

Mountain communities and climate change adaptation: barriers to planning and hurdles to implementation in the Southern Rocky Mountain Region of North America

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Abstract Geographic factors make mountain communities around the world vulnerable to the direct effects of climate change, and reliance on recreation and tourism can increase vulnerability to the secondary economic impacts. The goal of this research was to investigate the current state of community adaptation planning in the Southern Rocky Mountain region of North America. Using original survey data this paper discusses the challenges that community and county officials currently face, the perceived effects of future climate change in this region, and the perceived barriers to adaptation planning and hurdles to adaptation implementation. Results show lack of resources, information and political will are the most commonly reported barriers to adaptation. This paper also examines the connectivity between mountain communities and the surrounding federal public lands. Fifty one percent of respondents report that decisions made on nearby public lands frequently or always affect planning and decision making in their community. Collaborative efforts between these entities are proposed as a way to reduce the resource burden of adaptation planning for both entities. Finally, this paper discusses how attitudes and beliefs about climate change affect responses to questions about adaptation planning. On average, respondents who report higher levels of concern about and belief in climate change and those who are better informed about climate change report higher levels of adaptation planning. Elected officials in this sample have, on average, lower concern about and belief in climate change than bureaucratic respondents. Thus changes in elected official composition or improved leadership on climate change planning by incumbent officials could facilitate progress on adaptation

Keywords Climate change · Adaptation · Communities · Rocky Mountains · Decision making

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1 Introduction

Impacts resulting from global climate change are already being seen around the world. Temperatures in North America have increased over the last century and the largest increases in the United States of America have been seen in the West and Alaska (U.S. Environmental Protection Agency 2007). In addition to increases in surface temperatures, the West and Southwest have seen the largest increases in frost free days (Tebaldi et al. 2006). In the same regions more precipitation has been falling in the form of rain than snow and this trend is expected to continue, leading to decreases in snow depth and shorter snow seasons for most of the country (Knowles et al. 2006; IPCC 2007a). Increases in rain on snow events will also likely lead to increases in flood risks from high volume runoff (IPCC 2007a). High altitude ecosystems in North America and elsewhere are especially sensitive to climate change as warmer surface temperatures restrict already confined species to even smaller habitable zones and topography often makes migration impossible (Moritz et al. 2008). Some consequences such as changes in annual snow pack and snow melt timing associated with climate change are of concern to both native alpine flora and fauna as well as to local human systems (ICCATF 2011).

Climate change not only impacts natural systems, but is also affecting communities around the world (Casassa and Rosenzweig 2007; ICCATF 2011). Previous work has suggested that the localized effects of climate change necessitate local scale adaptation activities and municipalities have been increasingly recognized as playing a critical role in overall adaptation schemes (Turner et al. 2003; Naess et al. 2005; Smith et al. 2009; Measham et al. 2011). Dissatisfaction with scenario-based, top-down climate change adaptation strategies has led to research on local level adaptation planning (van Aalst et al. 2008), and recent work on the adoption of climate related policy in the U.S. showed that despite major differences in state level policy, local characteristics are the main drivers of mitigation policy adoption (Krause 2010). Though U.S. municipalities are not currently required under federal law to conduct climate change adaptation planning, the U.S. Interagency Climate Change Adaptation Task Force (ICCATF) cites “building resilience to climate change in communities” as one of the main areas where progress has been made. Partnerships between U.S. federal entities such as the U.S. Forest Service (USFS), the National Oceanic and Atmospheric Administration (NOAA), The Federal Emergency Management Agency (FEMA), and local communities have spawned a variety of local programs and responses aimed at decreasing community vulnerability to climate change. Though these and other efforts have made progress toward increasing local resilience to climate change the ICCATF admits that more work needs to be done (ICCATF 2011). Amundsen and others explain that a lack of action at the national and state level often leads to a lack of adaptation action at the local level (2010). In this paper, I will consider adaptation in the same manner as the United Nations Intergovernmental Panel on Climate Change (IPCC) which defines climate change adaptation as “adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects” (IPCC 2001).

2 Why the Southern Rocky Mountains?

The Rocky Mountains are a continental mountain range in North American running 3,000 miles north and south from Western Canada to the U.S. state of New Mexico. In the mid-nineteenth century, discovery of precious metals, suitable habitat for ranching and ample timber for extraction prompted the early settlement of most Southern Rocky Mountain

communities (Silberman and Rees 2010). Though many of these settlements followed the boom and bust cycle often associated with natural resource dependent towns, others were successful in reinterpreting themselves as centers for recreation and tourism on nearby U.S. federal public lands (Dorward 1990; Powers 1991; Rothman 1998). An increase in demand for middle class leisure activities following World War II prompted the conversion of former mining towns into centers for outdoor recreation, particularly skiing (Rothman 1998). The influx of visitors drawn to the area by its natural beauty and abundance of outdoor activities spurred the creation of additional Southern Rocky Mountain resort towns, during the 1960s in previously undeveloped areas (Silberman and Rees 2010).

Geographic factors make mountain communities worldwide especially vulnerable to both the direct effects of changes in climate such as flooding, increased risks of fire (Westerling et al. 2006), and loss of biodiversity. Many mountain communities rely on recreation and tourism which increases their vulnerability to the secondary economic effects of climate change such as decreases in tourism from lack of snow for winter recreation, and changes in management practices on nearby public lands (Scott et al. 2003). In the U.S. for example, federal land management practices are driven by high level mandates which do not always align with the interests of local communities (Loomis 2002). Recent work has shown that federal public lands in the Rocky Mountain region have begun the process of adaptation to climate change which might involve changes in decision making that could affect mountain communities in this area (Archie et al. 2012). Southern Rocky Mountain communities located in the U.S. state of Colorado are of interest as they are both vulnerable to the impacts of climate change and particularly visible both nationally and internationally as prime vacation destinations for both domestic and international travelers. The state of Colorado as a whole has a stake in the successful adaptation of these valuable mountain communities as tourism (of which skiing is the largest sector) generated over \$13.6 billion of revenue in 2009, and in the same year despite the tough economic climate, Colorado recorded the second highest number of overnight visitors on record (Econ. Dev. Data Book 2010).

Despite profuse potentially negative impacts, it is important to note that climate change could have some positive impacts on mountain communities as well. As temperatures increase in lower elevation areas, residents are likely to seek respite in the cooler environments of higher elevation towns. Mountain towns that co-exist with a ski resort were traditionally thought of as winter destinations, but in recent years diversification has made ski towns popular summer destinations as well (Scott and McBoyle 2007). Warmer spring temperatures could lead to shorter ski seasons, but extended summer weather could merely shift seasonal visitation rates. Mountain towns not located near a ski area have always relied on summer tourism, and increased temperatures could stimulate increased visitation as their warm season is expanded. In fact, recent research on the potential effects of climate change on alpine National Park visitation in the U.S. predicted increases in willingness to pay for recreation as a result of warmer, dryer weather (Richardson and Loomis 2005).

A 2008 study conducted in Rocky Mountain resort communities of Colorado focused on the vulnerability of these tourism dependent areas to drought, one of the most visible and well documented consequences of climate change in the American West (IPCC 2007b). In their work, Wilhelmi and others highlighted the importance of water resources to the economic health of resort communities, and noted that the drought of 2002 actually facilitated across-sector cooperation over water resource management (Wilhelmi et al. 2008). Though the Wilhelmi et al. study was not conducted under the auspices of climate change adaptation, the results clearly point to some potentially favorable social responses to similar climate events in the future. The stakeholders involved in this study presented some strategies that could help to alleviate economic stresses resulting from drought in the

future—strategies that will become increasingly important as consequences of climate change become more pronounced. However, other work in the U.S. intermountain west has suggested that politics, lack of information and resources, and lack of urgency make climate change policies difficult to implement (Metz and Below 2009; Carter and Culp 2010).

Lack of urgency in regard to adaptation planning has been linked to attitudes and beliefs about climate change. Previous work has demonstrated that climate change risk perception is highly correlated with demographic and social variables (O'Connor et al. 2002). Other work has shown that attitudes about climate change can affect decision making. A comparison of case studies from Germany and Zimbabwe shows that socio-cognitive factors were better predictors of adaptive behavior than were socio-economic factors (Grothmann and Patt 2005), and Adger et al. (2007) suggest that individual social characteristics such as risk denial can interact with underlying societal values to prevent adaptation action.

3 Diagnosing barriers to adaptation

This paper uses a framework presented by Moser and Ekstrom (2010) to analyze the perceived barriers to climate change adaptation in communities located in the Southern Rockies. Focusing on barriers to adaptation is of particular importance as overcoming these challenges is often one of the primary targets of early adaptation efforts (GAO 2009; NRC 2010). Identifying the specific barriers to adaptation for an organization can provide valuable information about where in the adaptation process that organization currently resides. Understanding how far along in the adaptation process an organization is can allow for more effective provisioning of resources and information to facilitate further progress in the adaptation process (Moser and Ekstrom 2010). Though, competing local priorities, lack of information and resources, institutional limitations and a culture of reactive management have been shown to pose a challenge for localized adaptation (Measham et al. 2011), a variety of strategies have been suggested that could overcome these barriers.

The Moser and Ekstrom framework includes three phases each containing three stages of the adaptation process (2010). It begins with the “understanding” phase which includes the stages of “detecting the problem”, “gathering and using information” and “(re)defining” the problem. In this first phase the perspective of the actors involved are highly influential. Moser and Ekstrom explain that signals of change in the system of interest may go undetected due to lack of governmental leadership or personal beliefs and understanding about climate change (2010). Though the stages and phases are not always followed systematically, the next step in the framework is the “planning” phase. The three stages associated with this phase deal with developing, assessing and selecting adaptation options. The first stage of this phase includes identification of agreed upon goals and relies heavily on leadership. Information accessibility and relevance are also of great importance in this phase of the adaptation process, and a lack of either leadership or information can cause the process to stall. After an option has been selected, the final phase of the process is “managing.” The three stages included in this phase involve implementing options, monitoring outcomes and evaluating the effectiveness of the chosen option. New actors that were not included in the planning phase often enter the process at the implementation phase as ideas take practical shape on the ground. At this stage, the feasibility of adaptation options becomes extremely important, particularly as it relates to available resources such as funding and personnel. During the final stages of the adaptation process the ability to assess the outcome and evaluate the effectiveness of an option depends heavily on the availability of technology and expertise. Lack of resources needed to properly monitor and evaluate

options can undermine both the success of existing projects as well as the success of future adaptation planning.

The goal of this research was to investigate the current state of climate change adaptation planning in communities of the Southern Rocky Mountains. Understanding the challenges associated with adaptation for these communities fills a void in the literature on local scale adaptation by providing a case study of communities in a mountainous region. In addition to being useful for communities located in other mountainous regions, lessons learned here will be broadly applicable to natural resource dependent communities around the globe regardless of geography. The major questions this paper addresses are: (i) Is adaptation planning currently taking place, and if not what are the barriers? (ii) Do community officials in this region view climate change as a challenge, and what are the perceived hurdles to implementing adaptation plans? (iii) How do attitudes and beliefs about climate change influence reported adaptation planning? (iv) How do decisions made on nearby U.S. federal public lands affect decision making in mountain communities of the Southern Rockies?

4 Methods

In order to obtain data about adaptation planning in communities of the Southern Rockies, an online survey was conducted building on previous efforts and surveys on adaptation planning (Moser and Tribbia 2006 / 2007; Tribbia and Moser 2008; Theoharides et al. 2009; Amundsen et al. 2010; Archie et al. 2012). Similar to recent surveys of U.S. coastal managers in the U.S. state of California (Moser and Tribbia 2006/2007), this survey was sent to 603 local and county government employees in the mountainous region of Colorado who have some role in decision making. Qualified participants included: directors, planners, engineers, water resources managers, environmental specialists, town council members, and others involved in environmental protection, resource allocation, development or public infrastructure. Thus, this sample includes both those making municipal decisions as well as those providing material in support of decision making. Prior research on municipal adaptation has suggested that these types of employees are those most likely to be involved in activities or decision making that could be affected by potential consequences of climate change (Moser and Tribbia 2006/2007; Tribbia and Moser 2008; Amundsen et al. 2010; Flugman et al. 2012). A wide range of participants was selected as climate change adaptation has been shown to require an integrated approach (Measham et al. 2011).

An extensive web search was employed and the sample was limited to those municipalities which provided publicly available contact information for employees that met the criteria. Even though the vast majority of websites that were searched did contain contact information for employees that met the participant criteria, this sample is not necessarily representative of every municipality in the entire Southern Rocky Mountain region. The names and email addresses of municipal employees were obtained from publicly available phone and email lists on municipal websites. To preserve anonymity respondents were not asked specifically about which town or county they were employed by. The survey was pre-tested on a group of qualified respondents to ensure questions were worded clearly and were relevant to the proper audience. Approval was obtained from the University of Colorado Institutional Review Board prior to testing.

The survey was distributed via email as administering a survey electronically has been shown to have a variety of advantages over delivery in other formats. These advantages include: decreased average response time (Sheehan and McMillan 1999), increased ability to track responses (Sheehan 2001), more candid participant responses (Bachmann et al. 1999), and longer open ended question responses (Paolo et al. 2000). Recent research has

emphasized the importance of multiple reminders in increasing response rates (Murphy et al. 1991; Sheehan and McMillan 1999; Taylor and Lynn 1998; Mehta and Sivadas 1995; Dillman 2000; Sheehan and Hoy 1999), so a description of the study including a link to the survey was emailed to the sample of municipal employees four times over 2 months beginning in October of 2011. SurveyMonkey was used to collect the survey data and to manage the respondent lists, maintaining confidentiality and allowing potential respondents the option to opt out permanently.

Municipalities in this region are located proximate to public lands managed by the U.S. federal government, who are beginning the process of adapting to climate change (Archie et al. 2012) (see Fig. 1). Communities in this region also share common geographic, economic and demographic characteristics. All municipalities are located in mountainous regions, and have economies which are heavily reliant on tourism and outdoor recreation that often takes place on proximate U.S. federal public lands. For this study local government employees from both the town and county level were included because in this region they often work together and potential effects of climate change would span the jurisdictions of these entities. In some cases county governments were not included because they either housed much larger population centers that were not consistent with the rest of the sample or contained large areas of non-mountainous terrain.

The survey was composed of 26 total questions including open-ended, Likert scale, check-all and forced-choice questions, and was administered from October 26, 2011–December 31, 2011. Two hundred thirty eight respondents began the survey, 212 completed the entire survey and 2 refused the informed consent and were not allowed to continue. The

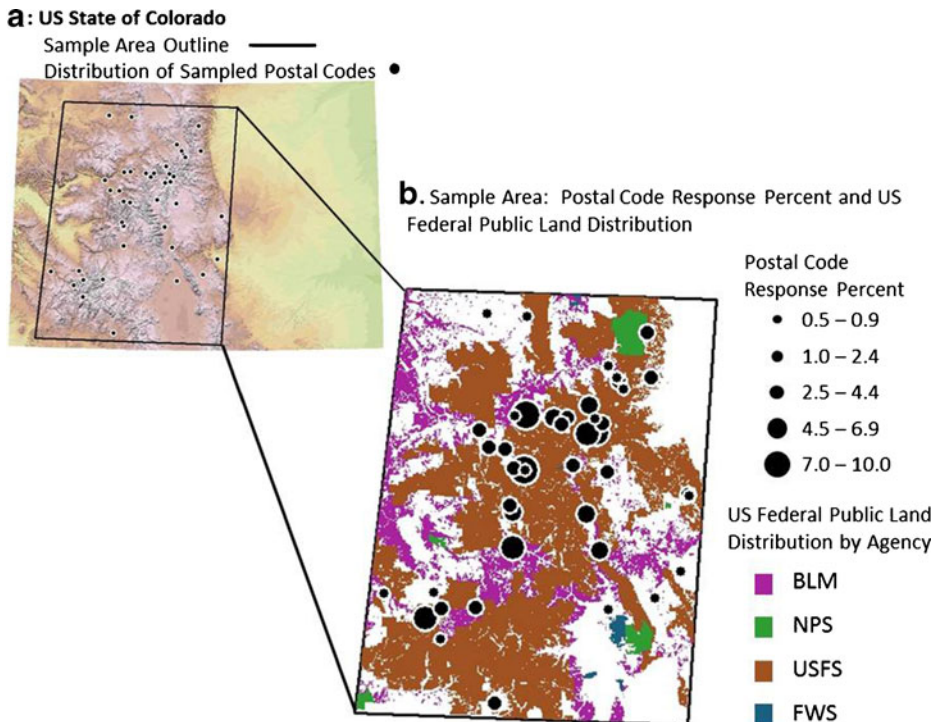


Fig. 1 Distribution of responses across the sampling region

overall response rate was 39.5 % which is higher than what is typically expected of an online survey of this size launched after the year 2000 (Sheehan 2001). Responses were well distributed across the targeted sampling region and were obtained from 43 different postal codes. No single postal code accounted for more than 10 % of the responses (see Fig. 1). Because all questions except for the initial informed consent requirement were optional, some questions have more responses than others.

5 Results

5.1 Challenges facing Southern Rocky Mountain communities

To gain contextual perspective, respondents were asked to rank the top three management challenges currently faced by their county or community. Budget constraints, development decisions, political will and stakeholder conflicts were the most common responses to this question. It is notable that the top eight challenges chosen by respondents deal with social issues (either political or economic) whereas biologically driven challenges were not chosen as often. Climate change did not rank very high compared to other challenges. Twenty three percent of respondents ranked climate change as one of their top challenges and a mere 4 % chose climate change as the number one challenge currently facing their office (Fig. 2).

To gauge the relative importance of the challenges provided by the respondents, I asked them to rate the severity of the top management challenge that they chose in the previous question. Forty one percent of respondents rate the top management challenge in their office as severe or very severe with another 43 % reporting that their biggest challenge is of moderate severity. The remaining 15 % consider their top management challenge as either slightly problematic or not severe at all. Thus, the challenges listed by respondents are not trivial and can be assumed to comprise or impact a large part of their work.

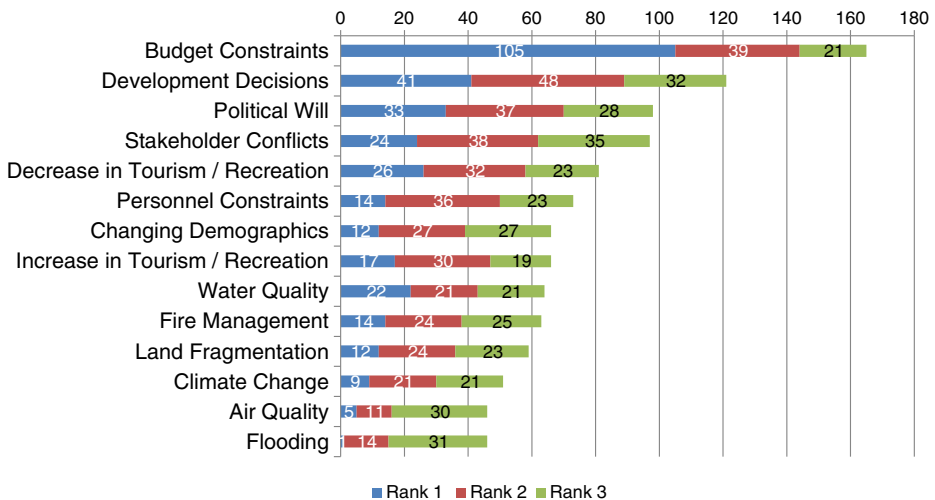


Fig. 2 Top management challenges for Colorado Mountain Communities as identified by survey respondents. Survey respondents were asked to rank their top three choices with “1” being the biggest challenge (by total responses)

5.2 Effect of decisions made on nearby U.S. federal public lands and surrounding communities

I chose the locations of this study based in part on their proximity to U.S. federal public lands. I hypothesized that actions taken on nearby public lands and in nearby communities / counties would have an effect on the decisions made in the communities and counties participating in this survey. To test this hypothesis, respondents were asked about the extent to which decisions made in nearby communities/counties and on nearby public lands affect planning and decision making in their community. Fifty one percent of respondents report that decisions made on nearby public lands frequently or always affect planning and decision making in their community. Another 37 % report that decisions made on nearby public lands sometimes affect planning and decision making in their community while only 3 % report that decisions made on nearby public lands do not affect their decision making. Fifty three percent of respondents report that decisions made in nearby communities / counties frequently or always affect planning and decision making in their community. Another 43 % report that decisions made in nearby communities or counties sometimes affect planning and decision making in their community while only 4 % report that decisions made in these areas do not affect their decision making. Thus, decisions made outside the jurisdiction of the municipality, especially those made on nearby public lands, reportedly have a large influence on the decisions made in the municipalities participating in this survey (Fig. 3).

5.3 Consequences of climate change and changes in management plans

To assess perceptions of local vulnerability to climate change, respondents were asked to rate the likelihood of 13 potential impacts of climate change on their county or community. I hoped that these responses would provide a backdrop for the adaptation planning questions. Four of the potential consequences that were offered: increased local air temperatures, changes in local runoff timing, negative impacts on recreation and negative impacts on ecosystems were perceived as at least moderately possible and all other potential consequences were believed to have a less than moderate possibility of happening as a result of

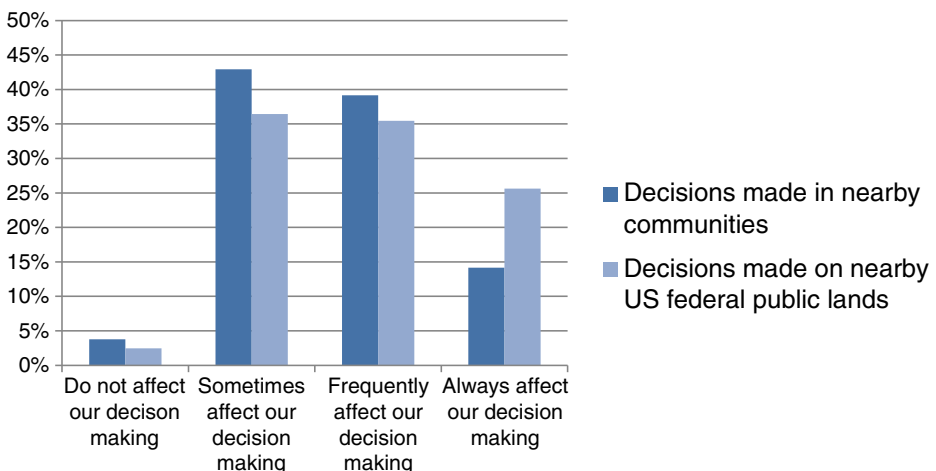


Fig. 3 Effect of decisions made on nearby federal public lands and surrounding communities

climate change. The three potential consequences which were considered to be the least likely were those which assume positive impacts from climate change: positive impacts on ecosystems, positive impacts on local recreation, and less local flooding.

Respondents were also asked what, if any, changes their community/county has already made or will make in response to climate change. As shown in Fig. 4, the three most common responses: pursue renewable energy opportunities, inventory greenhouse gas emissions, and limiting or reducing emissions are more directly related to mitigation than to adaptation. It is likely that mitigation remains the most popular climate change response at this time due to either a lack of understanding about adaptation or a lack of clear climate signals to respond to. The two most common adaptation responses were forest thinning / fuel reduction and provision of additional information / educational materials to the public.

6 Adaptation planning and barriers to planning

One of the main goals of my research was to establish how far along Southern Rocky Mountain communities currently are in the adaptation process. Respondents were first asked whether or not their office has developed strategies or plans to deal with the potential impacts from climate change. The answers to this question varied. Overall, 54 % of the respondents report that their office is not currently planning for adaptation to climate change, 15 % report that their office is currently developing adaptation plans while an additional 23 % report that adaptation plans are currently being carried out. The remaining 9 % of respondents report that they don't know (Fig. 5). Prior literature on the topic that suggests few adaptation efforts have reached the implementation stage (Berkhout et al. 2006; Adger et al. 2007; Wheeler 2008; Dovers 2009; GAO 2009; Berrang-Ford et al. 2011). Results suggest that Southern Rocky Mountain communities may be adopting adaptation plans at a faster rate than other areas, but it is also possible that respondents could be referring to actions that would typically be considered mitigation.

I conducted ordered logistical regression analysis using demographic data from the survey as well as other potentially influential variables to analyze their potential effect on

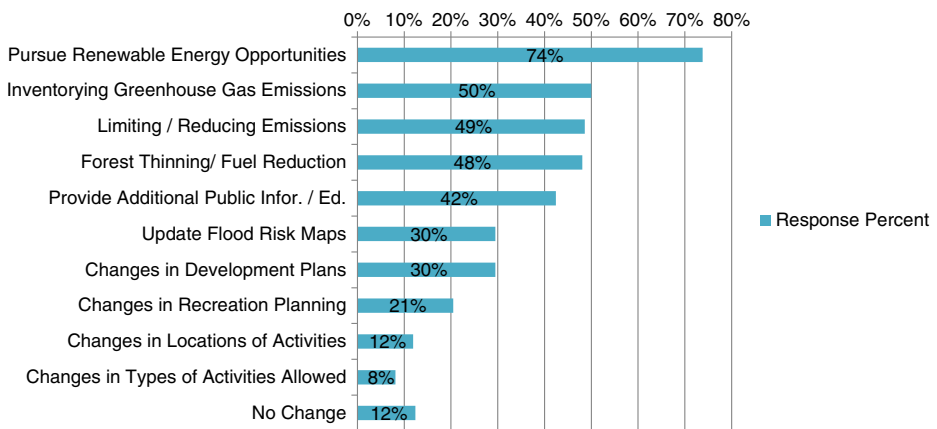


Fig. 4 Changes in management plans (present or future) in response the climate change (by percent of community respondents choosing each option)

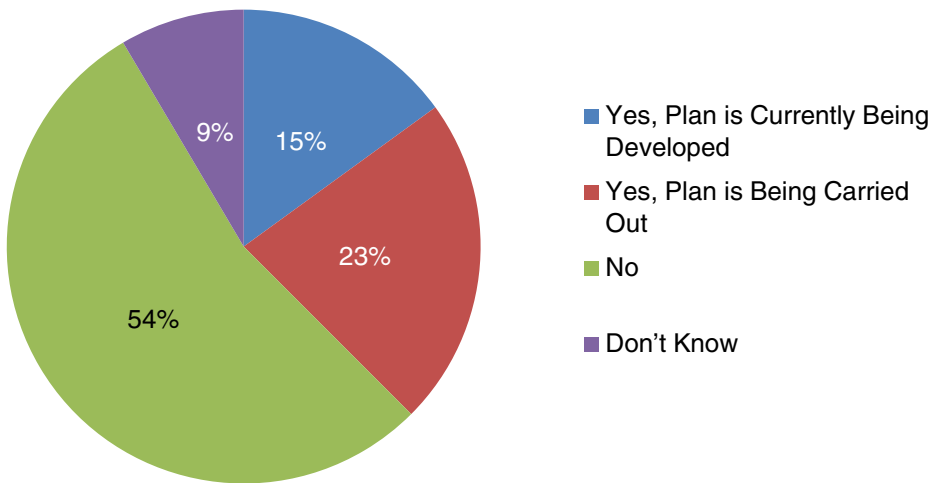


Fig. 5 Current adaptation planning at the local office level as reported by mountain community survey respondents

the reported status of adaptation planning. In addition to demographic questions, I asked respondents questions aimed at establishing their attitudes and beliefs about climate change. I used this information to assess whether these characteristics were correlated with responses about adaptation planning. The responses to the attitudinal questions revealed that 66 % of respondents believe that climate change is real and already happening and 67 % believe that climate change is a serious or very serious problem. Respondents were then asked to report how well informed they are about climate change and 91 % report they are either moderately or well informed about these topics. The distribution of these responses is similar to those of U.S. federal public lands managers in the same region (Archie et al. 2012). I conducted a reliability analysis for the questions about beliefs and attitudes toward climate change and computed an index variable to establish a composite attitudinal variable. This new index variable was then used in further analysis. (Chronbach's $\alpha=.82$).

The results of this ordered logistic regression show that beliefs and attitudes about climate change, and how well informed a respondent is about climate change are statistically significant predictors of adaptation planning ($p>|z|=0.001$, $p>|z|=.013$). On average, respondents who report higher levels of concern about and belief in climate change and those who are better informed about climate change report higher levels of adaptation planning. None of the other predictors (education, age, gender, years in the community) had a significant relationship with adaptation planning (Table 1).

Because beliefs and attitudes about climate change were shown to be strong predictors of reported adaptation planning, I conducted a subsequent ordinary least squares regression using the same set of predictive variables to analyze their effect on the beliefs and attitudes index variable. My sample consists of both elected officials and bureaucratic employees, so I included a dummy variable for the elected officials to determine whether this distinction had an effect on climate change beliefs and attitudes. The results of this regression show that being an elected official ($p=0.012$), gender ($p=0.002$), number of years in the community ($p=0.015$) and how well informed a respondent is about climate change ($p=0.003$) are statistically significant predictors of climate change beliefs and attitudes. On average elected officials have lower concern about and belief in climate change than bureaucratic respondents, while women and respondents who are better informed about climate change

Table 1 Ordered logistical regression analysis of adaptation planning

| Ordered logit analysis of adaptation planning | | | | |
|---|---------|-----------|----------|-----------------------|
| Predictor | β | <i>SE</i> | <i>z</i> | <i>p</i> > <i>z</i> |
| CC Belief Index | 0.761 | 0.229 | 3.32 | 0.001 |
| Years in community | 0.018 | 0.015 | 1.19 | 0.236 |
| Education | -0.050 | 0.161 | -0.31 | 0.758 |
| Gender | -0.125 | 0.373 | -0.33 | 0.738 |
| Age | 0.023 | 0.017 | 1.37 | 0.172 |
| Informed about CC | 0.724 | 0.292 | 2.48 | 0.013 |
| Cut 1 | 5.757 | | | |
| Cut 2 | 6.665 | | | |

*psuedo R*2 0.09, *psuedoR* 0.3

have higher levels of concern about and belief in climate change. Neither of the other two predictors (education, age) had a significant relationship with attitudes and beliefs about climate change (Table 2).

To understand why survey respondents think that adaptation planning is not taking place more widely I asked respondents to rank the top three most important factors preventing them from planning for adaptation. Overall, budget constraints and political will were the two most common answers, followed by lack of locally specific information, lack of leadership and lack of information at relevant scales. Overall, responses dealing with information comprised 35 % of the responses to this question. Budget constraints and political will were also listed as two of the most pressing general challenges for counties and communities (Fig. 6).

Respondents were then asked to determine whether options from a separate list are hurdles in the adaptation process. I consider these responses as characterizing the types of problems respondents associate with the implementation of adaptation plans (as opposed to the planning process itself). Respondents were allowed to indicate choices as a big hurdle, small hurdle, not a hurdle or to report that they don't know. Once again, budget constraints was seen as the biggest hurdle to adaptation, followed by lack of perceived importance to public, insufficient staff resources to analyze and assess relevant information and lack of public awareness or demand to take action. The options that ranked the lowest as potential hurdles were: science is too uncertain, legal pressures to maintain status quo, and not a high priority in my office (Fig. 7).

There were no statistical differences in the rankings of the barriers to adaptation planning for respondents based on their responses to the question about current adaptation planning. Thus, the barriers to planning reported by respondents are consistent regardless of where in the process a community or county resides. Rankings of the top five barriers to adaptation

Table 2 Regression analysis of climate change beliefs and attitudes

| Predictor | β | <i>SE</i> | <i>t</i> | <i>p</i> |
|--------------------|---------|-----------|----------|----------|
| CC informed | 0.285 | 0.096 | 2.99 | 0.003 |
| Education | 0.033 | 0.055 | 0.59 | 0.554 |
| Elected official | -0.308 | 0.122 | -2.53 | 0.012 |
| Sex | 0.416 | 0.130 | 3.20 | 0.002 |
| Age | 0.002 | 0.006 | 0.47 | 0.638 |
| Years in community | -0.013 | 0.005 | -2.45 | 0.015 |

*R*2 = .18, *R* = .42

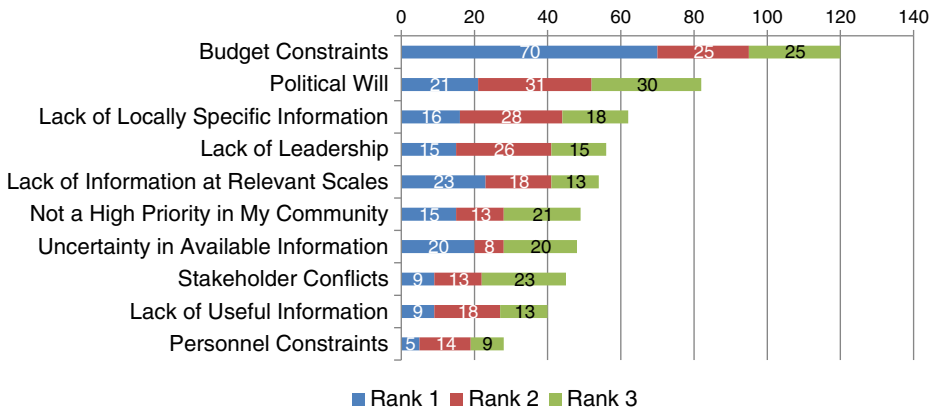


Fig. 6 Top barriers to adaptation planning as identified by mountain community survey respondents. Survey respondents were asked to rank their top three choices with “1” being the biggest barrier to adaptation (by total responses)

planning were the same for both elected officials and bureaucratic respondents. Therefore, differences in beliefs and attitudes about climate change between these two groups do not affect perceptions of the challenges associated with progress toward adaptation. Responses by elected officials and bureaucratic employees differed for only one of the top four hurdles to adaptation implementation. Bureaucratic employees see insufficient staff resources to analyze and assess relevant information as a bigger hurdle than do elected officials ($p=0.039$).

6.1 How different are adaptation plans from other types of plans?

Some actions reportedly taken in response to climate change, such as forest thinning, are similar to, or the same as, plans that already exist for alternative reasons (Spittlehouse and Stewart 2003; D’Amato et al. 2011). To assess whether current plans are being relabeled as adaptation or alternatively that adaptation planning incorporates strategies aimed specifically

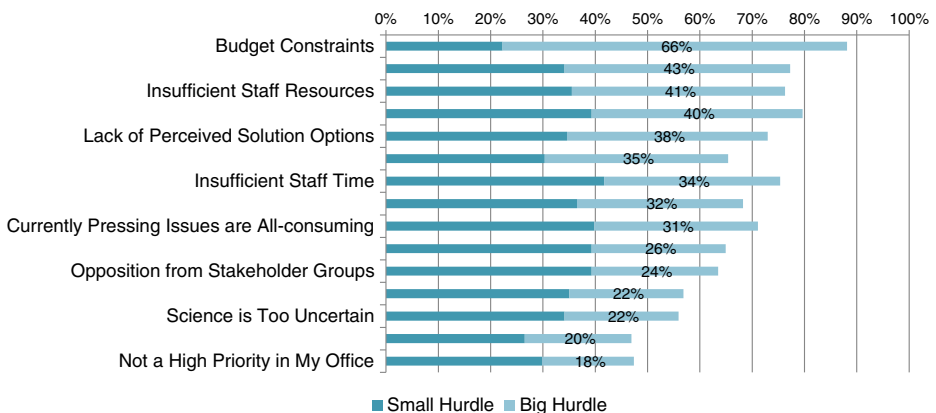


Fig. 7 Hurdles to implementation of adaptation plans as identified by mountain community survey respondents (by big hurdle percent). Respondents had the option of choosing big hurdle, small hurdle, or not a hurdle

at addressing risks from potential effects of climate change, respondents were asked about the degree to which climate change adaptation plans differ from prior management plans. Twenty eight percent of the respondents report that they don't know how plans will change, 17 % report that there will be no change in planning, 39 % report that there will be slight changes and 16 % expect adaptation plans to differ significantly from prior management plans. It is impossible to tell whether responses of "no change" reflect a lack of need or ability to change plans in response to climate change or whether it means current plans will relabeled as adaptation activities.

7 Discussion

The main goal of this study was to investigate the current state of adaptation planning in communities located in the Southern Rocky Mountains. The ICCATF has suggested that there is movement toward adaptation planning in communities nationwide (2011), and it appears that these efforts have begun to take shape in this area. Though slightly more than half of my sample reported that adaptation planning is not currently taking place in their community or county, these results suggest that some municipalities are indeed both planning for adaptation and implementing these plans. Statistical analysis from this survey showed that the more informed respondents were about climate change, the higher their concern about and belief in climate change and the more likely they were to report current adaptation planning or implementation. In addition, beliefs and attitudes about climate change were found to be heavily influenced by gender and whether the respondent was an elected official or a bureaucratic employee. Previous work has shown that women generally have higher levels of concern about environmental issues and about climate change risks in general, (Bord et al. 1998; O'Connor et al. 1999; Kellstedt et al. 2008) so it is not surprising that women in this sample report higher levels of concern than men.

Why elected officials in this study had lower levels of belief in and attitudes about climate change than their bureaucratic counterparts is beyond the scope of this research. However, two of the main barriers to adaptation planning reported by this sample—lack of leadership and political will—could be explained by this factor. I included political will as a potential response to survey questions about general challenges and barriers to planning for adaptation at the suggestion of my pre-testers. It was their understanding that despite the lack of clear definition there would be enough consensus on its general meaning to make this a popular choice with respondents. Despite its ambiguity, political will is a commonly used term both in academic literature and in political rhetoric (Post et al. 2010; Lieberman 2012). A recent paper by Post et al. provides a working definition of political will that has four conditions: a sufficient set of political actors, a common understanding of the issue, genuine intent to act on the issue and a commonly perceived solution (2010). Another recent paper defines political will in the context of decision maker willingness and ability to make changes to current policy (Gifford et al. 2011). It is impossible to know from my survey results how each individual respondent interprets the concept of political will, but the popularity of the response makes it likely that they share the same general understanding of the term as is proposed by these other works. I assume that a response of "lack of political will" means that at least one of the four conditions set forth by Post et al. are missing (2010).

It appears that even if there is general willingness on behalf of the community, lack of support from elected officials may prevent adaptation planning from going forward. Previous research in the U.S., United Kingdom and Australia found that several factors including the presence of political champions and political will to address emerging

conflicts were key in determining the extent to which local policy was influenced by the rhetoric of climate policy (Bulkeley and Betsill 2003). Interestingly, both elected officials and bureaucratic employees point to the lack of political will as a barrier to adaptation planning, suggesting some agreement. Lower overall attitudes about climate change among elected officials would suggest that they do not see the lack of progress on adaptation as a problem.

7.1 Adaptation progress for Southern Rocky Mountain communities

Because I anticipated limited action on adaptation by these municipalities, my secondary goal was to determine what the barriers were to further adaptation planning and action and thus where in the adaptation process these municipalities currently reside. The most common barrier to adaption planning reported by this sample was budget constraints. As one of the major cross-cutting issues identified by Moser and Ekstrom in their 2010 framework, it is difficult to determine where in the adaptation process budget becomes a major barrier. Political will and lack of leadership were also at the top of the list of barriers highlighted by respondents and are both barriers associated with the planning or second phase of the adaptation process. These barriers relate specifically to the developing options stage which relies heavily on leadership. Answers that deal with information issues also accounted for a substantial portion of the responses to this question. Information barriers are commonly associated with the second stage of the planning phase which deals with assessing adaptation options. Overall, the responses to this question coupled with the data from the question about current adaptation planning are consistent with the second or planning phase of the three phase adaptation process. During this phase, leadership and information are vital components facilitating development and assessment of potential adaptation options. Lack of necessary information and leadership at this point in the process would explain responses of both no planning and some planning without implementation (Moser and Ekstrom 2010).

Of the four biggest hurdles to adaptation implementation identified by the sample, two deal with a lack of sufficient resources (budget constraints and insufficient staff resources to analyze and assess relevant information) and two concern issues related to political will (lack of perceived importance to public and lack of public awareness or demand to take action). These responses echo the same themes found in questions about barriers to adaptation planning and general challenges facing the municipalities. More than half of the respondents report that adaptation plans will differ at least slightly from current planning. This result suggests that most respondents are at least somewhat confident that climate change will have effects substantial enough to challenge the status quo. However, because the most common current responses by communities in the Southern Rockies to climate change are mitigation strategies, I hypothesize that the concept of adaptation is either poorly understood or that adaptation strategies are either inaccessible or less attractive.

Finally, nearly two thirds of respondents report that decisions made on nearby U.S. federal public lands either frequently or always affect decision making in their municipality. In response to Executive Order is issued from U.S. President Obama in 2009, some federal public lands in this region are making progress in planning for adaptation (CruceT and Holsinger 2010; Archie et al. 2012). Because decisions made on these lands reportedly have a substantial influence on planning in Southern Rocky Mountain communities, it is likely that we will see increases in adaptation planning for the communities and counties as federal agencies move forward with planning of their own. Similarly, more than half of the

respondents report that decisions made in nearby communities either frequently or always affect decision making in their own municipality. This result suggests that adaptation in this region could be contagious. Though planning and implementation is not currently widespread, the interconnectedness of this area could facilitate a speedy spread of adaptation efforts once they are established. This result is consistent with prior work on municipal climate change response that highlights the importance of regional networking in development of local climate change policy (Betsill and Bulkeley 2006; Granberg and Elander 2007; Young 2007).

8 Conclusion

This paper presents results from a specific geographic region in North America; however mountain communities around the globe will face similar ecological and economic challenges as they deal with the impacts of global climate change. The impacts of attitudes and beliefs about climate change on reported adaptation planning detailed here have wide reaching implications for community adaptation planning regardless of locale. Similarly, globalization provides an opportunity for decision-makers around the world to establish and exploit both local and international networks which have been shown to facilitate community scale adaptation. Networking provides a venue to learn from the experiences of others, thus, understanding the challenges facing Southern Rocky Mountain communities as they begin the process of adaptation is broadly useful to other communities world wide.

Analysis of the survey data presented above results in four major conclusions:

1. Attitudes and beliefs about climate change can greatly influence progress on local adaptation.
2. Changes in elected official composition or improved leadership on climate change planning by incumbent officials in this region could facilitate progress on adaptation.
3. Collaborative efforts between Southern Rocky Mountain communities and nearby U.S. federal public lands units could reduce the resource burden of adaptation planning for both entities.
4. Co-production of science by researchers and users could create information that is practically usable for adaptation planning and could help to address decision-maker information concerns.

The correlation between attitudes and beliefs about climate change and current adaptation planning in this study is consistent with prior research (Leiserowitz 2006) and suggests that changes in elected official composition or improved leadership on climate change planning by incumbent officials could facilitate progress on adaptation. Because this sample is not necessarily representative of community officials in this region as a whole it is impossible to tell whether elected officials who did not respond share the same beliefs and attitudes as those included here. The fact that budget constraints and political will were seen as the biggest general challenges, the biggest barriers to adaptation planning and the biggest hurdles to adaptation implementation highlights the importance of both resource allocation and public education in promoting climate change adaptation in this region. As discussed earlier political will is an abstract concept that has not been neatly conceived of (Post et al. 2010). However, Post et al.'s four part definition provides some insight into how this concept could be seen as a barrier (2010). In this case a deficiency in any of the four components could account for the popularity of this response.

The connection between political will and adaptation is not surprising as prior work has shown that even in cases where municipal leaders recognize the risks from climate change, translating political will into policy can be difficult (Betsill 2001). Political will has also been reported to be a main requirement for climate change action on a variety of fronts (Bulkeley and Betsill 2003; Watson 2003; Betsill and Bulkeley 2007; Thuiller 2007; Malhi Et al. 2008). Though public education about climate change could lead to increased collective knowledge about the potential risks and consequences, it may not be sufficient to change the political climate surrounding this often controversial issue. Further research should be conducted that addresses the degree to which the beliefs and attitudes of elected officials in this region are influenced by those of their constituents. It is possible that elected officials are responding to perceived views of those residing in their municipalities, but it is not obvious that residents of these communities share the same beliefs and attitudes expressed by the these officials. The strong *sense of place* of these small municipalities could be partly responsible for the substantial role that beliefs and attitudes about climate change seem to play in the decision making in these communities. However, strong connections between residents and their communities could be beneficial for future adaptation progress. Research has shown that communities with a strong sense of place have a better understanding of their own specific challenges and are thus more capable of making planning decisions that lead to effective adaptation outcomes (Measham et al. 2011; Measham and Lane 2010). Measham and others also found that in places where leaders consider climate change to be an important issue they addressed information issues and found the resources to address adaptation (2011). It is possible that stronger leadership promoting adaptation in this region could also overcome the reported barriers.

Recent research on adaptation planning by U.S. federal public lands in the same region showed results similar to those reported here. Budget constraints and public sentiment were some of the major hurdles to implementation reported by public land managers, and improved education of and information for stakeholders were seen as important steps in overcoming obstacles (Archie et al. 2012). Collaborative efforts between communities of the Southern Rockies and nearby U.S. federal public lands units could reduce the resource burden of adaptation planning for both entities. The reported interconnectivity of mountain communities and the similar challenges that these areas may face as a result of changes in climate should make sharing of information and adaptation strategies both possible and prudent. Because of the high proportion of responses that highlight issues dealing with information as barriers to planning and hurdles to implementation for these communities and nearby U.S. federal public lands, further research should be conducted that addresses exactly what type of information is needed to promote additional adaptation planning. Co-production of science by researchers and users creates information that is practically usable for decision making and could help to reconcile the the supply of and demand for science in this area (Sarewitz and Pielke 2007; Dilling and Lemos 2011). Further research is also needed to distinguish whether lack of resources and information are true barriers to adaptation planning and action, or if they are, as has been found in the past (Measham et al. 2011), merely reasons to stall.

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