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Structuring international development decisions: confronting trade-offs between land use and community development in Costa Rica

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Abstract For more than half a century, research and practice in international development has focused on improving the quality of life of people living in developing regions of the world. Recently, researchers, practitioners, and policy makers have recognized the need to blend insights from experts and community stakeholders in development decisions. Research in the decision sciences tells us that these kinds of multiparty and multiattribute decisions are extremely challenging. However, recent experience using structured decision-making (SDM) approaches suggests that the quality of both expert and stakeholder input, and resulting decisions, can be improved by ensuring that people address a series of basic principles relating to identifying objectives and their associated attributes, estimating the consequences of proposed actions, and directly confronting trade-offs that arise during the evaluation of management alternatives. In this paper, we provide an overview of SDM and then discuss a research initiative aimed at applying the approach to a pressing international development problem in rural Costa Rica: management of the lucrative but also environmentally destructive pineapple industry. The objectives of this research were twofold: First, we sought to help inform policy decisions by eliciting land management preferences regarding the pineapple industry from people living in communities surrounding plantations. Second, we evaluated the effectiveness of the SDM approach in a developing community context.

Keywords Structured decision making · Decision support · Expertise · Trade-offs · Developing countries · Costa Rica

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1 Introduction

For more than half a century, research and practice in international development has focused on improving the quality of life for people living in developing regions of the world. Much of this work encompasses projects aimed at poverty reduction, encouraging democratic governance, facilitating private sector development, enhancing human health, providing sustainable infrastructure for basic education, and encouraging social justice and equality. The federal governments of almost every industrialized nation sponsor agencies and programs aimed at meeting these goals; the United States Agency for International Development, Canada's International Development Agency, and the UK Department for International Development are high-profile examples. Several other countries and organizations participate in international development activities through representation in the United Nations (UN) or with donor agencies such as the World Bank.

Recently, these organizations have recognized the need to do a better job of incorporating insights from both experts *and* community stakeholders in development decisions. Moreover, greater emphasis is being placed by

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providers of foreign aid on decisions dealing with environmental sustainability (in addition to more traditional development contexts such as economic development, educational opportunities, and human health). From a development and systems science perspective, the expansion of the aid mission to include environmental objectives makes sense: in all regions of the world, human health and quality of life are directly linked to the health of the environment and the sustainable use of natural resources. And given that one of the goals of international development initiatives is to empower local communities through democratic processes—by giving voice to local knowledge and values—it also makes sense to more meaningfully involve community stakeholders and NGOs alongside experts in these decisions (National Research Council 2007).

Successfully eliciting—and then merging—expert and community input for environmental policy making is not easy. Research dating back to work on bounded rationality (Simon 1955) points out that people do not readily evaluate *all* of the available alternatives in a given decision in terms of the pros and cons associated with *all* of their associated attributes (e.g., economic impacts, and human and environmental health). Instead, people tend to focus only on a very small subset of the attributes—usually those that are the most salient or easiest to evaluate—and ignore others; this lexicographic process implies that choices typically do not accurately reflect the full range of associated values and concerns. Other, related problems also persist. For example, people find it difficult to identify and characterize the full range of objectives that matter to them and which, logically, should guide choices among the alternatives that are under consideration (Bond et al. 2008). When people do attempt to balance multiple objectives in choosing among alternatives, they often have a hard time balancing the pros and cons of competing alternatives (Lichtenstein et al. 2007; Richardson et al. 2013). Complicating matters further are findings relating to the widespread use of a panoply of simplifying heuristics that reduce the amount of time and effort required by people to make a choice but can introduce systematic biases (Gilovich et al. 2002; Kahneman 2011). Research in this area has resulted in a profusion of scholarly articles that point out possible flaws —and their consequences—when cognitive shortcuts characterize human judgment and decision making.

In response, related research has focused on how to improve the quality of choices that are made by individuals, small groups, and decision makers responsible for public policy. The bulk of this work in the area of international and community development has been focused on two needs: improving decisions by providing better information to decision makers (Ajzen 2001; Millennium Ecosystem Assessment 2005) and creating more opportunities for stakeholders to become involved alongside experts in decision-making processes (Chambers 1994; Ostrom 1996). It is difficult to argue against either of these positions. Indeed, providing a solid foundation of supporting information to inform the judgments of stakeholders and decision makers should be preferred to the provision of an inferior one. Likewise, policy makers and analysts should make it possible for stakeholders to participate in consequential decision-making processes. But equally important is providing empirically derived guidance about how to help effectively combine these needs with insights from studies about how people typically make decisions and, importantly, how they might make these decisions better (Kellon and Arvai 2011).

The question is: *how*? Recent work on structured decision making (SDM) (Arvai and Post 2012; Gregory et al. 2012) suggests that in addition to the provision of information and stakeholder participation in decision-making processes, the quality of stakeholder input can be improved by ensuring that those involved in a decision—experts and stakeholders alike—address four basic principles: (1) thoroughly exploring and then defining what matters in the form of clearly articulated and agreed-upon objectives; (2) creating a set of attractive and feasible management alternatives; (3) employing the best available technical information to characterize the consequences of these alternatives in terms of the agreed-upon objectives; and (4) directly confronting the value trade-offs that inevitably arise when objectives conflict.

While these principles build upon the concepts of multiple criteria decision analysis (Clemen 2004; Hammond et al. 1999; Keeney 1992; Kirkwood 1997), it is important to stress that SDM is not simply "decision analysis *lite*." Rather, SDM—with its foundation in multiattribute utility theory—adds insights from good practice in analytic-deliberative processes (NRC 1996) while also reflecting findings from behavioral decision research. In this sense, SDM should not simply be viewed as a series of decision-aiding steps coupled with opportunities for stakeholder engagement. Instead, SDM is best viewed as a facilitated de-biasing technique in so far as the decision-aiding platforms help users to interact with each other and construct more thoughtful and internally consistent preferences, while the facilitator—working directly with users or virtually through a computerized interface—helps to ensure that the negative effects of common judgmental biases are minimized (Bessette et al. 2014).

For example, being explicit about first exploring a full range of objectives and then narrowing the list based on those areas that are most relevant (vs. most salient) to the decision at hand helps to avoid problems associated with anchoring with insufficient adjustment (Tversky and Kahneman 1974). Likewise, being clear about the impacts

of the alternatives under consideration in terms of how they meet, or do not meet, stated objectives makes the direction of improvement from the status quo unambiguous; this, in turn, helps to negate problems associated with framing effects (Bessette et al. 2014). And, from the standpoint of developing the information base for decision making as well as facilitating community involvement, SDM processes are recognized for integrating disparate technical knowledge and stakeholder values while also democratizing decision-making processes (Failing et al. 2007).

SDM approaches now have been applied successfully to a wide range of environmental management problems (Bessette et al. 2014; Gregory et al. 2013; Gregory and Failing 2002; Gregory et al. 2001b). However, there have been relatively few applications SDM approaches outside of North America or in developing country contexts (Arvai and Post 2012; Kenney et al. 2014). Among the reasons for this are the limited time that stakeholders have to devote to these kinds of multiparty initiatives, a general lack of technical facilities where people can interact with computer-based decision support tools, the language, and cultural barriers that often exist between predominantly western SDM facilitators and local stakeholders, and the willingness of political powers to encourage transparent deliberations among citizens, experts, and policy makers.

In light of the need for encouraging meaningful input from different stakeholders and experts regarding community development initiatives, the goal of the research reported here was to devise a way to overcome these obstacles through the development—and testing—of a SDM framework to aid in eliciting input from community members about controversial land-use decisions in rural Costa Rica.

2 Methods

2.1 Context

Costa Rica is a middle-income developing country located in Central America bordered by Nicaragua to the north and Panama to the south. Despite its small land area (approximately 51,100 km^2), Costa Rica is one of the 20 most biologically diverse countries in the world and forms an integral part of the Mesoamerican Biodiversity Hotspot. Costa Rica is also keenly interested in economic growth. In addition to electric circuit manufacturing and tourism, which are its top two revenue generators, Costa Rica also relies heavily on agricultural exports to support economic development. Costa Rica's largest agricultural export is pineapple and production levels continue to increase.

Pineapple production in Costa Rica involves a wide range of growers but is dominated by a small number of foreign-owned multinational corporations. Over the past 30 years, these corporations have invested heavily in the crop, developing hundreds of large plantations, packing and storage facilities, and transportation networks. In many cases, the corporations also make packing, storage, and export infrastructure available to smaller-scale operations so that they may get their products to market. In addition, the large corporations build and maintain other infrastructure that people in rural communities use, such as roads and bridges. They also provide employment for tens of thousands of people in rural Costa Rica.

Yet, large-scale pineapple production in Costa Rica comes at a cost. In particular, to meet export demands and to comply with phytosanitary requirements, the once low-impact crop now requires significant amounts of pesticides and herbicides. This has resulted in a buildup of agrochemicals in groundwater near some large pineapple plantations. Not surprisingly, many residents of communities adjacent to plantations are concerned about the impacts of agrochemicals on their air and water and, in turn, their health. At the same time, a lack of adherence to appropriate soil conservation techniques by some producers has resulted in severe erosion problems. There is concern among agronomists because, if unchecked, the degree of soil degradation could become so severe that affected lands cannot be cultivated for decades. Additionally, improper postharvest management of the pineapple crown and leaves by some producers has created a pest problem, predominantly in the form of *Stomoxys calcitrans*—an aggressive biting fly that, if not controlled, can wreak havoc on cattle production, both in terms of beef and milk. As a result, farmers and other residents who live on lands adjacent to the pineapple farms, yet who fail to benefit directly from these multinational operations, are carrying an unequal share of the costs.

In light of the partial accounting and uneven distribution of the benefits and costs of pineapple production, many Costa Ricans are beginning to call for more careful regulation of the industry. Policies being discussed range from more stringent regulation and monitoring of the existing pineapple industry to significant limits on the scale of production that would be allowed in the country. Some Costa Ricans have even begun to call for an outright ban on pineapple production in certain ecologically sensitive areas. In response to these calls, a Presidential Commission was charged with developing a better understanding of the concerns of both community stakeholders and pineapple producers, and with making recommendations to the government about possible ways to address these them. One of this paper's authors (León) was named as the commission's facilitator, and this research was used as a vehicle for obtaining stakeholder and expert input.

To this end, the objectives of the research reported here were twofold. First, and foremost, we aimed to help inform

policy decisions by learning about and eliciting pineapple production preferences from recognized experts as well as people living in communities surrounding plantations. Second, we sought to study the effectiveness of the SDM approach in a developing community context, to test whether the approach might hold promise as a decision aid to government officials in Costa Rica and in other developing countries that are dealing with similar issues.

2.2 Design

Our research unfolded in two phases: The first phase involved a series of individual meetings and small-group workshops were conducted with technical experts (agronomists, soil scientists, etc.), regional officials from the Costa Rican Ministry of Agriculture and Ministry of Environment and Energy, pineapple producers, and community representatives identified through contacts with community development associations and municipal government offices. The second phased utilized one-on-one SDM sessions with residents of communities located near pineapple plantations.

2.2.1 Phase 1: Workshops

These workshops and meetings addressed three key elements of the SDM approach (i.e., characterizing and bounding the decision problem, eliciting management objectives, and creating alternatives). A first round of workshops—typically lasting between 2 and 6 h—took place in 2008 and 2009, focused on the systemic nature of the pineapple production problem; during these workshops, we also elicited from different stakeholders and expert groups a list of guiding objectives that participants felt should be addressed by any pineapple management initiative. These objectives included ensuring the economic viability of pineapple as an export crop, protecting human health and safety, maintaining environmental health, ensuring that land remains cultivable in the long run (e.g., after pineapple production in the area ceases), creating realistic land-use policies that could be sustained though enforcement, and maintaining access to critical infrastructure by members of the public. All consultations and workshops were held at convenient locations, and discussions were conducted in Spanish.

Facilitated discussions in these workshops also focused on identifying the components of different pineapple production scenarios that would help to meet these guiding objectives. These included (1) reducing in the number of leachable herbicide and pesticide applications per year as a means of protecting human and environmental health; (2) limiting the allowable size of plantations as a means of protecting environmental health; (3) requiring buffer zones to both prevent the airborne spread of agrochemicals (to protect human health) and provide a visual barrier (an aesthetic improvement); (4) requiring that soil conservation techniques be employed by producers as a means of ensuring long-term cultivability; (5) mandating monitoring and compliance checks to ensure that agreed-upon policies were being enforced; and (6) generating revenue, in Costa Rican colones (₡),[1] to ensure that community infrastructure was protected by the government if production capacity in the area was reduced, and for funding more intensive environmental monitoring.

The rationale behind cost increases stems from the fact that large pineapple producers are helping to provide infrastructure used by the communities. If the scale of production was to shrink, producers' revenues would decrease as would their ability (and motivation) to provide ancillary community services. As a result, community members would be asked by the government to help cover the costs of these services, which they do not wish to lose, through a monthly contribution. Since few households in the areas where we conducted this research pay property taxes, a method was required to pass the costs associated with smaller pineapple plantations on to local residents. All households now pay fees to *Grupo ICE*, the national electricity and telecommunications (television, as well as wired and wireless phones and Internet) and electricity provider; as a result, monthly bills from *Grupo ICE* were selected as the preferred revenue collection method.

A final round of 1-day workshops were conducted with experts and managers in 2009 and 2010; these workshops were aimed at assembling a series of five realistic management alternatives, including the status quo (Alternative 1) as well as the expected impacts (or effort levels) associated with these alternatives on the objectives identified in our first round of workshops (Table 1).

2.2.2 Phase 2: Individual SDM Sessions

The purpose of these sessions, which took place in late 2010 and lasted 60 min on average, was to ask community members to evaluate the five alternatives and then using both decomposed and holistic judgments, to rank them from *most* to *least* acceptable. To inform the evaluation process, we subcontracted with Compass Resource Management (Vancouver, Canada) to develop a software tool that ran on a laptop computer carried in the field by the research team. The software interface depicted the five management alternatives (Table 1) and included a values weighting module, which was used by respondents to prioritize objectives and—indirectly via a decomposed

[1] During the period, this research was conducted, $1 USD ≈ ₡ 523.

Table 1 Management alternatives developed in consultation with experts and community stakeholders

Objective	Attribute	Alternative				
		1[a]	2	3	4	5
Human and environmental health	1. Allowed number of leachable agrochemical applications/year	4[w]	1	1	0[b]	2[w]
Environmental health	2. Maximum plantation size (hectares)	>250 ha[w]	50–250 ha	<50 ha[b]	<50 ha[b]	>250 ha[w]
Human health	3. Requirement that external buffer zones be established	No[w]	Yes[b]	No[w]	No[w]	Yes[b]
Long-term cultivability	4. Required implementation of soil conservation techniques	No[w]	Yes[b]	Yes[b]	No[w]	No[w]
Enforcement	5. Number of random compliance checks per year	0[w]	1	1	>3[b]	>3[b]
Infrastructure and monitoring	6. Monthly household fee added *Grupo ICE* bill (colones, ₡)	₡0[b]	₡463	₡1,837	₡2,452[w]	₡105

Attribute values denoted by a superscript *w* and *b* denote the worst and best performing attribute levels, which were used in swing weighting

[a]Alternative 1 reflects the status quo

judgmental process—obtain a ranking of the available alternatives. In order to obtain this ranking, the software computed the overall subjective utility via an additive utility model for the family of alternatives (a_1, through a_6), which was represented according to a weighted set of all m attributes (g_1, $g_2 \ldots g_m$):

$$U(a) = \sum_{i=1}^{m} u_i[g_i(a)]$$

Weights were elicited via swing weighting. In swing weighting, respondents are asked to consider the gap between the worst and best performance levels for each attribute (accounting for all of the alternatives); they are then asked to weight the attributes according to which of these gaps they would most like to eliminate by making the worst performance level for an attribute equal to the best performance level for the same attribute (see von Winterfeldt and Edwards 1986). A weight of zero was allowed when respondents judged an attribute to be irrelevant (Baron 2000; Clemen 2004).

After completing the swing-weighting procedure, respondents were shown (via the software's dashboard interface) the rank order of alternatives that best reflected their stated priorities. If they desired, respondents were also given the opportunity to alter their priorities (i.e., by re-weighting objectives using the swing-weighting module) which, depending upon the extent to which they changed their weights, could change the rank order of alternatives. Only the final weights, and the corresponding ranking of alternatives (via the utility model), were used in our analysis. After showing respondents the preference order implied by their weights, we also asked them to state a holistic preference by simply selecting their preferred management alternative (from the set of five; Table 1).

When respondents were finished with the elicitation process, they were asked to complete a short follow-up survey. The survey, administered orally and in Spanish, consisted of six questions. These questions, with responses recorded on 5-point Likert scales, asked for respondents to provide ratings of (1) their level of satisfaction with their resulting choices, specifically the rank order of alternatives (where 1 = very unsatisfied and 5 = very satisfied); (2) the level of difficulty associated with the decision-making process (where 1 = very difficult and 5 = very easy); (3) how well their ranking of alternatives reflected what mattered most to them in the context of pineapple production (where 1 = very poorly and 5 = very well); (4) the degree to which the decision-making process seemed realistic in light of their knowledge about agricultural production in the region (where 1 = very unrealistic and 5 = very realistic); (5) the extent to which the decision-making process seemed biased in the direction of specific alternatives (where 1 = extremely biased and 5 = not at all biased); and (6) how certain they were in their ability to consider trade-offs when making their choices (where 1 = not at all certain and 5 = very certain).

2.3 Respondents

We selected three cantons (Pococí, Guácimo, and Siquirres) within the Limón Province in the Atlantic region of Costa Rica as our study site because this area contains most of the pineapple production in the region. A stratified random sample of 95 households was drawn from these cantons. Rather than sampling on an ad hoc village-by-village basis, we worked with the National Institute of Statistics and Census (INEC) based on the national capital San José, to draw a stratified random sample of

respondents. We sought to maximize the credibility of our research by following the same sampling procedures utilized by the Government of Costa Rica when conducting the national census and other surveys of national interest. We also wanted to avoid oversampling respondents from high-conflict areas, where strongly negative feelings about large-scale pineapple production would prevail, as well as from areas so removed from any production that respondents might have no relevant opinions at all. INEC therefore took into account each canton's total population and its urban, semi-urban, and rural distribution in order to produce a representative group of sampling segments for each canton. Each of these segments was then rendered on cadastral maps, and a sample of three households was randomly selected for interviews. Researchers visited a total of 287 houses (152 of which were eligible), collected 121 surveys, and completed a total of 95 surveys for an adjusted response rate of 0.63.

The SDM sessions described in this paper were conducted only with respondents who were responsible for making financial decisions, either jointly or alone, on behalf of the household. Thirty-eight percent of these respondents were male, and the average age of respondents was 44 years. Forty-one percent of respondents were originally from the Limón Province, and of that group, the average length of residency was 40 years. Respondents not originally from Limón had lived in their community for an average of 26 years and in their canton for an average of 31 years. The majority of participants, 59 %, were married or in "free union" with their partner (41 % were married and 18 % in "free union"). The average monthly income of respondents was below the Costa Rican poverty line —<₡218,433—with 18 % earning that income through farming. An average of 43 % of respondents reported that they themselves (27 %) or a family member (16 %) currently worked (or had recently worked) in some aspect of pineapple production. The majority of respondents (59 %) had only a primary school (i.e., completion of grades 1 through 6) education and 12 % of respondents self-identified as active members of a community, canton, or provincial committee or organization (such as a local environmental committee or the Rural Aqueduct Association).

2.4 Analysis

Statistical analysis of the data was carried out using general linear models in PASW (formerly SPSS) 18. Means weights assigned to attributes by respondents were compared using one-way analyses of variance (ANOVA) coupled with Tukey's posttests and—for gender and relationship to the poverty line—independent sample t tests.

3 Results

Tables 2 and 3 highlight the comparisons of the relative priorities among attributes based on respondents' expressed swing weights and revealed statistically significant differences across all three 3-level comparisons, i.e., respondents' region (canton) of residence ($p = 0.001$), age ($p = 0.015$), and level of education ($p = 0.001$). According to the posttests[2] that followed, respondents' priorities regarding the presence of buffer zones ($p = 0.004$), compliance checks ($p = 0.001$), and cost ($p = 0.011$) were significantly different across the three study regions (Table 3). Differences across respondents' priorities as a function of age (Table 2) were significant for the requirement that soil conservation practices be undertaken by plantation owners ($p = 0.045$). In terms of respondents' level of education (Table 2), respondents' priorities regarding the presence of buffer zones ($p = 0.001$), the requirement that soil conservation practices be undertaken ($p = 0.026$), and cost ($p = 0.039$) all differed significantly.

Independent sample t tests were performed for three additional groups: respondents' gender and relationship to the poverty line, and whether the respondent or a close family member works on a pineapple plantation (Table 3). Gender comparisons show that women placed a higher average weight on limiting both the frequency of pesticide applications ($p = 0.027$) and the size of pineapple plantations ($p = 0.011$), whereas men were more concerned about cost ($p = 0.001$).

With regard to level of income (Table 3), respondents who earn at a level that is below the poverty line tend to place greater emphasis on limiting the frequency of pesticide applications ($p = 0.038$). Those above the poverty line, by contrast, placed a higher average weight on limiting plantation size (0.019), ensuring that buffer zones be established between villages and plantations ($p = 0.006$), and enforcing a larger number of random compliance checks ($p = 0.006$).

Those respondents who work on pineapple plantations, or have a close family member that works on one (Table 3), placed a higher average weight on the requirement that soil conservation be undertaken ($p = 0.001$) and on cost (0.039). Those respondents who neither work on a plantation, nor have a close relative that does, placed a higher average weight on limiting the number of allowed pesticide applications ($p = 0.001$) and the requirement the buffer zones be established ($p = 0.026$).

These results are important in that they clarify some key between-subject differences that are not unexpected in light

[2] Within-attribute differences, determined using a Tukey's posttest, are shown in Tables 3 through 5. All posttest results shown are significant by a margin of *at most* $p < 0.05$.

Table 2 Comparison of mean weights ($\bar{x}$) elicited for each attribute by region (Pococí, Guácimo, Siquirres), age category (18–40 years, 41–60 years, >60 years), and education level (0–6 years, 7–11 years, >11 years)

A#	Pococí		Guácimo		Siquirres		*F*	Sig.
	$\bar{x}_1$	SE	$\bar{x}_2$	SE	$\bar{x}_3$	SE		
1	0.92	0.08	0.93	0.13	0.96	0.05	1.62	NS
2	0.69	0.02	0.77	0.19	0.81	0.2	1.79	NS
3	0.90	0.07	0.82	0.18	0.84	0.11	5.85	‡[1,3]
4	0.93	0.05	0.87	0.15	0.88	0.13	2.95	NS
5	0.95	0.08	0.86	0.11	0.8	0.17	9.38	‡[1,3]
6	0.93	0.11	0.78	0.24	0.86	0.19	4.75	†[1]
	$n = 31$		$n = 31$		$n = 33$			
A#	18–40 years		41–60 years		>60 years		*F*	Sig.
	$\bar{x}_1$	SE	$\bar{x}_2$	SE	$\bar{x}_3$	SE		
1	0.94	0.08	0.95	0.07	0.88	0.15	1.07	NS
2	0.74	0.21	0.81	0.19	0.66	0.25	2.25	NS
3	0.82	0.15	0.86	0.09	0.91	0.13	2.78	NS
4	0.93	0.1	0.86	0.13	0.86	0.14	3.22	NS
5	0.89	0.1	0.84	0.16	0.87	0.18	1.36	NS
6	0.84	0.21	0.86	0.19	0.9	0.16	0.38	NS
	$n = 45$		$n = 34$		$n = 16$			
A#	0–6 years		7–11 years		>11 years		*F*	Sig.
	$\bar{x}_1$	SE	$\bar{x}_2$	SE	$\bar{x}_3$	SE		
1	0.92	0.11	0.97	0.05	0.91	0.09	2.81	NS
2	0.73	0.22	0.82	0.18	0.72	0.24	1.06	NS
3	0.88	0.96	0.85	0.12	0.7	0.22	9.17	‡[2,3]
4	0.87	0.14	0.92	0.07	0.97	0.04	4.89	†[3]
5	0.87	0.16	0.88	0.11	0.86	0.13	0.19	NS
6	0.9	0.17	0.82	0.2	0.7	0.23	5.05	†[3]
	$n = 57$		$n = 28$		$n = 10$			

For the Tukey's posttest, all significant differences are at the $p < 0.05$ level where superscript 1 corresponds to $\bar{x}_1 \neq \bar{x}_2$; superscript 2 corresponds to $\bar{x}_2 \neq \bar{x}_3$; and superscript 3 corresponds to $\bar{x}_1 \neq \bar{x}_3$

A# = attribute number (see Table 1)

Significance levels: * < 0.05; † <0.01; ‡ <0.001

NS Not significant

of the controversial nature of discussions about future management options for pineapple farms in the region. Of greater interest, however, to policy makers and to us as decision scientists, was the interpretation of the average weights across groups in terms of what they might mean for respondents' preferences for different management alternatives. When respondents' mean weights were analyzed using a stepwise additive utility model, we found that differences in average weights of fewer than 20 points across individual attributes had virtually no impact on the overall preference order (Fig. 1). This result is significant as a reassuring response to decision makers, that it is possible—in this case, with the assistance of structured decision-aiding processes—to open up discussions about a controversial land-use policy choice to stakeholders and to end up with useful prescriptive advice regarding the choice among preferred policies and broad-based agreement concerning future strategies despite the disparate views of the participants.

Specifically, an analysis of mean swing weights showed that Alternative 2 always performed best in terms of overall utility, followed by Alternatives 3 and 5, which were nearly indistinguishable. These alternatives were followed by Alternative 4 and Alternative 1, respectively. After completion of the weighting task, 66 % of respondents told us they would select Alternative 2 if given the choice with 26 and 8 % opting instead for Alternatives 5 and 3, respectively.

Table 3 Comparison of mean weights ($\bar{x}$) elicited for each attribute by gender, annual family income relative to the poverty line, and relative to the respondents' or a family member's employment within the pineapple industry

A#	Women		Men		t	Sig.	<Poverty line		>Poverty line		t	Sig.
	$\bar{x}_1$	SE	$\bar{x}_1$	SE			$\bar{x}_1$	SE	$\bar{x}_1$	SE		
1	0.96	0.06	0.96	0.06	2.30	†	0.95	0.07	0.92	0.13	2.12	*
2	0.80	0.21	0.80	0.21	3.16	†	0.70	0.21	0.83	0.21	−2.39	†
3	0.84	0.014	0.84	0.014	−0.74	NS	0.81	0.16	0.90	0.08	−2.82	†
4	0.90	0.012	0.90	0.012	0.62	NS	0.88	0.12	0.91	0.12	−1.22	NS
5	0.84	0.012	0.84	0.012	−2.60	NS	0.83	0.16	0.91	0.10	−2.85	†
6	0.81	0.21	0.81	0.21	−4.18	‡	0.83	0.20	0.90	0.17	−1.46	NS
	$n = 59$		$n = 36$				$n = 49$		$n = 43$			

A#	Employed: no		Employed: yes		t	Sig.
	$\bar{x}_1$	SE	$\bar{x}_1$	SE		
1	0.97	0.05	0.89	0.12	−5.58	‡
2	0.77	0.21	0.73	0.22	−1.08	NS
3	0.88	0.90	0.82	0.16	−2.28	*
4	0.85	0.13	0.95	0.09	4.07	‡
5	0.86	0.15	0.87	0.13	0.71	NS
6	0.81	0.20	0.91	0.18	2.10	*
	$n = 41$		$n = 54$			

A# = attribute number (see Table 1)

Significance levels: * < 0.05; † < 0.01; ‡ < 0.001

NS Not significant

Alternatives 4 and 1 were never selected by respondents when given the opportunity to choose.

In terms of the follow-up survey (Table 4), respondents indicated that the information presented to them seemed unbiased (Question 5; $\bar{x} = 4.9$, SD = 0.2), and the choices they were asked to make seemed realistic given their knowledge about pineapple production and land use (Question 4; $\bar{x} = 4.3$, SD = 0.7). Likewise, the respondents indicated that the SDM approach helped them to confront trade-offs by balancing the pros and cons associated with all of the alternatives (Question 6; $\bar{x} = 4.5$, SD = 0.5) and, therefore, make choices that reflected what mattered most to them (Question 3; $\bar{x} = 4.3$, SD = 0.5). Overall, respondents reported a generally high level of satisfaction with their decisions (Question 1; $\bar{x} = 4.2$, SD = 0.8). However, it is worth noting that the SDM method did not necessarily make the decision *easier* for respondents (Question 2; $\bar{x} = 3.4$, SD = 0.9).

4 Discussion

The primary objective of our research was to help inform policy decisions by eliciting judgments from stakeholders about different management options regarding the pineapple industry in Costa Rica. From the standpoint of our workshop participants, the SDM approach was viewed as adding much-needed precision and civility to a consultative process between experts, stakeholders, and policy makers, which, to date, had been fraught with inconsistency and conflict. In the workshops with experts and stakeholders, participants were able put aside long-standing conflicts and, instead, focused on a discussion of critical objectives and realistic management alternatives. Perhaps, the best measure of success for these workshops lies on the reaction of the objectives, attributes, and alternatives that were developed received from participants in the individual SDM elicitation sessions. Generally speaking, participants in these sessions felt that the information presented to them for the analysis did not seem biased (Table 4, Question 5; $\bar{x} = 4.9$, SD = 0.2); moreover, the decisions they were asked to make using this information felt very realistic to them (Table 4, Question 4; $\bar{x} = 4.3$, SD = 0.7).

As part of the individual SDM elicitation sessions, we did not observe any major differences in terms of the individual utility of the five management alternatives (Table 1; Fig. 1) across any of the group-level comparisons we undertook (Tables 3, 4). Specifically, across all of the group-level comparisons, neither Alternative 1 (i.e., the status quo) nor Alternative 4 (the organic option) were at

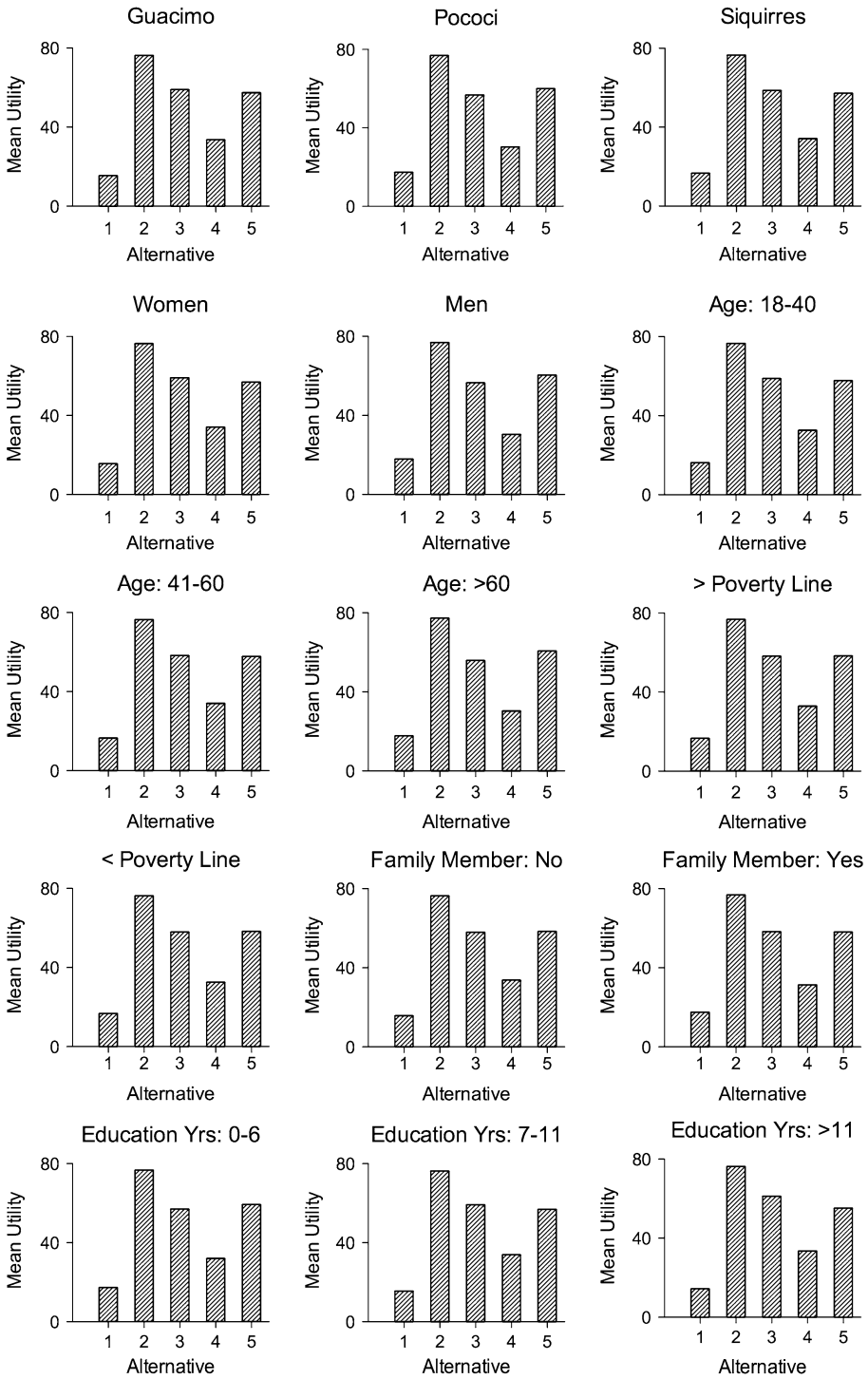

Fig. 1 Mean utility (calculated using the additive utility function described above) and relative ranks (by group) of alternatives as a function of respondents' average elicited weights on attributes

all competitive in terms of their overall utility. Alternative 2, by contrast, performed the best across *all* of the groups we studied. This option mandates a moderate reduction in the allowable size of pineapple plantations, reduces by more than half the maximum number of agrochemical applications allowed on pineapple plantations, and requires that both soil conservation practices be used and buffer zones be established between plantations and any neighboring communities. To ensure that these changes were implemented, Alternative 2 also calls for a moderate increase in the number of random compliance checks by government monitors that would take place each year. The overall cost to local households of implementing Alternative 2 is ₡463 per month.

Table 4 Follow-up survey results reporting subjects' mean ($\bar{x}$) responses and standard deviations (SD) on 5-point Likert (i.e., low–high) scales

Question	$\bar{x}$	SD
1. Satisfaction with choices	4.2	0.8
2. Difficulty with decision-making process	3.4	0.9
3. Choices reflect what matters	4.3	0.5
4. Choices seemed realistic	4.3	0.7
5. Information seemed unbiased	4.9	0.2
6. Ability to balance pros and cons	4.5	0.5

Respondents were largely indifferent between Alternatives 3 and 5. Since these alternatives were substantially different from a management perspective, we feel these results are worthy of attention. Whereas the utility of Alternative 2 was driven largely by a focus on reducing the number of pesticide applications and ensuring the implementation of soil conservation practices as well as the establishment of buffer zones, Alternative 3 tended to be favored by respondents who attached higher weights to a drastic reduction in the allowable plantation size. The utility of Alternative 5, by contrast, was linked most strongly to respondents' desire to increase the frequency of monitoring and/or minimize the cost of management, or increase farm size. In terms of the remaining options, there was a universal dislike of the status quo management system (the only option with no cost); even respondents who were most concerned about the cost of management agreed that a revision to the current management structure for pineapple farmers in Costa Rica is needed. At the same time, however, there was near-universal dislike of the most costly option, Alternative 4.

In terms of our second research objective, which focused on the effectiveness of the SDM approach in a developing community context, we observed several clear benefits. During our discussions with respondents during the elicitation procedure, people agreed that the SDM framework helped them to take what many in our study area viewed as an intractable problem and organize it into a series of interrelated, yet cognitively manageable, steps, e.g., thinking about objectives, connecting these objectives to sensible attributes, reviewing the available management alternatives in a user-friendly format, and confronting trade-offs across the full range of their concerns. At the same time, people were pleased that they were given the opportunity to offer their own opinions, in a constructive fashion, about the management of an important issue in their communities. In the past, many people had been asked for their opinions through interviews and surveys. However, respondents reported that our research was the first time that they had the opportunity to reflect on their preferences in a more in-depth and constructive manner.

Follow-up survey results (Table 4) seem to bear this out. For example, respondents felt strongly that the SDM approach helped them to confront trade-offs by balancing the pros and cons associated with all of the alternatives and, therefore, make choices that reflected what mattered most to them. It is our view that, in large part, respondents' high level of satisfaction with their decisions can be attributed to this aspect of the SDM method.

However, it is worth noting that the SDM method did not necessarily make the decision *easier* for respondents. A common misconception about SDM is that it simplifies complex decisions. In fact, there is nothing simple about a complex problem that requires people to confront challenging trade-offs. What SDM does is provide people with a systematic method for clarifying the multiple, related aspects of a decision and then balancing the pros and cons of alternatives through a deliberative and iterative process. We acknowledge that this process still can be challenging, for participants as well as for decision makers. The benefit, however, is in helping to ensure that the resulting decision takes account of the full range of concerns and that the process guiding selection of higher-ranked alternatives is internally consistent.

It is important to note that a variety of other approaches for eliciting these kinds of preferences also exist. We agree with our colleagues who have suggested that stated choice and other monetary-based methods (Adamowicz et al. 1998; Boxall et al. 1996), such as conjoint analysis, would be both easier and faster to deploy in a developing country context; indeed, such approaches have been widely used in Costa Rica, for example in the design of incentive programs intended to motivate environmental protection (e.g., see Alpizar and Carlsson 2003; Richardson et al. 2013).

These methods use survey instruments to present respondents (local community members, other stakeholders) with a series of alternatives, characterized as multidimensional composites or scenarios, that present integrated (i.e., conjoined) combinations of different attributes (e.g., different levels of air quality, water quality, and local employment). Multiple regression or similar analyses of decision makers' choices among the presented options are then used to estimate the relative contributions of individual attributes to their expressed preferences for the conjoint alternatives. Combinations generally reflect actual or projected variations in the attributes (e.g., different levels of air and water quality and local employment opportunities). In the more sophisticated conjoint surveys, often termed "choice experiments," the represented attributes are specified by an experimental design that estimates the separate and interacting effects of component attributes (Louviere 1988).

However, we believe that there are significant challenges associated with stated choice approaches stemming

from (1) the need to make expert–stakeholder processes more credible and (2) based on how judgments requiring trade-offs across benefits and costs are constructed. Specifically, a wealth of research in psychology and behavioral economics demonstrates that people are not the ideally rational maximizers of multiattribute utility that many policy makers assume they are (Kahneman et al. 1982; Tversky and Kahneman 1974). Instead, people construct their judgments in response to contextual and experiential cues that are available to them during the decision-making process (Arvai et al. 2006; Lichtenstein and Slovic 2006; Payne et al. 1992; Slovic 1995). As a result, information about implied trade-offs may be misleading because the judgmental processes that led to them were prone to judgmental inconsistencies. This problem is likely to be more significant when the choice context is unfamiliar, which has been shown to be true for many environmental policy options (Wilson and Arvai 2006, 2010).

With stated choice approaches, for example, questions may be raised about the extent to which survey respondents are actually confronting trade-offs across *all* of the attributes and levels that are being presented to them in choice experiments. This problem, which has been termed "process validity" in the literature on choice experiments (Carson et al. 1994; Mitchell and Carson 1995), may bedevil even the most carefully designed process. For example, conjoint surveys assume that respondents are considering the full set of described attributes when choosing among options; the expectations are that some of these attributes will be more important than others and that choices between the presented options will provide important insights about the trade-offs that people are willing to make (Adamowicz et al. 1998).

One problem is that attributes given a weight of zero, or near zero, may not be unimportant (as the zero value implies). Instead, such an attribute may be quite important to a decision maker but may nevertheless largely be ignored during the preference construction process. A common reason for this, which has been studied in other contexts (Arvai and Gregory 2003; Arvai et al. 2006, 2007; Gregory 2003; Gregory et al. 2001a; Lichtenstein et al. 2007), is trade-off avoidance associated with constitutive incommensurability (Baron and Spranca 1997; Tetlock 2000; Tetlock et al. 2000). When confronted with trade-offs that make decision makers feel as though they must subvert some morally significant values in favor of others, many people respond by anchoring on a single important attribute while blocking out the others. This occurs not because the blocked attributes are not important—quite the opposite. These attributes *are* important but they are discounted because they are difficult or uncomfortable to balance against other attributes.

The swing-weighting procedure reported here, as part of a SDM approach, counters this problem by making the need to evaluate alternatives on an attribute-by-attribute basis both explicit and subject to review by each participant. Swing weighting has a built-in advantage over other approaches—like stated choice methods—in that it is very sensitive to the range of values that an attribute takes on (with the range of values book-ended by the worst and best performing forecasts for each attribute). In other words, respondents are required to consider the range of possible outcomes across all of the attributes and then make a determination about which of these ranges—and by extension, the associated attribute—are most in need of attention; respondents then repeat this procedure for each attribute in the set. As a result, the risk that respondents will make decisions based solely on a single attribute—which we believe to be a significant shortcoming of stated choice approaches—is reduced considerably (Clemen 2004; von Winterfeldt and Edwards 1986). At the same time, SDM does not oversimplify the decision by unrealistically dissecting a complex problem into its component parts (which tends to falsely portray them as unrelated). Rather, after helping decision makers evaluate each attribute and their levels, SDM's holistic approach and explicit focus on deliberative trade-off analysis helps decision makers weigh the pros and cons of the consequences of different combinations of attribute levels.

In the end, decisions focused on the management of land-use systems present imposing challenges to policy makers, scientists, and stakeholders alike. Adding to these challenges, decisions about the environment are not simply decisions about the environment; they affect the health and social well-being of individuals and communities as well as business and commercial interests. As a result, these decisions must contend with multiple, conflicting, and often poorly understood values that, in turn, are linked to a range of environmental, social, cultural, spiritual, economic, and governance objectives and concerns. These challenges are made all the more pressing and significant in developing communities, where most decisions about the environment directly influence the livelihood of one or more stakeholder groups. Due to the precarious socioeconomic status of people living in these areas, these direct—and even indirect—influences can have significant effects on the ability of resource-dependent individuals and communities to sustain themselves (Kellon and Arvai 2011).

This brings us to the second objective of our research in Costa Rica: establishing the effectiveness of a SDM approach in a developing community context. Both the quality of the information and judgments elicited, coupled with respondents' self-reports (Table 4) strongly suggest that the SDM approach as developed and fielded provided an effective and user-friendly means of involving both experts and community stakeholders in complex environmental management decisions.

An added benefit of this test of a SDM approach in a developing country context was our ability to use an interactive, software-based decision support tool in the field. Previous applications of this decision-aiding approach in developing countries (e.g., Tanzania and Vietnam) have relied upon stripped-down SDM frameworks; the basic procedures were the same, these applications used paper-and-pencil tools as a stand-in for bespoke decision-aiding software (Arvai and Post 2012; Kenney et al. 2014). Though there were concerns about both the durability of portable computers in the field, and the potential complexity of the software-based decision-aiding tasks, neither of these potential obstacles prevented us—and, importantly, participants in our research—from feeling comfortable with the process and the results it generated (Table 4).

Overcoming these potential challenges was an important motivator of our research. We hope our results will encourage other researchers and practitioners to continue to search for appropriate methods that can bring together experts and stallholders, and assist decision makers to make sound international development choices and communities to have an effective voice in local development decisions.

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