International Institute for
Applied Systems Analysis
Schlossplatz 1
A-2361 Laxenburg, Austria

Tel: +43 2236 807 342
Fax: +43 2236 71313
E-mail: publications@iiasa.ac.at
Web: www.iiasa.ac.at

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# Demographic Differentials in the Concern about Climate Change and Engagement in Climate-friendly Behaviours

Raya Muttarak (muttarak@iiasa.ac.at)
Thanyaporn Chankrajang (t.chankrajang@googlemail.com)

**Approved by**

Wolfgang Lutz
Program Director, World Population Program

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International Institute for Applied Systems Analysis
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## Abstract

Using a nationally representative survey of 3,900 adults on Opinions about the Environment and Global Warming 2010, this study investigates demographic differentials in the concern about climate change and climate-relevant behaviours in Thailand. The factor analysis of 11 environmentally friendly and carbon emissions reduction behaviours identifies two factors underlying climate-relevant behaviours: 1) electricity and water saving efforts; and 2) technical and behavioural change. The multivariate analyses show that women and individuals with higher education are more likely to worry a great deal about global warming and to perform technical and behavioural change. That education is positively related to technical and behavioural change but not with electricity and water saving actions could be because the former requires greater efforts and knowledge to pursue while the latter is commonly taken for economic reason. Concern about global warming and experience of environmental problem also increase the adoption of climate-relevant behaviours. Moreover, there is a spill-over effect of community-level education such that individuals living in a community with higher level of education are more likely to be concerned about climate change likewise.

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## About the Authors

Raya Muttarak is a Research Scholar at the Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/ÖAW, WU), Vienna Institute of Demography of the Austrian Academy of Sciences and International Institute for Applied Systems Analysis, Laxenburg, Austria.

Thanyaporn Chankrajang is a lecturer at the College of Population Studies, Chulalongkorn University, Bangkok, Thailand.

# Demographic Differentials in the Concern about Climate Change and Engagement in Climate-friendly Behaviours

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## 1 Introduction

Households are major contributors of the total carbon emissions of a country. The heating of homes in the United States and most European countries, for example, accounts for as much as 30-40% of total energy consumption (Abrahamse et al. 2005). Day-to-day activities ranging from burning gas for home heating, using electricity generated from non-renewable resources, and burning gasoline when driving, all contribute to greenhouse gas (GHG) emissions. Accordingly, changing energy-related behaviours of the public could contribute substantially in reducing the emission of GHG. Since the development and implementation of new technologies for low-carbon energy supply, energy efficiency and carbon sequestration will take decades to achieve, individual and household behavioural change appears to be a feasible quick option in emission reduction (Pacala and Socolow 2004).

Although behavioural changes such as the adoption of existing household technologies or altering mode of personal transportation can be implemented fairly straightforwardly (Gardner and Stern 2008), a voluntary change in environmental behaviour in the absence of regulations is not always easily achieved (Dietz et al. 2009).Barriers to the adoption of proactive environmental strategy range from lack of awareness and understanding, doubt about efficacy of one's action, to lack of knowledge on how to change behaviour to mitigate climate change. Meanwhile, raising concern about climate change may lead to active responses in changing climate-relevant behaviour or political action as found in previous studies that the uptake of direct and indirect pro-environmental behaviours is positively correlated with such concern (Tobler et al. 2012; Wicker and Becken 2013). In particular, when climate risks or impacts are perceived as psychologically close (e.g. geographically or temporally proximate), this can subsequently motivate mitigation behaviour (Alexa Spence et al. 2012).

Nevertheless, public attitudes to climate change and pro-environmental values and behaviours vary considerably by demographic and socioeconomic characteristics. Extant studies predominantly carried out in Europe or the United States found that environmentalism, environmental concerns and belief in climate change are positively associated with younger age, being female, left political ideology and higher education and income (McCright and Dunlap 2011; Running 2013; Whitmarsh 2011).Younger people are more environmentally aware possibly because younger cohorts are more exposed to the media and school curricula related to environmental issues (Howell and Laska 1992). Likewise, the gender gap could be due to different expectations for men

and women during parenthood and socialization processes (Zelezny et al. 2000), gender roles and division of labour (Blocker and Eckberg 1997), and different value formation processes (Stern et al. 1995). While boys are raised up to be independent and dominant over others, girls are raised to value nature and nurturance.With respect to socioeconomic characteristics, higher education may enhance knowledge about environmental problems and how to change one's behaviour as well as facilitate the process of environmental information (Liere and Dunlap 1980; Semenza et al. 2008) whereas higher income implies the fulfilment of basic material needs and subsequent increase in demand for quality of life and environmental sustainability (Inglehart 1995).

Furthermore, not all climate-relevant behaviours require similar efforts to implement. Behaviours contributing to climate change mitigation can be classified into high- and low- cost behaviours. The cost of adopting a certain behaviour includes not only pecuniary cost but also opportunity cost involving time, inconvenience or effort one has to put to pursue such behaviour (Diekmann and Preisendörfer 2003). Typically, the cost is high for switching from private car to using public transport whereas recycling or buying eco-friendly products is a low-cost behaviour. Accordingly, when the cost difference is small, behavioural change is more likely.

Pro-environmental behaviour can also be distinguished between efficiency behaviours and curtailment behaviours (Gardner and Stern 2002). Efficiency behaviours are one-shot behaviours which encompass the purchase of energy-efficient items such as cars and household appliances. On the other hand, curtailment behaviours entail continual efforts to reduce energy use by reducing consumption and utilization of energy such as by lowering thermostat settings. Subsequently, it appears that technical measures are more accepted than behavioural measures and changing of consumption patterns (Poortinga et al. 2003). Given demographic differentials in preferences and opportunities, the adoption of different types of climate-relevant behaviours can vary considerably with population subgroups.

Meanwhile, previous cross-national studies have shown that public attitudes and perceptions of the threat posed by climate change differ substantially across countries (Lorenzoni and Pidgeon 2006). Risk perception itself is specific to culture and place (Weber and Hsee 1999). Different exposure to climate hazards as well as social factors such as ethics, norms, and knowledge may thus explain this national variation. Likewise, attitudes and public's support for climate change policies can vary considerably between developed and less developed nations. People in developing countries, for example, are found to express lower willingness to pay to combat climate change (Alló and Loureiro 2014). It is explained that since lower income countries are still occupied with meeting their "material" needs, they have less room to consider post-materialistic values such as quality of life, freedom, and the environment (Dunlap and York 2008; Gelissen 2007).

Nevertheless, with rapid urbanization and industrialization in emerging economies, the increasing demand for energy use will have a significant impact on their GHG emissions (Sadorsky 2014). While industrialized developed countries have to put greater effort in emissions reduction, developing countries are also central to climate action given their significant increase in the share of global carbon dioxide (CO2) emissions– from 33% in 1990 to 53% in 2008 (Romani et al. 2012). Understanding the

public's awareness and perceptions of climate change in such countries could therefore be useful in designing and communicating climate change policies.

Extant studies that focus on perceptions of climate change and pro-environmental behaviours, however, are mainly carried out in high income countries. Evidence from less developed countries is scarce. Hence, this study aims to provide new empirical evidence on demographic differentials in the concern about climate change and climate-relevant behaviours in Thailand using the 2010 Opinion Survey on Environment and Global Warming (OEGW).The two main research questions investigated in this study include: 1) whether concern about climate change differ with demographic characteristics; and 2) what the determinants of climate-relevant behaviour are and whether they vary with different types of behaviours.

Being the second largest economy in Southeast Asia, Thailand is also the second largest CO2 emitter in the region (Shrestha and Pradhan 2010). As GDP rises, electricity demand also increases and demand from the household sector seemed to rise steadily regardless of the economic slump in 2008 (APEC 2010).Under the business-as-usual scenario (BAU), Thailand's greenhouse gas emissions are estimated to be 715.2 million tons of carbon dioxide equivalent (MtCO2eq) in 2030 and 1,398.7 MtCO2eq in 2050 (Chotichanathawewong and Thongplew 2012). The latter is almost equivalent to the total emissions of India in the year 2008 (IEA 2010). Accordingly, in order to improve energy security and reduce GHG emissions, Thailand has adopted a 20-year Energy Efficiency Development Plan 2011-2030 (EEDP). Apart from implementing mandatory requirements via regulations and standards as well as promoting technology development and innovation, fostering public awareness and change in energy consumption behaviour were included as key strategies towards sustainable energy (EEPO 2011). Understanding public perceptions of climate change and individual environmental behaviour thus is fundamental in designing effective energy and climate policies.

The remainder of the paper is organized as follows. The next sections describe the survey data and methods used for empirical analysis. Results are then presented. The findings are discussed in the discussion section and the final section concludes.

## 2 Data

This study uses a nationally representative, cross-sectional population-based survey on Opinions about the Environment and Global Warming (OEGW) 2010 carried out by the National Statistical Office of Thailand (NSO). Aiming to inform policy makers about public opinions, the survey collected environmental and global warming-related information including environmental problems experienced, impacts and concern about global warming, activities undertaken to reduce global warming and strategies recommended to confront global warming. Information on basic demographic and socio-economic characteristics was also available in the survey.

The OEGW survey was carried out in April 2010 comprising a nationally representative sample of adults aged ≥15 years in all regions in Thailand. A stratified, three-stage cluster sampling designed was adopted with the strata being five geographic regions: Bangkok Metropolitan area, north, northeast, central, and south regions. Primary sampling units (PSUs) were blocks in urban areas or villages in rural areas. In the first stage, the PSUs were randomly selected using selection probability proportional

to size sampling. 390 blocks/villages out of 109,966 blocks/villages in the whole country were selected. In the second stage, 10 households were randomly selected from the previously chosen urban or rural PSUs, using simple systematic random sampling. In the third stage, within the selected household, one eligible person i.e. a household member aged ≥15 was randomly selected for a face-to-face interview.

In total, 3,900 households were sampled whereby 1,829 men and 2,071 women were interviewed. There was no missing information in the variables of interest thus all 3,900 observations were retained for statistical analysis.

# 3 Methods

## 3.1 Measures and Variables

### *3.1.1 Dependent Variables*

This study investigates two outcomes:

1. *Concern about global warming*

The variable concern about global warming is derived from the question which asked"How much are you worried about the problem of global warming?". The respondents were given four responses: 1) a great deal; 2) a fair amount; 3) a little; and 4) not at all. Only 4.4% and 3.2% of the respondents chose "a little" and "not at all" categories respectively. The two categories thus are combined in our statistical analysis.

2. *Climate-relevant behaviours*

Climate-relevant behaviours are taken from a question which asked the respondents whether they had taken any actions to minimize the problem of global warming. A list of 11 actions were provided (see Table 1). The respondents had to indicate which actions they had taken and how often they carried out such actions given the options: 1) regularly; 2) sometimes; and 3) not at all/not applicable. Note that the third category could be problematic since a particular action such as "setting up air conditioner to 25°C" would not apply to the respondents who do not possess an air conditioner. Accordingly, in the survey those respondents would be considered as not having carried out such action to reduce global warming. This could be misleading especially when assessing socio-demographic determinants of climate-relevant behaviours. In the final analysis, such problematic items are excluded.

Table 1. Overview and Descriptive Statistics of Dependent Variables

| Dependent variables | Scale | % of respondents |
|---|---|---|
| **Concern about global warming** | ordinal | |
| a great deal | | 52.4 |
| a fair amount | | 40.0 |
| little/not at all | | 7.6 |
| **Climate relevant behaviours** | | |
| *Use cloth bag instead of plastic bag* | ordinal | |
| regularly | | 13.1 |
| sometimes | | 55.4 |
| never | | 31.5 |
| *Plant trees and forest conservation* | ordinal | |
| regularly | | 20.4 |
| sometimes | | 61.6 |
| never | | 18.0 |
| *Use energy saving light bulbs* | ordinal | |
| regularly | | 38.7 |
| sometimes | | 38.5 |
| never | | 22.8 |
| *Unplug electrical devices when not in use* | ordinal | |
| regularly | | 70.1 |
| sometimes | | 28.2 |
| never | | 1.8 |
| *Turn off unused lights* | ordinal | |
| regularly | | 81.1 |
| sometimes | | 18.0 |
| never | | 0.9 |
| *Use energy-efficient appliances* | ordinal | |
| regularly | | 54.5 |
| sometimes | | 36.3 |
| never | | 9.2 |
| *Set up air conditioner to 25°C* | ordinal | |
| regularly | | 17.6 |
| sometimes | | 12.7 |
| never | | 69.7 |
| *Use public transportation rather than private vehicle* | ordinal | |
| regularly | | 22.6 |
| sometimes | | 52.3 |
| never | | 25.1 |
| *Turn off the tap while brushing teeth/taking shower* | ordinal | |
| regularly | | 65.4 |
| sometimes | | 27.5 |
| never | | 7.1 |

| Dependent variables | Scale | % of respondents |
|---|---|---|
| *Fill in a container when washing rather than running tap water* | ordinal | |
| regularly | | 57.1 |
| sometimes | | 33.7 |
| never | | 9.2 |
| *Reduce the use of styrofoam container* | ordinal | |
| regularly | | 20.5 |
| sometimes | | 57.9 |
| never | | 21.6 |

### *3.1.2 Independent Variables*

A set of other explanatory and control variables including demographic characteristics, climate change and environmental perceptions, and contextual characteristics added in the analysis are presented in Table 2.

Table 2. Overview and Descriptive Statistics of Independent Variables

| Independent variables | Scale | % of respondents |
|---|---|---|
| **Individual characteristics** | | |
| *female* | dummy | 53.1 |
| *Age groups* | ordinal | |
| aged 15-19 years | | 7.6 |
| aged 20-29 years | | 15.8 |
| aged 30-39 years | | 23.1 |
| aged 40-49 years | | 22.3 |
| aged 50-59 years | | 19.7 |
| aged ≥ 60 years | | 11.6 |
| *Highest level of education* | ordinal | |
| no education | | 2.0 |
| primary education | | 43.3 |
| lower secondary | | 15.9 |
| upper secondary | | 13.0 |
| vocational | | 5.4 |
| diploma | | 6.6 |
| bachelor and above | | 13.9 |
| **Climate change perceptions** | | |
| Had environmental problem in community | dummy | 68.6 |
| Felt that climate has changed compared to last year | dummy | 96.0 |
| Heard about global warming/climate change | dummy | 95.3 |
| **Contextual characteristics** | | |
| Region of residence | nominal | |
| Bangkok | | 20.0 |
| central | | 20.0 |

| Independent variables | Scale | % of respondents |
|---|---|---|
| north | | 20.0 |
| northeast | | 20.0 |
| south | | 20.0 |
| average level of education in community | continuous | 3.28 (0.63)[a] |

Note: [a] mean and standard error in parentheses.

*Demographic characteristics*

The main interest is to investigate how concern about global warming and climate-relevant behaviours vary by demographic characteristics including gender, age and educational attainment. Gender is a dummy variable coded 1 if the respondent is female, 0 otherwise. Due to gender differences in socialization, political orientation and risk perceptions, women are reported to be more likely to believe in global warming and to engage in behaviours contributing to global warming mitigation (Joireman and Liu 2014). Age is grouped into 6 categories: 15-19 years; 20-29 years; 30-39 years; 40-49 years; 50-59 years; and $\geq$ 60 years. Age has generally been found to be negatively correlated with concern about global warming. With fewer years of remaining life expectancy, older people may perceive that it is unlikely for global warming to affect them personally and consequently less likely to change their behaviour. Educational attainment is divided into 7 levels: no education; primary; lower secondary; upper secondary; vocational; diploma; and bachelor and above. Education is expected to increase knowledge and familiarity with a range of issues including environmental problems and global warming (Tjernström and Tietenberg 2008), which in turn can increase concern about climate change.

*Climate change and environmental perceptions*

Concern about climate change is influenced by perception of climate change, which can consequently affect people's motivation to act (Swim et al. 2009). Furthermore, concern about climate change and climate-relevant behaviours are also associated with experience of environmental problems/natural disasters and knowledge of global warming. It is commonly found that people often conflate climate change with other environmental problems (Reynolds et al. 2010). It is therefore possible that experiencing environmental problems increase the willingness to adopt mitigation activities. Similarly, perceptions of having experienced warming or perceived changes of weather-related events have been found to be positively correlated with belief in and concern about climate change (Li et al. 2011; Taylor et al. 2014). Here we include three dummy variables indicating whether the respondents: 1) have experienced environmental problem in a community; 2) felt that the weather had changed compared to last year; and 3) have heard about global warming/climate change.

*Contextual characteristics*

We control for a region of residence which is divided into five areas: Bangkok Metropolitan; central; north; northeast; and south. The five areas differ substantially in terms of social, economic and geographical characteristics and this can influence

climate change attitudes and behaviours accordingly. Average level of education in a community measured as the aggregated level of education in each PSU is also included. The educational category in the OEGW is hierarchical ranging from 1 to 7, with 1 referring to no education and 7 referring to the bachelor level and above. Previous literature suggests that there could be a spill-over effect of community level education on individual behaviours such as being prepared for a disaster (Muttarak and Pothisiri 2013). This could also be the case for concern about climate change and climate-relevant behaviours.

### *3.1.3 Statistical Analysis*

The data analysis consisted of three main steps. First, in order to address the first research question on demographic differentials in the concern about climate change, the variable that measures the level of "worry about the problem of global warming" was recoded into three categories in a sequential order: 1) little/not at all; 2) a fair amount; and 3) a great deal. Because the outcome variable was not normally distributed, ordinary least squares (OLS) regression could not be used because the normality assumption would be violated. Thus, ordered logistic regression, as outlined below, is employed to estimate the association between concern about climate change and demographic characteristics given the ordinal response variable like ours.

$$y_i^* = \beta_0 + \beta_1 female_i + \beta_2 age_i + \beta_3 education_i + \beta_4 \boldsymbol{x}_i + \varepsilon_i,$$

$$y_i = 1 \quad if \quad y_i^* \leq \gamma_1$$

$$y_i = 2 \quad if \quad \gamma_1 < y_i^* \leq \gamma_2$$

$$y_i = 3 \quad if \quad y_i^* > \gamma_2,$$

where $y_i^*$ is the underlying latent concern about climate change of an individual *i*, which is modelled as a function of demographic variables $female_i$, $age_i$, and $education_i$, and other controlled characteristics $\boldsymbol{x}_i$ such as environmental perceptions, region of residence and average level of education in the region. If $y_i^*$ is smaller than or equal to the unknown parameter $\gamma_1$, the individual *i* will report that he or she concerns a little or not at all about the problem of global warming. If $\gamma_1 < y_i^* \leq \gamma_2$, the individual *i* will report that he or she concerns a fair amount. If $y_i^* > \gamma_2$, the individual *i* will report that he or she concerns a great deal. Both $\gamma_1$ and $\gamma_2$ are estimated jointly with $\beta_i$ in the model.

In addition, likelihood-ratio test was performed to test the proportional odds assumption and the results confirmed that the assumption was not violated (Wolfe and Gould 1998). Hence, the use of ordered logistic estimation is justified. (A sentence is deleted.)

Second, Principal Components Analysis (PCA) was performed to cluster items that measured the same climate-relevant behaviours. The 11 items of the behaviours listed in Table 1 were subjected to a principal components exploratory factor analysis. The item "set up air conditioner to 25°C" has a rather high uniqueness value of 0.52 i.e. 52% of the common variance of the variable not associated with the factors. Thus, the item is excluded from the final factor analysis. In addition, since a response to the item "use public transportation rather than private vehicle" depends considerably on whether

the respondents possess a private vehicle or not, this item is also excluded. Exploratory factor analysis is then performed on 9 items.

Table 3. Factor Loading and Item-scale Correlations for Each Item of Climate-relevant Behaviour Scales

| Scale | Items | Factor loading | Item-total correlation |
|---|---|---|---|
| **Electricity and water saving** | Unplug electrical devices when not in use | 0.63 | 0.67 |
| Eigenvalue = 2.62 | Turn off unused lights | 0.69 | 0.65 |
| Explained variance = 55.3% | Turn off the tap while brushing teeth/taking shower | 0.45 | 0.73 |
| Cronbach's α = 0.64 | Fill in a container when washing rather than running tap water | 0.42 | 0.73 |
| **Technical and behavioural change** | Use energy saving light bulbs | 0.55 | 0.61 |
| Eigenvalue = 1.31 | Use energy-efficient appliances | 0.42 | 0.70 |
| Explained variance = 44.7% | Use cloth bag instead of plastic bag | 0.49 | 0.61 |
| Cronbach's α = 0.60 | Plant trees and forest conservation | 0.37 | 0.55 |
| | Reduce the use of styrofoam container | 0.45 | 0.62 |

The factor analysis for items capturing climate-relevant behaviours resulted in a two-factor solution as presented in Table 3. For both factors retained, all items have factor loadings >.40 except for “planting tree and forest conservation” which has factor loadings of .37. The first factor labelled “electricity and water saving” explained 55.3% of the variance and consisted of four items tapping two actions contributing to electricity saving (i.e. unplugging electrical devices when not in use and turning off unused lights) and another two actions representing water saving efforts (i.e. turning off the tap while brushing teeth/taking shower and filling in a container when washing rather than running tap water). The index of electricity and water saving was constructed based on these four items (Cronbach's α = 0.64). The second factor labelled “technical and behavioural change” explained 44.7% of the variance and consisted of five items. Two items represent efficiency behaviours (i.e. using energy saving light bulbs and using energy-efficient electrical devices) while the rest three items are curtailment behaviours involving repetitive efforts to reduce GHG emissions (i.e. using cloth bag instead of plastic bag, planting trees and forest conservation, and reducing the use of styrofoam container). The index of technical and behaviour change was constructed based on these five items (Cronbach's α = 0.60).

Third, to answer the second research question on the determinants of climate-relevant behaviours and how these determinants vary with different behaviours, OLS regressions on the two behaviour indices (i.e. electricity and water saving and technical and behaviour change) created from factor analysis were performed. OLS regression is an appropriate method since the two indices are normally distributed. Each index has the maximum score of 3. The higher the score, the more engaged the respondents in climate-friendly behaviours.

## 4 Results

### *Demographic differentials in concern about global warming*

Table 4. Ordered Logit Estimates of Concern about Global Warming

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | Demographic characteristics | | Climate change perceptions | | Contextual characteristics | |
| | *B* | *s.e.* | *β* | *s.e.* | *β* | *s.e.* |
| *Demographic characteristics* | | | | | | |
| female | 0.119+ | (0.063) | 0.143* | (0.064) | 0.142* | (0.064) |
| aged 15-19 years | 0.017 | (0.137) | -0.001 | (0.138) | 0.004 | (0.138) |
| aged 20-29 years | 0.057 | (0.105) | 0.031 | (0.106) | 0.039 | (0.107) |
| aged 30-39 years | ref | | ref | | ref | |
| aged 40-49 years | 0.051 | (0.096) | 0.038 | (0.097) | 0.027 | (0.097) |
| aged 50-59 years | -0.097 | (0.102) | -0.110 | (0.103) | -0.124 | (0.103) |
| aged ≥ 60 years | -0.026 | (0.122) | 0.017 | (0.123) | 0.010 | (0.124) |
| no education | -0.661** | (0.243) | -0.561* | (0.249) | -0.500* | (0.251) |
| primary education | -0.276* | (0.109) | -0.285** | (0.110) | -0.247* | (0.113) |
| lower secondary | -0.205+ | (0.118) | -0.201+ | (0.119) | -0.172 | (0.120) |
| upper secondary | ref | | ref | | ref | |
| vocational | -0.210 | (0.163) | -0.174 | (0.165) | -0.182 | (0.165) |
| diploma | 0.097 | (0.154) | 0.109 | (0.155) | 0.087 | (0.156) |
| bachelor and above | 0.327* | (0.127) | 0.325* | (0.128) | 0.276* | (0.130) |
| *Climate change perceptions* | | | | | | |
| Had environmental problem in community | | | 0.566*** | (0.068) | 0.570*** | (0.070) |
| Felt that climate has changed compared to last year | | | 0.983*** | (0.164) | 0.970*** | (0.164) |
| Heard about global warming/climate change | | | 0.360* | (0.153) | 0.325* | (0.154) |
| *Contextual characteristics* | | | | | | |
| central | ref | | ref | | ref | |
| Bangkok | | | | | -0.221* | (0.109) |
| north | | | | | -0.115 | (0.102) |
| northeast | | | | | -0.107 | (0.103) |
| south | | | | | -0.374*** | (0.101) |
| average level of education in community | | | | | 0.169** | (0.065) |
| Little versus a fair amount/great deal | -2.579*** | (0.121) | -0.945*** | (0.240) | -0.596+ | (0.325) |
| Little/a fair amount versus great deal | -0.158 | (0.109) | 1.534*** | (0.240) | 1.891*** | (0.326) |
| Observations | 3,900 | | 3,900 | | 3,900 | |
| Log likelihood | -3485 | | -3426 | | -3417 | |
| DF | 12 | | 15 | | 20 | |

Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 4 presents a series of ordered logit models estimating the level of concern about global warming taking into account demographic characteristics and other relevant factors. The first model considers only demographic characteristics while the second model controls for perceptions about climate change and the environment. The last model includes contextual characteristics that may influence the level of concern about global warming.

Across the three models, we observe significant gender and educational differentials in concern about global warming. The odds of having greater concern about global warming for women is 1.2 times ($e^{0.142}$) that of men. The association between educational attainment and the level of concern about global warming is rather linear. Compared to those with upper secondary education, the respondents with no education and primary education are significantly less likely to worry about global warming. Meanwhile, those with bachelor degree have 1.3 times ($e^{0.276}$) greater odds of concerning about global warming. Age does not have significant relationships with concern about global warming. Individuals whose community had environmental problem have greater concern about global warming. Likewise, feeling that the weather has changed compared to the past year and having heard about global warming/climate change increase the odds of concern about the problem of global warming by 2.6 times ($e^{0.970}$) and 1.4 times ($e^{0.325}$) respectively. Compared to the central region, respondents living in Bangkok and the south significantly have lower concern while those living in a community with higher level of education have greater concern about global warming.

***Demographic differentials in climate relevant behaviours***

Table 5. Distribution of Climate-relevant Behaviours by Gender

| | Male | Female | All |
|---|---|---|---|
| *Use cloth bag instead of plastic bag**** | | | |
| regularly | 9.8 | 16.0 | 13.1 |
| sometimes | 52.8 | 57.7 | 55.4 |
| never | 37.4 | 26.4 | 31.5 |
| *Plant trees and forest conservation** | | | |
| regularly | 22.0 | 19.0 | 20.4 |
| sometimes | 61.3 | 61.9 | 61.6 |
| never | 16.7 | 19.1 | 18.0 |
| *Use energy saving light bulbs** | | | |
| regularly | 37.9 | 39.5 | 38.7 |
| sometimes | 40.5 | 36.7 | 38.5 |
| never | 21.5 | 23.9 | 22.8 |
| *Unplug electrical devices when not in use*** | | | |
| regularly | 67.9 | 72.0 | 70.1 |
| sometimes | 30.5 | 26.1 | 28.2 |
| never | 1.6 | 1.9 | 1.8 |
| *Turn off unused lights* | | | |
| regularly | 80.2 | 82.0 | 81.1 |
| sometimes | 18.9 | 17.2 | 18.0 |
| never | 0.9 | 0.8 | 0.9 |

| | Male | Female | All |
|---|---|---|---|
| *Use energy-efficient appliances** | | | |
| regularly | 52.3 | 56.5 | 54.5 |
| sometimes | 38.3 | 34.5 | 36.3 |
| never | 9.4 | 8.9 | 9.2 |
| *Set up air conditioner to 25°C* | | | |
| regularly | 16.6 | 18.5 | 17.6 |
| sometimes | 13.4 | 12.0 | 12.7 |
| never | 70.0 | 69.5 | 69.7 |
| *Use public transportation**** | | | |
| regularly | 19.1 | 25.8 | 22.6 |
| sometimes | 53.3 | 51.4 | 52.3 |
| never | 27.7 | 22.8 | 25.1 |
| *Turn off the tap while brushing teeth/taking shower*** | | | |
| regularly | 63.1 | 67.5 | 65.4 |
| sometimes | 29.6 | 25.6 | 27.5 |
| never | 7.3 | 6.9 | 7.1 |
| *Fill in a container when washing rather than running tap water* | | | |
| regularly | 56.0 | 58.0 | 57.1 |
| sometimes | 34.1 | 33.4 | 33.7 |
| never | 9.9 | 8.6 | 9.2 |
| *Reduce the use of styrofoam container*** | | | |
| regularly | 19.6 | 21.4 | 20.5 |
| sometimes | 56.9 | 58.8 | 57.9 |
| never | 23.6 | 19.8 | 21.6 |

*** p<0.001, ** p<0.01, * p<0.05

Note: P-value is obtained from a chi-square test of association between gender and each behaviour.

Table 5 presents the distribution of 11 items related to climate-relevant behaviours by gender. Chi-square tests were performed to test the relationship between gender and each climate action. For most actions, the proportion of individuals who regularly adopt environmentally friendly behaviours is significantly greater for women than for men. The four actions most commonly carried out regularly by both men and women include electricity and water saving actions i.e. turning off unused lights (82.0%), unplugging electrical devices when not in use (72.0%), turning off the tap while brushing teeth/taking shower (67.5%), and filling in a container rather than running tap water (58.0%). The majority of the respondents reported using energy-efficient appliances (56.5%) while about two-fifth use energy saving light bulbs. Only about one-fifth of the respondents adopted actions that require efforts to change behaviours and involve some inconvenience such as using public transportation, planting trees, and setting up air conditioner to 25°C.

Table 6. OLS Regression Analysis for Climate-relevant Behaviours

| | Electric and water saving | | Technical and behavioural change | |
|---|---|---|---|---|
| | *β* | *s.e.* | *β* | *s.e.* |
| *Demographic characteristics* | | | | |
| female | 0.039** | (0.012) | 0.045*** | (0.013) |
| aged 15-19 years | -0.093*** | (0.027) | 0.018 | (0.027) |
| aged 20-29 years | -0.056** | (0.020) | -0.033 | (0.021) |
| aged 30-39 years | ref | | ref | |
| aged 40-49 years | 0.008 | (0.019) | 0.057** | (0.019) |
| aged 50-59 years | 0.034+ | (0.020) | 0.057** | (0.020) |
| aged ≥ 60 years | 0.036 | (0.024) | 0.047+ | (0.024) |
| no education | -0.024 | (0.050) | -0.304*** | (0.051) |
| primary education | 0.004 | (0.022) | -0.128*** | (0.022) |
| lower secondary | -0.014 | (0.023) | -0.060* | (0.024) |
| upper secondary | ref | | ref | |
| vocational | 0.021 | (0.031) | 0.026 | (0.032) |
| diploma | -0.009 | (0.030) | 0.056+ | (0.030) |
| bachelor and above | 0.018 | (0.025) | 0.122*** | (0.025) |
| *Climate change perceptions* | | | | |
| Worry a little/not at all about global warming | ref | | ref | |
| Worry a fair amount about global warming | 0.022 | (0.024) | 0.131*** | (0.025) |
| Worry a great deal about global warming | 0.092*** | (0.024) | 0.200*** | (0.025) |
| Had environmental problem in community | 0.026+ | (0.014) | 0.058*** | (0.014) |
| Felt that climate has changed compared to last year | 0.044 | (0.032) | 0.051 | (0.032) |
| Heard about global warming/climate change | 0.125*** | (0.030) | 0.104*** | (0.031) |
| *Contextual characteristics* | | | | |
| central | ref | | ref | |
| Bangkok | -0.012 | (0.021) | 0.012 | (0.021) |
| north | -0.006 | (0.020) | -0.022 | (0.020) |
| northeast | -0.005 | (0.020) | -0.155*** | (0.020) |
| south | -0.032+ | (0.020) | -0.002 | (0.020) |
| average level of education in community | -0.015 | (0.012) | 0.009 | (0.013) |
| Constant | 2.440*** | (0.064) | 1.748*** | (0.065) |
| Observations | 3,900 | | 3,900 | |
| R-squared | 0.03 | | 0.12 | |

Standard errors in parentheses. *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

The factor analysis (see Table 3) reveals that climate-relevant behaviours can be grouped into two types of actions: 1) electricity and water saving measures; and 2) technical and behavioural change. Table 6 displays OLS regression estimates for the two climate-relevant behaviours considering demographic and contextual characteristics as well as climate change and environmental perceptions.

Women are significantly more likely to adopt both climate-relevant behaviours than men. With respect to age, compared to those aged 30-39 years, the younger age groups are less likely to undertake electric and water saving action. Meanwhile, the older age groups (i.e. those aged ≥ 40 years) are more likely that those aged 30-39 years to pursue technical and behavioural change. While education is not significantly associated with electric and water saving, it has a positive relationship with technical and behavioural change. Concern about climate change is positively related with the uptake of climate-relevant behaviours especially technical and behavioural change. The respondents who have heard about global warming/climate change are significantly more likely to adopt both climate-relevant behaviours while those whose community had environmental problem are significantly more likely to undertake technical and behavioural change. Respondents living in the northeast are significantly less likely to pursue technical and behavioural change compared to those living in the central region.

Figure 1. Predicted Score of Adopting Electricity and Water Saving Behaviour for a Person Aged 40-49 Years Living in the South

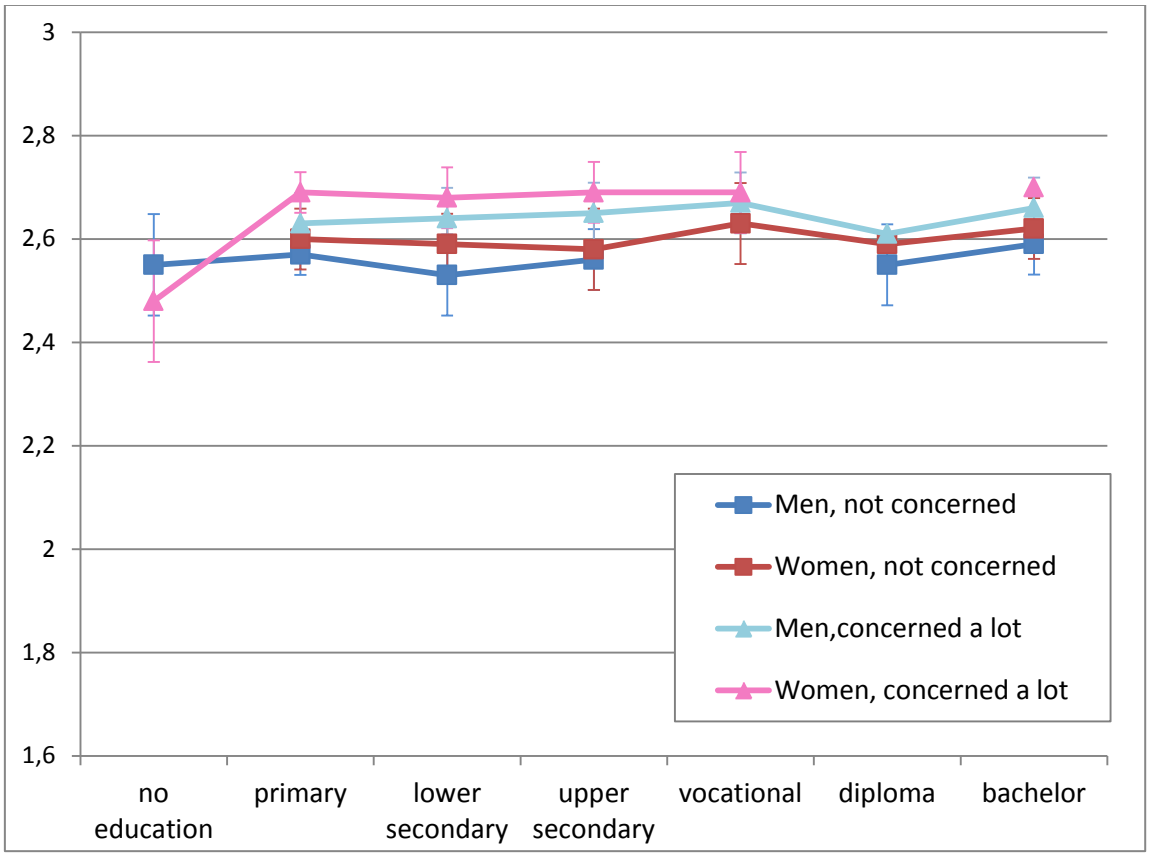
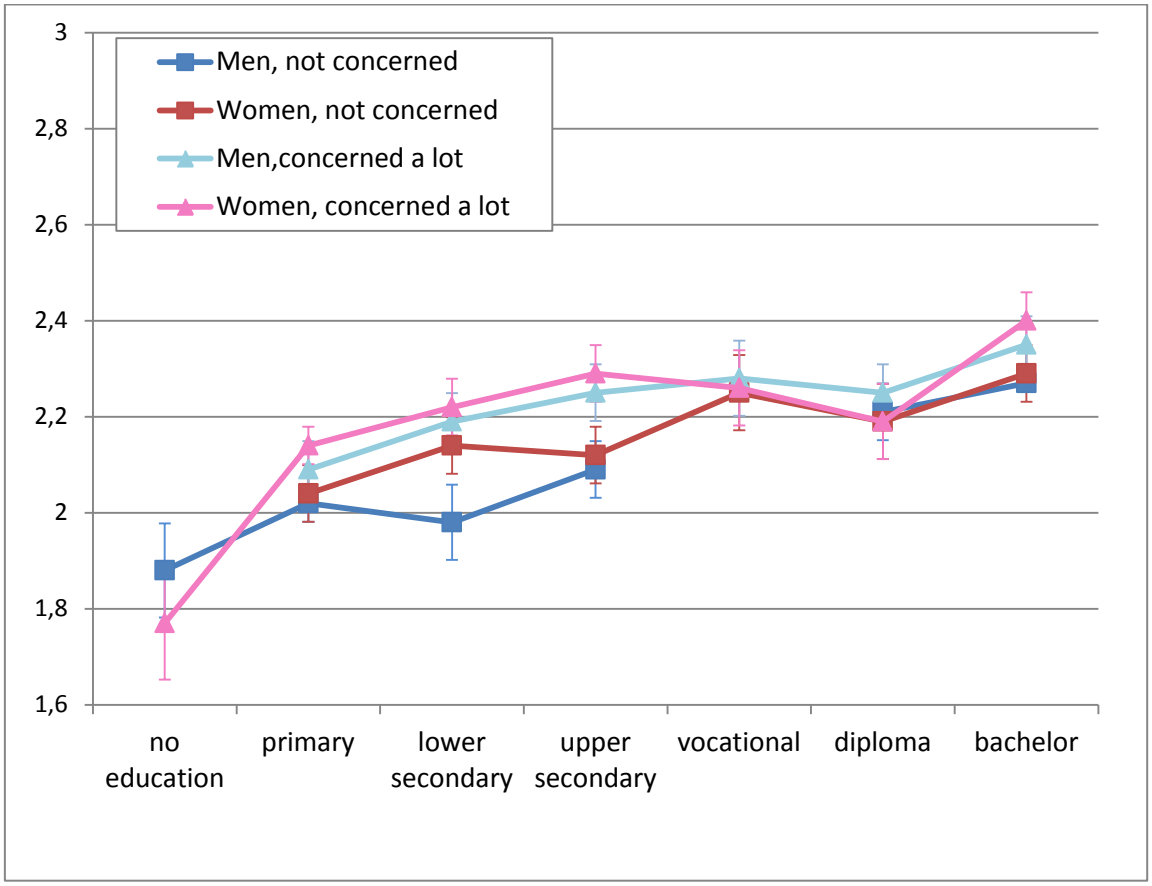


Figure 2. Predicted Score of Undertaking Technical and Behaviour Change for a Person Aged 40-49 Years Living in the South




In order to visualize the relationship between education and uptake of climate-relevant behaviours, we calculated predicted scores of climate-relevant behaviours for a hypothetical person aged 40-49 years and living in the south based on the OLS estimates in Table 6. Figures 1 and 2 illustrate the level of adopting electricity and water saving behaviour and undertaking technical and behavioural change respectively by gender, education and the level of concern about global warming. Figure 1 shows that there is not much gender and educational variation in the level of adopting electricity and water saving behaviour. The adoption of this behaviour does not seem to vary greatly by concern about climate change either. On the other hand, with respect to adopting technical and behavioural change in Figure 2, the education gradient is evident as well as the variation by the level of concern about global warming.

## 5 Discussion

Based on a nationally representative survey of 3,900 adults on Opinions about the Environment and Global Warming 2010, we found that the key demographic characteristics explaining the level of concern about climate change and the adoption of behaviours contributing to the reduction of GHG emissions are gender and education. The level of concern about climate change and the engagement in mitigation behaviours is greater among women as compared to men. This finding is consistent with previous studies in industrialized countries such as the United States (McCright and Dunlap 2011) and Australia (Tranter 2011).Upon empirically testing different hypotheses

explaining gender differences in climate change concern, McCright (2010) found evidence supporting the gender socialization argument, which explains that the emphasis on nurture, empathy and care attached to feminine identity translates into greater concern about the environment and climate change. Despite the active participation of women in the economy, public sector, businesses and professional occupations, women in Thailand have also been socialized to serve and care for family members and the community (Vichit-Vadakan 2008). Gender socialization thus may explain our findings of the gender difference in concern about climate change and climate-relevant behaviours.

We also found that the level of concern about climate change is greater among individuals with higher education. More highly educated individuals generally have better understanding of scientific knowledge and familiarity with a range of issues. Since greater knowledge about climate change is positively correlated with concern about climate change (Milfont 2012), this consequently can explain the positive relationship between educational attainment and climate change concern. Interestingly, there is no educational discrepancy in the case of electric and water saving actions but education is positively associated with actions involving technical and behavioural change. The former might be performed simply due to economic reasons to save the cost of utilities while the latter especially behavioural measures such as using cloth bag instead of plastic bag or reducing the use of styrofoam container require an additional effort or decreased comfort. Individuals with higher education who generally have greater concern for the environment and climate change may be more willing to perform these actions (Diamantopoulos et al. 2003; Ortega-Egea et al. 2014). Likewise, technical behaviour such as using energy saving light bulbs or energy-efficient appliances require capacity and intention to accept new information and knowledge, which individuals with higher education are more likely to possess (Karytsas and Theodoropoulou 2014; Welsch and Kühling 2010). Our finding suggests that education increases both concern about climate change and competency to carry out climate friendly actions.

The relations between age and climate change-related attitudes and behaviours are not conclusive in the literature. While most previous studies generally report negative correlations of age with climate change concern, we found no significant relationships between the two factors in our Thai sample. Regarding climate-relevant behaviours, it appears that older people are more likely to perform both electric and water saving and technical and behavioural change. This finding is consistent with a recent study in European countries (Ortega-Egea et al. 2014) showing that engagement in some form of climate change-motivated activity is higher among older people. Due to lifestyle change in older age, older people are more likely to accept energy-saving measures such as those related to transport because they are generally less mobile than younger people (Poortinga et al. 2003). Accordingly, it has been found that older people have lower consumption of energy-intensive goods, especially transportation(Kluge et al. 2014; Poortinga et al. 2004).

The finding that experience of environmental problem in a community increases the level of concern about global warming as well as the level of adoption of climate-relevant behaviours is similar to that of previous studies which look at the impact of flood experience (A. Spence et al. 2011; Whitmarsh 2008). Experience of natural disasters is easily linked to climate change perception since the likelihood of a risk can be readily imagined. Meanwhile, why those having experienced environmental

problems are more likely to worry about climate change could be due to the common conflation of climate change with other environmental risks (Read et al. 1994; Reynolds et al. 2010). Even in European countries where generally climate change issues receive greater media attention than in less developed countries (Schmidt et al. 2013), people often fail to distinguish between environmental and climate change issues (Fischer et al. 2012). While the conflation of climate change with other environmental problems may hinder appropriate behavioural changes and taking up of mitigation and adaptation actions (Weber and Stern 2011), in the case of Thailand, we found that people who experienced environmental problems are also more likely to adopt technical and behavioural change. Promoting accurate knowledge about climate change nevertheless remains crucial since lack of knowledge is one key barrier of behavioural changes.

Contextual factors such as hazard exposure and geographical risk can also influence risk perception and consequently concern about climate change. Indeed we found that individuals living in Bangkok and the southern region are less likely to express concern about climate change as compared to those living in the central region. In particular, people living in the south are also less likely to be worried about climate change than those living in the north, northeast and central part where drought and flood are more frequent (Garbero and Muttarak 2013). While there is no substantial regional difference in performing electric and water saving, people living in the northeast are significantly less likely to adopt technical and behavioural change than those living in other parts of the country. Being the poorest region in Thailand (Jitsuchon and Richter 2007), the northeast may have contextual factors that constrain pro-environmental behaviour e.g. lack of the market supply of goods. Likewise, the northeast also have the lowest average level of education in the country and this may hinder the diffusion of knowledge and know how to adopt technical and behaviour change.

Indeed education at the community level matters in improving concern about climate change of an individual. The positive spill-over effects of community-level education on individual or household behaviours have been documented in such outcomes as disaster preparedness (Muttarak and Pothisiri 2013; Witvorapong et al. 2013), infant mortality (Pamuk et al. 2011) and contraceptive use (McNay et al. 2003). Given interactions among community members, this allows exchange of information including climate change knowledge. A community with higher average level of education may have better knowledge about climate change and this translates into a greater concern among community members.

In addition, our analysis clearly shows that pursuing electricity and water saving action and carrying out technical and behavioural change are different types of behaviours. The vast majority of the respondents reported that they regularly carry out electricity and water saving measures. This behaviour despite being weakly correlated with concern about global warming is rather often motivated by a desire to save money (Whitmarsh 2009). On the other hand, the actions that requires technical and behavioural change involve efforts to change behaviours, reduce comfort and acquire new appliances. Accordingly, we find that the level of education matters greatly for this type of behaviour but not so much for electricity and water saving action. While paying attention to electricity and water consumption is a rather straightforward thing to do since it translates into cheaper electricity and water bills, technical and behavioural change may require certain knowledge, awareness about climate change and ability to

afford new equipment, such characteristics that highly educated individuals are more likely to have.

The present study has two main limitations. First, using the secondary survey data i.e. the Opinions about the Environment and Global Warming (OEGW) 2010 data, we relied on how the questions were framed in the survey. In particular, in the case of climate-relevant actions, the respondents were given a response option of: 1) not having performed a particular action; or 2) the question does not apply to them in the same response category. This could lead to underestimation of climate-relevant behaviours since a particular action such as setting up air conditioner to 25°Cmight be reported as not being performed simply because a respondent does not possess an air conditioner. Such problematic actions i.e. setting up air conditioner to 25°C and using public transportation were therefore excluded from the statistical analysis to avoid the underestimation problem.

Secondly, this study relies on self-reported climate-relevant actions. Accordingly, concern about climate change and engagement in mitigation actions observed may be overstated by the respondents due to social desirability biases. In particular, if certain demographic groups have greater tendency to give socially desirable responses instead of choosing responses that represent their true feelings or beliefs, the climate change concern and mitigation actions estimated will be biased upward for such groups. It is possible that individuals with higher level of education over-report their concern about climate change and their engagement in mitigation actions as found in the case of voter turnout (Karp and Brockington 2005) or reading to children (Hofferth 1999). Nevertheless, as our data include non-student samples and climate-relevant behaviours measured are those of past/present (instead of intended/future), our measures of climate concern and mitigation actions are unlikely to be affected by social desirability biases (Frick et al. 2004).

## 6 Conclusion

Despite ratifying the Kyoto Protocol in 2002, GHG emissions in Thailand continued to increase due to rising energy consumption at a rate of 4-5% per year following the economic growth (APEC 2010). While power generation, transportation and manufacturing industrial sectors are major CO2 emitters, household electricity and energy demand has been on a constant rise due to both population growth and economic expansion. It is estimated that with the implement of high efficiency lighting devices and electrical appliances alone, 6.53 million tonnes of CO2 emissions in the residential sector can be mitigated in 2020 (Chaosuangaroen and Limmeechokchai 2008). As a consequence, the government has implemented several plans and measures to promote energy conservation and measures to accelerate use of alternative fuels. The past few years have been featured by an increase in public awareness campaigns promoting energy saving measures, waste reduction, reducing the use of plastic bag and the like.

Our study has pointed to the importance of considering demographic differentials in perceptions towards climate change and the relevant behaviours. With different lifestyles, values and attitudes, men and women, older people and younger people, and the highly educated and less educated differ in their concern and actions perform to mitigate climate change. There are also substantial regional differences in climate-related attitudes and behaviours. Consequently, how different subgroup of

populations experience psychological, technical and economic barriers to behavioural change should be considered in GHG emission reduction efforts.

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