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Development of a Participatory Method for Capturing Preferences of Andean Smallholders Regarding Urbanization

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In the tropical Andes, uncontrolled urban growth and the loss of agricultural land severely affect periurban smallholders who depend on the lease of farmland. In this context, the hinterland of Huancayo, Peru, represents a case in point, given that the urbanization of irrigated land resources on the valley floor endangers agricultural production during the dry season and thus forces agriculturalists to adapt their land use—a problem largely attributed to policy failures. If smallholder farmers had been policy-makers in the past, what type of urban growth would have taken place? Which future settlement structure would they prefer? To answer these questions, an easy-to-use and practice-oriented method for visualizing smallholder views on urbanization and landscape change was developed and tested. A combination of photomontage-based visualization exercises and interviews revealed that the interviewees mostly agreed that agricultural areas should remain between a mix of low and high buildings along the existing road. Hence, to a certain degree, their perception toward dispersed urban development seems not to be as negative as one could suppose. Additionally, some peasants argue that urban expansion should be on the steep and nonirrigated slopes adjacent to the city in order to conserve the fertile and irrigated land on the valley floor. Finally, the results of this study point to the potential of landscape visualizations for enabling mountain smallholders to participate in periurban land use planning and lead to the conclusion that photomontages, visualization exercises, and interviews should increasingly be used to improve understanding of smallholders' views, for this method includes an important emotional component that is rarely considered by planners and policy-makers.

Keywords: *Urban development; mountain agriculture; participation; perception; photomontages; Andes; Peru.*

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Introduction

The computer-aided participatory generation of geographical information is a topic of growing importance in practice-oriented research on good environmental governance (Brown 2003; Bussink 2003; McCall 2003; Dunn 2007; Bourgoin and Castella 2011; Garrard et al 2012; Young and Gilmore 2013). In this context, the use of visual resources (Schmid 2001) and the application of qualitative methods based on a geographic information system (Cope and Elwood 2009) for enabling the local population to participate in land use planning and management processes is considered a major step toward sustainable development (Nakamae et al 2001; Dockerty et al 2006; Grêt-Regamey et al 2007).

In fragile mountain ecosystems (Borsdorf and Braun 2008; Messerli 2012: S60; Grover et al 2015) of urbanizing valleys, this is of particular importance (Walz et al 2008; von der Dunk et al 2011) because conversion of arable land into built-up areas severely affects farmers' incomes and the local production of food; in tropical Andean countries (Sarmiento 2008; Saravia et al 2013), these negative impacts are increased by social inequalities between smallholders and land use policy-makers.

Landscape visualizations, such as photomontages, represent a useful tool for communicating the landscape visions of planners and policy-makers to other stakeholders. Yet urban policy-makers, focused on the active participation of local people, can also profit from visualized landscape preferences that communicate periurban smallholders' opinions, for this contributes to a better understanding of normative aims that exist within agricultural stakeholder groups. Neglecting their views may hinder the fulfillment of these nonexperts' needs and thus is likely to boost land-related conflicts and to cause resistance to spatial policies (Coy 2001; Hunziker et al 2008). Thus, the central research question was this: If smallholders had been policy-makers in the recent past,

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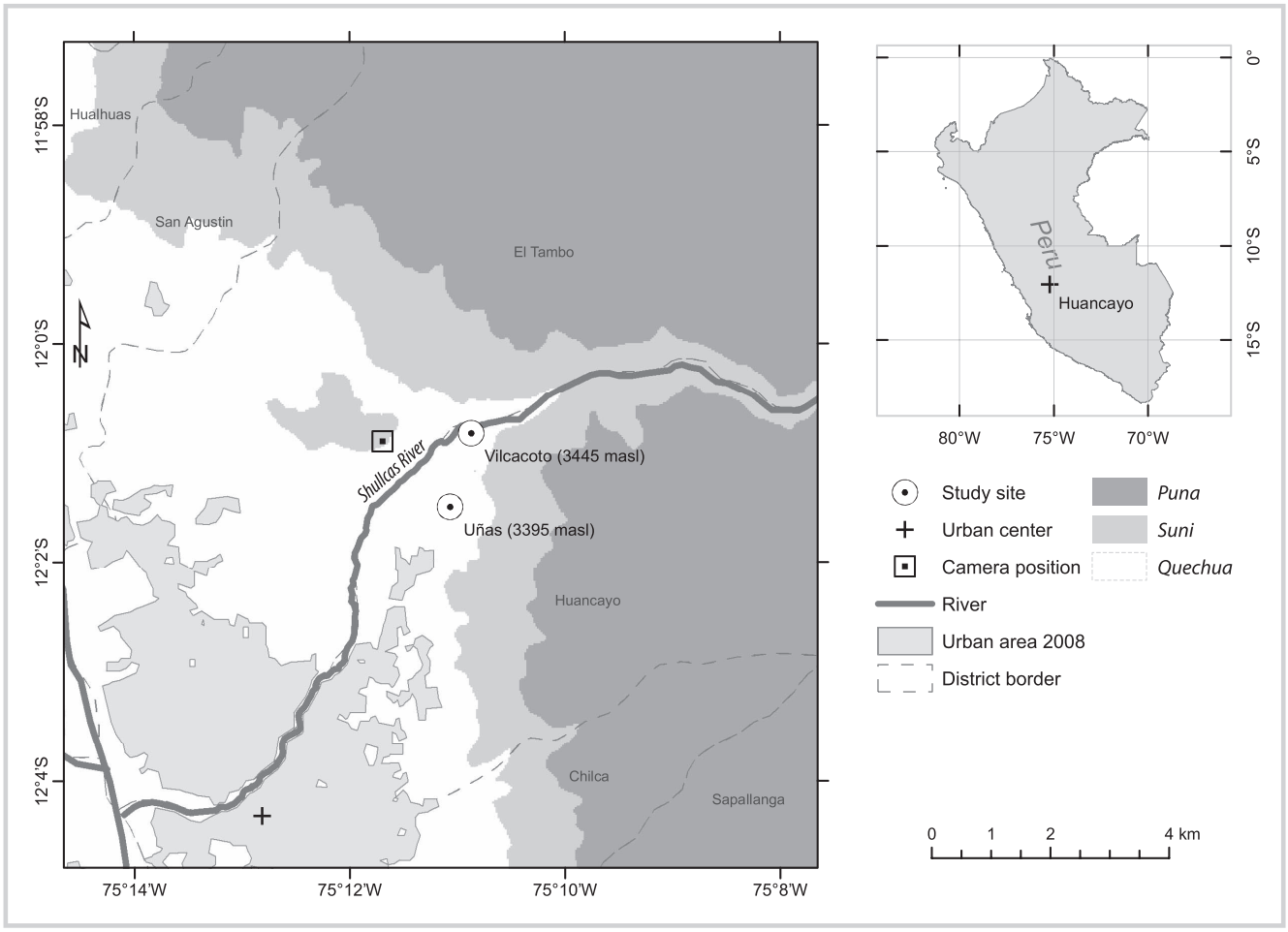
FIGURE 1 The Shullcas Valley near Huancayo Metropolitano, central Peruvian Andes, with camera position for photo used in photomontage. (Map by Andreas Haller)



what type of urbanization would have taken place? This study aimed to (1) develop an easy-to-implement method for elaborating photomontages based on smallholder preferences toward mountain urbanization; (2) test this method in a periurban valley section of the Peruvian Andes; (3) evaluate the results, considering potential gender differences; and (4) formulate recommendations for mountain development practitioners and policy-makers.

Study area

This method was tested in 2 villages of the Shullcas Valley in central Peru (district and province of Huancayo, Junín region). The settlements of Uñas and Vilcacoto, which were classified as agricultural units of approximately 1000 inhabitants in the most recent Peruvian statistics on hamlets and villages (Instituto Nacional de Estadística e Informática 1993), are 1 km and 2 km, respectively, from the continuously urbanized area of Huancayo Metropolitano (Figure 1)—an emerging Andean city of about 420,000 inhabitants located at 12°4′S and 75°12′W and approximately 3300 m above sea level (masl) between the Western and Eastern Cordillera (Haller and Borsdorf 2013). Land cover and land use in the study area are a mix of urban and rural; the area can thus be considered periurban (Allen 2003; Borsdorf and Hidalgo 2008; Simon 2008). The smallholder families of Uñas and Vilcacoto are—apart from urban-based work—principally involved in rural economic activities: male inhabitants focus mainly on agriculture, and women often run small corner shops in their villages. In sum, the households' livelihood strategies include a mix of subsistence and market-oriented agriculture and nonagrarian work (both in the village and abroad)—a pattern also observed in the small hamlets of Chamisería and Acopalca of the Shullcas Valley (Milan and Ho 2014).

Both settlements were eminently suitable for the aims of this study. First, Huancayo's urban area expanded from approximately 3600 ha in 1988 to more than 5200 ha in 2008 (Haller 2012; Figure 2), a development driven by the construction of single-family houses that, due to the loss of agricultural land resources at the irrigated and fertile

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FIGURE 2 Settlement patterns in the lower Shullcas Valley in 2011. The view in this and subsequent figures is toward the south. (Photo by Andreas Haller)

valley floor, represents a major challenge to periurban smallholders. Second, the growing demand for lots at the rural–urban fringe is driving speculation, boosting land prices, and thus impeding farmers' lease of additional parcels, which are needed for the market-oriented production of artichokes, maize, or potatoes (Haller and Bender 2013; Haller 2014). Third, these settlements' location at the border between 2 agroecological zones—the *quechua* (from Quechua *qheswa*, meaning "inhabitants of temperate valleys") up to 3500 masl and the *suni* (Quechua for "high", "large," or "deep") and *puna* (Quechua, meaning "high and cold area") regions above (Pulgar Vidal 1946; regarding similar zonation models, see Stadel 1992 or Borsdorf and Stadel 2013)—emphasizes the geographic specificities of urban growth impacts on agriculture in tropical Andean valleys.

In the present case, as outlined by Haller and Bender (2013), smallholders' land use has changed in the privately owned (*quechua*) and state-owned/community-managed altitudinal belts (*suni* and *puna*). Because of the reduced possibilities for year-round and market-oriented production on the valley floor (*quechua*), many smallholders plant eucalyptus in the higher *suni* zone (traditionally used to cultivate crops for home consumption) in order to produce and sell timber all year long; as a consequence, the subsistence-oriented cultivation of Andean tubers increasingly shifts upward to the border between *suni* and *puna* (Table 1).

Methodology

The study had 3 major steps. First, a detailed photomontage showing 1988 conditions was produced. Second, copies of the photomontage were used in interviews with inhabitants of the agricultural settlements in February 2014. Third, the results were digitally processed, analyzed, and used to adapt the initial photomontage to visually represent participants' urbanization preferences.

Preparation of a photomontage for visualization of land cover

The input data for the photomontage consisted of a land cover classification (30 m resolution) based on a Landsat 5 Thematic Mapper scene (path 6, row 68) from 7 August 1988 (described in detail in Haller 2012), a digital elevation model (Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Digital Elevation Model [ASTER GDEM], 28 m resolution), and a

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TABLE 1 Impacts of urbanization on smallholder land use in the lower Shullcas Valley, Huancayo. (Source: adapted from Haller and Bender 2013: 23)

Zone	Altitude (m)	Land tenure	Land use before urbanization		Land use adapted to urbanization	
			Activity	Aim	Activity	Aim
Puna	**4000–4800**	Mainly state-owned; land use rights held by agrarian communities and shared between members	Extensive keeping of sheep and cattle all year round	Mainly income generation	Intensive keeping of sheep and cattle all year round	Clearly income generation
Suni	**3500–4000**				Rainfed cultivation of potatoes, mashua (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*), and olluco (*Ullucus tuberosus*)	Clearly home consumption
			Rain-fed cultivation of potatoes, mashua (*Tropaeolum tuberosum*), oca (*Oxalis tuberosa*), and olluco (*Ullucus tuberosus*)	Mainly home consumption	Cultivation of wood crops (*Eucalyptus* spp) all year round	Clearly income generation
Quechua	**3300–3500**	Mainly privately owned; a few nonagrarian big landowners and some smallholders	Irrigated cultivation of potatoes, maize, and artichokes	Mainly income generation	Intensive breeding of small animals (guinea pigs) all year round	Clearly income generation

digital photo taken from a known camera position (Figure 1) in August 2011.

First, the digital elevation model (DEM) was converted into point data (with x, y, and z coordinates) in a geographic information system to enable further processing in a 3-dimensional animation, modeling, and rendering application, where a new vector-based DEM was created. Next, the viewpoint was adjusted according to the known interior and exterior camera orientation, the existing land cover map from 1988 was orthogonally projected on the DEM, and a land cover rendering was produced. In a graphics editing program, the rendering was overlaid on the 2011 digital photo to create a photomontage (Figure 3) showing settlement areas, wood and shrubland, grassland and cereal crops, and vegetable and pasture crops. Additionally, selected long-standing points or line features (predominantly copses of eucalyptus) not visible on the land cover map were included on the basis of spatial data gathered on high-resolution satellite images in Google Earth from 2005. Finally, 25 copies of the photomontage were printed on standard A4 sheets, laminated, and used in the interview process.

Interviews: visualization exercise and structured questions

In order to select 25 participants (older than 14 years) in Uñas and Vilcacoto, the principles of quota sampling (Daniel 2012: 105–107) were followed. Based on the 1993 statistics on hamlets and villages (Instituto Nacional de Estadística e Informática 1993), assuming that the relative population characteristics had not changed significantly over the years and considering the thoughts of Haller (2014: 240–242), a quota plan based on 2 variables, gender and place of residence—representing the likely structure

FIGURE 3 Visualization of the lower Shullcas Valley as it appeared in 1988. (Photomontage by Florian Einsiedler)

of the settlements' total population—could be designed. (Regarding gender differences and environmental perceptions, see Mohai 1997, Verma 2014, or, exemplarily, Burger et al 1998.) This included 7 female and 6 male interviewees residing in Uñas, as well as 7 female and 5 male interviewees residing in Vilcacoto.

After an introductory explanation of the project, participants were shown the photomontage and asked where they would have prohibited and permitted construction if they had been policy-makers in 1988. Each interviewee was given 3 red dots (to mark lots to be preserved from urbanization) and 3 white dots (to mark lots preferred for construction) and asked to place them on the photomontage. Additionally, 3 structured and closed questions regarding future urban development were asked:

1. Should the buildings be low (1 or 2 stories) or higher?
2. Should urbanization be compact (without agricultural areas between houses) or spread out (with agricultural areas between houses)?
3. Would Huancayo's urban growth be primarily advantageous or disadvantageous for the villages of Uñas and Vilcacoto?

After each interview, unsolicited complementary information (in the form of narrative sequences) was written up as ethnographic field notes in Spanish (then translated into English by the authors), to enable a better understanding of the smallholders' decisions.

Processing participants' responses

In addition to recording the results of the dotting (visualization) exercises and answers to structured interview questions, we digitized the participants' dots (6 each) and combined them in 3 new images representing the views of men alone, women alone, and men and women together. Then a perspectival quadratic raster (60 m side length) was laid over the respective images. If a majority of white points existed within a grid, settlement areas were added to the respective 60 m × 60 m square to get a more qualitative impression of participants' preferences.

Results and discussion

Insights from the visualization exercise

In the dotting exercise, summarized in Figure 4, both male and female participants indicated they would prohibit development along the Shullcas River. Yet the

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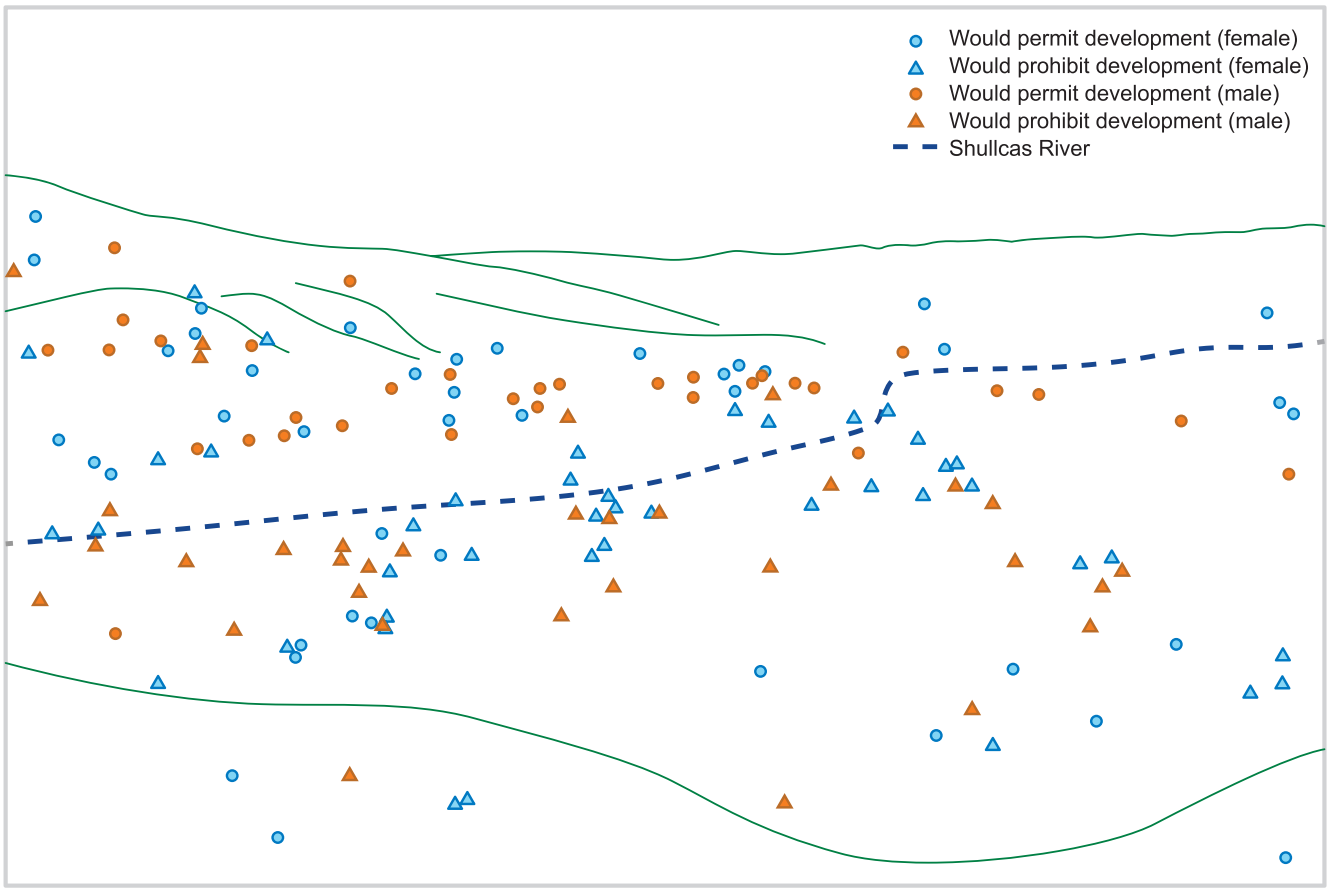
FIGURE 4 Participants' preferred locations for development by gender. (Figure by Florian Einsiedler)



interviews revealed diverse motives for this decision. Some participants gave safety concerns as the reason, because floods occur frequently during the rainy season; others aimed to conserve plants and soils along the river. Permission to develop predominated south of the river, where 2 settlements and a road already existed in 1988 and were shown in the visualization shared with participants (Figure 3). The main argument given for choosing these locations was the existence of transport infrastructure and thus better accessibility, as the opinion of a woman from Vilcacoto exemplifies:

> *Houses should be constructed along the road, I suppose—or not? Because now there are buses connecting the village with the city. Years ago we had almost no buses to the city; now the bus passes by every 15 minutes or so. I am not an engineer, but I would say this is the best place for constructing a house.*

One smallholder from Uñas, a critic of urbanization, expressed the rather pessimistic conclusion that the arable land left between the houses should be entirely urbanized, since once houses emerge, the soils get contaminated and thus would no longer produce high-quality food.

Regarding the steep slopes of the *suni* (south of the river), mixed responses with no clear gender differences pointed to tensions between 2 opposing views. Those who would permit construction on the unirrigated slopes said that this could contribute to the conservation of agricultural land on the fertile and irrigated valley floor. A Vilcacoto inhabitant (cited in Haller 2014: 245) said:

> *What will we eat now—houses? It would be better to urbanize the hills instead of the fertile agricultural land, because our life is based on the cultivation of crops. This development threatens us. Without a doubt urban growth also has a positive side, yet our agricultural production should not be damaged.*

On the other hand, during field research in February 2014, a male smallholder from Uñas pointed out that potential settlement areas in the *suni* and *puna* belong to the *comunidad campesina* (agrarian community)—and complained that, despite the high number of agriculturalists in Uñas, this land is reserved for a few privileged members of that association, which mainly belong to the community's founding families:

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Above, on the slopes, there are vast areas of mostly unused land. The agrarian community consists of only 70 members, but Uñas has many more smallholders. Nevertheless, the established community members do not permit the admission of new farmers. For their own consumption, they only produce some tubers during the rainy season—or they plant some trees and sell the wood in order to gain money for buying coca.

According to a woman in Uñas, who runs a corner shop in her village, this separation between community members and other agriculturalists is in part due to the terrorism-driven arrival of displaced people during the 1980s:

Here in the village, not all inhabitants are real uñasinos! Several families arrived during the violent era of the Shining Path and built houses here in our Uñas; in fact, many are from Huancavelica. . . . As far as I know, they often lease small parcels of land for sowing potatoes or beans; moreover, as my neighbors told me, several huancavelicanos are also working in Huancayo, in the construction sector I think. But I do not know exactly.

The opponents of steep-slope urbanization argue that the soils are not suitable for constructing houses and, thus, construction would cause landslides that could threaten the population living on the valley floor. A female inhabitant of Vilcacoto said:

In 1991, a huayco *[mudslide] destroyed parts of the village; to settle on the slopes would be dangerous. But I know that many people do not care about the risks; they even like hazards because of the aid the government provides in case of a catastrophe.*

In sum, the construction of houses on the steep slopes of the *suni* is a controversial topic; whereas some interviewees consider it the solution for the growing problem of the urbanization-driven loss of irrigated agricultural land in the *quechua* altitudinal zone, others see in it a potential source of hazards for the current inhabitants of the village.

Concerning the areas north of the river, almost no male participants said they would permit development. Men, who are predominantly engaged in agriculture, obviously aim to conserve the orographic right side of the lower Shullcas Valley and argue that this area is especially suitable for market-oriented production. Among women, who fulfill multiple socioeconomic roles, there was no clear majority in favor of prohibiting development. A young mother from Uñas, for instance, explained:

For our children it would be better to settle on this side, because there are a lot of trees, the air is cleaner, and the landscape is definitely more beautiful. But I would only permit a few small houses. Otherwise, we would have the same situation as in our Uñas.

Answers to structured questions

To further interpret the results of the dotting exercise, we undertook quantitative analysis of the responses. As shown in Table S1 (*Supplemental material*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-14-00052.S1), there are clear patterns in participants' answers to the structured and closed questions.

Regarding the height of future buildings in the lower Shullcas Valley, most preferred buildings with only 1 or 2 stories; male interviewees in Vilcacoto in particular opted for lower buildings, but the remaining groups did not show such a clear preference. Although the construction of higher buildings is often considered a strategy for conserving arable land on irrigated valley floors, many interviewees pointed out that there is a legal limit of 4 stories, because of the potential for earthquakes. The ground in this zone is dominated by alluvial, fluvial, and glacial Quaternary deposits (Instituto de Geología y Minas 1975), which are said to be unsuitable for taller buildings.

With respect to the density of construction (with or without agricultural areas between houses), the majority voted for the low-density variant; this preference is also represented by the individual results of the single groups of interest. Again, the only exception was the Vilcacoto male group, which slightly favored a more compact settlement. Their responses might be read as an indicator of their conservative preference for the status quo (compact settlements with lower buildings). Answers to the third question, on the expected effects of Huancayo's future urban growth for Vilcacoto or Uñas, showed the most unambiguous distribution; more than two thirds of the interviewees said that the positive effects of urban growth (for example, infrastructure improvements or increasing possibilities for selling agricultural products; Haller 2014) would prevail. This clear tendency was valid for 3 of the 4 categories of participants—only male participants from Uñas (the agricultural settlement located closer to Huancayo) were rather undecided.

Evaluation and synthesis

Surprisingly, participants seemed to prefer a less dense settlement pattern of mixed higher and lower buildings along the existing road; beyond that, urban expansion would be favored on the adjacent slopes of the *suni* region in order to conserve the arable land of the remaining valley floor north of the Shullcas River. But is this impression, which is based on the responses of the group as a whole, confirmed by the individual interviewees' answers?

To help answer this question, we looked more closely at the *combinations* of answers to the 3 structured/closed questions. To enable us to count how often any given combination occurred, we generated a unique numeric identifier for each, using a formula that assigned a binary code (0 or 1) to the answers to each question. The formula and resulting numerical identifiers are shown in Table S1 (*Supplemental material*, Table S1; http://dx.doi.org/10.1659/MRD-JOURNAL-D-14-00052.S1).

Of the possible answer combinations, 4 stand out (together representing 22 of the 25 participants).

TABLE 2 The most frequent responses (combinations of answers) to the structured questions. (Table by Andreas Haller)

Numeric identifier of response	Number of times response was given					Response		
	Total	Men	Women	Uñas	Vilcacoto	Future form	Future structure	Expected effect
26	7	3	4	3	4	Lower buildings (1 or 2 stories) preferred	With agricultural areas between them	Such urban growth would be positive.
22	6	4	2	2	4		Without agricultural areas between them	
42	5	1	4	3	2	Higher buildings (more than 2 stories) preferred	With agricultural areas between them	
41	4	2	2	3	1		Without agricultural areas between them	Such urban growth would be negative.

Combination 26 was the most frequent (appearing 7 times), followed by 22 (6 times), 42 (5 times), and 41 (4 times) (Table 2). Given that 8 different answer combinations were possible among these 22 interviews, the appearance of just 4 indicates clear tendencies of opinion. Moreover, positive evaluations of urban growth—found in more than two thirds of the conducted interviews—are assignable to only 3 combinations (numeric identifiers 26, 22, and 42), of which two thirds in turn appear together with a preference for agricultural areas between buildings. Thus, the overall impression of urbanization preferences based on the dotting exercise is evidently supported by the quantitative assessment's outcomes.

The visualizations shown in Figures 5 and 6 indicate that, regarding the orographic left side of the lower Shullcas Valley (south of the river), there are no major differences between men's and women's opinions. Men, however, seem to agree slightly more that urbanization should mostly occur along the road and, to a certain degree, on the slopes of the *suni*. Some women, as shown in Figure 4, also preferred to settle on the orographic right side of the Shullcas Valley (north of the river), mainly because of its more intact or natural environment and thus perceived higher quality of life. Hence, the results support the conclusion of Mohai (1997), who found that gender differences in the perception of environmental problems are quite modest. This might apply to urbanizing areas of many developing regions, where the reduction of patriarchal structures results in improved access to education and information for women.

The comparison of the participatory visualizations with the 2011 photograph of the area (Figure 2) makes clear that urbanization has been much greater than both male and female interviewees would have preferred. It conveys the impression that, rather than temporal periurbanization—understood as the process that leads to mixed rural and urban land use patterns—the subsequent densification and complete urbanization of the valley represents a major challenge to periurban smallholders because it leads to the loss of important periurban green space and thus to the disappearance of several ecosystem services (Breuste et al 2013). The desires brought to light by the visualizations were confirmed by quantitative results (Table 2), which underline the desire for a dispersed construction of mixed lower and higher buildings along the road, provided that agricultural land remains free between them.

Contrary to the common opinion that dispersed settlement patterns would be mainly negative (for an overview see Johnson 2001), the findings of the present study show that—at least among the people interviewed in the Shullcas Valley—other points of view exist. Urbanization also leads to the improvement of infrastructure (Haller 2014), and smallholders appeared to prefer a mix of agricultural and residential land uses along the existing road. Although the mostly pristine

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FIGURE 5 Male participants' preferred development scenario. (Photomontage by Florian Einsiedler)

agricultural areas on the orographic right side of the river should be protected, planned settlement on the slopes is considered a potential strategy for conserving irrigated land for food production in the *quechua* on the valley floor.

This study demonstrated that a combination of photomontages, visualization exercises, and interviews has the potential to provide urban planners with spatial information about the affected smallholders' views on land use change, which is necessary for defining future-proof policies that will be accepted by local populations (La Rosa et al 2014). As also reported by Lewis and Sheppard (2006) and Warren-Kretzschmar and Von Haaren (2014), the visualization exercise aroused the interest of local people, and almost all potential interviewees were willing to participate—both men and women. Compared with experiences of a previous study in Huancayo (Haller 2014), when survey questions seemed to repulse rather than attract interviewees, this method represents an improvement. Moreover, because of the short and crisp formulation of questions, none of the participants canceled the interview, and some of them even started to talk about additional urbanization-related problems—providing information of particular interest for practitioners, planners, and policy-makers.

Conclusions and recommendations

Given the results of the present study, 4 central recommendations can be formulated. First, the use of visualization exercises and interviews to hypothetically turn back time—and redesign urbanization processes—are highly suitable for encouraging smallholders to participate in land use planning discussions, probably because the process appears more like a game than a test; moreover, photomontages represent a landscape setting well known by the smallholders who live in the area and include an important emotional component that is often neglected by planners and policy-makers (Young and Gilmore 2013). In any case, it is especially important to explicitly make clear to participants that there are no right or wrong answers to the questions.

Second, it appears helpful—although time consuming—to carry out single face-to-face interviews, avoiding group discussions during the initial phase, in order to prevent answers being influenced by group pressure. An additional second round where the participants are informed about the decisions others have made—similar to the Delphi method (Bender 2006)—could be useful to negotiate jointly agreed development planning and would contribute to a

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FIGURE 6 Female participants' preferred development scenario. (Photomontage by Florian Einsiedler)

better understanding of differences between the stakeholder groups.

Third, the often generalized negative connotations regarding the periurbanization of mountain valleys should be critically questioned; our results indicate that smallholders who live on the outskirts of cities might prefer low-density urban development because—unlike in high-density urbanization—at least some arable land remains; the perceived negative impacts of more spread-out expansion might increase with the distance from the urban–rural boundary.

Fourth, planners and policy-makers in tropical Andean valleys should increasingly consider the diverse agricultural suitability of the respective altitudinal belts for sustainable land use planning of rural–urban fringes. Especially at the border between the *quechua* and *suni* regions, the loss of irrigated land on the valley floor may have wide-reaching consequences for the livelihoods of periurban smallholder families—who, ironically, often do not have access to the land managed by local agrarian communities at the higher altitudes of the hinterlands of tropical Andean cities.

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Supplemental data

TABLE S1 Participants' answers to the structured and closed questions. Answers were coded as acceptance = 1, rejection = 0. The resulting binary code (for example, for participant A, 011001) was converted into a unique numeric identifier (using the same example, $0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 0 + 16 + 8 + 0 + 0 + 1 = 25$) to identify answer combinations. (Table by Andreas Haller) Found at DOI: 10.1659/MRD-JOURNAL-D-14-00052.S1