



Effects of Thermal Radiation Using Wood Stoves on Population Health: Casas Viejas Community, Jipijapa Canton



Rafael Santiago Rodríguez Vallejo ^a
María Rodríguez Gámez ^b
Andrés Manuel Salas Espinales ^c
Antonio Vázquez Pérez ^d

Article history:

Received: 9 March 2019
Accepted: 31 May 2019
Published: 15 June 2019

Keywords:

abdominal;
biomass;
health;
Manabí;
thermal radiation;

Abstract

The use of biomass for cooking food in the rural sector of the province of Manabí is very common. The present work analyzes the situation of families that use wood stoves for the cooking of food in the community of Casas Viejas, canton Jipijapa, province of Manabí. Thermography techniques have used to measure the level of emissivity to which users of traditional kitchens are exposed. It was determined that the exposure is direct and reaches temperatures up to 250 ° C, being able to raise its body temperature in the abdominal area up to 80 ° C. This periodic and prolonged exposure to thermal radiation can seriously affect the health of users.

2395-7492© Copyright 2019. The Author.
This is an open-access article under the CC BY-SA license
(<https://creativecommons.org/licenses/by-sa/4.0/>)
All rights reserved.

Author correspondence:

Rafael Santiago Rodríguez Vallejo,
Linkage Project, Electrical engineering, Faculty of Mathematical, Physical and Chemical Sciences, Universidad Técnica de Manabí, Portoviejo, Ecuador.
Email address: taliangel270557@gmail.com

1. Introduction

Due to the adverse economic situation or the geographical location of some places, in rural areas of difficult access, more than 2000 million people directly depend on biomass as the main or only source of Energy. It provides about 30% of primary energy in developing countries (Cortés Fuentes & Ridley, 2013).

- ^a Linkage Project, Electrical engineering, Faculty of Mathematical, Physical and Chemical Sciences, Universidad Técnica de Manabí, Portoviejo, Ecuador
^b Electrical Engineering Course, Faculty of Mathematical, Physical and Chemical Sciences, Universidad Técnica de Manabí, Portoviejo, Ecuador
^c Electrical Engineering Course, Faculty of Mathematical, Physical and Chemical Sciences, Universidad Técnica de Manabí, Portoviejo, Ecuador
^d Industrial Engineering career, Faculty of Mathematical, Physical and Chemical Sciences, Universidad Técnica de Manabí, Portoviejo, Ecuador

The biomass includes firewood, crop residues, and animal waste, among others. Of these, firewood is a good alternative for cooking food; it is fuel from wood, abundant in most rural areas. This type of biomass is a cheaper option than the use of LPG or electricity. The consumption of firewood for the preparation of food in the rural sector is constant. It is estimated that half of the world's population, mostly located in developing countries, uses this type of biomass to cook their food (Torres Muro *et al.*, 2012; Tomaselli *et al.*, 2008; Ramírez Quirama & Taborda Vergara, 2014).

The most common way to use firewood for cooking is by wood stoves, wood ovens, and stoves.

Traditional or conventional wood stoves differ in design and construction materials. There are simple models, consisting of 3 stones, up to those where there is an effective channeling of the gases generated in the combustion (Ramírez Quirama & Taborda Vergara, 2014). In spite of the economic benefits, in most of the planet the problem of the open fires inside the house supposes a very serious risk for the health of the people, either by the waste of combustion (gases and ash) or by the radiation thermal (Delgado García *et al.*, 2016; Escobar *et al.*, 2018).

One of the many pathologies is the so-called "chronic obstructive pulmonary disease" (POC). This has characterized by the progressive obstruction of the airflow and destruction of the lung parenchyma, which hinders the exchange of oxygen and functional capacity. It is one of the most important causes of morbidity and mortality worldwide, with a global prevalence of 10% in adults. In 2005, COPD was responsible for more than 3 million deaths, which accounted for 5% of global mortality. 90% of these deaths occurred in developing countries.

COPD is also responsible for the loss of 33 million years of life adjusted for disability in developing countries and by 2020 it is projected to be the fourth cause of disability-adjusted years of life lost in those countries (López, Mongilardi & Checkley, 2014). It should have mentioned that, in most cases, the consumption of firewood as fuel is not sustainable. Deforestation is the main consequence of the indiscriminate consumption of this resource. That is why several countries are trying to reduce the consumption of firewood as an energy source. In Mexico, 20 years ago, an effort was made with which 40% of the households that used firewood in 1990 were reduced to 13% in 2000 and 7% in 2010 (Lagunes Díaz *et al.*, 2015).

Research has conducted to determine the amount of firewood used in Ecuador in 2006, to estimate the demand for this biomass a factor of 6.4m³ /family/year was used and estimating the number of 353.978 families that use it. a national consumption of 2,265,461 m³ / year. It is estimated that 75% of firewood is used in the rural area, 10% in the urban area, 3% for the artisanal demand, 7% for the industry; 5% is used to make charcoal (Jorge Grijalva, 2012).

In the Community of Casas Viejas, of approximately 60 families, all use firewood as the main source of energy to cook their food, that is, 100% of people in that place use this alternative, although they have other options such as gas cookers and electricity (Noa *et al.*, 2018; Sutapa *et al.*, 2018).

The inhabitants of the pre-Columbian cultures, settled along Manabí, using these devices (wood ovens) for the cooking of their food. At present, the custom that has even reached the urban areas has maintained. (Ramos, 2018). It is common to find in houses in the cities houses that have some kind of oven, or wood stove, various reasons, the most common is the taste, and continue with the tradition of generations.

Vegetables, grains, legumes and seafood, key ingredients of the Manabi gastronomy, have their main ally in the clay oven. As pots between 50 and 80 centimeters lined with wood and earth, these stoves were used by the pre-Columbian inhabitants of the Valdivia, Chorrera, Manteña, and Machalilla cultures. What makes them different is that cooking with wood keeps the flavors. (Ramos, 2018; Zambrano *et al.*, 2018; Rodriguez *et al.*, 2018).

2. Materials and Methods

To carry out the study, a Fluke thermographic camera, model TiS65, was used, and based on different parameters, such as emissivity, which is the body's ability to emit infrared rays, which has detected by our equipment, calibrated adequately to obtain an appropriate result in the study. Field research was carried out, where the level of thermal radiation to which people are exposed was evidenced, especially the women of the community of Casas Viejas in the province of Manabí. Surveys, methods of observation, interviews with the inhabitants of the community have applied.

3. Results and Discussions

Despite having alternatives such as LPG cookers and electricity, in the Casas Viejas community, the 60 settled families use firewood as the main source of energy to cook their food. These have found inside and outside of homes. The standard model of these kitchens consists of two main parts: the lower cavity, where the biomass has placed and the upper part, where the pots have placed figure 1 shows a standard working wood stove.



Figure 1. Manabita wood cooking

When the food was cooked with firewood, the essence of its flavor has captured. In addition to the tortillas, rice, chicken, casseroles, sausages, among other dishes, which are part of the ancestral Manabí gastronomy, they have cooked in the clay ovens. Tourists like those dishes a lot. In urban restaurants, they use clay pots.

According to historical data and research carried out in the province, Regalado affirms that the ancestors of Manabí that in many cases flow into the Manteña culture use the kilns from the formative periods. These artifacts are ecological. They are made of mud, earth, wooden structures, and bamboo cane. In figures. In Manabí, the use of wood in the kitchen is a custom practiced by 48,528 people, according to the National Institute of Statistics and Censuses (INEC). In these figures, which correspond to the last population and housing census, there is no classification by ethnic groups. (<http://www.eldiario.ec>, 2018)

The objective of the research is to determine the rates of thermal radiation to which people who cook with firewood have subjected in the Casas Viejas community, located in the province of Manabí, Cantón Jipijapa.

In the community-studied firewood, kitchens called Manabitas kitchens declared heritage of Ecuador. (<http://revistaplanisferio.com>, 2018). These have found outside and inside the homes of Manabitas and have used for cooking different types of food. This kitchen consists of two main parts where the biomass for the cooking of the food is located as shown in figure 2. One of these parts has used as an oven and the other to place the waves where the food goes, in this the oven to make corn cakes.



Figure 2. Part of the kitchen oven Manabita

As you can see, these kitchens have no protection to minimize emissions of gases from the burning of biomass, have an approximate height of 1 meter, and in many cases, its Thermal insulation is not adequate. These difficulties can cause certain difficulties in the health of people.

The research carried out has focused mainly on knowing the influence of heat on the body of people who interact with the kitchen, for these purpose thermography techniques have Images have taken with the thermographic camera to know the incidence of thermal emissions. In figure 2, a person has shown using a wood stove, inside a house, but thanks to the good design of it, it is not exposed to high temperatures, as you can see, the emissions do not fully reach their body.

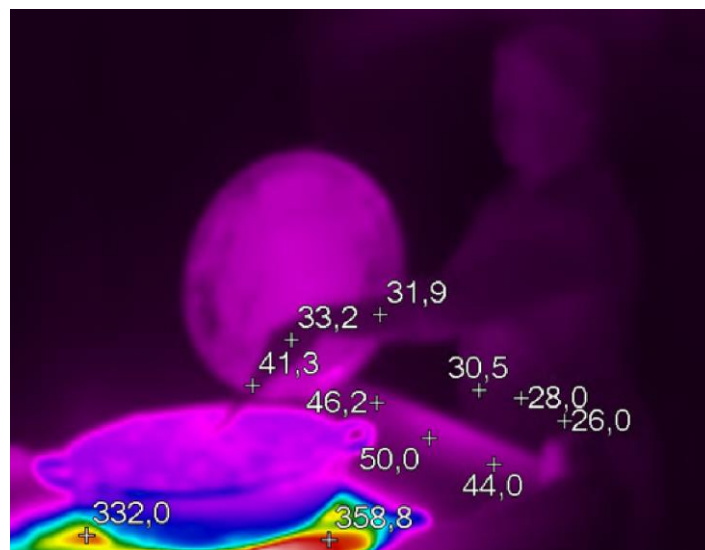


Figure 3. The thermal emissivity of a wood stove with design inside the house

Figure 4 shows the level of temperature at which the person in the image is exposed; we see that at the height of the belly receives a thermal emission of 63 ° C, which could cause serious health problems.

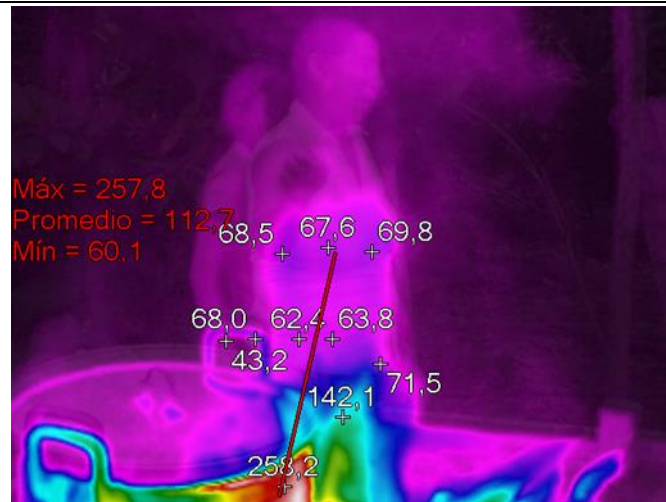


Figure 4. Levels of thermal emission that the person receives

Figure 5 shows a behavior curve of thermal emissions, taking as reference figure 4, here a temperature curve has made, where the variation of the temperature can have appreciated, same from the part where the fire is, to the temperature of the person.

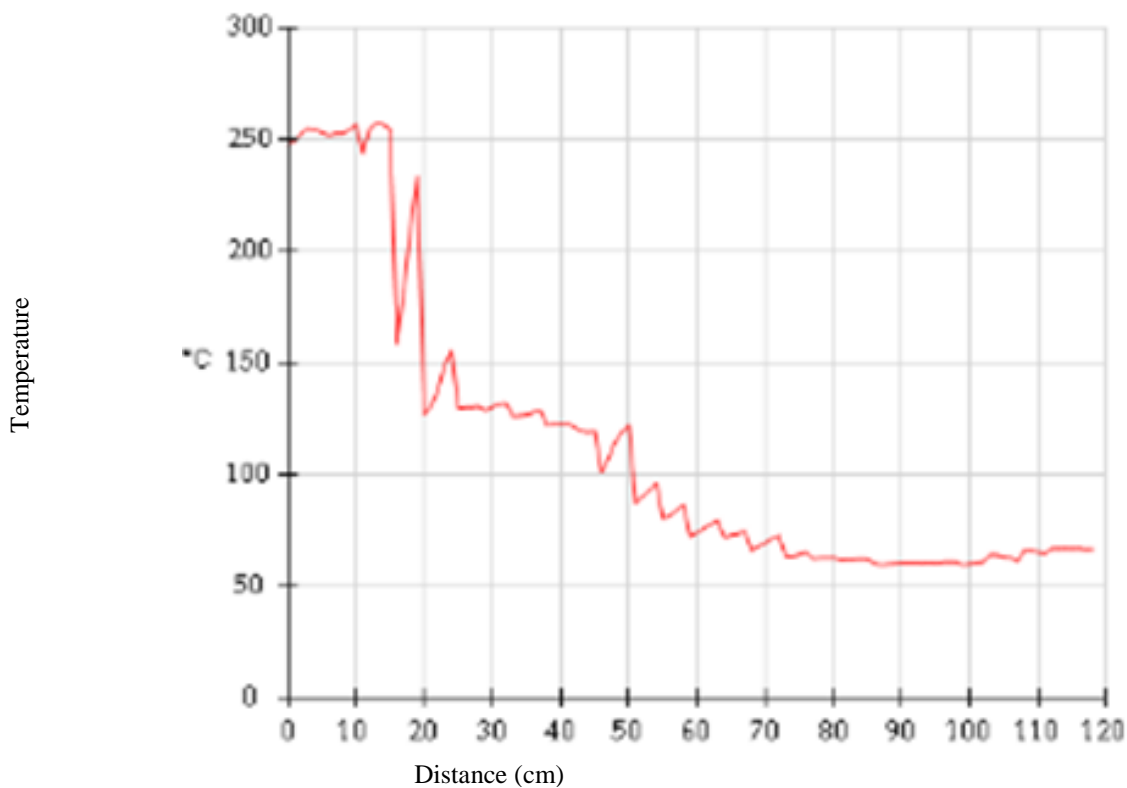


Figure 5. Distance vs. Temperature Curve

Figure 6 shows an image showing that the person receives temperatures that reach 70 ° C, in vital areas such as the abdomen, such as the abdomen, which could cause problems in the abdomen, health in the organs located in that place, like kidneys, etc.

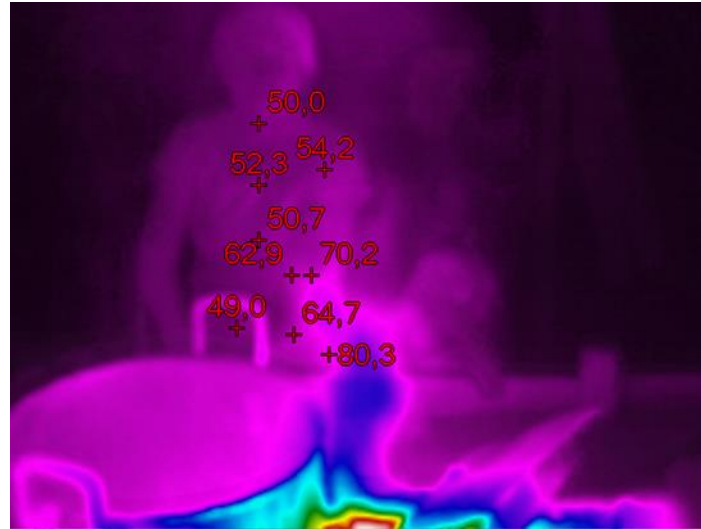


Figure 6. High-temperature values in vital organs

Different images have taken like the one shown in figure 7 here you can see the temperature at which the person observed is exposed, it receives temperatures that exceed 50°C , which could be a cause of some kind of pathology to the future.

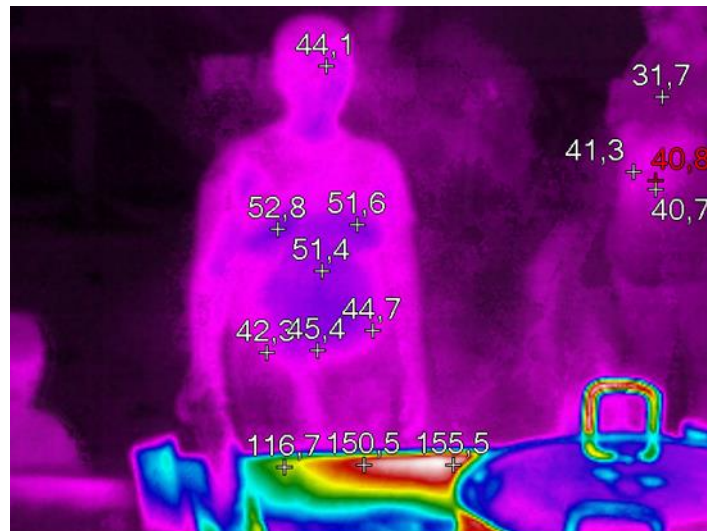


Figure 7. Elevated emissions in the body of the image

As you can see the thermal emissions of this type of kitchen was shown in the research that affects more people who frequent the vicinity of the facilities may affect the part of their health.

Studies of emissions of gases from the burning of biomass were not carried out, pending these studies although it can be argued that this type of kitchen. Have studied by mechanical engineering specialists that allow the design of a kitchen where the difficulties observed has mitigated, thus achieving an improved quality of life for people who use these technologies for cooking food.

4. Conclusion

It has learned that currently in the community where the study was conducted; all families make use of this type of kitchen. Several are the reasons, one of them is the speed with which food is prepared, and another the minimum

expense they make, when making use of biomass as fuel, since in the community trees abound, which are used for firewood. It was noted that the temperatures to which these people are exposed are high, which in the long term will cause damage to health. It should also be mentioned that not all the kitchens emitted great values of thermal radiation, there were a few kitchens that were built in such a way that the heat to which people were exposed was minimal, which suggests that they were technically constructed.

Conflict of interest statement and funding sources

The authors declared that they have no competing interest.

Statement of authorship

The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

Acknowledgments

The authors would like to thank the Editor of IRJMIS for their valuable time, support, and advice in completing the current study.

References

- Broadhead, J., & Killmann, W. (2008). *Forests and Energy: Key Issues* (No. 154). Food & Agriculture Org..
- Cortés, A., & Ridley, I. (2013). Effects of the combustion of firewood on indoor air quality: The city of Temuco as a case study. *Invi Magazine* , 28 (78), 257-271.
- Delgado-García, R., Velasco-Roldán, L., Onofa-Cuichán, E., & Armas-Figuero, E. (2016). Construction, development and tests of a low cost, high efficiency stove-boiler for low calorific power biomasses. *Dyna*, 83(199), 183-190.
- Escobar, A. A. H., Solorzano, D. R. V., & Gamez, M. R. (2018). Susceptibility to flooding in abdon calderon of canton portoviejo parish. *International Journal of Life Sciences*, 2(3), 111-120. <https://doi.org/10.29332/ijls.v2n3.220>
- Lagunes-Díaz, E., González-Ávila, M., & Ortega-Rubio, A. (2015). Transition of firewood to liquefied gas under pressure (LPG) in the south of Mexico, an opportunity for the mitigation of climate change in the less developed region of the country. *University Act* , 25 (6), 30-42.
- Lopez, M., Mongilardi, N., & Checkley, W. (2014). Chronic obstructive pulmonary disease due to exposure to biomass smoke. *Peruvian Journal of Experimental Medicine and Public Health* , 31 , 94-99.
- Muro, HAT, Paredes, JNA, & Bravo, CAP (2012). Environmental impact assessment produced by the use of traditional kitchens in the Vilacota-Maure regional conservation area of the Tacna region. *Technical Informer* , 76, 13.
- Noa, AP, Perez, AV, Hechavarria, JM, & Santos, RD (2018). Energy interpretation of solar radiation affects for Artemisa province. *International Journal of Physical Sciences and Engineering* , 2 (2), 39-49. <https://doi.org/10.29332/ijpse.v2n2.142>
- Porro, R., Miller, R. P., Tito, M. R., Donovan, J. A., Vivan, J. L., Trancoso, R., ... & Gonçalves, A. L. (2012). Agroforestry in the Amazon region: a pathway for balancing conservation and development. In *Agroforestry-The Future of Global Land Use*(pp. 391-428). Springer, Dordrecht.
- Ramírez Quirama, J. F., & León Taborda Vergara, A. (2014). Firewood consumption in traditional stoves among traditional peasant families from the Antioquian Eastern region. *Producción+ Limpia*, 9(1), 99-114.
- Ramos, C. L., Huo, Y., Jung, U., Ghosh, S., Manka, D. R., Sarembock, I. J., & Ley, K. (1999). Direct demonstration of P-selectin–and VCAM-1–dependent mononuclear cell rolling in early atherosclerotic lesions of apolipoprotein E–deficient mice. *Circulation research*, 84(11), 1237-1244.
- Rodriguez, A. C. Z., Gamez, M. R., & Faure, L. G. (2018). Design, construction, and energy of sustainable solar dryers in Jipijapa Canton. *International Journal of Physical Sciences and Engineering*, 2(2), 88-100. <https://doi.org/10.29332/ijpse.v2n2.170>
- Sutapa, G. N., Yuliara, I. M., & Ratini, N. N. (2018). Verification of dosage and radiation delivery time breast cancer (Mammae Ca) with ISIS TPS. *International Journal of Health Sciences*, 2(2), 78-88. <https://doi.org/10.29332/ijhs.v2n2.174>
- Zambrano, M. L. V., Barreto, M. D. L. A. C., & Chica, T. K. M. (2018). Intervention of social work in political participation of women in forming process of neighborhood councils of canton Portoviejo. *International Journal of Social Sciences and Humanities*, 2(1), 134-146. <https://doi.org/10.29332/ijssh.v2n1.104>