Environmentalism and Contraceptive Use: How people in less developed settings approach environmental issues

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The rise in environmental concerns around the globe has prompted increasing research on the links between such concerns and behavior. However, most studies have focused on pro-environmental behaviors in affluent western societies, such as willingness to pay for environmental protection, pro-environmental political actions, and consumption patterns. Using multiple data sets from the Chitwan Valley Family Study in Nepal, this paper examines the impact of environmental perceptions on contraceptive use in a rural agricultural setting. The results of our analyses show that perceptions about certain aspects of the environment are related to individuals' subsequent use of contraceptives. Specifically, those individuals who think that their environment—agricultural productivity—has deteriorated are more likely to use contraceptives than those who think that their environment has improved or has remained about the same. This study thus provides a first step in our understanding of the relationships between environmental perceptions and fertility behavior in a less developed setting.

KEY WORDS: environmental perceptions; environmental concern; environmental behavior; contraceptive use; rural agricultural societies; Nepal.

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INTRODUCTION

The debate about the relationship between population growth, human welfare, and ecological stability has been an overriding issue among the public, policy makers and scholars. These concerns about population growth and environment, of course, have greatly varied over time (Pebley, 1998). The fear of unprecedented world population growth and the impact of environmental deterioration on humanity rose to unprecedented levels in the 1960s and the early 1970s, culminative in the celebration of the first Earth Day in the U.S in 1970 (Dunlap & Mertig, 1992; Dunlap & Scarce, 1991) as well as a spate of new environmental legislation throughout the 1970s and the 1980s (Kraft, 2004). The fears of the negative impact of environmental deterioration on humanity have resulted in a rise in public environmental concerns and in ecological research studies; in effect, the ever-growing interest in the environment became a new focus among researchers and polls (Dunlap, Gallup, & Gallup 1993). Public awareness and concerns about the environment has not been limited to the U.S., however, numerous studies throughout the 1990s testify to the fact that environmental concern has become a worldwide phenomenon, including both industrialized and developing countries (Brechin, 1999; Diekmann & Franzen, 1999; Dunlap et al., 1993; Inglehart, 1995).

The rise in environmental concerns throughout the globe has prompted increasing research on the links between the growing environmental concerns and pro-environmental performance and behaviors. Studies in the past have focused on three major areas: (a) willingness to pay for the improvement and protection of environment, (b) pro-environmental political actions, and (c) changes in individuals' personal consumption patterns (Bratt, 1999; Dunlap & Mertig, 1992; Guber, 2003; Nordlund & Garvill, 2002; Stern, 2000). Although these studies are quite relevant in more affluent developed western countries where environmentalism is often believed to be a manifestation of affluence (see for example, Van Liere and Dunlap, 1980) these studies have very little significance in subsistence economies (the poorer part of the world) where people's willingness to pay for environmental protection and changes in consumption patterns are constrained by their economic circumstance. In fact, people in poor countries whose willingness to pay or to change in consumption patterns are constrained by their economic circumstance and who are experiencing high fertility may choose to alter their fertility behavior. However, despite appealing theoretical reasons to suspect an important influence of these environmental concerns on fertility in poor parts of the world,

contemporary environmental sociologists have yet to enter this promising line of research.

In this paper we examine this *missing but quite plausible* link between environmental concerns and fertility behavior—contraceptive use. We argue that individuals concerned about their immediate environment in less developed settings such as in Nepal, where an individual's ability to pay for environmental protection and options to make changes in consumption patterns are very limited, may address their environmental concerns by adjusting their fertility through contraceptive use. We examine the relationship between environmental perception and contraceptive use particularly paying attention to demand theories of fertility. We hypothesize that individuals, who perceive their immediate environment as deteriorating, are more likely to use contraception than those who perceive their environment as better, or about the same as in the past. This is because those who perceive their environment as deteriorating may be more aware of the consequences of population growth than those who do not perceive their environment in this way.

We examine the relationship between individuals' perceptions toward their immediate environment such as agricultural productivity, the groundwater table and the quality of drinking water and individuals' subsequent contraceptive use. We draw on unique data from a setting in the early stage of transition both in terms of environmental changes and fertility. As we describe below, Chitwan Valley is currently undergoing rapid socioeconomic changes that potentially have a profound impact on the local environment and fertility. The changes in local environment, on the one hand, have perhaps influenced individuals' perceptions about their immediate environment through their own observation and experiences, and on the other hand, also pushed individuals to make new adjustments in their life styles such as adjusting their fertility through contraceptive use as a form of birth control, which was not common in the past.

To execute this study we take advantage of a setting in the midst of dramatic social change, measures of environmental perception and contraceptive use, and statistical analytical techniques appropriate to these measures. The Chitwan Valley in rural Nepal provides an ideal setting for tests of the theoretical framework outlined above. Nepal, a historically pro-natalist society, is experiencing persistently high population growth, poor economic progress, and rapid environmental degradation. The study of environmental perception and contraceptive use is particularly relevant in the Nepalese context. First, although Nepal initiated its anti-natalist programs as early as the 1960s, the country is experiencing persistently high fertility with a slow rate of fertility decline (Dongol, Retherford, & Thapa, 1997; Tuladhar, 1989).

The Total Fertility Rate (TFR) dropped from 6.3 in 1971 to 4.1 in 2001 (HMG, 2001). Second, Nepal is also experiencing rapid environmental deterioration putting heavy pressure on the poor economic base and threatening the very survival of this Himalayan ecology. Finally, recent opinion polls show rapidly growing environmental concerns among the Nepalese people (MSI, 2000).

We believe that the new knowledge and information this study proposes to generate may help planners and policy makers to formulate new policies and programs that could help address the country's socioeconomic problems in general and population problems in particular.

THEORETICAL FRAMEWORK

During the second half of the last century, particularly after the 1970s, the world has witnessed an unprecedented rise in environmental concern. While the rapidly growing environmental concerns were initially considered a manifestation of affluence and thought to be linked to the post-materialist shift in cultural values (Inglehart, 1990; Kanagy, Humphrey, & Firebaugh, 1994) the more recent studies have shown this as a global phenomenon including both industrialized and developing countries (Brechin, 1999; Dunlap et al., 1993; Guha & Martinez-Alier, 1997; Kim, 1999). In fact, the empirical evidence from various studies all around the globe show that (1) environmentalism is neither a new phenomenon nor limited to post materialistic values; (2) it is a global phenomenon fundamentally emerged in context-specific ways; and (3) thus, the relationship between pro-environmental concerns and behavior must be studied within the relevant context (Brechin, 1999; Brechin & Kempton, 1994; Guha & Martinez-Alier, 1997; Haynes, 1999; Kim, 1999).

The rapidly increasing global environmentalism has prompted research that links growing environmental concerns to pro-environmental actions and behaviors. Most studies on environmental concern and pro-environmental actions and behaviors have tended focus on three main areas: (1) willingness to pay for the improvement and protection of the environment, (2) pro-environmental movements and political actions, and (3) changes in individuals' personal consumption patterns (Bratt, 1999; Dunlap & Mertig, 1992; Guber, 2003; Inglehart, 1990; Nordlund & Garvill, 2002; Stern, 2000). These studies have produced quite consistent results concerning the links between environmental concern and pro-environmental intensions and behaviors. However, most studies of environmental actions and behaviors have been concentrated in relatively affluent western countries where the ability to pay for environmental benefits is higher and the means

and opportunities for taking political actions and making ''green'' lifestyle choices are prevalent. These studies may have very little relevance in subsistence economies (the poorer part of the world) where people's willingness to pay for environmental protection and changes in consumption patterns are constrained by their economic circumstance.

Indeed, Ehrlich, Ehrlich, and Daily (1993) suggest that the societies in the '''Third World''' are trapped in a vicious circle of a ''population–food security–environment trap''. They argue that a great deal of ecological destruction in the forms of deforestation, desertification, wetland destruction, and toxic pollution of air, water, and land are the direct consequences of the struggle to feed the rapidly growing population. In a similar vein, Bongaarts (1996) argues that the demand for agricultural land and inappropriate agricultural practices to meet the growing demand for food production primarily is responsible for the deterioration of environmental resources. Along the same line the findings of Kumar and Hotchkiss' (1988) study in Nepal suggests that the deforestation in highlands is a result of low agricultural productivity. Moreover, as food production is closely tied to the number of people needing to be fed, population growth is argued to be negatively correlated with environmental conditions. In fact, people in poor countries, whose willingness to pay or to change consumption patterns is constrained by their economic circumstance and who are experiencing high fertility, may choose to alter their fertility behavior.

In fact, a number of studies on fertility do indicate this possibility. Cosford, Neill, Grocott, Caldwell, and Caldwell (1976) suggest that the changes in attitudes toward population and environmental problems have legitimated preferences for small or even childless families. However, Preston (1986) notes that ''No attempt was apparently made to relate individual views on this matter (*environment*) to preferred or intended fertility''(p.181). Although ideational changes about the environment may be more rapid in industrialized societies, the impact of such changes on population growth could be more pervasive in less developed agricultural societies where individuals directly encounter a scarcity of resources. However, much less theory and empirical evidence exist to guide our understanding about how these changes in ecological orientation and values are related to individuals' fertility behaviors.

Building on the demand theories of fertility we formulate a theoretical framework to guide our investigation of environmental perceptions and contraceptive use. In general, demand theories of fertility suggest a positive relationship between environmental quality and fertility (Becker, 1976; Biddlecom, Axinn, & Barber, 2005). This argument assumes that a better quality of immediate environment means abundance of natural resources to

support a larger population. On the other hand, deterioration in the environment means a decrease in productivity making it difficult to support a large population. The decrease in productivity may include both at the household level and at the public level, making the natural resources that were once easily available more scarce. As a result, as both the household production and natural resources from common land become less available, it will be seen as being more difficult to raise a larger number of children and people may choose to control their fertility.

However, this simple argument has not gone unchallenged. The proponents of the counter argument suggest that once the environment deteriorates the agricultural productivity will go down, and, as a result, people will have to either clear more forestland for cultivation or intensify crop cultivation to produce enough food, which in turn requires a larger labor force to do the extra work (Filmer & Pritchett, 1997). Similarly, as the environment deteriorates, natural resources such as firewood, fodder for livestock, and timber for construction will become more scarce, leading to higher demand for labor, and people will fulfill this demand by having more children. The increased number of people will create more pressure on the environment, eventually leading to a vicious circle of poor people and poor environment (Filmer & Pritchett, 1997). Although the latter argument may be valid, because the possibilities of clearing new forest land for agriculture and collecting natural resources such as fire wood, fodder and other forest products from the common land is already limited in Chitwan, this pathway seems quite unlikely. Indeed, Loughran and Pritchett (1997), in a report to the World Bank, documented a negative relationship between environmental scarcity (firewood and drinking water collection) and demand for children in Nepal.

Besides additional demand for labor, microeconomic theories of fertility suggest that individuals' fertility intentions and behaviors are shaped by their current economic circumstances and future prospects. Although the economic explanations have predominated as explanations of family change, recent critiques have emphasized the failure of such economic models to explain historical trends in a range of family behaviors and have called for the inclusion of ideational factors as part of the explanations (Cleland & Wilson, 1987; Caldwell, 1982; Chesnais, 1992; Mason, 1997). Our own research and that of others in Nepal suggest that ideational forces have been important elements of family change (Ahearn, 2001, 2004; Axinn & Barber, 2001; Axinn & Yabiku, 2001; Barber, 2004; Barber, Axinn, & Thornton, 2002; Ghimire, Axinn, Yabiku, & Thornton, forthcoming; Suwal, 2001).[1]

Thus, we argue that individuals' preferences are affected more by their perceived seriousness of environmental problems than the actual state of the environment itself. This is particularly so in less developed societies

(Guha & Martinez-Alier, 1997). Therefore, individuals' perceptions about their immediate environment should be a better predictor of what they will do to address the problems.

We hypothesize that individuals, who perceive their immediate environment as deteriorating, are more likely to use contraceptives than those who perceive their environment as better, or about the same as in the past. This is because those who perceive their environment as deteriorating may be more aware of the consequences of more people than those who do not perceive their environment in this way. This should work in two ways. First, those who are concerned about the deteriorating environment may think that there will be not enough food and other resources for a large number of children in the future. Second, they may also believe that a larger number of children may mean further deterioration of the environment which they believe has already begun deteriorating.

HYPOTHESIS

Individuals, who perceive their immediate environment as deteriorating, are more likely to use contraception than those who perceive their environment as better, or about the same, as in the past.

(i) Individuals who think that agricultural productivity has decreased compared to 3 years ago are more likely to use contraception.
(ii) Individuals who think that the ground water table has decreased compared to 3 years ago are more likely to use contraception.
(iii) Individuals who think that their drinking water quality is worse now, compared to 3 years ago are more likely to use contraception.

SETTING

Chitwan Valley, which lies in the south central part of Nepal, is the study area for this research. Until the early 1950s, this valley was completely covered with dense forest and was the habitat of many wild animals including the Bengal Tiger and one-horned Rhino, among others. Around the mid-1950s, in order to lessen the impact of rapid population growth in the rather fragile mountain environment, the Nepalese government opened this valley for human settlement as a buffer zone for a rapidly increasing population. People from neighboring hills and mountains were brought in for settlement. The flat terrain, with its highly fertile soil and warm climate,

offered promising opportunities for people who were struggling with the steep mountain slopes to support their survival. Since then, the valley has undergone rapid changes both in terms of physical and socioeconomic conditions (Shivakoti, Axinn, Bandari, & Chhetri, 1997).

As a result, the dense forest turned into a populated agriculture-based settlement area. In the late 1970s the valley was connected east to west of the country by a national highway. A few years later another road connected the valley with Kathmandu, the nation's capital. There has been massive expansion of schools, health services, markets, bus stops, and employment centers within the study area (Axinn & Yabiku, 2001; Ghimire, 2003).

Although the expansion of these services is pervasive, the level of physical development is still in a very primitive stage. Except for the national highway, which runs along the northern border of the study area, most of the roads within the study area are still seasonal and unpaved. The employment centers mentioned above are basically service-oriented government agencies and a few agro-based industries. Despite this massive transformation, this valley remains predominantly an agriculture-based society. Eighty-three percent of the respondents of the study analyzed here reported that they were growing crops at the time of our survey. Therefore, the kind of environmental concerns the residents have are closely related to the deterioration of their micro-environment such as soil fertility, ground water quality, fodder, and fuel wood availability.

With respect to fertility, although Nepal has undergone a steady decline in fertility since the 1970s, the fertility rate is still quite above replacement level. The slow pace of fertility decline and continuous flow of migrants from the hills has kept the growth rate in Terai (low land) quite high. A recent estimate suggests an annual growth rate of 2.37% per annum (HMG, 2001). However, a recent survey reveals that women desire relatively small families: the mean ideal number of children is 2.9 (Pradhan, Aryal, Regmi, Ban, & Govindasamy, 1997). Indeed, only one-quarter of women would ideally prefer a family with four or more children.

Nepalese society, which was characterized by high fertility (6.5 children per woman) with very low contraceptive prevalence until the late 1970s, is now experiencing moderate fertility with wide-spread contraceptive use. Knowledge of modern contraceptive methods is nearly universal. Almost all Nepalese of reproductive age (98%) knew at least one modern contraceptive method. The contraceptive prevalence rate increased from 3% in 1976 to 38% 1998, almost a 13 time increase (Olenick, 1998). The patterns of contraceptive use are even more dramatic in Chitwan. Among the women born between 1942 and 1951, less than 5% had used permanent methods of contraception before they reached age 25. However,

among the women born between 1962 and 1971, more than 35% used these methods by age 25 (Axinn & Barber, 2001).

Despite this dramatic increase in contraceptive prevalence, the population of the valley continues to grow both through the continuing flow of in-migration from the hills, as well as by natural increase. The population in Chitwan is growing at a faster rate than in the rest of the country. The population of Chitwan grew from 259,571 to 354, 488 between the 1981 census and the 1991 census. The annual growth of 3.66% was one of the highest among the different districts of Nepal (Pearce, 1999). The high population growth has increased pressure on the limited land allowed for settlement and on other natural resources, such as groundwater and the surrounding natural forest. This situation has pushed the residents of the valley to think about their environment and the number of people it can support without damaging its ability for reproduction. This is the situation that we expect people may consider when deciding to use contraception.

DATA AND METHODS

This study uses multiple data sets collected by the Chitwan Valley Family Study (CVFS) from 1996 to 2000. The CVFS selected an equal probability, systematic sample of neighborhoods in Western Chitwan. A two-stage sampling technique was used to select 171 neighborhoods. Stage 1 was a sample of settlements selected using the 1990 census sampling frame. Stage 2 was a sample of neighborhoods from the selected settlements (for more detail see Barber, Shivakoti, Axinn, and Gajurel, 1997). The CVFS defined a neighborhood as a geographic cluster of 5–15 households. Once the neighborhoods were selected all the households within those neighborhoods were selected for interview. In all, 1805 households were selected for the study. Once the households were selected CVFS administered several waves of interviews both at the household and individual level as well. The information we use here comes from those respondents who were interviewed in all three surveys: household survey, individual survey, and prospective monthly contraceptive use survey. In the household survey, respondents were asked information pertaining to their households, such as household resources and agricultural practices. They were also asked about their environmental perceptions. In this survey anyone who ate and slept in that household most of the time in the past 6 months and can accurately give household information was recruited for the household interview. Four to six weeks after the household survey, an individual survey of all the

people, including those interviewed in the household survey, aged 15–59, residing in a sampled household and their spouses was carried out. In this individual survey, respondents were asked a series of questions about life events and attitudes towards various aspects of social life using a structured survey questionnaire and a Life History Calendar (LHC) method. In the LHC, a complete history is collected of an individual's life experiences, such as migration history, current place of residence, marriage, childbearing, contraceptive use, living arrangement, schooling, and employment. The response rate for the household-level survey was 100%. The individual-level survey had a 97% response rate. Note that the information we use here in our analyses comes from 1059 individuals who were personally interviewed both in the household-level survey and in the individual-level survey.

After the individual-level survey interviews ended in 1997, CVFS started collecting information on contraceptive use through a monthly survey of contraceptive use. The individuals selected consisted of men aged 15–59, and women aged 15–49, and further, neither of the spouses had undergone sterilization at the time of interview in 1996. Since 1997 to the present, these individuals have been visited regularly and asked about their contraceptive use, and if any of these respondents had moved out of the sampled neighborhood but stayed within Nepal they were followed and interviewed. In this study, we analyze information for a total of 36 months of monthly data.

Dependent Variable

Our dependent variable is monthly hazard of using contraceptives. Here the term ''*hazard*'' means the monthly probability of using contraceptives, given that the individual has not used contraceptives in the previous months. The term ''*hazard*'' was first used by Barlow (1963) and is more generally defined as the probability per time unit (in this case the month) that a case that has survived to the beginning of the respective time unit will fail in that time unit. Specifically, it is computed as the number of failures per time units in the respective time unit, divided by the average number of surviving cases at the mid-point of the time unit (see details on hazard models in the Appendix). By contraceptives we mean any methods used to delay or avoid pregnancy. Both in the individual interviews and later in the monthly contraceptive use survey, respondents were asked ''Do you or your (husband/wife) or your partner ever use any kind of contraceptives or any methods for delaying or avoiding pregnancy?'' If the respondent answered with yes, then the respondent was asked a series of questions about each of the nine methods (Pills, Depo-Provera, Condom,

Foam, IUD-Loop, Norplant, abstinence, male sterilization and female sterilization) and any other method not listed in the survey instruments. In this study, we use information about whether an individual or his or her spouse has used any of the nine modern contraceptive methods. Because the information on contraceptive use is collected precisely on a person per month basis, we constructed a person-month file of contraceptive use. To code the dependent variable, the outcome is 0 in all months before the respondent uses a contraceptive method. The dependent variable is coded 1 in the month that the respondent uses a contraceptive method, at which point the respondent is censored (dropped-off) from the analysis. Similarly, individuals who did not use any contraceptive methods during the observation period (36 months) are also censored at the end of this period. In Table 1 we present the descriptive statistics of all the variables used in our analyses.

Independent Variables

Concepts such as attitudes, values, beliefs, and perceptions are complex and often difficult to accurately measure. Therefore, to keep these concepts simple and understandable, we concentrate on those issues that are directly related to individuals' daily lives and are most relevant to this specific context. We focus on three micro-environmental issues: agricultural productivity, groundwater table, and drinking water quality and, so, in the household survey we ask questions pertaining to individuals' perceptions of agricultural productivity, ground water table, and drinking water quality. A translation of the Nepalese question that was asked to measure perceptions of agricultural productivity was worded as ''Compared to 3 years ago, do you think crop production has increased, decreased or stayed the same?''

Because our purpose is to examine whether those who perceived their agricultural productivity to have decreased in the past 3 years are more likely to use contraceptives than others; we created a dummy variable by coding the response as 1 if the answer was decreased and 0 for the other responses.[2]

Questions asked to measure perceptions of groundwater table and water quality were worded in a slightly different way. First, for ground water table respondents were asked, ''Compared to 3 years ago, is there a difference in the level of the water table in your or your neighbors' well or tube-well?''

A follow-up question was asked of those who answered that they observed a difference in the water table: ''Compared to 3 years ago, has the level gone down a lot, gone down a little, risen a little, or risen a lot?'' Using the responses to these questions we constructed a dummy variable, coded

TABLE 1

Descriptive Statistics of Variables Used in the Analysis

	Code	*N*	Mean	Std. Dev.	Min.	Max.
Dependent variable						
Contraceptive use	Yes=1, No=0	1059	.09	.29	0	1
Independent variables						
Agricultural Productivity	Decreased =1, Other=0	1059	.56	.50	0	1
Water Quality	Worse=1, Other=0	1059	.20	.40	0	1
Ground Water Table	Decreased=1, Other=0	1059	.31	.46	0	1
*Control variable*s						
Gender						
Male	0=No, 1=Yes	1059	.58	.49	0	1
Female	0=No, 1=Yes	1059	.42	.49	0	1
Ethnicity						
Hindu high caste	0=No, 1=Yes	1059	0.48	.50	0	1
Hindu low caste	0=No, 1=Yes	1059	.12	.32	0	1
Newar	0=No, 1=Yes	1059	.05	.21	0	1
Hill Tibeto-Burman	0=No, 1=Yes	1059	.18	.38	0	1
Terai Tibeto-Burman	0=No, 1=Yes	1059	.18	.38	0	1
Respondent's age	Years	1059	36.65	10.01	15	59
Respondent's experiences						
Education	Years	1059	5.01	5.46	0	24
Number of children	Number	1059	3.82	2.21	0	13
Work for pay	Ever=1, Never=0	1059	.67	.47	0	1
Previous contraceptive use	Ever=1, Never=0	1059	.10	.30	0	1
Family background						
Mother's children	Number	1059	6.01	2.64	1	16
Parents education	Both=2, Either one=1, None=0	1059	.20	.44	0	2
Household information						
Household size	Number	1059	5.71	2.48	1	26
Farm size	Hectare	1059	.81	.81	.01	7.33
Household equipment	All=3, Either two=2, Either one=1, None=0	1059	.64	.69	0	3
Access to contraceptives						
Distance to nearest health service	Minutes	1059	18.95	17.42	0	90

''1'' for those who thought the water table had decreased and coded ''0'' for those who did not think it had decreased (the others). Second, the perception of water quality was measured by asking, ''Compared to 3 years ago, do you think that the water you drink is more clear or has it become less clear?'' Then we constructed a dummy variable, coded 1, if the respondent answered their drinking water was getting less clear, and 0 if the respondent chose other options. As environmental problems greatly vary with social, economic, and level of physical development, we believe that these variables broadly represent the environmental problems that are most common in the valley.

Control Variables

In order to accurately estimate the effect of individuals' environmental perceptions on their contraceptive use, we control for a number of variables that are likely to affect either the outcome variable, the explanatory variables or the relationship between the two. We grouped these variables into three categories (1) a respondent's characteristics and experiences, (2) family background, and (3) access to contraceptives. Respondents' characteristics include gender, ethnicity and age group. Family background consists of parental experiences and household characteristics. Parental experiences include respondent's mother's number of children and education. Household characteristics include household size, farm size, and number of household possessions. Because of the variations in respondents' gender, ethnic group, and age group, we expect to have a different baseline rate of contraceptive use for different groups. On the other hand, family background could influence contraceptive use both by directly affecting individuals' contraceptive use, and by indirectly through independent variables (Axinn & Barber, 2001; Axinn & Yabiku, 2001).

Respondents' Characteristics and Experiences

Gender

A respondent's gender may influence our explanatory variables, outcome variable, and the relationship between the two in several ways. First, previous research has shown that women are likely to hold more environment friendly attitudes than men (Davidson & Freudenburg, 1996; Guber, 2003; Mohai, 1992, 1997).

Second, as women are primarily responsible for household management, such as fetching water from the well, preparing food for the family, and fetching firewood from the forest, they are the first victims of environmental deterioration. Thus, the direct experience of women may lead them to hold a different opinion than men. Nevertheless, as elsewhere in South Asia, Nepalese society is organized around gender hierarchy, and there are several gender inequalities in various aspects of social life (Acharya & Bennett, 1981; Bennett, 1983; Stash & Hannum, 2001). Compared to men, women have a lower social status (Adhikari 1998; Morgan & Niraula, 1995; Vaidya, Manandhar, & Joshi, 1993) and most women are constrained from participation in various social realms, such as education, employment, politics and business. As a consequence women are less likely to experience schooling, work outside of the home, and exposure to information—mass media—all of which are likely to affect both attitudes toward their environment and contraceptive use (Axinn & Barber, 2001; Axinn & Yabiku, 2001). We expect that compared to men, women are less likely to use contraceptives, therefore, we included gender as a control in our analysis. We coded 1 if the respondent is female and 0 if male.

Age

Previous work in Chitwan has shown significant differences between birth cohorts both in terms of various family formations and fertility behavior (mate selection, marriage timing,) and the variables involved in the hypotheses (contraceptive use) (Ghimire et al., forthcoming; Yabiku, 2001; Axinn & Barber, 2001). For example, among those born between 1936 and 1945 only 31% ever attended school and are less likely to use contraceptives, whereas among those born between 1966 and 1975 fully 84% had ever attended school and are more likely to use contraceptives. Similarly, previous studies in the United States show a strong correlation between individuals' age and their environmental attitudes (Guber, 2003; Mohai & Twight, 1987). Thus, we included the respondent's age as a control.

Ethnicity

Ethnicity is another way Nepalese society is organized into subpopulations (Bista, 1967; Dahal, 1993; Gurung, 1998; Thapa, 1997). Nepal's ethnic diversity is as varied as its bio-diversity; Nepalese society consists of many ethnic and linguistic subgroups (Bista, 1967; Dahal, 1993; Gurung, 1998). These subgroups differ in many respects that have important consequences on the relationship between people and the natural environment. Although ethnicity in Nepal is very complex, for analytical purposes, scholars have often categorized ethnicity into five

major groups: Hindu High Caste, Hindu Lower Caste, Newar, Hill Tibeto-burmise, and Terai Tibeto-burmise (Axinn et al., 1999; Blaike et al., 1980). For our purpose here, we have adopted the same categories. For more information see Axinn et al. (1999); Bista (1967); Fricke (1986); Gurung (1980); and Macfarlane (1976). Although the first two groups, Hindu High Caste and Hindu Lower Caste, have the same Indian origin and both practice Hinduism, the first group has historically had the most power and access to opportunities in both the formal and informal sectors. The Hill Tibeto-burman group are of Tibetan origin, and they tend to practice Buddhism. This group is mainly known as hill and mountain people, such as the Tamang, the Gurung and the Magar (Bista, 1967; Fricke, 1986; Macfarlane, 1976). The Terai Tebeto-burmise people are the original inhabitants of the Chitwan Valley. They were jungle dwellers before the valley was opened for settlement, and they adopted farming only after the people from surrounding areas started growing crops. Newars are distinct from all of the above mentioned groups in the sense that they practice a mixture of Hinduism and Buddhism and are heavily involved in the business sector of Nepal country. For our analysis, we have coded each of these categories as dummy variables and treated Hindu High Caste as the reference group for comparison.

Experiences

Previous research has shown a strong association between a respondent's experiences and our explanatory variables, as well as outcome variable. Previous research on environmental attitudes shows that a respondent's education and income through employment are positively associated with pro-environmental attitudes and behaviors (Tarrant & Cordell, 1997). Similarly, previous work in Chitwan shows that an individual's education, work, media exposure, and number of children have a strong positive effect on contraceptive use (Axinn & Barber, 2001; Axinn & Yabiku, 2001). Similarly, Satayavada and Adamchak (2000) also found the positive effects of education and work for pay on the current rates of contraceptive use in a much larger population in Nepal. We, therefore, control for a number of individuals' experiences. These experiences include respondent's schooling, work for pay, number of children, and previous contraceptive use.

Our measures for respondents' experiences come from responses to a series of questions in the Life History Calendar. For each type of experience, respondents were asked, did they ever experience a specific event or not. If the answer was yes, then they were asked a series of follow-up questions—when they first experienced the event, how long the experienced

event lasted, when they stopped experiencing it, when it started again. For schooling, respondents were asked, ''Did you ever go to school to study even for one day?'' If a respondent's response was ''yes'' the interviewer asked, ''In which year did you first go to school?'' Every year the respondent was in school was recorded on the life history calendar. This procedure recorded the total length of time each respondent spent in school. From this information, we calculated years of schooling. Similar questions were asked about respondents' work, child-bearing and contraceptive use. From the information collected using the LHC we calculated the number of years respondents were employed; the number of children respondents have; and their contraceptive use experiences. Therefore, schooling and employment are recorded in number of years, children are recorded in numbers, and previous contraceptive use (before observation periods) is recorded as a dummy variable.

Family Background

Family background is another important domain that has enduring impact on individuals' lives. Previous studies have shown the significant effects of parental characteristics and household characteristics on their children's fertility behavior (Barber & Axinn, 1998; Yabiku, 2005). Because parental experiences and household characteristics may affect both children's experiences and contraceptive use, we control for a number of parental experiences and household characteristics in our multivariate models. Parental experiences include parents' education, and number of mother's children. The household characteristics include household size, farm size, and household possessions. The measures of these variables come from both the individual interviews with the respondents and the household interviews.

Parent's Educational Experience

The measure of parental education comes from the response to a series of questions beginning, ''Did your father ever go to school?'' Positive responses are coded as ''1'' and negative responses are coded ''0''. The same question was asked regarding the mother's education. Because there is very little variation in education level in this parental generation, a simple measure of whether both parents of the couple ever went to school, either one went to school, or both of them did not go to school, seems to be a more appropriate measure of parental education.

Mother's Number of Children

Parents' fertility behavior may influence their children's outcomes in many different ways. Here we control for the respondent's mother's number of children. In individual interviews we ask the respondent about the number of children his or her mother has. Therefore, the measure of the mother's children comes from the report of the respondent and is measured in exact number.

Household Size

An individual's household size may influence an individual's desire for children and preferences for their future fertility. Individuals in a large, overly crowded, family may develop a negative desire for additional children, and therefore, may choose to use contraceptives. Thus, we expect that individuals who live in large families are more likely to use contraceptives than those who live in small families. Our measure of household size comes from the household census taken during the household survey. The census includes all people who ate in the same kitchen and slept in the same house for at least 50% of the time in the 6 months prior to the survey; the census also included these people's spouses, whether or not they lived in the house at least 50% of the time in the past 6 months.

Farm Size

Several previous studies have suggested a strong association between individuals' household wealth and both their attitudes about the environment and their desire for children. However, the effect of household wealth may greatly vary with the level and nature of economic development. On the one hand, in an agrarian society under low mechanization, such as Chitwan, household wealth is represented by the size of one's farm. Under low mechanization, larger farm size requires more family members to manage the family resources. Therefore, in our multivariate models we control for the farm size. Our measure of farm size comes from the responses to a series of questions in the household survey. We ask a respondent how much land his or her household is currently farming. The size of farm currently farmed is coded in the number of hectares. The size of the farm ranges from .033 to 6.67 hectares.

Household Possessions

Unlike the effect of farm size several previous studies have shown that the desire for luxury goods such as a radio, television, motor bike or a car

has shifted individuals' preferences from having an additional child to having an additional luxury item. Therefore, we also control for household possessions that include radios, televisions, and motorbikes. Our measure of the number of possessions in a household also comes from the household survey. Respondents were asked whether the household possessed a radio, a television, or a motorbike. For each item in the household, the index of household goods increased by one; therefore, this index ranges from 0 to 3. Because the possession of these equipment symbolizes both economic status as well as social prestige, we expect that controlling for the possession of equipment significantly controls the influence of economic as well as social capital.

Access to Contraceptives

Another important factor that likely impacts the likelihood of using a contraceptive is the cost of contraception. Because contraceptive methods are available free of cost, the time it takes to get to those health services is the major part of the cost. In order to control for the effect of variation in cost of contraception, we included the distance to nearest health service from the respondent's neighborhood in 1996 that provides contraceptive methods in our multivariate models. The distance is measured in walking time in minutes.

ANALYTICAL STRATEGY

We use event history methods to model the risk of using contraceptives. Event history methods (sometimes also called ''survival analyses'') are particularly appropriate to model risk of experiencing an event, contraceptive use in this case, when the events are recorded in unique time intervals for a certain period of time (Allison, 1982, 1995; Petersen, 1991). Because the data are precise to the month, we use discrete-time methods to estimate these models. Person-month of exposure is the unit of analysis. We consider the individuals to be at risk of using contraceptives if they are men who are 15–59 years of age or women who are 15–49 when neither the respondent nor her or his spouse has been sterilized, and neither partner used any contraceptive in the first month (at the beginning of this observation period). To estimate the discrete time hazard models, we use logistic regression in the form:

$$\text{LOG}(\pi/1-\pi) = \alpha + \Sigma(\beta i * Xi)$$

where π is the monthly probability of using a permanent contraceptive method, $\pi/1-\pi$ is the odds of the contraceptive use occurring, α is a constant term, βi represents the effects parameters of the explanatory variables, and *Xi* represents the explanatory variables in the model. Although using the person-month of exposure to risk as the unit of analysis substantially increases the sample size, Petersen (1991) and Allison (1982, 1995) have shown that using the discrete-time methods does not deflate the standard errors, and thus provides an appropriate test of statistical significance. Furthermore, because the probability of using a contraceptive method is so small within each month, the estimates obtained using discrete-time methods are very similar to those that would be obtained using continuous methods. In addition, again because the probability of using contraceptive methods is so small within each month, the *hazard* of contraceptive use is very similar to the *rate* of contraceptive use.[3]

The interpretation of the estimates of effect parameters in terms of log odds is not entirely intuitive. In order to make the interpretation of the results more intuitive, we present coefficients as odds ratios, which are antilogs of the raw coefficients. These odds ratios can then be interpreted as the amount by which the odds are multiplied for each unit change in the respective independent variable. This means, if the coefficient is greater than 1, the effect is positive and every unit change in the independent variable increases the odds of contraceptive use. If the coefficient is less than 1, then every unit change in the independent variable decreases the rate of contraceptive use. Moreover by subtracting 1 from the odds ratio and multiplying by 100 these ratios can be easily transformed into a percent change in the odds associated with each unit change in the respective independent variable.

In our multivariate analysis, we estimate models for each of the three environmental perceptions separately controlling for respondents' family background, personal characteristics, and prior experiences, including number of children and prior temporary contraceptive use. Then, in a final model we include all three environmental perceptions in order to estimate the independent effects of each of these environmental perceptions. Below, we present the results of our analyses.

RESULTS

We present the findings of our analyses moving from very simple to complex analyses. In order to answer whether an individual's perception about his or her immediate environment is related to his or her fertility behavior, such as contraceptive use, first, we look at frequency of contraceptive use. Next, using environmental perception as a predictor, we model the risk of using contraceptives.

Figure 1 shows the relationship between environmental perception and contraceptive use in terms of proportion of people who ever used contraceptives. This figure shows that 30% of those who think ''Compared to 3 years ago, the crop production has decreased now'' have ever used contraceptive methods. Twenty percent of those, who think crop production has neither increased nor decreased have ever used any contraceptive methods. Finally, only 14% of those who think that the crop production has increased have ever used any contraceptive methods.

Likewise, the effect of perception about the ground water table also shows a similar pattern to the effect of perception about agricultural productivity. Of those who think that compared to 3 years ago the ground water table has decreased 23% have ever used any contraceptive methods. Of those who think the ground table is about the same as 3 years ago, an equal percentage, 23%, have ever used any contraceptive methods. But, in contrast to

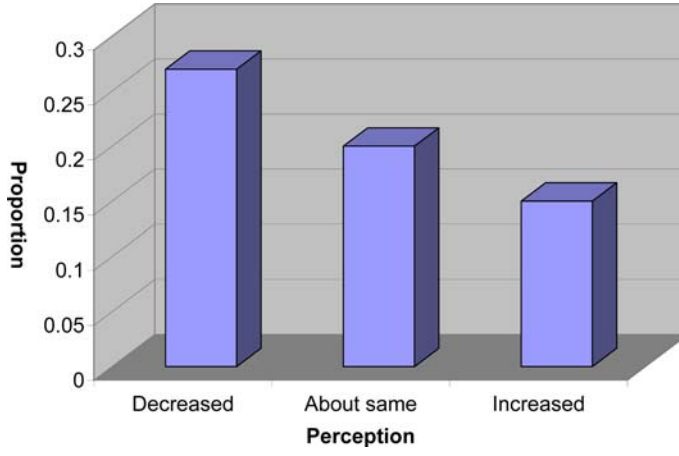

FIGURE 1. Proportion of people whoever used contraceptives and their perception about agricultural productivity.

both who think the ground water table has decreased or is about the same as 3 years ago, of those who think the ground water table has actually increased, only 15% have ever used any contraceptive methods. This shows an 8% difference in contraceptive use between those who think their environment is deteriorating or about the same, and those who think it is actually improving.

Unlike the effect of the perception of both agricultural productivity and the ground water table, however, we find an opposite relationship between perception of water quality and contraceptive use. Twenty percent of those who think their drinking water quality is worse now than 3 years ago have ever used any contraceptive methods, whereas of those who either think the quality of their drinking water is about the same or actually improved, 23% have ever used any contraceptive methods. However, because the difference is so small, it is difficult to know whether it is meaningful or not.

Although these findings are striking, because the measures of contraceptive use include contraceptive use both before and after we measured individuals' environmental perceptions, we cannot draw any conclusion about causality between perceived environmental deterioration and contraceptive use simply from these findings. Indeed, we have not yet examined whether there is even a statistically significant association between environmental perceptions and contraceptive use. Next we present the results of our multivariate analyses to determine whether the relationship between perceived environmental deterioration and contraceptive use is independent of the respondent's personal characteristics and life experiences. Although not demonstrating by itself causality, we wished to eliminate as many alternative explanations of contraceptive use as possible to determine whether an independent effect from environmental perceptions is evident.

In Table 2, we present estimates of the effects of environmental perceptions on the rate of contraceptive use. As we mentioned above, we transformed the logistic regression coefficients into odds ratios. Because the frequency of events in any single time interval (month) is quite small, the odds of using contraceptives are very similar to the rate of contraceptive use. Therefore, we discuss our results in terms of rates rather than odds.

In Model 1 of Table 2, we first estimate the effects of control variables, which include the background of respondent's family of origin, current household characteristics, the respondent's personal characteristics and experiences and access to contraceptives. The effects of most control variables are in the expected direction. Respondent's gender has a significant effect on the monthly rate of contraceptive use. The odds ratio of .69 indicates that compared to men, women are 31% less likely to use contraceptives.[4] However, the effect is significant only at a .1 significance level.

TABLE 2

Discrete-Time Hazard Models Estimates of the Effects of Environmental Perception on the Hazard of Contraceptive Use

	Dependent variable: monthly odds of contraceptive use				
	I	II	III	VI	VII
Independent variables					
Agriculture productivity		1.72*** (2.39)			1.74*** (2.45)
Ground water table			1.00 (.00)		1. 00 (.02)
Water quality				.91 (.42)	.84 (.67)
Control variables					
Respondent's characteristics					
Gender (Male omitted group)					
Female	.69* (1. 33)	.73 (1.11)	.69* (1.31)	. 69* (1.32)	.74 (1.09)
Age	.91*** (4.05)	.92*** (3.92)	.91*** (4.03)	.92** (3.97)	.92** (3.80)
Ethnicity: (Hindu high caste omitted group)					
Hindu lower caste	.62 (1.20)	.65 (1.08)	.62 (1.20)	.62 (1.21)	.65 (1.08)
Newar	1.14 (.21)	1.21 (.30)	1.14 (.21)	1.15 (.22)	1.25 (.35)
Hill Tibeto-Burman	1.27 (.88)	1.28 (.85)	1.27 (.88)	1.27 (.88)	1.28 (.90)
Tarai Tibeto-Burman	.66 (1.23)	.74 (.87)	.67 (1.22)	.66 (1.24)	.75 (.85)
Respondents' personal experiences					
Education	1.08*** (3.27)	1.09*** (3.67)	1.08*** (3.27)	1.08*** (3.26)	1.09*** (3.69)
Number of children	1.19** (2.27)	1.17** (2.00)	1.19** (2.28)	1.19** (2.23)	1.16** (1.90)
Work for pay	.99 (.02)	.99 (.04)	.99 (.20)	.98 (.07)	.97 (.14)
Previous contraceptive use	2.85*** (4.70)	2.91*** (4.80)	2.85*** (4.70)	2.87*** (4.73)	2.96*** (4.86)

Family background					
Mother's number of children	1.04 (1.05)	1.04 (.90)	1.04 (1.05)	1.04 (1.09)	1.04 (.97)
Parents' education	.49 (2.64)	.49 (2.67)	.59 (2.63)	.50 (2.59)	.50 (2.58)
Household size	1.02 (.42)	1.03 (.88)	1.03 (.64)	1.02 (.46)	1.04 (.71)
Farm size	1.02 (.09)	.97 (.14)	.98 (.11)	1.01 (.07)	.96 (.20)
Household equipment	.70 (2.09)	.72 (1.88)	.65 (2.51)	.695 (2.12)	.71 (1.93)
Access to contraceptives					
Distance to health service	.99 (.24)	.99 (.25)	.99 (.26)	.99 (.27)	.99 (.24)
Time	.95*** (4.56)	.95*** (4.38)	.95*** (4.56)	.95*** (4.55)	.95*** (4.35)
Time squared	1.01*** (5.65)	1.06*** (5.67)	1.01*** (5.67)	1.01*** (5.68)	1.01*** (5.67)
Person-months	11871	11871	11871	11871	11871
Chi-square	133.72	139.67	133.72	133.90	140.21
(df)	18	19	19	19	21

Note: *$p<.10$, **$p<.05$, *** $p<.01$; all probabilities are one-tailed. Odds ratios are reported with *t* statistics in the parentheses. All models were estimated using multivariate ordered logistic regression.

The effects of the respondent's age are in the predicted direction. Compared to older people, younger people are more likely to use contraceptives. Each one-year increase in the respondent's age decreases the monthly rate of contraceptive use by 9%. This difference is statistically significant at the .01 level. This finding is also consistent with the findings of other studies in Nepal (Axinn & Barber, 2001; Axinn & Yabiku, 2001). The respondent's ethnicity has no significant effect on the rates of contraceptive use; i.e., none of the ethnic groups differ from Hindu high caste, the reference group.

Respondents' educational experiences have a positive significant effect on the rate of contraceptive use, as expected. The positive effect of education on the rate of contraceptive use suggests that more educated people are likely to use contraceptives at higher rates. This finding is consistent with many other studies of fertility in Nepal and elsewhere (Axinn, 1992; Axinn & Barber, 2001; Axinn & Yabiku, 2001). The respondent's number of children also has a significant positive effect on the rate of contraceptive use. This suggests that people who have more children are likely to use contraceptives at higher rates than those who have fewer children. Similarly, the respondent's previous contraceptive experiences have a strong positive effect on the monthly rates of contraceptive use. These effects are statistically significant at the .01 level. However, the effects of work for pay outside of the home are not significant.

In order to control for the parental influence on their children's fertility behavior, we added the mother's number of children, and parent's education in our model. The results of our analyses show that the respondent's mother's number of children has no significant effect on the respondent's contraceptive use. However, we find a negative effect of parents' education on respondents' contraceptive use, contrary to our expectation. These findings are not consistent with the findings of previous studies. This could be because education in the parental generation was very much limited to religious teaching; therefore, the educated parents of this sample may hold negative attitudes toward contraceptive use, which makes their children less likely to use contraceptives.

Among the current household level variables, household size, although having a positive effect on contraceptive use as expected, is not statistically significant. Contrary to expectations, number of household possessions has a negative effect on the respondent's contraceptive use. Similar to the effect of parent's education, this result is not consistent with the findings of previous studies. This could be because the possession of household equipment is highly associated with social and religious prestige, which may discourage the respondent from using contraceptives.

Finally, in terms of impact of access to contraceptive methods we find no statistically significant effect of distance to the nearest health service providing contraceptive methods. This may be because of easy accessibility of contraceptives across the valley.

Next, treating all variables in Model 1 as controls, we added the three independent variables: perceptions concerning agricultural productivity, ground water table, and water quality in our model. First, we added these variables, one at a time and all together. Each environmental perception measure indicates whether the respondent thinks his or her immediate environment is worse now than 3 years ago, or about the same or better.

In Model 2 in Table 2 we present the effects of perception about agricultural productivity on rates of contraceptive use. Perceiving things to be worse has a positive effect on the rate of contraceptive use. The odds ratio of 1.72 means those who think agricultural productivity has decreased used contraceptives at rates 72% higher than those who think agricultural productivity has remained the same or increased in the past 3 years. This effect is statistically significant at the .01 level for a one-tailed test. This result supports our hypothesis that people who perceive that their agricultural productivity has decreased, compared to 3 years before, are significantly more likely to use contraceptives. Those who think their environment is deteriorating use contraceptives at higher rates than those who think the environment is improving or is about the same. Particularly noteworthy about this finding is that the effect of the perception about environmental degradation is much stronger on contraceptive use than several other variables considered as prime predictors of contraceptive use, such as schooling, work for pay, and number of children.

In Model 3 in Table 2 we present the effects of the perception about the groundwater level on the rate of contraceptive use. We find that the respondent's perception about the groundwater table has no significant effect on the rate of contraceptive use. Next, in Model 4 in Table 2, we present the effects of perceptions about drinking water quality. The effects of perceptions about drinking water quality also are not statistically significant. This may be because, compared to agricultural productivity, the quality of water may be hard to judge as to whether it is getting better or worse.

Finally, in Model 5 of Table 2, in order to estimate the independent effects of each of the independent variables, we added all three variables together. We find almost no change in the effects of any of these variables, except a slight increase in the coefficient of perception about agricultural productivity. Thus, the findings of our analyses suggest that the people who perceive that the productivity of their land is getting worse are likely to use contraceptives at higher rates than those who think that land productivity is

getting better, or is about the same as it was in the past. Furthermore, this relationship is independent of respondents' characteristics and experiences and family background, including such important factors as age, education, and farm size.

CONCLUSION

In this paper, we began by reorienting our focus on the relationship between population and environment. Unlike most previous studies that have focused on population growth as the cause of environmental degradation, this study examines the relationship between environmental perceptions and fertility behavior in an agriculture-based society. We examine the influence of the three most critical environmental issues in this study setting: agricultural productivity, the groundwater table, and drinking water quality. The results of our analyses generally support our hypotheses. Individuals who think that agricultural productivity has decreased, compared to 3 years before, are likely to use contraceptives at significantly higher rates than those who think that agricultural productivity has increased or is about the same. This is even after controlling for many influences thought to affect contraceptive use, including age, education, gender, farm size, and previous contraceptive use.

Although the effects of the groundwater table and drinking water quality on rates of contraceptive use are not statistically significant, the effects of perception about agricultural productivity can be taken as an indication of how the depletion of natural resources may have effects on individuals' contraceptive use. Even though we did not find evidence of the effects of perception about the ground water table and drinking water quality, perhaps the non-significant findings of these variables may be due to the fact that the changes in the ground water table and water quality may not be as noticeable or serious as changes in agricultural productivity. Perceptions of changes over a longer period may produce a more statistically significant difference.

The evidence from this study provides a new focus on the connection between population and environment that has been largely unexplored. As we argued in our theoretical framework, the findings of our analyses suggest that people who are concerned with the deteriorating environment do make certain adjustments in their life style and behavior depending on the specific social, economic, and political context in which they live. As revealed from the review of previous research findings, it is clear that based on the context in which they are situated people have different strategies for addressing the

problem. The adjustments people make in their tastes, preferences and ultimately in their behavior have profound implications for the delicate relationship human beings have with their environment. Here we have shown that it is not always necessary that population growth be a cause and environmental deterioration an effect of population growth. Instead, rapidly increasing concerns about the environment (as seen in polls) may actually influence individuals' fertility behavior—contraceptive use. Our finding is consistent with most recent findings that suggest that environmental scarcity, rather than inducing higher demand for children as suggested by demand theory, acts as a check on population growth (Loughran & Pritchett, 1997).

Some of the reasons for this weak relationship may be attributable to our methodological limitations. As most other studies, this study also inherits some of the common weaknesses and, therefore, the findings should be interpreted with caution specific to the study context and limitations which come with it. First, the environmental perceptions are measured by only three items at only a single point in time. Although agricultural productivity, the ground water table, and drinking water quality are the most relevant environmental issues to our study context they may not actually fully capture the respondents' perceptions about their immediate environmental condition. For example, we could have measured perceptions about the depletion of the natural forest, public grazing land for animals, and the availability and quality of irrigation water. Second, environmental degradation does not occur overnight, and indeed, it takes a long time to show noticeable impact of the degradation on humans. The comparison between now and 3 years previous may be too short to notice changes in agriculture productivity, the ground water table, and drinking water quality. However, allowing too much time to pass may also result in the respondent's perceptions suffering from recall biases. Better timing for comparison may modify our results. Finally, our analyses are based on cross sectional data collected at one point in time, and therefore, are subject to period effects too.

Therefore, the evidence from our study should be interpreted with caution and should not be taken as an answer to the question. Rather, it should be treated as a first step toward understanding the link between environmental concern and a previously unexplored response: contraceptive use. Although previous studies examining the link between environmental concern and environmental consumerism, activism and willingness to pay have provided valuable insights, we are unaware of any prior examination of the link between people's concerns about environmental degradation and their desire to limit family size. We believe this is an especially relevant linkage to explore in poor developing countries where

questions about willingness to pay and consumerism may make less sense than in more affluent countries. We believe that this is also an important subject given worldwide concern about the impact of population growth on the health of the planet generally. We also believe that future efforts to examine this relationship should explore multi-item based measurement and panel data in multiple countries and settings. Finally, supplementing the quantitative survey data with in-depth qualitative information may even better ratify the relationship we have found in our analyses.

APPENDIX

To model the effects of environmental perception on contraceptive use we use event history analyses. Event history analysis methods are best known for studying the causes of events (Allison, 1994). Beginning with Life Tables, event history analyses are known by different methods: Kaplan–Meier estimators, exponential regression models, log-normal regression, proportional hazards regression, competing risk models, and discrete-time methods, to name only a few. Although different methods are designed for slightly different purpose they are based on same concept—propensity of occurring an event. There are three basic mathematical functions of Event History Analysis: survivor function, hazard rate, and probability distribution function.

The survivor function is formulated as follows:

$$\hat{S}(t_i) = \prod_{j=1}^{i} (1 - q_j) \tag{1}$$

where $\hat{S}(t_i)$=estimated survivorship function at time t_i and q_j=conditional probability of event.

This function is computed by multiplying one minus the conditional probability of the event, $(1-q_i)$, for each period. The survival probability of the event is the product of the survival probability for each preceding period and the probability of survival for the current period.

The hazard rate is a ratio formed by the number of events under examination (here, contraceptive use) to the effective sample size, the conditional probability of the event. This probability of the ''event'' is the probability of the event under study conditional upon the event of interest not occurring prior to the current period. The hazard function can also be

calculated. The failure rate at the beginning of the interval is also called the conditional rate of failure. If this conditional rate, referred to in Equation (1) as $q(t)$, is known, then the survival rate can be computed. The survival rate is the complement of the failure rate, sometimes referred to as the cumulative distribution function. The survival probability is equal to $1-q(t)$. This is the proportion of events that have taken place before the end of the period. From the conditional probability of failure, the failure rate can be calculated. When this conditional probability of failure is multiplied by the survival rate of the previous period, the amount added to the failure rate is obtained to compute the failure rate of the next time period. This cumulative event function is the probability density function. *The probability distribution function (p.d.f.)* defines the probability that an event takes place within a time period, even though the interval is small.

To model the hazard of contraceptive use we use discrete-time hazard models. Discrete-time is particularly ideal when the events are recorded precisely to a time interval (month, here) using time-varying covariates. For details about the discrete-time hazard models see Barber, Murphy, Axinn, and Maples (2000) and Allison (1982, 1995).

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ENDNOTES

1. In addition, because our study setting is relatively a small valley with an area of 92 square miles, macro-level economic shocks such as changes in wage, increase in commodity price or market price inflation should have fairly uniform effects across the valley. However, we do not mean to say that changes in wage and commodity price are not important. We want to highlight the fact that in a small area such as ours, macro level economic changes should affect every one in the valley in a fairly similar way. Second, our study setting is still a very rural and predominantly subsistence agricultural society with very low levels of wage employment outside the household. Although there has been gradual increase in employment opportunity in the valley the level of employment continues to be low. Finally, child labor is still quite common in most parts of the country and children do help their parents in household chores. Because schooling in Chitwan has

been almost universal in this valley for more than a decade (Beutel & Axinn, 2002) return to child labor in general and child wage in particular, may have little relevance for fertility decisions in this setting.

2. Measures of perception about agricultural productivity raises a question about how we can be sure that perceived decline in agricultural productivity is attributed by the respondents to environmental degradation and not to other reasons such as economic factors. So in order to understand the perceived causes of decline in agricultural productivity, those respondents who responded to the previous question with ''decreased'' were asked a followup question: ''What, in your opinion, are the reasons for this decrease in production?'' They were allowed to choose multiple responses from 10 different options including ''other'' for reasons not included in the list. Indeed, out of 577 respondents, 351 responses were ''inadequate manure'', 318 responses were ''inadequate irrigation'', 179 responses were ''bad weather'', 69 ''pest and diseases'', 68 were ''poor management'', 61 were ''poor soil quality'', and 131 were ''other''. The 131 respondents who indicated ''other'' were asked to specify the reasons. Only 10 respondents mentioned ''shortage of labor during the agricultural season'' as a reason for the decrease in productivity. These responses make it reasonable to assume that perception of decreased agricultural productivity is a proxy for perception of environmental degradation.
3. For instance, assume that there were 1000 women at risk of first birth, and 23 of them had a first birth in a given year. The probability, p, of first birth in that year, is 23/1000 or .023. The odds of first birth in that year are .023/(1−.023)=.0235. The rate for the same year, with the assumption that births are evenly distributed throughout the year, is 23/(1000−11.5)=.0232. These values are very similar but not exactly the same; the rate is slightly smaller than the odds. The size of this difference depends on the number of events in a time interval and the size of the risk set. As the size of the risk set becomes larger and the number of events occurring in a time interval gets smaller, the odds converge on the rates. In our models of first birth timing, the number of first births occurring in each year is small relative to the number of individuals at risk; thus the odds are similar to the rates.
4. Indeed, in order to test whether or not the women who think their agricultural productivity has decreased in the last 3 years use contraceptives at rates significantly different than their male counterparts, we test for the interaction term between women and perception of agricultural productivity. However, we find no statistically significant effect of the interaction term on the rate of contraceptive use.

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