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Using proverbs to study local perceptions of climate change: A case study in Sierra Nevada (Spain)

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ABSTRACT

Local communities' dependence on the environment for their livelihood has guided the development of indicators of local weather and climate variability. These indicators are encoded in different forms of oral knowledge. We explore whether people recognize and perceive as accurate one type of such forms of oral knowledge, climate-related proverbs. We conducted research in the Alta Alpujarra Occidental, Sierra Nevada, Spain. We collected climate-related proverbs and classified them according to whether they referred to the climatic, the physical, or the biological system. We then conducted questionnaires (n=97) to assess informant's ability to recognize a selection of 30 locally relevant proverbs and their perception of the accuracy of the proverb. Climate-related proverbs are abundant and relatively well recognized even though informants consider that many proverbs are not accurate nowadays. Although proverbs' perceived accuracy varied across informant's age, level of schooling, and area of residence, overall proverb's lack of reported accuracy goes in line with climate change trends documented by scientists working in the area. While our findings are limited to a handful of proverbs, they suggest that the identification of mismatches and discrepancies between people's reports of proverbs (lack of) accuracy and scientific assessments could be used to guide future research on climate change impacts.

Keywords: *Andalucía (Spain); climate change impacts; ethnoclimatology; indigenous and local knowledge; proverbs.*

Length: Text: 5406; Figures: 2; Tables: 3.

Introduction

In their quest to better understand local climate change impacts, both natural and social scientists are challenged by the scarcity of grounded data. This has resulted in climate scientists calling for the exploration of new data sources (Rosenzweig and Neofotis 2013). Within this context, several authors have argued that local ecological knowledge has an untapped potential to contribute to further our understanding of local climate change impacts (Barnes et al. 2013; Savo et al. 2016). Researchers have documented many instances in which Indigenous peoples or local communities with a long history of interaction with the environment have developed complex knowledge systems that allow them to detect changes in local weather and climatic variability, as well as the impacts of such changes in the physical and the biological systems on which they depend (e.g., Orlove et al. 2000; Fernández-Llamazares et al. 2015; Reyes-García et al. 2016). Through observations of their immediate environment accumulated over generations and continuously adapted to environmental and other changes local populations have developed a large body of ethnoclimatological knowledge, defined as "*the comprehensive system of insights, experiences, and practices regarding climate and local weather events, as well as their changes at different spatiotemporal scales"* (Reyes-García et al. 2018).

An important component of ethnoclimatological knowledge is weather forecasting. Traditional weather forecasting, or the short- and long-term predictions of weather variability, is typically based on the observation of local phenomena of different types, which are used as weather indicators (King et al. 2008; Zuma-Netshiukhwi et al. 2013; Kagunyu et al. 2016). For example, in several parts of the Mediterranean region, short-term weather is forecasted through the observation of physical phenomena (e.g., clouds, fog), astronomical conditions (e.g., the moon), or plant and/or animal behavior (Lefale 2010; Enock 2013). In the same region, annual weather is forecasted through observations of weather conditions during specific days of the month of August, observations that are then extrapolated to the coming months, a method in Spain known as *cabañuelas* (Mesa et al. 1997). Moreover, research shows that some of these traditional weather forecasting methods may be accurate (e.g., Orlove et al. 2000; Marin 2010; Lefale 2010). For example, Orlove and colleagues (2000) showed that farmers in drought-prone regions of Andean South America make observations of changes in the apparent brightness of stars in the Pleiades around the

time of the southern winter solstice. These observations are then used to forecast interannual variations in summer rainfall and to decide when to plant the most important crops. These researchers found that poor visibility of the Pleiades in June is caused by an increase in high cirrus clouds which is indicative of an El Niño year, usually linked to reduced rainfall during the growing season. In other words, the studied Andean weather forecasting method seems to be based on a visible indicator of El Niño variability.

methods have raised the interest of some atmospheric institutions, such as the Philippine Atmospheric Geophysical and Astronomical Services Administration or the weather agencies of New Zealand and Australia (Galacgac and Balisacan 2009). Out of this interest, the Australian Bureau of Meteorology supports the collection of local weather calendars (Parrotta and Agnoletti 2012) and Mozambique includes traditional weather forecasting knowledge in its National Adaptation Plan for Action (Bambaige 2007). However, some researchers have started to call for caution in the use of traditional weather forecasting methods, signalling that these methods might lose their predictive ability in the current situation of rapid climatic changes (Weatherhead et al. 2010).

In this work, we explore whether local people recognize climate-related proverbs, a traditional weather forecasting method, and whether they perceive such proverbs as accurate. Proverbs are concise and short sentences known by many people and containing locally accepted truths, teachings, and traditional points of view. Proverbs typically appear as fixed, metaphorical, and easy to remember forms, for which they are considered an effective form of storing and transmitting knowledge and thus maintaining people-place relations (Sterling et al. 2017). Previous studies have already explored the potential use of proverbs for biodiversity conservation and management (e.g., Kurien 1998), including their potential as a source of information to predict meteorological phenomena (Kanno et al. 2013). In this work, we advance this line of research by analyzing trends in proverbs' recognition and perceived accuracy, and by exploring whether changes in the perceived accuracy of proverbs are in line with climate change impacts documented by scientists in the study area.

Sierra Nevada and its people

We conducted research in Sierra Nevada, a rural and high mountainous region (reaching 3482 m.a.s.l.) in Andalusia, southwestern Spain. Traditionally, Sierra Nevada was occupied by farmlands, mainly devoted to herbaceous and mixed crops. Like in other areas of Spain during the 20th century, the integration of local economies in global markets and agricultural mechanization and intensification lead to the loss of competitiveness of traditional agriculture, the decrease in job opportunities for young generations, and urban migration in Sierra Nevada (Cozar Valero 2000).

Conservation policies also contributed to dramatically change land uses in Sierra Nevada. The area was designated as Biosphere Reserve in 1986, then as Natural Park in 1989, and finally as National Park in 1999. These protection figures recognize the area as one of the most important hotspots for biodiversity in the Mediterranean Region (Lorite et al. 2007). The creation of the protected area occurred at the same time that agro-silvopastoral uses were abandoned and the area experienced an active reforestation with pine trees and increasing urbanization. In 2006, only 4.72% of the protected area was dedicated to farmlands; traditional mixed crops had been replaced by a monospecific arboriculture of olive and almond trees, and sheep transhumance was much less frequent. Nowadays, although agriculture, livestock and beekeeping continue to be present, the economic activity is rapidly shifting to the tertiary sector (e.g., tourism, skiing) (Pérez-Luque et al. 2016).

Sierra Nevada is a relevant case to study how the accuracy of climate-related proverbs might help in scientists' quest to detect local climate change impacts for two reasons. First, Sierra Nevada inhabitants have a history of dependency on natural resources to maintain their livelihood, which also translates in an important pool of local knowledge (Iniesta-Arandia et al. 2015). Livelihood activities in Sierra Nevada were traditionally linked to local weather conditions and water management techniques that –over centuries- shaped an engineered landscape dominated by water transport, i.e., *acequias,* and water storage infrastructures, i.e., *aljibes* (Castillo Martín 1999). Traditional agriculture, livestock and other subsistence activities were highly dependent on the maintenance of this human modified landscape.

The second reason why Sierra Nevada provides a relevant case study is the availability of scientific data that can be partly used as a base for comparison. In 2007, a global change observatory (i.e., the *Observatorio del cambio global de Sierra Nevada*)

was stablished in the National Park. Scientists and technical staff from the *Observatorio* collect information on climatology, phenological changes in plants, bird's migration, and changes in the cryosphere. Scientists at the *Observatorio* have also compiled temporal series for some of those indicators. In line with predictions for the Mediterranean region (Planton et al. 2012; IPCC 2014), data from this observatory show that the area has experienced a decrease in rainfall and an increase in the average annual maximum and minimum temperatures. Data also show that snow duration at altitudes above 2500 m.a.s.l. has decreased of 3.8 days in 17 years and that the soil thermic regime has changed, resulting in the disappearance of permafrost (Zamora Rodríguez et al. 2015). Furthermore, a delay in the flowering seasons has been detected, specially affecting early flowering plants at high altitudes. Finally, while net values of bird species diversity have not changed significantly, bird species that predominated in the 1980s (such as *Sylvia communis*) are less abundant nowadays and new species, like *Saxicola rubicola*, *Prunella modularis* or *Sylvia conspicillata*, have appeared (Zamora Rodríguez et al. 2015). The *Observatorio* disseminates the most significant findings of its research through scientific publications and local mass media (e.g., regional journals such as *Granada hoy* or *Ideal de Granada*), but it does not have a dissemination strategy directly targeting local populations.

Methods

Data from this work come from a bibliographic compilation of proverbs and a face-to-face survey (n=97) conducted during June and July 2018. Data collection received the approval of the Universitat Autònoma de Barcelona (CEEAH-3367). We collected the free, prior, and informed consent of all participants before starting the survey (Supplementary Material 1).

Proverbs compilation

Drawing on Hong et al. (2016), to select proverbs we followed a two-step procedure. In our first step, we consulted different national, regional, and local compilation books and paremiology webs (see Supplementary Material 2). We transcribed proverbs from our sources into a file, grouping proverbs with similar formulations. We then selected those referring to weather, seasons, wild fauna and flora, and/or agriculture. Our preliminary list included 665 proverbs. We refined this list by excluding strictly agricultural proverbs (i.e., proverbs that explain how or when to plant

or harvest), as agricultural production is affected by many drivers. This procedure reduced our list to 366 proverbs. In the second step we reduced the list by eliminating proverbs without local relevance. To do so, we interviewed eight local key informants, three women and five men, selected because they had previously participated in the collection of proverbs/songs/stories, because they maintained traditional weather forecast practices (*cabañuelas*), or because they were locally recognized as experts. We asked key informants whether they knew the proverbs in our list and we only retained proverbs recognized by at least two of the key informants. Our final list includes 283 proverbs.

Following Reyes-García et al. (2019), we classified proverbs as *climatic* if they referred to temperature, precipitation, air masses, or seasonal events; *physical* if they referred to soil moisture, snow cover, or ice sheet; and *biological* if they referred to fauna and flora phenology or abundance. Each proverb could be included in more than one category. For example, we classified the proverb *Wet December, frozen January* as referring both to the climatic and the physical systems. Most of the proverbs in our list (n=166 out of 283) referred exclusively to the climatic system, 55 referred to the biological, and 26 to the physical system. The remaining proverbs simultaneously referred to more than one system. Thus, 21 proverbs simultaneously referred to the climatic and the biological system, 11 to the climatic and the physical systems, three to the biological and physical systems, and one of the proverbs included information referring to the three systems.

Sample

Our sampling strategy for the face-to-face survey includes village and informants selection. To reduce variability in the weather conditions experienced by informants answering the survey, we selected neighboring municipalities in the Alta Alpujarra Occidental, in the southern face of Sierra Nevada (Figure 1). To reduce potential differences in perception generated by dependency in different livelihood activities, we selected villages with more than 300 inhabitants, located inside the Sierra Nevada Natural Park, and at an altitude higher than 500 m.a.s.l. Specifically, we applied the survey in five study areas corresponding with five different ravines or watersheds, for a total of 12 villages.

INSERT FIGURE 1

We directed our survey to people who had lived in the area for 25 years or more, assuming that they would be knowledgeable about local proverbs and able to comment on their current accuracy. We used a convenience sampling strategy to target a stratified sample of respondents, aiming to interview a similar number of people working on the primary (e.g., agriculture, livestock, apiculture) and other sectors (e.g., transport, tourism). To select potential interviewees, in each village we first had a meeting with the mayor to introduce ourselves and to present our intended work. During that meeting, we asked the mayor to introduce us to people who could be interested in participating in the study. We then used snowball sampling to contact other potential survey respondents (Huntington 2000). We also approached people in the street and asked them whether they wanted to participate in a survey. If a person said s/he was willing to participate, we first asked for the time living in the area and main profession, and only interviewed people who fitted our sampling criteria.

Survey

Our survey had two distinct sections. In the first section, we asked about informants' sociodemographic characteristics. Particularly, we asked about informants' *age* (in years), *sex* (i.e., women and men), *schooling* (i.e., people who had never attended school versus people who had), *primary sector* and *ravine* (i.e., Bérchules, Trevélez, La Taha, Poqueira, and Lanjarón). As in this area people who work in the primary sector typically engage in different tasks simultaneously, we could only differentiate between informants whose economic activity was in the primary sector versus people with occupations in other sectors.

In the second section of the survey, we asked informants about a list of 30 randomly selected proverbs from the full list of 283 identified proverbs. From the 30 proverbs selected, 10 referred to the climatic, 10 to the physical, and 10 to the biological system. We then asked informants whether they knew each of the proverbs and whether they thought they were accurate. We created a variable called *recognition* that was coded as (1) when the person knew the proverb and (0) otherwise. To limit variation in responses associated to people having different interpretations of proverbs, after the question on recognition, we commented with informants the meaning of the proverb, and then asked the informant whether s/he thought the proverb was accurate nowadays. We coded responses to this second question in a variable called *accuracy* which took

the value of (0) when the person said the proverb was not accurate, (1) when the person thought it was accurate, (2) when the person did not know if it was accurate, and (3) when the person thought it was accurate only sometimes.

Data analysis

We start the analysis calculating the percentage of proverbs refereeing to the climatic, the physical, and the biological system recognized in each ravine. Then, to identify the correlates of proverbs' *recognition* and *accuracy*, for each informant we calculated 1) the number of proverbs recognized and 2) the number of proverbs considered as ***i)*** accurate, ***ii)*** not accurate, ***iii)*** sometimes accurate, and ***iv)*** for which the person ignored accuracy. We then aggregated these percentages across the three categories of proverbs (i.e., climatic, physical, and biological).

We explored the sociodemographic correlates of individual proverb recognition by running a multivariate regression with the number of proverbs recognized as dependent variable against informant's sociodemographic information (i.e., age, sex, schooling, economic activity sector, and ravine) as potential explanatory variables, while controlling for ravine fixed-effects. Since our dependent variables are the count of proverbs (recognized or accurate), we used a Poisson regression, typically used for modeling events where the outcomes are discrete data with non-negative integer values (Cameron and Trivedi, 1998). We control for ravine's fixed-effects, or invariant characteristics that might affect the estimated association, by including a set of dummies for the five ravines. To test whether our results hold for proverbs referring to climate change impacts on different systems, we ran a set of similar models, but using as dependent variables the disaggregated variables that capture the number of climatic, physical and biological proverbs recognized by the informant. All regressions include clusters by ravines, to indicate that the observations may be correlated within ravines, but independent between them.

We use the same approach to explore the correlates of accuracy. In this analysis, we use as dependent variable the number of proverbs the informant considered not accurate. As for the previous analysis, we ran regressions for the variable capturing overall proverbs' lack of accuracy as well as regressions considering the number of climatic, physical, and biological proverbs that are not accurate.

In all the analyses we report p-values <0.10 as indicator of statistical significance. However, as our sample size is small and some of our groups of heterogeneous size (e.r., 20 women vs. 77 men), the coefficients and statistical significance of our estimates should be read with caution. For the statistical analysis, we used STATA for Windows, version 13.

Results

Descriptive analysis

On average, survey respondents were 65.1 years old. We interviewed 20 women and 77 men. As much as 40 of the informants had never attended school and 37 had only completed primary school. From the people interviewed, 44 worked in the primary sector and 53 in other economic sectors. The number of informants was similarly distributed across ravines, except for Lanjarón where we could only conduct 11 interviews.

Sociodemographic correlates of proverb's recognition

On average, 83.3% of informants recognized the 10 climatic proverbs in our list, a percentage considerably higher than for proverbs referring to the physical (44.54%) and the biological systems (36.29%) (Table 1). Indeed, some proverbs referring to the climatic system were known by most people in the sample (i.e., proverbs Cli1, Cli7, Cli9, and Cli10 were known by more than 95% of informants) and only one (Cli6) was only known by 54% of the informants. Comparatively, the recognition of proverbs referring to the physical system was lower. Thus, only one of the proverbs referring to the physical system (Phy7) was known by all informants whereas the rest were known by less than 60% of informants. One of the proverbs (Phy6) was only recognized by 14.4% of the informants, being the proverb least recognized. Only two of the proverbs referring to the biological system (i.e., Bio6 and Bio9) were recognized by more than half of the informants. Proverbs refereeing to the biological system generally displaying the lowest level of recognition (Table 1).

INSERT TABLE 1

Proverb recognition varied across informants, some people recognizing more proverbs than others. On average, informants recognized 16.4 out of 30 proverbs in our survey (SD 5.36), although one person only recognized seven proverbs and another

person knew 29. The number of proverbs recognized differed between informants from the five ravines, people in Bérchules recognizing more proverbs than people in the other four ravines and people in Lanjarón displaying the lowest level of recognition, particularly for proverbs referring to the physical and biological systems (Figure 2).

INSERT FIGURE 2

Results from multivariate analysis partly confirm these findings. Thus, when using the number of proverbs recognized by the informant as a dependent variable, we found that age was not associated in a statistically significant way with proverb recognition. We found that people who had received school education recognized fewer proverbs than people who had never gone to school and that informants in all other ravines knew fewer proverbs than informants in the ravine of Bérchules (Table 2, column 1).

INSERT TABLE 2

Different sociodemographic characteristics are associated to the recognition of climatic, physical, and biological proverbs. Thus, older informants recognized more climatic proverbs than younger informants (column 2), but age was not associated to the recognition of proverbs referring to the physical or the biological systems. Women recognized fewer proverbs referring to the climatic system than men (column 2), but there were no statistically significant differences between women and men in the recognition of proverbs referring to the physical (column 3) and the biological systems (column 4). School attendance was not related to informant's level of recognition of climatic proverbs, but it was negatively associated to level of recognition of proverbs related to the physical and biological systems. Informants working in the primary sector recognized more proverbs related to the physical system than informants working in other sectors. Finally, although people in Bérchules generally recognized more proverbs than people in all the other ravines, regression results show that people in Poqueira recognized more proverbs related to the climatic system than people in Bérchules (Table 2, column 2).

Sociodemographic correlates of proverbs' accuracy

Overall, levels of proverb's perceived accuracy are lower than levels of proverb's recognition. On average, 51.1% of the proverbs in the list were considered

accurate nowadays by people interviewed, while 36.6% of the proverbs were considered not accurate, and 3.2% were considered accurate only sometimes. For 9.0% of the proverbs an answer could not be provided due to uncertainty. In general, proverbs referring to the climatic system were the ones considered less accurate (42.4% not accurate and 6.3% sometimes accurate), followed by proverbs referring to the biological system (33.2% not accurate and 1.4% sometimes accurate). On average, proverbs referring to the physical system were considered the most accurate (55.4% accurate).

The climatic proverbs considered less accurate are Cli5, referring to extreme variability in September rains (considered accurate by only 15.5% of informants), Cli1, referring to how clouds shape can predict rain (21.7%), and Cli10, referring to how weather in March and April influences flowering in May (23.7%). The proverbs referring to the physical system considered less accurate were Phy3, which refers to the time when snow can be found at different altitude levels (8.3%), Phy6, which relates to the presence of fog during March with the risk of frost in May (9.3%), and Phy4, referring to the frequency of frost during the month of May (41.2%). Finally, the proverbs referring to the biological system perceived as less accurate were Bio4, referring to the fructification of the chestnut tree (35.1%), Bio10, referring to the relation between the flowering period of the olive tree and the female partridge's reproduction season (51.1%), and Bio8 referring to the flowering period of the genus *Carduus* (52.2%).

As for the variable recognition, results from multivariate analysis examining the sociodemographic correlates of accuracy also suggest that there is variation in the sociodemographic characteristics of informants associated to the perceived accuracy of proverbs (Table 3). Thus, when using as a dependent variable the total number of proverbs that the person considers as inaccurate, we found that older informants perceived as inaccurate more proverbs than younger informants. We also found that men perceived as inaccurate more proverbs than women, and that people working in the primary sector perceive more proverbs as inaccurate as people working in other sectors. Schooling was not related to the total number of proverbs considered as inaccurate by an informant, but ravine was: informants in Poqueira and Lanjarón considered as inaccurate more proverbs than informants in the ravine of Bérchules, while informants in La Taha considered as inaccurate less proverbs than informants in the ravine of Bérchules (Table 3, column 1).

INSERT TABLE 3

The analysis by proverbs referring to different systems also suggests that different sociodemographic characteristics are associated to the perception of accuracy of climatic, physical, and biological proverbs. Age was related with a higher report of inaccurate proverbs related to the climatic and the physical, but not to the biological system (column 4). Women considered climatic (column 2) and biological (column 4), but not physical (column 3) proverbs less inaccurate than men (Table 3). People who had attended school reported less inaccuracy in proverbs related to the physical system, and people working in the primary activity reported more inaccuracy on proverbs related to the climatic and the biological systems. Finally, there was considerable variation across ravines and types of proverbs (Table 3).

Discussion

In this work, we assess the level of recognition and accuracy of proverbs referring to the climatic, physical, and biological systems in Sierra Nevada, an area where people continue to depend on the environment for their livelihood and where local climate change impacts have been documented. Before commenting on the main results of the analysis, we signal two potential caveats of our work. First, our results might suffer from omitted variable bias. For example, the mode of transmission, e.g., whether the proverb was learned from elders or neighbors could be a relevant predictor for our two dependent variables, recognition and perceived accuracy. However, we did not collect information on how respondents came to learn about proverbs. Lack of inclusion of this and other potentially relevant variables might bias our results. Second, our results might also suffer from measurement error. Particularly, our measure of accuracy refers only to the present-day, without questioning whether proverbs were accurate at any point in the past. The difference in perceived past accuracy and present accuracy of the selected proverbs could be a more powerful indicator if the results are to be interpreted as perceptions of climate change. Further work in this line should aim to address these caveats.

The first result from this work is that proverbs are generally well recognized among people in our sample. Thus, while there is variation in the level of proverbs' recognition, most proverbs are recognized by more than half of the informants. Moreover, according to both, the number of proverbs in our original list and the number

of proverbs recognized by survey respondents, proverbs related to the climatic system seem to be predominant in the area. Thus, contrary to what studies in other regions of Granada have shown (Benítez Cruz 2009), in the Alta Alpujarra Occidental ethnoclimatological knowledge seems tightly linked to climatic elements such as clouds, fog, or rainbows. Indeed, during our interviews, several informants mentioned indicators of short-term weather forecast related to the presence of clouds or fog in specific mountains. For example, one informant in La Taha said that "*when the fog stops at Coto Corona, it will rain*" and another informant from Trevélez said that "*when there is fog in Piedraventana, there will be a cold rain the following way*". Furthermore, during the surveys, informants mentioned local climatic proverbs not included in our original list (see Supplementary Material 3). Our results then suggest that climate-related proverbs, continue to be recognized in the study area.

The second finding from this work is that many informants consider that proverbs, and particularly climate-related proverbs, are not accurate nowadays. It should be noted that, as we only asked about present accuracy, our data do not allow us to discern between proverbs which have become inaccurate and proverbs which might have never been accurate in the area. However, while conducting interviews, some informants made statements such as: "*I no longer pay attention to water signals because they are no longer credible*", or "*In the past, cattle used to announce the rain; but now they only know when it rains after they get wet, as rain now is unpredictable*", which suggest indeed a general loss of accuracy of traditional weather forecasting methods.

Moreover, the lack of reported accuracy of several of the proverbs selected often goes in line with trends documented by the *Observatorio* de Cambio Global de Sierra Nevada (Zamora Rodríguez et al. 2015; Pérez-Luque et al. 2016) and other trends reported in local, regional, and national scientific literature. Thus, for 19 out of the 30 selected proverbs, we find agreement between proverbs' perceived accuracy and indicators of climate change reported in the scientific literature. For example, lack of accuracy of proverbs indicating changes in precipitation regimes (Cli1, Cli2, Cli3), the start of the snow period (Phy3), frequency of frost events (Phy4, Phy 5, Phy 6), or blackbird (*Turdus merula*) abundance (Bio1), match well with scientific reports for the area (see Supplementary Material 4).

For seven out of the 30 proverbs studied we found disagreement between the two sources of information. For example, the scientific literature available reports an

increase of seasonal temperatures while less than 50% of informants consider proverbs related to these trends as inaccurate (e.g., Cli4, Cli8 and Cli9). These discrepancies, however, deserve further analysis. For three out of the seven proverbs in which there is no agreement (Phy2, Phy5 and Bio3), the comparison had to be done with scientific literature from outside Spain due to lack of more local reports, which weakens the term of the comparison. Similarly, at least for one of the proverbs (i.e., Phy9 referring to soil humidity), the mismatch could be explained by the use of different scales of observation, as the reference used (i.e., Oliva et al. 2014) studied soil temperature at higher altitudes (e.g., above 3000 m.a.s.l) than the villages surveyed.

Finally, for five of the proverbs in our list, we did not find any scientific source reporting the same change. This is the case, for example, for proverbs referring to changes in cultivated species fruiting times (Bio2 and Bio4). Although some studies have shown the relation between fruiting times and climate change (Lebourgeois et al. 2018), such type of work has not been conducted in our study area. All in all, mismatches and lack of correspondence between information from the two knowledge systems could be then considered as potential entry points for additional research (e.g., Marin 2010; Tengö et al. 2014).

The third important finding of this work relates to variation in level of proverb's recognition and perceived accuracy across informants. Consistent with previous work, our study generally shows that individual characteristics are associated to proverb recognition and perceived accuracy (Uekermann et al. 2008; Je and Wright-Harp 2011). From the several association found, some deserve further discussion. First, we found that respondents with formal schooling have a lower level of proverb's recognition, a finding that dovetails with work suggesting that formal education is not complementary to forms of traditional knowledge, particularly when traditional knowledge is not taught at schools (Reyes-García et al. 2010; McCarter et al. 2014). Second, our results suggest that older people perceive more proverbs as inaccurate than younger people, probably because age give a longer basis for comparison (Fernández-Llamazares et al. 2015) and a more concrete comprehension of proverbs (Uekermann et al. 2008). Finally, our results also suggest that people who work in the primary sector perceive more proverbs as inaccurate, probably because their dependence from and daily interaction with the environment makes them more aware of changes.

In the same line, a consistent finding in our analysis is that proverb's recognition varies between ravines, with Lanjarón displaying the lowest level of proverb recognition. While the difference could be attributed to sampling issues (i.e., we had a smaller sample size for Lanjarón), it could also be explained by different levels of rurality. Lanjarón is the ravine with the highest percentage of cultivated area (22.7%), largely dominated by olive and almond trees, as well as the ravine with the highest conversion to the tertiary sector, with a 65.4% higher occupation hotel capacity than Poqueira, the second most touristic ravine (INE 2017). Lanjarón has diversified also its economy to the secondary sector, locating the fourth biggest company of mineral water of Spain. It is also the first village of the mountain range, closer to Granada (province´s capital) and the seaport. In contrast, Bérchules, the ravine with the highest level of proverb recognition, is the ravine with the highest percentage of herbaceous crops cultivated area (2.6%).

Conclusion

In this work, we explore whether people in Sierra Nevada recognize climate-related proverbs and consider them accurate. We found that climate-related proverbs are abundant and relatively well maintained in the study area, although informants generally consider that many of them are not accurate. We found both alignments and mismatches between people's perceptions of proverbs accuracy and information provided by scientific assessments of climate change impacts in the area. While our findings are limited to a handful of proverbs, the evidence is enough to suggest that the study of local perceptions of proverbs accuracy could enrich our understanding of climate change impacts. Particularly, the identification of mismatches and discrepancies between people's perceptions and scientific assessments should be used, not to dismiss one of the two bodies of knowledge, but rather to guide future research.

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Figure captions

Fig. 1 Map of the study area

Fig. 2 Percentage of proverbs recognized in the five ravines, per category

Tables

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Table 2 Results of Poisson regression showing sociodemographic correlates of proverb recognition

Table 3 Results of Poisson regression showing sociodemographic correlates of proverb accuracy

Fig. 1 Map of the study area

Fig. 2 Percentage of proverbs recognized in the five ravines, per category

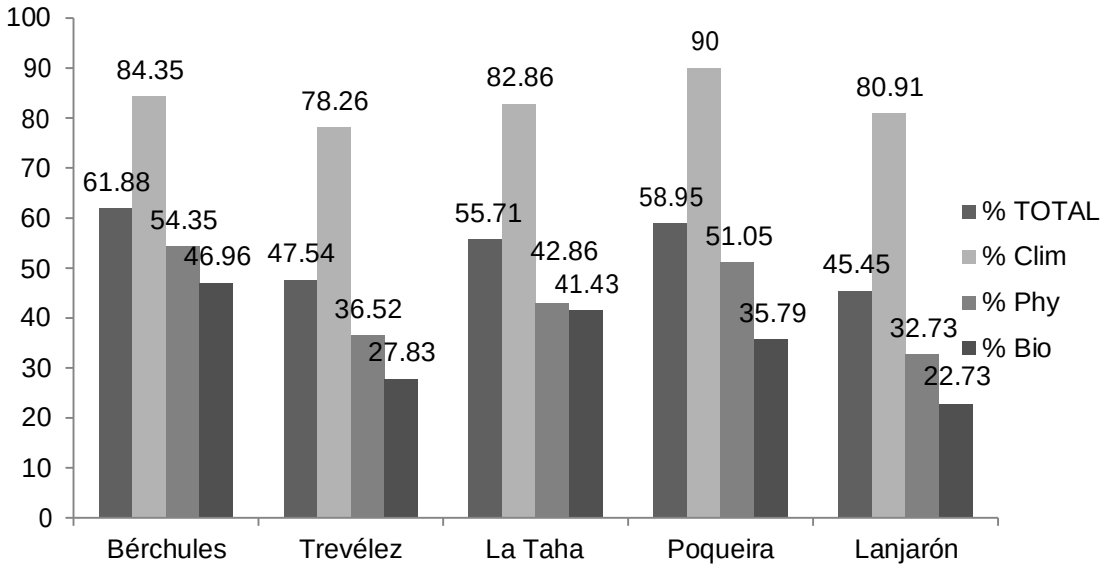

Table 1 Recognition and accuracy of proverbs included in our survey instrument

Code	Proverb	Recognition (%)	Accuracy (%)			
			Yes	No	Sometimes	Don't know
[Cli1]	***Cielo aborregado, a los tres días remojado*** Fleecy sky, in three days soaked	96.91	21.65	68.04	6.19	4.12
[Cli2]	***Cuando marzo mayea, mayo marcea*** When March feels like May, May feels like March	91.75	42.27	35.05	12.37	24.74
[Cli3]	***Mañanitas nubladas, tardes paseadas*** Cloudy mornings, sunny evenings	62.88	49.48	23.71	17.53	12.37
[Cli4]	***En febrero busca la sombra el perro y en marzo el perro y el amo*** In February the dog looks for shade, and in March the dog and the master	93.81	52.58	42.27	4.12	1.03
[Cli5]	***Septiembre o lleva los puentes o seca las fuentes*** September either carries bridges or dries up fountains	60.82	15.46	79.38	3.09	2.06
[Cli6]	***Cuando los pájaros van en banda, los hombres de parranda*** When birds flock together, men go on spree (a flock of birds flying together is an indicator of heavy rains)	53.61	68.04	11.34	0	20.62
[Cli7]	***Febrerillo el loco, sacó a su padre al sol y lo apedreó*** Crazy February, took his father to sunbathe and stoned him (meaning that weather in February is very variable, in which sunny days can alternate with hail)	98.97	70.1	26.8	2.06	1.03
[Cli8]	***Agosto, frío en rostro*** August, cold in the face	78.35	62.89	30.93	5.15	1.03
[Cli9]	***Septiembre, el que no tenga ropa que tiemble*** If you don't have clothes in September, be ready to tremble	95.88	52.58	38.14	9.28	0
[Cli10]	***Marzo ventoso y abril lluvioso sacan a mayo florido y hermoso*** March winds and April showers bring May flowers	100	23.71	70.1	6.19	0
	AVERAGE CLIMATIC	83.3	45.88	42.37	6.29	5.46
[Phy1]	***Enero claro y heladero*** January, clear sky and frosty	56.7	76.29	21.65	2.06	0
[Phy2]	***Es preciso prevenir la helada de abril*** It is necessary to prevent April frosts	42.27	60.82	37.11	2.06	0
[Phy3]	***Por Todos los Santos la nieve en los altos, por San Andrés la nieve en los pies*** For All Saints Day (November 1st), snow in the heights, for San Andrés (November 30th) snow in the feet	59.79	8.25	90.72	1.03	0
[Phy4]	***Hiela en mayo hasta el día 10, alguna que otra vez***	35.05	41.24	54.64	3.09	1.03

	It can freeze until May 10th, but rarely					
[Phy5]	***Pues que en marzo siempre hiela, que se espere cuanto pueda*** As in March it always freezes, it is better if the freeze comes late.	28.87	68.04	28.87	3.09	0
[Phy6]	***Niebla de marzo, helada en mayo*** Fog in March, frosts in May	14.43	9.28	17.53	1.03	72.16
[Phy7]	***Año de nieves, año de bienes*** Snowy year, bumper harvest year	100	86.6	12.37	1.03	0
[Phy8]	***Hielos en la cruz de mayo siempre hacen daño*** Frosts in the May 3rd (La Cruz de mayo) are always harmful	49.48	45.36	51.55	3.09	0
[Phy9]	***Lluvia o nieve de febrero, el mejor estercolero*** February rains or snows, the best manure	35.05	64.95	20.62	3.09	11.34
[Phy10]	***Arbolitos que estáis en flor libraos de los bruscos de la Encarnación*** Blooming trees, avoid the freeze of the Encarnación (March 25th)	23.71	92.78	7.22	0	0
	AVERAGE PHYSICAL	44.54	55.36	34.23	1.96	8.45
[Bio1]	***A higuera sin higos no acuden mirlos*** In a fig tree without figs, there are no common blackbirds (*Turdus merula*)	19.59	74.23	23.71	0	2.06
[Bio2]	***La noche de San Juan cuaja la almendra y la nuez*** In San Juan's night (June 23rd), the almond and walnut curd	31.96	63.92	16.49	3.09	16.49
[Bio3]	***El cuco a 10 ó 15 de abril; si no está, malo o se va a morir*** If the common cuckoo (*Cuculus canorus*) has not arrived by April 10th or 15th is because it is sick or dead	48.45	51.55	42.27	0	6.19
[Bio4]	***Por San Cipriano castaña en mano*** In San Cipriano (September 16th), chestnut in hand	19.59	35.05	60.82	3.09	1.03
[Bio5]	***Al final de abril en flor la vid*** The vine should bloom at the end of April.	41.24	61.86	21.65	3.09	13.4
[Bio6]	***Entre San Pedro y San Juan las hierbas olores dan*** In between San Pedro (June 29th) and San Juan (June 23rd), the herbs smell	52.58	83.51	15.46	1.03	0
[Bio7]	***Los estorninos cien visitas diarias hacen a los olivos pero acaba la aceituna ninguna*** The common starling (*Sturnus vulgaris*) visit olive trees a hundred times per day, but only when there are olives in the tree.	25.77	42.27	49.48	0	8.25
[Bio8]	***Cuando vienen los vilanos es conclusión del verano*** With the appearance of the *Carduus* flower, summer is over	17.53	34.02	26.8	3.09	36.08
[Bio9]	***Por enero, florece el romero*** In January the Rosemary blooms	79.38	56.7	25.77	1.03	16.49

[Bio10]	***Cuando el olivo empieza a cernir se caza la perdiz*** When the olive trees start to release the flower pollen, it is time to hung partridges.	26.8	18.56	49.48	0	31.96
	AVERAGE BIOLOGICAL	36.29	52.16	33.2	1.44	13.2
	TOTAL AVERAGE	54.71	51.13	36.6	3.23	9.04

Table 2 Results of Poisson regression showing sociodemographic correlates of proverb recognition (n=97)

	(1) All proverbs	(2) Climatic proverbs	(3) Physical proverbs	(4) Biological proverbs
Age	0.0024	0.0030***	0.0007	0.0031
	(0.0019)	(0.0008)	(0.0025)	(0.0039)
Woman	-0.0039	-0.0365***	-0.0536	0.1267
	(0.0329)	(0.0099)	(0.0460)	(0.1178)
Schooling	-0.1936***	0.0057	-0.4568***	-0.3453***
	(0.0276)	(0.0468)	(0.0068)	(0.0033)
Primary	0.0536	-0.0040	0.1649**	0.0610
sector	(0.0611)	(0.0255)	(0.0781)	(0.1281)
Municipality (excluded Bérchules)				
Trevélez	-0.3419***	-0.0737***	-0.5911***	-0.6607***
	(0.0122)	(0.0181)	(0.0033)	(0.0004)
La Taha	-0.2042***	-0.0584***	-0.4167***	-0.2747***
	(0.0204)	(0.0009)	(0.0416)	(0.0566)
Poqueira	-0.1328***	0.0347***	-0.2416***	-0.3777***
	(0.0027)	(0.0033)	(0.0166)	(0.0097)
Lanjarón	-0.3717***	-0.0888***	-0.5930***	-0.8040***
	(0.0028)	(0.0008)	(0.0130)	(0.0080)
_cons	2.9116***	1.9629***	1.9587***	1.5718***
	(0.1711)	(0.0927)	(0.1893)	(0.3212)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 Results of Poisson regression showing sociodemographic correlates of proverb inaccuracy (n=97)

	(1) All proverbs	(2) Climatic proverbs	(3) Physical proverbs	(4) Biological proverbs
Age	0.0038***	0.0075***	0.0112***	-0.0072
	(0.0010)	(0.0027)	(0.0009)	(0.0078)
Woman	-0.1329***	-0.2228***	-0.0074	-0.1378***
	(0.0179)	(0.0345)	(0.0884)	(0.0027)
Schooling	-0.0613	-0.0718***	-0.0181	-0.0819
	(0.0828)	(0.0263)	(0.1602)	(0.1308)
Primary Sector	0.1096***	0.2037***	0.0571	0.0634***
	(0.0071)	(0.0036)	(0.0358)	(0.0044)
Municipality	(excluded Bérchules)			
Trevélez	0.0007	-0.1945***	-0.3349***	0.3757***
	(0.0329)	(0.0100)	(0.0613)	(0.0579)
La Taha	-0.0952***	-0.2520***	0.2100***	-0.2734***
	(0.0119)	(0.0315)	(0.0362)	(0.0641)
Poqueira	0.1443***	0.0329*	0.3384***	0.0962***
	(0.0136)	(0.0200)	(0.0213)	(0.0194)
Lanjarón	0.2328***	0.1132***	0.6986***	-0.3578***
	(0.0024)	(0.0362)	(0.0035)	(0.0751)
_cons	2.1167***	1.0152***	0.2949**	1.6552***
	(0.1202)	(0.1757)	(0.1415)	(0.5651)
N	97	97	97	97

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Responses from Blanca Ramos from the Observatorio de Sierra Nevada to our questions on their level of involvement with local communities and dissemination strategy

Contesto a tus preguntas:

1. **"Participan las comunidades locales en la recolección de datos del Observatorio?"** - Con carácter general no, aunque hay una actividad concreta del Observatorio, el seguimiento de las mariposas diurnas, que se desarrolla con una importantísima participación de un grupito de voluntarios que son residentes en el entorno geográfico próximo a Sierra Nevada. Todos los años realizan transectos cada 15 días desde que las mariposas inician los vuelos (desde marzo-abril) hasta que llega el otoño y dejan de estar activas por el frío, allá por septiembre-octubre. Al final del invierno o principios de la primavera organizamos una reunión en la que exponen sus resultados y aprovechamos para invitar a algún profesor o experto que nos dé una charla magistral. Dura un día completo y es de lo más gratificante, pues todos aprendemos mucho de un tema que nos apasiona. Este año la celebraremos el día 14 de marzo y nos acompañará una representante de un programa internacional de seguimiento de mariposas con el que Sierra Nevada colabora desde hace años. El resto de los datos del Observatorio que están inlcuidos en el Manual de Metodologías (que seguramente conoces) los levantan los técnicos y auxiliares de la Agencia de Medio Ambiente y Agua (la empresa pública medioambiental de la Junta de Andalucía) y nuestros Agentes y Celadores, muchos de los cuales son oriundos de la zona. También los científicos de las Universidades de Granada y Almería contribuyen recabando datos y especialmente con sus análisis y modelos.
2. **"Son las campañas de investigación visibles para las comunidades locales?"** Los resultados de investigación son objeto de gran interés por parte de los medios de comunicación locales (sobre todo Granada Hoy e Ideal de Granada), que con frecuencia sacan dobles páginas a color sobre el cambio global, las especies de fauna y flora más sobresalientes o sobre temas de conservación de la naturaleza. Otra fuente de divulgación es la difusión de trabajos como "La Huella del Cambio Global". Es difundida entre los componentes del Consejo de Participación del Espacio Natural de Sierra Nevada, compuesto por representantes de las administraciones con competencias en la zona, incluyendo las locales (Ayuntamientos y Diputaciones) y a todo aquel que nos lo pide. La difusión ya dentro de sus respectivos ámbitos ya es muy variable, como puede suponer. La página web del Observatorio dejó de funcionar bien hace algunos años pero se está trabajando activamente por recuperarla. Ya se puede acceder a algunos contenidos (http://obsnev.es/) y es de suponer que con el paso del tiempo mejore su accesibilidad y la información que contenga. También hay mucha conexión en las redes sociales, aunque de este tema yo tengo poca información porque me salen granos solo de oir hablar de ellas (las odio). A lo mejor otras personas te pueden informar mejor que yo. Otra cosa que hacemos con frecuencia es ir a Colegios de Infantil y Primaria y a Institutos de Bachillerato a contar nuestra experiencia de gestión, y aprovechamos la ocasión para contarles los resultados más interesantes de los trabajos de Observatorio y en general de las investigaciones científicas que se realizan aquí. También recibimos cada año un número variable (entre 3 y 10) de alumnos que realizan sus prácticas de Grado o de Máster con nosotros. Se les incorpora a los equipos de segumiento con toma de datos en campo y se les familiariza con la búsqueda de información, los instrumentos de ordenación del espacio, la legislación ce conservación de la biodiverisdad, etc.
3. **"La data que se recoge se difunde ampliamente entre las comunidades?"** Los datos como tales no se difunden ampliamente. Se difunden mucho más los resultados de los

análisis de los datos. No obstante, el repositorio de datos es público puesto que se financia con fondos públicos y eso lo tenemos muy claro. Están disponibles para quien los solicite, pero a demanda. También estamos divulgando las series de datos mediante lo que se conoce como "data papers", es decir se publican en revistas formato Open Access el conjunto de datos en bruto sobre temas específicos durante un período amplio de tiempo. Por ejemplo, acabamos de enviar un data paper sobre los datos de abundancia, distribución, estructura poblacional y ecología de la cabra montés (*Capra pyrenaica*), que es exclusivamente propia de la Península Ibérica, en Sierra Nevada, donde la especie presenta la población más abundante y mas diversa genéticamente de toda su área de distribución. Por ejemplo si un investigador de Irán quiere hacer un trabajo comparativo entre las cabras de su país y las de España, podrá hacerlo contando con los datos de Sierra Nevada sin moverse de su silla. Finalmente te señalo que hay datos que por ser sensibles no se pueden divulgar así como así, por ejemplo la localización exacta de rapaces o de especies sensibles, pues esa información las puede poner en peligro. Hay mecanismos para que esa información sensible sea manejada por gente que no la va a usar para fines inconfesables.

Sobre lo que preguntas relativo a si "el contacto con el observatorio pueda influir en la percepción local del cambio climático", francamente no tengo argumentos para decirte si si o si no. A nosotros nos llegan muchos comentarios sobre artículos que la gente lee con mucho interés en el periódico y otros medios de comunicación y también nos piden información adicional. Pero de ahí a "influir en la percepción local de cambio climático", ya es más difícil de medir. Mi impresión es que poco a poco, con lo que se oye en la tele y en la radio, con lo que se ve en prensa, con lo que los propios ciudadanos perciben en carne propia y con las consecuencias devastadoras de los cada vez más frecuentes eventos climáticos extremos, la gente está convencida de que efectivamente el clima está cambiando. Otra cosa es que sean conscientes de que ellos mismos contribuyen con sus hábitos de consumo y en consecuencia que estén dispuestos a cambiarlos. Yo creo que es una bola que ya se ha puesto en movimiento y que ya es imparable.

Poisson regression results using i) age as continuous variable, and ii) education as a set of 5 categories (0=no school, 1= primary, 2=secondary, 3=technical education, 4=university degree).

Knowledge

Poisson, correlates of Proveb Knowledge

	(1) prov1_tot	(2) prov1_clim	(3) prov1_phy	(4) prov1_bio
main				
age	0.0017	0.0015*	0.0014	0.0033
	(0.0020)	(0.0009)	(0.0028)	(0.0040)
female	-0.0067	-0.0367***	-0.0664	0.1383
	(0.0342)	(0.0073)	(0.0491)	(0.1141)
0.education	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
1.education	-0.1766***	0.0182	-0.4463***	-0.3023***
	(0.0269)	(0.0447)	(0.0170)	(0.0075)
2.education	-0.2409***	-0.0304	-0.5154***	-0.4147***
	(0.0145)	(0.0393)	(0.0106)	(0.0658)
3.education	-0.2628***	-0.2845***	-0.2888***	-0.1940
	(0.0853)	(0.0599)	(0.0989)	(0.1425)
4.education	-0.2050***	0.0601*	-0.2515***	-0.8900***
	(0.0180)	(0.0342)	(0.0011)	(0.0206)
activity	0.0482	-0.0278	0.1860**	0.0718
	(0.0705)	(0.0322)	(0.0894)	(0.1446)
1.municipality	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
2.municipality	-0.3283***	-0.0626***	-0.5811***	-0.6386***
	(0.0133)	(0.0183)	(0.0099)	(0.0062)
3.municipality	-0.1909***	-0.0392***	-0.4107***	-0.2762***
	(0.0210)	(0.0013)	(0.0474)	(0.0523)
4.municipality	-0.1200***	0.0486***	-0.2284***	-0.3688***
	(0.0011)	(0.0028)	(0.0203)	(0.0002)
5.municipality	-0.3596***	-0.0756***	-0.5793***	-0.8017***
	(0.0000)	(0.0012)	(0.0147)	(0.0025)
_cons	2.9518***	2.0646***	1.8971***	1.5411***
	(0.1835)	(0.1008)	(0.2149)	(0.3418)
N	97	97	97	97

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Poisson regressions using i) age a dichotomous variable (retired=0 if age<65, and retired=1 if age>=65) and ii) education in 5 categories

Knowledge

Poisson, correlates of Proveb Knowledge

	(1) prov1_tot	(2) prov1_clim	(3) prov1_phy	(4) prov1_bio
main				
retired	-0.1291***	-0.0400***	-0.2216***	-0.2447***
	(0.0038)	(0.0022)	(0.0038)	(0.0016)
female	-0.0078	-0.0361***	-0.0688	0.1329
	(0.0337)	(0.0070)	(0.0472)	(0.1119)
0.education	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
1.education	-0.2293***	-0.0023	-0.5353***	-0.4090***
	(0.0177)	(0.0406)	(0.0334)	(0.0152)
2.education	-0.2961***	-0.0576**	-0.5900***	-0.5302***
	(0.0144)	(0.0260)	(0.0320)	(0.1236)
3.education	-0.4187***	-0.3607***	-0.5128***	-0.4936***
	(0.0221)	(0.0333)	(0.0022)	(0.0121)
4.education	-0.2247***	0.0410*	-0.2688***	-0.9095***
	(0.0042)	(0.0226)	(0.0304)	(0.0508)
activity	-0.0307	-0.0647***	0.0722	-0.0691
	(0.0428)	(0.0199)	(0.0480)	(0.0912)
1.municipality	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
2.municipality	-0.3564***	-0.0723***	-0.6355***	-0.6920***
	(0.0122)	(0.0178)	(0.0151)	(0.0050)
3.municipality	-0.1358***	-0.0108	-0.3365***	-0.1713***
	(0.0041)	(0.0091)	(0.0101)	(0.0031)
4.municipality	-0.1036***	0.0613***	-0.2208***	-0.3429***
	(0.0124)	(0.0092)	(0.0043)	(0.0247)
5.municipality	-0.3297***	-0.0571***	-0.5478***	-0.7406***
	(0.0190)	(0.0092)	(0.0114)	(0.0449)
_cons	3.1870***	2.2051***	2.1904***	1.9873***
	(0.0410)	(0.0384)	(0.0084)	(0.0546)
N	97	97	97	97

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Poisson regression results using i) age as continuous variable, and ii) education as a set of 5 categories (0=no school, 1= primary, 2=secondary, 3=technical education, 4=university degree).

Accuracy

Poisson, correlates of Proveb non-accurate, from all proverbs in the list

	(1) prov_fail3_tot	(2) prov_fail3_clim	(3) prov_fail3_phy	(4) prov_fail3_bio
main				
age	0.0031***	0.0072*	0.0099***	-0.0083
	(0.0002)	(0.0042)	(0.0007)	(0.0073)
female	-0.1183***	-0.2090***	0.0090	-0.1210***
	(0.0158)	(0.0414)	(0.0851)	(0.0106)
0.education	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
1.education	-0.0816	-0.1194***	-0.0157	-0.0885
	(0.1000)	(0.0276)	(0.1788)	(0.1753)
2.education	0.0083	0.0536	0.0120	-0.0439
	(0.0159)	(0.0786)	(0.0871)	(0.0371)
3.education	-0.3741***	-0.4537***	-0.6499***	-0.2818
	(0.0418)	(0.1272)	(0.0779)	(0.2275)
4.education	-0.1812***	-0.0535	-0.4255***	-0.2973*
	(0.0450)	(0.0717)	(0.1308)	(0.1717)
activity	0.0817***	0.1706***	0.0230	0.0384**
	(0.0040)	(0.0001)	(0.0392)	(0.0181)
1.municipality	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
2.municipality	-0.0184	-0.2331***	-0.3371***	0.3674***
	(0.0493)	(0.0068)	(0.0801)	(0.0963)
3.municipality	-0.1053***	-0.2699***	0.2017***	-0.2753***
	(0.0331)	(0.0464)	(0.0615)	(0.0337)
4.municipality	0.1251***	-0.0006	0.3217***	0.0881***
	(0.0341)	(0.0333)	(0.0461)	(0.0120)
5.municipality	0.2146***	0.0832	0.6821***	-0.3663***
	(0.0217)	(0.0550)	(0.0224)	(0.0403)
_cons	2.1873***	1.0679***	0.4134***	1.7493***
	(0.0486)	(0.2768)	(0.0494)	(0.5685)
N	97	97	97	97

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Poisson regressions using i) age a dichotomous variable (retired=0 if age<65, and retired=1 if age>=65) and ii) education in 5 categories

Poisson, correlates of Proveb non-accurate, from all proverbs in the list

	(1) prov_fail3_tot	(2) prov_fail3_clim	(3) prov_fail3_phy	(4) prov_fail3_bio
main				
retired	0.1331***	0.1808*	0.2934***	-0.0857
	(0.0116)	(0.1068)	(0.0407)	(0.1743)
female	-0.1145***	-0.2031***	0.0160	-0.1312***
	(0.0191)	(0.0333)	(0.0965)	(0.0029)
0.education	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
1.education	-0.0601	-0.1077***	0.0067	-0.0689
	(0.1009)	(0.0293)	(0.1802)	(0.1855)
2.education	0.0079	0.0211	-0.0147	0.0269**
	(0.0152)	(0.0519)	(0.0956)	(0.0118)
3.education	-0.3651***	-0.5427***	-0.7264***	-0.1075
	(0.0395)	(0.0751)	(0.0653)	(0.1370)
4.education	-0.2173***	-0.1379***	-0.5215***	-0.1638***
	(0.0489)	(0.0201)	(0.1397)	(0.0585)
activity	0.1092***	0.1732***	0.0488	0.0978***
	(0.0119)	(0.0069)	(0.0634)	(0.0119)
1.municipality	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
2.municipality	-0.0025	-0.2201***	-0.3121***	0.3693***
	(0.0488)	(0.0133)	(0.0758)	(0.1093)
3.municipality	-0.1039***	-0.2338***	0.2391***	-0.3502***
	(0.0336)	(0.0262)	(0.0647)	(0.0042)
4.municipality	0.1363***	0.0329**	0.3603***	0.0382
	(0.0333)	(0.0136)	(0.0428)	(0.0497)
5.municipality	0.2326***	0.1343***	0.7483***	-0.4362***
	(0.0188)	(0.0232)	(0.0133)	(0.0112)
_cons	2.2937***	1.4252***	0.8635***	1.2341***
	(0.0534)	(0.0672)	(0.0565)	(0.1966)
N	97	97	97	97

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Accuracy

Poisson, correlates of Proveb non-accurate, from all proverbs in the list

	(1) prov_fail3 _tot	(2) prov_fail3 _clim	(3) prov_fail3 _phy	(4) prov_fail3 _bio
main				
retired	0.1331***	0.1808*	0.2934***	-0.0857
	(0.0116)	(0.1068)	(0.0407)	(0.1743)
female	-0.1145***	-0.2031***	0.0160	-0.1312***
	(0.0191)	(0.0333)	(0.0965)	(0.0029)
0.education	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
1.education	-0.0601	-0.1077***	0.0067	-0.0689
	(0.1009)	(0.0293)	(0.1802)	(0.1855)
2.education	0.0079	0.0211	-0.0147	0.0269**
	(0.0152)	(0.0519)	(0.0956)	(0.0118)
3.education	-0.3651***	-0.5427***	-0.7264***	-0.1075
	(0.0395)	(0.0751)	(0.0653)	(0.1370)
4.education	-0.2173***	-0.1379***	-0.5215***	-0.1638***
	(0.0489)	(0.0201)	(0.1397)	(0.0585)
activity	0.1092***	0.1732***	0.0488	0.0978***
	(0.0119)	(0.0069)	(0.0634)	(0.0119)
1.municipality	0.0000	0.0000	0.0000	0.0000
	(.)	(.)	(.)	(.)
2.municipality	-0.0025	-0.2201***	-0.3121***	0.3693***
	(0.0488)	(0.0133)	(0.0758)	(0.1093)
3.municipality	-0.1039***	-0.2338***	0.2391***	-0.3502***
	(0.0336)	(0.0262)	(0.0647)	(0.0042)
4.municipality	0.1363***	0.0329**	0.3603***	0.0382
	(0.0333)	(0.0136)	(0.0428)	(0.0497)
5.municipality	0.2326***	0.1343***	0.7483***	-0.4362***
	(0.0188)	(0.0232)	(0.0133)	(0.0112)
_cons	2.2937***	1.4252***	0.8635***	1.2341***
	(0.0534)	(0.0672)	(0.0565)	(0.1966)
N	97	97	97	97

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure

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