and yearly analyses. Results correspond to adaptive operational patterns.

As a result, monthly assessments could significantly vary in comparison with yearly assessments, particularly in the months with greater climate severity. The building's technical characteristics influenced energy demand during these months, so several dwellings' technical conditions were filtered to assess the differences between yearly and monthly assessments. The thermal transmittance of façade and roof/floor was considered as variables in the parametric analysis, as well as the performance of the HVAC systems, so dwelling typologies were divided into 6 groups: (i) dwellings with a thermal transmittance lower or equal to 0.6 W/m^2K, and a COP lower than 3.1 (671,328 cases); (ii) dwellings with a thermal transmittance lower or equal to 0.6 W/m^2K, and a COP equal or greater than 3.1 (863,136 cases); (iii) dwellings with a thermal transmittance between 0.6 and 1.4 W/m^2K, and a COP lower than 3.1 (1,193,472 cases); (iv) dwellings with a thermal transmittance between 0.6 and 1.4 W/m^2K, and a COP equal or greater than 3.1 (1,534,464 cases); (v) dwellings with a thermal transmittance equal or greater than 1.4 W/m^2K, and a COP lower than 3.1 (671,328 cases); and (vi) dwellings with a thermal transmittance equal or greater than 0.6 W/m^2K, and a COP equal or greater than 3.1 (863,136 cases). To simplify the analysis, the months with more EP cases in winter (December) and summer (August) were only assessed. Figure 8 summarises the results obtained by the static operational pattern, and Figure 9 summarises the results obtained by the adaptive operational pattern. As for the static behaviour pattern, the behaviour in the six dwelling configurations was like that obtained in the total set of cases. This was observed in both the confusion matrices and the values of the statistical parameters. Kappa oscillated between -0.10 and 0.11, specificity oscillated between -0.07 and 0.05, and sensitivity was the same in all cases. In the confusion matrices there was a total agreement in the yearly assessment of not EP, whereas the monthly assessment obtained more EP cases. This result was also obtained in dwelling typologies with effective energy features. The adaptive behaviour pattern obtained similar results. Statistical parameters obtained small variations in comparison with the assessment performed with the total dataset (between -0.08 and 0.09 for kappa, between -0.06 and 0.07 for specificity, and sensitivity with a value of 1 for all cases), thus increasing EP cases in all dwelling typologies. The only difference was the lower increase in EP cases in August in comparison with December, following the tendency of lower cases in the remaining analyses. The results therefore showed that the characteristics of the dwelling are not crucial to determine if the analysis should be yearly or monthly performed. In addition, the differences in the total dataset are extrapolated to the analyses performed in specific dwelling typologies. The monthly analysis in all these cases detected many family units that could be in EP situation in the months with greater climate severity.

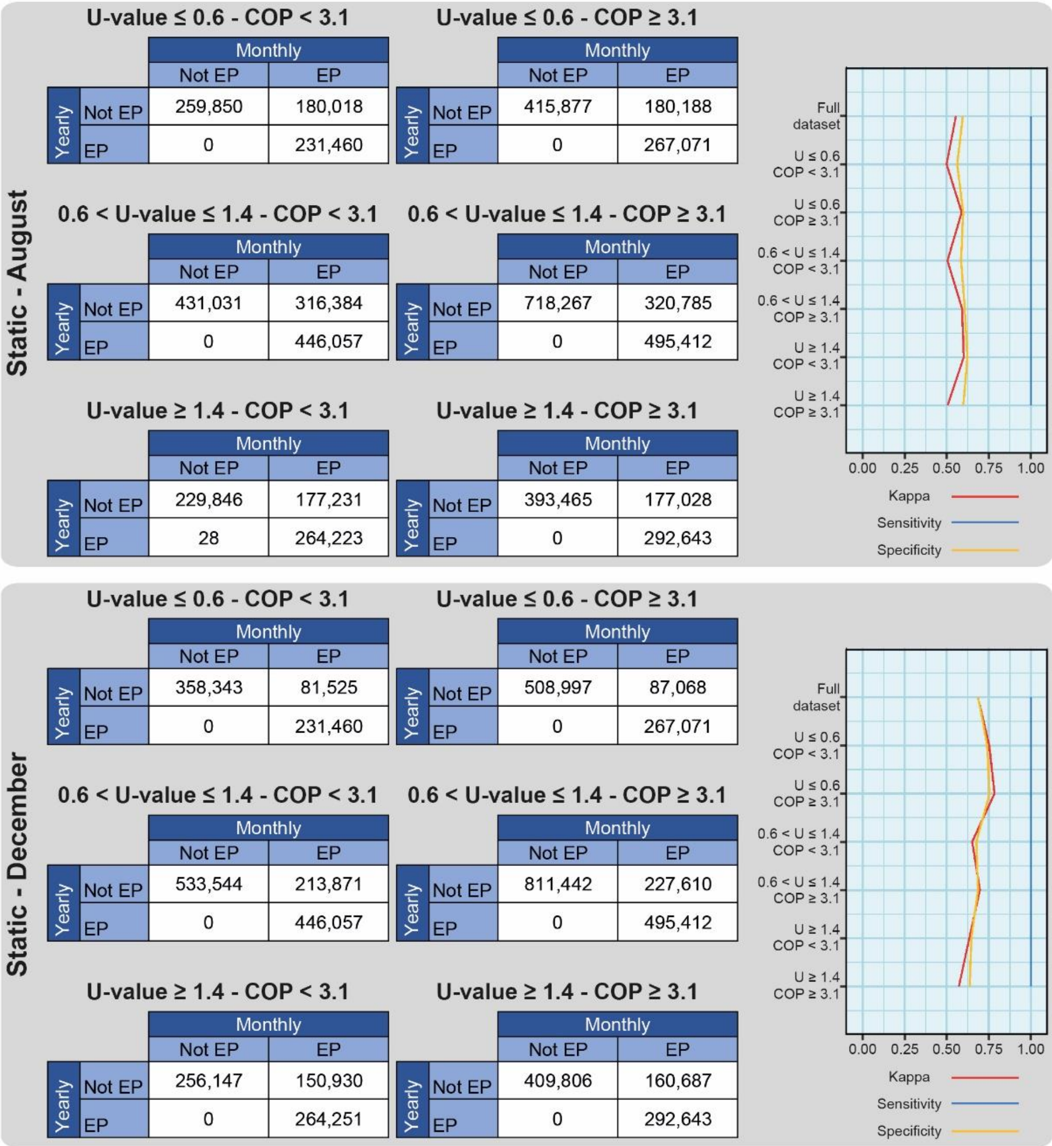

Fig. 8. Dispersion matrices by classifying family units for various building typologies. Results correspond to static operational patterns.

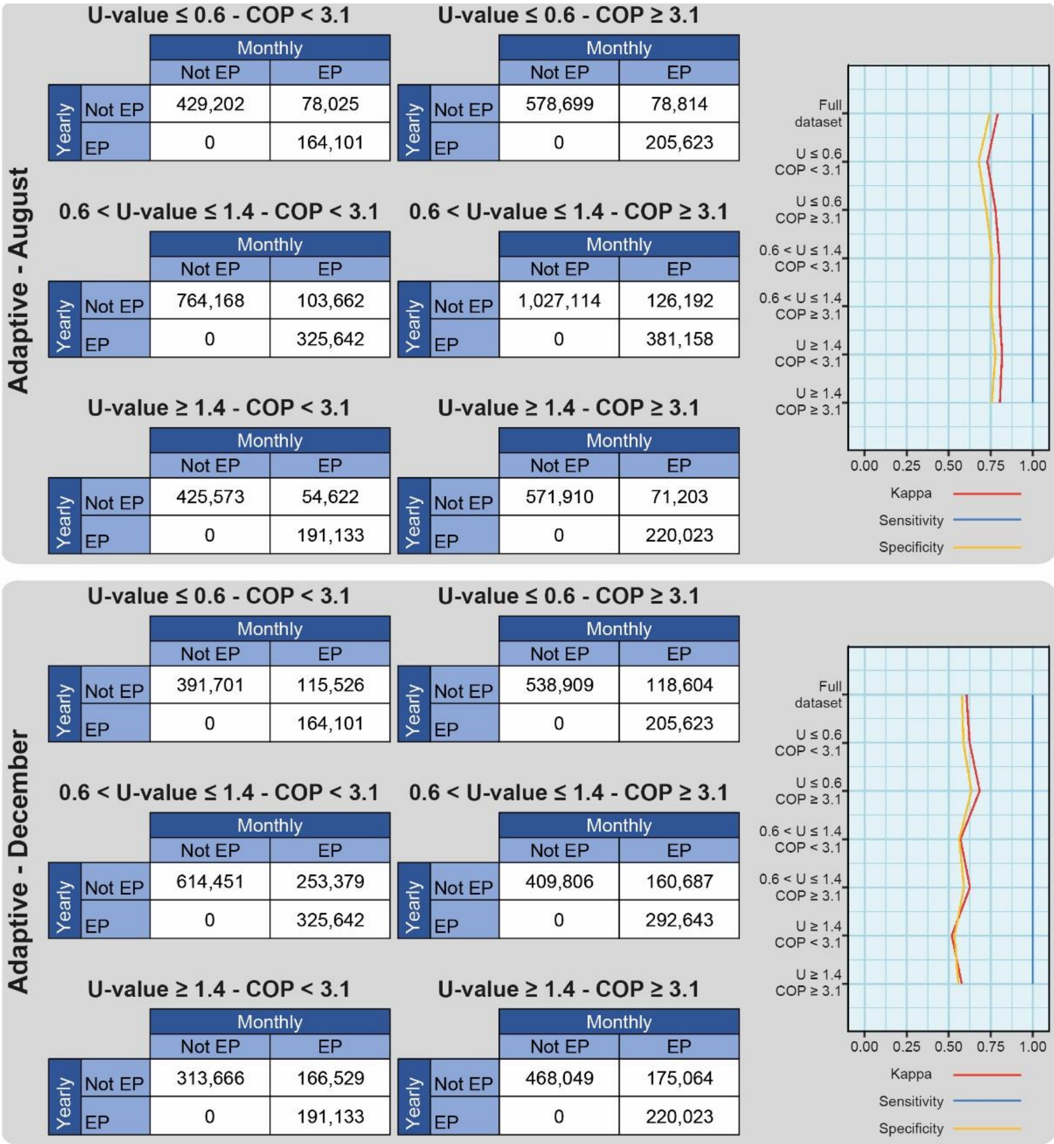

Fig. 9. Dispersion matrices by classifying family units for various building typologies. Results correspond to adaptive operational patterns.

5. Conclusions

Assessing energy poverty could be something of a challenge as many factors could affect family units. Many indicators and approaches can therefore be used. Most analysis approaches are based on assessing energy poverty globally, without considering its variable character throughout the year. This study assessed the differences expected in yearly and monthly assessments by using the 2M indicator, one of the most used indicators. The following conclusions are drawn from a set of 36,230,400 cases assessed in the predominant climate zone:

- Monthly assessments usually varied the energy poverty ratio values obtained at a yearly scale. These variations could be increased in the months with greater climate severity, whereas energy poverty ratio values decreased in the spring and autumn months. Nonetheless, variations were greater in the summer and winter months.
- Energy poverty ratio variations implied a lack of concordance in energy poverty cases at yearly and monthly scales. In winter and summer months, monthly analyses detected more energy poverty cases than yearly assessments, sometimes with an increase in energy poverty cases by 20%. This was significant considering that these months have greater risk for family units' health because of heat and cold waves. Likewise, family units' income threshold was crucial because variations were related to family units with high, medium-high, and medium-low incomes, whereas family units with low or very low incomes were in energy poverty situation with both analysis scales.
- Spring and autumn months were generally related to a high concordance with yearly assessments, except when the monthly scale classified more family units with no energy poverty risk. This aspect was related to the lower energy demand of family units in these months, with a decrease in energy consumption. Nonetheless, the low impact of discords in the classifications of the family units (up to 9.4%) were not significant in comparison with the months with greater energy demand.
- The variation detected by monthly scales was independent of dwellings' technical characteristics. The analysis performed with 6 dwelling typologies according to their technical characteristics showed that the discords observed with the full dataset were repeated in the grouped analyses.

- The operational pattern of HVAC systems did not significantly vary the differences between yearly and monthly analysis scales. The results obtained by the two operational approaches (static and adaptive) showed that monthly analysis scales obtained more energy poverty cases in the months with greater climate severity. The exception was the lower number of energy poverty cases obtained by the adaptive approach in the summer months due to the reduction of energy consumption related to this operational approach. Consequently, EP cases increased in the summer months over 20% by using the static pattern, and, less than 9% by using the adaptive approach. The use of adaptive strategies could therefore be effective to reduce energy poverty cases in the summer months.

The results of this study therefore show that monthly scales should be used to know family units' energy poverty more accurately. Using this type of scale in the months with greater energy demand (winter and summer) allow more family units in energy poverty situation to be detected than with yearly analyses (false negatives). These results are therefore crucial for energy poverty policies and strategies that governments should adopt. Analyses based on yearly data obtain results quickly, but sensitivity in energy poverty assessments is lower. Approaches should therefore be adapted to monthly scales, thus limiting the months with greater energy demand due to the high discord found in this study. Nonetheless, some limitations should be stressed. These results are based on the 2M indicator. Other indicators that assess energy poverty have a similar approach of family units' expenditure/income, but there could be differences in the discords that should be addressed in further studies. Although the results are based on the analysis of the built environment in the south of Spain, the results are expected to be extrapolated to other regions and countries. Sensitivity and specificity could vary, but energy poverty is expected to be more important in the months with greater demand than in yearly analysis scales. Nevertheless, further studies should address the climate variation though yearly and monthly comparisons. Likewise, the types of dwellings used in this study did not have photovoltaic systems. Although this aspect is common in the built environment of the region, it is to be expected to change in the coming years by increasing energy rehabilitation. Further works should analyse the possible effect of photovoltaic systems on monthly assessments of energy poverty in the summer months.

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Annex A

Static - January

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	257,580	519,666
EP	0	1,487,154

Kappa	0.39
Sensitivity	1.00
Specificity	0.74

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	895,670	1,147,986
EP	0	220,744

Kappa	0.13
Sensitivity	1.00
Specificity	0.16

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	1,770,560	493,442
EP	0	398

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,194,325	70,075
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,262,162	2,238
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A1. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both January and the whole year. Results correspond to static operational patterns.

Static - February

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	450,423	326,823
EP	775	1,486,379

Kappa	0.64
Sensitivity	1.00
Specificity	0.82

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	1,808,795	234,861
EP	3,776	216,968

Kappa	0.59
Sensitivity	1.00
Specificity	0.48

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,254,880	9,122
EP	9	389

Kappa	0.08
Sensitivity	1.00
Specificity	0.04

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A2. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both February and the whole year. Results correspond to static operational patterns.

Static - March

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	721,993	55,253
	EP	536,823	950,331

Kappa	0.49
Sensitivity	0.57
Specificity	0.95

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,043,656	0
	EP	219,644	1,100

Kappa	0.01
Sensitivity	0.90
Specificity	1.00

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,002	0
	EP	398	0

Kappa	0.00
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A3. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both March and the whole year. Results correspond to static operational patterns.

Static - April

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	777,239	7
	EP	1,487,141	13

Kappa	0.00
Sensitivity	0.34
Specificity	0.65

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,043,656	0
	EP	220,744	0

Kappa	0.00
Sensitivity	0.90
Specificity	NA

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,002	0
	EP	398	0

Kappa	0.00
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A4. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both April and the whole year. Results correspond to static operational patterns.

Static - May

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	656,326	120,920
	EP	51,842	1,435,312

Kappa	0.83
Sensitivity	0.93
Specificity	0.92

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,043,656	0
	EP	206,507	14,237

Kappa	0.11
Sensitivity	0.91
Specificity	1.00

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,002	0
	EP	398	0

Kappa	0.00
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A5. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both May and the whole year. Results correspond to static operational patterns.

Static - June

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	446,661	330,585
	EP	73	1,487,081

Kappa	0.64
Sensitivity	1.00
Specificity	0.82

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	948,316	1,095,340
	EP	0	220,744

Kappa	0.14
Sensitivity	1.00
Specificity	0.17

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,046,711	217,291
	EP	0	398

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,260,545	3,855
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A6. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both June and the whole year. Results correspond to static operational patterns.

Static - July

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	297,908	479,338
	EP	54	1,487,100

Kappa	0.45
Sensitivity	1.00
Specificity	0.76

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	541,000	1,502,656
	EP	0	220,744

Kappa	0.07
Sensitivity	1.00
Specificity	0.13

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	843,288	1,420,714
	EP	0	398

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	1,728,994	535,406
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,170,875	93,525
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,261,293	3,107
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

Fig. A7. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both July and the whole year. Results correspond to static operational patterns.

Static - August

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	272,976	504,270
	EP	30	1,487,124

Kappa	0.42
Sensitivity	1.00
Specificity	0.75

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	539,373	1,504,283
	EP	0	220,744

Kappa	0.07
Sensitivity	1.00
Specificity	0.13

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	784,216	1,479,786
	EP	0	398

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	1,652,545	611,855
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,139,101	125,299
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,257,401	6,999
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

Fig. A8. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both August and the whole year. Results correspond to static operational patterns.

Static - September

IPREM 0.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	0	0
Yearly: EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	0	0
Yearly: EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	474,446	302,800
Yearly: EP	73	1,487,081

Kappa	0.67
Sensitivity	1.00
Specificity	0.83

IPREM 2.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	1,691,638	352,018
Yearly: EP	5,850	214,894

Kappa	0.47
Sensitivity	1.00
Specificity	0.38

IPREM 2.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,256,080	7,922
Yearly: EP	65	333

Kappa	0.08
Sensitivity	1.00
Specificity	0.04

IPREM 3.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A9. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both September and the whole year. Results correspond to static operational patterns.

Static - October

IPREM 0.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	0	0
Yearly: EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	0	0
Yearly: EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	765,547	11,699
Yearly: EP	1,109,258	377,896

Kappa	0.18
Sensitivity	0.41
Specificity	0.97

IPREM 2.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,043,656	0
Yearly: EP	220,744	0

Kappa	0.00
Sensitivity	0.90
Specificity	NA

IPREM 2.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,002	0
Yearly: EP	398	0

Kappa	0.00
Sensitivity	1.00
Specificity	NA

IPREM 3.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

	Monthly: Not EP	Monthly: EP
Yearly: Not EP	2,264,400	0
Yearly: EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A10. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both October and the whole year. Results correspond to static operational patterns.

Static - November

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	626,205	151,041
	EP	185,404	1,301,750

Kappa	0.67
Sensitivity	0.77
Specificity	0.90

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	1,969,175	74,481
	EP	64,976	155,768

Kappa	0.66
Sensitivity	0.97
Specificity	0.68

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,261,919	2,083
	EP	333	65

Kappa	0.05
Sensitivity	1.00
Specificity	0.03

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. A11. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both November and the whole year. Results correspond to static operational patterns.

Static - December

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	236,750	540,496
	EP	0	1,487,154

Kappa	0.37
Sensitivity	1.00
Specificity	0.73

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	739,995	1,303,661
	EP	0	220,744

Kappa	0.10
Sensitivity	1.00
Specificity	0.14

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	1,490,909	773,093
	EP	0	398

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,055,182	209,218
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,236,270	28,130
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,263,419	981
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

Fig. A12. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both December and the whole year. Results correspond to static operational patterns.

Annex B

Adaptative - January

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
Yearly	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	53,040
Yearly	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	375,413	1,712,239
Yearly	EP	0	176,748

Kappa	0.03
Sensitivity	1.00
Specificity	0.09

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	1,317,868	946,532
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,179,878	84,522
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,263,894	506
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B1. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both January and the whole year. Results correspond to adaptive operational patterns.

Adaptative - February

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
Yearly	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	53,040
Yearly	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	628,636	1,459,016
Yearly	EP	0	176,748

Kappa	0.06
Sensitivity	1.00
Specificity	0.11

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,163,398	101,002
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B2. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both February and the whole year. Results correspond to adaptive operational patterns.

Adaptative - March

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	1,620,775	466,877
EP	195	176,553

Kappa	0.35
Sensitivity	1.00
Specificity	0.27

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B3. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both March and the whole year. Results correspond to adaptive operational patterns.

Adaptative - April

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	2,084,092	3,560
EP	176,717	31

Kappa	0.00
Sensitivity	0.92
Specificity	0.01

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B4. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both April and the whole year. Results correspond to adaptive operational patterns.

Adaptative - May

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	53,040
	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,085,408	2,244
	EP	176,748	0

Kappa	0.00
Sensitivity	0.92
Specificity	0.00

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B5. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both May and the whole year. Results correspond to adaptive operational patterns.

Adaptative - June

IPREM 0.5

		Monthly	
		Not EP	EP
Yearly	Not EP	0	0
	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly	
		Not EP	EP
Yearly	Not EP	0	53,040
	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly	
		Not EP	EP
Yearly	Not EP	1,653,088	434,564
	EP	21,639	155,109

Kappa	0.32
Sensitivity	0.99
Specificity	0.26

IPREM 2.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,390	10
	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly	
		Not EP	EP
Yearly	Not EP	2,264,400	0
	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B6. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both June and the whole year. Results correspond to adaptive operational patterns.

Adaptative - July

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
Yearly	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	53,040
Yearly	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	854,678	1,232,974
Yearly	EP	0	176,748

Kappa	0.10
Sensitivity	1.00
Specificity	0.13

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,115,738	148,662
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,363	37
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B7. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both July and the whole year. Results correspond to adaptive operational patterns.

Adaptative - August

IPREM 0.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	0
Yearly	EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	0	53,040
Yearly	EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	733,858	1,353,794
Yearly	EP	0	176,748

Kappa	0.08
Sensitivity	1.00
Specificity	0.12

IPREM 2.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,065,542	198,858
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,067	333
Yearly	EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

		Monthly: Not EP	Monthly: EP
Yearly	Not EP	2,264,400	0
Yearly	EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B8. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both August and the whole year. Results correspond to adaptive operational patterns.

Adaptative - September

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	2,062,840	24,812
EP	111,579	65,169

Kappa	0.46
Sensitivity	0.95
Specificity	0.72

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B9. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both September and the whole year. Results correspond to adaptive operational patterns.

Adaptative - October

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	2,073,821	13,831
EP	176,748	0

Kappa	-0.01
Sensitivity	0.92
Specificity	0.00

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B10. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both October and the whole year. Results correspond to adaptive operational patterns.

Adaptative - November

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	899,703	1,187,949
EP	0	176,748

Kappa	0.11
Sensitivity	1.00
Specificity	0.13

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	2,188,879	75,521
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,398	2
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B11. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both November and the whole year. Results correspond to adaptive operational patterns.

Adaptative - December

IPREM 0.5

Yearly \ Monthly	Not EP	EP
Not EP	0	0
EP	0	2,264,400

Kappa	NA
Sensitivity	NA
Specificity	1.00

IPREM 1.0

Yearly \ Monthly	Not EP	EP
Not EP	0	53,040
EP	0	2,211,360

Kappa	0.00
Sensitivity	NA
Specificity	0.98

IPREM 1.5

Yearly \ Monthly	Not EP	EP
Not EP	328,682	1,758,970
EP	0	176,748

Kappa	0.03
Sensitivity	1.00
Specificity	0.09

IPREM 2.0

Yearly \ Monthly	Not EP	EP
Not EP	984,819	1,279,581
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 2.5

Yearly \ Monthly	Not EP	EP
Not EP	1,982,992	281,408
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.0

Yearly \ Monthly	Not EP	EP
Not EP	2,247,093	17,307
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 3.5

Yearly \ Monthly	Not EP	EP
Not EP	2,264,375	25
EP	0	0

Kappa	0.00
Sensitivity	1.00
Specificity	0.00

IPREM 4.0

Yearly \ Monthly	Not EP	EP
Not EP	2,264,400	0
EP	0	0

Kappa	NA
Sensitivity	1.00
Specificity	NA

Fig. B12. Dispersion matrices per classification of family units (in EP and not in EP) with the analysis performed for both December and the whole year. Results correspond to adaptive operational patterns.