‘INDOOR ENVIRONMENTAL QUALITY IN VERY LOW INCOME HOUSEHOLDS DURING THE WINTER PERIOD IN ATHENS

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Abstract

This paper presents and discusses monitored data of the indoor temperature in almost 50 low income houses in Athens Greece during the winter of 2012-2013. The aim of the research was to identify the degree that the actual economic crisis in the country influences the indoor environmental conditions, comfort and health in low income households. Analysis of the data has shown that indoor temperatures in the monitored low income houses were much lower than the appropriate threshold set for comfort and health. It is concluded that the actual economic crisis decreases seriously the potential of residents to buy energy and heat their houses and puts the local population under a serious environmental and health risk.

Introduction

It is well known that low indoor temperatures in houses have very serious environmental and health consequences [1]. Adequate heating is necessary to achieve temperatures that provide thermal comfort and does not threat the health of the residents. According to the World Health Organisation, [2], the benchmark indoor temperature for vulnerable population is 20ºC, while Boardman suggested a temperature around 18ºC, (3). As mentioned in [4], medical literature asks for a minimum temperature of 21ºC for the more vulnerable population, 18ºC for sedentary activities and 18ºC for able healthy people.

The association of low indoor temperatures and human health is extremely well documented. Exposure to low indoor temperatures in cold houses may cause serious respiratory deceases, increased blood pressure, risk of stroke, frequent accidents, arthritis, deceases of mental nature [5]. A 2007 study of WHO [2] carried out in eight European countries has shown that residents in cold houses and also non properly insulated houses as well as houses with single glazing or houses without a tight roof, may suffer from respiratory diseases at a much higher percentage than those living in properly heated homes. Low temperatures were highly associated with bronchitis and pneumonia, cold/throat illnesses, allergies and asthma. Similar results are also reported by Shortt and Rugkasa [6], for Northern Ireland. It is important that aged people (older than 65 years of age), shown an increased rate of respiratory problems, they are exposed to an important physiological health risk, as ageing may cause a diminished cold induced thermoregulation that results to a reduced body temperature, hypothermia and death. Low indoor temperatures are highly associated with poor mental health. Cold homes may have a damaging psychosocial impact including depression, stress, social isolation and constraints of mobility.

Previous research has shown that the thermal quality of low income houses in Greece is poor [7]. Only a very small part of the low income housing stock is insulated and has double glazing while the energy spent for heating purposes is quite high because of the poor envelope quality. As a consequence of the insufficient housing quality, low income residents experience extreme environmental conditions especially during the warm summer period and heat waves [8]. The economic crisis that started in the country after 2009, has created very important financial problems to the low income households. Their income has been seriously diminished while a high percentage of the population is unemployed. As a matter of fact, a study carried out during the winter period of 2011-2012 found that the energy spent for heating purposes has been seriously reduced and homes were not kept at adequate conditions [9].

The present study is a follow up of the previous research carried out in Greece to investigate indoor environmental conditions in low income houses. This study aimed to identify the levels of indoor temperature in the houses and associate them with social and economic parameters. This is a preliminary presentation of the results.

Description of the Study

In order to assess the environmental quality of low income households in Athens, Greece, almost fifty residences have been selected for monitoring. In each house a miniature temperature sensor has been placed measuring indoor temperature at 15 minutes interval. Sensors were placed in a well-ventilated and heat protected part of each house. All sensors were properly calibrated. Measurements are performed for the period between December 2012 and April 2013.

All information about the main characteristics defining the thermal performance of the houses, such as the existence and the type of insulation or the heating system, have been collected. Information on the social and economic status of the households was collected as well. The possible energy consumption of the present and past years was also collected when available. All houses were regularly visited by trained surveyors to download the recorded data and get a report on the actual problems and the applied conditions in the households. All data were subjected to quality control and measurements not satisfying the requirements were rejected and not taken into any futher account.

Main Results

This paper presents a preliminary analysis of the collected data from the monitored houses. Following a quality control procedure, data from 44 houses (out of a total of 50) are selected and analysed. Statistical analysis is performed for the whole set of the considered data and every month separately. In the remainder of this paper, data and analysis concerning just January 2013 are presented. It is noted that January was the coldest month of the specific winter period and presents the highest interest concerning the severity of the results. The whole analysis will be presented in an extended paper to be submitted in the near future.

The winter of 2012-2013 was a very mild one. According to the National Observatory of Athens, the average ambient temperature during January 2013 was close to 10.6ºC, while the absolute maximum and minimum were 19.0ºC and 0.9ºC. In parallel, the number of heating degree days was 228. Temperature levels during January were quite high compared to past years. Only three days of low ambient temperature were recorded, in particular, the 8th, 9th and 10th of January with average temperatures around 2.5, 3.9 and 6.8ºC, respectively. The cumulative frequency distributions of the average and minimum ambient temperatures for the whole month are given in Figure 2.

Figure 1 shows the variability of the indoor temperature in all 44 houses. The average temperature varied between 11.7 and 21,1ºC with the vast majority being below the threshold of 18ºC. Minimum temperatures ranged between 5.2 and 18.8ºC and in most of the buildings, minimum temperatures were below 15ºC. It is characteristic that in almost two thirds of the houses, the maximum temperature was always below 20ºC. It has to be pointed out that in about 5% of the sample, indoor temperature was at freezing levels. The specific buildings were characterized by a very low quality of envelope while the tenants could not afford (for economic reasons) the use of any kind of energy.

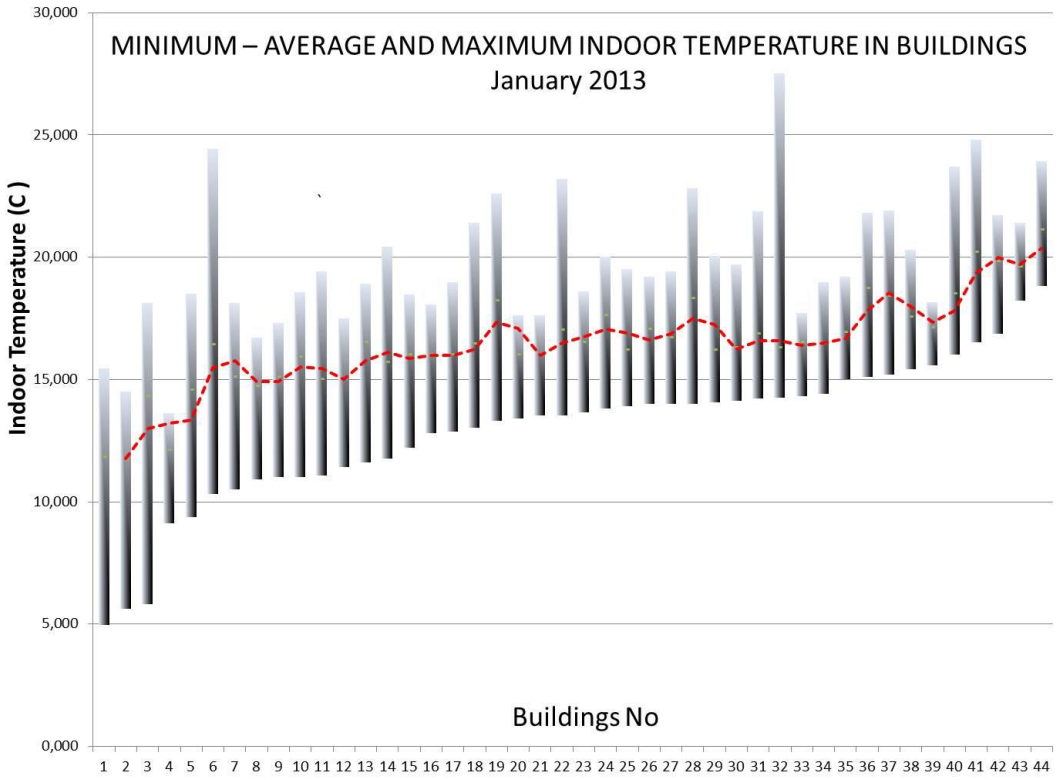

Figure 1. Variability of the measured indoor temperature in the 44 houses. Median temperature (line) and minimum and maximum temperatures are shown (bars).

A better representation of the indoor average and minimum temperatures are given in comparison to the corresponding ambient temperatures in Figure 2. As shown in almost 90% of the houses the levels of the indoor average temperature were below 18ºC, while for about 25% of the house, the average indoor temperature was below 15ºC. In parallel, indoor minimum temperature in all buildings was below 18ºC, while for 70% of the buildings the minimum

temperature was below 14ºC. Finally, the 17% of the buildings was below 10ºC and the 10% of the houses it was below 7ºC.

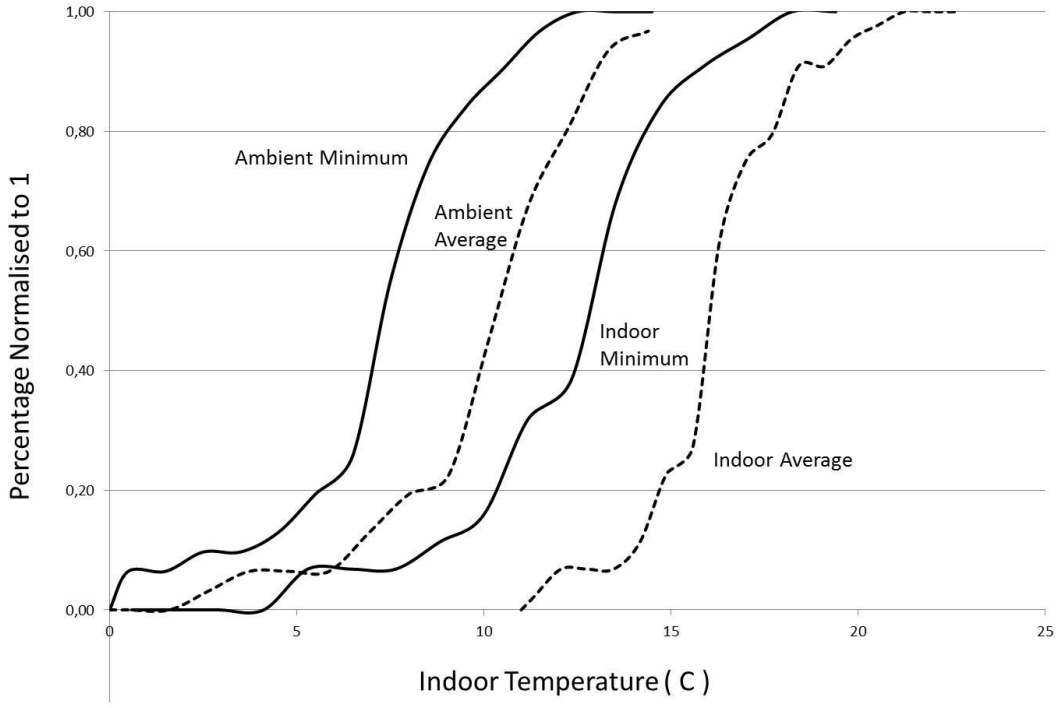

Figure 2. Cumulative frequency distribution of indoor and ambient minimum and average temperatures for January 2013. All 44 houses are included.

As it concerns the indoor environmental conditions during the entire January period, it is found that almost 79% of the global monitoring period for all houses (44 houses × 31 days × 24 hours), indoor temperature was below 18ºC, while for the 22% of the monitoring period, indoor temperature was below 15ºC. The specific percentage of the monitoring period for each house, (31 days × 24 hours), for which indoor temperatures were below 18 and 15ºC, is given in Figure 3. As shown, for almost 18 out of the 44 houses, indoor temperature was below 18ºC, for the whole monitoring period, while for almost 35 houses, temperature was below 18ºC for 80 %of the time. Only four houses have succeeded to keep indoor temperatures above 18 C for more than 80 % of the time. For three houses, indoor temperatures were below 15ºC for almost the whole period and for 10 houses, temperature was below 15ºC for more than 60% of

the monitoring period. For almost half of the houses, indoor temperature was lower than 15ºC for almost 20% of the time.

As already mentioned, the month of January was quite mild and it was quite difficult to extract specific information on the behaviour of the buildings and the families under extreme weather conditions. To evaluate the performance of buildings as well as the indoor conditions during low temperature periods, a specific analysis is performed for the two cold days of 8th and 9th of January.

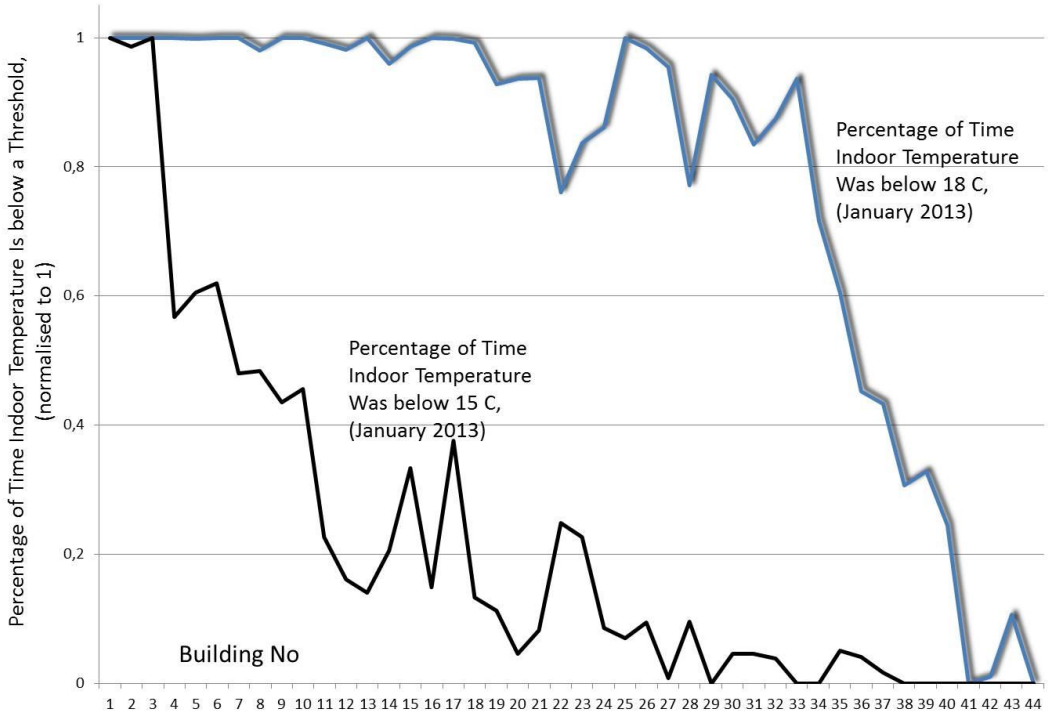

Figure 3. Percentage of the total monitoring period for each house with indoor temperatures below 18 and 15ºC.

The variability of the indoor temperature of all the monitored houses for these two specific days is given in Figure 4.

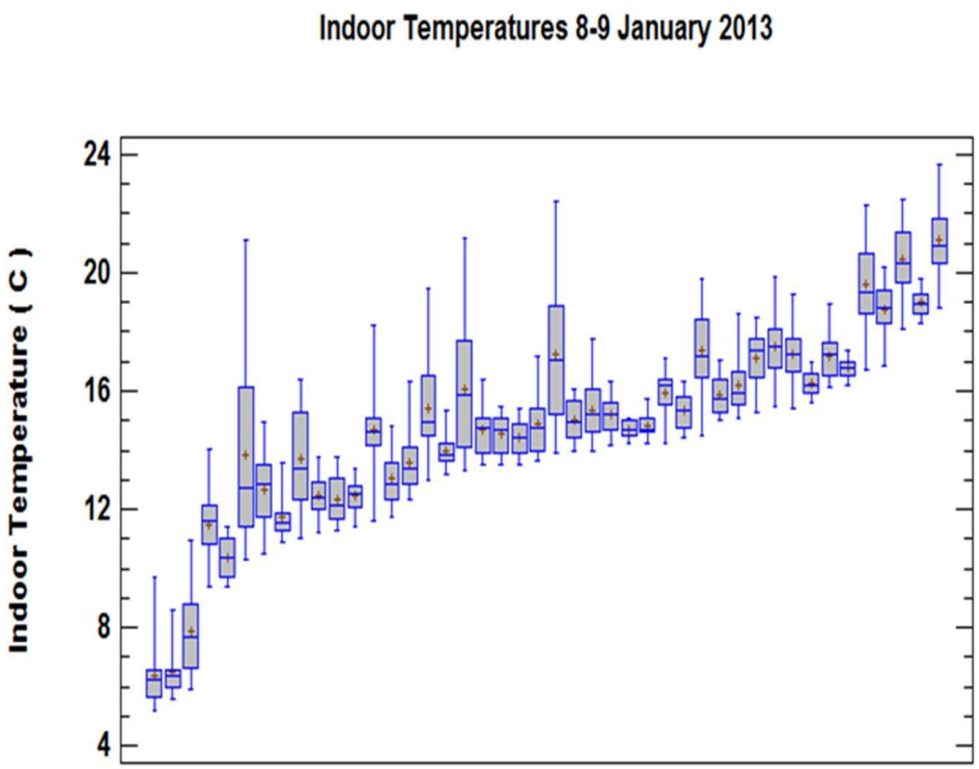

Figure 4. Variability of indoor temperatures in all monitored buildings during the cold days of 8th and 9th of January 2013.

Study of Figure 4 shows clearly that during the two specific days, indoor temperatures in most of the buildings was very low and much below the proper thresholds. The average median temperature for all houses was close to 14.7ºC, while the average and absolute minimum were 13.2 and 5.5ºC respectively. For two of the houses, indoor temperature was below 8ºC for almost the entire two days period, while for almost 25% of the houses the average indoor temperature was below 12ºC. The variation of the indoor temperature in the three coldest houses as well as the variation of the ambient temperature for the period of the two specific days, is given in Figure 5.

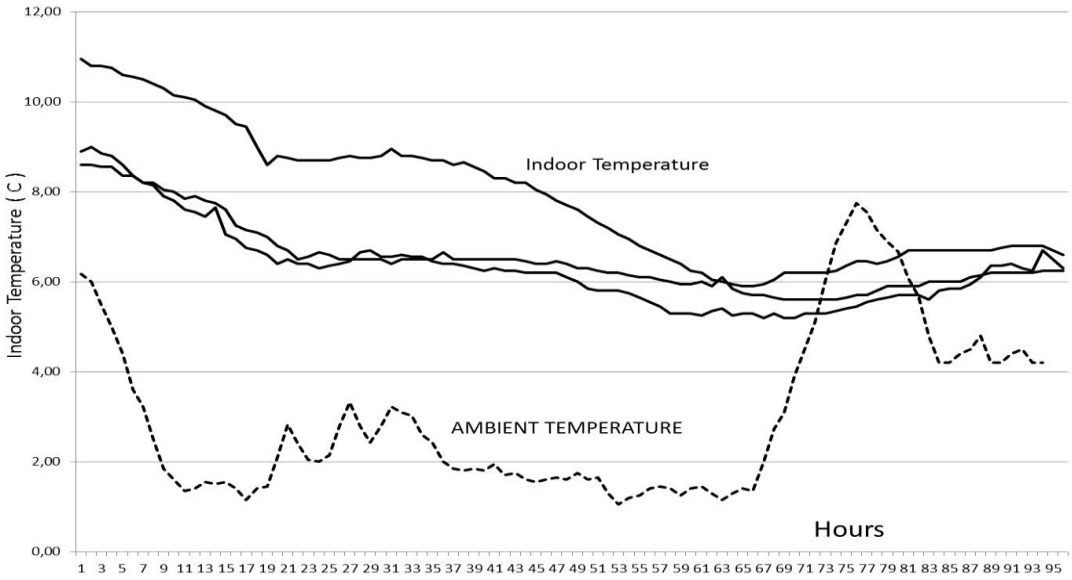

Figure 5. Indoor temperature variation for the three coldest buildings during the two specific days of low ambient temperature.

It is more than evident that indoor environmental conditions in the specific low income houses is completely unacceptable and put the life of the residents at high risk. At the same time, the levels of indoor temperature in almost 95% of the monitored houses are found much below the appropriate thresholds. A more detailed and specific analysis associating the specific levels of indoor environmental quality against economic, social and health characteristics is going to be published in the near future.

Conclusions

Low income population in Greece lives in badly protected houses that need a quite high energy load to heat and cool. Previous studies have shown that low income population has to spend much higher energy amounts per capita and area compared to high income population as their houses are improperly insulated and thermally protected. It is also known that the serious decrease of the financial income caused by the economic crisis had a serious impact on the energy spent for heating purposes by low income population and has tremendously decreased the heating bills. This new financial situation has an important impact on the indoor environmental quality in the houses as the lack of resources does not allow the achievement of proper indoor temperatures. Monitoring of about 50 low income houses during the winter of 2012 – 2013 in Athens has shown that indoor temperatures are much lower than the threshold

values set for comfort and health purposes. In most of the houses, long spells of low indoor temperatures are recorded while during periods of low ambient temperatures the specific indoor conditions in selected houses were completely unacceptable and for most of the houses much below the internationally accepted conditions.

It is a serious need to improve indoor temperatures in low income houses in Greece. It is obvious that there is a very serious environmental and health risk for the residents. Programs to supply cheap energy for heating together with programs to improve the thermal performance of the low income houses have to be defined and undertaken urgently.

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