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Spatial Analysis of Socioeconomic Issues: Gender and GIS in Nepal

Spatial patterns in socioeconomic data reveal issues and trends that would otherwise be missed by data aggregation to political or other units. Geographic Information System (GIS) tools provide display and analysis capabilities that are underutilized by many social scientists. The present article combines field-based surveys that maintain locational information with GIS tools to examine gender roles, responsibilities, and workloads in a spatial context for a case-study watershed in Nepal. Adult women outworked men by an average of 3.8 hours per day. Spatial differences in workloads are related to road access, with women living near the road working longer days, and men near the road participating more in "typically" female tasks such as collecting drinking water. Households with poor access have larger landholdings, greater total production, and are more reliant on subsistence agriculture. Households with road access use more agrochemicals, have smaller landholdings, and are more reliant on off-farm employment to meet their families' needs. GIS helps communicate these spatial trends more clearly and quantifies key issues when combined with statistical analysis. The use of field-based participatory techniques, aerial photographs and quantitative GIS and statistical analysis is infrequent in gender analysis but provides social scientists with powerful tools for investigating variability. In this study, the significant influence of the road on socioeconomic issues was highlighted, along with the need to focus development activities spatially.

Keywords: *Gender roles; GIS; labor; socioeconomic data; Nepal.*

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Introduction

Gender division of rights, responsibilities, work, and knowledge provides a point of departure to examine and explain the multiple roles of women and men as users and managers of natural resources (IDRC 2001; OECD 2001). An integrated gender focus is fundamental to the collection of relevant information and the development and adoption of effective resource management options (Thomas-Slayter and Rocheleau 1998). In the context of rural Nepal, gender analysis is critical. Women are largely responsible for the day-to-day tasks within the farming system. Cash crop production and the migration of males to urban work centers is increasing the workload of rural Nepali women (Gurung 1995; Brown 1997). As the main users of natural resources, women are affected most by environmental degradation and "imposed" solutions to environmental issues (Agarwal 1988; Karl 1996).

Geographic Information System (GIS) software provides tools for the display and analysis of spatial information (Starr and Estes 1990). Typical GIS applications include topographic mapping, forest inventory, soil or geological mapping, land use mapping, and political boundaries (Heit et al 1996). Socioeconomic information is rarely collected in a spatial context, and when it is, it is generalized to census units, political boundaries, or ecological units, and spatial variability is lost. Joshi et al (1999) collected socioeconomic information at national, district, and block scales, and used GIS to aid in delineating regions to understand production systems more systematically. Ashby et al (1999) combined poverty mapping at the municipal level with soil erosion maps in GIS to identify hotspots. Schreier and Brown (2001) related land use activities to socioeconomic and biophysical conditions, using GIS overlay techniques in combination with a statistical classification system. Louis and Magpili (2002) used multilayered GIS maps to analyze environmental indicators, industry types, and demographic characteristics based on census units to aid environmental policy making. Troyer (2002) used GIS to explore statistical relationships between measures of ecological and human conditions aggregated at the watershed scale. In all these examples, socioeconomic data were aggregated spatially, either at the time of collection or analysis. Collecting socioeconomic data in a geographic context and maintaining the original location information could reveal patterns in the data, which would otherwise be missed.

The focus of the present research is to identify women's perspectives on key issues in natural resources management, define the gender-specific division of labor within the farming system, link socioeconomic indicators to the workload of women, and examine the spatial context of those interactions in a GIS framework.

Study area

The Yarsha Khola watershed is located 200 km east of Kathmandu along the Lamu Sangu Jiri road. The total area of the watershed is 5400 hectares, and the economy is largely based on subsistence agriculture. Rainfed agriculture occupies 37% of the area, irrigated agriculture 14%, forest 31%, rangeland 15%, and other nonproductive land-covers 3%. The dominant cropping systems are irrigated rice–wheat at lower elevations (<1500

m) and rainfed maize–millet above 1500 m. One prominent feature of the watershed is access. The south-facing side of the watershed has road access and is largely occupied by Brahmin and Chhetri households (upper-caste Hindus). The north-facing side of the watershed is largely occupied by Tamang households (lower-status Buddhist hill tribe) and has poor access, because of the presence of a deep canyon along the lower third of the Yarsha Khola River.

Methods

To evaluate gender issues and socioeconomic conditions in the watershed, a gender-disaggregated resource-use survey was conducted. The sampling scheme was designed to evaluate the main natural-resource uses in the watershed, isolate the biophysical and management factors that affect the resources, and collect gender-disaggregated information. The following classes were sampled: 3 elevation classes—reflecting changes in climate and the dominant farming systems; 2 aspect classes—dominantly south-facing, hotter, drier, with road access, and dominantly north-facing, cooler, more moist, with poor access; 3 main soil and geological classes that influence land productivity; and 4 land use classes—irrigated and rainfed agriculture, forests, and rangeland. Within each combination of factors (eg, low elevation, south-facing, non-red soil, irrigated agriculture) a minimum of 7 samples were taken, for a total of 337 sites.

At each site, a survey using a short questionnaire was conducted, summarizing site conditions and management factors. For 75 households, a more detailed socioeconomic assessment was completed. Simultaneous and separate interviews with female and male farmers were conducted by local female and male Nepali interviewers to account for the typical division of labor and compare the perceptions of female and male farmers. Information on agricultural production, forest products, sufficiency status, ethnic distribution, off-farm employment, and decision-making responsibility was compiled and analyzed to evaluate household access to resources and indices of poverty.

In addition to the household surveys, 182 daily diaries (Buenavista and Flora 1994) were compiled for female and male farmers, to highlight typical winter activities throughout the watershed and document differences in ethnicity. Ten households of each of the dominant ethnic groups (Brahmin, Chhetri, and Tamang) within each of the geographic subdivisions (with and without road access) were interviewed. Forests and rangelands, which are largely under community management, were evaluated separately through key informant interviews (Schonhuth and Kievelitz 1994) with 20 forest-user groups, including both female and male informants at all sites. All sites were located on 1:5000 scale aerial photographs to facilitate spatial analysis using GIS techniques.

Results and discussion

A day in the life

A typical farmer's work day in Yarsha Khola starts between 5 and 6 AM and ends between 8:30 and 9:30 PM. Typical tasks include the collection of water, animal fodder, and fuelwood, feeding and watering the livestock, crop production, off-farm employment, and domestic activities such as cooking, cleaning, and child care. Table 1 lists gender differences in daily activities by task. Both men and women were active in crop production activities during mid-November. Women were involved in harvesting millet grain, cutting millet straw, and manually digging fields in preparation for planting wheat, whereas men would cut millet straw and plow fields for wheat. Women spent significantly more time on household-related work including the collection of water, and men spent more time working off-farm and in farm management.

Women get up earlier, work longer, and spend a greater proportion of their day working than their male counterparts (Table 2). Adult women typically worked 3.8 hours per day longer than the adult men surveyed. These trends are mirrored elsewhere in both developing and non-developing countries (FAO 1996; SWC 2001; IFAD 2002; Lindén 2002).

Spatial differences in workloads are largely related to road access. Women living near the road spend more time on household tasks, livestock care, and other work per day, and spend a greater percentage of their day working than women living on the north-facing aspects. Figure 1 illustrates spatial differences in women's workloads. Women living near the road spend an average of

TABLE 1 Gender differences in daily activities (n = 364).

Activity	Workload (h/d)	
	Women	Men
Household tasks	4.5	0
Water collection	0.6	0
Forest product collection	1.0	0.7
Livestock care	1.7	1.3
Crop production	5.8	5.7
Off-farm employment	0	1.9
Farm management	0	0.1

TABLE 2 Gender disparity in workloads (n = 364).

Activity	Women	Men
Wake up (AM)	4:57	5:39
Go to bed (PM)	9:19	8:41
Length of day (h)*	16.3	15.0
Working time (h/d)*	13.5	9.7
% Day working*	82	63

*Significant difference $\alpha = 0.05$.

85% of their day working, compared with 79% for women living on the north-facing aspects (no road access). Brahmin and Chhetri women (high caste) spend significantly more time collecting water than Tamang (Buddhist hill tribe) women. However, Tamang villages are generally located on north-facing slopes and at lower elevations (ie, wetter areas). Differences in workload are also noted with elevation but are largely related to land use. For example, the time spent collecting fodder is greatest at high elevations, where fodder is more abundant, whereas crop production is a major activity at middle and low elevations where productivity is greatest.

Labor allocation

Social factors such as cultural attitudes, religious practices, caste, and the legal system influence gender roles, responsibilities, and decision-making authority (Cameron 1998; Cornwall 2001; IIAV 2001). In the Yarsha Khola watershed (Table 3), crop production typically involves shared responsibility, with women more involved in planting, gathering manure, and applying compost, whereas plowing, terrace repair, and irrigation-system maintenance are predominantly male tasks. Livestock care is generally the responsibility of farm women, whereas buying and selling livestock or livestock products are male-dominated in over half of the households sampled. Domestic activities (cleaning, cooking, child care, fetching water) are largely the responsibility of women, whereas household decision-making and farm management are male-dominated activities. Farm-management decisions are taken predominantly (>75%) by men in 44% of the households, compared with only 7% by women. Additionally, there are 2 female-headed households in the watershed.

FIGURE 1 Spatial differences in the percentage of day that women spend working.

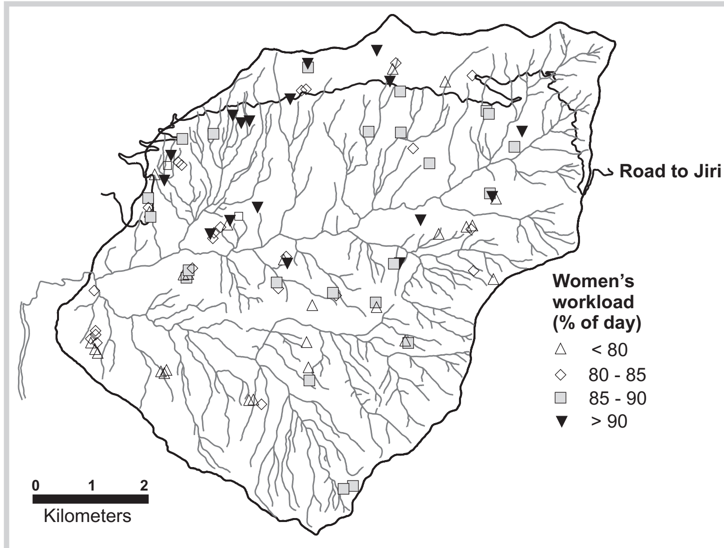


FIGURE 2 Spatial differences in the percentage of responsibility women have for collection of drinking water.

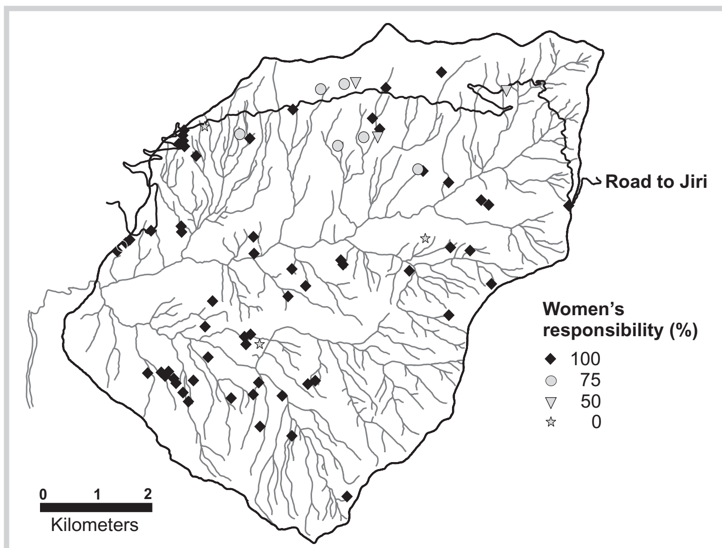


TABLE 3 Gender-disaggregated allocation of labor.

Tasks	% responsibility	
	Women	Men
Crop production	45	55
Livestock	76	24
Household care	76	24
Farm management	32	68

Access is one factor that influences labor allocation. Households with road access (south-facing aspect) display greater shared responsibility in the allocation of tasks between men and women, including collection of drinking water (Figure 2), livestock care, and managing farm labor. Bravo (2002) did not find a similar pattern in Peru. Improved roads reduced travel time to markets, improved access to health care, and facilitated seasonal migration of workers, but in only 1 of 3 case studies did men start to assume family responsibilities.

Socioeconomic indicators

Socioeconomic factors play an important role in determining constraints on resource management (Brown 1997; Scherr 2000). Major indicators include education, landholdings, basic-needs fulfillment, marketing of agricultural products, and off-farm employment.

In the Yarsha Khola watershed, illiteracy limits agricultural and forestry extension, participation in user groups, and the effective use of technologies and products (eg, pesticide instructions are written). Illiteracy is especially problematic for women. Ninety-two percent of the adult females interviewed in the watershed had no formal education, and only 1% had completed schooling beyond the primary level. In comparison, 70% of the adult males are literate. The Government of Nepal has taken steps to encourage young children, particularly girls, to go to school, through programs such as the free textbook policy and nonformal training for girls but gender discrepancy persists. Fifteen percent of school-age girls have received no formal education, and 63% of girls have obtained basic literacy only, whereas 79% of boys have completed secondary school education.

Land provides a major source of income, and inequity in land distribution translates into economic disparity. The median landholding per household in the Yarsha Khola watershed is 0.8 hectare, but ownership is unevenly distributed. Thirty percent of households own 10% of the agricultural land and have holdings <0.5 hectare, whereas 11% of households own 31% and have holdings >2 hectares. The disparity is even greater for irrigated land, where 14% of households have holdings >1 hectare and farm 42% of the irrigated land. Landholdings also vary spatially. Households with smaller landholdings (<0.5 hectare) tend to be concentrated along the road.

The fulfillment of subsistence requirements is the primary objective of the majority of farmers in the middle mountains of Nepal (Carson 1992; Brown 1997). Fifty-three percent of households in the watershed reported that they were not able to meet their basic needs from farming; the average sufficiency status was 10 months. Households near the road (Figure 3) are generally more reliant on nonfarm income to meet their family needs.

Involvement in market-oriented production or off-farm employment or both are 2 ways by which households can generate income. Seed potatoes are the main market crop, but households also sell surplus production of millet, wheat, rice, and maize. Total returns are generally low, with only 27% of households reporting annual returns >US$100. The majority of farmers sell their produce at local markets (Figure 4) or nearby towns (<20 km). Although the road facilitates travel to Tamakosi, Charikot, and Jiri, few farmers on the road-access side of the watershed sell agricultural products. Surplus production appears to be more of a limitation

FIGURE 3 Basic-needs sufficiency status (symbols represent location of farm households).

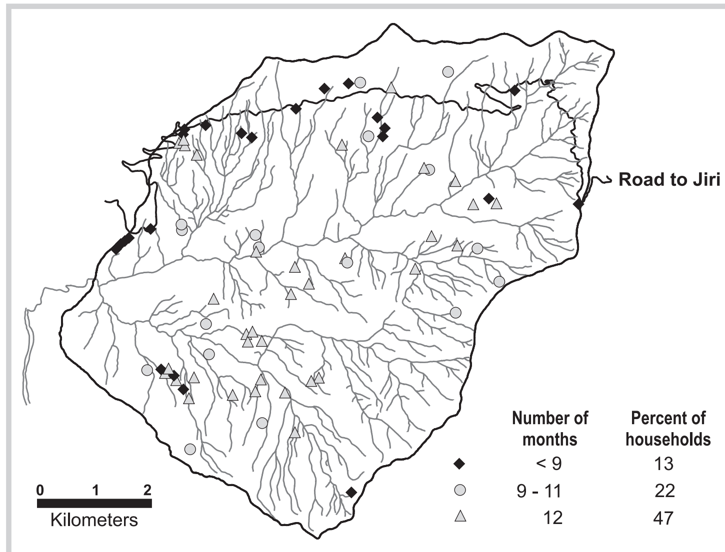


FIGURE 4 Distances to local markets from households involved in the sale of agricultural products.

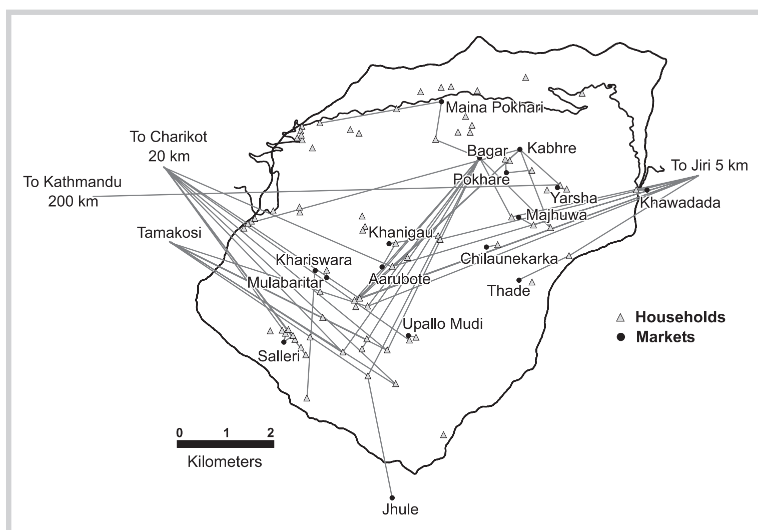
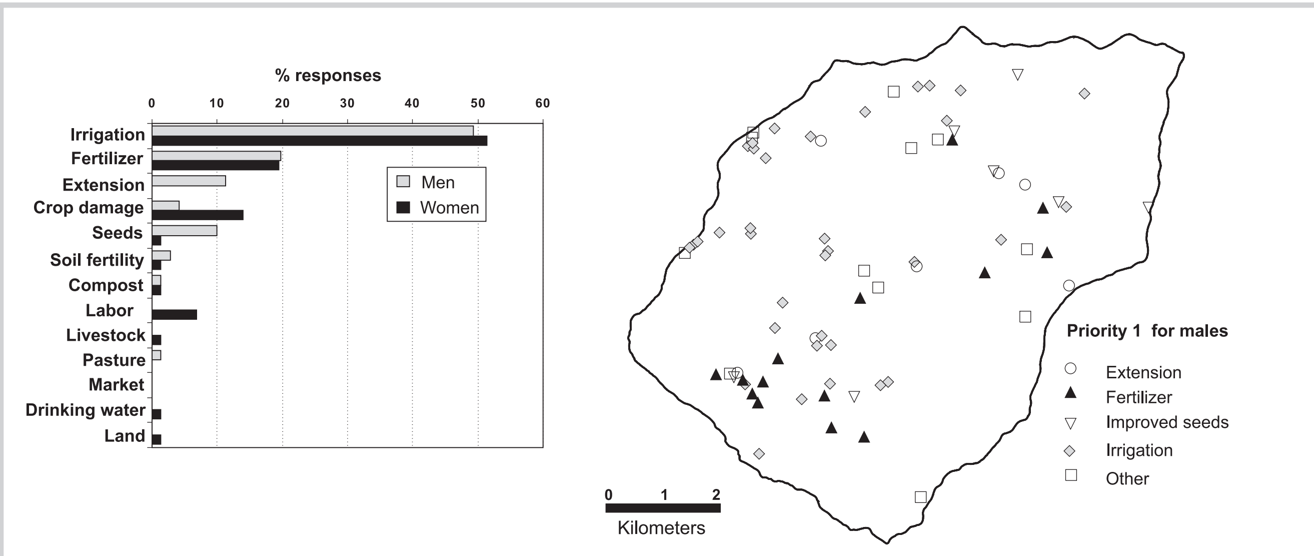


FIGURE 5 Agricultural constraints prioritized by female and male farmers.



than direct road access.

Income from off-farm employment is variable. Forty-eight percent of households earn no income, whereas 17% earn more than US$400 per year (carpenters, teachers, textile workers, building contractors), and the majority of those employed are male. Sixty-two percent of men work off-farm compared with 13% of women, and wage differentials are 3:4 (female:male) for laborers. Employment opportunities are concentrated near the road (67%), and the majority of fulltime employed are teachers (male). However, women do report off-farm employment of their spouses as advantageous for the purchase of household goods such as cooking oil, spices, and kerosene and for paying school fees.

Spatial interactions

The Lamo–Sangu–Jiri road has had a major impact in the watershed, influencing workloads, agrochemical use, employment, income and indirectly landholdings, self-sufficiency, and education. Households with road access use more agrochemicals, are more reliant on off-farm employment to meet their family needs, and have smaller landholdings. Other studies have found similar impacts, with roads leading to increased pressure on existing natural resources while being a key factor in development (eg, Farrow 2001).

Indicators of economic well-being, such as land ownership and total returns to cropping, appear to influence education; that is, greater affluence equates to higher education. Off-farm employment income increases with the education level of adult males, and interestingly, adult females are less involved in decision-making when adult males are better educated. Women have less decision-making power in households that own more land, produce more agricultural products, and in which the males are better educated.

Land ownership is a key indicator of economic well-being. Households with greater landholdings produce more rice, maize, and millet, earn more from the sale of agricultural products, own more livestock, and are better able to meet their families' subsistence needs. Fulfillment of basic-need requirements is in turn linked to agricultural production.

Households near the road show greater shared responsibility in labor allocation, the opposite of what would be expected on the basis of cultural distribution. It might be anticipated that Brahmin and Chhetri households (upper-caste Hindu) would display less shared responsibility than Tamang households (Buddhist hill tribe), but the opposite is found. This suggests that economic opportunities linked to the road may transpose cultural norms. Differences within ethnic groups with and without road access were not statistically significant; however, households near the road and in particular, males in Chhetri households do take on more responsibility in daily tasks ($\alpha = 0.05$). Cameron (1998) found a similar pattern in western Nepal, where labor allocation was related to economic productivity. In households where women made greater economic contributions, gender roles were less rigid. In Yarsha Khola, levels of commercialization and off-farm employment opportunities are still low, and women note the positive benefits of male employment, mainly for financing the education of their children. In contrast, Bhatt et al (1994) found that with commercialization of milk production, young men were involved in fodder collection, but women attributed men's motivation to their concern about economics, whereas women worked more and had less mobility and limited control over the returns.

Labor allocation and household economic well-being are only weakly related in Yarsha Khola. In households with greater off-farm income, men are less involved in harvesting and women more active in agriculture. In households with greater agricultural production, men appear to be more involved in household-related tasks. However, these relationships are statistically weak.

Agricultural constraints identified by female and male farmers in the watershed provide an interesting example of the relevance of maintaining spatial integrity in socioeconomic data. Both female and male household heads identified lack of irrigation and the availability of fertilizers as major constraints faced by farming households. When examined spatially, it is clear that both issues are relevant but in different areas of the watershed (Figure 5). A lack of irrigation was identified as a major constraint on south-facing slopes, which are hotter and drier than north-facing sites, while access to fertilizer for sites along the road was not a concern. Fertilizer availability was a key issue on north-facing slopes, where access is limited but water availability is sufficient.

Conclusions

If the household data were aggregated to the village level, would the impact of the road be obscured? No. In the case study, 2 village development committees exist on the road-access side of the watershed and 2 on the nonroad-access portion of the watershed. Because the village and political units coincide with access, the general trends would not change. The use of GIS is not absolutely necessary to reach the conclusions of the study. The same conclusions could be reached by using variables that characterize spatial aspects such as accessibility. Would information and variability be lost? Absolutely. Communities and political units are not homogenous. The median household provides relevant information, particularly for comparison at larger scales, but the extremes and variability between households are more descriptive of local gender relations.

Maintaining spatial integrity in socioeconomic data collection, analysis, and presentation permits a deeper understanding of socioeconomic interactions than traditional methods lumping data by political units (eg, village development committee). Spatial patterns emerge by separating data geographically, and interrelationships become clearer. Although only 19% of female and male farmers surveyed identified fertilizer availability as their primary constraint, 93% of those farmers are located on the no-road access side of the watershed, and fertilizer availability is a major constraint for farmers on north-facing, low-elevation sites. Variability between households was related to economic, biophysical, cultural, and infrastructure factors, all with a spatial component.

In the case study, the combination of a road and a deep canyon dividing the lower section of the watershed has significant implications for employment opportunities, availability of agrochemicals and other products, access to markets, and dependence on subsistence agricultural production. The south-facing part of the watershed has road access and related employment opportunities, availability of agrochemicals and other products, better access to markets, and consequently less dependence on subsistence farming. South-facing slopes are also hotter and drier, making water a limiting factor for agricultural production, particularly at lower elevations. In contrast, the north-facing slopes are wetter, irrigation is less of a concern, employment opportunities are more limited, and reliance on subsistence agriculture is greater.

The watershed is also culturally divided north–south: Brahmin and Chhetri castes dominate south-facing slopes, and Tamang tribes are predominant on north-facing slopes. However, cultural norms appear to be overridden by economic opportunity, and households near the road display greater shared responsibility in traditionally female tasks such as collection of water.

Without the use of GIS for spatial analysis, many of these relationships would be indistinct. However, one danger of keeping full spatial information is not keeping single-household information confidential. This needs to be guarded against by using an appropriate scale for data presentation and amalgamation techniques that do not obscure spatial variability.

Using GIS tools facilitates the analysis of socioeconomic and gender data to reveal spatial patterns, and GIS maps communicate this information more effectively than graphs or tables. In the case-study area, the significant influence of the road on socioeconomic issues and development is highlighted, and the need to focus development activities away from the road becomes clear. GIS analysis of gender and socioeconomic data has implications for policy and project management, particularly infrastructure projects that require a socioeconomic assessment. By using GIS tools, the considerable impact of infrastructure projects can be clearly demonstrated and monitored. Using aerial photographs and GIS in combination with socioeconomic survey instruments is a useful combination of tools, providing greater analytical power to socioeconomic scientists.

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REFERENCES

Agarwal B. 1988. Neither sustenance nor sustainability: Agricultural strategies, ecological degradation and Indian women in poverty. *In:* Agarwal B, editor. *Structures of Patriarchy: The State, the Community and the Household.* London: Zed Books, pp 83–120.
Ashby JA, Sanz JI, Knapp EB, Imbach A. 1999. CIAT's research on hillside environments in Central America. *Mountain Research and Development* 19:241–250.
Bhatt N, Shrestha L, Thomas-Slayter B, Koirala I. 1994. *Managing Resources in a Nepalese Village: Changing Dynamics of Gender, Caste and Ethnicity*. Kathmandu, Nepal: Institute for Integrated Development Studies.
Bravo A. 2002. Impact of improved rural roads on gender relations in Peru. *Mountain Research and Development* 22:221–224.
Brown S. 1997. *Soil Fertility, Nutrient Dynamics and Socioeconomic Interactions in the Middle Mountains of Nepal* [PhD dissertation]. Vancouver, Canada: Interdisciplinary Studies in Resource Management Science, University of British Columbia.
Buenavista G, Flora CB. 1994. Participatory methods for analyzing household activities, resources and benefits. *In:* Fieldstein H, Jiggins J, editors. *Tools for the Field: Methodologies Handbook for Gender Analysis in Agriculture*. West Hartford, CT: Kumarian Press, pp 36–44.
Cameron M. 1998. *On the Edge of Auspicious: Gender and Caste in Nepal*. Chicago: University of Illinois Press.
Carson B. 1992. *The Land, the Farmer and the Future: A Soil Fertility Management Strategy for Nepal.* ICIMOD Occasional Paper no. 21. Kathmandu, Nepal: International Centre for Integrated Mountain Development and USAID.
Cornwall A. 2001. *Making a Difference? Gender and Participatory Development*. IDS Discussion paper 378. Brighton, UK: Institute for Development Studies, University of Sussex. Available at: http://www.ids.ac.uk/ids/bookshop/index.html; accessed on 15 Jan 2002.
[FAO] Food and Agriculture Organization. 1996. *Women, Agriculture and Rural Development. United Republic of Tanzania.* Fact sheet. Rome: Sustainable Development Department, Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/waicent/faoinfo/sustdev/WPdirect/WPre0010.htm; accessed on 15 Jan 2002.
Farrow A. 2001. *Accessibility: The Case of Honduras*. Cali, Colombia: CIAT. Available at: http://www.ciat.cgiar.org/access/accessibility-case-studies.htm; accessed on 15 Jan 2002.
Gurung J. 1995. Invisible farmers? Hill and mountain women of the Himalaya. *In:* Schreier H, Shah PB, Brown S, editors. *Challenges in Mountain Resource Management in Nepal: Processes, Trends and Dynamics in Middle Mountain Watersheds,* Workshop Proceedings; 10–12 Apr 1995; Kathmandu, Nepal. Ottawa: International Development Research Centre, pp 96–105.
Heit M, Parker D, Shortreid A. 1996. *GIS Applications in Natural Resources 2.* Fort Collins, CO: GIS-World.
[IDRC] International Development Research Centre. 2001. *Gender Analysis as a Development Research Tool*. Ottawa: Gender and Sustainable Development Unit, International Development Research Centre. Available at: http://www.idrc.ca/gender/tool.html; accessed on 15 Jan 2002.
[IFAD] International Fund for Agricultural Develpment. 2002. *Women's Workload in Livestock Development. Gender and Household Food Security*. Rome: International Fund for Agricultural Development. Available at: http://www.ifad.org/gender/learning/sector/agriculture/w_ld.htm; accessed on 15 Jan 2002.
[IIAV] International Information Centre and Archives for the Women's Movement. 2001. *Mainstreaming Gender in Water Resources Management: Why and How*. Amsterdam: International Information Centre and Archives for the Women's Movement. Available at: http://www.iiav.nl/eng/ic/water/index.html; accessed on 15 Jan 2002.
Joshi PK, Pande S, Asokan M. 1999. Socioeconomic dataset and use of GIS. *In:* Pande S, Johansen C, Lauren J, Bantilan FT Jr, editors. *GIS Analysis of Cropping Systems*. New York: ICRISAT and Cornell University, pp 55–63.
Karl M. 1996. *Inseparable: The Crucial Role of Women in Food Security.* Manila: Isis International.
Lindén K. 2002. *Larger Total Workload Behind Women's Poorer Health. Women, Work and Health,* 3rd International Congress; 2–5 Jun 2002; Stockholm. Available at: http://www.arbetslivsinstitutet.se/wwh/articles/22.asp; accessed on 1 Jul 2003.
Louis GE, Magpili LM. 2002. Representing inequities in the distribution of socioeconomic benefits and environmental risk. *Environmental Monitoring and Assessment* 79(2):101–119.
[OECD] Organization for Economic Cooperation and Development. 2001. *DAC Guidelines for Gender Equity and Women's Empowerment in Development and Cooperation*. Paris: Gender Equity Group, OECD. Available at: http://www.oecd.org/dac/gender; accessed on 15 Jan 2002.
Scherr SJ. 2000. A downward spiral? Research evidence on the relationship between poverty and natural resource degradation. *Food Policy* 25(4):479–498.
Schonhuth M, Kievelitz U. 1994. *Participatory Learning Approaches: Rapid Rural Appraisal, Participatory Appraisal.* Robdorf, Germany: GTZ-Verlag.
Schreier H, Brown S. 2001. Scaling issues in watershed assessments. *Water Policy* 3:475–489.
Starr J, Estes F. 1990. *Geographical Information Systems: An Introduction*. Englewood Cliffs, NJ: Prentice Hall.
[SWC] Status of Women Canada. 2001. Women still work more than men [Press release]. *Status of Women Canada.* Available at: http:/www1.newswire.ca/releases/March2001/12/c3053.html; accessed on 15 Jan 2002.
Thomas-Slayter BP, Rocheleau DE. 1998. Research frontiers at the nexus of gender, environment, and development: Linking household, community and ecosystem. *In:* Landon S, editor. *Gender: Readings and Resources for Community-Based Natural Resource Management Researchers.* Volume 1. Ottawa: IDRC, pp 79–116.
Troyer M. 2002. A spatial approach for integrating and analyzing indicators of ecological and human condition. *Ecological Indicators* 2(1):211–220.