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Per Capita (PC) versus Per Adult Human Unit Method (PAHUM): A Net Assessment of EU28-Population, Family/Household, Food Consumption and Environmental Impact

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Abstract: Communication of Lisbon Strategy sets out an integrated package of measures to deliver more sustainable consumption (including food), better environmental protection, correct population and production evaluations by using appropriate and more meaningful methods. It lays ahead as one of the key challenges for EU28-PC, Adult Equivalent (AE) and conjoint evaluations and implementation are not sufficiently dynamic and forward-looking to drive the performance of methods upwards. Those evaluations do not serve the above purpose. On PC, AE method use overall, voluntary and regulatory instruments are not sufficiently connected and potential synergies among the different instruments are not exploited. Divergent national, international approaches send conflicting signals to producers and consumers. As a result, the full potential of the internal food market of EU28 and its impact on environment are not realized and evaluated on properly identified UNIT basis. Misidentified UNIT for measurement would not give correct results and if one installs his correct assumptions on the wrong unit, the falls results will start following each other. The developed PAHUM-(Copy-right©1989) and policy approach may integrate the potential of the different policy instruments, helping implement them (gender, age, structure and household size) to food consumption and environmental issues.

Key words: Per capita, per adult human unit, adult equivalents, food, environment.

1. Introduction

The European Union has taken important steps to reach its objectives of growth and jobs. The Lisbon strategy has delivered significant results. Within two years over six million jobs have been created and unemployment has been reduced significantly, especially in Germany. However, the challenge is now to integrate sustainability into this picture. Sustainable development aims at the continuous improvement of the quality of life and well-being for present and future generations in a correct and complete form in its evaluation methodology [1]. This is a key objective of the European Union. Yet, increasingly rapid global changes, from the melting of the icecaps to growing energy and food resource demand, are challenging this objective that need to be revaluated and assessed correctly on unit basis. It is very interesting to indicate that all the evaluations stated and discussed above and all the conclusive predictions are made on PC (unit/criteria) basis. Per capita is not only one of the most used measurement but also one of the misused in every aspect of evaluations of global macro economy including food (organic/conventional) consumption/production predictions. It is virtually in every interest area, including environment (CO_2 emission). In people’s daily life, the two words—Per Capita is invoked by academics, business people, news man, TV anchors and politicians. Continued interest in

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using "PC" reflects the pervasive feeling that the unit basis fundamental is happening in the world economy where there are a lot of big issues and evaluations of those interconnected under the umbrella of the term "Per Capita" (Unit). PC evaluations of the individual citizens—the most obvious indicators of measured change are those which impinge most directly on a person's daily family life activities that is acquiring the necessities of life (food and clothing), making a living and providing for their children to sustain their future and environment. Above challenges and assessments based on PC, Adult Equivalent (AE) and conjoint evaluation are directly linked to people's way of life that they produce and consume which contribute to global warming, pollution, material use and natural resource depletion including food (organic and conventional). The impacts of consumption (especially food) in the EU are felt globally, as the EU is dependent on the energy imports and natural resources. Furthermore, an increasing proportion of products consumed in Europe are produced in other parts of the world including food. The need to move towards more sustainable patterns of consumption and production is more pressing than ever [2]. Agriculture and fisheries are highly dependent on specific climate conditions. Changes in temperature, amount of CO_2 emission in the atmosphere and the frequency and intensity of extreme weather could have significant impacts on crop yields [3-5].

State of art of the article is implementing developed PAHU method (Copy-right©1989)—(age and gender corrected Per Capita–PC^{agc}) to revaluate demographic structure, consumer and food consumption potential of EU28, Candidate States and its safety (and efficacy) as needed for the period of 1999/2010/2020. In addition, practical application and CO_2 emissions are also discussed. It involves systematic attempts to create awareness of error inherent to PC (19.4 percentage unit) food and other goods consumption, consumer evaluations and their impact on society and environment. The other aim is to identify the areas of scientific harmonization of quantitative and qualitative development including family and household evaluations. It may likely to influence the future demographic change of EU, its expansion, environmental policies and strategies. In order to compare the available/calculated data on UNIT basis, researchers have to look into main issues.

1.1 Evaluation of the Food Consumption of Different Households and Impact of Environment

Will the world and EU really need more food? Given the enormously unequal distribution of food today around the planet, one might think that distributing food more equally could solve the food challenge. Yet, even if all the food calories available in the world today were equally distributed across the projected population for the year 2050, no food calories were lost between the farm and the fork. Those calories would still fall short of the UNFAO's "average daily energy requirements" 2,300 kcal PC/day by more than 200 kcal PC/day. If the current rate of food loss and waste were to remain in 2050, the gap would grow to more than 900 kcal per person (PC/day). In short, current global food availability is insufficient to feed the world in 2050 [6, 7]. How can the world adequately feed more than 9 billion (PC) people by 2050 in a manner that advances economic development and reduce pressure on the environment? This is one of the paramount questions the world faces over the next three decades. Answering it requires a "great balancing act" of two needs, each of which must be simultaneously met.

First, the world needs to close the gap between the food available today and that needed by 2050. UNPD [8] presented the detailed world and EU population prospects and the results were summarized that this gap is in part a function of increasing population and wealth [9]. The United Nations Population Division [8] projected that global population will most likely grow from 7 billion PC in 2012 to 9.3 billion PC by 2050. At least 3 billion PC more people are likely to enter the global middle class by 2050, and they will almost certainly demand more resource-intensive foods. At the same time, approximately 870 million PC of the world's poorest people remain undernourished even today. When production falls short of people's needs, the world's rich can out-compete the poor and hunger will increase. The second, above evaluations, predictions and figures may depict the reality. However, the correctness of the figures that are evaluated on PC, AE and conjoint evaluations and other methods may need to be confirmed, revaluated and corrected for future strategy and policy determination to eliminate hunger and protect the environment.

1.2 Population Dynamics/Environment Relations

Climate change is one of the greatest challenges humanity face today. Its effects are already felt from strengthened storms and rising sea levels to change temperature and weather patterns. They will only grow worse in the future. Urgent action is needed to reduce emissions to mitigate and adapt to these changes. UN [10-14] is working with governments and other partners to better understanding population dynamics—how they affect the changing climate and how people can become resilient in the face of these changes. Only with this knowledge, policy-makers can take on this gravest challenge. Everyone will be impacted by climate change, especially those who are poor, vulnerable and lacking of resources (food). Consumption drives climate change and different groups of people consume differently. However, many analyses of the impacts of population on climate change fail to take these differences into account. Age structure, household size and spatial distribution all affect not only on error bound PC but also on defined UNIT (PAHUM = PC^{gac}) emissions and should be integrated into climate change modeling. Analyzing population dynamics on well defined UNIT basis may clarify the reasons and how interventions can most effectively reach them.

1.3 Age Structure, Spatial Distribution and Urbanization

Age structure, household size and spatial distribution all affect PC emissions and also should be integrated into climate change modeling [10-12]. Babies, young children and older people who have past their peak working years consume less and produce fewer greenhouse gas emissions than working-age people. Worldwide, the proportion of older persons is rising, with UNDP projecting an increase in the proportion of people over 60 years of age from 10% in 2005 to 22% in 2050. All things being equal, this will result in a reduction in emissions over time [8]. Developing countries have higher percentage under 19-year old population than developed countries. One cannot assume that 6-month old baby nor < 66-year eat and emit CO_2 as much as 20-65-year old.

To evaluate the ideal of the EU28 and European cities urban areas, it is necessary to interrelate different social perspectives to a widened conception and spatial perspective [15]. The rural/urban distribution of the population is a major determinant of emission levels, though not always in predictable ways [14]. The battle for a sustainable environmental future is being waged primarily in the major cities of the world, where population, economic activity and environmental issues are increasingly concentrated. As cities in the developing world grow, unmanaged urbanization can outpace infrastructure and environmental safeguards, leading to high pollution and CO_2 emissions and increasing vulnerability for residents. Better urban planning is quite essential to poverty reduction. Women's empowerment and slum improvements could help mitigate greenhouse gas emissions, while also provided resilient and adaptive environments to reduce vulnerability, particularly for impoverished urban dwellers [13, 16].

1.4 Gender and Household Size

Women's historic disadvantages—their restricted access to resources and information and their limited power in decision-making make them most vulnerable to the impacts of climate change. Rural women in developing countries are still largely responsible for securing food, water and energy for cooking and heating. Drought, deforestation and erratic rainfall cause women to work harder to secure these resources. They can play an essential role in the climate change negotiation process as well as in the development of sustainable and ecologically sound food consumption, production patterns and approaches to natural resource management [17]. Researchers should not forget that particular groups of people are most vulnerable to impacts of climate change and food consumption: women, children, single, female-headed households and the elderly [11, 14, 17].

In a report published in the journal—"Environment, Development and Sustainability" [18], researchers conclude that the dramatic increase in the number of younger, more affluent people living alone are likely to cause a resource consumption crisis in England and Wales. Their findings should serve as a serious warning to other nations. One-person households increase rapidly: previously, the typical one-person householder was the widow, often on a tight budget and thrifty. The rises in younger, wealthier one-person households have a serious impact on the environment. The number of one-person households in the UK has increased significantly over the last 30 years from 18% of all households in 1971 to 30% in 2001. Experts believe that the figure will increase to 38%, to more than a third of all households by 2026 [19]. This pattern is observed all over EU28. One-person households consume more resources: According to the research, people who live in one-person households are the biggest consumers of energy, land and household goods such as washing machines, refrigerators, televisions and stereos PC. They consume 38% more products, 42% more packaging, 55% more electricity and 61% more gas PC than four-person households. In households of four or more, each person produces 1,000 kilograms of waste annually, while those living alone create 1,600 kilograms of waste each year. One-person households also produce more carbon dioxide PC [19]. It was concluded that because of economies of scale, larger households, while emitting more in total, emit less PC. Therefore, decreases in household size mean more emissions, even without more people [20]. Here, from above stand point, the evaluation of the households on PAHU instead of PC basis may be the best approach when household size, gender and age are considered on defined UNIT basis.

2. Material and Methods

2.1 PC, AE versus PAHU Method Evaluations

PC versus PAHU Method: Redefining PC—PC, AE, conjoint evaluations are currently a somewhat controversial set of units and evaluation methods used by different researchers and scientists in food production consumption, economic and environmental evaluations. One reason for the controversy is that these evaluations cover a wide range of concepts that are often used interchangeably. Failure to recognize and address the problems inherent to error bound PC, "one-size-fits-all accept or reject" approach in food and other goods consumption calculations and projections (which are easy to use) may result in erroneous production and consumption projections, misappropriations of resources and discontent among consumers. It may be extremely important to measure the food consumption of the families/households of developed (EU) and developing (Turkey) countries on a standardized UNIT base that may make them comparable.

2.2 Eliminating Inconsistencies

In general, scientists are looking for a suitable yardstick to measure the level of sustainability of a country. Aim is to evaluate the real consumer potential of a developed or developing state or predicting pollution level by a suitable measuring instrument which may not be found (PC, Adult Equivalent and Conjoint Measurements etc.). Although the main existing indexes were examined, one had to conclude that none of them seem to fit the needs completely. The main shortcomings are:

(1) A limited definition of sustainability;

(2) Lack of transparency;

(3) High complexity;

(4) Absence of regular updates;

(5) Inconsistencies of the method and criteria used (Adult Equivalent (AE)).

The developed comprehensive model (PAHU Method/Gender and Age Corrected PC^{gac}) aims to redefine PC for the evaluation of family, household, target groups of developed and developing nations on standardized UNIT basis (20-24-year old man/woman) Furthermore, measure their real food consumption potentials, environmental issues for future planning and eliminate the inconsistencies.

3. Material and Methodology: Concept, Key Innovations

State of the art of this paper is implementing PAHU to evaluate the real consumer potential of EU28 and/or any population or target group (on unit basis). PAHU aims to reduce the errors (19.4 percentage units, Fig. 1) inherent in PC projections for food and other commodities production and consumptions [25-27]. Calculation of PAHU (UNIT = 20-24-year-old) based on Basal Metabolic Body Rates (BMR) to obtain the conversion factors for each age group into PAHU (Table 1) that standardizes any population or a target group on UNIT basis. Since PAHU development and its practical use were presented previously [21-29], the criteria used in the method development are summarized.

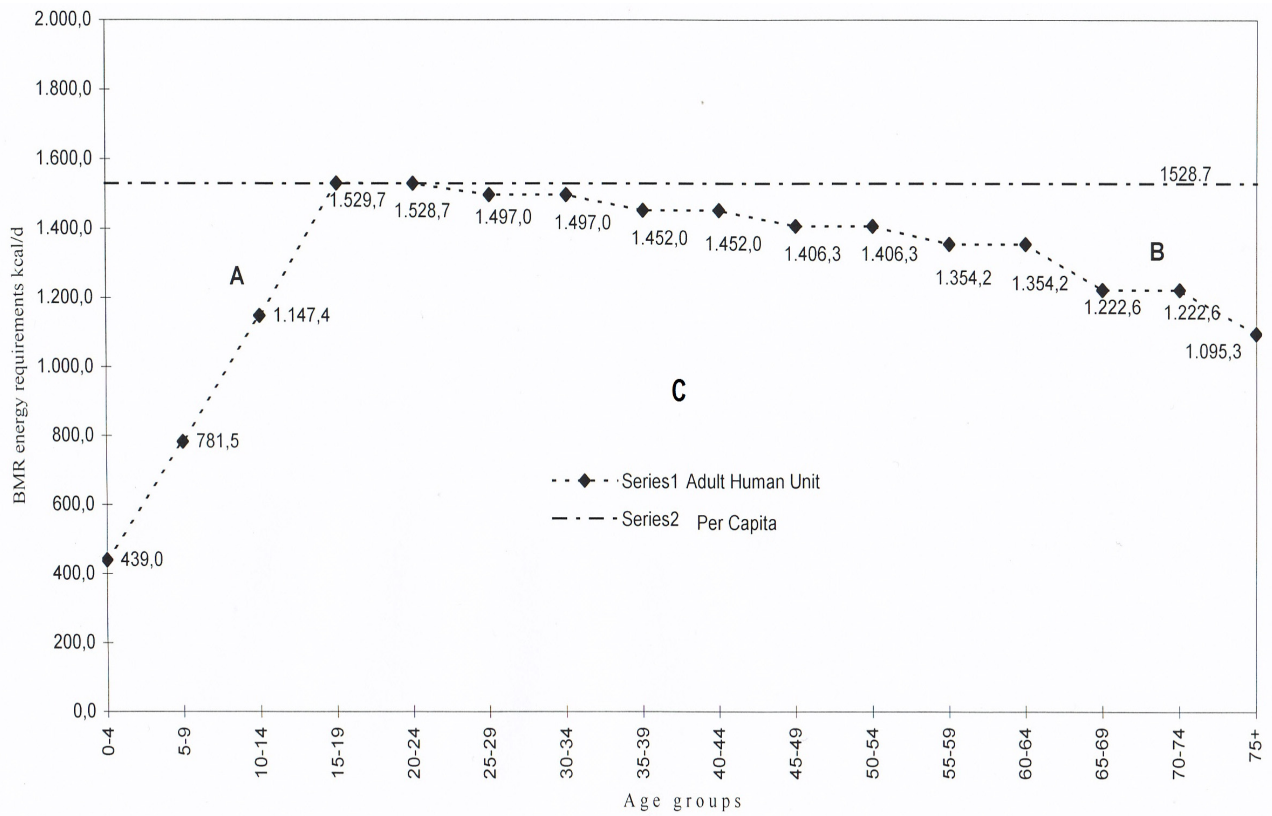

Fig. 1 Per Capita error level—BMB energy requirement differences between PC and PAHU (kcal/d). (Assumed reality—(Series 2) · — · — · PC vs. Ideal/actual representation—(Series 1) - ♦ · · · · · ♦ PAHU) (Rectangle (C) is PC area = 100%; triangle A is < 20 – age group = 7.6% of rectangle; triangle B > 20 – age group = 11.8 % of rectangle totalling 19.4 % and PAHU is 100 – (7.6 + 11.8) = 80.6 % of PC area).

Table 1 Calculated conversion factors of the age groups[2].

	Calculated BME [3] requirements kcal/day			[2] PAHU conversion factors		
Age groups	Male	Female	Average	Male	Female	Average
0-4	445.1	432.7	438.9	0.262	0.317	0.287
5-9	782.1	780.5	781.4	0.462	0.572	0.511
10-14	1,138.6	1,156.1	1,147.4	0.672	0.848	0.751
15-19	1,571.5	1 ,487.9	1,492.5	0.974	1.091	0.976
20-24[1]	**1,694.0**	**1,363.3**	**1,528.7**	**1.000**	**1.000**	**1.000**
25-34	1,659.0	1,336.0	1,494.5	0.979	0.979	0.980
35-44	1,609.0	1,295.0	1,452.0	0.950	0.950	0.950
45-54	1,558.5	1,254.0	1,406.3	0.920	0.920	0.920
55-59	1,473.8	55-59	1,354.2	0.870	0.906	0.886
60-64	1,473.8	1,234.5	1,354.2	0.870	0.905	0.886
65-74	1,354.6	1,090.6	1,222.6	0.800	0.800	0.800
75+	1,218.0	972.6	1,095.3	0.719	0.713	0.716

*[1] Standard Adult Human Unit (Age 20-24) for male and female BME requirements are 1,694.0 and 1,363.36 kcal/d respectively, averaging 1,528.7 kcal/d. [2] PAHU calculation = Population of the age group × Age group's conversion factor. Conversion Factor Calculation = Male or Female BME kcal/d: 20-24-year old (PAHU) Male or Female BME kcal/d. [3] Basal Metabolic Energy (BME) is the minimum energy cost of body process, representing the excess of endothermic over exothermic reaction.

3.1 Nutrition and Energy Expenditure for Human Productivity

Method deals with primarily the requirement for a standard reference individual (20-24-year-old = PAHU) BMR energy which are calculated for each "5-year-interval" age-groups. An age group of 20-24 was chosen as a standard adult age group (PAHU or reference person) for both male and female because up to that age, the growth represents the bone and the muscle, whereas, after that, every increase almost always represents fat (Table 1). Economics Nobel Price winner [49] Fogel in 2000 used the terminology "technophysio evolution" in his evaluations and concluded that basal metabolic energy, plus energy used for productivity are essential elements of macro economic production.

3.2 Age and Gender Structure of a Population/Target Group

Selected method design correlates to deviant anthropometry that includes defined age and sex structure along other factors (body weight, height, body frame, environmental temperature etc.) affecting BMR, which are also included in the calculations.

3.3 Selected Anthropometric Criteria

Cut-off points for indicators were selected carefully and all were based on literature and were documented. Comparing to research results can characterize changes and trends on BME within the age/gender groups of the population.

3.4 Calculation Procedure of PAHU

BMR and affecting factors are the criteria used to calculate the PAHU conversion factors for the different age groups (five year-intervals) to standardize a population or a target group under one unit (Table 1) because BMR is an essential part of human vitality. The formula and calculations were based on the long-term research findings [30, 31]. It was suggested [32] a three-fourths power of the body weight is the best correlation between body size and resting metabolism.

It has been considered that W^n is a measure of physiological body size, or metabolic size, and the values of the exponent, n, should be determined from the data in question. The relationships may be expressed mathematically as: $C = bW^n$ or $\log C = \log b + \log W^n$. If C is kcal of basal metabolism and W^n is metabolic size, then the ratio C/W^n should be a statistical constant b determined by Brody in 1945 [30]. Thus, the slope of the curve proved to be 0.73, and the value of b, the ratio $C/W^{0.73}$, was 70.5 which indicated that, on the average, kcal basal metabolism = 70.5 ($W^{0.73}$). Brody [30] and Kleiber [31, 32] recommended that the equation be written: kcal of basal metabolism = 70 ($W_{kg}^{0.75}$) and considered it to be a biological constant applicable not only persons of quite different body builds to all homiotherms (mice and elephant) [33]. The basal metabolism value depends on the biological size and this has been accepted by nutritionists generally.

3.5 Age Groups' BME Requirements-PAHU versus PC Evaluations and Error Level

PAHU method considers younger, older and gender differences where error bound PC evaluations do not considers those parameters. Its basic objective was to reduce uncertainty and to give definitive stature to the quantities being described. PC is defined—Webster Dictionary: "Equal to each individual, per unit of population and/or for each person". When data are presented on the basis of PC for production and consumption of commodities including goods and foodstuffs/grain, the assumption is 0-19-year old, (6-month old baby) and 66 to 75+ year-old will produce and consume food/emit CO_2 as much as a mature person (20-65-year old) man and/or woman. The prejudice use of PC hardly been challenged in the literature as it was the only unit that should be used in every aspects of economics, environmental evaluations and food consumption projections. Scientists have to eliminate the error from the beginning of the planning stage. Using the detailed anthropometric criteria is generally neglected in the evaluations. Plotting average BMR kcal requirement values (Table 1) against each age groups, illustrates deleterious assessments are not less than 7.6 percentage units for the age group less than 20 and 11.8 percentage unit for the age group over 25-year respectively (Fig. 1), totalling up to 19.4 in the evaluations. Earlier graphic analysis made by using the calculated findings of (Table 1) by percentage units for each PC as compared to PAHU confirmed the findings [25-29].

4. Results and Discussion

4.1 EU Population Evaluation

Aim involved systematic attempts to create awareness of error inherent to PC (19.4 percentage unit, Fig. 1) food and other goods consumption, consumer evaluations and their impact on society and environment. It includes family and household evaluation likely to influence the future demographic change of EU, its expansion policies and strategies and also to explain the effect of error bound PC evaluations on the EU economic crisis that causes the contractions. To start, each mini market of EU28, candidate country, whole Europe's PC and PAHU-real consumer potentials are calculated for 1999, 2010 and 2020, summarized and tabulated (Table 2). The expansion of the EU between 1999 and 2010, added 187 million PC and/or 156 million PAHU, (including candidate Turkey). The EU-29 population added up to 561 million PC and 469 million PAHU. In 2020, EU28 plus candidate country (577 million PC and 486 million PAHU), plus other 28 European countries with the dependency of EU-member states, Europe's consumption potential will go up to 701 million PC and 591 million PAHU. So, Europe (total-56 countries) will be the world's third largest organized trading, production power and organic/conventional food consumer and polluter after China and India (Table 2). The EU, currently, has to cope with demographic decline, low natural growth and the aging of its population. EU28 policy-makers may have to consider looking into the erroneous use of PC and its effects on the results of the decision–making and policy

Table 2 Europe's pass and future consumer potential evaluation on Per Capita (PC) and Per Adult Human Unit (PAHU) for the years 1999, 2010 and 2020.

Years	1999		2010		2020	
Countries (000)	PC	PAHU	PC	PAHU	PC	PAHU
1-EU (15)	374,322	317,342	374,222	317,637	392,158	330,286
2-EU (13)	109,996	92,031	110,524	93,069	105,627	89,211
3-Candidate (Turkey) (1)	65,599	54,003	76,574	63,583	79,678	66,635
4-Dependencies of EU member states. (7)	862	707	985	834	1,081	906
5-Potential candidate countries (5)	20,310	17,382	21,191	17,999	21,332	17,606
6-Future enlargement possibilities (4)	12,395	10,491	12,770	10,683	12,435	10,470
7-Micro states (4)	125	107	138	118	144	122
8-Former soviet republics (7)	94,699	80,270	90,676	78,284	88,564	75,871
Europe* total (56)	**678,278**	**572,297**	**675,581**	**573,207**	**701,015**	**591,121**

* Total 56 countries including dependencies.

implications not only in food consumption issues but also in other economic and environmental issues that affect the continuing global and EU economic crisis.

4.2 Grain and Red Meat Consumption Evaluations on Error Based PC

To emphasize the difference between developed and developing countries, two almost equally populated countries are considered: Belgium 10,423,493 and Chad with 10,543,464 populations for the year 2010. Although the population numbers (PC) are similar (0.98% difference), the PAHU population numbers showed huge differences (8,784,050 and 7,840,591 respectively) especially in the age groups, under 20 (22.0% and 57.4% for Belgium and Chad respectively). On the basis of 200 kg/Y world PC grain consumption [26], both Belgium's and Chad's total grain requirements would be almost the same, 2,084,698 T/Y and 2,108,692 T/Y respectively. However, on the PAHU basis, the requirements would be 1,756,810 T/Y and 1,568,118 T/Y respectively. Percentage unit deviations of PAHU grain consumption from PC (savings) were 16.6% and 26.9% for Belgium and Chad respectively. Similar saving values for meat were 15.7 and 34.4 percentage unit respectively. Previous evaluations of differences between equally populated Sweden and Zambia for the year 1995 gave similar results and their under age 20 population (24.0% and 61.5% respectively) confirmed the results. These findings illustrate the presence of the big gap between PC and PAHU from the standpoint of projecting organic or conventional grain and also meat consumption of developed and developing countries (Tables 3 and 4).

4.3 Carbon Dioxide Emission of Equally Populated Developed and Developing Countries Evaluation on PC and PAHU

Data reported on Tables 4-7 consider carbon dioxide emissions from the burning of fossil fuels and cement manufacture only but not emission from land use such as deforestation from international shipping or bunker fuels also are not included in national figures (Table 6).

Equally populated Belgium (9.9 T/PC) and Chad (0.04 T/PC) (Table 6) actual CO_2 emissions showed huge differences on both PC and PAHU 1.032, 6, 0.870, 0.042 and 0.032 billion T/Y respectively (Table 4). Differences between PC and PAHU for Belgium and Chad were 0.162 billion tons and 0.010 billion tons respectively. When world CO_2 emissions (4.8 T/PC) (Table 6) are used in evaluations, the differences between Belgium and Chad on PC basis were almost the same (-0.005 billion T/Y) but differences PC and PAHU basis were 0.080 and 0.130

Table 3 Evaluation of the red meat and grain consumption of the almost equally populated countries Chad (developing) and Belgium (developed) on Per Capita and Per Adult Human Unit basis [26].

	Country	Country	Differ.	Differ.
Observations	Belgium	Chad	#	%
Population PC	10,423,493	10,543,464	91,199	0.87
Population PAHU	8,784,050	7,840,591	943,459	10.74
Difference, #	1,639,443	2,702,873	1,009,430	8.91
PAHU, % of the total population	84.27	74.36		9.91
% deviation of PAHU from total PC pop.	15.73	25.64		
Percentage of <20-year old in total population	22.00	57.40		
PC red meat consumption, ton/year*	309,527	313,140	3,613	1.67
PAHU red meat consumption, ton/year*	260,886	232,865	28,021	10.70
Difference between PC and PAHU, ton/year	48,641	80,275	31,634	
PC grain consumption, ton/year*	2,084,698	2,108,692	23,994	1.15
PAHU grain consumption, ton/year*	1,756,810	1,568,118	188,692	10.7
Difference between PC and PAHU, ton/year*	327,888	540,574		

* World average PC grain consumption is 200 kg/Y and red meat consumption is 29.7 kg/Y [22].

Table 4 Evaluation CO_2 emissions of the almost equally populated countries Belgium (developed), and Chad (developing) on Per Capita and Per Adult Human Unit basis.

Observations	Belgium	Chad	Differ.
Actual CO_2 emission, PC T/Y*	9.9	0.04	
CO_2 emission PC billion T/Y	1.032	0.042	0.990
CO_2 emission PAHU billion T/Y	0.870	0.032	0.830
Difference between PC and PAHU T/Y	0.162	0.010	
World CO_2 emission, PC/T/Y*	4.8	4.8	
CO_2 emission PC billion T/Y	0.501	0.506	-0.005
CO_2 emission PAHU billion T/Y	0.421	0.376	0.045
Difference between PC and PAHU T/Y	0.080	0.130	

* Values from Table 5—(Note: A normal car emits 120-140 g CO_2/klm).

billion tons for Belgium and Chad respectively due to differences between the PC and PAHU population—1,639,443 and 2,702,873 respectively. Because PAHU calculations considered five year interval age groups and gender differences in its population evaluations on UNIT basis.

4.4 Family/Household Dynamics, Socio-Economic Processes and Their CO_2 Emitting Evaluations on PC/AE/PAHU Basis

Families and the households are the main consumer units and demanding source of goods and foodstuffs that need to be evaluated very carefully on unit basis in order to create comparable data.

Family and household structures are changing with a steady rise in the number of single-person homes/households and the descending number of family members. This increase is seen in developed-EU and USA, emerging-Turkey and developing economies. One should not forget that household numbers and the number of occupants in the households have great impact on economy, food consumption and carbon dioxide emission. In EU, average household occupant is 2.6. However, this number in Turkey is 4.2. In Eastern Anatolia average household number is 5.2 and in the rural areas, goes up to 7.2 [34]. In order to illustrate the effect of gender and age differences between equally numbered, two households were picked from the real world of two developing countries. Equal numbered two households with different age and gender structure (Table 5) show that PC and AE calculations can result in unintended deleterious assessments of food (Grain) consumption projections as compared to PAHU.

On the PC basis, the picture looks different (Table 4). Many argue that the household, and not the individual (PC) is the more appropriate unit for measuring emissions. However, above findings indicate that PAHU household emission evaluations (20.9 T/Y and 24.9 T/Y) would be better and more sensitive unit in reflecting the age and gender differences as compared to other (PC—28.8 T/Y and 28.8 T/Y and AE—13.0 T/Y and 15.8 Y/T) units for the Ahmed and Celik families (Table 5) respectively. As indicated, above households generally consume together and often produce/emit together and they are affected by the age and gender composition of the family/household. Since these air pollutants are pertinent to local human health (in particular their high concentrations in urban areas), it cannot withstanding their trans-boundary effects. Reporting their concentrations on PC basis may be informative only. In 2010 [35], on PC basis, the EU-27 average emissions were 7.2 kg PC for ammonia (NH_3), 14.8 kg for NMVOCs, 18.3 kg for nitrous oxides (NO_x) and 9.1 kg for sulphur oxides (SO_x) respectively. Since predictions on PC basis is error bound (19.4 percentage unit, Fig. 1), those pollutant values when corrected on PAHU would be 8.6 kg/PAHU, 17.6 kg/PAHU, 21.8 kg/PAHU and 10.9 kg/PAHU respectively.

(a)

(b)

Fig. 2 (a) Household Aboubakar—CHAD and (b) household Çelik—TURKEY with one week food supply respectively.

Table 5 Comparing Household-Aboubakar-Chad and Household-Celik-East Turkey[1] yearly grain requirements and CO_2 emissions on PC, AE and PAHU basis.

Household Aboubakar					Household çelik			
Gender (age)	PC	AE	PAHU	X	Gender (Age)	PC	AE	PAHU
Woman (49)	1	1.0	0.920	X	Woman (65)	1	1.0	0.800
Boy (15)	1	0.5	0.974	X	Man (45)	1	0.5	0.920
Girl (12)	1	0.3	0.848	X	Woman (38)	1	0.5	0.950
Boy (10)	1	0.3	0.672	X	Girl (18)	1	0.5	1.091
Girl (7)	1	0.3	0.572	X	Boy (16)	1	0.5	0.974
Girl (3)	1	0.3	0.317	X	Boy (9)	1	0.3	0.461
Total	6	2.7	4.303	X	Total	6	3.3	5.196
Grain reg. T/Y*	1.2	0.54	0.86	X	Grain reg. T/Y*	1.2	0.66	1.04
CO_2 emissions Ton/year**	28.8	13.0	20.9	X	$C0_2$ emissions Ton/Year**	28.8	15.8	24.9

* [1] World average PC grain consumption [26] is 200 kg and red meat consumption is 29.7 kg;

* Grain: T = Tons; Y = Year; PC = Per Capita; AE = Adult Equivalents; PAHU = Per Adult Human Unit; AE: First adult in the house = 1; other adults > 13 = 0.5 and child (13 or under) = 0.3; Gender is not considered nor the > 66 age group [36, 37]; PAHU values, from Table 1;

** CO_2 emissions: world average 4.8 Tons/PC value is used to calculate the household annual CO_2 emission calculations (values are from Table 6).

4.5 Inconsistencies Among and Within Adult Equivocal Evaluations (AE)

One of the most popular method of comparing families' consumption and other criteria is the adult equivalent (AE) scale that was developed by Friedman as long ago in 1935 [42] which is a generalization of the income PC method [43]. There are different approaches to convert the number of persons in the household to "adult equivalents" by developed concepts and formulas. Different formulae are used in discounting gender and counting children and adults [36, 37 and 44]: (1) Adult Equivalent (AE) was described [44]: first adult in the house = 1; other adults > 13 = 0.5 and child (13 or under) = 0.3; (2) Basciary et al. [45] used adult equivalency scale when creating a poverty map for Azerbaijan with a World Bank project. Adult equivalent children aged below the age of six have been assigned a weight of 0.2, children aged 7-12 have been assigned of a weight 0.3, age 13-17 have been assigned a weight of 0.5 and a weight of 1.0 if the household member is older than 17 years and (3) UN approach was used [46] to treat each child between the ages 0 and 14 as equivalent to half an adult and any person over the age of 14 as 1 adult. In another World Bank, Programmatic Poverty Assessment [47] assumed a scale parameter of 0.8 (individuals of age 18 and below) in 70% of the cost of an adult. None of researchers considered gender nor the > 66 age group.

Above defined AE (AE-1, AE-2 and AE-3), evaluations were compared to PC and PAHUM in Table 6. Results illustrated the inconsistencies exist not only among the AE-1 and AE-2, but AE-3 was also among the PC, PAHU and AE units when the grain requirement and CO_2 emissions for 12-member Egyptian Ahmed Household evaluated and compared. Since AE-2 evaluation age groups were divided into more age groups [45] gave slightly higher values then PAHU but still did not consider gender differences and age > 66 that may be one of the reasons gave higher value than PAHU. Certainly, there are consistency problems not only among EU nations and its institutions but also at the international level that do not use the same definitions. These inconsistencies give too much space for arbitrary decisions that will damage the comparability of the family and household statistical data, along consumer population projections.

Finally recent economic EU crisis need to be fixed

Table 6 List of countries by Per Capita carbon dioxide emissions (Ton/PC/Y) [35, 38-41].

Developed countries	1990	2000	2009
Germany	-	10.9	9.1
Netherlands	11.0	11.2	11.0
Spain	5.9	7.1	5.8
Belgium	10.8	11.3	9.9
EU	8.8	8.2	7.4
Euro area	-	-	7.4
World	4.3	4.1	4.8
Developing countries	1990	2000	2009
Turkey	2.7	3.2	4.1
Chad	0.0	0.0	0.04
Egypt	1.3	2.0	2.6
High income countries			12.97
Middle income countries			1.56
Low income countries			0.214
Highest emissions countries (year)	1990	2000	2011
Saudi Arabia	13.2	14.3	19.65
Australia	17.2	17.2	18.02
USA	19.1	20.0	17.56
Russia	13.5	-	12.55

* The data only considers carbon dioxide emissions from the burning of fossils fuels and cement manufacture.

Fig. 3 Egyptian household, Ahmed family.

and need a solution, but economists and as it was indicated above politicians can't decide which way to go. World is rapidly moving toward a period of basic resource scarcity-oil, water, arable land and especially food that will test the states to maintain future good market relations that is compounded by climate shift as it was emphasized. Previously, without common goals and workable multilateral efforts of global institutions, it will not be likely lead to finding a mutual solution of applying error bound PC evaluations that may not make the findings comparable, may not consider population/target groups age and gender structure. The aim is to give the opportunity data to be considered/compared on equalized unit bases that may

Table 7 PC, AE and PAHU evaluation of Egyptian household Ahmed family—(Per Capita = 12)—(with one week food consumption supply), 387.85 Egyptian pound = 68.53 dollars [48]).

Egyptian household								
Ages	Male or female	PC	Per adult equivalent evaluation**			PAHU		
			AE (1)	AE (2)	AE (3)	Male	Female	Avg.
1	M	1	0.3	0.2	0.5	0.262	-	0.262
2	F	1	0.3	0.2	0.5	-	0.317	0.317
6	M	1	0.3	0.2	0.5	0.672	-	0.672
8	M	1	0.3	0.3	0.5	0.672	-	0.672
10	M	1	0.3	0.3	0.5	0.672	-	0.672
18	F	1	1.0	1.0	1.0	-	1.091	1.091
27	F	1	0.5	1.0	1.0	-	0.979	0.979
29	M	1	0.5	1.0	1.0	0.979	-	0.979
35	M	1	0.5	1.0	1.0	0.950	-	0.950
40	F	1	0.5	1.0	1.0	-	0.950	0.950
42	M	1	0.5	1.0	1.0	0.950	-	0.950
60	M	1	0.5	1.0	1.0	0.870	-	0.870
Total		12	5.5	8.3	9.5	6.027	3.337	9.364
% of PC		100.0	45.8	69.2	79.0			78.0
Grain req., T/Y		2.4	1.1	1.7	1.9			1.87
CO_2 emissions T/Y*		31.2	14.3	21.6	24.7			21.3

* Egyptian family Ahmed's PC, AEs and PAHU CO_2 emissions T/Y calculated from the values given in Table 6;
** AE # (1)—[3, 36, 44] (EUROSTAT, 1999; 2005; 2008) and (OECD, 2012); AE # (2)—[45] Baschieri et al.;
AE # 3—[46] Wadan Lal criteria that were used in calculations are described in section 4.5.

eliminate EU Member States "Me first" strategies. PAHU as an alternative method certainly may contribute to the economic and social challenge the people are facing with today. The challenge is achieving a more sustainable society and environmental issues that are evaluated on PC, AE and conjoint assessments.

5. Conclusions

PAHU versus PC method development [50] suggest that there are four building blocks of a theory: constructs, propositions, logic and boundary and conditions/assumptions. Constructs capture the "what" of theories (what concepts are important for explaining a phenomenon), propositions capture the "how" (how are these concepts related to each other), logic represents the "why" (why are these concepts related) and boundary conditions/assumptions examines the "who, when and where" (under what circumstances will these concepts and relationships work). It should also be mentioned here that innovation diffusion as a process of communication where people in a social system learn about a new innovation and its potential benefits through communication channels (such as mass media or prior adopters) and are persuaded to adopt it.

Developed method—PAHU addresses the following problem: How can global and EU social policies be used to enhance social capacities for economic development by evaluating the population not on error bound PC or AE but PAHU/Gender and age corrected PC^{gac} in the process, eroding the intrinsic values of the social ends that policy makers purport to address. The article argues that this requires rethinking social policy away from its conception as a residual category of "safety nets" of development of both developed and developing countries that merely counteract policy failures. Social policy based on population and consumer evaluations should be conceived as involving overall and prior concerns with social development, and as a key instrument that works in tandem with economic policy including food production and consumption to ensure equitable and socially sustainable development. Major economic growth and improved living standards, rapidly increasing demand for food and other goods that increase the CO_2 emissions are the major issues facing the population. This is compatible with the negative side of production, measured in terms of PC and family evaluations on Adult Equivalent units respectively. The idea to develop a single composite indicator-PAHU/Gender and age corrected PC = PC^{gac} has so far not been taken into work list in scientific community. This deficiency may now be covered. As Albert Einstein ones put it "people cannot solve problems by using the same kind of thinking they used to create them". Thus, it is time to develop a new society-wide single composite indicator (PAHU) that describes welfare in more sophisticated way than old and primitive PC-GDP and/or PC organic/conventional food consumption/production or PC-CO_2-emission measure. This composite may also guide scientists in next decades towards sustainable world where economy does not exceed the global limits and endanger global ecosystems as today. PAHU = (PC^{gac}) evokes innovation playgrounds not only for researchers but also decision makers of EU. It can well be applied to every EU member country's/target groups' food consumption evaluations and environmental issues and problems. In addition, it may have the potential to have an impact on economic evaluations when Genuine Progress Indicator (GPI) and Sustainable Society Indicator (SSI) are used as basis for the societies-replacement of PC-GDP that is needed for the development in economic re-evaluations. The innovative action of PC^{gac} may require shifts in government planning by adding its ecological impacts into the equation.

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