Chapter 12
Citizen Panels on Climate Targets: Ecological Impact at Collective Level

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Abstract The objective of this chapter is to ascertain whether the cooperation of citizens as participants of citizen panels has had a positive impact at collective level by contributing to the achievement of a 2 % annual reduction in the carbon dioxide equivalent (CO_{2e}) emissions in their city or region. This chapter discusses several challenges that emerged in the course of the analysis. These challenges suggest that a combination of different methodological approaches is the best option to assess the ecological impact of the citizen panels on the collective level. Results show that, depending on the kind of calculation, some panels met the reduction targets completely, others partially, and one did not at all. However, reductions in CO_{2e} are the general trend, even in those panels that fail to achieve the target. So, altogether, improvements of the CO_{2e} balances on the collective level have been achieved. An important finding is that the results of the panels (improvements or deteriorations) are the same after 1 year of measuring and after 2 years. So learning results are obtained in a single year and longer climate participation processes do not seem to be suited to achieving further savings, but to preventing relapse.

12.1 Introduction

The main objectives of the e2democracy (e2d) project are to investigate the possibilities for evaluating the impact of citizen participation and to analyze whether there is any difference between traditional and Internet-based forms of participation. As explained in Chap. 7, the instrument employed is citizen panels, set up in seven cities and regions in Austria, Germany, and Spain. The policy field of climate

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G. Aichholzer et al. (eds.), *Evaluating e-Participation,* Public Administration and Information Technology 19, DOI 10.1007/978-3-319-25403-6_12

change has been chosen because of the assumption that the impacts of participation can be measured more easily and accurately by counting the kg CO_{2e} (carbon dioxide equivalent) emitted by the panels during the participation period of up to 2 years. No comparable measurement scales exist in other areas where participation is common, such as in the field of urban planning or participatory budgets.

In the broad field of climate protection, experiences with feedback functionalities aimed at the reduction of household energy consumption and related goals (e.g., waste reduction and choice of environmental friendly traffic mode) are already available. According to Thaler and Sunstein (2008), carbon reductions can be achieved by small but precise nudges at citizens that steer their household energy consumption in the targeted direction. High expectations are currently placed on feedback mechanisms in the household energy consumption domain. Recent studies arrived at mixed results, depending on the type of feedback used, the duration of the field trials, and the type of information provided, with reduction potentials in the range of 4–20 % (Abrahamse and Steg 2005; Darby 2006; Ehrhardt-Martinez 2010; Fischer 2008). A recent field experiment carried out within the social ecological research on so-called smart meters in about 2000 households in Austrian and German municipalities put the aforementioned findings into perspective, as they only revealed 3.7 % of savings (Schleich et al. 2011). Similar results with about 3 % savings were disclosed in a study carried out in Denmark (Gleerup et al. 2010). According to Darby (2006), the more effective feedback programs targeting the reduction of energy consumption include direct feedback measures such as self-meter reading, frequent interactive feedback (e.g., via PCs). Indirect feedback (e.g., billing) in combination with targeted information tends to be better suited to help households understand the effects of changes. Some kind of competition (e.g., which panel achieves the highest household energy reductions) and the possibility of comparing the results of participants may trigger further savings (Thaler and Sunstein 2008), as evidenced in a field trial by the EcoTeam Program which came very close to the design of the e2d project (Abrahamse and Steg 2005, p. 280; Staats et al. 2004, p. 357). It seems that activities that combine different intervention strategies are promising as regards sustainably reducing energy and changing behavior in several domains (Abrahamse and Steg 2005, p. 280).

However, in the field of climate change, there are also difficulties in how performance is measured and accounted for (Cooper and Pearce 2011). Issues raised by previous research include concerns about measurement, control, and accountability. Comparisons among cities are difficult, mainly for two types of reasons: objective ones (such as different local climate conditions and national energy mix) and different methods used to calculate emissions (CEPS 2010; OECD 2010).

The question to be answered in this chapter is whether the cooperation of citizens as participants of citizen panels has had a positive impact by contributing to their city's or region's objective of reducing CO_{2e} emissions by 2 % per year. To provide an answer to this research question, we will present and discuss the results of the CO_{2e} monitoring in the seven panels on a collective level, that is, as the average of the individual CO_{2e} balances discussed in Chap. 11. As explained in Chap. 8, the data gathered from participants are self-reported by entering figures from meters, by reporting kilometers for different kinds of mobility, and by choosing among a few categories for nutrition and consumer goods consumption.

In the course of analysis, several challenges emerged concerning the comparability of the results of the seven panels. The main challenges which have to be considered in answering the research question are as follows:

- Different CO_{2e} calculators were employed in Austria and Germany, on the one hand, and Spain, on the other hand (see Chap. 8).
- The panels started at different points in time and were carried out for a different time span (see Chap. 7).
- Because of a high variation of the CO_{2e} emissions within the panels, in some cases the average calculated by the arithmetic means yields different results than the average calculated by the median. Therefore, we will present both calculations in our analysis.
- Individual flights by some of the members of a panel are a main factor that distorts the average of a panel. Therefore, we will present the CO_{2e} emissions and savings with and without emissions caused by individual flights.

The next section presents the data sources used in this chapter. Taking all the aforementioned challenges into account, the research question is answered in two steps. First, the collective CO_{2e} emissions and savings for each of the seven panels over time are presented by considering the reduction achieved by comparing arithmetic means and medians, with and without flights (Sects. 12.3–12.5). We will see that some panels met the reduction targets completely, others partially, and one did not at all, depending on the kind of calculation. These sections are mostly descriptive and illustrate the methodological problems encountered. Then the chapter continues (Sect. 12.6) with the comparative analysis on the level of three consumption areas: *at home* (heating and electricity), *mobility* (private car, public transport, and flights), and *nutrition and consumer goods*. The different achievements in these areas are partly explained by differences in the context of the seven cities and regions in the three countries, as well as by what could be learned from panelists. These explanations are not exclusive, as they also have to be seen in light of other factors known from sociology and environmental psychology as influencing CO_{2e} relevant behavior. The chapter closes with a summary of the impact on CO_{2e} emissions in the seven citizen panels.

12.2 Data

The main foundations of analyses are the CO_{2e} balances per citizen panel over time. As described in Chap. 11, CO_{2e} balances have been calculated for each participant. These individual CO_{2e} balances have been added to a collective CO_{2e} balance, one for each citizen panel. Only the balances that contained complete data over 1 or 2 years were used for the analysis. Otherwise, results would be skewed inadmissibly. CO_{2e} balances are subject to natural variations, mainly depending on changing energy demands during the four seasons. For example, in the winter months, CO_{2e} emissions caused by heating and electricity contribute to an increase of the balance curve. In the months of summer, CO_{2e} emissions from heating are rather zero, while emissions from (holiday) traffic increase. To compensate for these seasonal variations during the year, only the CO_{2e} emissions of panelists participating for 1 or 2 full years could be considered. In five of the seven panels (Bregenz, Mariazell, Bremen, Pamplona, and Saragossa), we can resort to 12 periodic measurements (2 years of monitoring), whereas in two of the panels (Bremerhaven and Wennigsen) data are only available for six periodic measurements (1 year of monitoring). Comparing 2 years with 1 year of monitoring allows us to determine whether longer participation periods yield better results in terms of CO_{2e} reduction and change of habits than shorter periods.

12.3 Development of Total CO_{2e} Balances over Time in the Seven Citizen Panels (Arithmetic Mean)

The average CO_{2e} balance of a typical citizen is different in each country and year. The level is dependent on, for example, the economic structure, the energy flows, and geographical characteristics. According to KlimAktiv (2013) and the European Environment Agency (2013), the average CO_{2e} balance for a 2-month period of a citizen in Austria was at about 1.72 tons (t) CO_{2e}, 1.84 t in Germany, and 1.28 t in Spain.[1] The balances of the seven panels in the e2d project mirror these general emission levels: The three German sites have the highest balances, followed by the two Austrian and, finally, by both Spanish panels with the lowest emissions. Wennigsen takes the lead with the highest CO_{2e} emission levels closely followed by the panel in Bremerhaven and, with some distance, the Bremen panel. The Austrian sites, Bregenz and Mariazeller Land, show similar emissions levels, which are significantly lower than those of Bremen. Finally, the Spanish sites of Saragossa and Pamplona show comparably low emissions.

A series of underlying and interlinked factors help to account for the different contributions of urban areas to CO_{2e} emissions, both within and across countries (Romero-Lankao 2012, pp. 12–13). The first is the geographic and climatic situation. For instance, latitude determines a city's need for more or less energy to run air-conditioning and heating systems within its buildings. The economic base of a city is the second, with "heavy industrial" cities, having much higher carbon emissions per capita than financial centers. Urban form and density are other determinants. Spatially compact urban developments offer several benefits: reduced costs for heating and cooling result from smaller homes and shared walls in multi-unit dwellings, lesser line losses related to electricity transmission and distribution, and reduced average daily vehicle-kilometers travelled. However, as regards private traffic use, urban density is not the only explanatory factor: transport accessibility

[1] For context factors see also Chap. 7.

Table 12.1 Development of CO_{2e} balances over time (arithmetic mean, in t CO_{2e})

City	N[a]	CO_{2e} balance at start	CO_{2e} balance after 1st year	Changes in 1 year (%)	CO_{2e} balance after 2nd year	Changes in 2 years (%)
Bregenz	21	1.612	1.513	−6.1	1.490	−7.6
Mariazell	21	1.645	1.597	−3.0	1.598	−2.9
∑ Austrian sites	*42*	*1.629*	*1.556*	*−4.5*	*1.544*	*−5.2*
Bremen	49	1.750	1.737	−0.8	1.749	−0.1
Bremerhaven	29	1.896	1.767	−6.8	–	–
Wennigsen	38	1.906	1.802	−5.5	–	–
∑ German sites	*116*	*1.829*	*1.766*	*−3.9*	–	–
Pamplona	73	0.860	0.946	+10.0	0.944	+9.8
Saragossa	179	0.970	0.933	−3.8	0.924	−4.7
∑ Spanish sites	*252*	*0.938*	*0.937*	*−0.1*	*0.930*	*−0.9*

[a] Number of panelists with at least six periodic measurements in Bremerhaven and Wennigsen, and 12 periodic measurements in Bremen, Bregenz, Mariazell, Pamplona, and Saragossa

and pedestrian friendliness, attitudes and preferences also influence driving behavior. Socioeconomic factors such as income, levels of education, and household size also play a key role (see Romero-Lankao 2012, p. 13).

All these factors influence the CO_{2e} balances reported in Table 12.1. For example, as regards climatic conditions, significant differences can be found among the sites participating in this project. In the Spanish cities, the average temperatures throughout the year are 15 °C in Saragossa and 12.5 °C in Pamplona, respectively. The average maximum temperatures in the hottest months are 31.5 and 27.8 °C, whereas the average lows in January are 2.4 and 1.2 °C, respectively. By contrast, the average yearly temperatures in the Austrian and German cities are much lower at about 9–10 °C in Bregenz, 6–7 °C in Mariazellerland, and 8–9 °C in Bremen, Bremerhaven, and Wennigsen. The number of average hours of sunlight is also lower in the Austrian and German cities, which also have lower average temperatures in summer and winter than Spain. All this translates into higher heating and electricity demands, and higher CO_{2e} emissions, in the Austrian and German panels, as evidenced in Table 12.1. In addition to the development over time of the average CO_{2e} balances in absolute figures, Table 12.1 also shows the corresponding savings or deterioration rate (in percent) achieved after 1 and 2 years of monitoring, compared to the baseline measurement.

As can be seen, even though there is some variation, all panels except the one from Pamplona achieved a reduction in their emissions. The results vary from 6.8 % savings in the first year in Bremerhaven to 10 % deterioration in Pamplona. Five out of seven citizen panels (Bregenz, Mariazell, Bremerhaven, Wennigsen, and Saragossa) achieved the 2 % savings target in the first year. Bremen improved below the 2 % objective, and Pamplona deteriorated. In the second year of measurement, no noticeable improvements have been achieved compared to the results after 1 year. None of the panels has achieved another 2 % savings in the second year. The maximum savings reached were about 1–1.5 % in Saragossa and Bregenz. The panels in Mariazell, Bremen, and Pamplona rather stagnated in the second year.

Taking years 1 and 2 together, only the panels in Bregenz and Saragossa reduced their emissions by more than 4 %. The Mariazell panel improved by about 3 %; the panel in Bremen remained more or less on the same level as in the baseline measurement, and the one in Pamplona deteriorated by almost 10 %. Hence, considering the target of 2 % savings per year, none of the panels succeeded by this criterion in the second year. Only Bregenz and Saragossa were successful overall, but only through bigger savings in the first year that helped achieve the 4 % target over 2 years.

In the following, the development of CO_{2e} emissions over time in the seven citizen panels is presented on a country level. Section 12.6 further explains the developments in the CO_{2e} balances per consumption area, once the different approaches to calculating savings and deteriorations have been used.

12.3.1 CO_{2e} Results in the Austrian Sites

The two Austrian panels ran between May 2010 and April 2012 (Mariazell) and July 2010 and June 2012 (Bregenz). The results for the panels from Bregenz and Mariazell are illustrated in Fig. 12.1 and Table 12.1.

The bars in Fig. 12.1 show the overall size of CO_{2e} emissions separated into their sources, compared between the two sites as well as with the Austrian average. The column on the right marks the average CO_{2e} balance of a citizen in Austria for a 2-month period in 2010 (1.72 t CO_{2e}). As can be seen, both panels improved their balances during the 2-year period and Bregenz more than Mariazell. Both panels started and ended with measurements that are clearly below the Austrian average (dotted line). It indicates that participants in Bregenz and Mariazell were already relatively engaged in environmental issues. Developments in heating and mobility are especially remarkable. Much improvement was achieved in the reductions of CO_{2e} emissions caused by heating systems (second part in the columns seen from

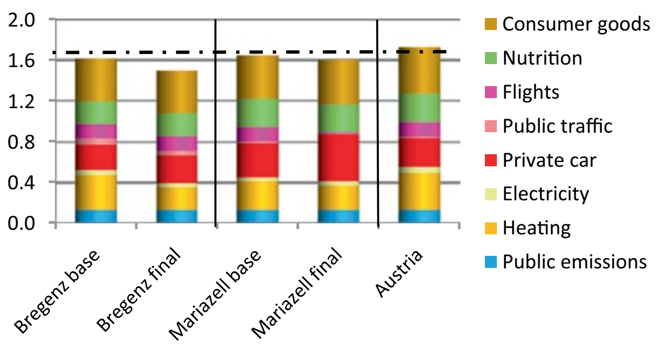

Fig. 12.1 Comparison of CO_{2e} balances of the two Austrian sites before and after monitoring over 2 years (arithmetic mean, in t CO_{2e})

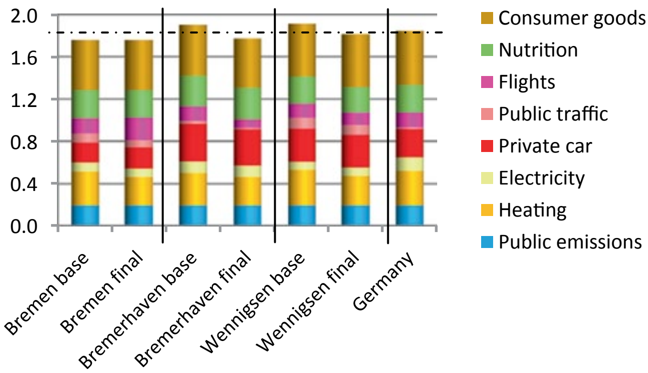

Fig. 12.2 Comparison of CO_{2e} balances of the three German sites before and after monitoring over 1–2 years (arithmetic mean, in t CO_{2e})

the bottom). By contrast, CO_{2e} emissions caused by private traffic (private car) increased significantly (fourth part in the columns seen from the bottom).

12.3.2 CO_{2e} Results in the German Sites

In contrast to the citizen panels in Austria and Spain, all three German panels ran over different time frames. The results for the three German sites are illustrated in Fig. 12.2 and Table 12.1. The column on the right marks the average CO_{2e} balance of a citizen in Germany for a 2-month period by 2010 (1.84 t CO_{2e}). As can be seen, the panels in Bremerhaven and Wennigsen started with a balance higher than the German average, but both panels improved after 1 year of monitoring, finally achieving a balance better than the German average. Bremen started and ended with a better balance than the German average, but only improved slightly through the 2-year period. The biggest differences among the three German sites become visible with regard to heating, private cars, and flights. As in Austria, the three German sites have significantly improved their emissions related to heating. As regards private cars (fourth part in the columns seen from the bottom), Bremerhaven has significantly improved, whereas Bremen has deteriorated and Wennigsen has remained more or less at a similar level. Finally, regarding flights Bremen has worsened significantly, whereas Bremerhaven and Wennigsen have significantly improved.

12.3.3 CO_{2e} Results in the Spanish Sites

The results for the panels in Pamplona and Saragossa are illustrated in Fig. 12.3 and Table 12.1. In contrast to Austria and Germany, where the IFEU provides data about average carbon emissions per citizen (KlimAktiv 2013), at the time of the project

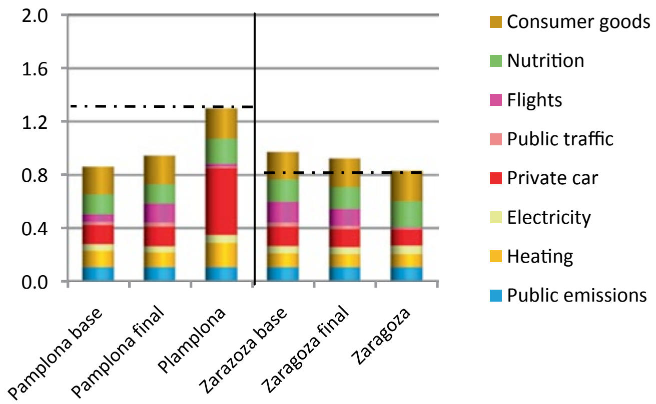

Fig. 12.3 Comparison of CO_{2e} balances of the two Spanish sites before and after monitoring over 2 years (arithmetic mean, in t CO_{2e})

in Spain there was no comparable carbon balance at national level. As explained in Chap. 8, CIRCE estimated the average carbon balances for a citizen in Pamplona and Saragossa with input data provided by the local governments or national statistics (in the case of electricity). As shown in Fig. 12.3, the estimated carbon balance of an inhabitant of Pamplona (1.30 t CO_{2e} per 2 months) is much higher than the estimated figure for Saragossa (0.83 t). So, the estimations made by CIRCE could be understood as a range for the real CO_{2e} emissions in both cities. As the results of Fig. 12.3 show, the base and final average emissions of panel members in both cities fall into the estimated ranges for an average citizen in those cities (and below the 1.28 t estimated by the European Environmental Agency for an average Spanish citizen), but closer to the estimation made with the data provided by the local government of Saragossa. The results are very different in the two Spanish panels. While the Saragossa panel successfully reduced its CO_{2e} emissions in the 2-year period, the Pamplona panel even increased them. The baseline emissions were significantly lower in the case of Pamplona, whereas the final emissions are almost the same in both panels (see Table 12.1).

As in Austria and Germany, improvements in heating (second part in the columns seen from the bottom) are noticeable in Spain. These developments are particularly outstanding in Pamplona, as the baseline measurements of panelists in this site were lower than the estimated average, which shows that improvements are possible even for citizens whose initial emissions are low. As regards electricity, baseline emissions in the panels were also lower than the average emissions of a Spanish citizen (data for electricity were not available at local level and CIRCE used data from national statistics). In this case, only the panel in Pamplona succeeded in further reducing its emissions. As regards private cars, emissions significantly improved in Saragossa, but deteriorated in Pamplona. Finally, regarding flights (third part in the columns seen from the top), Fig. 12.3 clearly shows that Pamplona has worsened significantly. Indeed, this is the reason why the Pamplona panel has increased its overall CO_{2e} emissions during the 2-year period. On average, panelists in Pamplona have taken more flights during their participation in the project than they usually do (as reported in the baseline measurement). On the contrary, the Saragossa panel reduced the emissions caused by flights.

12.4 Comparing Results Using the Median and Effect of Flight Emissions

The results presented above are those obtained when the arithmetic means of all individual CO_{2e} balances per citizen panel are used. Before drawing conclusions from these results, two important aspects have to be considered:

- The number of panelists in each panel and whether the distribution of their balances is symmetric or not
- The decisive factor of CO_{2e} emissions caused by flights that may offset changes in other areas of CO_{2e} balancing.

12.4.1 Number of Panelists and Distribution of CO_{2e} Balances

The results presented in Table 12.1 are calculated by using the arithmetic mean. However, this method may not be the most adequate, particularly if the number of panelists in a citizen panel is low, if there are outliers (significantly high and/or significantly low individual CO_{2e} balances) and/or the different values are not symmetrically distributed around the mean value. When the data are not symmetrical, the median gives a better idea of any general tendency in the development of the CO_{2e} balances (Devore and Berk 2011, p. 417).

As an example, Fig. 12.4 presents the distribution of the 73 individual CO_{2e} balances in the Pamplona panel. The *x*-axis represents the CO_{2e} balances at the start of the panel (baseline measurement) and the *y*-axis represents the average CO_{2e} balance of the second year. The dotted lines represent the average CO_{2e} balances at the start of the panel and after 2 years of periodic measurements (0.86 and 0.942 t, respectively). As can be seen, the balances are not symmetrically distributed around the mean values and some outliers exist.

Table 12.2 presents the development of the average CO_{2e} balances over time by using the median as an alternative parameter. This changes the picture: The two Austrian, the three German panels, and the Saragossa panel achieved the 2 % savings objective per year very well. Pamplona, which deteriorated by about 10 % using the arithmetic mean, now improves by about 2.5 %, achieving the 2 % target in the first year, but not in the second year. The explanation is that the CO_{2e} balances of only a few panelists are so high after 2 years (see Fig. 12.4) that the overall arithmetic mean of all panelists is also pulled upward. Hence, it seems that outliers

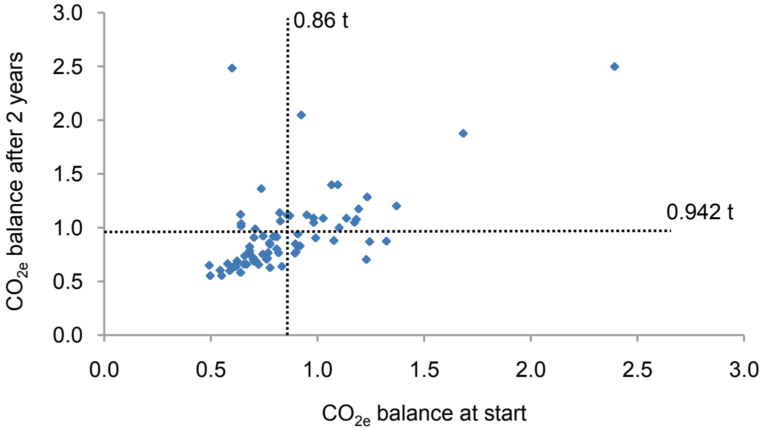

Fig. 12.4 Distribution of the individual CO_{2e} balances in Pamplona (arithmetic mean, in t CO_{2e})

Table 12.2 Development of CO_{2e} balances over time using the median (in t CO_{2e})

City	*N*	CO_{2e} balance at start	CO_{2e} balance after 1st year	Changes in 1 year (%)	CO_{2e} balance after 2nd year	Changes in 2 years (%)
Bregenz	21	1.366	1.292	−5.4	1.270	−7.0
Mariazell	21	1.636	1.449	−11.4	1.447	−11.6
∑ Austrian sites	*42*	*1.501*	*1.371*	*−8.7*	*1.359*	*−9.5*
Bremen	49	1.677	1.571	−6.3	1.537	−8.4
Bremerhaven	29	1.819	1.596	−12.2	–	–
Wennigsen	38	1.850	1.619	−12.5	–	–
∑ German sites	*116*	*1.755*	*1.593*	*−10.0*	–	–
Pamplona	73	0.777	0.754	−3.0	0.758	−2.5
Saragossa	179	0.821	0.770	−6.3	0.761	−7.3
∑ Spanish sites	*252*	*0.809*	*0.765*	*−5.4*	*0.760*	*−5.6*

play a key role in the overall target achievement, and the influence of these outliers is minimized by using the median. This also corresponds to the results of Chap. 11 on individual ecologic impacts: The general tendency of the majority of panelists' individual CO_{2e} balances is improvement.

12.4.2 The Decisive Factor of CO_{2e} Emissions Caused by Flights

Flying is the traffic mode that generally causes the highest CO_{2e} emissions per km compared to, for example, cars, buses, or trains. Furthermore, air transport is mainly used to cover long distances, which means a high impact on the CO_{2e} balance of an individual. Going on holiday by plane in many cases exceeds energy savings

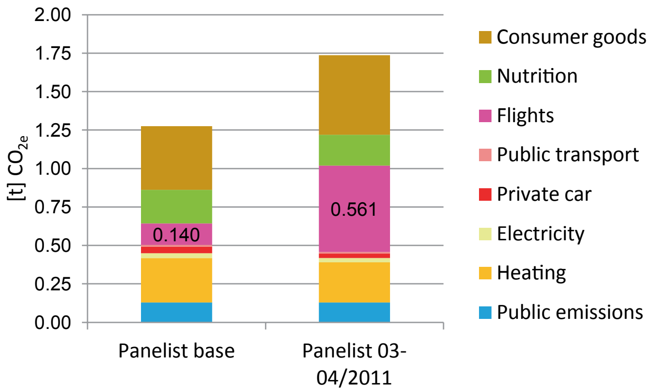

Fig. 12.5 Example of the impact of flight emissions of a panelist in t CO_{2e}

and changed behavior in other CO_{2e} relevant areas (e.g., switching off stand-by or, reducing the heating temperature by 1 °). Figure 12.5 depicts the impact of flying in the CO_{2e} balance of a panelist from Austria. As can be seen, one return flight from Vienna to Amsterdam in the period March/April 2011 increased her overall emissions drastically. The flight emissions in the baseline measurement were 0.14 t CO_{2e}, whereas this figure increased to 0.561 t in the period when the flight took place. In all her other periodic measurements, she did not fly, so she had zero emissions in the flights category. With this single flight she was not able to reduce her overall emissions. Instead, her balance deteriorated by more than 10 % after 2 years.

Apart from impact at the individual level, flights undertaken by only few panelists can damage the overall CO_{2e} balance of a citizen panel. So, it is necessary to compare the development of the balances with and without consideration of flight emissions (see also Chap. 8 for more information).

12.4.3 CO_{2e} Emissions with and Without Flights

Table 12.3 presents the development of the average CO_{2e} balances over time without consideration of the emissions resulting from air traffic. It compares the results by using the arithmetic mean and the median. Considering the arithmetic mean, the Bregenz panel has improved very well (reduction of 8.6 %) while Mariazell deteriorated (increase of 5 %). On the aggregate country level, the Austrian panels improved, but clearly failed the 2 % savings target per year. Considering the median, the picture among both Austrian sites completely changes: Bregenz increased its emissions by 3.6 % while Mariazell improved by 3.8 %. In contrast, the three German panels developed homogenously, regardless of whether the arithmetic mean or the median is considered, with aggregate improvements of 4.4 and 6 %. In Spain, small improvements are obtained considering either the arithmetic mean or the

Table 12.3 Development of CO_{2e} balances over time without flights. (2 years in all the sites except for Bremerhaven and Wennigsen (1 year))

		Arithmetic mean in t CO_{2e}			Median in t CO_{2e}		
City	*N*	Balance at start	Balance at the end	Changes (%)	Balance at start	Balance at the end	Changes (%)
Bregenz	21	1.472	1.346	−8.6	1.226	1.270	+3.6
Mariazell	21	1.505	1.580	+5.0	1.496	1.439	−3.8
∑Austrian sites	*42*	*1.489*	*1.463*	*−1.7*	*1.361*	*1.355*	*−0.5*
Bremen	49	1.610	1.536	−4.6	1.537	1.447	−5.9
Bremerhaven	29	1.756	1.689	−3.8	1.679	1.583	−5.7
Wennigsen	38	1.766	1.690	−4.3	1.710	1.602	−6.3
∑German sites	*116*	*1.698*	*1.622*	*−4.4*	*1.614*	*1.532*	*−6.0*
Pamplona	73	0.803	0.802	−0.1	0.762	0.746	−2.1
Saragossa	179	0.817	0.798	−2.3	0.749	0.746	−0.4
∑Spanish sites	*252*	*0.813*	*0.799*	*−1.7*	*0.753*	*0.746*	*−0.9*

median. However, both panels clearly failed the 2 % savings target per year, again regardless of whether the arithmetic mean or the median is considered.

Overall, comparing the monitoring results with and without flights, there is no homogenous development, neither among the seven citizen panels nor at the aggregate country level.

12.5 Summary of the Development of CO_{2e} Balances Using the Different Approaches

Undoubtedly, flights are an important source of emissions and an important area where behavior change has to start. From this point of view, there is no important reason to remove the flight emissions from the CO_{2e} balance of participants. However, due to the constraints mentioned above (e.g. huge share of flights on the overall CO_{2e} balance, low number of panelists, and different treatment of flights in the baseline measurement in the Austro-German and Spanish calculators), the development of CO_{2e} balances over time could be biased if flights are included. Furthermore, behavior change in other daily areas could fail to be visible because of a single holiday trip in a 2-year period. Using the median would mitigate the impact of flights to a great extent, but changes in other areas would also be offset. Moreover, the technical constraints of the Austro-German calculator would still be present. Hence, in order to obtain an overall picture of the impact of the panels, it is necessary to combine the results of the different methodological approaches used so far (see Table 12.4).

Key:

Definition	Symbol
Well done - target achieved (reduction per year ≥ 2%)	↓
Not bad - reduction between 1 and 2% per year	↘
Stagnation - only slight reduction between 0 and 1% per year	→
Failed - increase between 0 and 1% per year	↗
Clearly failed - increase > 1% per year	↑

The two *Austrian* citizen panels developed differently during the 2-year monitoring period. Considering the arithmetic mean, the Bregenz panel has decreased its CO_{2e} emissions by 7.6% after 2 years and clearly met the savings target. The citizen panel in Mariazell only decreased its emissions by 2.9%, and hence failed the target. If flights are not considered, Bregenz further improved by a total decrease

Table 12.4 Summary of development of CO_{2e} balances

	With flights		Without flights	
	Arithmetic mean	Median	Arithmetic mean	Median
Bregenz	↓	↓	↓	↑
Mariazell	↘	↓	↑	↘
∑ Austria	↓	↓	→	→
Bremen	→	↓	↓	↓
Bremerhaven	↓	↓	↓	↓
Wennigsen	↓	↓	↓	↓
∑ Germany	↘	↓	↓	↓
Pamplona	↑	↘	→	↘
Saragossa	↓	↓	↘	→
∑ Spain	→	↓	→	→

of CO_{2e} emissions of 8.6 % and Mariazell deteriorated, by increasing its emissions by 5 %. This means that panelists in Mariazell mainly improved their balance by a reduction of flight emissions while, overall, there were impairments in other areas of CO_{2e} balancing (mainly due to a significant increase in the use of private car, as shown before in Fig. 12.1). On the other hand, panelists in Bregenz achieved reductions in several CO_{2e} relevant areas (especially in heating, see Fig. 12.1 above). If the median is considered, the picture is different. Now Mariazell improves independently of whether flights are considered (a reduction of 11.6 %) or not (3.8 %). However, when using the median, Bregenz only improves if flights are considered. The inconsistency of these results makes interpretations very speculative, but they suggest that outliers seem to play a key role in Mariazell and Bregenz. The number of panelists in the Austrian sites is the lowest among the sample (21 in each site) and deviation from the average of a few individual balances has a remarkable impact on the overall balance development on a collective level.

As regards the *German* panels, Bremerhaven and Wennigsen have developed very unambiguously. By using the arithmetic mean, Bremerhaven has reduced its CO_{2e} emissions by 6.8 % and Wennigsen by 5.5 %. Even without considering flights, the reductions in Bremerhaven are still at 3.8 % and in Wennigsen at 4.3 %. By using the median, the improvements are even higher: 12.2 % in Bremerhaven (respectively, 5.7 % without flights) and 12.5 % in Wennigsen (respectively, 6.3 % without flights). Hence, important savings have been achieved in the monitoring year. In contrast, the developments in Bremen proceeded completely different. After 1 year of monitoring, the arithmetic mean showed only a minor reduction of 0.8 % and the situation after 2 years remained unchanged compared to the baseline measurement (0.1 % reduction). The situation is completely different when the median is considered, with a reduction of 6.3 % in the first year and 8.4 % in the second year. Hence, some outliers with high CO_{2e} balances have led to the stagnation of the arithmetic mean, but the general tendency was a decrease in the CO_{2e} balance, as evidenced by the median. The calculation of the carbon emissions without flights confirms this appraisal. Without flight emissions, the Bremen panel has reduced its CO_{2e} emissions by 4.6 % (5.9 % when the median is considered); so there were savings in the other areas of CO_{2e} balancing. Hence, in Bremen too, the citizen panel had a positive impact on the development of carbon emissions.

As regards the *Spanish* sites, very different results are obtained in Pamplona and Saragossa by using the arithmetic mean: Pamplona increases its CO_{2e} emissions by 9.8 %, whereas Saragossa achieves the target with a reduction of 4.7 %. When looking at the median, both Pamplona and Saragossa reduce their emissions (by 2.5 and 7.3 %, respectively). This shows that some extremely high emission values in Pamplona hide a general trend of reduced CO_{2e} emissions. When looking at the data without flights, in Pamplona the improvements are of 0.1 % (arithmetic mean) and 2.1 % (median). This confirms that most of the outliers in Pamplona were caused by extremely high emission values in the flights area. However, in Saragossa the improvements are much lower when flights are excluded (2.3 % when using the arithmetic mean and 0.4 % when using the median). This shows that in Saragossa most of the savings are due to a reduction in flights during the 2-year period. Overall, the results show that the participation process has had a limited impact in Pamplona and Saragossa.

These results show that, depending on the methodology used, in all seven sites some improvements in the CO_{2e} balances on the collective level could be achieved. The higher reductions in Austria and Germany as compared to Spain are consistent with the results of the recent Eurobarometer surveys (European Commission 2009, 2011) and the representative surveys carried out in each site before the citizen panels started (see Chap. 7). Due to the financial crisis and political disaffection in Spain, interviewees ranked the importance of climate change after the aforementioned problems. However, as shown in this chapter, the CO_{2e} emission levels of both Spanish panels, as well as of the average for a Spanish citizen, are still noticeably below the Austrian and German levels, and the lower the balance level is, the harder is it to achieve further reductions. In any case, there seem to be learning effects for panelists in some areas of CO_{2e} balancing that have led to CO_{2e} savings. The next section describes the details of the results per consumption area, showing which panels are more successful in each area of CO_{2e} balancing and what context factors may be favoring climate-friendly behavior.

12.6 Comparing CO_{2e} Emissions by Consumption Area

The development in the different areas of CO_{2e} balancing is analyzed by reporting remarkable differences and findings in the following sections:

- At home (heating and electricity)
- Mobility (private car, public transportation, and flights)
- Nutrition and consumer goods

12.6.1 CO_{2e} Development in the "at Home" Section

In the "at home" section, covering heating and electricity (see Table 12.5), three of the panels (Bremen, Wennigsen, and Pamplona) developed very well, with reductions above 2% per year in the two areas irrespective of which measure is used. Bremerhaven has improved in heating, but conflicting results are obtained in electricity depending on the calculation method. Bregenz only improved when considering the arithmetic mean, but not when looking at the median. Mariazell and Saragossa improved in heating, but deteriorated in electricity.

It seems that activities within the panels were successful as regards heating. More doubts arise as regards the impact of the citizen panel in the electricity area. However, we have to bear in mind that the baseline emissions of participants in electricity of all the panels were below the average emissions in the respective countries in this category and obtaining further reductions in this category was, therefore, difficult.

Table 12.5 CO_{2e} development in "at home" section

CO_{2e} area	Bregenz	Mariazell	Bremen	Bremerhaven	Wennigsen	Pamplona	Saragossa
HEATING							
Arithmetic mean	↓	↓	↓	↓	↓	↓	↓
Median	↑	↓	↓	↓	↓	↓	↓
ELECTRICITY							
Arithmetic mean	↓	↑	↓	↓	↓	↓	↑
Median	↑	↑	↓	↑	↓	↓	→

As indicated in Sect. 12.3, climate conditions are an important factor affecting heating-related emissions. In this regard, it is important to consider whether the reductions obtained in the heating area are "real" savings due to behavioral changes on the part of participants, or whether they are due to a less cold winter season. In the case of Spain, for example, data[2] show that the winters of the year 2010 and 2011 had similar average temperatures to a regular year. However, the months of summer of the year 2011 were, on average, around 2° hotter than the regular values, which may explain the inability to achieve the target in electricity in the case of Saragossa (because of higher use of air-conditioning during the summer months).

12.6.2 CO_{2e} Development in the "Mobility" Section

The mobility section covers CO_{2e} emissions caused by the use of private car, public transportation, and airplanes. As not all panelists used all three modes of transportation, their CO_{2e} emissions could be zero in one or several transportation components. This has a direct impact on the calculation of the median. For example, as only a minority of participants produced flight emissions, the median would be zero in all seven sites. There were also many panelists who did not use any public transportation or did not own a car, and hence produced no emission in these areas. Therefore, the median is not presented in the traffic section; only the arithmetic mean. Furthermore, we have to bear in mind that because of some panelists having zero emissions, it is impossible for them to improve (for them stagnation is a success). In the mobility area, it is impossible for some citizens to reduce their individual emissions; therefore, at collective level, it is also more difficult to achieve the target in this section (Table 12.6).

[2] Values per month available at: www.tutiempo.net. Standard climate values available at: www.aemet.es. Last access: 2 October 2013.

Table 12.6 CO_{2e} development in "mobility" section

CO_{2e} area	Bregenz	Mariazell	Bremen	Bremerhaven	Wennigsen	Pamplona	Saragossa
PRIVATE CAR							
Arithmetic mean	↑	↑	↑	↓	→	↑	↓
PUBLIC TRANSPORT							
Arithmetic mean	↓	↓	↓	↓	↓	↑	↓
FLIGHTS							
Arithmetic mean	↑	↓	↑	↓	↓	↑	↓

The mobility area seems to be a crucial section, deserving more attention in most of the sites. Only two of the panels (Bremerhaven and Saragossa) developed very well, with reductions above 2 % per year in the three areas. But caution is needed as these improvements cannot be attributed only to the participation in citizen panels in these cities, but also to external factors, especially the economic situation. According to the latest available data from Statistics Bremen, the unemployment rate in Bremerhaven was almost 17 % in July 2010, which is one of the highest rates throughout Germany. Similarly, the economic crisis has had a greater effect in Saragossa than in Pamplona.[3]

The use of a *private car* significantly decreased in Bremerhaven and Saragossa, it remained more or less the same in Wennigsen, and it increased significantly in the other four panels. The reduction in the use of a private car by more than 5 % within 1 year of monitoring in Bremerhaven clearly corresponds to the results of the third panel survey questions on mobility: more than one third of respondents reported that they avoided travelling by car and used the bicycle or walked more often since their participation in the citizen panel. However, although in Wennigsen more than one third of panelists reported that they have replaced a share of their individual car traffic by cycling or walking, their CO_{2e} balance for private car traffic only improved slightly during the monitoring period. Even more strikingly, 67 % of the panelists in Bregenz reported a positive change in individual car traffic, although the average emissions significantly increased during the 2-year period. Therefore, attitudes reported in the third panel survey seem to have clashed with other priorities in life. Even though some motorized trips could have been replaced by environmental friendly means of transport, this saving behavior seems to become absorbed by an increase of trips or by covering longer distances per trip. This phenomenon, known as the rebound effect, has frequently been observed. Energy savings, for

[3] Data at the regional level from the Spanish National Institute of Statistics (www.ine.es) shows that in the last quarter of the year 2008 the unemployment rate was around 7 % in both regions. However, in the first quarter of 2011 the figures were 19.5 % in Saragossa and 13.4 % in Pamplona. In the third quarter of 2012 (when the periodic measurements finished) the figures were 20 % and 15 %, respectively.

example, by increased efficiency, are eliminated by an increase of the product use (Boulanger et al. 2013; Sorrell 2007; see also Chaps. 7 and 10).

Lifestyles, in particular the way in which people commute, are crucial in the generation of CO_{2e}. As urban areas become denser and rely more on public transport, carbon emissions can be reduced significantly (OECD 2010, p. 57). European metropolitan regions have been able to lower car use through a more extensive use of public transport, as well as development of other transportation modes including walking and cycling (OECD 2010, p. 60). However, the sites analyzed have very different *public transport* infrastructures, which may facilitate or hamper behavioral changes in mobility. For example, as regards the German panels, Bremen has a very well developed public transportation system in comparison to Bremerhaven and Wennigsen. Compared to Bremen with a share of 14 % of public transportation, the share in Bremerhaven is only 6 % (Schallaböck et al. 2009) and in Wennigsen 11 % (Infas 2012). Instead, the share of individual motor car traffic is higher in Wennigsen (59 %) and Bremerhaven (57 %) than in Bremen (42 %). Also, the proportion of commuters that work in urbanized areas clearly affects the individual modal split. In Saragossa, much has been going on in recent years regarding public transport and mobility. A new tram system has been developed and a complete reorganization of traffic has taken place. Furthermore, the use of the bicycle has significantly increased in recent years due to various initiatives carried out since 2008, like the new cycle lanes and a municipal bike service (www.biziZaragoza.com). Since then, the use of the bicycle has significantly increased in Saragossa, which has undoubtedly contributed to the reduction in the use of private transport for travel within the city.

Generally, the decrease of a CO_{2e} balance is a success, but not in the public transportation domain (unless the public transportation is replaced by bicycle or walking). Emissions from public transportation decreased in all panels but Pamplona, but in this case the use of the private car has also increased. So, most citizen panels did not succeed in reducing individual traffic or in transferring private traffic to public transportation systems. This is all the more remarkable in Bremen, as there is a rather well-received public transportation system.

As regards *air traffic*, results were also different among the panels. Mariazell, Wennigsen, Bremerhaven, and Saragossa have achieved the target, whereas panelists in Bregenz, Bremen, and Pamplona have increased their emissions. However, the results of the Austro-German panels have to be taken with caution, as these operated with an average flight emission factor for all participants in the baseline instead of individual empirical values for this component (see Sect. 8.6 for explanation). An increase of more than 50 % of CO_{2e} emissions has to be noticed for Bremen. Certainly, a big share of the increase is due to the inability of the CO_{2e} calculator to consider the real individual consumption of flights in the baseline. In some cases, such as Bremen, the increase of flight emissions complies with the assumption that an airport nearby does influence the mobility behavior (cf. Pfleiderer 2009). Long distances to the nearest airport seem to have a positive impact on the flying behavior in Bremerhaven, Mariazell, and Wennigsen. However, this is not the case in the Spanish cities: Pamplona has increased its emissions whereas Saragossa has reduced them, in spite of the fact that Saragossa is better connected with

Madrid and Barcelona airports. Here the economic situation seems to have played a significant role, as the economic crisis has affected Saragossa to a greater extent. In this regard, the unemployment rates suggest that other needs than air trips are currently more important (particularly in Saragossa and Bremerhaven). On the other hand, there is an overrepresentation of panel participants with a university degree (more than 70 % in Bremen and about 48 % in the seven panels) that suggests that higher income levels are connected with increased flight behavior.

12.6.3 CO_{2e} Development in the "Nutrition and Consumer Goods" Section

For nutrition and consumer goods, the interpretation of results is limited by the specific characteristics of these areas. The reasons are twofold. First, the calculation of CO_{2e} emissions in the nutrition and consumer good areas is rather complex and in many cases poorly received (see Chap. 8). This circumstance is reflected in the CO_{2e} calculator by providing either abstract or only few answering options. Second, even though the savings potential in both areas is high in principle, the opportunities to noticeably decrease one's emissions are rather low to date. For example, climate-friendly nutrition behavior would require food that is locally produced and that the generated CO_{2e} emissions are presented on the product in a transparent way so that consumers are informed and have the choice. However, such infrastructure hardly exists today.

Even though the nutrition section received high interest and was voted the section where most behavioral changes were reported by the panelists, there was little in the way of perceptible improvements in the CO_{2e} balance. As the symbols in Table 12.7 show, the developments in the panels can be characterized as nonexistent, with a majority of stagnation arrows. So, the monitoring results and the panel

Table 12.7 CO_{2e} development in "nutrition and consumer goods" section

CO_{2e} area	Bregenz	Mariazell	Bremen	Bremerhaven	Wennigsen	Pamplona	Saragossa
NUTRITION							
Arithmetic mean	↘	→	→	↗	↓	→	→
Median	→	↘	→	↗	→	↗	→
CONSUMER GOODS							
Arithmetic mean	→	↗	→	↘	↘	↑	↑
Median	→	↗	↑	↘	↘	→	→

surveys show that the impact of nutrition and consumer goods on the climate is still not very well received by the panelists. Even though high interest (particularly in nutrition) has been indicated in the panel surveys, nutrition habits still seem to be rather a question of lifestyle and health. The impact of the participation process in this area seems to be questionable at least.

12.7 Conclusions

This chapter aimed at evaluating whether the cooperation of citizens as participants of citizens' panels has had a positive impact, at collective level, by contributing to the achievement of a 2% annual reduction in the CO_{2e} emissions in their city or region. Difficulties have arisen in assessing the ecological impacts at the collective level. Measuring CO_{2e} emissions is a difficult task, but comparing emissions within the panels and across sites and countries has turned out to be still more difficult. Comparisons among the panels and countries are complex because of different context factors (e.g., geographic position), methodological issues (different CO_{2e} calculators), and because of the high variation of the CO_{2e} emissions within the panels. Furthermore, the economic crisis has affected the participant countries, regions, and cities differently.

Because of the aforementioned challenges, different methodological approaches were used to assess the ecological impact of the citizen panels at the collective level, by comparing the evolution in the arithmetic mean and median figures, and by analyzing the CO_{2e} emissions with and without flights. Results show that only two panels (Bremerhaven and Wennigsen) met the reduction target completely (independent of the type of calculation) and only one (Pamplona) never met the target. However, even in those panels that failed to achieve the target, reductions in CO_{2e} are the general trend. So, altogether, considering flights or not, the arithmetic mean or median, in all seven sites, improvements in the CO_{2e} balances on the collective level could be achieved. This is a positive finding, especially if we bear in mind that participants voluntarily engaging in this project were already concerned about the environment and, in most cases (both Austrian and Spanish sites, and also Bremen), the initial CO_{2e} emissions were lower than the average in the respective countries, which made further improvements more difficult.

The higher reductions in Austria and Germany as compared to Spain are consistent with the results of the recent Eurobarometer surveys (European Commission 2009, 2011) and the representative surveys carried out in each site before the citizen panels started. Due to the financial crisis and political disaffection in Spain, interviewees ranked the importance of climate change after the aforementioned problems. However, the CO_{2e} emission levels of both Spanish sites, as well as of the national average in Spain, are still noticeably below the Austrian and German levels, and the lower the balance level is, the harder is it to achieve further reductions.

It is important to highlight that the results of the panels (improvements or deteriorations) are almost the same after 1 year of monitoring and after 2 years: That is, if savings have been achieved in the first year, savings have also been achieved in the second year. Furthermore, comparing both years, the level of savings and deteriorations is more or less the same. This finding suggests that learning effects have already been achieved after 1 year. Conversely, panelists who have not learned to change their behavior within 1 year will not change it within activities that last for more than 1 year. As the tendency for savings or deteriorations is already found in the first year, climate participation processes lasting for longer than 1 year will not contribute to further savings. They might help to avoid relapsing into old routines that would cause higher CO_{2e} emissions again, but to further reduce carbon emissions, the participation instrument as well as the format needs to be improved and/or new ways to trigger further savings need to be developed.

Results show that the participation process was more successful in promoting behavioral changes in some consumption areas. The activities within the panels were very successful as regards heating, but varying results are found in electricity, mobility, nutrition, and consumer goods. This finding is consistent with previous studies (Abrahamse and Steg 2005; Staats et al. 2004, p. 357). There, too, the biggest savings were achieved in the heating energy section, and only minor effects in the electricity domain and mixed ones for mobility, nutrition, and consumption. All this makes it difficult to generalize the e2d results for the collective ecological impact. As a consequence, neither citizen panels nor any other single measure leads to the fulfillment of the climate protection goals alone. Instead, a multitude of actions, coming from different disciplines and activating citizens on different levels, must be taken into account in order to trigger behavioral changes and CO_{2e} reductions that, in turn, support the achievement of the ambitious climate protection targets.

Future research should analyze more deeply why participation processes seem to be more effective in certain domains, such as in heating, and less effective in traffic, nutrition or consumption. Certainly, the rebound effect and modern lifestyles play an important role as regards electricity emissions: energy savings (by increased efficiency of domestic appliances and so on) are eliminated by an increase in the use of these products. As regards the mobility area, we have to bear in mind that for some participants it was not possible to reduce their individual emissions; therefore, at collective level, it was also more difficult to achieve the target in this section. However, in any case, the mobility area deserves more attention in most of the cities analyzed and in future research, as the use of the private car increased in four of the seven panels. Finally, our results suggest that the impact of nutrition and consumer goods on the climate is still not very well perceived by citizens. Future research also needs to address the issue of how to effectively influence citizen behavior in these areas.

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