AAG
AMERICAN ASSOCIATION of GEOGRAPHERS

Factors affecting domestic water consumption in the Spanish Mediterranean coastline

Journal:	*The Professional Geographer*
Manuscript ID	PG-2017-0058.R3
Manuscript Type:	Revised Manuscript
Key Words:	Domestic water consumption, determinants, tourism, Spain, Mediterranean

Abstract:	During the last decades in the Spanish Mediterranean coastline there has been a great development of low density urban area, as well as a change of the sociodemographic structures, especially in the municipalities that have developed a residential tourism model. Likewise, urban and tourist development have stressed the balance between the availability of water resources and urban water demands, generating situations of scarcity which may be aggravated by climate change. This study identifies the determinants of water consumption in the Spanish Mediterranean coastline, focusing on the variables related to urban land uses, socioeconomic and sociodemographic variables at the municipal level using an ordinary least square (OLS) and a geographically weighted regression (GWR) model. The GWR model results substantially improved the results of the OLS model, explaining 88.27 percent of the variance in domestic water consumption and solving the spatial autocorrelation problem of some independent variables. The most influential variables include the percentage of second homes or the percentage of residential properties with swimming pools at municipal level. These characteristics must be considered to develop demand management policies and an updated water planning to ensure urban supply in a future with less available water resources.

Factors affecting domestic water consumption in the Spanish Mediterranean coastline

Rubén Alejandro Villar-Navascués

University of Alicante

Alfredo Pérez-Morales

University of Murcia

Abstract: During the last decades in the Spanish Mediterranean coastline there has been a great development of low density urban area, as well as a change of the sociodemographic structures, especially in the municipalities that have developed a residential tourism model. Likewise, urban and tourist development have stressed the balance between the availability of water resources and urban water demands, generating situations of scarcity which may be aggravated by climate change. This study identifies the determinants of water consumption in the Spanish Mediterranean coastline, focusing on the variables related to urban land uses, socioeconomic and sociodemographic variables at the municipal level using an ordinary least square (OLS) and a geographically weighted regression (GWR) model. The GWR model results substantially improved the results of the OLS model, explaining 88.27 percent of the variance in domestic water consumption and solving the spatial autocorrelation problem of some independent variables. The most influential variables include the percentage of second homes or the percentage of residential properties with swimming pools at municipal level. These characteristics must be considered to develop demand management policies and an updated water planning to ensure urban supply in a future with less available water resources.

Key Words: *Domestic water consumption, determinants, tourism, Spain, Mediterranean.*

In Spain, the explosion of the real estate bubble and the economic crisis of 2008 have had serious consequences in the urban and demographic dynamics, ending the intense property development and population growth. This fact accentuated the regressive trend in urban water consumption, which began some years earlier in some cities along the Spanish Mediterranean coastline (Gil et al. 2015). Various reasons have been attributed to this reduction, such as technical improvements in urban water management (Morote, Hernández and Rico 2016); the reduction of disposable income by households (March and Saurí 2017); the increase in water rates and prices (Morote, Hernández and Rico 2016); the change in the demographic structure (March, Perarnau and Saurí 2012), or the impact that the restrictions of certain domestic uses in drought situations have had on the modification of the consumption habits (March, Domènech and Saurí 2013). However, an analysis of the explaining factors of domestic water demand for the Spanish Mediterranean coastline has not yet been carried out, which may contribute to explain this trend.

Together with the studies of the Anglo-Saxon tradition on factors affecting domestic water demand (March and Saurí 2009), numerous studies have been carried out in Europe in the last decade (Mazzanti and Montini 2006; Romano, Salvati and Guerrini 2014) and more specifically in the Spanish Mediterranean coastline (Domene and Saurí 2006; March and Saurí 2010; March, Perarnau and Saurí 2012; Garcia, Llausàs and Ribas 2013). The research carried out has confirmed that one of the main determinants of domestic water consumption is the predominant urban form, due to the influence that external uses have on final consumption (Wentz and Gober 2007; March and Saurí 2010; House-Peters, Pratt and Chang 2010; Morote, Hernández and Rico 2016). Also, other Spanish studies have focused on the influence that the tourism sector exerts in the increase of the domestic demand of water, due to the impact of detached houses for residential tourism use on the seasonal water consumption (Rico 2007; Rico, Olcina and Saurí 2009; Hof and Schmitt 2011; Hof and

Blázquez 2013, 2015; Hof and Wolf, 2014). However, according to the literature consulted, the influence of tourism on domestic water demand has not been analyzed at international level, since research has focused mainly on water consumption by hotels or leisure activities (Gopalakrishnan and Cox 2003; Gössling et al. 2012; Gabarda-Mallorquí, Garcia and Ribas 2017).

Our hypothesis is that domestic water demand on the Spanish Mediterranean coastline is not only determined by urban factors, but also by the residential tourism specialization of the municipality and the sociodemographic and socioeconomic characteristics of the population. The aim is to ascertain the influence of these variables on domestic water consumption, measured in liters / inhabitant / day, through an ordinary least square (OLS) regression model and a geographically weighted regression (GWR). Considering the future reduction of available water resources because of climate change (IPCC, 2013) measures are needed to address water scarcity (Jaeger et al. forthcoming), but the budgetary constraints of public administrations make it difficult to maintain the supply-oriented water policies, based on engineering solutions and the construction of large water infrastructures (Arahuetes, Villar and Hernández 2016). These circumstances require the adoption of demand-oriented measures, for which a better knowledge of the factors that affect domestic water demand is necessary. It should be borne in mind that demand management measures are usually focused on the increase of rates and the price of water, which can lead to the emergence of water poverty situations even in countries of the so-called developed world (March and Saurí 2017). Thus, the results of this work are oriented to improve other demand management measures such as the design of awareness campaigns, hydrological planning and other measures of demand management beyond economic ones.

The article is organized as follows. First, we introduce a brief literature review on the main factors influencing domestic water consumption, with a special emphasis on urban-tourist and socio-demographic variables. Afterwards, we present the study area and explain the methodology of the implemented models as well as the variables used in them. The results obtained and the subsequent discussion constitutes the next section of the article. Finally, some conclusions and future lines of research are outlined, focusing on the relevance of the local scale for water planning and the need for more statistical information on the occupation of second homes.

Determinants of domestic water consumption: a brief review

In recent years, there has been a great deal of research on factors influencing domestic water demand, which have resulted in several literature reviews (Arbués, García-Valiñas and Martínez-Espiñeira 2003; Dalhuisen et al. 2003; Worthington and Hoffman 2008; March and Saurí 2009; House-Peters and Chang 2011a). Generally, most research has been carried out in the United States or Australia by economists, where the price of water, measured in different ways, is always present as an independent variable in order to find out the best price mechanism to regulate water demand (Worthington and Hoffman 2008). Generally, it is concluded that water behaves as an inelastic good, that is, that changes in price does not affect water demand (House-Peters and Chang 2011a), at least for a "subsistence level" of consumption (Martínez-Espiñeira and Nauges 2004). Also, the income usually appears in most of the research, although its elasticity is low in the short term (Worthington and Hoffman 2008) and its relation to water consumption is not always linear (Chang et al. 2010). Nevertheless, a higher level of income may influence other aspects related to water consumption, such as the housing typology or the purchase of water using appliances (Domene and Saurí 2006).

Regarding the influence of urban land uses in domestic water consumption, several studies performed on the Spanish Mediterranean coastline have demonstrated the inverse relationship between urban density and water consumption (Domene and Saurí 2006; Rico, Olcina and Saurí 2009; March and Saurí 2010; Morote, Hernández and Rico 2016; Morote and Hernández 2016a). The housing typology is presented as the most influential in the water consumption of a municipality, since each residential typology has certain physical characteristics (Troy and Holloway 2004; Fox, Mcintosh and Jeffrey 2009; Morote, Hernández and Rico 2016). Detached houses are presented as having the highest and most variable consumption, since depends largely on several aspects such as the existence of gardens and their size (Domene and Saurí 2006), typologies of planted species (House-Peters and Chang 2011b; Garcia, Ribas and Llausàs 2014; Morote and Hernández 2014), typology and frequency of irrigation (Loh and Coghlan 2003), or the presence and size of swimming pools (Wentz and Gober 2007; Morote, Saurí and Hernández 2017), among other aspects. Moreover, some studies have included other urban factors such as the surface and the age of the dwelling as explanatory factors (Nauges and Thomas 2000; Wentz et al. 2014; Chang et al. 2017). As a general rule it is considered that recently built homes have less leakage and usually include appliances that make a more efficient use of water, therefore should have lower consumption as long as no home remodeling has been done. In addition, it should be noted that under temporary occupancy patterns, several studies have shown that domestic water consumption can increase considerably compared to that of the permanently resident population (Gössling et al. 2012). In the Spanish Mediterranean coastline, several studies have shown that in detached houses, water consumption can be up to three times higher than that observed under permanent occupation regimes (Rico, Olcina and Saurí 2009; Hof and Schmitt 2011). Given the lack of data on temporary residential occupancy, some variables such as the percentage of main dwellings (Martínez-Espiñeira 2002) or second homes have been used in some studies (Arbués, García-Valiñas and Martínez-Espiñeira 2003).

With respect to demographic variables the most relevant is the size of the household, as relative demand decreases as the number of members living in a household increases, due to the effect of the economies of scale (Murdock et al. 1991; Höglund 1999). However, the influence on water consumption of the variables related to the demographic structure has not been as studied as the previous ones. Some studies show that older population, understood as the population in retirement age, and immigrants have patterns of consumption more austere (Nauges and Reynaud 2001; Pfeffer and Mayone 2002; Smith and Ali 2006; March, Perarnau and Saurí 2012). However, studies with very different conclusions can be found, since they do not represent socioeconomically homogeneous groups (Garcia, Llausàs and Ribas 2013; Garcia et al. 2013; Morote and Hernández 2016b). While some studies indicate that, for example, the retired population has lower consumption, since they have a lower level of income and consumption habits more oriented to saving (Gregory and Di Leo 2003), other studies indicate the opposite. The arguments put forward to indicate that the retired population consumes more water are related to the fact that these households tend to have fewer occupants (Beal, Stewart and Fielding 2013), spend more time at home (Fox, Mcintosh and Jeffrey 2009) and have higher water needs for uses related to personal hygiene (Schleich and Hillenbrand 2009). Conversely, the relationship between young age groups and water consumption is often positive since they are usually located in larger households (Kim et al. 2007), as well as with a greater frequency in the use of showers (Makki et al. 2013) and washing machines (Nauges and Thomas 2000).

A consumer behavior oriented towards conservation and saving may also affect domestic demand. Some studies positively correlate the educational level with the degree of environmental awareness, which can be manifested through various actions such as the acquisition of water saving appliances or the choice of garden typologies with low water requirements (Gilg and Barr 2006; Straus, Chang and Hong 2016). However, the influence of this factor can be very diverse, since generally the level of studies is in function of the income level and, in addition, a greater level of environmental awareness does not always imply that the consumption habits are modified (Beal, Stewart and Fielding 2013). In other studies, different variables are used to determine environmental awareness, such as the degree of knowledge of local environmental problems (Gregorio and Di Leo 2003) or local identity (García, Llausàs and Ribas 2013; Garcia et al., 2013).

Methods

Study Area

Our study area includes the Spanish Mediterranean Coastline municipalities. By 2012, they concentrate almost nine and a half million of its inhabitants that comprise 20 percent of the total population in Spain (INE 2013a). In addition, it is the most important tourist area of Spain and one of the main at global scale, with growth prospects for the coming years (Olcina, Saurí and Vera 2016). Between 1997 and 2006 in Spain there was an intense development of housing construction, especially on the Mediterranean coastline (Burriel 2008). The result of real estate development has been one of the largest increases in low-density urban area on the European coastline (Rico, Olcina and Saurí 2009). This has occurred especially in the periphery of mass tourist destinations, which entails an intense development of detached houses with a significant presence of seasonal occupation (Hof and Schmitt 2011).

In fact, Spain is the European Union country with a greater number of second homes (Olcina, Saurí and Vera 2016), considered as such when they are not the usual place of residence and are used at least fifteen days per year (Torregrosa et al. 2010). Real estate development in Spain cannot be understood without considering the strong investments made by foreigners (Saurí et al. 2013). The result of this process is that in 2011, half of the foreign population and half of the second homes of the total Spanish provinces were concentrated on the Mediterranean coastline. In addition, the residential tourism model has attracted many European retirees which has strongly modified the demographic structure in many municipalities (Morote and Hernández 2016b).

Although in Spain, overall, around 80 percent of water demand corresponds to agricultural uses and only 12 percent to domestic uses (INE 2013b), at regional level urban-tourist water consumption can account for more than half of the total uses (Govern de les Illes Balears 2015; ACA 2017), and in the coastal municipalities is the main demand (March and Saurí 2010). Indeed, the competition for water resources among different users has intensified the situation of natural scarcity that has motivated the diversification of the supply sources, with an intense development of the unconventional sources, as desalination and reutilization (Rico et al. 2013; March, Saurí and Rico 2014; Arahuetes, Villar and Hernández 2016). Therefore, it is necessary to study the influence of the urban and socio-demographic characteristics associated with the residential tourism models on domestic water consumption. This is especially relevant on the Mediterranean coastline, where tourism is one of the most vulnerable economic sectors to climate change since less water is expected to be available, which will compromise the urban water supply especially in low-density urban models (Hof and Schmitt 2011; Gössling et al. 2012; Saurí et al. 2013).

Analysis

Previous studies in this area have demonstrated the importance of urban and sociodemographic variables in explaining domestic water consumption differences between municipalities (Domene and Saurí 2006; Rico, Olcina and Saurí 2009; March and Saurí 2010; Hof and Schmitt 2011; March, Perarnau and Saurí 2012). For this reason, our starting hypothesis is that from urban and sociodemographic variables it is possible to explain the variations in the domestic water consumption in tourist environments. The identification of higher domestic consumption in those municipalities with a residential tourism model causes our analysis to focus on these two groups of variables (Rico, Olcina and Saurí 2009; Hof and Schmitt 2011). Usually these municipalities tend to have a higher proportion of second and detached houses, as well as a demographic structure with a higher proportion of immigrants, in some cases of retirement age.

To discern the main factors influencing water use in Spanish Mediterranean coastline municipalities, we performed two regression models. First, we create an OLS model to explain the variation in domestic water consumption per capita in 2012, based on a set of independent variables. This method has been widely used to analyze the determinants of domestic water consumption for cross-sectional data (Arbués, García-Valiñas and Martínez-Espiñeira 2003; Worthington and Hoffman 2008; March and Saurí 2010). Our cross-sectional data set includes ninety nine of the 215 municipalities on the Spanish Mediterranean coastline (Figure 1).

It should be noted that although the sample represents 46 percent of the total coastal municipalities, it incorporates 56.2 percent of municipalities with more than 5.000 inhabitants, and concentrates 71 percent of the population registered in 2012 (INE 2013a), so this analysis is being carried out for the most populated municipalities. We have excluded the less inhabited municipalities because some of the variables used showed more extreme values in them, which had a negative effect on the model.

According to the exploratory data analysis results, no case was regarded atypical (Cook's distance < 1), so the initial ninety nine cases remained. It has also been evaluated that the independent variables that were considered in the model meet a normal distribution. Likewise, the most influential variables have a variance inflation factor (VIF) less than 1.2, so the problem of multicollinearity is ruled out. Furthermore, we have considered that some studies have shown how the impact of some variables varies from one geographic region to another (Kontokosta and Jain 2015). So, to explore for possible spatial effects, as previous studies have done (Wentz and Gober 2007; House-Peters, Pratt and Chang 2010; Wentz et al. 2014), we applied Moran's I index to the dependent and independent variables, as well as to the model residuals. After performing this analysis, we acknowledge necessary to implement a GWR model to account for variability in the influence of each factor, result of the OLS model, for each analyzed spatial unit, in this case the municipalities (Wentz and Gober 2007; Chang, Parandvash and Shandas 2010; House-Peters, Pratt and Chang 2010; Wentz et al. 2014; Kontokosta and Jain 2015).

The GWR models are effective to solve the two spatial characteristics of the explanatory variables which are not taken into account in the OLS models: spatial autocorrelation and non-stationarity, or regional variation, of some variables. Thus, the results of the OLS model are improved since it is possible to differentiate the local spatial variations of the parameters estimated by means of the implementation of a kernel function, that allows to make estimations adjusted to each observation giving greater influence on the closer observations (Brunsdon, Fotheringham and Charlton, 1996).

The estimation of the GWR model was performed using the functions available in the R *spgwr* (Bivard and Yu, 2017) and *GWmodel* packages (Gollini et al. 2015). The model was obtained using an adaptive kernel because our observations were unequally spaced in the study area. The local kernel bandwidths used in the weighting function were estimated by a cross-validation procedure (Fotheringham, Brunsdon and Charlton 2002), obtaining an adaptive quantitative final of 0.1169 (11 points out of 99).

Although the territorial scale used does not allow to verify the variance of the variables within the municipalities, several methodological questions have required this choice, as has happened in other cases of study in Spain (March and Saurí 2010; Torregrosa et al. 2010). The main reason has been the difficulty in accessing information on water consumption for intra-municipal scales, which is provided by the concessionaire companies of the municipal water service. Due to the lack of homogeneous data series, it has been decided to carry out the analysis for the year 2012, as are available more records. In spite of this the results of this study can be useful for the city councils, which are the public administrations in charge of urban supply management. Consequently, they can promulgate ordinances regarding domestic use, conduct awareness campaigns to reduce the consumption or drafting municipal emergency plans against drought risk (March and Saurí 2010).

Data

The dependent variable is the domestic water consumption (DWC12), expressed in liters per person per day (lpd). This indicator is calculated from annual data on aggregate household-metered water at municipal scale, so leaks are not considered. The total domestic consumption of the year 2012 has been divided among the registered population, so it must be clarified that this indicator does not take into account the temporary population that resides in the municipality. In the regression analysis, the logarithmic form of domestic water consumption (LNDWC12) is used to give robustness to the model, to comply with normalcy tests (Kolmogorov–Smirnov and Shapiro–Wilk) and to facilitate the interpretation of the results (March, Perarnau and Saurí 2012).

On the other hand, a set of 18 socio-demographic and urban land use factors are defined as independent variables (Table 1), identified from the brief review presented previously. It should be noted that not all the independent variables provide information for the year 2012. However, it is assumed that given the stability of urban and demographic dynamics after the economic crisis, the variables used have not changed significantly. For the calculation of the urban density variable, the area occupied by continuous and discontinuous urban tissue collected in the Corine Land Cover project for 2006 has been considered, dividing that area among the population registered in 2012. We consider that this variable is indicative of the urban model, as from 2008 there has not been a significant change in urban land uses. Table 2 presents a descriptive statistical analysis of the variables incorporated in the model as well as the dependent variable, expressed in liters/ inhabitant/day (DWC12) as well as in logarithmic form (LNDWC12).

Results and Discussion

According to the OLS model obtained (Table 3), the *F-test* was significant ($p < 0.001$) and 72.62 percent of variance was explained by the regression and an *AIC* value of -10.692. The most influential variables were percentage of second homes (SEC_HM%), percentage of residential properties with swimming pools (PROP_POOL%), income per capita (INC) and percentage of low-income pensioners household (LOW_RETH%).

However, the results of the Moran's I index indicate that the income variable has a clustered spatial pattern (Table 4), since are differentiated by regions, decreasing from north to south. In addition, this analysis shows that PROP_POOL% and model residuals don't present a random distribution. For this reason, our model presents spatial dependence on the results (Moran's I statistic= 0.356, p-value = 0.0012), and spatial non-stationarity (Breusch-Pagan's statistic=8.648, p-value=0.0705), so we have developed a GWR model applying the significant OLS model variables.

In order to discern the spatial variation of the influence of each variable, the GWR model allows each predictor to vary for each municipality according to the values of the dependent and independent variables of that municipality and those around it (Kontokosta and Jain, 2015). The GWR model significantly improves the fit of the model (*AIC* = -81.110, R^2 = 0.887), with substantial reduction of the spatial autocorrelation problem (Moran's I statistic = 0.0238, p-value = 0.3838). Likewise, we considered convenient to include the ANOVA table (Table 5) as goodness of fit test to check the improvement of the GWR over the OLS model.

However, median values for the regression coefficients of the independent variables differ between both models. In the GWR model, the coefficients of the variables SEC_HM% and PROP_POOL% are very similar to the previous model (Table 6). On the contrary, the values of the variables LOW_RETH% and INC are modified.

The R^2 values at the municipal level indicate that the model explains better the variation in water demand in the northern half of the Mediterranean coast, especially in the Catalan municipalities, which are those with a higher level of income and per capita domestic water consumption (Figure 2). However, the major distinction between the OLS model and the GWR model results is the considerable spatial differences in the coefficients of the income variable. This variable has negative coefficients in many of the municipalities, especially in the southern half, where the lowest income values are located. These findings contrast with the results of other research since domestic water consumption and income levels are usually positively related (Worthington and Hoffman 2008; House-Peters and Chang 2011). It should be borne in mind that in the Spanish Mediterranean coastline the income difference between regions can become very large because the wage differentials (Table 2). Municipalities in the southern half have low incomes and, in some instances, a high domestic water consumption per capita due to the influence of the residential tourism. In these cases, the temporary population influences the increase of the dependent variable, especially in municipalities with a high percent of second homes, and the underestimation of the income level, since it is calculated from the permanent population. This fact may explain the negative coefficients of the income variable in the southern half, where less domestic water consumption would be expected because of the large income differences with the northern half.

Concerning the explanation of the GWR model, we must emphasize the great influence of the percent of second homes in increasing the per capita domestic water consumption. This is the result of calculating the domestic consumption of water per capita without taking into account the seasonal population, due to lack of data, which increase per capita consumption in those municipalities with a high percentage of second homes. This does not detract from the fact that in the Mediterranean coastline the domestic water consumption carried out by the seasonal population is a factor of first order to differentiate consumption among municipalities. This fact has not been identified in most of the international studies on determinants of domestic water consumption consulted (Worthington and Hoffman 2008; House-Peter and Chang 2011a), partly because of the importance of the second homes in the Mediterranean coastline case (Koç, Bakış and Bayazıt 2017). If we look at the correlation values between independent variables (Appendix 1), it is worth noting that this variable is positively related to the percentage of households of up to two members (0.345), as well as inversely related to urban density (-0.563) and the age of the residential properties (-0.396).

In addition, we find other explanatory variable related with the urban model and the residential tourism specialization that has already been previously reported in other studies: the proportion of residential properties with swimming pool (Wentz and Gober 2007; Hof and Schmitt 2011; Hof and Wolf 2014; Morote, Saurí and Hernández 2017). This variable is directly associated with the average size of residential properties (0.569) and is inversely related to urban density (-0.490). In addition, both the percentage of second homes and that of properties with swimming pools shows a positive correlation with the percentage of foreigners.

In half of municipalities, income is positively related to domestic water consumption, which is consistent with the results of other investigations (Arbués, García-Valiñas and Martínez-Espiñeira 2003; Romano, Salvati and Guerrini 2014). As a matter of fact, income influences domestic water consumption in several ways: directly through the household's ability to purchase water (Dalhuisen et al. 2003), or indirectly as an indicator of the wealth of a population (Domene and Saurí 2006; March and Saurí 2010). However, it has been verified that this variable is negatively related to consumption in those municipalities with a lower level of income, which will require future research at household level in these municipalities to shed light on these results.

Finally, it is interesting to analyze the effect of sociodemographic variables since up to nine different variables have been considered and only the percentage of low-income pensioner households has been included in the model. This variable is negatively related to domestic water consumption per capita, as in other studies (Murdock et al. 1991; Nauges and Thomas 2000; March and Saurí 2010; March, Perarnau and Saurí 2012). However, this relation occurs only with low-income pensioners. Therefore, the influence of a lower income level and their relationship with the presence of a higher urban density at the municipal scale, as shown in Appendix 1 and March, Perarnau and Saurí (2012), seems to explain the lower level of consumption in this population group. These relations reject in part our main hypothesis since we have not been able to find relationships between domestic water consumption and sociodemographic variables related to the residential tourism model. The results are in contrast with other studies since neither household size nor variables related to the origin of the enumerated population explain variations in per capita consumption (Pfeffer and Mayone 2002; Smith and Ali 2006; March, Perarnau and Saurí 2012).

Conclusions

Our objective in this article was to understand the joint influence of a set of urban, sociodemographic and socioeconomic factors on domestic water consumption of the Spanish Mediterranean coastline. Even if the studies on determinants of the demand of water attach great importance to the variables related to pricing and taxation, in the Spanish Mediterranean context, the greater influence of the urban model and tourist activity reported on other studies has motivated the independent variables selection. However, despite the inclusion of numerous sociodemographic variables, the results of our regression model indicate that domestic consumption is mainly influenced by urban, touristic and socioeconomic variables. Therefore, the changes in the demographic structure of coastal municipalities linked to a greater presence of immigrants or an aging population have not had a clear influence on domestic water consumption. Moreover, the influence of residential tourism specialization on water consumption is confirmed, mainly by the proportion of second homes and residential properties with swimming pool. Likewise, the socioeconomic level of the municipal population in some cases is related to domestic water consumption. However, the results of the GWR indicate that it is necessary to develop further analysis on the local scale since it has been observed that the explanatory power of income level varies spatially.

Despite this, the results may contribute to explain the negative trend of water consumption, which has generally been occurring in the Mediterranean cities since the mid-2000s (Gil et al. 2015). The effect of the economic crisis on the decline in average household income (Morote, Hernández and Rico 2016), lower occupancy of second homes (Gil et al. 2015), and a greater number of pensioner households (March, Perarnau and Saurí 2012) may partly explain this trend. Nevertheless, we recognize the limitations of the study, mainly due to the lack of rigorous information on the temporary population and the length of their stay. Another limitation is the use of aggregate city-scale data on domestic water consumption, because we have assumed "*lack of variation in spatial patterns and processes*" (House-Peters and Chang 2011a:4). However, it must be considered that the information on water consumption in Spain is not public access and the data collection involves many difficulties. The use of aggregate city-scale data has made it difficult to study climatic variables, which, according to the international literature, are the main variables to explain the differences in domestic consumption between the base use (winter) and the seasonal use (summer) (House-Peters and

Chang 2011a; Chang et al. 2017). Nonetheless, to carry out this analysis in tourist environments, it will be necessary to calculate the temporary population since this variable affects water consumption more than the climate. Some studies have estimated it through indicators such as monthly water consumption or solid waste generation from detailed studies at an intra-municipal scale (Sánchez-Galiano, Martí-Ciriquián and Fernández-Aracil 2017).

Water policies at the local level should take these relationships into account since in some municipalities characterized by high concentrations of second homes and detached houses with swimming pool, seasonal demand for water has grown above water availability causing supply cuts (Marina Plaza 2015). This situation will require implementing emergency plans in drought situations in municipalities with more than 20.000 inhabitants, as reflected in the Spanish National Hydrological Plan. To do this, an effort must be made in those municipalities with high presence of second homes to have a more accurate and up-to-date knowledge of it occupancy level. Furthermore, the introduction of non-conventional resources such as rainwater harvesting and greywater recycling systems in residential buildings must be promoted by the city councils to deal with water scarcity situations, as is already occurring in some Catalan municipalities (Domènech et al. 2015; Vallès-Casas, March and Saurí 2016).

References

Arahuetes, A., R. Villar, and M. Hernández. 2016. El ciclo hidrosocial en la ciudad de Torrevieja: retos y nuevas tendencias [The hydrosocial cycle in the city of Torrevieja: challenges and new trends]. *Revista de geografía Norte Grande* 65:109-128.

Arbués, F., M. A. García-Valiñas, and R. Martínez-Espiñeira. 2003. Estimation of residential water demand: a state-of-the-art review. *The Journal of Socio-Economics* 32:81-102.

Beal, C., R. A. Stewart, and K. Fielding. 2013. A novel mixed method smart metering approach to reconciling differences between perceived and actual residential end use water consumption. *Journal of Cleaner Production* 60:116-128.

Bivand, R. and D. Yu. 2017. spgwr: Geographically Weighted Regression. R package versio n 0.6-31. https://cran.r-project.org/web/packages/spgwr/index.html (last accessed 18 Septemb er 2017)

Brunsdon, C., A.S. Fotheringham, and M.E. Charlton.1996. Geographically weighted regressi on: a method for exploring spatial nonstationarity. *Geographical Analysis* 28 (4):281-298.

Burriel, E. 2008. La década prodigiosa del urbanismo español (1997–2006) [Spanish prodigious decade of urbanism (1997-2006)]. *Scripta Nova* 270(64). http://www.ub.es/geocrit/sn/sn-270/sn-270-64.htm (last accessed 18 September 2017)

Agència Catalana de l'Aigua (ACA) [Catalan Water Agency]. 2017. *Plan de gestión del distrito de cuenca fluvial de Cataluña 2016-2021* [Management plan of the river basin district of Catalonia 2016-2021]. Generalitat de Catalunya, Spain: Agència Catalana de l'Aigua [Generality of Catalonia, Spain: Catalan Water Agency]. http://aca-web.gencat.cat/aca/appmanager/aca/aca?_nfpb=true&_pageLabel=P121075446120820077270 1&profileLocale=es [last accessed 3 July 2017].

Chang, H., G. H. Parandvash, and V. Shandas. 2010. Spatial variations of single-family residential water consumption in Portland, Oregon. *Urban Geography* 31: 953–97.

Chang, H., M. Bonnette, P. Stoker, B. Crow-Miller and E. Wentz. 2017. Determinants of single family residential water use across scales in four western US cities. *Science of the Total Environment* 596-597:451-464.

Dalhuisen, J. M., R. J. G. M. Florax, H. L. F. De Groot, and P. Nijkamp. 2003. Price and income elasticities of residential water demand: a meta-analysis. *Land Economics* 79: 292–308.

Domene, E., and D. Saurí. 2006. Urbanization and water consumption: influencing factors in the metropolitan region of Barcelona. *Urban Studies* 43:1605-1623.

Domènech, L., H. March, M. Vallès, and D. Saurí. 2015. Learning processes during regime shifts: Empirical evidence from the diffusion of greywater recycling in Spain. *Environmental Innovation and Societal Transitions* 15: 26-41.

Fotheringham A.S., C. Brunsdon, and M. Charlton. 2002. *Geographically weighted regression: the analysis of spatially varying relationships*. Chichester: John Wiley & Sons.

Fox, C., B. Mcintosh, and P. Jeffrey. 2009. Classifying households for water demand forecasting using physical property characteristics. *Land Use Policy* 26 (3): 558-568.

Gabarda-Mallorquí, A., X. Garcia, and A. Ribas. 2017. Mass tourism and water efficiency in the hotel industry: A case study. *International Journal of Hospitality Management* 61:82-93.

Garcia, X., A. Llausàs, and A. Ribas. 2013. Landscaping patterns and sociodemographic profiles in suburban areas: Implications for water conservation along the Mediterranean coast. *Urban Water Journal* 11(1): 31-41.

Garcia, X., A. Ribas, A. Llausàs, and D. Saurí. 2013. Socio-demographic profiles in suburban developments: Implications for water-related attitudes and behaviors along the Mediterranean coast. *Applied Geography* 41: 46-54.

Garcia, X., A. Ribas, and A. Llausàs. 2014. Jardines privados y consumo de agua en las periferias urbanas de la comarca de La Selva (Girona) [Private gardens and water consumption in the urban peripheries of the region of La Selva (Girona)]. *Investigaciones Geográficas* 61: 55-69.

Gollini, I., B. Lu, M. Charlton, C. Brunsdon and P. Harris. 2015. GWmodel: An R Package f or Exploring Spatial Heterogeneity Using Geographically Weighted Models. *Journal of Statis tical Software* 63(17):1-50.

Gilg A., and S. Barr. 2006. Behavioral attitudes towards water saving? Evidence from a study of environmental actions. *Ecological Economics* 57: 400–414.

Gil, A., M. Hernández, A. F. Morote, A. M. Rico, D. Saurí, and H. March. 2015. *Tendencias del Consumo de Agua Potable en la Ciudad de Alicante y Área Metropolitana de Barcelona, 2007–2013[Trends in Drinking Water Consumption in the City of Alicante and Metropolitan Area of Barcelona, 2007-2013]*. Alicante, Spain: Universidad de Alicante-Instituto Interuniversitario de Geografía.

Gopalakrishnan, C., and L. J. Cox. 2003. Water consumption by the visitor industry: The case of Hawaii. *International journal of Water Resources Development* 19(1): 29-35.

Gössling, S., P. Peeters, C. M. Hall, J. P. Ceron, G. Dubois, L. V. Lehmann, and D. Scott. 2012. Tourism and water use: Supply, demand, and security. An international review. *Tourism Management* 33: 1-15.

Govern de les Illes Balears [Government of the Balearic Islands]. 2015. *Plan Hidrológico de las Illes Balears 2015-2021[Hydrological plan of the Balearic Islands 2015-2021]*. Govern de les Illes Balears: Consellería d'Agricultura, Medi Ambient i Territori, Dirección General de Recursos Hídricos. [Balearic Islands Government: Counseling of Agriculture, Environment and Territory, General Management of Water Resources] http://www.caib.es/sacmicrofront/contenido.do?cont=79759&mkey=M080801111218572932 3&lang=es [last accessed 3 July 2017].

Gregory, G. D., and M. Di Leo. 2003. Repeated behaviour and environmental psychology: the role of personal involvement and habit formation in explaining water consumption. *Journal of Applied Social Psychology* 33: 1261-1296.

Hof, A., and T. Schmitt. 2011. Urban and tourist land use patterns and water consumption: Evidence from Mallorca, Balearic Islands. *Land Use Policy* 28(4): 792-804.

Hof, A., and M. Blázquez. 2013. The linkages between real estate tourism and urban sprawl in Majorca (Balearic Islands, Spain). *Land Use Policy* 2:252–77.

———. 2015. Changing tourism patterns, capital accumulation, and urban water consumption in Mallorca, Spain: a sustainability fix? *Journal of Sustainable Tourism* 23(5):770-796.

Hof, A., and N. Wolf. 2014. Estimating potential outdoor water consumption in private urban landscapes by coupling high-resolution image analysis, irrigation water needs and evaporation estimation in Spain. *Landscape and Urban Planning* 123:61–72.

Höglund L. 1999. Households demand for water in Sweden with implications of a potential tax on water use. *Water Resources Research* 12: 38–63.

House-Peters, L., B. Pratt, and H. Chang. 2010. Effects of urban spatial structure, sociodemographics, and climate on residential water consumption in Hillsboro, Oregon. *Journal of the American Water Resources Association* 46(3): 461-472.

House-Peters, L., and H. Chang. 2011a. Urban water demand modeling: review of concepts, methods, and organizing principles. *Water Resources Research* 47(5): W05401.

———. 2011b. Modeling the impact of land use and climate change on neighborhood-scale evaporation and nighttime cooling: A surface energy balance approach. *Landscape and Urban Planning* 103:139-155

Instituto Nacional de Estadística (INE) [National Institute of Statistics]. 2012. *Censo de población y vivienda. 2011* [Census of population and housing]. Madrid, Spain: INE. http://www.ine.es/censos2011_datos/cen11_datos_resultados.htm [last accessed 3 July 2017].

———. 2013a. Estadística del padrón continuo [Municipal Register Statistics]. Madrid, Spain: INE.http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736177012&menu=ultiDatos&idp=1254734710990 [last accessed 3 July 2017].

———. 2013b. Estadística sobre el suministro y saneamiento del agua [Statistics on water supply and sanitation]. Madrid, Spain: INE. http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176834&menu=ultiDatos&idp=1254735976602 [last accessed 3 July 2017].

IPCC (Intergovernmental Panel on Climate Change). 2013. *Climate change 2013: The physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change*. Cambridge, U.K., and New York, U.S: Cambridge University Press.

Jaeger, K. W., A. Amos, D. P. Bigelow, H. Chang, D. R. Conklin, R. Haggerty, C. Langpap, K. Moore, P. W. Mote, A. W. Nolin, A. J. Plantinga, C. L. Schwartz, D. Tullos, and D. P. Turner. Forthcoming. Finding water scarcity amid abundance using human-natural system models, *Proceedings of the National Academy of Sciences*.

Kim, S. H., S. H. Choi, J. Y. Koo, S. I. Choi, and I. H. Hyun. 2007. Trend analysis of domestic water consumption depending upon social, cultural, economic, parameters. *Water Science & Technology: Water Supply* 7(5-6): 61-68.

Kontokosta, C. E., and R. K. Jain. 2015. Modeling the determinants of large-scale building water use: Implications for data-driven urban sustainability policy. *Sustainable Cities and Society* 18:44-55.

Koç, C., R. Bakış, and Y. Bayazıt. 2017. A study on assessing the domestic water resources, demands and its quality in holiday region of Bodrum Peninsula, Turkey. *Tourism Management* 62:10-19.

Loh, M. and P. Coghlan. 2003. *Domestic Water Use Study in Perth, Western Australia 1998-2001*. Perth, Australia: Water Corporation.

Makki, A. A., R. A. Stewart, K. Panuwatwanich, and C. Beal. 2013. Revealing the determinants of shower water end use consumption: enabling better targeted urban water conservation strategies. *Journal of Cleaner Production* 60:129-146.

March, H., and D. Sauri. 2009. What lies behind domestic water use? a review essay on the drivers of domestic water consumption. *Boletín de la A.G.E.* 50: 297–314.

———. 2010. The Suburbanization of Water Scarcity in the Barcelona Metropolitan Region: Sociodemographic and Urban Changes Influencing Domestic Water Consumption. *The Professional Geographer* 62(1): 32-45.

———. 2017. When sustainable may not mean just: a critical interpretation of urban water consumption decline in Barcelona. *Local Enviroment, The International Journal of Justice and Sustainability* 22 (5):523-535.

March, H., J. Perarnau, and D. Saurí. 2012. Exploring the Links between inmigration, ageing and domestic water consumption: The case of the metropolitan area of Barcelona. *Regional Studies*, 46(2):229-244.

March, H., L. Domènech, and D. Saurí. 2013. Water conservation campaigns and citizen perceptions: The drought of 2007-2008 in the Metropolitan Area of Barcelona. *Natural Hazards* 65(3):1951-1966.

March, H., D. Saurí, and A. M. Rico. 2014. The end of scarcity? Water desalination as the new cornucopia for Mediterranean Spain. *Journal of Hydrology* 519 (C): 2642–2651.

La Marina Plaza. 2015. Teulada y Benitachell sufren cortes de agua que esta noche han afectada a más de 2.000 vecinos [Teulada and Benitachell suffer water shortages that have affected more than 2,000 neighbors this night]. *La Marina Plaza, 10 July 2015*. Available in: http://lamarinaplaza.com/2015/07/10/teulada-y-benitatxell-sufren-ya-cortes-de-agua-que-esta-noche-han-afectado-a-dos-mil-vecinos/ [last accessed 13 April 2017]

Martínez-Espiñeira, R. 2002. Residential water demand in the northwest of Spain. *Environmental and Resource Economics* 21 (2):161–87.

Martínez-Espiñeira, R., and C. Nauges. 2004. Is all domestic water consumption sensitive to price control? *Applied Economics* 36:1697-1704.

Mazzanti, M., and A. Montini. 2006. The determinants of residential water demand: empirical evidence for a panel of Italian municipalities. *Applied Economics Letters* 13(2):107-111.

Morote, A. F., and M. Hernández. 2014. Jardines y urbanizaciones, nuevas naturalezas urbanas en el litoral de la provincia de Alicante [Gardens and housing developments, new urban natures on the coast of the province of Alicante]. *Documents d'Anàlisi Geogràfica* 60 (3):483–504.

———. 2016a. Urban sprawl and its effects on water demand: A case study of Alicante, Spain. *Land Use Policy* 50:352–62.

———. 2016b. Población extranjera y turismo residencial en el litoral de Alicante (1960-2011): repercusiones territoriales [Foreign population and residential tourism on the coast of Alicante (1960-2011): territorial repercussions]. *Eure* 126: 55-76.

Morote, A. F., M. Hernández, and A. M. Rico. 2016. Causes of domestic water consumption trends in the city of Alicante: Exploring links between the housing bubble, the types of housing and the socio-economic factors. *Water*, 8 (374):1-18.

Morote, A. F., D. Saurí, and M. Hernández. 2017. Residential Tourism, Swimming Pools, and Water Demand in the Western Mediterranean. *The Professional Geographer* 69(1): 1-11.

Murdock, S. H., D. E. Albrecht, R. R. Hamm, and K. Backman. 1991. Role of sociodemographic characteristics in projections of water use. *Journal of Water Resources Planning and Management* 117: 235–251.

Nauges, C., and A. Reynaud. 2001. Estimation de la demande domestique d'eau potable en France [Estimation of the residential water demand in France]. *Revue Économique* 52(1): 167–185.

Nauges, C., and A. Thomas. 2000. Privately operated water utilities, municipal price negotiation, and estimation of residential water demand: The case of France. *Land Economics* 76 (1): 68-85.

Olcina, J.; D. Saurí, and F. Vera. 2016. Turismo, Cambio Climático y Agua: Escenarios de Adaptación en la Costa Mediterránea Española [Tourism, Climate Change and Water: Adaptation Scenarios on the Spanish Mediterranean Coast]. In *Libro jubilar en homenaje al profesor Antonio Gil Olcina*, eds. J. Olcina, and A. M. Rico, 171-193. Alicante, Spain: Universidad de Alicante.

Pfeffer, M., and J. Mayone. 2002. Immigrant environmental behaviors in New York city. *Social Science Quarterly* 83: 64–81.

Rico, A. M. 2007. Tipologías de consumo de agua en abastecimientos urbano-turísticos de la Comunidad Valenciana [Typologies of water consumption in urban-tourist supplies of the Valencian Community]. *Investigaciones Geográficas*, nº 42, pp. 5-34.

Rico, A. M., J. Olcina, and D. Saurí. 2009. Tourist land use patterns and water demand: evidence from the Western Mediterranean. *Land Use Policy* 26: 493–501.

Rico, A. M., D. Saurí, J. Olcina, and J. F. Vera. 2013. Beyond Megaprojects? Water Alternatives for Mass Tourism in Coastal Mediterranean Spain. *Water Resources Management* 27(2): 553-565.

Romano, G., N. Salvati, and A. Guerrini. 2014. Estimating the Determinants of Residential Water Demand in Italy. *Water* 6: 2929–2945.

Sánchez-Galiano, J. C., P. Martí-Ciriquián, and P. Fernández-Aracil. 2017. Temporary population estimates of mass tourism destinations: The case of Benidorm. *Tourism Management* 62:234-240.

Saurí, D., J. Olcina, J. F. Vera, J. Martín-Vide, H. March, A. Serra-Llobet, and E. Padilla. 2013. Tourism, Climate Change and Water Resources: Coastal Spain as an Example. In *European Climate Vulnerabilities and Adaptation: A Spatial Planning Perspective,* eds. P. Schmidt-Thomé, and S. Greiving, 231-252. Chichester (UK): John Wiley & Sons.

Schleich, J., and T. Hillenbrand. 2009. Determinants of residential water in Germany. *Ecological Economics* 68(6):1756-1759.

Smith, A., and M. Ali. 2006. Understanding the impact of cultural and religious water use. *Water and Environment Journal* 20:203–209.

Straus, J., H. Chang, and C-Y. Hong. 2016. An exploratory path analysis of attitudes, behaviors and summer water consumption in the Portland Metropolitan Area. *Sustainable Cities and Society* 23: 68-77.

Torregrosa, T., M. Sevilla, B. Montaño, and V. López-Vico. 2010. The integrated management of water resources in Marina Baja (Alicante, Spain). A simultaneous equation model. *Water Resources Management* 24: 3799-3815.

Troy, P., and D. Holloway. 2004. The use of residential water consumption as an urban planning tool: a pilot study in Adelaide. *Journal of Environmental Planning and Management* 47: 97-114.

Vallès-Casas, M., H. March, and D. Saurí. 2016. Decentralized and user-led approaches to rainwater harvesting and greywater recycling: The case of Sant Cugat del Vallès, Barcelona, Spain”. *Built Environment* 42(2):243-257.

Wentz, E., and P. Gober. 2007. Determinants of small-area water consumption for the city of Phoenix, Arizona. *Water Resources Management* 21 (11): 1849-1863.

Wentz, E. A., A. J. Wills, W. K. Kim, S. W. Myint, P. Gober, and R. C. Balling. 2014. Factors influencing water consumption in multifamily housing in Tempe, Arizona. *The Professional Geographer* 66(3):501-510.

Worthington, A. C., and M. Hoffman. 2008. An empirical survey of residential water demand modelling. *Journal of Economic Surveys* 22(5):842-871.

Author Bios

RUBÉN ALEJANDRO VILLAR-NAVASCUÉS is a PhD student in the Interuniversity Institute of Geography at the University of Alicante, Alicante, 03080 Spain. E-mail: rvnavascues@ua.es . His research interests include studies about urban water consumption, urban water governance, non-conventional water resources and urban political ecology.

ALFREDO PÉREZ-MORALES is Associate Professor of Geography at the University of Murcia, Department of Geography, 30001 Murcia, Spain. E-mail: alfredop@um.es. His research has focused on environmental hazards, water resources management, and landscape assessment.

Acknowledgments

The authors would like to thank the editor and the reviewers for their comments and criticisms that have contributed to the improvement of the article. The authors are also thankful for the data provided by many companies and councils of the Spanish Mediterranean coastline.

Funding

The results presented in this article are part of a research project entitled “Uses and management of non-conventional water resources on the coast of the regions of Valencia and Murcia as a drought adaptation strategy” funded by the Spanish Ministry of Economy and Competitiveness under grant number CSO2015-65182-CS-2-P. Likewise, this work is a result of a pre-doctoral fellowship (FPU/01144), granted by the Spanish Ministry of Education, Culture and Sport.

APPENDIX 1: Pearson correlation coefficient between independent variables and influential variables

	PROP_POOL%	SEC_HM%	LOW_RETH%	INC
URBPOP_DENS	-0.490**	-0.563**	0.290**	0.114
PROP_GAR%	0.558**	0.050	-0.99	0.002
PROP_POOL%	1	0.232*	-0.212*	0.171
PROP_AGE	-0.95**	-0.396**	0.348**	0.423**
PROP_AREA	0.569**	-0.151	-0.108	0.120
SEC_HM%	0.232*	1	-0.149	-0.055
H_SIZE	-0.103	-0.310	-0.128	-0.285**
H_SIZE_1_2	0.205*	0.345**	0.024	0.271**
LOW_RETH%	-0.212*	-0.149	1	0.088
HIGHRETH%	0.239*	0.035	0.028	0.485**
CHILDH%	-0.293**	-0.451**	0.128	-0.038
AGE_P%	0.144	0.143	0.296**	0.021
YOU_P%	0.010	-0.175	-0.187	0.013
FORE_P%	0.254*	0.350**	-0.455**	-0.366**
EURO_P%	0.338**	0.333**	-0.369**	-0.358**
LOCAL_P%	-0.374**	-0.300**	0.401**	-0.253*
INC	0.171	-0.055	0.088	1
EDUEXP	0.016	-0.251*	0.117	0.782**

Note: *$p < 0.05$ (two tailed). **$p < 0.01$ (two tailed).

Tables

Table 1. Dependent and independent variables description

Variable	Short Description	Abbreviated names	Source
Domestic water consumption	Neperian logarithm (NL) of domestic water consumption per capita	LNDWC12	Municipalities and local water companies
Urban model	Urban Population Density (people/km²)	URBPOP_DENS	INE & Corine Land Cover
Presence of Gardens	Residential properties with garden in 2014 (%)	PROP_GAR%	AIS Group
Presence of Pools	Residential properties with pool in 2014 (%)	PROP_POOL%	AIS Group
Building age	Average age of residential properties in 2014	PROP_AGE	AIS Group
Size of housing	Average area of residential properties in 2014 (m²)	PROP_AREA	AIS Group
Second homes	Second homes in 2011 (%)	SEC_HM%	INE
Household size	Average number of people per household in 2011	H_SIZE	INE
Single and two-member homes	Households with two or fewer members in 2011 (%)	H_SIZE1-2%	INE
Low-Income retirement homes	Low-income pensioner households of up to two members in 2013 (%)	LOW_RETH%	AIS Group

High-Income retirement homes	High-income pensioner households of up to two members in 2013 (%)	HIGH_RETH%	AIS Group
Presence of children and teenagers	Upper and lower-class households with children or teenagers in 2013 (%)	CHILDH%	INE
Aged population	Population over 65 years (%) in 2012	AGE_P%	INE
Young population	Population under 15 years in 2012 (%)	YOU_P%	INE
Foreigners	Foreign population in 2012 (%)	FORE_P%	INE
European foreigners	European foreign population in 2012 (%)	EURO_P%	INE
Local identity	Population born in the municipality in 2012 (%)	LOCAL_P%	AIS Group
Income	Average monthly income in 2012 (€/inhabitant)	INC	AIS Group
Education expenditure	Average annual expenditure on education in 2012 (€/inhabitant)	EDUEXP	AIS Group

Table 2. Descriptive statistics on dependent and independent variables

Variable	Min.	Max.	Mean	Std. dev.
DWC12	90.83	523.57	199.25	94.73
LNDWC12	4.51	6.26	5.19	0.42
URBPOP_DENS	781.96	22203.53	6088.22	4572.23
PROP_GAR%	0.02	88.73	31.38	17.82
PROP_POOL%	0.00	34.45	4.66	5.67
PROP_AGE	15.19	52.93	32.09	6.25
PROP_AREA	76.01	220.56	127.70	26.97
SEC_HM%	0.64	68.52	28.64	19.05
H_SIZE	2.16	3.20	2.57	0.18
H_SIZE1-2%	39.01	69.84	54.93	6.20
LOW_RETH%	2.84	19.87	10.12	3.43
HIGH_RETH%	1.00	10.62	5.00	1.99
CHILDH%	10.11	37.97	24.83	7.03
AGE_P%	7.43	31.06	16.90	3.99
YOU_P%	11.08	21.01	15.66	1.89
FORE_P%	5.15	61.98	21.90	12.62
EURO_P%	1.69	54.95	13.06	11.91
LOCAL_P%	9.37	66.98	29.29	13.75
INC	535.11	923.72	722.21	87.00
EDUEXP	45.27	258.96	132.91	52.05

Note: N = 99.

Table 3. Results of the OLS regression model

Parameter	b	Z	Std. Error	P-value
Intercept	4.1119		0.2007	<0.001
SEC_HM%	0.01363	0.6136	0.0012	<0.001
PROP_POOL%	0.0234	0.3144	0.0042	<0.001
INC	0.0011	0.2430	2.6410E-4	<0.001
LOW_RETH%	-0.02626	-0.2131	0.0067	<0.001

Table 4. Moran's I applied to model variables and regression residuals

	Moran's I	**Z score**	**p-value**
LNDWC12	0.029	1.74	0.08
SEC_HM%	-0.06	-2.19	0.02
PROP_POOL%	0.293	2.74	0.00
INC	0.669	5.88	0.00
LOW_RETH%	-0.011	-0.04	0.96
Model residuals	0.168	7.86	0.00

Table 5. Goodness-of-fit test for improvement in model fit of GWR over OLS

Source	Df	Sum Sq	Mean Sq	F-value	p-value
OLS Residuals	5	4.6091			
GWR Improvement	26.102	2.6240	0.100528		
GWR Residuals	67.898	1.9851	0.029236	3.4385	0.0161

Note: Df: effective degree of freedom; p-value: the probability of F-distribution with degrees of freedom 7 and 11.62.

Table 6. Results of the geographically weighted regression model

Parameter	Min.	1st Qu.	Median	3rd Qu.	Max.
Intercept	3.0830000	4.2340000	4.7290000	5.1190000	5.5520000
SEC_HM%	0.0085120	0.0115600	0.0144800	0.0165400	0.0182700
PROP_POOL%	0.0008067	0.0179900	0.0241500	0.0289300	0.0424300
INC	-0.0012980	-0.0003496	0.0002918	0.0008108	0.0026660
LOW_RETH%	-0.0400300	-0.0258900	-0.0158500	-0.0110100	-0.0020020

Figures captions

Figure 1. Municipalities of the Spanish Mediterranean Coastline for which data are available

Figure 2. Mapped GWR local R^2 results in the Spanish Mediterranean coastline municipalities

Figures

Figure 1

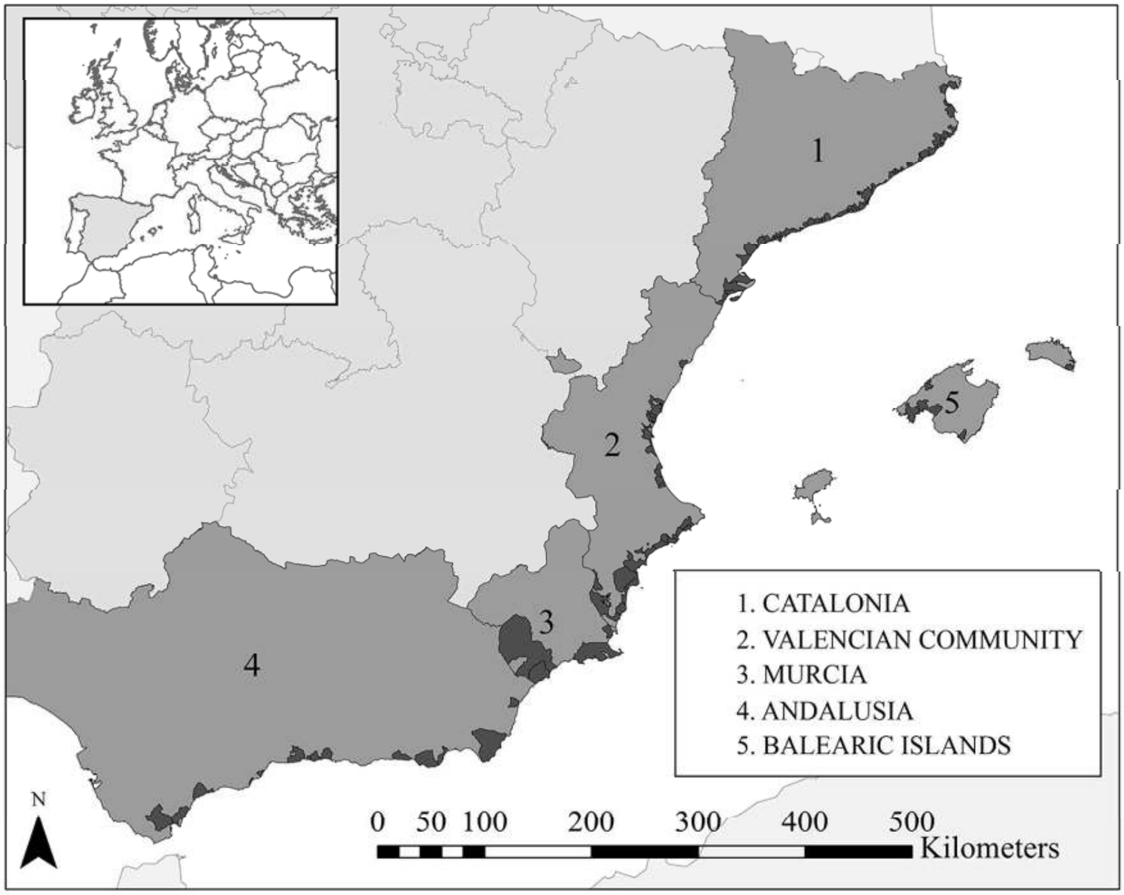
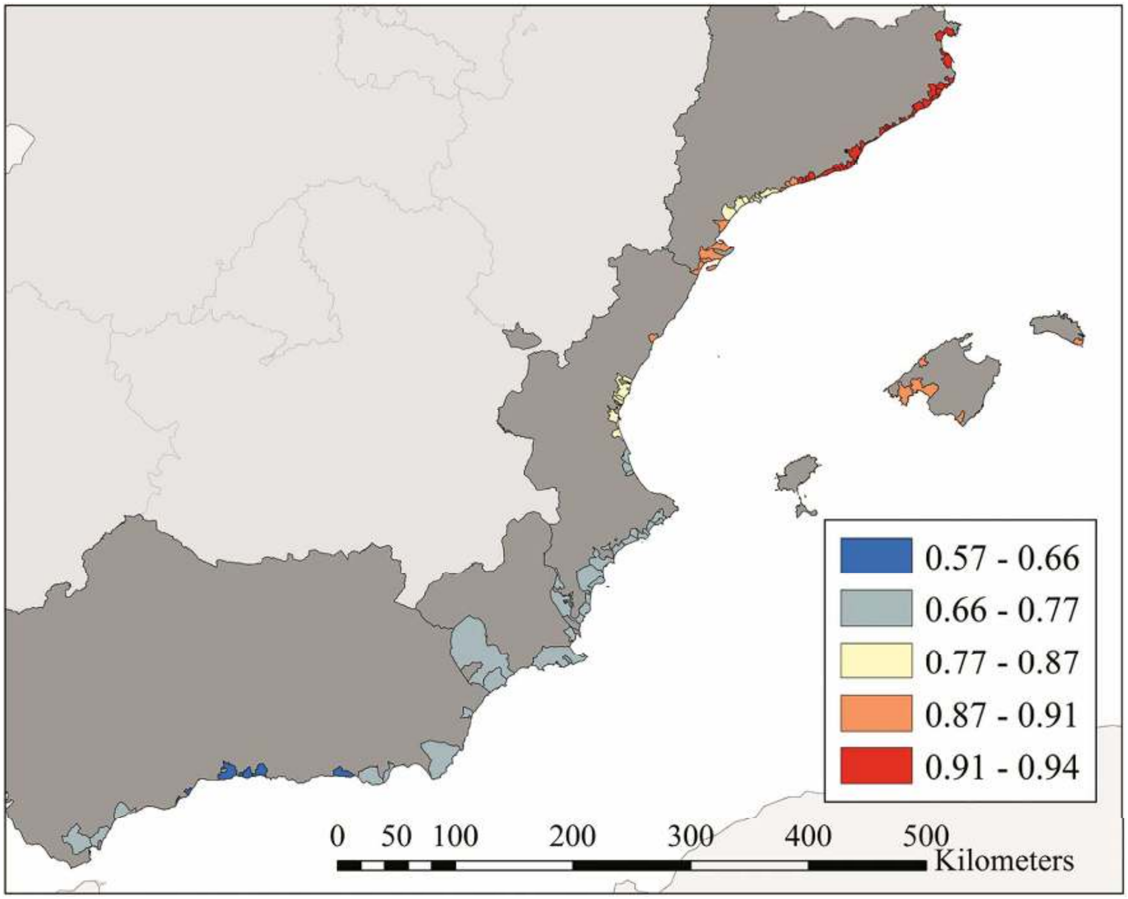


Figure 2


0.57 - 0.66
0.66 - 0.77
0.77 - 0.87
0.87 - 0.91
0.91 - 0.94
0 50 100 200 300 400 500
Kilometers

Tables

Table 1. Dependent and independent variables description

Variable	Short Description	Abbreviated names	Source
Domestic water consumption	Neperian logarithm (NL) of domestic water consumption per capita	LNDWC12	Municipalities and local water companies
Urban model	Urban Population Density (people/km²)	URBPOP_DENS	INE & Corine Land Cover
Presence of Gardens	Residential properties with garden in 2014 (%)	PROP_GAR%	AIS Group
Presence of Pools	Residential properties with pool in 2014 (%)	PROP_POOL%	AIS Group
Building age	Average age of residential properties in 2014	PROP_AGE	AIS Group
Size of housing	Average area of residential properties in 2014 (m²)	PROP_AREA	AIS Group
Second homes	Second homes in 2011 (%)	SEC_HM%	INE
Household size	Average number of people per household in 2011	H_SIZE	INE
Single and two-member homes	Households with two or fewer members in 2011 (%)	H_SIZE1-2%	INE
Low-Income	Low-income pensioner	LOW_RETH%	AIS Group

retirement homes	households of up to two members in 2013 (%)		
High-Income retirement homes	High-income pensioner households of up to two members in 2013 (%)	HIGH_RETH%	AIS Group
Presence of children and teenagers	Upper and lower-class households with children or teenagers in 2013 (%)	CHILDH%	INE
Aged population	Population over 65 years (%) in 2012	AGE_P%	INE
Young population	Population under 15 years in 2012 (%)	YOU_P%	INE
Foreigners	Foreign population in 2012 (%)	FORE_P%	INE
European foreigners	European foreign population in 2012 (%)	EURO_P%	INE
Local identity	Population born in the municipality in 2012 (%)	LOCAL_P%	AIS Group
Income	Average monthly income in 2012 (€/inhabitant)	INC	AIS Group
Education expenditure	Average annual expenditure on education in 2012 (€/inhabitant)	EDUEXP	AIS Group

Table 2. Descriptive statistics on dependent and independent variables

Variable	Min.	Max.	Mean	Std. dev.
DWC12	90.83	523.57	199.25	94.73
LNDWC12	4.51	6.26	5.19	0.42
URBPOP_DENS	781.96	22203.53	6088.22	4572.23
PROP_GAR%	0.02	88.73	31.38	17.82
PROP_POOL%	0.00	34.45	4.66	5.67
PROP_AGE	15.19	52.93	32.09	6.25
PROP_AREA	76.01	220.56	127.70	26.97
SEC_HM%	0.64	68.52	28.64	19.05
H_SIZE	2.16	3.20	2.57	0.18
H_SIZE1-2%	39.01	69.84	54.93	6.20
LOW_RETH%	2.84	19.87	10.12	3.43
HIGH_RETH%	1.00	10.62	5.00	1.99
CHILDH%	10.11	37.97	24.83	7.03
AGE_P%	7.43	31.06	16.90	3.99
YOU_P%	11.08	21.01	15.66	1.89
FORE_P%	5.15	61.98	21.90	12.62
EURO_P%	1.69	54.95	13.06	11.91
LOCAL_P%	9.37	66.98	29.29	13.75
INC	535.11	923.72	722.21	87.00
EDUEXP	45.27	258.96	132.91	52.05

Note: N = 99.

Table 3. Results of the OLS regression model

Parameter	b	Z	Std. Error	P-value
Intercept	4.1119		0.2007	<0.001
SEC_HM%	0.01363	0.6136	0.0012	<0.001
PROP_POOL%	0.0234	0.3144	0.0042	<0.001
INC	0.0011	0.2430	2.6410E-4	<0.001
LOW_RETH%	-0.02626	-0.2131	0.0067	<0.001

Table 4. Moran's I applied to model variables and regression residuals

	Moran's I	Z score	p-value
LNDWC12	0.029	1.74	0.08
SEC_HM%	-0.06	-2.19	0.02
PROP_POOL%	0.293	2.74	0.00
INC	0.669	5.88	0.00
LOW_RETH%	-0.011	-0.04	0.96
Model residuals	0.168	7.86	0.00

Table 5. Goodness-of-fit test for improvement in model fit of GWR over OLS

Source	Df	Sum Sq	Mean Sq	F-value	p-value
OLS Residuals	5	4.6091			
GWR Improvement	26.102	2.6240	0.100528		
GWR Residuals	67.898	1.9851	0.029236	3.4385	0.0161

Note: Df: effective degree of freedom; p-value: the probability of F-distribution with degrees of freedom 7 and 11.62.

Table 6. Results of the geographically weighted regression model

Parameter	Min.	1st Qu.	Median	3rd Qu.	Max.
Intercept	3.0830000	4.2340000	4.7290000	5.1190000	5.5520000
SEC_HM%	0.0085120	0.0115600	0.0144800	0.0165400	0.0182700
PROP_POOL%	0.0008067	0.0179900	0.0241500	0.0289300	0.0424300
INC	-0.0012980	-0.0003496	0.0002918	0.0008108	0.0026660
LOW_RETH%	-0.0400300	-0.0258900	-0.0158500	-0.0110100	-0.0020020