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Poverty and Comfort?

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POVERTY AND COMFORT?

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Summary

Some facts on New Zealand households, their energy use and expenditure, and comfort levels.

- In the "average" house most energy is used for heating — either water or space heating.
- Over the last decade, housing costs as a proportion of income have doubled from 18% to 36% in the lowest incomes, and reduced from 21% to17% in the highest income groups.
- Energy expenditure does not appear to increase directly with income. In 1997 the 2nd Decile income averaged $15,800 per year with weekly energy expenditure of $17.70, while the 9th Decile annual income of $78,100 spent $25.40 on energy — a 400% difference in income but only 40% more spent on energy.
- There is a narrow range of temperatures within which people feel comfortable — around 18 to 26 °C.
- The World Health Organisation recommends 18 °C as the minimum indoor temperature, but to keep rooms for the elderly, children and handicapped people warmer (below 16 ºC there are health issues).
- There is limited information on the actual temperatures within New Zealand houses, but the few surveys which are available suggest that winter time temperatures on average are below 18 °C, and often below 16 ºC.
- The climates in which most New Zealanders live are mild, so with reasonable house design and insulation it is possible to achieve healthy indoor temperatures with minimal energy expenditure.
- New Zealand has a high rate of seasonal mortality, which may be related to low indoor temperatures.

Keeping Comfortable

To help keep comfortable in winter, here are a few low cost ideas:

- STOP HEAT ESCAPING - the cheapest things you can do to keep heat in are:
    - use "cloth sausages" to fill in gaps under doors
    - borrow heavy curtains from a "curtain bank", fit them to stop draughts
    - use carpet off-cuts or throw rugs to keep the floor warm (but remember to clean them regularly)
    - close gaps around windows with "foam" or "v-seal" products from the hardware shop
    - close gaps around internal doors from the bathroom and toilet (these rooms must be ventilated)
    - plan to stay warm — during the day trap heat inside, and use curtains to keep it in at night
    - very damp houses may benefit from a plastic sheet covering the ground under the floor
    - keep your head and feet warm — these lose a lot of heat and often feel cold first.
- USE THE MONEY SPENT ON HEAT WELL
    - don't use the oven to heat the room, it is not designed to work that way
    - use a low cost thermostat on the heater to maintain even temperatures, not peaks & troughs
    - portable LPG heaters are not cheap to run, and must only be used in well ventilated rooms
    - heat only the room you are using, but keep bedrooms reasonably warm
    - repair dripping taps, turn the hot water cylinder temperature down (but not below 60 °C) and use low flow shower heads.
- GET HELP AND IDEAS
    - local power companies still offer energy efficiency advice
    - the Government's "Energy Saver Fund" offers financial support for energy efficiency projects (Contact: David Weinstein, EECA, PO Box 388, Wellington. Ph (04) 470 2200).

Introduction

After many thousands of years developing our understanding of the conditions we need for life, on 12 April 1961 we artificially created these conditions to permit the first person to live in the most hostile of our known environments — space. Vostok I had truly taken our "domain … over all the earth" (Genesis I 26) to an extreme. On the terrestrial plain, people continued to build buildings in order to protect themselves from the extremes of the natural environment, and ideally to create conditions of "comfort". Yet if it has been possible for nearly 40 years to create a perfect environment for one person in space, why can't we do this for more people on earth?

The building scientist's interest is in how buildings work, why they don't achieve desired results, and how the people in the buildings "pay" for their comfort. This work must cross the boundaries of a range of research specialities, both physical and social.

This paper examines how we define comfort, compares this with the results from some recent research into the conditions found inside New Zealand homes, and then examines how the various income groups have been able to "afford" this over the past decade. Keeping warm, comfortable and healthy involves many issues, which interact in complex ways. The goal of this paper is to start discussion and improve understanding.

Comfort

There is a remarkably narrow band of air temperature, humidity, and air movement in which humans can exist, and an even narrower band in which they feel comfortable.

For a "normal" sedentary Caucasian American wearing a reasonable level of clothing, this comfort zone is between 20 ºC and 26 ºC in temperature, and between 20% to 80% for Relative Humidity[1]. This comfort temperature varies with gender (females tend to need slightly warmer temperatures for comfort), clothing (more clothing traps heat next to your body, making cooler temperatures comfortable), activities (physical activity generates the need to remove excess heat from your body, making cooler temperatures comfortable), and even between individuals (a comfortable temperature to one person may be too warm for another). It is not believed that "comfort" conditions vary with race, although there is increasing evidence that where you are living (or have lived) can alter your comfort expectations e.g. people who live in very hot climates may well be uncomfortable in temperate climates[2]. Our definition of comfort is far from precise, but there is a belief, represented by an international standard, that we can define a set of conditions that will be acceptable to at least 95% of a given group of people[3].

Comfort conditions for New Zealanders have not been investigated, but anecdotal comments suggest that 18 °C would be acceptable.

Normal, healthy humans will respond to changes in climate by adjusting some aspect of their surroundings — either the "building" they carry (i.e. their clothes) or the "building" they are using for protection. On a warm, sunny day there are very few healthy people who will sit on the beach in heavy winter clothing, just as there are few people who will sit in the snow wearing only a bathing suit (and feel comfortable). Even on a day you think is comfortable, someone else may not feel as comfortable, and will adjust their personal space by using more (or less) clothing, opening (or closing) a window, turning on (or off) a light.

New Zealand is commonly referred to as a "temperate" country — our climate provides a only small range of extremes in the places where most people live. Table 1 provides some key indicators for some selected locations[4].

The World Health Organisation recommends a minimum indoor temperature of 18 ºC, with a 2-3 ºC warmer minimum temperature for rooms occupied by sedentary elderly, young children and the handicapped[5]. Below 16 ºC there is an increased risk of respiratory disease, while below 12 ºC the risk is of increased cardiovascular strain[6]. The New Zealand Building Code (NZBC)(Clause G5 Internal Environment) requires that temperatures above 16 ºC are maintained in old people's homes and early childhood centres, but there are no heating requirements for any other building use.

A house, with the benefit of a few occupants and their activities, will provide additional warmth of about 3 °C above the outside temperature. Table 1 suggests a moderately well designed Auckland house should provide 18 °C as an annual average, or very close to a comfortable temperature. Even in Wellington a 3°C increase would bring indoor temperatures to just below the healthy 16 °C limit.

Location	Mean Rain (mm)	Annual Mean Temperature (°C)	July Average Daily Minimum (°C)	Avg. No. of Days of Ground Frost	Mean Sunshine Hours
Auckland	1185	15.3	7.8	4	2102
Hamilton	1214	13.4	2.6	63	NA
Wellington	1240	12.5	5.5	15	2019
Christchurch	666	11.6	1.4	89	1974
Invercargill	1037	9.7	0.8	111	1621

Table 1: Climate Indicators for Selected Locations

A poorly designed and built house will not support or improve the health of the occupants. The National Health Committee recognised this earlier in the year, and concluded[7]:

Overcrowding, damp and cold have direct detrimental effects on physical and mental health.

The poor physical condition of some accommodation is one of five areas that the Committee regard as a high priority, which needs to be addressed as a matter of urgency.

The way in which the house can modify the climate to provide this comfortable "average" is considered next.

Indoor Environments

Houses create comfortable conditions by moderating the external climate in two ways:

- **Passive** - the house structure can retain heat or coolness (e.g. by the use of heavy walls and insulation), or it can selectively exclude undesirable conditions (e.g. exclude the hot afternoon sun with awnings).
- **Active** - purchased or brought-in energy is used to heat or cool the house.

The passive approach to climate control often made use of local materials and knowledge. The raupo reed hut was ideally suited to our environment — cool in summer and the high insulating value of the many layers of reeds made it warm in winter. Such a hut would probably meet today's NZBC insulation requirements, but would need some work on the control of dampness. The raupo hut led to the first New Zealand building control, after a disastrous fire in Wellington on 9 November 1842[8].

The active approach has an equally long history, as our ancestors have had the ability to use wood or coal to heat their homes for a very long time. However the active control of the indoor environment changed dramatically in the 19th century, with firstly gas (coal gas in the main cities from 1862, with natural gas in the North Island from 1971) and then electricity or even heating oil, becoming available. The later fuels were clean (at least in comparison to coal, wood or tallow), easy to control and abundant.

It is surprising to recognise that it is only in the last 100 years that we have been able to supplement the "passive" features of buildings with simple or clean "active" control. It has become a simple matter to replace good design with energy, and it is here the interface of income and climate takes place. If the house

is well designed, orientated to collect needed winter sun, insulated to retain heat, provided with adequate windows, and excess ventilation is controlled then very little purchased energy will be required. This is the situation for much of the north of the North Island. In the rest of the country a well designed and insulated house will minimise the need for purchased energy — and here the link between income and comfort becomes explicit. Zero energy houses exist today in the far colder Sweden, Germany & USA.

If the house is uninsulated, does not use curtains to trap winter warmth and does not control summer overheating or make use of the winter sun, then it will be necessary for the occupants to pay to be warmer or even comfortable. But how warm are New Zealanders in their homes?

Temperatures in New Zealand Homes

There is limited information available on the temperatures New Zealanders maintain within their dwellings during the cooler months. There has been no national collection of data on the conditions inside our homes since the 1971/2 Household Electricity Survey[9]. That survey found that during the two-month period August to September 1971, national mean temperatures were 16.3 °C for the kitchen, 15.8 °C for the lounge room and 14.4 °C for the main bedroom. No statistical difference in the temperatures was found between the insulated and non-insulated houses. A 1986 study of 28 houses nationwide found average winter internal temperatures ranging from 13.7 °C to 16.3 °C[10]. A 1989 study of units for the elderly found that more than one third of the lounge room minimum daily temperatures during the year were below 16 °C[11]. A recent study by the Building Research Association of New Zealand (BRANZ) of retro-fitting insulation to one house, reported that during the first winter following insulation, average temperatures increased by 1 ºC to 2 ºC, while energy use remained the same.[12]

In 1995 BRANZ started a long term research project (Household Energy End-use Project or HEEP)to investigate energy use and temperatures in New Zealand homes[13]. The first year was spent setting up the methodology in selected Wanganui houses, and we now have data on 49 houses in Wanganui, Wellington and Christchurch. In the current year BRANZ are monitoring a further 41 houses in the Wellington region, and the coverage will be expanded to the whole country in the coming years.

Figure 1 shows the average lounge temperatures for 16 Wanganui houses for the August and September months, with the average of these temperatures (dotted line) and the average temperatures found for a statistically valid sample of houses from the 1971/2 survey. Although the Wanganui sample is neither large nor statistically random, it appears that the average temperature is unlikely to have increased beyond that found in 1971/72. These homes were all owner-occupied and most had household incomes above $50,000 per year.

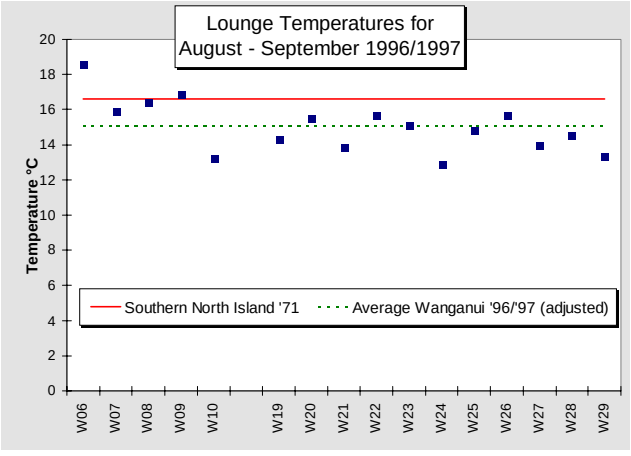


Figure 1: Lounge Average Temperatures

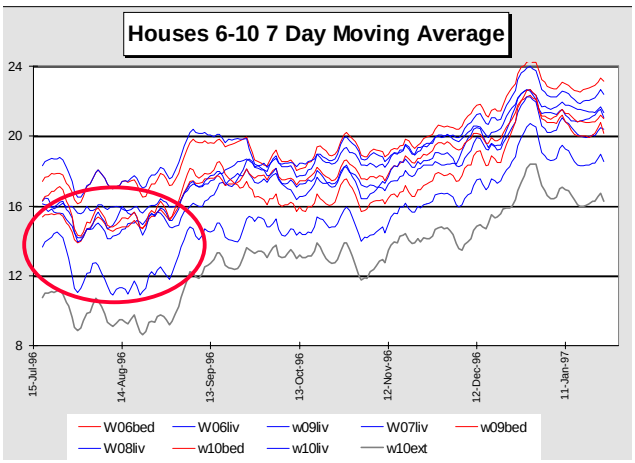


Figure 2: Bed & Living Room Temperatures

Figure 2 shows the outside temperature (lowest line) and the indoor living and bedroom temperatures for five Wanganui houses. It can be seen that during the winter period (mid-July to early-September) temperatures are all low. In all but one house (top two curves) the temperatures are below 16 ºC for the winter period. The bottom-most curve is from a living room which has no heating, and it can be seen how the temperature is approximately 3 ºC warmer than the outside temperature.

Household Energy Use

The 1971/72 survey generated average electricity end-use data, which has not been able to be questioned since that time. The HEEP project will eventually be able to provide statistically valid data to permit the evaluation of changes in New Zealand household energy use patterns, but at present it is limited to a small group of houses.

Table 2 and Figure 3 provide average weekly electricity consumption for the monitored appliances from 10 Wanganui houses[14]. Heating is the largest single user of energy, with hot water a close second, and a wide mix of other appliances making up the remaining 29%.

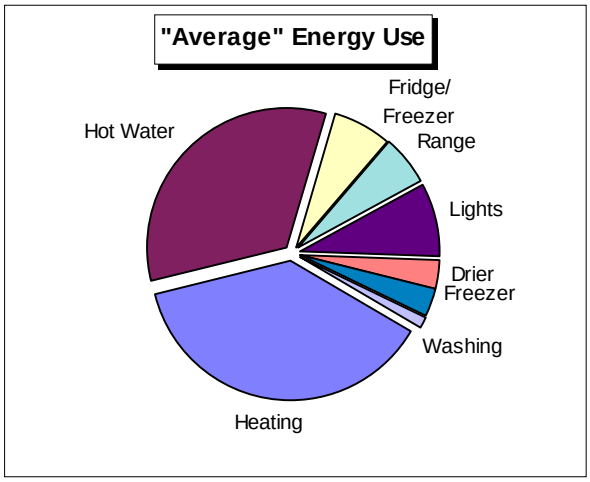


Figure 3: "Average" Energy by End Use

End Use	kWh/week	% of total
Heating	67	38%
Hot Water	59	33%
Fridge/ Freezer	12	7%
Range	11	6%
Lights	14	8%
Drier	6	3%
Freezer	6	3%
Washing	2	1%
TOTAL	176	100%

Table 2: 10 House "Average" Energy Use

Thus in the “average” New Zealand house, the majority of energy is used for heating — either the spaces in which people live or the water they use for washing or sanitary purposes. The other uses are relatively small, and hence their cost is also relatively small.

Household Expenditure

If the building does not provide “passive” comfort, then it is necessary for it to be provided by “active” means, generally by the use of a purchased fuel. Houses with open fires or enclosed burners may be able to use “free” fuel, such as timber from a nearby plantation, but in most cases even this will cost money in the form of transportation. However, unless the house has a “wetback” or some other form of supplementary water heating, the remaining two thirds of the energy use will still have to be purchased from someone — most likely the electricity or gas supplier.

Statistics New Zealand has carried out a Household Economic Survey (HES) since 1973, although the name has changed over the years[15]. Although originally intended to provide statistics on the expenditure patterns of private households, it has expanded into the fields of household income, and social and demographic information. Data in this paper is taken from the survey for the period from 1 April 1996 to 31 March 1997, the 24th year of the survey[16]. From 1998 the survey will no longer be conducted annually due to limited resources.

The HES provides data on a wide range of household expenditure, grouped into eight commodity "parent" groups as listed in Table 3. Data on the 2127 items, along with information on the household, is collected through a detailed survey interview and a diary. The diary is completed by each household member over 15 years of age, and includes all expenditure for 14 consecutive days, major expenditure from the previous 12 months, and income and employment data.

Commodity Group	Items	Sub-group Examples	Sample Error
Food	607	Fruit, Vegetables, Meat	4%
Housing	17	Rent, Capital, Mortgage, rates	24%
Household Operation	354	Energy, Appliances, Furniture, Supplies	4%
Apparel	218	Clothing, Footwear	7%
Transportation	156	Public, Overseas, Vehicles	7%
Other Goods	405	Tobacco, Alcohol, Pets, Leisure	6%
Other Services	253	Health, Education, Legal, Savings	6%
Refunds, Sales and Trade-ins	117	Refunds, Sales, Trade-ins	NA

Table 3: HES Coverage

Table 3 also provides the Sample Error for each commodity grouping. In general, the higher the percentage of surveyed households which contributed to an expenditure statistic, the more statistically reliable that expenditure statistic. This is an issue for "Housing", where in some cases only a small proportion of households report each type of expenditure e.g. in the 1997 survey, 26% of households reported expenditure on rent and 32% on mortgage payments. The HES does not provide estimates of response errors or other non-sampling errors, although it is known that expenditure on some items (such as tobacco and alcohol, meals away from home, and food such as ice-cream and confectionary) tend to be understated. GST, which was introduced in 1986 at 10% and increased to 12.5% in 1989, is included in all expenditure statistics.

Incomes reported to the HES may also be understated, as not all income is necessarily reported. The Family Support tax credit was introduced in 1986, and along with other tax based support payments, has been changed at various times in the period 1986/67 to 1996/97.

The results from the HES can be analysed by a range of different socio-economic variables. The Household Income is defined as the total gross regular income reported by the household, while the Expenditure is made using after-tax income. Income can be negative or zero e.g more money went out of the house than was received in that year, and includes wages, salaries, self-employed income, social welfare benefits and investment income. Income groups are based on tenths (deciles) of the total number of households — approximately one tenth of all households will be in each income decile.

Decile	1996/97 Income	Decile	1996/97 Income
1	< $13,100	2	$13,100 -≤$18,500
3	$18,500 -≤$22,500	4	$22,500 -≤$27,800
5	$27,800 -≤$34,700	6	$34,700 -≤$43,400
7	$43,400 -≤$53,900	8	$53,900-≤$68,200
9	$68,200 -≤$88,000	10	>$ 88,000

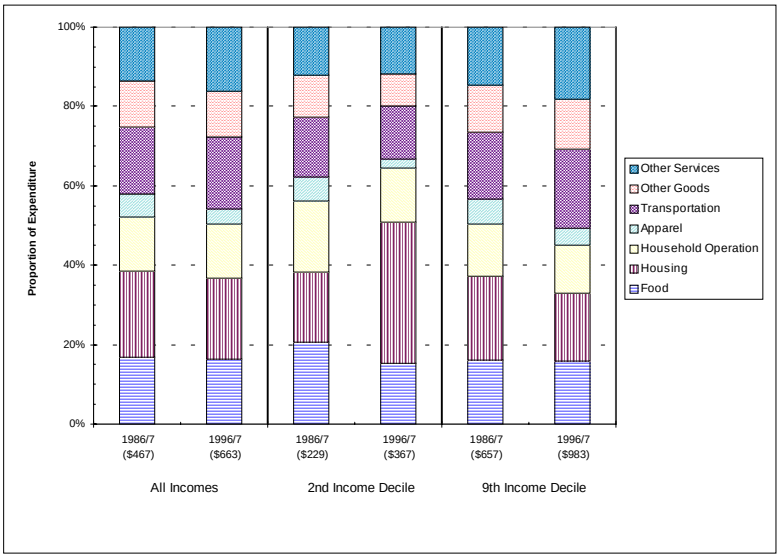
Table 4: 1996/7 Household Income Deciles

Table 4 provides the income decile ranges for the 1996/7 HES. It can be seen that both the bottom (1st Decile) and the top (10th Decile) income groups are not bounded. Careful adjustment of self-employed income can also result in households with a comparatively high real income falling into the lowest income decile. Thus for the purposes of this paper, the analysis is based on the 2nd and 9th income Deciles.

As the HES is conducted regularly on a consistent basis, it is possible to compare changes in expenditure patterns over time. Although the analysis reported in this paper has been carried out for the ten-year period 1986/87 to 1996/7, comparisons are only made between the end periods. The differences which are

examined for these two end periods can be traced through the annual HES to show that there is a real trend rather than a simple anomaly.

Figure 4 compares expenditure by commodity group for the 1986/87 and the 1996/97 HES for the summary of all ten income groups, the 2nd Decile and the 9th Decile. The total expenditure (in brackets) is given in dollars-of-the-day below each bar.



The changes in the proportion of expenditure in four of the commodity groups are most noticeable:

- **Food** has fallen from 21% in 1986/7 to 15% in 1996/7 for the 2nd Decile, but stayed the same at 16% for the 9th Decile.
- **Housing** has risen from 18% to 36% for the 2nd Decile, but fallen from 21% to 17% for the 9th Decile.
- **Housing Operation** has fallen from 18% to 14% for the 2nd Decile, and fallen from 13% to 12% for the 9th Decile.
- **Apparel** has fallen from 6% to 2% for the 2nd Decile, and fallen from 6% to 4% for the 9th Decile.

Figure 4: Household Expenditure by Group & Income

Thus over the decade households in the lower income group are now spending a smaller proportion of their income on Food, Housing Operation and Apparel while spending a greater proportion on Housing. Households in the higher income group are spending the same proportion on Food but less on Housing, Housing Operation and Apparel.

The overall group expenditures are based on a weighted average of all expenditures reported in each income decile. For example, in 1996/7 nearly all (99%) households report expenditure on the Housing group, but only 26% reported expenditure on the Rent sub-group, and 32% on the Mortgage sub-group. Thus the HES average house is unlikely to be matched to any real household. In order to understand the changes occurring in expenditure, it is necessary to limit the analysis to those households actually reporting the specific expenditure.

Household energy is termed “Fuel & Power” for the HES, and is included in the “Household Operation” group. The only other “energy” related aspect of household expenditure is “Fuel for road vehicles” which is included in the “Transportation” group.

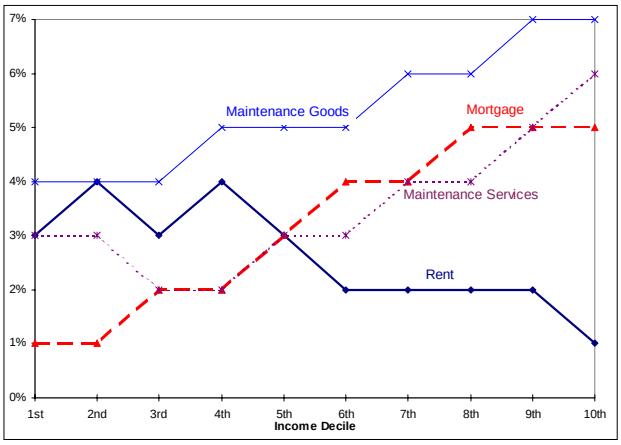


Figure 5: Housing Sub-group Expenditure by Expenditure Decile

Figure 5 shows for some selected Housing sub-groups the proportion of households reporting expenditure by expenditure decile.

As income **increases**, the number of households reporting expenditure on rent **decreases**, while expenditure on mortgage **increases**.

These proportions have remained within the rounding error (a reported 1% is rounded from actual proportion of between 0.5% and 1.5%) over the period i.e. there does not appear to have been a sizeable increase or decrease in the proportions for the different deciles. For the purposes of analysis, deciles reporting expenditure of 1% or less in a sub-group are excluded from analysis.

The HES data is reported as an average over the specific decile. Thus, unless the sub-group is the subject of expenditure in all of the houses in a particular decile (i.e. 10% report expenditure), it is necessary to use the proportion reporting to calculate the average expenditure in the houses which do make that expenditure. For example, in both the 2nd and 9th Deciles "Energy" expenditure is reported in all houses, but as shown in Figure 5, "Rent" expenditure is reported in 4% of the 2nd Decile but only 2% of the 9th Decile. The HES reported for 1996/97, "average weekly" Rent expenditure of $47.70 for the 2nd Decile and $35.10 for the 9th Decile, which appears to suggest that lower income houses actually spent more on rent than the higher income households. However, if only the households that actually spent money on Rent are considered, their average expenditure was $119.30 and $175.50.

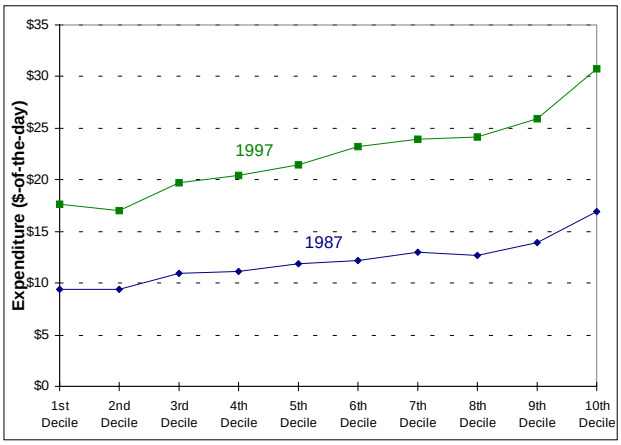


Figure 6: "Fuel & Power" Expenditure

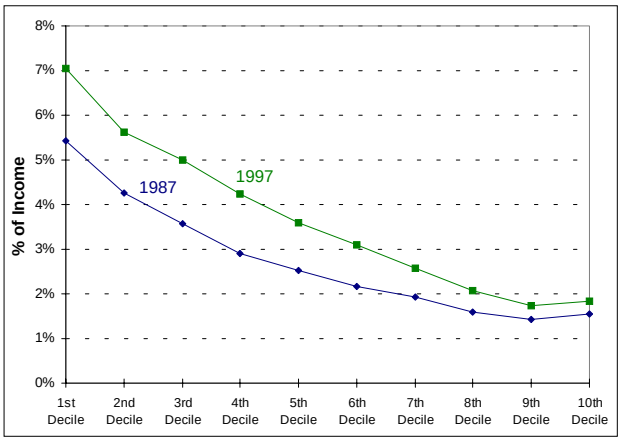


Figure 7: "Fuel & Power" as % of Income

In the period June 1987 to June 1997 the Consumer's Price Index increased by 37% (790 to 1083, March 1994 = 1000), and it would be expected that expenditure in dollars-of-the-day on the various aspects of household operation would also increase, all other things being equal.

Figure 6 provides for the "Fuel & Power" component of household expenditure, the expenditure per week for the income deciles for the 1987 and 1997 surveys. It can be seen that the expenditure does increase from 1987 to 1997, but the increase is smaller for the higher income deciles. Figure 7 compares the proportion of income spent on "Fuel & Power" for the 2nd and 9th Deciles, and again although the proportion has increased for both deciles, the greatest increase is for the lower decile.

Table 5 compares expenditure for the 2nd and 9th income Deciles between the 1986/87 and the 1996/97 surveys. Examination of the data showed that although there was a consistent trend over the period, the small proportions of households reporting some expenditures results in fluctuations between years. Table 5 weekly expenditures by sub-group are thus based on the average over two years (i.e. 1985/86 and 1986/87, and 1995/96 and 1996/97 respectively).

	Annual Income		**$/wk (averaged over 2 yr)**									
	Decile midpoint		**Energy**		**Rent**		**Mortgage**		**Maintenance Goods**		**Maintenance Services**	
	1987	**1997**	**1987**	**1997**	**1987**	**1997**	**1987**	**1997**	**1987**	**1997**	**1987**	**1997**
2nd Decile	$11,500	$15,800	$9.80	$17.70	$51.90	$ 121.70	$61.50	$155.00	$13.30	$16.80	$23.30	$43.30
9th Decile	$51,000	$78,100	$14.00	$25.40	$83.10	$ 157.00	$104.80	$241.30	$26.30	$41.90	$54.30	$103.30
Ratio 2nd :9th	4.4	4.9	1.4	1.4	1.6	1.3	1.7	1.6	2.0	2.5	2.3	2.4
Proportion of Income												
2nd Decile			4.4%	5.8%	23.6%	39.8%			6.0%	5.5%	10.6%	14.1%
9th Decile			1.4%	1.7%	8.4%	10.5%	10.6%	16.2%	2.6%	2.8%	5.5%	6.9%
Proportion of Total Sample Reporting Expenditure												
2nd Decile					3%	4%	1%	1%	4%	4%	3%	3%
9th Decile					2%	2%	6%	5%	8%	7%	5%	5%

Table 5: Expenditure and Income

Table 5 suggests that energy expenditure does not appear to increase with income. In 1997 the 2nd Decile income averaged $15,800, with a weekly energy expenditure of $17.70, while the 9th Decile income averaged $78,100, with weekly energy expenditure of $25.40 — a 400% difference in income but only a 40% difference in energy expenditure.

The ratios between the expenditures for each sub-group given in Table 5, permit a comparison between the income groups across time without the need to adjust the expenditure for inflation. Over the ten-year period the largest changes are in rent, where the lower income group is spending more than the higher income, and in maintenance goods, where the reverse is the case. In both sub-groups concerned with the maintenance of housing, the higher income group is spending more than twice the amount spent by the lower income group.

In 1986/87 between the 2nd and 9th Deciles there was a 340% increase in income and a 40% increase in expenditure on energy. By 1996/97 the difference in incomes was 400% but the energy expenditure was still only 40% greater. There are currently no New Zealand studies of energy use over time, which show whether changing income results in changed energy expenditure.

From a building research viewpoint, this difference in levels of expenditure on household maintenance also raises concern. The BRANZ House Condition Survey was first carried out in 1993/94. It found on average houses each had over $3,000 of outstanding maintenance — but as with any average there will be many houses with more or less maintenance required[17]. The survey is being repeated this year, and it will be interesting to see if the changes in expenditure are matched by changes in the required levels of maintenance. Auckland research found that the condition of the dwelling rated highly as a stressor for physical and mental health.[18]

Although the absolute expenditure is important for statistical and some economic uses, the issue for the householder is how much of their income is spent on the different aspects of their daily lives. Figure 7 uses the mid-point of the limits for each Decile as a divisor for the expenditure. Thus for the 2nd Decile 1997 the mid-point is $15,800 (see Table 4) while weekly energy expenditure is $17.70, with 100% of households reporting this expense. Assuming a $52.14 week year, then 5.6% of the income is spent on Fuel & Power. For the 1st and 10th Deciles the maximum and minimum incomes respectively are used.

Figure 6 reveals that in 1987 a house in the 2nd Decile spent $9.40 compared to $13.90 in the 9th Decile (for every $1 spent by a 2nd Decile house, $1.50 is spent by the 9th Decile household), but in 1997 the expenditures were $17.00 and $25.90 ($1.00 for each $1.52). In other words the dollars-of-the-day expenditures have increased in almost the same proportion for both low and high income households. However, Figure 7 shows that there has been an increase in the proportion of income allocated to Fuel & Power over the ten-year period, with those on lower incomes spending a higher proportion (+ 1.4%) than those on the higher incomes (+ 0.3%). Hence, assuming the same amount of energy use is maintained, expenditure has had to be diverted in low income houses from some other expenditure item.

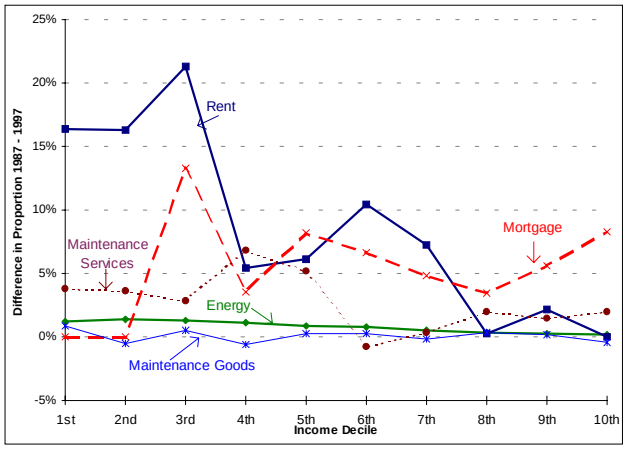


Figure 8: Change in % Income Spent on Housing sub-groups

Figure 8 shows the change in the proportion of income spent on selected sub-groups between the 1987 and the 1997 HES, for the Deciles with more than 1% reporting expenditure. Figure 5 shows that this excludes Mortgage expenditure for the 1st and 2nd Deciles, and Rent for the 10th Decile.

For Energy, shown in Figure 7, over the ten years the proportion of income spent by the 2nd Decile increased by 1.3% (4.3% in 1987 increased to 5.6% in 1997), while for the 9th Decile the proportion only increased by 0.3% (1.4% to 1.7%).

Rent increases have taken a large proportion of the incomes for the 1st, 2nd and 3rd Deciles, but very little for the 8thand 9th Deciles.

The main changes in the proportion of income spent on the different sub-groups shown in Figure 8 are:

- **Maintenance Goods** - very little change for all income deciles
- **Maintenance Services** - increase in the lower and higher income deciles
- **Energy** - increase for lower incomes but little change for middle to higher income deciles
- **Rent** - large increase for lower income groups, falling with increasing income
- **Mortgage** - similar increase for all income deciles.

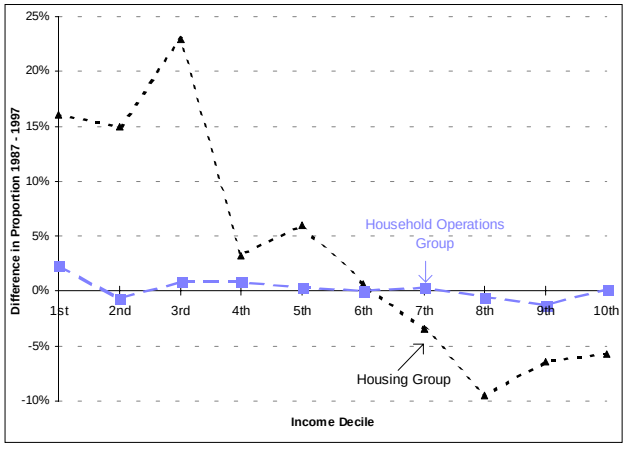


Figure 9: Change in % Income Spent on Housing & House Operations

Figure 9 compares the change in the proportion of income spent on:

- Housing Group - includes rent, net capital, mortgage, rates, property maintenance; and
- Household Operations Group - includes fuel & power, appliances, equipment, furniture, furnishings, floor coverings, textiles, cleaning supplies, telecommunications and other services.

Household Operations shows a small increase in the proportion of income spent for the lower income deciles. Housing shows a very large increase for the lower income deciles, but a decrease for the higher deciles. This pattern is very close to that for the Rent sub-group in Figure 8.

Indirect Measures of House Conditions

An initial viewing of the evidence suggests the general complacency about New Zealand's climate is correct, with few reported deaths attributable to low temperatures. However the patterns of mortality across the year offer a measure of how well our buildings protect us from the extremes of climate. One method is to compare the monthly mortality (after adjustment for the varying number of days in the month), and identify if there are certain periods of the years in which "excess" mortality occurs[19].

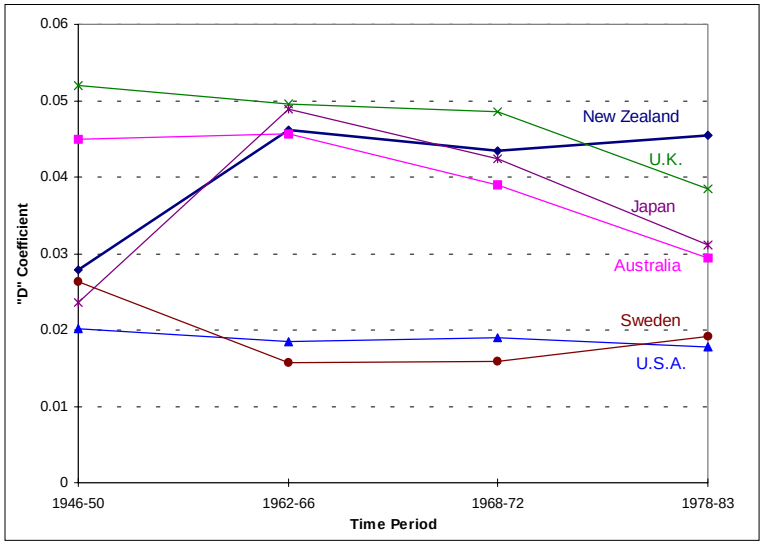


Figure 10: Seasonal Mortality "D" Parameter 1940 to 1980

The analysis presented here is based on published mortality data, but two caveats must be placed on the use of this data. Firstly the month in which a death is reported need not be the actual month in which death occurred. Secondly, prior to 1951 New Zealand Maori deaths did not have to be recorded; so mortality statistics collected prior to this time are not comparable with later data.

Figure 10 provides the "D" parameter (the greater the "D" parameter the greater the seasonal mortality) for the United Kingdom (England and Wales), United States of America, Australia, Japan, Sweden and New Zealand. The time periods start at New Zealand quinquennial census years. Monthly data was used, except for 1946-1950 where only quarterly data was available for New Zealand and the United Kingdom.

Figure 10 suggests these countries show a declining or lower constant pattern of seasonal mortality compared to New Zealand. For the period 1978-1983 New Zealand has 18% greater seasonal mortality than United Kingdom, 50% greater than Australia and Japan, and over 140% greater than either the United States of America or Sweden.[20]

The Japanese medico-geographer Sakamoto-Momiyama has argued that improved levels of comfort in housing have resulted in decreased seasonal mortality.[21] If this is correct, then Figure 10 suggests that whilst other developed countries have improved the comfort conditions in their housing, this is not the case in New Zealand. The complexity of the interactions between housing, the climate and the occupants makes the identification of the reasons extremely difficult.

Complex Interactions

People, and how they live, make housing one of the most complex research subjects. It almost seems self-evident that no one house will suit any or every person, group of people, culture or society. Yet there is almost always one common need that we expect our houses to meet — we want them to be comfortable. Surveys of new house buyers have found they place "comfort" at the top of their list of things they want in their house[22], but often the reality is that cost forms the actual base for the final decision.

When we find that the house does not offer all the comfort we desire, we modify the environment using any tool within our grasp. Adhesive tape and wrapping paper make a low capital cost way of closing up a hole that lets in the cold winter air. If this is not enough to permit comfort, then purchased energy is required. Even though the capital cost of an electric heater is small the lack of control over operating costs, possibly coupled with its lack of "grunt" to heat a cold and damp house, do not make it attractive to many people. Far

more attractive to many low income households are portable LPG heaters. Portable LPG heaters are moderately expensive to buy, very expensive to run, contribute considerable undesirable moisture to the air[23] and are potentially fatal if not operated correctly. However they generate very large amounts of heat very quickly and the operating cost is readily controllable — if the tank runs out before the weekly heating fund then a refill is possible, if not then for the rest of the week the house (or more likely one room) is cold.

Thus creating comfort involves a complex interaction between:

- location - what is the local climate (windy, very cold in winter, damp ground, etc)?
- house construction - is it easily kept warm?
- house size - big spaces need more energy to achieve the same temperatures
- house design - good design will maximise the benefits from the free energy from the sun
- occupant expectations - how warm does each person want to be?
- occupant dress - can the person who is not warm enough put on extra clothes, or do they need the space to be heated?
- occupant wealth - can the occupants afford the capital cost of a better designed or thermally performing house, or the running costs of the heater needed for a house with poor thermal performance?
- plus a range of other occupant, building, climate, economic issues.

Discussion

The need for housing is recognised by the United Nations "Universal Declaration of Human Rights" (adopted 10 December 1948), to be as important as any other aspect of daily life. Article 25 states:

> *1. Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.*

This paper has examined the conditions we desire to be provided for us, whether by the building itself ("passive") or through the use of purchased energy ("active"). It has been shown that New Zealand has a temperate climate, and that with a suitable house it is possible to easily achieve comfortable conditions. It has only been in the last century that we have been able to distance the conditions we have within our buildings from the conditions outside, but one result has been to expect that rather than the building offering "passive" comfort, purchased energy will be used. The response that appears to be used by New Zealanders is to provide their homes with minimum amounts of purchased heat and to accept the resulting temperatures. Even so, around one third of the purchased energy is used as heat.

The NZBC **Clause H1: Energy Efficiency** defines legal minimum thermal performance for houses, and equivalent legislation has been in place since 1 April 1978. The NZBC philosophy is that Government should only legally define what is unacceptable, and that good practice should be defined by market demand. Unfortunately too many people treat the NZBC as defining good practice, as was the case for the previous code. One result is that the improved standards of heating and insulation in European, American and Australian buildings over the past 40 years have resulted in significant improvements in comfort and health; but these improvements cannot be observed in New Zealand.

Energy is a significant cost item for low income households, but there is no data on what levels of service are provided for this expenditure. It would appear that in the past decade the proportion of income spent by low income houses on energy has increased faster than in higher income households. The rent paid by low income households has also increased at a faster rate than in higher income households.

There is currently no data on whether low income households occupy houses which are more or less energy efficient than higher income households. It is clear that if the houses occupied by people on low incomes have a poor energy efficiency, the addition of a heating appliance will merely increase the already high

demand on the household income. Given the enormous market growth for LPG heaters, which are expensive to purchase and operate but permit the household to closely control fuel expenditure, it is likely that the additional heating appliance will not be used.

The evidence suggests improving the thermal comfort by making our houses more energy efficient would be beneficial. The evidence also suggests our houses are not achieving conditions which promote or even support good health, and that merely providing additional heating appliances is not a satisfactory answer. It is possible that educating households to make more efficient use of their energy by pulling curtains, maintaining minimum ventilation etc would be of benefit, but there is no New Zealand data on the likely benefits.

The philosophy behind this paper is that people want buildings to provide an environment which provides them with pleasure, through permitting them to be both comfortable and healthy. The intention has been to bring together evidence on thermal comfort, household expenditure, measurements of energy and temperature in New Zealand houses, and measurements of how well our houses perform as a basis for discussion. It is clear that this evidence raises more questions than it answers, and that additional facts can only improve our understanding of how to provide better, more comfortable houses for all New Zealanders.

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The analysis and comments in this paper are the sole responsibility of the author, and must not be taken to represent the views, official or otherwise, of any other person or organisation. This paper is intended to promote discussion and comment, which should be directed to the author.

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