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LIFE CYCLE ASSESSMENT: A TOOL FOR INNOVATION IN LATIN AMERICA

YUPI®, a regional footprint calculator

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Abstract
Purpose Many tools to quantify the environmental impact of human decisions have been developed, but all of them seem to have a limited application at the regional or local level. A free-of-charge, Argentina-based personal footprint calculator software (YUPI®) has been developed in order to raise awareness among local citizens about the environmental impacts generated by their daily habits. The extensive use of the tool will generate information suitable for future scientific studies based on local data.
Methods The software calculates the ecological, carbon, and water footprints of individuals, implementing specific regional data from Argentina developed by the CLIOPE group, complemented with data from the Water Footprint Network and the Global Footprint Network. The calculator was developed focusing on interface attractiveness, ease of use, language simplicity, and a good trade-off between completion time and fullness.
Results and discussion The YUPI® software allows its users to understand at a glance their contribution to the environmental impacts of modern society and to quantify the reduction opportunities they have at hand. The program's language and variables reflect local lifestyle choices, making the filling process accessible for children. The calculator was placed online as an educational tool for teachers and students from all educational levels, and it was also used by visitors in local science and educational fairs. Valuable data was collected for future initiatives on impact mitigation.
Conclusions Amplified by the mass media, the new tool has helped raise awareness and discussion about the individual environmental footprint, both in the educational and in the domestic terrain. The strategy of creating a simple, easily administered, and widely available quiz helped bridge the gap between the academy and the people, making available to them the continuously updated information generated by the research groups. This is facilitating citizen not only to understand the complexity of the environmental problems but also to take informed actions leading to their mitigation.

Keywords Argentina · Carbon footprint · Community outreach · Ecological footprint · Online calculator · Water footprint

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1 Introduction

The idea that humanity is going beyond the ecosystem's capacity has been spreading during the last decades, reaching all educative levels. This is certainly a necessary but not sufficient condition for moving into a more sustainable way of living. According to our experience as educators at undergraduate and graduate levels in many Argentinean and Latin-American institutions, there is a widespread idea that the main contributors to these problems are "others" (e.g., oil

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companies, the mining industry, some citizen from affluent countries), eliminating responsibility from them as individuals.

One of the main objectives of this initiative is to raise the awareness of the local community on their individual power over the global environmental impacts that so deeply concern them. This is achieved by increasing their capacity to comprehend and critically assess the impact of their own consumption patterns, which in turn facilitate the prioritization of measures toward mitigation action, by pinpointing their main impact contributions. Understanding the direct consequences of human being lifestyle and consumption choices requires the use of indicators that quantify their magnitude.

Nowadays, the environmental footprints have spread as indicators of the anthropogenic impact in an unprecedented level. Ecological footprint (EF), carbon footprint (CF), and water footprint (WF) have been developed for assessing the environmental impact associated with different systems, ranging from countries, regions, companies, products, services, and individuals. These indicators are being used today by individuals around the world for assessing the impact associated with their consumption habits. They present a quantifiable basis regarding the efficiency of production processes, the limits of resource consumption, the distribution of the world's natural resources, and how to address the sustainability of the use of ecological assets across the globe (Galli et al. 2012).

Among these three indicators, the ecological footprint was the first one to be defined and published (Rees 1992). However, the concept of carbon footprint, introduced with its current meaning about 20 years later, was the one becoming popular and adopted by the mass media in every country, paving the way for new environmental footprints, such as the water footprint, and also to bring back the ecological footprint concept into popularity.

Several international organizations have developed personalized EF, CF, and WF calculators. Franz and Papyrakis (2011) provide a list of some of the most popular online EF calculators. These have been developed by Global Footprint Network, World Wide Fund for Nature, Best Foot Forward, Ökologischer Fußabdruck, BioRegional, and Redefining Progress. According to Franz and Papyrakis (2011), other EF calculators are significantly less comprehensive and provide even less guidance about altering habits in order to reduce individual pressure on global resources. CF calculators developed for consumers and households are common on the Internet. Čuček et al. (2012) highlight the simplicity and speed of implementation of calculators developed by Carbon Footprint Ltd., University of California (Berkeley), The Nature Conservancy and US EPA. Calculators developed by US EPA account emissions related to trips, home energy consumption, and waste production. The Nature Conservancy calculator quantifies trips, home energy, food, recycling, and waste. University of California adds emissions related to production of goods and services but does not consider recycling and waste production. The calculator developed by Carbon Footprint Ltd. is the most comprehensive because it includes home energy, trips, food preferences, good and services, wastes, and recycling. Of these four calculators, only Carbon Footprint Ltd. calculates the CF for different countries, while the rest are specific to the USA.

The number of WF calculators is limited but it is growing. Examples are the calculators developed by the Water Footprint Network, National Geographic, Kemira, and Alliance for Water Efficiency, among others. The extended version of the Water Footprint Network calculator considers a larger amount of food groups compared to the other calculators. The National Geographic calculator quantifies aspects that are absent in the others, such as transportation and home energy consumption. The Alliance for Water calculator is specific for USA and Canada, while the others have global geographic reach. All international footprint calculators evaluated proved to be inadequate for a local application, mainly due to consumer behavior discrepancies and to user experience issues (complexity of requested data, time required to complete the quiz, others) (Table 1). Specific calculators for individuals and households that integrate more than one footprint were not found in the literature.

Nationally, some organizations offer on its website links to international footprints calculators (e.g., Plantarse contra el cambio climático foundation uses the CF calculator developed by Carbon Footprint Ltd.). Few organizations and government entities have developed footprint calculators (Table 1). Reciduca foundation offers an EF calculator addressing transportation, food, energy, water, and waste, although the options are very general and do not reflect local consumer behavior. The government of the city of Buenos Aires has an EF calculator that only considers the emissions released by different transportation options.

Complexity and amount of required data, lack of identification with the lifestyle depicted by the quiz, and interface unfriendliness tend to discourage the use of footprint calculators within the non-expert community. This is preventing an extensive adoption of lifecycle thinking among the population. With the aim of filling this gap, a personal footprint calculator was designed, enabling any Argentine consumer to take a first step toward a sustainable community. In a globally connected society, this web-based tool is able to give an estimate of ecological, carbon, and water personal footprints altogether, and to compare them with the mean inhabitant, or to relate them with easily understandable references. The quiz, called YUPI® ("footprint" on Millcayac, an Argentine native language), is designed for capacity development among citizens from any educational background, toward the achievement of one of the UNNEP/SETAC Life Cycle Initiatives: to *put lifecycle thinking into practice*. In 2010, the Argentine

Table 1 Main characteristics of the EF, CF, and WF online calculators tested

Footprint	Developer	Geographic application	Issues considered	Request data	Time required	Website
EF	Global Footprint Network	Global	Trips, food, home, home energy	Complex (e.g., type and size of home)	Less than 5 min	http://www.footprintnetwork.org/es/index.php/gfn/page/personal_footprint/
	World Wide Fund for Nature	UK	Trips, food, home energy, goods and services, waste, and recycling	Complex (e.g., pets expenses)	5–10 min	http://footprint.wwf.org.uk/
	Best Foot Forward	Global	Trips, food, home energy, waste, and recycling	Simple	Less than 5 min	http://www.environmenttools.co.uk/directory/tool/name/best-foot-forward-ecological-footprint-calculator/id/399
	Ökologischer Fußabdruck	Global	Home energy, water	Complex (e.g., energy source)	Less than 5 min	http://www.mein-fussabdruck.at/%23start
	BioRegional and Redefining Progress	Global	Trips, food, home energy, water, goods and services, waste, and recycling	Complex (e.g., amount of energy consumed at home	5–10 min	http://myfootprint.org/subscription.php
	Islandwood	Global	Trips, food, home energy, water, goods and services, waste, and recycling	Simple	5–10 min	https://islandwood.org/footprint-calculator/
	Reciduca	Argentina	Trips, food, home energy, water, and waste	Simple	Less than 5 min	http://www.fundacionreciduca.org.ar/la-huella-ecologica/mide-tu-huella/
	Government of the city of Buenos Aires, Argentina	Argentina	Trips	Simple	Less than 5 min	http://www.buenosaires.gob.ar/ecobici/huellaecologica
CF	Carbon Footprint Ltd.	Global	Trips, food, home energy, good and services, waste, and recycling	Complex (e.g., kWh of energy consumed at home)	5–10 min	http://calculator.carbonfootprint.com/calculator.aspx?lang=es
	University of California (Berkeley)	USA	Trips, food, home energy, goods, and services	Complex (e.g., distance traveled)	Less than 5 min	http://coolclimate.berkeley.edu/calculator
	Nature Conservancy	USA	Trips, food, home energy, recycling, and waste	Complex (e.g., distance traveled)	5–10 min	http://www.nature.org/greenliving/carboncalculator/
	US EPA	USA	Trips, home energy, and waste	Complex (e.g., electricity expenses)	5–10 min	http://www3.epa.gov/carbon-footprint-calculator/
	Standford University	Global	Trips, home energy, food, goods, and services	Complex (e.g., kilometers flown)	5–10 min	http://web.stanford.edu/group/inquiry2insight/cgi-bin/fp-alpha2f/fp.php
WF	Water Footprint Network	Global	Food	Simple	Less than 5 min	http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/
	Water Footprint Network (extended version)	Global	Food, water use (indoors and outdoors)	Simple	Less than 5 min	http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/personal-calculator-extended/
	National Gegraphic	Global	Tips, food, home energy, good and services	Complex (e.g., zip code)	More than 10 min	http://environment.nationalgeographic.com/environment/freshwater/change-the-course/water-footprint-calculator/
	Kemira	Global	Food, water use (indoors and outdoors)	Simple	More than 10 min	http://www.waterfootprintkemira.com/meter
	Alliance for Water Efficiency	USA and Canada	Water use (indoors and outdoors)	Complex (e.g., garden surface)	5–10 min	http://www.home-water-works.org/calculator
	Cuauhtémoc Moctezuma	Global	Water use (indoors)	Simple	Less than 5 min	http://www.consumodeagua.com/

government created optimal opportunities for web-based learning through the "Conectar igualdad" (Connecting equity) Program (Decree N° 459/10 of the Presidency of the Argentine Nation). By this program, students and teachers from every public high school were provided with a free computer and Internet connection for educational purposes. Given these conditions, online-based, free-of-charge software seemed to be the best way to target the objective of generating awareness inclusively, taking advantage of the existing infrastructure for information dissemination.

2 Methods

The outline of the general calculation method used by YUPI® reflects the aim of capturing the lifecycle of the most relevant aspects of personal consumption of Argentines.

YUPI® focuses on consumption of three major categories: housing, travel, and food. The model uses the data provided by the user when filling the questionnaire, including information that reflects local habits in terms of energy sources, transportation, travel preferences, diet, artifacts, and appliances commonly used in the country. The data output is expressed in three different environmental indicators: ecological footprint, carbon footprint, and water footprint. The data provided by the user is transformed into each environmental footprint using a convenient conversion factor, as described in Sect. 2.2. Results are shown on screen upon completion of the form, allowing the users to gain an insight on their contribution to the main global environmental concerns. Input data and results are stored on a database.

2.1 System boundaries

The system's boundaries include the energy use for preservation and cooking of the food; appliances, heating, ventilation, air conditioning, and lighting of the house. They also include water consumption in daily activities (such as cleaning, washing clothes, garden irrigation) and the production of food. Finally, fuel consumption is calculated both for daily transportation and for vacation trips using the main transportation means available in the country (Fig. 1).

2.1.1 Exclusions

The transport of food from the market to the consumer's residence is not considered due to the uncertainty associated with the consumer's behavior, the travelled distances, the amount of goods sharing the trip, etc.

The manufacturing of durable goods (electrical appliances, gas-fueled artifacts, lighting devices, others) have not been included, since they have a limited impact on the results. The consumptions and emissions involved in housing construction, as well as in the production of the materials and components included in the building, are also excluded from the system's boundaries.

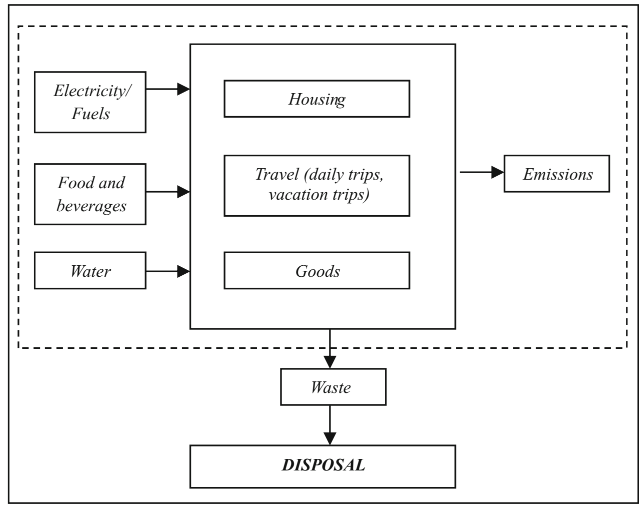

Fig. 1 Simplified system flow chart. The *dotted line* represents the boundaries of the system

The societal components, such as government assistance, public services, roads and infrastructure, etc., are not included in the calculation because the consumer does not have full control of these aspects.

The functional unit is defined as "*the environmental footprint, expressed in carbon, water and ecological terms, of a person in one year.*"

2.2 Definitions, assumptions, and calculation procedures

2.2.1 Definitions

Ecological footprint

The ecological footprint is a measure of the amount of biologically productive land and water that an individual, population, or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices (Wackernagel and Rees 1998).

The ecological footprint calculation is based on the methodology proposed by the Global Footprint Network (Wackernagel and Rees 1998). Calculating the EF of an individual allows its comparison with nature's capacity to support his/her lifestyle and to explore different practices with the aim of reducing the EF found. One of its main features is that it intrinsically provides the idea of limit, something missing in other indicators.

Carbon footprint

A carbon footprint is "the total set of greenhouse gases (GHG) emissions caused directly and indirectly by an individual, organization, event or product" (Wiedmann and Minx 2008).

The carbon footprint is measured in kilograms of carbon dioxide equivalent (kg CO_2e), which is calculated by multiplying the emitted amount of each greenhouse gas by its 100-year global warming potential (GWP 100). Even being a single issue indicator, the CF has become very popular because it measures the currently most widely known impact category, and also due to the ease of interpretation.

Water footprint

The water footprint is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer. Water use is measured in terms of water volumes consumed (evaporated or incorporated into a product) and/or needed to dilute pollutants per unit of time (Hoekstra et al. 2011).

The water footprint calculated is performed following Hoekstra et al.'s (2011) methodology from the Water Footprint Network. This methodology accounts for the volume of freshwater consumed and contaminated during housework (direct water footprint) and during the production of goods and services consumed (indirect water footprint).

2.2.2 General assumptions

When available, primary and secondary data are taken from national sources. In order to complement the missing data, additional information was taken from widely recognized international sources. The calculations for primary emissions are based on conversion factors sourced from the following:

- Global Footprint Network
- Water Footprint Network
- Carbon Trust
- Intergovernmental Panel on Climate Change
- CLIOPE Group
- LCA literature

2.2.3 Calculation procedure

Consumptions calculation Household consumption

YUPI® users should provide information about their usual domestic activities as well as the amount of electrical appliances, gas-fueled artifacts, and lighting devices used at home.

Most of houses in the country are powered both with electricity and some fuel for heating, domestic hot water production, and cooking purposes, such as natural gas or liquid petroleum gas or wood. In order to calculate the impact associated with energy consumption in houses, the amount of energy consumed is required. This information can be easily gathered from the energy bills, but people hardly ever keep these amounts in their heads. Therefore, the energy consumption is calculated considering the average power of the most common appliances and the average operation time supplied by the Argentine National Energy Secretariat, the National Institute of Industrial Technology (INTI), and the National Regulatory Body for gas (ENARGAS). Equation 1 illustrates the calculation procedure.

$$E_{ea} = \sum\nolimits_{ea} \left(C_{[ea]} * P_{[ea]} * to_{[ea]} \right) \quad (1)$$

Where:

E_{ea}: is the amount of electricity consumed by the electrical appliances *ea*;

$C_{[ea]}$: is the number of electrical appliances *ea*;

$P_{[ea]}$: is the average power of electrical appliances *ea*;

$to_{[ea]}$: is the average operation time of electrical appliances *ea*.

The same procedure is applied for the calculation of the amount of any type of fuel consumed in the house (Eq. (2)).

$$E_{fa} = \sum\nolimits_{fa} \left(C_{[fa]} * P_{[fa]} * to_{[fa]} \right) \quad (2)$$

Where:

E_{fa}: is the amount of fuel consumed by appliances *a* in the house;

$C_{[fa]}$: is the number of appliances *a* that consume fuel *f*;

$P_{[fa]}$: is the average power of appliances *a* consuming fuel *f*;

$to_{[fa]}$: is the average operation time of the appliances *a* consuming fuel *f*.

Consumption of food and beverages

The type of food eaten at every meal is supplied by YUPI®'s users through the software's interface, considering breakfast, lunch, afternoon tea, and supper.

The calculation procedure assumes that the user consumes one daily portion of food or beverages selected. The amounts of food per portion recommended by the World Health Organization and the Food and Agriculture Organization are taken into account.

The impacts associated with home storage and preparation of food has already been considered in household consumption. To avoid double counting, these impacts are not included in this section.

Energy consumption during travelling

In the calculation of energy consumed for travelling, a distinction is made between daily trips (from home to school and/or to workplace) and summer and winter vacations.

Daily trips

The amount of fuel consumed during daily trips is calculated using the travelled distance and the specific fuel consumption according to the type of vehicle (car, taxi, urban bus, school bus) published by Frischknecht et al. 2005.

Since most of the people are unaware of the amount of kilometers they travel every day, a proxy for the traveled distance is calculated, based on the required time to reach their destination, and the maximum legal urban speed rate admitted by the Argentine Ministry of Transport (40 km/h) (Eq. (3)).

$$E_{fdt} = tt * Fs * Frt * Fc_{[v]} \tag{3}$$

Where:

E_{fdt}: is the amount of fuel consumed during daily trip *dt*;

tt: is the traveling time to school or the workplace;

Fs: is the maximum legal urban speed permitted in Argentina;

Frt: is the return-trip factor;

$Fc_{[v]}$: is the fuel consumption for the type of vehicle *v*.

In all cases, it is considered that the passenger uses the same type of transport and takes the same route for both the outward and return trip. The amount of fuel consumed during each trip is equally allocated among all passengers sharing that trip. This is performed considering the following share rates for vehicle type: 1 passenger for car and taxi; 4 passengers for carpool; 3 for shared taxi; 10 for school bus, and 33 for urban bus.

Vacation trips

In order to calculate the distance traveled during the vacations, the average distances within each province and within the country, and distances to foreign cities most visited by Argentines according to the World Tourism Organization (WTO 2013) are considered. Then, the distance traveled is affected by the average fuel consumption taken from the Ecoinvent database (Frischknecht et al. 2005), according to the type of vehicle (private car, long-distance bus, airplane) (Eq. (4)).

$$E_{fvt} = d * Frt * Fc_{[v]} \tag{4}$$

Where:

E_{fvt}: is the amount of fuel consumed during vacation trip *vt*;

d: is the distance from departure to destination point.

The allocation is performed considering 175 passengers for airplane and 45 passengers for long-distance bus.

In the case of travelling by car, it is assumed that all the inhabitants of the house share the car (with a maximum of five passengers).

Air traveling deserves special attention, since it can dramatically worsen the environmental footprint of an individual, due to the huge amount of fuel burned. Keeping a frugal lifestyle during the year can be completely offset by a few flights during the holiday season.

The fuel consumption caused by air travelling is quite complex to estimate, since it depends on the size of the aircraft, its engine's efficiency, the flight distance, the seat occupancy rate, the seat class, and the passenger to cargo factor (ICAO 2015). This complexity falls beyond the scope of YUPI®, due to the amount of data and time required from the user for modeling all the involved factors. All calculations have been performed considering a Boeing 700-737 aircraft of Aerolineas Argentinas fleet.

Footprint calculation Once all the consumptions have been calculated, according to the procedure reported in Consumptions calculation section, and the associated conversion factors for each footprint category obtained from the available sources, as explained in General assumptions section, the calculation procedure is quite straightforward. The amount of energy and water consumed in household activities are equally allocated among the people sharing the house. Each consumption type (e.g., electricity, fuel, food) must be multiplied by the corresponding conversion factor associated with each footprint category, and then the results are summed up.

For instance, the impacts associated with food consumption, calculated as ecological, carbon, and water footprints, are computed using Eqs. (5), (6), and (7):

$$S_f = \sum_f \left(C_{[f]} * Cf_{[e,f]} \right) \tag{5}$$

$$CO2_f = \sum_f \left(C_{[f]} * Cf_{[c,f]} \right) \tag{6}$$

$$WF_{cons,indir,f} = \sum_f \left(C_{[f]} * Cf_{[w,f]} \right) \tag{7}$$

Where:

S_f: represents the necessary surface to assimilate the pollutants and produce each food type *f*;

$C_{[f]}$: is the consumed quantity of each food type *f*;

$Cf_{[e,f]}$: is the conversion factor of ecological footprint of each food type *f* (in ha/kg year);

$CO2_f$: represents the emissions CO2e of production of each food type *f*;

$Cf_{[c,f]}$: is the conversion factor of Carbon footprint of each food type *f* (in kg CO_2e/kg);

$WF_{cons,indir,f}$: refers to the water use related to the production of food *f* purchased by the consumer;

$Cf_{[w,f]}$: is the conversion factor of the water footprint for production of type of food *f*.

In some cases, the calculated footprint must be allocated among the amount of individual contribution (e.g., the people sharing the house or all the passengers who share a car, a bus, and so on). For instance, to calculate the ecological footprint associated with the house functioning, the amounts of energy and water consumed are considered, as well as the amount of people sharing the house and the corresponding conversion factor (Eqs. (8) and (9)).

$$S_{ea} = \frac{E_{ea} {*} Cf_{[e,ea]}}{P_h} \quad (8)$$

$$S_{fa} = \frac{E_{fa} {*} Cf_{[e,fa]}}{P_h} \quad (9)$$

Where:

S_{ea}: represents the surface required to produce the electricity and to assimilate the emissions released during its production (in ha/person year);

$Cf_{[e,ea]}$: is the conversion factor of ecological footprint for the electrical consumption *ea* (in ha/kWh year);

S_{fa}: is the surface required to produce the fuels and to assimilate the emissions released during their combustion (in ha/person year);

$Cf_{[e,fa]}$: is the conversion factor of ecological footprint for the consumed fuel (in ha/kWh year);

P_h: represents the number of people sharing the same house *h*.

In the Electronic Supplementary Material, a summary of the parameters and their sources used in footprints calculation is presented (Table S1).

2.3 Software design and main features

The software was conceived integrating the calculation of the three selected footprints using specially designed forms and background calculus that allow gathering information for more than one environmental footprint in each single question (see Fig. 2). Once the calculation procedures were created, the interface outline was defined and finally the graphic design project was set up. The visual code chosen pursues the aim of simplicity, intuitiveness, and attractiveness in its aesthetics, suitable for a wide range of ages, from children up to elderly persons.

The obtained results are expressed, besides the usual units of each one of the three selected footprints, in terms of familiar reference amounts. For instance, the result of the water footprint is compared with the volume of an Olympic swimming pool (Fig. 3).

YUPI® provides also with useful hints for offsetting or at least mitigating the calculated impacts; indications that can have a real influence on the environmental footprints.

The software was also designed to be used in scientific, educational, and technological fairs and tradeshows, where the use of a keyboard for entering data could be cumbersome. To overcome this issue, the design specification included the feature of enabling data input using only a mouse or a tactile screen. The quiz was planned for an expected completion time close to 5 min, finding a balanced compromise between thoroughness of information and people's willingness to spend their time in filling a questionnaire. The questions were carefully elaborated in order to obtain accurate answers that would not need further enquiry from the user (such as asking for past electricity bills) or complex computations (such as daily grams of food ingested or monthly miles traveled). This last feature was also planned to allow people of a wide age range and educational level to use the same form.

2.4 Implementation

Once the beta version of the software was ready, a pilot test was carried out among friends and colleagues from different backgrounds and ages, whose suggestions were thoroughly noted and discussed. After evaluating the experience and implementing some changes, a formal test was carried out in

Fig. 2 Screen showing the program's interface in relation to data collection

Fig. 3 Screen of the program's interface showing the results in relation to familiar quantities

a local public school that met the requirements of an adequate focus group. The institution chosen was the school number 4-143 located in Las Heras, Argentina, where students come from a variety of socioeconomic backgrounds. The calculator was tested for user experience while specific lessons on personal environmental impacts were organized. Then, students participated in debates and activities related to mitigation strategies. Subsequently, YUPI® was made available online on the CLIOPE official website (http://cliope.frm.utn.edu.ar/huella/). In November 8, 2013, during the "Mendoza Solar" event, one of the activities of the Argentinean network of solar cities (www.ciudadessolares.org.ar), the calculator was first introduced to the general public. The individual footprint subject became a popular subject among the local media that performed specific interviews in the air TV channels "Acequia," "Señal U," and "Canal 9 Mendoza"; the radio stations "UTN" and "Nihuil"; and the newspapers "Los Andes" (Los Andes 2014), "El Sol" (El Sol 2014), and "Vox Populi" (Vox Populi 2014), as well as being featured in various online websites (Universidad Nacional de Cuyo 2014; Universidad Tecnológica Nacional 2014). All these experiences have helped spread the perception of the extent of the environmental impacts related to consumer behavior, driving debates outside the academic community, and setting up the bases for more sustainable lifestyle choices.

3 Results and discussion

YUPI ® allows the calculation of individual ecological, carbon, and water footprints by completing a single quiz in a few minutes. The use of YUPI® has grown much faster than expected since it was placed online in October 2013, with a monthly average of 240 visits (see Fig. 4), reflecting the strong interest on the subject. The highest peaks of visits have been registered in correspondence with the mass media interventions and when the quiz was used for educational purposes in undergraduate or graduate courses.

YUPI® collects information about individual consumption habits classified by gender and age ranges and produces reports expressed in footprint units. Until August 31, 2015, 5230 people have completed YUPI®, providing 4782 good answers, representing more than 90 % of usable data, from which 45.7 % belonged to men and 54.3 % to women. Most of the answers are provided by people in the 22–45 age range (36.6 %), followed by the 13–17 age range (25 %). Only 2.7 % of answers are provided by children under 5 years old and adults over 65 years old. The remaining 35.7 % of responses were evenly distributed among the other age ranges (6–12, 18–21 and 46–65 years old).

In average, the registered footprints are lower for female than for male respondents: 11.8 % (±6.3 %) lower for the ecological footprint, 14.2 % (±7.1 %) for the carbon footprint, and 18.5 % (±2.1 %) for the water footprint. Similar differences in the consumption pattern of women and men can be found in the results published for other regions. Raj et al. (2012) show that the EF of women attending Panjab University (Chandigarh, India) is about 8 % lower than the corresponding value for their male colleagues, mainly due to the differences in consumption of food, personal goods, and use of services. In Sweden, Kanyama and Lindén found that women consume less energy than men, and they justified the differences in the transportation habits, since most women travel shorter distances, often with public transport, and using planes less frequently than men (Kanyama and Lindén 1999). However, in another research conducted using an online ecological footprint quiz, it was found that male and female have similar demands of natural resources (Solar 2011).

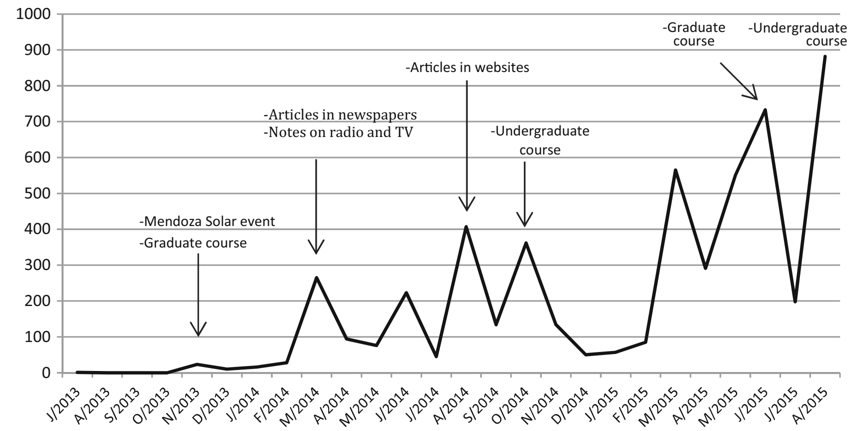

Fig. 4 YUPI software: number of online visits between July 2013 and August 2015

Regarding ages, the highest footprint values belong to users under 5 years and over 66 years old, while the lowest values are found in the 18–21 years group. There are no significant differences for the remaining age groups.

The mean ecological footprint of undergraduate students resulted to be 14.2 % (±17.7 %) lower than the average of the YUPI® users. A similar tendency of undergraduate students has been found at universities in Spain (Lopez Alvarez 2009). Studies at universities in Cuba (Leiva Mas et al. 2012) and India (Raj et al. 2012) show opposite results instead. Raj et al. (2012) explain a greater impact of undergraduate students due to their preference for processed foods, the use of more advanced transportation means and outings with friends, a behavior which is favored by students staying away from home during the school period. However, most Argentine undergraduate students live with their families until graduation, which could explain the difference in tendencies. On the contrary, the values obtained by postgraduate students are 72 % (±28 %) higher than the average, probably related with a higher economic condition of the members of this group.

These are some preliminary results of YUPI® data collection. The figures reported in this article are very promising, though they do not represent the result of a research. They are only reported with the intention of showing the potential of YUPI® as a tool for providing supporting information for research purposes. YUPI® will continue collecting local information, which will allow going deeper on this and other issues in the near future.

In order to have a picture of the users' experience using YUPI® compared to other, similar tools, anonymous inquiries across undergraduate and graduate courses have been performed. The responses were overall positive. The simplicity of language, the interface attractiveness, and the availability of input choices related to typical Argentinean cultural habits are among the most valued aspects according to the users' responses.

Results from this calculator are based on emission data corresponding to the years 2006–2015. The authors are in a continuous updating process of the emission factors used in the calculator. Currently, an improved version of YUPI® is under development, which will include the separation and treatment of waste. In addition, new emission factors for locally consumed products will be included, increasing the use of local instead of global factors in the footprint calculations. In order to accomplish these improvements, new lifecycle inventories related to local food, beverage, and appliances should be developed; for instance, the inventory of a local croissant named "factura" which is highly consumed as a breakfast pastry. Another improvement will be the possibility of comparing the user's results with the footprints of the average world inhabitant and to graphically compare the user's footprints before and after implementing mitigation actions. The mitigation initiative screen will also be improved, including personalized suggestions based on the user's results, rather than general ones as in the current version.

4 Conclusions

YUPI® produces quick answers about the user's own contribution to the environmental crisis that we are facing as a whole, useful for pinpointing the biggest opportunities for improving their footprints. The software is also proving to be a cost-efficient way to collect statistical information about a user's habits, to be processed for further awareness campaigns and scientific studies.

Interviewing respondents shows that usually, common people feel that the environmental crisis is produced by citizens from other countries and/or by big companies, and they are shocked when they understand that they are important contributors to that big picture. The tool is helping users not only to understand the complexity and magnitude of the environmental problems but also to take informed actions leading to their mitigation.

The strategy of creating a simple and widely available quiz was a very enlightening example of effective transference from scholarly research to community outreach, which is helping bridge the gap between them. It is a continuous process, a collaborative form of knowledge building which retrofits the scientific sector from the ever-changing society needs which are demanding for a faster flow of data from academy to their final users.

As a continuation of the YUPI® experience, some future steps have been outlined. One of them is related to education and community engagement, which is the logical step after awareness raising and topic dissemination. YUPI® can support teachers in environmental capacity building activities included in all educational levels and in a variety of subjects. It has been successfully used in energy-related courses (e.g., in bioclimatic architecture lessons), providing a quick feedback about the environmental effect of technology improvements, design strategies, or energy source substitution.

YUPI® is positively contributing to the objectives of the UNEP/SETAC Life Cycle Initiative, promoting sustainable actions and social patterns, creating a bottom-up action of sustainable development promotion.

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