

The role of nature contact and connectedness to nature as determinants of household water use: A case study from Spain

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Abstract: One of the targets of Sustainable Development Goal 6 is to increase water-use efficiency in all sectors to ensure the availability of water resources. In the domestic sphere, water consumption is largely conditioned by the habits and behaviour of individuals, but the influence of their relationship with nature on those habits remains largely unexplored. In this study, we investigate the influence of connectedness to and contact with nature on five different uses of water at home. Using ordered probit regressions with a sample of 874 students from the University of Granada (Spain), we found that connectedness to nature and nature contact is positively or nonsignificantly related to different dimensions of water efficiency. The results indicate that in order to encourage pro-environmental water use habits at home, efforts should be made to develop an ecocentric vision in schools and to promote school trips to explore and understand the nearest natural areas.

Keywords: domestic water use; water conservation habits; water efficiency; connectedness to nature; nature contact.

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1. Introduction

Water is essential for natural ecosystems and people. Food security, human health, economic development, and ecosystem conservation depend on this resource (UN, 2020). However, factors such as climate change and population growth compromise the availability of water resources globally (IPCC, 2018; UN, 2020). Among other measures, the United Nations (2015) proposes in Sustainable Development Goal (SDG) 6 the efficient use of water resources in all sectors to ensure the availability of water.

In the domestic environment, the behaviour of individuals is as important as the use of efficient technologies and infrastructure (Fielding et al., 2012). Many household water uses are influenced by individual lifestyle and behaviour (Willis et al., 2011), which explains why more water is often consumed than is actually needed. Identifying the factors that affect behaviour can be key to promoting household water conservation. In this regard, previous research has found a wide variety of determinants of water-use behaviour in households, including sociodemographic characteristics and psychological factors (Addo et al., 2018). Despite this, models explaining household water use tend to have low coefficients of determination (Jorgensen et al., 2009), indicating that other factors which may be driving efficient household water use have yet to be analysed.

Past studies have attempted to understand water-saving habits through sociodemographic variables, but in this study, we go one step further by including variables on people's relationship with nature as possible drivers of water-saving behaviour. In this research we propose the relationship with nature as a determinant of efficient water use, considering both the feeling of connectedness to and the contact with the natural world. Specifically, we seek answers to the following questions: (1) Is there a relationship between a person's connectedness to nature and his/her water use habits at home? (2) Is there a relationship between a person's nature contact and his/her household water use habits? We understand connectedness to nature as a holistic view of nature, or the extent to which a person perceives that he/she is part of an interconnected natural environment. Contact with nature is interpreted as the frequency with which a person visits natural spaces. Both factors have previously been recognised as drivers of pro-environmental behaviours of

different types (Alcock et al., 2020; Martin et al., 2020); however, the evidence is scarce for sustainable water consumption. There has been some notable research on connectedness to nature and pro-environmental behaviours (Gkargkavouzi et al., 2019; Petersen et al., 2015), but without a particular focus on water use habits; instead, such studies consider water saving along with other pro-environmental actions. To our knowledge, there is no evidence to date linking efficient water use and nature contact. Given that different types of water use can have different determinants (Makki et al., 2015), in the present research we address the relationship between nature connectedness and contact and efficient water uses, examining five different uses to reflect various dimensions of household water use. We conducted the analyses using ordered probit regressions with a sample of students from the University of Granada (Spain). The results suggest that a stronger relationship with nature is associated in different ways with pro-environmental water use habits; consequently, public policies that encourage citizens to spend time in natural environments and increase their affinity with nature may be a new way to contribute to the conservation of water resources.

The remainder of this paper is structured as follows: Section 2 reviews the literature on factors that promote household water conservation, with an emphasis on the evidence relating to nature connectedness and contact. Section 3 describes the dataset and variables used, as well as the method of analysis employed. Section 4 details the results obtained. Section 5 presents a discussion of the findings and deals with the political implications. Finally, a brief conclusion is presented in Section 6.

2. Literature Review

Water conservation, like other pro-environmental behaviours, is driven by both intrinsic and extrinsic factors, encompassing sociodemographic, psychological and contextual factors, among others (Blankenberg & Alhusen, 2018; Joseph, 2019).

Numerous studies have analysed how sociodemographic characteristics influence household water use. In fact, it has been suggested that demographic and socioeconomic variables may be more important than climatic and other physical factors in explaining per capita water use (Murdock et al., 1991). Some of the

sociodemographic factors that have been found to be related to water consumption in the household include age (Fielding et al., 2012; Gregory & Di Leo, 2003; Makki et al., 2015), level of education (De Oliver, 1999; Gilg & Barr, 2006; Gregory & Di Leo, 2003; Yu et al., 2015), income (De Oliver, 1999; Domene & Saurí, 2006; Fielding et al., 2012; Gilg & Barr, 2006; Gregory & Di Leo, 2003; Makki et al., 2015; Yu et al., 2015), and number of residents in the household (Domene & Saurí, 2006; Fielding et al., 2012; Gregory & Di Leo, 2003; Makki et al., 2015; van Vugt, 2001).

As for environmental variables, the most commonly studied variable is the role of environmental beliefs and attitudes as determinants of water consumption, taking into account an individual's predisposition to respond in a consistently favourable or unfavourable way towards the environment (Ajzen & Fishbein, 1973). In this respect, Corral-Verdugo et al. (2003) found that, although general environmental beliefs, such as beliefs related to the need to set limits on human activities, do not directly predict water consumption, they do influence the development of specific beliefs regarding water, which affect water consumption. In a similar vein, Willis et al. (2011) showed that people with very positive environmental and water conservation attitudes, i.e. people with high levels of environmental concern and water conservation awareness, consumed significantly less water in end uses influenced by lifestyle and behaviour. Although Willis et al. (2011) found that concern for environment is related to actual water end use consumption, Liobikienė and Minelgaitė (2021) reported that environmental concern has no impact on water-saving behaviour. In addition to beliefs and attitudes, emotions have also been proposed as an important factor in water conservation (de Miranda Coelho et al., 2016).

The environmental variables considered in previous literature in relation to efficient water use reflect beliefs, attitudes, and emotions. In contrast, there is less evidence regarding other dimensions of people's relationship with nature that puts the accent on how people relate to nature. In the present research, we seek to determine the relationship between water use efficiency habits and some as yet underexplored variables, namely feelings of connection with the natural world and exposure to natural environments.

2.1. The role of connectedness to nature

Connectedness to nature is understood as an individual's feeling of oneness with nature, referring to how a person perceives himself/herself in nature. Therefore, it reflects the extent to which a person sees the world and himself/herself as interconnected. The idea of connectedness to nature has been conceptualised and measured in different ways in the literature; for example, Schultz (2002) developed the Inclusion of Nature in Self Scale to measure the degree to which an individual includes nature in the conception of self, while Mayer and Frantz (2004) developed the Connectedness to Nature Scale to assess an individual's affective and experiential connection with nature. Numerous previous studies have found a positive relationship between some form of connection with nature and a wide range of pro-environmental behaviours (e.g., Gosling & Williams, 2010; Ibáñez-Rueda et al., 2020; Kim et al., 2018; Krizanova & Guardiola, 2020; Mackay & Schmitt, 2019; Martin et al., 2020; Nisbet et al., 2009; Yusliza et al., 2020). In contrast to this literature, the influence that connectedness to nature may have on residential water use remains largely unexplored.

Among the scarce evidence linking efficient water use and connectedness to nature, Petersen et al. (2015) found positive correlations between connectedness to nature and motivation to conserve water and electricity in a sample of university students. In the same vein, the study by Gkargkavouzi et al. (2019) showed the predictive power of nature connectedness in explaining different domains of pro-environmental behaviour, including behaviours in the household setting that encompass water and energy conservation actions. Given its domestic context, the study by Chen and Sintov (2016) may also be of interest for our research; their results indicate that people with higher levels of affiliation with nature are more willing to adopt home energy management technologies and programmes. In addition, other studies that point to connectedness to nature as a determinant of sustainable behaviour include in their measures of behaviour some actions aimed at making more sustainable use of water in the household (e.g., Geng et al., 2015; Kals et al., 1999).

These previous studies may be an indication of the power of connectedness to nature to encourage domestic water conservation. However, they do not explore in depth the

relationship between connectedness to nature and sustainable water use habits, but rather address this issue alongside other types of pro-environmental behaviours. To better understand the relationship between connectedness to nature and efficient water use, this study centres on water use habits. Previous research shows that the impact of certain determinants depend on the specific type of behaviour being considered (Blankenberg & Alhusen, 2018). For example, higher income levels have been found to be positively associated with investment in water-efficient technologies, but negatively associated with water-saving habits (Martínez-Espiñeira & García-Valiñas, 2013). Since different behaviours in the private sphere may differ in their determinants (Stern, 2000), connectedness to nature could have different effects on the various end uses of water in the household.

2.2. The role of nature contact

Nature contact can be defined as any interaction with elements of the biophysical system, such as flora, fauna and geological forms (Martin et al., 2020; Zylstra et al., 2014).¹ Previous evidence indicates that different ways of interacting with nature are positively correlated with pro-environmental attitudes and behaviours. For example, Martin et al. (2020) found, for a sample from England, that frequent visits to nature and watching nature documentaries are positively associated with different types of pro-environmental behaviour. Also using a sample from England, Alcock et al. (2020) identified a positive relationship between pro-environmental behaviour and two forms of contact with nature, recreational visits and exposure of the neighbourhood to natural areas. These results are in line with previous research by Nord et al. (1998), who found that frequency of visits to forest areas and recreational activities in the forest are associated with pro-environmental behaviour. Rosa et al. (2018) highlighted the importance of nature contact during childhood, given its association with greater nature contact during adulthood, which in turn is related to pro-environmental behaviour. Although these studies show a positive relationship between nature contact and different pro-environmental behaviours, many of them in the private

¹ There are discrepancies in the literature regarding both the definition of nature and the forms of interaction considered (Gaston & Soga, 2020). In this vein, Keniger et al., (2013) consider three types of interactions, depending on whether the contact is intentional, the result of another activity, or occurs without the person being physically present in nature (e.g. through pictures or documentaries). In this research, we focus on the two first types.

sphere (such as recycling or saving energy at home), there is no previous research addressing the possible association between nature contact and domestic water use.

3. Method

3.1. The fieldwork

Data collection was carried out by passing a questionnaire to 1283 students from different disciplines at the University of Granada, Spain, during the months of March and April 2019. A research team visited classrooms and provided students with the questionnaire, which was accessible online via Qualtrics. Students did not receive any payment for filling in the questionnaire. Before analysis, observations with missing and nonsense values for the variables of interest were removed, leaving a homogeneous sample of 874 observations.

3.2. Variables

Water use. We assessed individuals' use of water in the home in relation to five different habits. Specifically, we asked them: “do you collect the water in the shower while you wait for it to come out hot (put a bucket in the shower to catch the cold water that comes out first)?” (*shower*), “do you defrost your food in advance to avoid defrosting it under the tap?” (*food treatment*), “do you wait until the dishwasher and washing machine are full to run them?” (*appliances*), “do you close the stopcock a little to reduce the flow rate of the taps?” (*use of taps*), and “do you turn off the tap while brushing your teeth?” (*dental hygiene*). Individuals responded no (1), sometimes (2) or yes (3). These five variables allow us to take into account various dimensions of water use in the household. We thus intend to cover water use behaviour at different points in a standard household with no garden.

Connectedness to nature. We capture connectedness to nature through the connectedness to nature scale (CNS, Mayer & Frantz, 2004; Mayer et al., 2009). CNS is a well-established measure that assesses individual's affective, experiential connection to nature through 14 items, such as “I often feel a sense of oneness with the natural world around me” or “I think of the natural world as a community to which I belong”. Participants responded to these items on a 5-point Likert scale, with 1 being “strongly

disagree” and 5 being “strongly agree”. CNS was calculated as the mean of all items, with reverse scoring where appropriate, so that higher scores denote greater connectedness to nature.

Nature contact. We measured nature contact by asking the question “how many times a month do you usually spend time in nature?” Individuals responded on a 7-point Likert scale, with 1 being “never”, 2 “less than once a month”, 3 “once a month”, 4 “several times a month”, 5 “once a week”, 6 “several times a week”, and 7 “every day”.

Sociodemographic variables. We included questions on participants' income, age, gender, marital status and occupational status. Individuals indicated their parents' monthly income by selecting one of eight response intervals, with the lowest category being less than €499 and the highest category being €5000 or more. We estimated the income of each category using the midpoint of the interval (except for the top category which we estimated at €6000), and calculated per capita income by dividing by the number of people living in the household. In the analyses we include the natural logarithm of per capita income, age in years and three dummy variables respectively indicating whether the individual is female, single and working, or otherwise.

3.3. Hypotheses and method of analysis

As summarised in the literature review, the effects that connectedness to and contact with nature may have on how an individual uses water in the household remain largely unexplored. However, previous research suggests that those components of humans' relationship with nature are linked to more sustainable behaviour in general. Therefore, we draw inspiration from the related literature to formulate our hypotheses, considering water saving as a specific pro-environmental behaviour. We hypothesise that greater connectedness to nature (H1) and greater nature contact (H2) are generally related to more efficient residential water use. However, the relationship that each type of water use may have with nature contact and connectedness may be different. We cannot propose a more detailed hypothesis on this relationship as it remains unexplored in the literature.

To explore the role of connectedness to nature and nature contact in household water use, we use ordered probit regressions with standard errors robust to heteroskedasticity. We specified different models, incorporating the five water uses mentioned above as dependent variables. Given the ordered nature of the dependent variables, ordered probability models are the most appropriate choice. In all models we incorporated connectedness to nature and nature contact as potential predictors, in addition to sociodemographic variables. Analyses were performed using Stata15 statistical software.

4. Results

As an introduction to the analysis of the associations between people’s relationship with nature and water use in the household, we show the descriptive statistics of the variables included in the study. As shown in Table 1, the most common water-saving habit is turning off the tap while brushing teeth, while the least common is collecting water from the shower while waiting for the hot water to come out. As for the profile of the study participants, the average age is 20, 62% of the individuals are female, 63% are single and 26% are working as well as studying.

Table 1. Descriptive statistics.

	Mean/%	Std. Dev.	Min	Max
Water use				
<i>Shower</i>	1.293	0.610	1	3
<i>Food treatment</i>	2.779	0.523	1	3
<i>Appliances</i>	2.843	0.480	1	3
<i>Use of taps</i>	1.867	0.921	1	3
<i>Dental hygiene</i>	2.897	0.378	1	3
Relationship with nature				
<i>Connectedness to nature</i>	3.327	0.637	1.36	5
<i>Nature contact</i>	3.717	1.359	1	7
Sociodemographic variables				
<i>Income</i>	6.184	0.783	3.22	8.7
<i>Age</i>	20.753	3.128	18	59
<i>Female</i>	62%		0	1
<i>Single</i>	63%		0	1
<i>Work</i>	26%		0	1

Table 2 shows the results of the five ordered probit regressions. The chi-squared test of overall significance indicates that the models are significant, with all p-values below 0.05 except for the “Appliances” model. Since the ordered probit coefficients cannot be interpreted directly, Figures 1 and 2 shown below depict the marginal probabilities for the variables of connectedness to and contact with nature respectively. In this way, we can observe the contribution of each of these predictors to the value of the dependent variable. We describe below the results for each water use under study based on the results in Table 2 and Figures 1 and 2. The focus of this research is on connectedness to nature and nature contact, therefore most of our interpretations are centred on these variables. Nevertheless, we also provide some interpretation of the control variables, which may be of interest for future research focusing on those variables.

Table 2. Ordered probit regression models predicting water use.

	<i>Shower</i>	<i>Food treatment</i>	<i>Appliances</i>	<i>Use of taps</i>	<i>Dental hygiene</i>
<i>Connectedness to nature</i>	0.141* (0.0828)	0.133* (0.0788)	0.116 (0.0869)	0.012 (0.0675)	0.298*** (0.0989)
<i>Nature contact</i>	0.0626* (0.0373)	0.0217 (0.0392)	0.0072 (0.0454)	0.111*** (0.0320)	-0.0177 (0.0461)
<i>Income</i>	-0.0824 (0.0596)	-0.206*** (0.0705)	0.0622 (0.0712)	-0.110** (0.0529)	-0.0297 (0.0884)
<i>Age</i>	0.0254* (0.0136)	-0.00453 (0.0156)	0.0233 (0.0224)	0.0257** (0.0125)	-0.0410** (0.0160)
<i>Female</i>	-0.0195 (0.101)	0.250** (0.105)	0.205* (0.120)	-0.113 (0.0873)	0.340*** (0.131)
<i>Single</i>	0.008 (0.0987)	-0.114 (0.107)	-0.0744 (0.1190)	-0.0432 (0.0856)	-0.0459 (0.128)
<i>Work</i>	0.0807 (0.111)	-0.129 (0.122)	-0.00406 (0.130)	0.0755 (0.0971)	0.0859 (0.148)
<i>/cut1</i>	1.554*** (0.554)	-2.491*** (0.633)	-0.313 (0.706)	0.222 (0.498)	-1.945** (0.769)
<i>/cut2</i>	2.150*** (0.558)	-1.777*** (0.632)	0.103 (0.710)	0.576 (0.498)	-1.386* (0.764)
N	874	874	874	874	874
Pseudo-R ²	0.016	0.028	0.011	0.017	0.041
χ^2	19.47	26.32	9.52	29.88	25.41

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Shower. More efficient use of shower water is positively related to connectedness to nature ($b = 0.141, p < 0.1$) and nature contact ($b = 0.0626, p < 0.1$). As the feeling of connectedness and frequency of visits to natural environments increases, the likelihood of collecting the shower water while waiting for it to come out hot (either always or sometimes) increases (see Figures 1a and 2a). Age is also positively related to this habit.

Food treatment. Better use of water for preparing food is positively related to connectedness to nature ($b = 0.133, p < 0.1$), but not with nature contact. Higher levels of connectedness increase the likelihood of regularly defrosting food in advance to avoid having to do it under the tap (figure 1b). On the other hand, when connectedness to nature increases, the probability of doing this action decreases in the “sometimes” and “never” options. Regarding sociodemographic variables, income level is negatively related to this behaviour, while being a woman is positively associated.

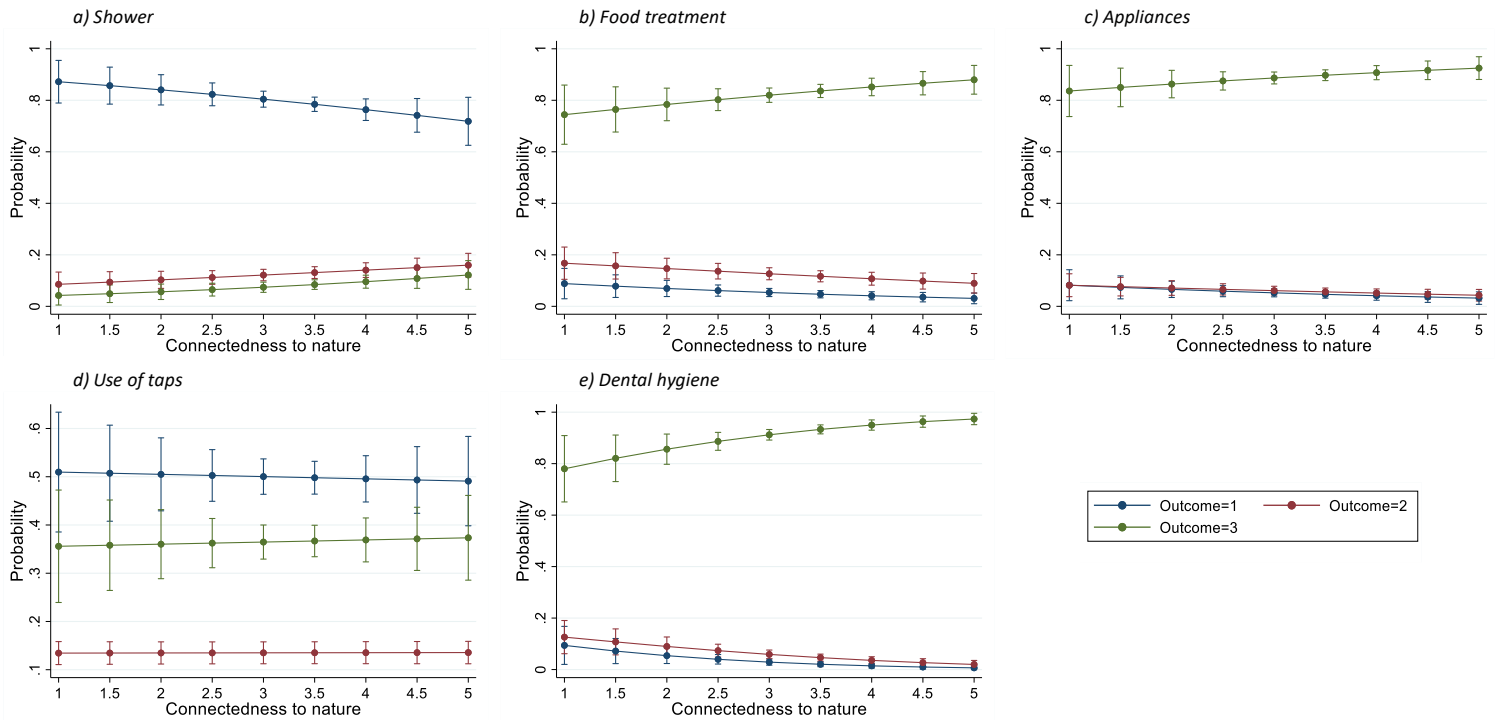
Appliances. Efficient use of water-using appliances is not associated with either connectedness to nature or with nature contact. Only the *female* variable is a significant predictor of this habit. As mentioned above, this model is not significant overall.

Use of taps. Using taps efficiently is positively related to spending time in nature ($b = 0.111, p < 0.01$), but is not associated with nature connectedness. Making frequent visits to natural environments increases the likelihood of regulating tap flow to consume less water, and reduces the likelihood of not doing so. It is worth highlighting that the slope of the marginal probabilities of “always” and “never” are the highest of all estimations in absolute value, suggesting that visiting nature has high importance. However, the probability of “sometimes” doing so remains constant for the different levels of nature contact (Figure 2d). Apart from the nature variables, we find that this habit is negatively associated with income and positively associated with age.

Dental hygiene. Turning off the tap while brushing teeth is positively related to connectedness to nature ($b = 0.298, p < 0.01$). For higher values of connectedness to nature, the probability of having this habit increases to maximum levels, while the

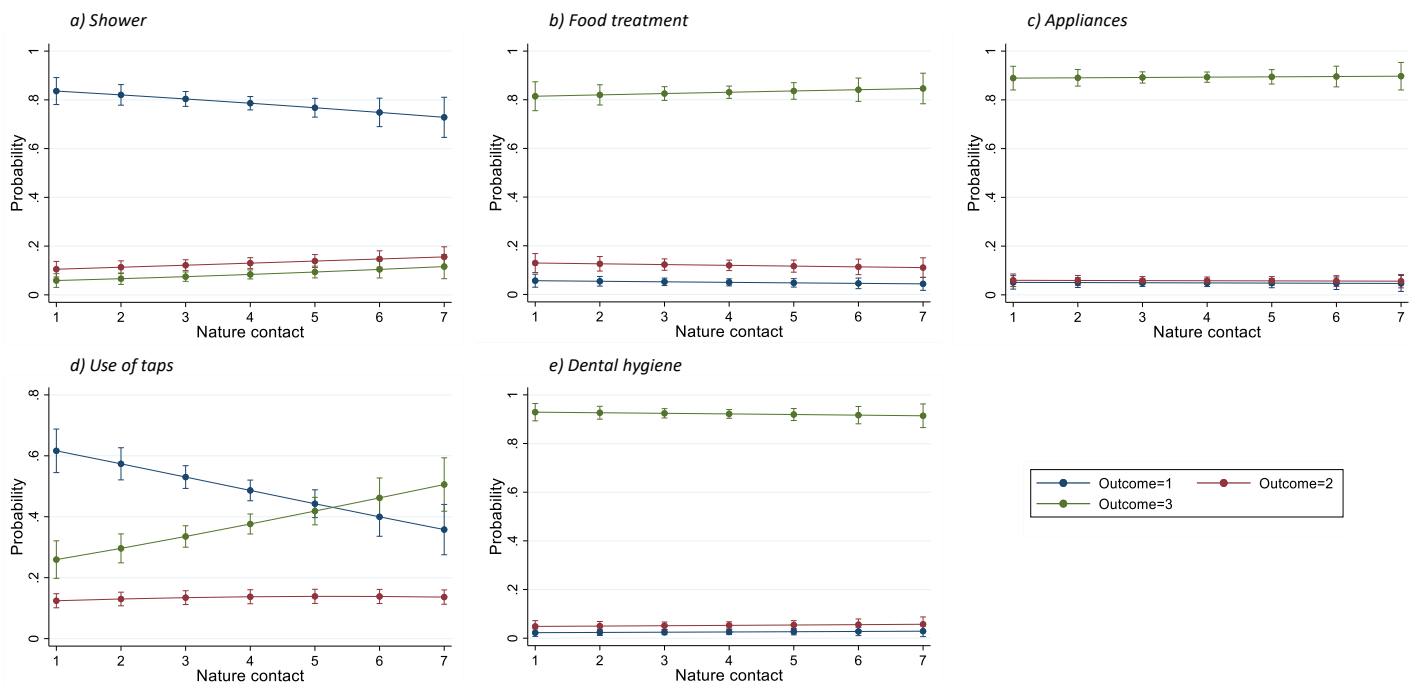
probability of not turning off the tap or only sometimes doing so is practically zero (Figure 1e). Furthermore, being a woman is a factor that is positively related to this practice, while age is negatively associated.

Figure 1. Predictive margins and 95% Confidence Intervals for water conservation behaviours as a function of connectedness to nature.



Shower: do you collect the water in the shower while you wait for it to come out hot (put a bucket to catch the cold water that comes out first)? *Food treatment:* do you defrost your food in advance to avoid defrosting it under the tap? *Appliances:* do you wait until the dishwasher and washing machine are full to run them? *Use of taps:* do you close the stopcock a little to reduce the flow rate of the taps? *Dental hygiene:* do you turn off the tap while brushing your teeth? Outcome 1=never, outcome 2=sometimes, outcome 3= always.

Figure 2. Predictive margins and 95% Confidence Intervals for water conservation behaviours as a function of nature contact.



Shower: do you collect the water in the shower while you wait for it to come out hot (put a bucket to catch the cold water that comes out first)? *Food treatment*: do you defrost your food in advance to avoid defrosting it under the tap? *Appliances*: do you wait until the dishwasher and washing machine are full to run them? *Use of taps*: do you close the stopcock a little to reduce the flow rate of the taps? *Dental hygiene*: do you turn off the tap while brushing your teeth? Outcome 1=never, outcome 2=sometimes, outcome 3= always.

5. Discussion, policy implications, limitations, and further research

Demand-side water management is essential to ensure the availability of water resources. In this regard, part of the research on the demand for water has focused on identifying the determinants of household water consumption. The present study extends this research by exploring the role of connectedness to nature and nature contact in five different household water uses.

Our results suggest that a closer relationship with nature, i.e., frequently visiting natural environments and feeling connected to the natural world, is positively or non-significantly associated with more efficient domestic water uses. These findings are consistent with previous, more general studies that found a positive relationship (and in a few cases a non-significant relationship) between nature connectedness and contact and environmental engagement (e.g. Alcock et al., 2020; Martin et al., 2020; Mayer & Frantz, 2004). Although both aspects of the relationship with nature are associated with the adoption of pro-environmental water use behaviours, there are

some differences between them. Connectedness to nature is related to the efficient use of water in the shower, in food treatment and during tooth brushing, while visits to nature are related to better use of water in the shower and more efficient use of taps. Therefore, efficient use of water in the shower is the only area of household water consumption that is associated with both factors, connectedness to nature and nature contact. In contrast, the efficient use of household appliances is not related to either of these factors. The fact that some water consumption behaviours are more influenced by the relationship with nature than others supports Stern's (2000) assertion that different types of private sphere behaviour may have different determinants.

There is evidence that stated water conservation habits are a good predictor of actual water conservation (Fielding et al., 2012). Given that some water uses account for a large proportion of total consumption, changing consumption habits could mean considerable water savings. For example, studies show that showering accounts for approximately one third of total per capita household water consumption (Willis et al., 2011, 2013), so making better use of water in this area would lead to substantial savings.

Our results emphasise the importance of the link with nature in increasing people's propensity to adopt sustainable water consumption behaviours. This potential of nature connectedness and contact to change water use patterns should be taken into consideration in the design of water conservation campaigns. A good strategy could be to design interventions that strengthen individuals' relationship with nature by reinforcing their feeling of connectedness to nature and increasing their exposure to natural environments.

More specifically, connectedness with nature could be enhanced at an early age by attempting to reorient the anthropocentric vision prevalent in schools (Kopnina, 2014; Ross, 2020). Indeed, people who claim to have a more ecocentric view demonstrate more pro-environmental behaviours (Casey & Scott, 2006). Taking a cross-cutting approach focused not just on science subjects, content could be included that would help students to develop an ecocentric view of the world around them (McClanahan, 2013). In history, for example, content could be introduced that delves into the

environment in which historical events took place and offers an understanding of people's relationship with nature. In subjects such as languages and mathematics, the activities to be carried out by the student could include examples and readings that help to reinforce the ecocentric view. In addition, school curricula should include trips out into nature and greenspaces should be created near schools (Stokoe, 2019). One option would be to incorporate a new subject of connection to the environment in school curricula, along with regular trips to nearby natural spaces in which to explain and explore aspects related to the geology, vegetation, fauna and physical and chemical processes of the surrounding area.

Finally, one limitation of our study should be noted: Our sample is composed only by students, mostly young people. Future studies could explore whether the associations found in this research hold for individuals with a different profile, since there is evidence that the factors influencing water use in the household may vary between different demographic groups (Yu et al., 2015).

In addition, future studies should further investigate the scope and intensity of measures aimed at promoting pro-environmental behaviour and, more specifically, the efficient and sustainable use of water. That is, there are studies that limit the impact of environmental awareness campaigns to a few months and sometimes question the intensity of the effects. It would be interesting to know whether measures aimed at enhancing connection and contact with nature are more far-reaching in terms of time and intensity.

6. Conclusion

The aim of this study is to explore the influence of connectedness to nature and nature contact on different water uses in the household. Using ordered probit regressions with a sample of Spanish university students, we found that individuals with a greater sense of connectedness to nature are more likely to adopt efficient water use habits in showering, food treatment and dental hygiene, while individuals who visit natural environments frequently are more likely to make efficient use of taps and shower water. Thus, we find a positive association between the relationship with nature and sustainable water use in the household, with the exception of efficient use of

household appliances, which is not significantly related to any of the nature variables. The fact that a close relationship with nature can motivate water conservation in different areas of the household highlights the importance of designing interventions that encourage citizens to have direct contact with nature and strengthen their psychological connection with the natural world.

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