**Title page**

**Understanding perceptions of the social impacts of Protected Areas: evidence from three NATURA 2000 sites in Greece**

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**ABSTRACT**

The social impacts of Protected Areas (PAs) are increasingly recognized as a key issue that needs to be explored and combined with existing evaluation frameworks assessing the economic and environmental impacts of PAs. The present paper focuses on the subjective assessment of social impacts of PAs and how these perceptions are formulated. Results of an empirical study, implemented in three PAs in Greece, are presented. According to the study, individuals’ perceived quality of life, trust in institutions, social trust and place attachment are the most important indicators influencing perceptions of social impacts. A main conclusion of the paper is that measuring social impacts is not sufficient for the planning and designation of a PA. Additional research is needed exploring the reasons behind these perceptions in order to plan actions minimizing negative impacts for local communities.

**Keywords**: Biodiversity conservation, perceived social impacts, subjective cultural ecosystem services, well-being, Quality of life, Place attachment

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1. **Introduction**

Protected Areas (PAs) are the most widely applied policy tool for biodiversity conservation (Juffe-Bignoli et al. 2014). PAs have become increasingly important not just because of the need to conserve biodiversity but also because they are closely linked to climate change adaptation (Dudley et al. 2010; IUCN 2012). In this context, a rapid increase of PAs designation has been observed internationally along with a tendency to re-establish existing ones.

Certain categories of PAs, such as national parks (IUCN category II) and strict nature reserves (IUCN Category Ia) are often accompanied by high socio-economic costs for local communities due to the significant changes in everyday activities for locals (eg Brockington and Wilkie 2015; Cernea and Schmidt-Soltau 2006; Jones et al. 2017). Furthermore, conflicts often occur between stakeholders regarding new regulations following the designation (Bennett and Dearden 2014; Hattam et al. 2014) resulting in low levels of public acceptance and low compliance with regulations (Keane et al. 2008; Bragangolo et al. 2017; Solomon et al. 2015). In order to resolve these conflicts, the importance of carefully exploring social aspects of PAs’ designation is widely recognized and an increasing literature has emerged focusing on Social Impacts (SIs) of PAs (Andrade and Rhodes 2012; de Lange et al. 2016; Jones et al. 2017; Kaplan-Hallam and Bennett 2017; Zafra-Calvo et al. 2017).

Social impact assessment in PAs can assist in a more holistic understanding of their impacts. The Ecosystem Services approach and Impact Assessments could benefit by incorporating aspects of one another into their processes (Baker et al. 2013; Helming et al. 2013). Such an integration will allow better communication of key information regarding these services to policy makers ((ie Nautiyal and Kaechele 2007; Partidario and Gomes 2013; Genelleti 2013) underlying clearer links regarding the costs and benefits of ecosystems for society (Karjalainen et al. 2013). However, there is very limited discussion in terms of how ecosystem services can be linked with social impact assessment.

The importance of SIs of PAs has significantly grown especially since the publication of the Millennium Ecosystem Assessment (MEA 2005) where the link between ecosystem services and their impact on well-being was underlined. As a result, an increase in studies measuring SIs of ecosystems services has been observed in recent years (de Lange et al. 2016; Franks and Small 2016; Oldekop et al. 2016; Corrigan et al., 2017).

The Millennium Ecosystem Assessment (2005) identified five dimensions of well-being: a) security, b) basic material for a good life, c) health, d) good social relations and e) freedom of choice and action. The SIs of PAs may be also linked to broader issues, as underlined in the social impact assessment literature, such as *‘the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of the society’* (Burdge et al. 1995; Vanclay et al. 2015). Furthermore, the ‘Framework on Well Being in developing countries’ highlights the importance of capturing different dimensions of well-being including objective indicators and also their subjective evaluation by individuals (University of Bath 2002; Wills et al. 2007; Tilouine 2007). Thus, the assessment of SIs can be divided in objective and subjective indicators (Woodhouse et al. 2015). Objective SIs are linked with standard well-being indicators, such as ‘health status’ and ‘poverty levels’ (OECD 2017), and also certain aspects of cultural ecosystem services such as the number of new recreational activities due to the establishment of the PA and the frequency of their use (MEA 2005). Subjective indicators, refer to assessments in which the opinions of individuals about these impacts are explored (Bryce et al. 2016). These include, for example, perceptions on ‘quality of life’ and ‘physical and mental health’ and are closely linked with subjective cultural ecosystem services. The exploration of this type of indicators is crucial because they refer to elements affecting both the level of local participation (Woodhouse et al., 2015) and the acceptance of PAs (Jones et al. 2012a, 2017).

Although the literature on objective social impact indicators has increased, subjective assessment of these impacts is limited. Furthermore, there are very few studies analyzing factors influencing perceptions of these subjective SIs. In this context, the aim of the present paper is to explore individuals’ perceptions of the SIs of PAs and identify explanatory factors influencing these perceptions. These issues are investigated in three Greek PAs through a quantitative social survey.

1. **Factors influencing perceptions of SIs**

In order to identify potential explanatory factors, evidence is drawn from existing paradigms and studies which have successfully linked certain indicators with perceptions of public policies (ie Dunlap et al. 2000; Nisbet et al. 2008; Putnam et al. 1993).

A starting point is the level of *environmental awareness* (Courrau 2005; Sia et al. 2010; Staub and Hatziolos 2004; Tempesta and Otero 2013) *and participation in decision-making processes* for a PA as they have been proven to have an impact on individuals’ perceptions of SIs (Courrau 2005; Staub and Hatziolos 2004). Higher environmental awareness may reduce perceived negative SIs, as individuals will identify multiple benefits for a proposed environmental policy (Jones and Clark 2013). Furthermore, the levels of *social capital* (Putnam et al. 1993), referring mainly to *social trust, institutional trust and social networks* are closely linked with collective action (Ostrom 1998) and perceptions of environmental policies (Jones 2010). Communities with low levels of institutional and social trust tend to consider that management frameworks for natural resources will be ineffective and this is expected to also have an influence on perceptions of the impacts of a PA (Jones et al. 2017). Social networks are equally important as they influence the level and type of information that reaches individuals (Pretty 2003) and have a direct effect on the level of trust towards institutions that provide this information (Jones and Clark 2014; Wolf et al. 2010). In addition, communities with weak social networks are often less aware of the aim of a conservation area and less informed about the benefits from the designation resulting in negative perceptions of the PA (Jones et al. 2012a). In close relation to social capital is also individuals’ *quality of life* as it is often linked in a positive way with the tendency to participate in collective activities (Putman 2000).

Perceptions concerning the *risks* with regard to natural resources and *perceived threats* have also been linked with individuals’ reactions towards environmental policies (Baldassare and Katz 1992; O’Connor et al. 1999; Thomassin et al. 2010). Thus, environmental perceptions of related risks, such as the loss of biodiversity, are expected to influence the level of SIs perceived by citizens. This is because ‘risk awareness’ can be an important predictor of the intention of individuals in relation to environmental issues (O’Connor et al. 1999). In the case of PAs, this means that perceptions of the risks from the loss of biodiversity are expected to influence individual beliefs about proposed PAs and their impacts. Another set of explanatory indicators is linked with *place attachment* referring in particular to emotional bonds and place related symbolic meanings (Devine-Wright 2011). In the case of PAs, the specific geographical area may have a high value for the local community (Charles and Wilson 2009; Pomeroy et al. 2004) which can take different forms (i.e. affective, functional and cognitive) (Lin and Lockwood 2014) and is expected to influence perceptions of locals for the PA (Pomeroy et al. 2004). As a result, place attachment parameters have been identified as predictors of pro-environmental public engagement and perceptions of PAs (Buta et al. 2014).

Finally, *demographics* also need to be taken into consideration in order to develop a framework, which can accurately capture explanatory factors for perceived SIs. Several demographic factors are expected to influence SIs as perceived by citizens and also the level of acceptability. *Gender* is one of them (Coad et al. 2008), mainly because differences in use of resources and power may mean that there will be different impacts between men and women. Other demographic factors that may affect perceptions of SIs are *age and education* (Karki 2013). The *location* of a community or a household (in relation to the PA) is also expected to influence perceptions (Karki 2013) along with the *frequency of use of the PA*. Perceptions about positive SIs will be influenced, for example, by how close a community is to new facilities provided by a PA and how often they use them (Ezebilo and Mattsson 2010).

1. **Methods**

The influence of the above-mentioned parameters on perceived SIs was tested through a social survey in three Greek PAs. The three sites were initially selected because of their common protection status as they are all included in the NATURA 2000 Network. We also selected the specific sites in order to explore SIs along with explanatory parameters in the context of areas with different socio-economic structures and also with a different management framework. The three sites are described below:

a) ***Prespes National Park*** is situated in the North-West border area of Greece (Size: 327 km2). It was first established in 1974 and new expanded restriction zones were confirmed in 2009. The local communities around the park are dependent on agriculture (Trakolis 2001), focusing on the cultivation of beans with some varieties registered as ‘products of protected geographical indication’. Livestock farming is also an important traditional economic activity in the Prespes National Park, while tourist activities have increased in the past years. For some residents, tourism is a supplementary source of income, with the majority having more than one job. The management of the area is the responsibility of a Management Actor consisting of members from the central government and local stakeholders.

b) ***Samaria National Park*** (Crete) is 48.5 km2 and has been awarded with the [European Diploma of Protected Areas](http://www.coe.int/en/web/culture-and-heritage) of the Council of Europe. It was established in 1962 while protection zones are currently being designated. A large part of the National Park is the Samaria Gorge which is a significant tourist attraction with an entrance fee. The surrounding communities are mainly dependent on livestock farming and they benefit significantly from the high levels of tourism in the area attracted by the gorge, especially in the coastal part. Agriculture is limited due to the mountainous character of the area. Management of the PA is the responsibility of a Management Actor in which state representatives and members of local stakeholders participate.

c) ***Chortarolimni-Limni Alyki & Thalassia Periochi*** (Limnos) is 182.32 km2 and was first designated in 2006 with final regulations confirmed in 2011. The surrounding population is mainly dependent on agriculture and fishing while tourism is very limited. No management actor exists for the specific area with the North Aegean Prefecture having some key responsibilities especially in the case of enforcing control measures.

*3.1 Questionnaire description*

In order to assess the SIs in the three PAs, a structured questionnaire was created, including mainly close-ended questions distributed to a sample of the local communities affected by the establishment of the PA. The study aimed to apply an advanced statistical methodology, following the Bayesian paradigm, and for this purpose, it was decided to apply close-ended questions, the majority of which were measured on a 10-point Likert scale. We decided to include a 10-point scale as it allows a larger variance (compared to smaller scales) and a higher degree of measurement precision (see, e.g., Wittink and Bayer, 2003). Furthermore, we partly treated the ordinal scales with statistical procedures that are more appropriate to metric and count variables due to the application of an advanced statistical analysis, hence the choice of the 10-point Likert scale was intuitively more suitable for our comparisons (Carifio et al., 2007). In the first part of the questionnaire, demographic data were collected (Table 1). In the second part, perceptions of 13 SIs were explored (Table 2). As it was not possible to predict whether these impacts were perceived by citizens as positive, negative or having no impact, a 10-point Likert scale was created where 0-4 represented negative impacts, 5 represented no impact and 6-10 represented positive impacts. In the next section of the questionnaire, all explanatory factors were measured (details of the questions and measurement scales are presented in Table S1 of the supplementary material). Based on the potential explanatory factors identified in the literature, we included variables measuring social trust, institutional trust, formal and informal social networks (World Bank 2010), place attachment (Raymond et al., 2010), risk perception for the loss of biodiversity, involvement in the decision making processes of the PA, satisfaction with quality of life, educational level, proximity to the PA (residency), age and gender.

*3.2. Sampling and sample characteristics*

The questionnaire was distributed to local communities affected by the designation of the PAs. Due to the lack of official population lists in the research areas, a stratified random sampling process was chosen. Initially, the local communities affected by the PA were identified and the total population of these communities was obtained from the National Office of Statistics. Data were available for individuals over 20 years of age and the total estimated population was 1506 individuals in Limnos, 1275 in Prespes and 1700 in Samaria. The sample size in each local community of the research areas was determined in order to represent the proportions of the actual population in terms of key demographic characteristics that were available from the National Statistics Office (age, gender and education). Experienced researchers distributed the questionnaire through face-to-face interviews. The sample was regularly tested against the available actual demographics of the population. Confidence intervals of sub-populations within PAs were tested and the final data sub-population selection was found to be included within the range of each confidence interval. In total, 614 questionnaires were completed (Prespes: n=254, Samaria: n=140 and Limnos: n=220). Sample characteristics are presented in Table 1.

**[Please Insert Table 1 here]**

*3.3. Data analysis*

A model-based approach and covariate selection following the Bayesian paradigm was applied in order to identify the most suitable estimation models for SIs. Special attention was given to the nature of the response variables, where the data are skewed or truncated and violate the assumptions of OLS regression, possibly leading to erroneous results when applying the latter methodology. The dependent variables do comply with the common discrete secondary scale, ranging from 0 to 10, hence are not the typical Gaussian data. Thus, instead of relying solely on the standard OLS regression, a series of alternative model assumptions were examined that acknowledge the nature of the collected response data, and compare the obtained results. Hence, we utilised models that assume the original responses to follow distributions suitable for discrete data, such as Poisson, negative binomial (NB) or the ordered logit (OL) and compare with the classic (Gaussian) linear model.

Additionally, we transform responses to account for non-normality. Some of the most applied transformations of the responses are compared with less known transformations. Specifically, we compare the results deriving from the fit of Bayesian regression models where the response has been log-transformed and square-root transformed, as well as with those results obtained by applying the inverse hyperbolic sine (HIS) transformation to the data (Burbidge et al., 1988). However, transformations may cause difficulties in the interpretation of regression coefficients and the re-transformation of predicted values (Kilian et al. 2002). Some scholars strongly advise against data transformations and suggest the use of more appropriate distributions to deal with ‘non-normal’ data (see for example Feng et al. 2014; O’Hara and Kotze 2010). Also, model comparisons are not straightforward between original and transformed data, since two models cannot be compared if the same variable is not modeled.

Particularly for the logarithmic transform, one of the difficulties is that it is not possible to calculate the logarithm if the data contain zeros, which is the case with the response data in this survey. In particular, the logarithmic transformation or the Box-Cox transformation (Box and Cox 1964) are not applicable in this case. One way to proceed with datasets that contain non-positive values is to drop these or to add some constant , in the transformation  so that each observation is positive. In these cases, the  transformation is often used instead of . This is typically when the lowest non-zero value in the data is one. However, there is no concrete reason as to why 1 is added rather than other constants, such as 0.5 or 2. (Yamamura, 1999). The addition of 1 is simply an arbitrarily chosen number to ensure that the log transformation is defined for zero values.

For comparison reasons, in addition to the standard  log shifted by 1 transformation, the  transformation will also be explored (Yamamura, 1999)*.* We will also test the frequently used square root transformation  and its effect on the results. Unlike the log transform, the square root transformation does not require special treatment of zero responses.

As the logarithmic and the square root transformations do not allow model comparisons, an alternative to the latter was also employed to make model comparisons between original and transformed (for approximating normality) data, namely the inverse hyperbolic sine (IHS) transformation. This may be adequately used as an alternative to the Box-Cox group of transformations, especially for zero-inflated data sets and data sets with a large number of negative values (Burbidge et al. 1988; Zhang et al., 2000).

All explanatory variables used in the model are described in Table S1. In order to facilitate the development of the models, an Explanatory Factor Analysis was conducted merging certain variables in new factors. These were the two variables measuring ‘place attachment’ (see supplementary material S1, Cronbach’s alpha: 0.75; % of variance explained: 81.1), two variables measuring ‘social trust’ (Cronbach’s alpha: 0.94; % of variance explained: 94.45) and two variables measuring formal social networks (Cronbach’s alpha: 0.71; % of variance explained: 77.8).

*3.3.1. Model selection*

In order to model the response variables (SIs), we assumed continuous-type distributions, such as the Gaussian fitted to the raw data as well as to corresponding transformations of the raw data. In addition, the responses were modelled utilizing distributions more suitable to count data, such as the Poisson and the negative binomial (NB) distributions.

The regression-type models fitted to our data are described by the following equations:

|  |  |
| --- | --- |
| **Normal (N):** | (1) |

|  |  |
| --- | --- |
| **Poisson (P):** | (2) |

|  |  |
| --- | --- |
| **Negative binomial (NB):** | (3) |

|  |  |
| --- | --- |
| **Ordered Logit (OL):**    where: | (4) |

where  denotes the  response of the  response variable (i=1,2,…,614; j=1,2,…,13),  denotes the  matrix that comprises the values of the  independent variables and vector the corresponding coefficients of the independent variables and the intercept .

In addition to the regression-type models described by equations (1) to (4), we then proceeded to various transformations in the Y variables. For our analysis and for comparison reasons, we will examine the  transformation, based on the suggestions of Yamamura (1999). This will be conducted in addition to the standard  transformation to account for the presence of zeros in the responses. We also test the square root transformation  and its effect on the results. Finally, the IHS transformation of data  is given by the following expression:

 ,

where  is a scale parameter. At the limiting case of , the IHS transformation gives the original untransformed response . To apply IHS to our count data, we have selected =0.5 (however, for checking the robustness of our results, we have also examined alternative values of , ranging between 0.01 and 0.5, obtaining similar or worst results in the fit statistics values).

We test the fit and performance of the four model specifications that are based upon the transformations of the response variables as these are presented below:

|  |  |
| --- | --- |
| **Squared-root transformed (SRT) Normal:** | (5) |

|  |  |
| --- | --- |
| **log transformed (LT)** **Normal:** | (6) |

|  |  |
| --- | --- |
| **log transformed (LT)** **Normal:** | (7) |

|  |  |
| --- | --- |
| **Inverse hyperbolic sine (HIS) Normal:** | (8) |

*3.3.2. Bayesian variable selection*

Due to the large number of potential predictors of social impact variables, the application of robust covariate selection methodology is imperative. Hence, Bayesian variable selection techniques were implemented based upon variations of g-prior mixtures. The hyper g-prior (Liang et al. 2008) approach was utilized for Bayesian variable selection and the effects of different specifications on the selected covariates within this context were studied. Variable selection in Bayesian regression modeling (George and McCulloch, 1993) includes a vector of binary indicators  in the regression equation that indicates the p possible sets of covariates that should be included in the final model (i.e.  or 1 if coefficient  is small or large, respectively). Then, Markov Chain Monte Carlo methodology was utilized in order to approximate the posterior distribution of  given the data.

Regarding the prior assignments for the γ parameters of the variable selection modeling approaches, we implemented two specifications, one using a uniform prior specification on model space, with  and one where a beta-binomial prior was used i.e.  where  (Chipman et al., 2001). Subsequently, inference concerning the issue of whether to include each one of the covariates in the final model selection was based on the posterior probabilities given by:

In the latter formulation,  stands for the marginal likelihood  whereas  are the prior model probabilities.

*3.3.3. Hyper g-Prior Specification*

The extension to the classical Zellner’s g-prior was followed (Zellner, 1986), known as the hyper g-prior (Liang et al, 2008; Sabanés Bové and Held, 2011), that assumes the vector of regression coefficients  of the candidate covariates follow a multivariate normal distribution:

 ,

Further, a Beta prior is assigned to the shrinkage factor g/(1+g):

 For our analysis, we have chosen α=4, as suggested by Sabanés Bové and Held (2011).

*3.3.4. Prior specification and Inference*

Having selected the covariates for inclusion in the final models for each one of the Y variables, we then fitted the selected models setting vague prior distributions for the  parameters (i.e.  ~N(0, K), K🡪∞). Here we used K=104.Markov Chain Monte Carlo techniques were used for Bayesian model inference. To obtain posterior distributions of the models’ parameters, 10,000 iterations were run as the burn-in period and an additional sample of 10,000 iterations with thinning one out of ten iterations. The WinBUGS software was utilized for model estimation (Lunn et al., 2000). Model selection was carried out through the use of the posterior mean deviance  (Spiegelhalter et al., 2002), with models with smaller  value fitting the data better. Note that transformations of the responses complicate the procedure of model selection, since models can generally be only compared on the original units of the dependent variable.

**4. Results**

*4.1. Perceptions of SIs of the PAs*

Perceptions of SIs along with comparisons between the three research areas are presented in Table 2. Data from the three research areas were compared using the ANOVA (F) statistical test. *Tourism* and the *natural environment* were considered to be influenced in a positive way by the establishment of the PAs with significantly higher scores compared to other impacts (Table 2). It is also interesting to note that *stock farming*, *agriculture* and *fishing* were all considered as being influenced in a negative way by the PAs with the score of the impact being below 5 (the threshold for an impact to be considered as negative). The only exception was *fishing* in Samaria where it was valued close to the ‘no-impact’ scale (close to 5). A significant negative impact was on *hunting* with individuals in Limnos reporting the highest negative impact compared to the other two areas. Results regarding the impact on *trade* and *employment* differed between the three areas with Prespes presenting results close to ‘no impact’, participants from Limnos perceiving a negative impact and respondents from Samaria having a relatively positive perception. *Infrastructure and buildings* were considered to have been influenced in a negative way in Limnos and Prespes. Residents in the Samaria case study considered this as having no impact. *Recreational activities* in Samaria and Limnos were seen as being positively influenced by the PAs, with a more neutral impact among Prespes residents. Impact on *environmental awareness* *of locals* appears to be limited in Prespes and Limnos with a slightly more positive perception in the local community of Limnos. Regarding the impact on *local quality of life*, all areas had an average score close to 6, which indicates a relatively positive perception but not a strong one. Finally, regarding the impact on the *level of engagement of citizens* with local environmental issues, this was moderate with individuals in Prespes perceiving it as being influenced in a negative way whereas no impact was observed in the other two areas.

**[Please Insert Table 2 here]**

*4.2. Analysis of explanatory factors*

Bayesian regression-type modeling and inference and variable selection was performed utilizing the methodology described in section 3 of the paper (see Tables S2-S7 in the supplementary material). Firstly, the various distributional specifications for the untransformed data were compared (Tables S2 & S3). Tables S4 and S5 present the performance of the fitted models from the perspective of covariate selection. The results indicated that there are no unique patterns across the response items, verifying the random variations in variable selection according to the specific choice of modeling the responses. Tables S6 & S7 present the results summarizing the outcome of the posterior inclusion probabilities  for the performance of covariate selection on each of the 13 SI models, allowing us to examine which of the independent variables are included as important predictors across the whole range of fitted models (S6:uniform prior; S7: beta-binomial prior). Only a few of the candidate independent variables were suggested to be included in all models using the threshold value of 0.5. Despite the different model results the aim of the analysis was to provide evidence contributing to the better understanding of SIs of PAs.

Regarding model comparison and selection of the best model, it must be noted that model comparisons are meaningful if the dependent variable is the same for the compared models. This is because a non-linear transformation influences the variance of the response variables, making the comparisons between the model of untransformed and transformed data incompatible. However, we first compared the various distributional specifications for the untransformed data (Tables S2 & S3). Although the Poisson and NB specifications performed similarly or worst in comparison to the Gaussian specification, the Ordered Logit (OL) model exhibited better fit in comparison to the three previous models applied to the untransformed data revealing that this model can result in the best fit to the data.

In regards to the transformed response data models, the log-transformed model where responses were shifted by 1 had the best fit, according to the posterior mean deviance  results, followed by the alternative log-transformation, shifting values by 0.5. Conversely, the square-root transformation did not seem to provide good fit to the data.

For the purpose of the present analysis, direct comparisons between untransformed and transformed data models were conducted based on corrections of the posterior mean deviance, in accordance to previously described corrections of the AIC statistic (Akaike, 1978). The results confirmed the superiority of the log-transformed model.

Taking the above into consideration, the posterior medians are presented, along with the corresponding credible intervals, of the parameters  of the statistically significant covariates, according to the best-fitted model, utilizing the transformed data, i.e. the log-transformed model shifting responses by 1  (Table 3).

It is clear from the results presented in Table 3 that the parameters have a different influence on the perceived SIs. However, there are certain explanatory variables and factors that do have a significant and consistent influence for the majority of SIs. On the other hand, among the selected covariates, we also observed covariate estimates that were marginally statistically significant, as their 95% credible intervals include the value of zero, near the borderline of the interval.

The level of satisfaction from the *quality of life* is an explanatory parameter for all SIs except in the increase of public engagement. In all cases, individuals who considered that they were more satisfied with their quality of life also stated more positive impacts from the establishment of the PAs.

The *research area (location)* is a significant factor explaining differences on perceptions in seven SIs. More positive perceptions of SIs were recorded in the Samaria area in comparison to the reference category of Prespes. As regards to respondents from Limnos, no significant differences were found when compared with the Prespes region (Table 3).

*Trust in the actor managing the PA* is also a significant explanatory parameter for all SIs except for hunting. Thus, individuals who tend to trust the management actor of the PA also have a tendency to perceive more positive impacts from the establishment of the conservation area. However, trust in government is not such an important parameter.

*Social trust* is an explanatory parameter for seven SIs. It is important to note that it is not an important covariate for stock farming, agriculture and fishing which refer to traditional uses of the PAs and are linked with income and employment levels. Where it is an explanatory parameter it has a positive influence, with individuals who tend to trust others perceiving more positive impacts from the PA.

*Concern of the risks from biodiversity loss* was also a significant explanatory parameter for the majority of the impacts measure with a positive link, except for hunting. Respondents who were more concerned of the risk of biodiversity loss were more likely to perceive positive impacts from the establishment of the PA. It is interesting to note that in the case of hunting, individuals who expressed a higher concern for biodiversity loss risks tended to believe that PAs had negative impacts on hunting.

*Place attachment* of individuals was an explanatory parameter for eight of the SIs. Respondents who had a strong sense of place attachment perceived more positive impacts from the existence of the PA. Conversely, individuals with a ‘weaker’ place attachment perceived more negative impacts from the PA.

*Years of residency* in the area is an additional significant explanatory parameter in most impacts linked negatively with stock farming, agriculture and fishing. It is interesting that individuals who lived longer in the area tend to perceive more negative impacts from the designation of the PA.

**[Please Insert Table 3 here]**

**5. Discussion**

Through the empirical study, several parameters were explored as explanatory for perceived SIs and we would like to highlight the most important ones here. The most consistent indicator explaining perceived SIs was perceived ‘quality of life’ with a positive influence on individuals’ perceptions. This result reveals that individuals who consider that they had a better quality of life at the time of the research also perceived increased benefits from the establishment of the PA. Although the importance of measuring quality of life prior to environmental planning has been underlined in the literature (Steg and Vlek 2009), its connection with SIs has not been adequately explored. A possible explanation is because of the impact of the PA on environmental quality. Individuals who benefit from the establishment of the PA because of the improved environmental quality also consider that their quality of life has increased. However, as our research is a ‘snapshot’ of the situation at the time that the questionnaires were distributed, longitudinal data are needed in order to understand in-depth how perceived quality of life is linked with perceive impacts of PAs in the long term.

Another important explanatory indicator was social trust, positively linked with perceived SIs. The importance of social trust has been highlighted in the literature especially in regards to environmental behaviour and collective management of natural resources (Pretty 2003). Social trust is considered to be consistently low in Greece compared to other European countries (Ervasti et al. 2018; Jones et al. 2010). It has also been correlated with the acceptance of participatory management policies in forest (Jones et al. 2012b; Jones et al. 2015) and wetland (Jones et al. 2012a) PAs in Greece, increasing citizens’ perceived social and environmental benefits of those policies (Jones et al. 2012a). A possible explanation for the importance of social trust in perceived SIs is that individuals who tend to trust their fellow citizens consider that other members of the community will act in a collective way protecting the environment, also resulting in considerable benefits for the local community from the establishment of the PA.

Regarding concerns about the risks from biodiversity loss, these have been linked with environmental behavioural intentions in the climate change literature (O’Connor et al. 1999). Based on our findings, these perceptions have an important role as they influence perceived impacts. This can be explained as individuals who are more concerned about biodiversity loss are expected to be more supportive of a PA and thus consider it as a policy with lower negative impacts.

According to our findings, individuals with a ‘stronger’ place attachment also perceived more positive SIs. This result is in line with existing literature highlighting that individuals with a strong sense of place attachment attribute a higher value to their place of residence (Charles and Wilson 2009; Pomeroy et al. 2004). Thus they view the establishment of a PA as a policy that will benefit their local area. This is an important finding considering that geographical mobility in Greece is quite low and individuals tend to stay in an area long-term. However, it is interesting to note that respondents who have lived longer in the area perceived more negative impacts especially regarding economic activities. This comes in contrast with the expectation that perceived negative impacts from the PA are reduced in the long-term because local communities become accustomed with the changes imposed. This finding requires further exploration as it may be linked with the complexities of existing local values (Voyer et al. 2015) and also with personal perceptions of the long-term deterioration of quality of life due to the PA.

It is also clear from the results of the study that in order to have positive perceptions of the SIs of a PA, it is essential that there is a management actor trusted by citizens. Previous studies have highlighted the importance of trust regarding biodiversity conservation initiatives and how actions to increase trust can reduce conflicts (Young et al. 2016). Higher trust in institutions means that citizens are more likely to consider that the management actor will fulfill proposed plans and will establish and effectively manage a PA taking into consideration local priorities (Vokou et al. 2014). In the case of Greece this is a significant issue that needs to be taken into consideration in future environmental planning as levels of institutional trust have significantly decreased in the past decade mainly because of the economic recession (Ervasti et al., 2018) while the establishment and management of PAs is still highly dependent on state actors (Vokou et al. 2014).

Finally, significant differences were observed among the three research areas concerning perceptions of SIs. This finding highlights the fact that the location of a PA is a parameter that can determine perceived SIs even if the management framework of the policy is similar. This is because local communities have very different characteristics and this should be further emphasized in future studies of SIs (Apostolopoulou et al. 2012; Jones et al. 2012c). In particular, there should be a more focused and in-depth approach in each PA, prior to the designation, exploring specific local characteristics. In this context, it is interesting to briefly discuss the reasons explaining differences between the three case studies.

Regarding the impact on economic issues, such as employment, it is interesting to note that the most agricultural community (Prespes) is the one where no impacts were observed. This is probably because everyday activities and employment levels have continued as in the past with some minor adjustments due to new regulations. In Limnos, the establishment of the PA has not been accompanied by economic benefits or information campaigns and this has resulted in negative perceptions regarding the impact of the PA on the economy. However, residents of local communities around Samaria perceive more positive impacts, possibly linked to the increase of tourism because of the PA designation. Furthermore, the existence of buildings and communities in the park influences perceptions regarding infrastructure. Samaria had the lowest impacts compared to the other two case studies. This was expected as very few communities are established in the boundaries of the protected area whereas in the other two sites this is not the case. In addition, in Limnos, hunting was considered as one activity with significant negative impacts. The PA in Limnos is an important wetland attracting a large number of birds and due to the establishment of the PA, hunting is prohibited.

Respondents from Prespes and Limnos present similar perceptions regarding the impact on environmental awareness despite the fact that Prespes has a more established management framework and is a more ‘mature’ PA. A possible explanation is linked with the time of establishment of the two areas. Prespes is an older PA and the impact on awareness should have been higher during its first decades of establishment. On the other hand, Limnos is a relatively new PA and its existence will still be influencing awareness levels. This result reveals that certain impacts, such as the one on awareness, may reach a certain positive threshold before it starts decreasing gradually over the years. However, more research needs to be done in order to understand how perceptions of such SIs change over time. Finally, our findings regarding the impact on local levels of engagement are disappointing considering that no positive perceptions were recorded. This result should be seen in the context of the wider efforts in Greece to establish co-management frameworks and increase local engagement (Vokou et al. 2014) revealing that additional initiatives need to be made towards this direction.

A final finding that we would like to highlight concerns the statistical process. The results of the study indicated that for the specific type of Likert-type dependent variables the most suitable approach for treating the dependent variables for regression-type analyses is the standard log-transformation shifted by 1, which outperformed other transformations as well as the distributional assumptions suitable for count data, such as the Poisson. This finding may be attributed to the fact that our data are restricted within the 0-10 range hence assumptions of the Poisson (and NB) model are violated. Another possible reason might be that our dependent variables are left-skewed, as indicated by running a simple skewness statistic check. However, the Poisson distribution, although not symmetrical, is a right-skewed distribution, and therefore it is possible to expect that the current data will not fit well to the latter distribution. Thus, a major finding from this research is that the direction and degree of skewness of the dependent variable should be taken into consideration for choosing the link distribution of the regression modeling.

Despite the significant findings of our study, there are certain limitations that we need to take into consideration in interpreting our results and reaching our main conclusions. First, assessing subjective perceptions of SIs of PAs captures only one aspect of these SIs. It is important that objective indicators assessing SIs, influenced both by the cultural ecosystem services literature and also well-being, are incorporated in future studies. Second, although the paper explores numerous explanatory factors explaining perceived SIs, these are not exhaustive. Additional factors in the growing discussion around the SIs of PAs and in particular the well being literature have been underlined and future research should focus on incorporating these elements in a new framework. These include local values (Voyer et al., 2015), objective measurements of SIs (Woodhouse et al., 2015) and also additional demographic factors such as the economic status of the individual and his/her inclusion or exclusion from certain groups. Finally, the paper presented an analysis of perceived SIs and their explanatory factors through a quantitative approach. It is important that future research focuses on gathering qualitative data, through interviews and focus groups, with key stakeholders. A mixed-methods approach will allow the in-depth understanding of the links between different socio-economic and environmental elements. Also, the ‘participatory’ nature of such qualitative techniques allows the more effective communication and knowledge exchange of such research findings.

**6. Conclusion**

The aim of the paper was to assess subjective SIs of PAs and empirically test which factors influence these perceptions through an in-depth modeling analysis. The results of the study revealed that a set of indicators are crucial in forming these perceptions. These included place attachment, social trust, trust in the management actor, concern of the risks from biodiversity loss, years of residence and most importantly, satisfaction with quality of life. Furthermore, significant differences in perceptions of SIs were observed depending on the locality where they were assessed. These factors need to be explored and considered prior to the final designation of PAs as they will allow policy-makers to understand how SIs are perceived.

Based on our findings, the following actions are proposed for the three case studies in order to mitigate negative impacts and increase perceived benefits. First, practitioners and policy makers need to increase activities in which they engage with local communities in order to ‘boost’ the low levels of institutional trust. Second, engagement and communication activities need to focus on re-connecting individuals with nature making clearer the provision of ecosystem services for local communities and their quality of life and also the risks from biodiversity loss, especially at a local level. Such initiatives should target all members of the public but especially individuals who have lived longer in the area as they seem to have the most negative perceptions among locals. Thirdly, engagement activities need to focus on increasing social networks and levels of trust among locals. It is important to increase social trust between members of the community linking older and more recent residents in the area. These short-term actions will have significant long-term impacts especially when combined with the assessment of objective and material SIs. As a final remark, we would like to emphasize that it is important to re-consider how SIs are assessed in PAs and it is also crucial to develop frameworks which explain SIs in order to identify actions which can minimize future conflicts and increase the level of public acceptance of PAs.

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**Τable 1. Sample characteristics**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Category** | **Prespes** | **Samaria** | **Limnos** | **Total** |
| Gender (%) | Male | 54.3 | 55.0 | 54.5 | 54.6 |
| Female | 45.7 | 45.0 | 45.5 | 45.4 |
| Educational Level (%) | Up to 6 years | 24.8 | 35.7 | 20.0 | 25.6 |
| 9 years | 16.9 | 22.9 | 6.4 | 14.5 |
| 12 years (Secondary education) | 27.6 | 19.3 | 23.2 | 24.1 |
| 15 years (post-secondary) | 12.6 | 14.3 | 20.9 | 16.0 |
| Higher Education | 16.1 | 6.4 | 20.9 | 15.6 |
| Post-Graduate Studies | 2.0 | 1.4 | 8.6 | 4.2 |
| Age (Mean) | | 47.22 | 44.29 | 44.07 | 45.4 |
| Years living in the area (Mean) | | 36.63 | 43.26 | 34.71 | 37.4 |

**Table 2. Comparison of perceived Social impacts in the three research areas**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Prespes**  (mean & sd) | **Samaria**  (mean & sd) | **Limnos**  (mean & sd) | **Total**  (mean & sd) | **ANOVA**  (*F*) |
| Stock farming | 4.43 (2.11) | 4.99 (0.47) | 4.58 (2.31) | 4.61 (1.96) | F=3.78\*\* |
| Agriculture | 4.39 (2.29) | 4.98 (0.30) | 4.17 (2.38) | 4.45 (2.07) | F=6.77\*\*\* |
| Fishing | 4.39 (2.38) | 5.41 (0.80) | 3.89 (2.25) | 4.45 (2.15) | F=23.26\*\*\* |
| Hunting | 3.85 (2.52) | 3.94 (1.07) | 2.73 (2.37) | 3.46 (2.28) | F=19.13\*\*\* |
| Trade | 4.96 (1.99) | 6.65 (1.43) | 3.94 (2.03) | 4.98 (2.15) | F=87.94\*\*\* |
| Employment | 5.29 (2.15) | 6.48 (1.29) | 4.49 (1.70) | 5.27 (1.96) | F=51.09\*\*\* |
| Natural environment | 6.21 (2.32) | 6.08 (1.03) | 7.07 (2.55) | 6.49 (2.23) | F=12.22\*\*\* |
| Tourism | 6.15 (2.45) | 7.79 (1.93) | 7.57 (2.27) | 7.04 (2.39) | F=32.30\*\*\* |
| Building | 4.00 (2.34) | 5.41 (1.00) | 2.81 (2.11) | 3.89 (2.24) | F=71.60\*\*\* |
| Recreational activities | 5.51 (2.28) | 7.54 (1.87) | 7.04 (2.59) | 6.53 (2.47) | F=42.52\*\*\* |
| Cultural activities | 5.47 (2.08) | 5.35 (0.71) | 5.88 (1.95) | 5.59 (1.82) | F=4.68\* |
| Quality of life | 5.79 (2.23) | 5.94 (1.18) | 6.21 (2.30) | 5.98 (2.07) | F=2.47\* |
| Public engagement | 3.88 (2.49) | 5.19 (0.45) | 4.9 (2.14) | 4.55 (2.07) | F=23.01\*\*\* |

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

**Table 3. Parameter median estimates for the candidate models along with the 95% credible intervals (uniform prior)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **SOCIAL IMPACTS** | | | | | | | | | | | | |
|  |  | **Stock farming** | **Agriculture** | **Fishing** | **Hunting** | **Trade** | **Employment** | **Environment** | **Tourism** | **Buildings** | **Recreation** | **Cultural activities** | **Quality of life** | **Public engagement** |
| **COVARIATES** | Samaria | 0.052  (0, 0.096) | 0.066  (0.015,  0.17) | 0.101  (0.043,  0.158) | 0.137  (0.076,  0.199) | 0.108  (0.066,  0.151) | 0.106  (0.064,  0.148) |  |  |  |  |  |  | 0.118  (0.07,0.166) |
| Limnos |  |  |  |  |  |  |  |  | -0.238  (-0.311,  -0.164) |  |  |  |  |
| Female | 0.033  (0, 0.066) | 0.058  (0.023,  0.094) |  |  | 0.034  (0.001,  0.066) |  |  |  |  | 0.029  (0.001,  0.059) | 0.026  (0.001,  0.05) |  |  |
| Aware of existence |  | -0.096  (-0.247,  0.054) | -0.128  (-0.285,  0.03) | -0.178  (0.356,  0.003) |  |  | 0.262  (0.145,  0.378) |  |  |  |  | 0.1  (-0.008, 0.207) |  |
| Lower Education |  |  |  | 0.072  (0.016,  0.127) |  | -0.061  (-0.09,  -0.026) |  |  |  | -0.028  (-0.061,  0.004) |  | -0.039  (-0.068,-0.009) |  |
| Medium Education | -0.029  (-0.062, 0.003) |  | -0.03  (-0.068,  0.006) |  |  |  |  |  |  |  |  |  | -0.035  (-0.069,-0.001) |
| Visit: Never |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Visit: Rarely |  |  |  |  |  |  | 0.033  (0.007,  0.061) | 0.041  (0.013,  0.07) |  |  |  |  |  |
| Visit: Often |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Area |  | -0.003  (-0.005,  0) | -0.002  (-0.004,  0) | -0.004  (-0.007,-0.001) | -0.005  (-0.007,  -0.003) | -0.003  (-0.005,-0.001) |  | 0.003  (0.002,  0.005) | 0.005  (0.001,  0.009) | 0.005  (0.003,  0.007) |  |  |  |
| Residency | -0.001  (-0.002, 0) | -0.001  (-0.002  ,0) | -0.001  (-0.002,  -0.001) | -0.001  (-0.003,  0) |  |  |  |  |  |  |  |  |  |
| Age |  |  |  |  | -0.001  (-0.002,  0) |  |  |  | -0.002  (-0.003,-0.001) |  |  |  |  |
| Quality Of Life | 0.018  (0.011,  0.026) | 0.017  (0.009,  0.025) | 0.008  (0,  0.017) | 0.02  (0.011,  0.031) | 0.021  (0.014,  0.028) | 0.014  (0.007,  0.021) | 0.008  (0.002,  0.014) | 0.011  (0.006,  0.017) | 0.021  (0.012,  0.03) | 0.017  (0.011,  0.023) | 0.005  (0,  0.011) | 0.012  (0.007,0.018) |  |
| Risks Loss Of Biodiversity |  |  |  | -0.008  (-0.016,0) |  | 0.007  (0.002,0.013) | 0.019  (0.014,0.025) | 0.016  (0.01,0.021) | 0.007  (0,0.015) | 0.011  (0.005,0.017) | 0.015  (0.01,0.019) | 0.021  (0.017,0.026) | 0.021  (0.014,0.028) |
| Trust Government |  |  | 0.01  (0,  0.022) | 0.032  (0.019,0.044) |  |  |  |  |  |  |  |  |  |
| Trust MA | 0.012  (0.005,  0.019) | 0.016  (0.008,  0.024) | 0.019  (0.01,  0.028) |  | 0.011  (0.004,  0.019) | 0.008  (0.002,  0.015) | 0.008  (0.002,  0.014) | 0.013  (0.007,  0.018) | 0.021  (0.013,  0.03) | 0.015  (0.009,  0.022) | 0.01  (0.005,  0.016) | 0.015  (0.009,  0.021) | 0.026  (0.018,0.034) |
| Informal networks | 0.011  (0,  0.023) | 0.009  (-0.003, 0.022) |  |  |  |  |  |  |  | 0.014  (0.003, 0.026) |  |  | 0.014  (0.002,0.026) |
| Informed On Decisions |  |  | -0.036  (-0.076,  0.003) |  |  | 0.023  (-0.007,  0.054) |  |  |  |  |  |  | 0.057  (0.019,0.095) |
| Participate In Decisions | 0.1  (0.064,  0.15) | 0.092  (0.041,  0.142) |  |  |  |  |  |  |  |  |  |  | 0.085  (0.035,0.137) |
| Support From Informal networks |  |  | 0.075  (0.013,  0.138) |  |  |  |  |  |  | -0.089  (-0.139,-0.038) |  |  |  |
| Social trust |  |  |  | 0.031  (0.008,  0.054) | 0.034  (0.016,  0.052) | 0.021  (0.005,  0.036) |  |  | -0.111  (-0.173,-0.049) |  | 0.015  (0.001,0.029) | 0.017  (0.003,0.031) | 0.038  (0.019,0.056) |
| Place attachment | 0.015  (-0.002,  0.032) | 0.025  (0.006,  0.044) | 0.029  (0.01,  0.049) |  |  |  | 0.012  (-0.001, 0.027) | 0.03  (0.017,0.044) | 0.025  (0.004, 0.047) | 0.03  (0.014, 0.046) | 0.021  (0.008, 0.034) |  |  |
| Formal social networks |  | -0.026  (-0.044,  -0.008) |  |  |  |  |  |  |  | -0.018  (-0.032,-0.004) |  |  |  |