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Abstract

What the current generation does today affects the future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without fully considering future generations' needs, which we call "intergenerational sustainability dilemma (ISD)," and it is a cause of many important problems such as climate change. Although deliberative democracy is demonstrated to be effective for some class of social problems such as prisoner's dilemma (PD), little is known about whether and how deliberative democracy is effective to solve ISD. Given this state of affairs, we examine (1) the factors to characterize the preferences and behaviors and (2) whether deliberative democracy resolves the problem in ISD through conducting an intergenerational sustainability dilemma game (ISDG) in two types of Nepalese fields (urban and rural areas). In ISDG, a sequence of six generations each of which consists of three people is organized, and each generation can either maintain intergenerational sustainability (sustainable option) or maximize its own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option) under deliberative democratic settings. Our results show that the probability of choosing sustainable options increases with a number of prosocial members per generation, implying that generations in rural areas choose sustainable options more frequently than those in urban areas. Second, deliberative democracy does not induce individual opinion changes and generation decisions in favor of intergenerational sustainability. Overall, our findings demonstrate that some new mechanisms in place of deliberative democracy may be necessary to enhance intergenerational sustainability unless societies would have more prosocial people or cultural changes in the future.

Key Words: Intergenerational sustainability; deliberative democracy; prosociality

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Contents

Nomenclature

IFG Imaginary future generation

ISDG Intergenerational sustainability dilemma game

NPR Napalese rupee

SVO Social value orientation

VDC Village development committee

1 Introduction

What the current generation does today affects the future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without fully considering future generations' needs, which we call "intergenerational sustainability dilemma (ISD)," and it is claimed to be a cause of many important problems (Kamijo et al., 2017, Shahrier et al., 2017). For instance, many serious intergenerational problems have occurred, such as climate change, resource depletion, biodiversity loss and long-term governmental debts. Capitalism and democracy are two social

institutions that have been widely spread and established in many parts of the world. Competition under capitalism have enabled economies to grow and achieve higher efficiency, while democracy favors individual freedom of preferences and speech in current generations. However, neither capitalism nor democracy is known to be future-oriented in nature, and it is pointed out that these institutions favor the current generation to maximize her benefits (Pigou, 1952, Krutilla, 1967, Garri, 2010, Thompson, 2010). In particular, the human oddities such as "optimistic bias" allow people not to sufficiently consider or imagine the pessimistic future events (Andrew and Malhotra, 2008, Sharot, 2011, Mitra and Sapolsky, 2012, Jacobs and Matthews, 2012), and these are considered the main reasons for ISD problems leading to various ecological and social challenges. This paper addresses the ISD problem under democratic settings by conducting filed experiments.[1]

Over the last decade, several studies have used an experimental approach to examine people's preferences and behaviors over intergenerational sustainability. Fisher et al. (2004) show that people become less motivated for exploitation of resources by the existence of "intergenerational link" in an intergenerational common pool experiment. Hauser et al. (2014) demonstrate that democracy or majority voting tends to promote sustainability of intergenerational goods when a majority of people are prosocial. Kamijo et al. (2017) design and implement a laboratory experiment of the intergenerational sustainability dilemma game (ISDG) by introducing the treatment of negotiators for future generation, claiming that the negotiators could improve intergenerational sustainability. Sherstyuk et al. (2016) analyze the level of difficulties in maintaining dynamic externality by implementing laboratory experiments of a dynamic game under two types of settings: (i) infinitely-lived decision makers and (ii) multiple generations. They find that strategic uncertainty makes it difficult to retain dynamic externality, and thus advice and history from the previous generation may help to improve dynamic efficiency in an intergenerational setting.

Many political scientists and psychologists have studied deliberation to understand processes of collective decisions making (Rawls, 1993, Chambers, 2003, Niemeyer and Dryzek, 2007). Several experimental studies have analyzed the role of deliberation in relation to equity and sociodemographic backgrounds, such as Simon and Sulkin (2002), in collective decision making. They conclude that deliberative discussion can bring about fair and equitable outcomes for group members. Goeree and Yariv

[1]Deliberative democracy or discursive democracy is a form of democracy in which deliberation is central to collective decision-making (Joseph, 1994).

(2011) also conduct deliberation experiments under different institutions of majority and unanimity, reporting that deliberation promotes fair outcome across the institutions. Ban et al. (2012) use field data in south India, suggesting that, even in heterogeneous societies, deliberation is important in that it can induce long-term agreement on the prioritization of public goods. List et al. (2013) use deliberative data to confirm that deliberation can support to resolve the salient issues. Overall, theories and empirical studies conclude that deliberation is effective in many collective decision environments, but none of them have focused on intergenerational sustainability.

Irrespective of types of governance, institutions and societies, whether people care about the others or future generations depends on the degree of prosociality, trust and fairness that are affected by the cultural and economic environment (Ockenfels and Weimann, 1999, Henrich et al., 2005, Wilson et al., 2009, Henrich et al., 2010, Brosig-Koch et al., 2011, Leibbrandt et al., 2013, Shahrier et al., 2017). Furthermore, as societies become more capitalistic and competitive, the current generation tends to become more proself, compromising sustainability (Fisher et al., 2004, Shahrier et al., 2016, 2017, Timilsina et al., 2017). Although social devices such as communication, discussion or deliberation in collective decision making are demonstrated to resolve some class of not only social but also economic problems such as prisoner's dilemma, public goods provision and common pool resource problems (Cardenas, 2000, Cardenas et al., 2000, Cason et al., 2012, Ghate et al., 2013), little is known about whether and how deliberative democracy is effective to resolve ISD.

We design and institute a series of new procedures for ISDG field experiments to examine whether and how deliberative democracy resolves ISD and influences individuals and generations of people. We organize a sequence of six generations, each of which consists of three subjects, and each generation is asked to decide between maintaining intergenerational sustainability (sustainable option) and maximizing its own generations payoff by irreversibly imposing a cost on future generations (unsustainable option) through deliberative discussion. As a new element of the ISDG experimental design in this paper, we conduct individual interviews to elicit each subject's thought and opinion before and after generation deliberation, enabling us to clarify how each subject supports and changes her opinions over a course of deliberation. To generalize and better characterize human nature in ISD, we conduct ISDG field experiments and questionnaire surveys for sociodemographic and psychological information in one of the least

developed countries, Nepal, in two types of fields: (i) urban and (ii) rural areas.

2 Methods and materials

2.1 Study areas

We conducted experiments in two kinds of Nepalese fields: (i) urban areas such as Kathmandu, Lalitpur, Bhaktapur and Pokhara and (ii) rural areas of several traditional villages from Prabhat and Chitwan districts. Both areas are almost homogeneous in terms of culture, language and religion. The urban areas usually have highest human development index (HDI) on the basis of UNDP (2014) and population density is also high. For instance, Kathmandu has the population density of $4416\,\mathrm{km}^{-2}$ (Central Bureau of Statistics, 2011), and is the most crowded city with $24.3\,\%$ of the total urban population in Nepal. Big cities such as Kathmandu and Pokhara are the centers for businesses and services. The rural areas consist of different villages of the Western Hills and Central Terai such as Prabhat and Chitwan districts (figure 1). The population densities of Chitwan and Prabhat are $261\,\mathrm{km}^{-2}$ and $297\,\mathrm{km}^{-2}$, respectively (Central Bureau of Statistics, 2011). All of these villages are mostly agrarian societies and the dwellers engage in farming generation after generation. A limited number of businesses and services such as small-scale one are available.

[Figure 1 about here.]

2.2 Experimental setup

We conducted an intergenerational sustainability dilemma game (ISDG), an individual interview, a social value orientation (SVO) game and questionnaire surveys for critical thinking disposition and sociodemographic data in the fields.

Intergenerational sustainability dilemma game and deliberation

An ISDG has been implemented, basically following laboratory and field experiments employed in Kamijo et al. (2017) and Shahrier et al. (2017). Building upon these previous ISDG experiments, we

also add a new element of individual interviews in experimental design the details of which shall be discussed later. Three subjects in a group are called a generation and each generation needs to choose between options A and B. The generation receives a payoff of X by choosing option A and the payoff $X - 300$ by choosing option B. After making a choice between A and B, the generation is asked to split the payoff associated with the option they choose among the generation members. Each of the subject's payoffs in ISDG is the sum of their generation share plus the initial experimental endowment of 300. For instance, by choosing A, the generation earns 1200 experimental points ($X = 1200$), while by choosing B, the generation earns 900 points ($= X - 300 = 1200 - 300$). Consequently, if members of this generation split the payoff equally among them, each member earns 400 by choosing A and 300 by choosing B as a generation share. Therefore, the total payoff of each subject with generation choice A becomes 700 ($= 400 + 300$), while it becomes 600 ($= 300 + 300$) with generation choice B. Each generation is allowed to deliberate the decision between A and B, determining how to split the generation payoff up to 10 minutes through discussion. After this process, each member goes through a personal interview where they are naturally induced to reveal their personal thoughts and opinions to support A or B before and after deliberation. This individual interview is a new element compared to the pre-existing ISDG experiments in Kamijo et al. (2017) and Shahrier et al. (2017), clarifying an individual opinion change over a course of deliberation and the role of deliberation that affects individuals and generations.

Each session consists of a sequence of 6 generations. Each generation is randomly assigned to the $1\text{st}, 2\text{nd}, \ldots$ and 6th generations. One generation's decision affects the subsequent generations such that subsequent generations' payoff declines uniformly by 300 when the generation chooses option A, otherwise not. For instance, suppose that $X = 1200$ and the 1st generation chooses A. Then, the 2nd generation will face the game in which they can get 900 and 600 by choosing A and B, respectively. However, if the 1st generation chooses B, the next generation can have the same decision environment as the 1st generation faced. When the 1st generation chooses B, the 2nd generation can have the game in which they can get 1200 and 900 by choosing A and B, respectively. Following the same rule, the game shall continue for the rest of the subsequent generations. Hence, option B can be considered as an intergenerational sustainable option, while option A is the choice that compromises intergenerational sustainability and can be considered as an unsustainable option. In each session, the 1st generation starts

the ISDG game with $X = 1200$, implying that the 5th and 6th generations may face the game in which options A and B are associated with payoffs of zero and -300, respectively.[2] In ISDG, subjects are paid NPR 550 ($\approx$ USD 5.00) at maximum and NPR 350 ($\approx$ USD 3.50) on an average.

Individual interviews

In order to know the effects of deliberation, we seek to find out the patterns of the shift in subjects' individual attitudes and opinions to support A, B or to be ambivalent (to have no ideas) coded as N before and after deliberation. Each subject is asked to answer whether she supported A, B or N and the associated reasons before and after deliberation or over a course of deliberation in the individual interviews. Interviewers are trained to naturally elicit such answers and the corresponding reasons for subjects' attitudes and opinions. The individual interviews successfully identify whether or not each subject changes their individual opinion to support A, B or N through deliberation. For instance, some subject is recognized to have supported A as an individual opinion before deliberation, but to have ended up supporting B after deliberation. In this case, her opinion change is coded as AB where the first letter represents her support for A before deliberation, and the second letter does her support for B after deliberation. In the same way, we identify and code subjects' opinion changes through individual interviews and all the possible combinations of opinion changes are $AA, AB, AN, BA, BB, BN, NA, NB$ and NN. With this information of individual opinion changes before and after deliberation, we can also identify whether or not each generation has had unanimity to decide between A and B before and after deliberation.

Social value orientation (SVO) games

The SVO experiment of the "slider method" has been conducted to identify subjects' social preferences as prosocial or proself in urban and rural areas, following Murphy et al. (2011). Figure 2 shows six items of the slider measure that gives numbers to represent outcomes for oneself and for the other in a pair of two persons where the other is unknown to the subject. Subjects are asked to make a choice

[2] When the 5th and 6th generations face the game in which options A and B are associated with zero or a negative payoff of -300, the generation members can refund themselves equally from their initial endowment of 300 to make the individual payoff to be at least zero.

among the nine options for each item. Each subject chooses her allocation by marking a line at the point that defines her most preferred distribution between oneself and the other. The mean allocation for oneself $\overline{A}_s$ and the mean allocation for the other $\overline{A}_o$ are computed from all six items (see figure 2). Then, 50 is subtracted from $\overline{A}_s$, and $\overline{A}_o$ to shift the base of the resulting angle to the center of the circle $(50, 50)$. The index of a subject's SVO is given by SVO $= \arctan \frac{(\overline{A}_o)-50}{(\overline{A}_s)-50}$. Depending on the values generated from the test, social preferences are categorized as follows: 1. altruist: SVO $> 57.15°$, 2. prosocial: $22.45° <$ SVO $< 57.15°$, 3. individualist: $-12.04° <$ SVO $< 22.45°$ and 4. competitive types: SVO $< -12.04°$.

[Figure 2 about here.]

The SVO framework assumes that people have different motivations and goals for evaluating resource allocations between oneself and others. Also, the SVOs or social preferences are established to be stable for a long time (see, e.g., Van Lange et al., 2007, Brosig-Koch et al., 2011). Responses that are yielded from six primary items give complete categories of social preferences. A major reason for using six primary slider measures developed by Murphy et al. (2011) is due to its simplicity and easy to implement in the Nepalese fields. It is intuitive for subjects to understand even with a limited level of education. As it is done in psychology, we further simplify the four categories of social preferences into two categories of prosocial and proself types; "altruist" and "prosocial" types are categorized as "prosocial" subjects, while "individualistic" and "competitive" types are categorized as "proself" subjects (see Murphy et al., 2011). Subjects are informed that the units represented in this game are points and the more points mean more real money he/she will earn. In this game, the subject receives Nepalese Rupees (NPR) 150 after applying some exchange rate to the points she obtains ($\approx$ USD 1.5) at maximum and NPR 100 ($\approx$ USD 1.0) at the average. To compute the payoff of the subjects from this game, we randomly match a subject with another subject as a pair. The experimental payoff in this SVO game is the summation of points from 6 selections by herself for oneself and 6 selection by the partner for the other. We also explain the ways of random matching and payoff calculation with the exchange rate for the real money incentive to subjects.

Critical thinking disposition

The logical thinking subscale of the critical thinking disposition scale has been adopted in the questionnaire surveys to measure individual abilities of how each subject can critically think about an issue, following Nakagawa (2015). This subscale consists of 13 items, which could be translated into English as follows: (1) "I am good at thinking about complex problems in an orderly fashion," (2) "I am good at collecting my thoughts," (3) "I am confident in thinking about things precisely," (4) "I am good at making persuasive arguments," (5) "I am confused when thinking about complex problems" (reversed item), (6) "I am usually the one to make decisions because my peers believe I can make fair judgments," (7) "I can concentrate on grappling with problems," (8) "I can continue working on a difficult problem that is not straightforward," (9) "I can think about things coherently," (10) "One of my shortcomings is that I am easily distracted" (reversed item), (11) "When I think about a solution, I am unable to think about other alternatives" (reversed item), (12) "I can inquire into things carefully," and (13) "I am constructive in proposing alternatives." Items were rated from 1 (strongly disagree) to 5 (strongly agree). The summation of rates from 1 to 5 over 13 items is the scale of critical thinking disposition, and the theoretical range is 13-65.

2.3 Experimental procedure

We collected subjects through local government offices known as village development committee (VDC) and randomly selected the required number of households in the list of residents for the rural areas (Central Bureau of Statistics, 2011). We invite one member from each household to participate in our experiments. For urban areas, we conducted occupation-based randomization by taking the desired number of subjects from each occupation. The field experiments have been conducted at elementary schools and governmental agricultural community halls in the rural area, whereas the experiments were conducted at district health organization training halls in the urban areas. In total, 12 and 13 sessions in urban and rural areas have been conducted, respectively, and 363 subjects participated in this experiment. On an average, we paid NPR 550 ($\approx$ USD 5.00) to each subject including a fixed show-up fee of NPR 100 ($\approx$ USD 1). Each session took $2 \sim 3$ hours approximately.

The subjects were given experimental instructions in each session by their native language (Nepali)

along with the verbal explanation for the rules of the game to double-check their understanding. Finally, in each generation, three subjects are randomly assigned to one generation within a sequence of six generations in a session. To maintain anonymity across generations, we place the 6 generations in 6 separate rooms by asking each subject to go and sit in a specific room according to their ID. Hence, a subject could communicate only with the members of his/her own generation. Thereafter, we elicit each generation's choice between intergenerational unsustainable option A and sustainable option B in an ascending order from the 1st generation to 6th generation. After generation decisions, each subject was interviewed to reveal their personal attitude and opinions to support A, B or N before and after the deliberation or over a course of the deliberation. Each subject knows which generation they belong to and the payoffs associated with the options of A and B. Therefore, each generation is able to calculate how many times A and B have been chosen by the previous generations. After the ISDG games, we conduct individual interviews, the SVO game and questionnaire surveys to elicit subjects' sociodemographic and psychological information.

3 Results

The summary statistics of socio-demographic and psychological (or cognitive) variables collected through questionnaire surveys are presented in table 1. In rural areas, $44\,\%$ of subjects are male, while, in urban areas, $66\,\%$ of subjects are male. This fact illustrates that a considerable portion of household heads are working away from home in rural areas (Massey et al., 2010). With respect to education, subjects in rural areas only possess 10 years of schooling on an average, while more than $50\,\%$ of the subjects in urban areas have an undergraduate degree with 16 years of schooling. In agricultural sector, $88\,\%$ of the rural subjects are engage in farming and forestry as their main activities, and only $37\,\%$ of urban subjects are related to agriculture. The household income is lower in rural areas than in urban areas, and percentages of a single family structure in rural and urban areas are, respectively, $47\,\%$ and $62\,\%$. An average family size does not vary in both areas. The critical thinking disposition is slightly lower in rural areas than in urban areas. With respect to social value orientation, $62\,\%$ and $47\,\%$ of subjects are prosocial, respectively, in rural and urban areas. Overall, the summary statistics of socio-demographic and psychological variables in table 1 suggest that there are some differences between these two areas.

[Table 1 about here.]

Summary statistics of generation choices for intergenerational unsustainable option A and sustainable option B in ISDG are presented in Table 2. It shows that from a total of $121\,\text{generations}$ (62 and 59 generations are in rural and urban areas, respectively), 90 ($74.38\,\%$) generations choose sustainable option B and 31 ($25.62\,\%$) generations choose unsustainable option A. Furthermore, 52 ($83.87\,\%$) generations choose option B and 10 ($16.13\,\%$) generations choose option A in rural areas. In urban areas, 38 ($64.41\,\%$) generations choose option B and 21 ($35.59\,\%$) generations choose option A. We run a chi-squared test with the null hypothesis that the distributions over generation choices between A and B across the two areas are the same. The result rejects the null hypothesis with a statistical significance of $5\,\%$. In summary, generations in rural areas choose more intergenerational sustainable option B than generations in urban areas.

[Table 2 about here.]

The frequency and percentage of generation choices between A and B with respect to a number of prosocial members in each generation are shown in table 3. In both rural and urban areas, the choices of sustainable option B increase with a number of prosocial members in a generation. Another interesting fact is that a majority of generations choose B in rural areas, when at least one subject in a generation is prosocial. On the other hand, in urban areas, a majority of generations do not necessarily choose B even when one subject in a generation is prosocial. These facts illustrate that, along with prosociality in a generation, there may be other factors such as a area effect to affect generation choices between unsustainable options A and sustainable option B. To this end, we run logistic regression to characterize generation choices with respect to prosociality, areas and other variables, taking generation choice as a dependent variable and other variables at generation level as independent variables.

[Table 3 about here.]

Table 4 presents the marginal effects of an independent variable on the probability for a generation to choose option B, taking generation choice of option A as a base group of the dependent variable in the logistic regression. In model 1, we include area dummy and a number of prosocial members

in each generation as independent variables. To check robustness of the result in model 1, we added sociodemographic and psychological variables such as gender, education, monthly income, single family type, critical thinking disposition and agricultural involvement at generational level in model 2 (See table 4 for the definitions). Model 1 in table 5 shows that the area dummy and a number of prosocial subjects in a generation are economically and statistically significant, showing that generations in rural areas have $14.2\,\%$ higher probability of choosing sustainable option B, compared with the generations in urban areas. Furthermore, an increase in a number of prosocial members per generation leads to $21.5\,\%$ rise in the probability of choosing B relative to the probability of choosing A. These two findings are statistically significant at $5\,\%$ and $1\,\%$ level, respectively.

In model 2 of table 5, gender, education, monthly income, single family type, critical thinking disposition and agricultural involvement as an explanatory variables have no effect on generation choices. At the same time, the area dummy becomes insignificant and a number of prosocial members per generation remains significant. We identify that the area dummy tends to become insignificant as in model 2, when we run regressions by adding more independent variables at generation level. This is because these additional variables such as education and agricultural involvement have high correlation with the area dummy and addition of these variables in the regression partial out the effect of the area dummy. We have also tried several different specifications of the models, consistently finding the same tendency that a number of prosocial members remains significant, but the area dummy becomes insignificant. Overall, the analysis suggests that the sociodemographic and psychological variables that correlate with the area dummy partial out the effect to be insignificant, and also demonstrates that a number of prosocial members per generation is robust enough to be significant irrespective of the regression specifications. It can be concluded that people in rural areas tend to choose more sustainable options than in urban areas mainly due to their prosociality, but it appears that the area-dummy effects may play some roles.

[Table 4 about here.]

[Table 5 about here.]

Table 6 shows the frequency and percentage of individual opinion (attitude) changes to support A, B or to be ambivalent (or to have no ideas) as N before and after deliberation. When there are no

individual opinion (attitude) changes before and after deliberation, such situations are coded as AA, BB or NN where the first (second) letter represents the attitude or opinion to support before (after) deliberation. The other combinations of the two letters represent a situation where a subject changes attitudes or opinion before and after deliberation. For instance, AB describes a situation where the subject initially had an opinion to support A before deliberation, but changed her opinion to support B after deliberation. Subjects who do not change their opinions for sustainable options B account for $78.49\,\%$ and $55.93\,\%$ in rural and urban areas, respectively. For unsustainable option A, they are $9.14\,\%$ and $16.95\,\%$. The result implies that a majority of subjects in rural areas have consistent opinions of BB, while approximately $45\,\%$ of subjects in urban areas followed opinion shifts other than BB. To see the effectiveness of deliberative democracy for intergenerational sustainability, we check whether subjects change their opinions from A (N) to B as AB (NB). $1.08\,\%$ ($2.15\,\%$) and $6.78\,\%$ ($1.13\,\%$) of subjects follow AB (NB) in rural and urban areas, respectively. These percentages are not necessarily high compared with those of other opinion shifts such as BA or BN. For instance, $2.15\,\%$ ($5.38\,\%$) and $6.21\,\%$ ($5.08\,\%$) of subjects followed BA (BN) in rural and urban areas, respectively. Therefore, it appears that deliberation do not induce subjects to support sustainable option B in both rural and urban areas.

[Table 6 about here.]

Past literature has suggested that deliberation leads to collective decisions with unanimity (Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Ruth and Danziger, 2016). With the data of individual opinion changes, we address whether the aforementioned claim is true in ISDG. To this end, we introduce some terminologies to classify various cases of unanimity that can arise in ISDG. When all members in a generation have the same opinion of A, B or N before the deliberation, we called such a situation preunanimity, otherwise, it is called non-preunanimity. Similarly, when all the members have the same opinion of A, B or N in a generation, it is called postunanimity, otherwise, it is called non-postunanimity. With these definitions, all the generations fall into one of the following "unanimity" categories: 1. Non-preunanimity - Postunanimity, 2. Preunanimity - Postunanimity, 3. Preunanimity - Non-postunanimity and 4. Non-preunanimity - Non-postunanimity.

Table 7 shows the number of generations by the unanimity categories. Out of total 121 generations, 75 generations have reached postunanimity ($= 7 + 68$) (See the "subtotal column" and the "Non-preunanimity - Postunanimity" & "Preunanimity - Postunanimity" rows in table 7). Also, a majority of generations that reached postunanimity choose option B, implying that reaching unanimity through deliberation is a key for intergenerational sustainability. However, we can also see that 91 ($= 68 + 23$) generations have had preunanimity (See the "subtotal column" and the "Preunanimity - Postunanimity" & "Preunanimity - Non-postunanimity" rows in table 7), implying that the number of generations that reach unanimity declines from 91 to 75 through deliberation in ISDG. To statistically confirm this result, we run the chi-squared test with the null hypothesis that the distributions of generations over preunanimity and postunanimity are the same. It rejects the null hypothesis with a statistical significance of $5\,\%$, implying that deliberation in ISDG decreases the likelihood of unanimity.

[Table 7 about here.]

Next, we analyze the factors that bring individual opinion changes (attitude) through deliberation. To see the effects of such factors, we run logit regression taking an individual opinion (attitude) change through deliberation as a dependent variable. The dependent variable is a dummy variable that takes 1 when a subject changes her opinion or attitude to support A, B or N before and after deliberation such as AB, AN, BA, BN, NA and NB. Independent variables in the regression contain area dummy, critical thinking disposition, preunanimity, minority dummy with additional sociodemographic factors such as gender, education, monthly income, family size and agricultural involvement. The definitions of all the variables in this logit regression are summarized as "variables at individual level" in table 4. Table 8 presents the marginal effects for models 1 and 2 from logistic regression. In model 1, we do not control for sociodemographic variables. For robustness check, we include sociodemographic variables in model 2.

We find that area dummy, critical thinking disposition, preunanimity, minority dummy are the major factors that cause individual opinion (attitude) changes through the deliberation in models 1 and 2. On the other hand, the sociodemographic variables do not exhibit any explanatory power. We have also tried different specifications of regressions in addition to models 1 and 2, and the qualitatively same results are obtained. The area dummy is statistically significant in that subjects in rural areas are $10.6\,\%$

less likely to change their opinions (attitudes) through the deliberation, compared to subjects in urban areas. This rural area effects are considered very strong because a high portion of subjects ($78.49\,\%$) have consistently chosen sustainable option B (See table 6). It explains that there is a less variation in heritable culture among rural people as they have a similar social learning. The culture and ways of thinking are homogeneous, passing from generations to generations through the social interactions in rural areas (Hooper et al., 2015, Schniter et al., 2015).

[Table 8 about here.]

The results in model 1 of table 8 also show that one unit scale increase in critical thinking disposition would decrease $1\,\%$ probability for a member in a generation to change his/her opinions through deliberation at $1\,\%$ significance level. However, the magnitude of critical thinking on opinion change could be considered rather small. Subjects with higher critical thinking abilities should be able to judge and understand the quality of arguments with a logical validity. Therefore, they are less likely to change their opinion and this result is consistent with previous research (Nakagawa, 2015, Howarth et al., 2016, Bear and Rand, 2016). Furthermore, generations with preunanimity have $10.3\,\%$ lower probability for its members to change their opinions than the generations without preunanimity at the statistical significance level of $5\,\%$. Therefore, whether preunanimity is reached or not is a key for individuals to change their opinions.

Finally, our result shows that a minority individual in a generation have $16.0\,\%$ higher probability to change their opinion, compared with a non-minority individual in a generation at $1\,\%$ statistical significance. We initially expect this result, hoping that the minority individual changes her opinion to the majority opinion for intergenerational sustainability. However, this is identified to be untrue. In fact, when the minority individual in a generation changes her opinion, the direction of the changes does not occur to align with majority opinions, which is confirmed in table 7. Table 7 demonstrates that 7 generations are able to reach postunanimity when there is a minority individual in the generations. On the other hand, 23 generations are not able to reach postunanimity when there is a minority individual in the generations, showing that the deliberation does not necessarily induce a majority winning through an opinion change for the minority individual to be in the majority side (Aldred, 2004, List et al., 2013).

In summary, a series of our results appear to suggest that deliberative democracy does not necessarily help maintaining intergenerational sustainability. First, we have shown that subjects in rural areas choose sustainable option B much more often than those in urban areas. Also, a number of prosocial members per generation is a key for generation choices where a proportion of prosocial subjects is higher in rural areas than in urban areas. To demonstrate how deliberative democracy is effective to maintain intergenerational sustainability, we have interviewed subjects to elicit individual opinion changes during deliberation. Tables 6 to 8 demonstrate that deliberation does not induce individuals and generations to support and to choose sustainable opinion B.

3.1 Discussion

Urban and rural areas function in a different way in terms of their environment, uses of technologies, and social interactions among people. In many cases, the basic city life in Kathmandu and Pokhara does not require people to have human interactions or intimacy even with their colleagues. On the contrary, people in rural areas have close interactions and intimacy with their neighbors due to direct dependency on agriculture-based activities. In summary, rural life in Nepal induces people to interact with neighbors and others on a daily basis, while urban life does not. With these realities, it is our belief that the difference of how people interact with others affects social preferences and behaviors. Therefore, a higher proportion of prosocial people are found in rural areas in comparison to urban areas. Prosocial preferences directly affect people decisions on how to live their everyday life, such as unplugging cell phone, using public transport to work, or installing a solar panel on a roof for energy (Van Lange et al., 2007). At individual level, effects from those activities are minimal, but at aggregate level, they substantial. Our research identifies that prosociality is a key driver to determine not only every day life event but also intergenerational sustainability.

A series of our results demonstrate that deliberative democracy is not effective enough to resolve ISDs. This result appears to be in sharp contrast with past literature (Cardenas, 2000, Cardenas et al., 2000, Neilson and Winter, 2008, Gerardi and Yariv, 2007, Gillet et al., 2009, Cason et al., 2012, Ghate et al., 2013, Ruth and Danziger, 2016). However, there is a clear distinction between ours and the previous works. In ISDG, there is no room for Pareto improvement, because either the current generation

or the future generation needs to bear the cost for intergenerational sustainability, while previous works deal with prisoner's dilemma or public goods game where possibilities of Pareto improvement always exist. We conjecture that deliberative democracy may not be effective to resolve the problems in which there are no possibilities of Pareto improvement such as ISDG and new mechanisms shall be necessary for the solutions.

A novelty of our experimental design lies in conducting individual interviews to identify individual opinion changes over a course of deliberation. The interviews reveal that there is a fundamental difference on how culture and society shape deliberation with varying social norms. In rural areas, approximately $80\,\%$ of subjects consistently support sustainable option B without any opinion change during deliberation, whereas approximately $50\,\%$ of urban subjects do so. In particular, we find that individual opinion changes have occurred more frequently in urban subjects. This is due to the fact that urban subjects have wider varieties of opinions than rural subjects, leading to more conflicts of interests during the deliberation of the generations. As a result, deliberation does not seem to induce individuals and generations to support sustainable option B. Overall, our findings demonstrate that deliberative democracy does not necessarily resolve ISDs, and some new mechanisms or devices shall be necessary for the solutions.

4 Conclusion

This paper has analyzed (1) the factors to characterize the preferences and behaviors and (2) whether deliberative democracy resolves the problem in intergenerational sustainability dilemma (ISD) through conducting an intergenerational sustainability dilemma game (ISDG) in two types of Nepalese fields (urban and rural areas). Our results show that generations are more likely to choose sustainable options when a number of prosocial members per generation increases. Since a considerable percentage of prosocial people are found in rural areas, rural people choose intergenerational sustainable options much more frequently than urban people. More specifically, individual livelihood and cultures seem to be an important aspect that shapes individual norms and values that affect intergenerational sustainability. Our results also demonstrate that deliberative democracy does not induce individual opinion changes and generation decisions in favor of intergenerational sustainability. Over, our research shows

that deliberative democracy does not resolve ISDs. This implies that some new mechanisms in place of deliberative democracy may be necessary to enhance or maintain intergenerational sustainability unless urban societies would have more prosocial people or cultural changes in the future.

We note some limitations of the present study and future research. First, our experiment is instituted under non-overlapping generations to focus only on the problems of ISDs. In reality, however, generations are overlapping in societies. Future research should address ISDs in the situation of overlapping generations. Second, although we find that deliberative democracy does not resolve the problems of ISDs, future research may be able to find another new type of social problems where deliberative democracy cannot resolve. Because many countries are operated under democracy, it is important to know the class of social problems that deliberative democracy does not resolve. Finally, this research does not fully utilize the contents of generations' discussions for analyzing individual opinion changes in deliberation and generation decisions. Future research should be able to characterize dynamic changes of individual and generation opinions through analyzing the detailed contents and conversations in deliberation. To this end, qualitative deliberative analysis shall be usefully applied as is done in psychology and political science. These caveats notwithstanding, we believe that this work is the important first step as an experimental study to demonstrate that deliberative democracy does not resolve ISDs.

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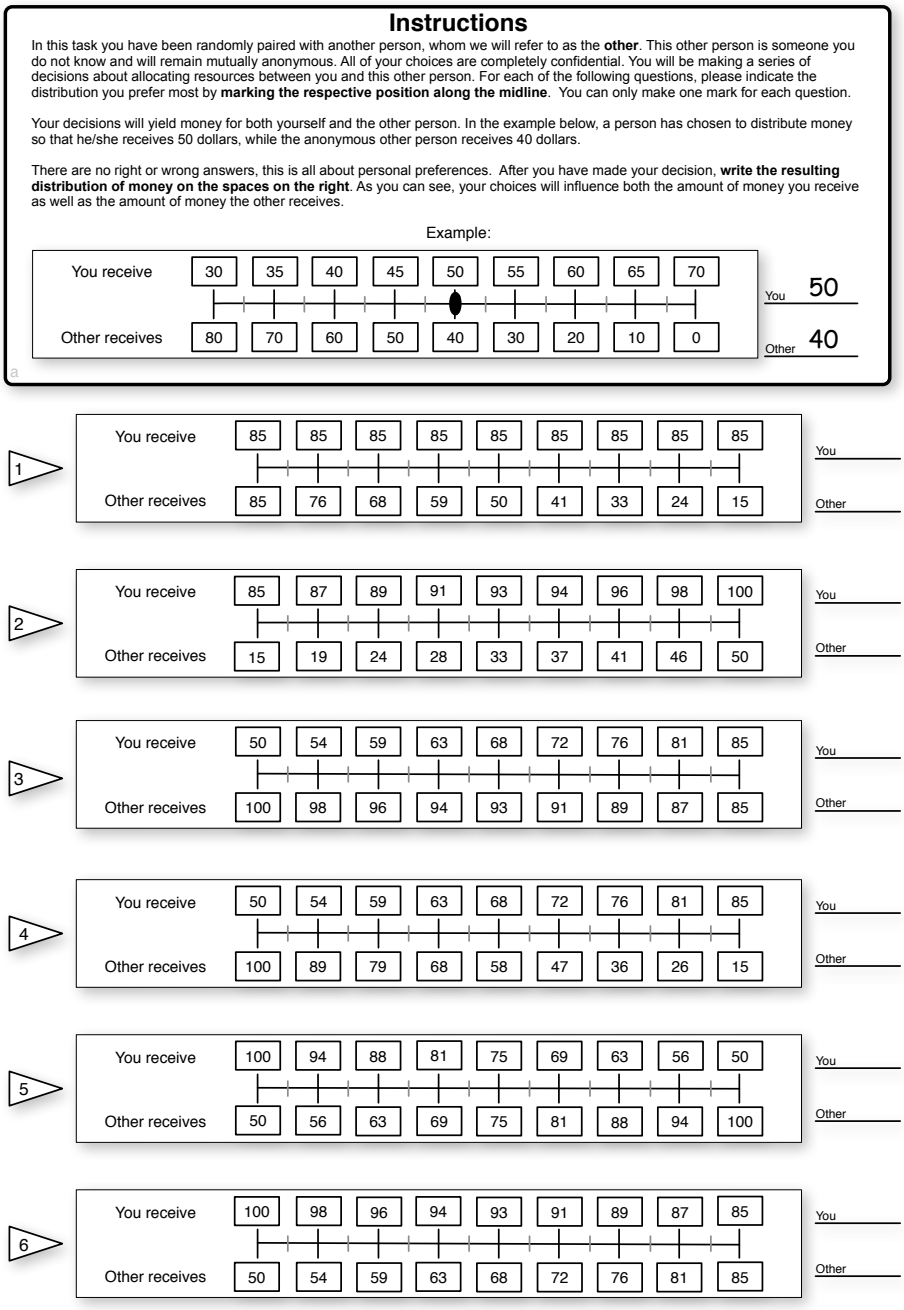
List of Figures

Figure 1: Urban and rural areas in Nepalese fields

Figure 2: Instructions of the "slider method" for measuring social value orientations



List of Tables

Table 1: Summary statistics

Variables	Urban (59 generations, 177 subjects)					Rural (62 generations,186 subjects)				
	Mean	SD[1]	Median	Min	Max	Mean	SD	Median	Min	Max
Age[2]	33.77	11.38	32.50	18.00	56.00	33.27	11.54	30.5	16.00	66.00
Gender[3]	0.66	0.47	0.00	0.00	1.00	0.44	0.50	0.00	0.00	1.00
Education[4]	15.20	3.42	16.00	5.00	18.00	10.18	2.86	10.00	1.00	18.00
Agricultural involvement[5]	0.37	0.50	1.00	0.00	1.00	0.88	0.33	1.00	0.00	1.00
Monthly income (in NPR 10,000)[6]	5.10	8.05	3.40	1.00	90.00	0.31	4.05	1.50	0.50	30.00
Single family[7]	0.62	0.48	1.00	0.00	1.00	0.47	0.51	0.00	0.00	1.00
Family size[8]	3.03	0.94	3.00	1.00	5.00	3.15	1.13	3.00	1.00	5.00
Cognitive & psychological variables										
Critical thinking disposition[9]	48.14	7.12	49.00	23.00	65.00	47.62	6.45	48.00	25.00	65.00
SVO[10]	0.47	0.50	1.00	0.00	1.00	0.62	0.48	1.00	0.00	1.00

[1] The "SD" stands for standard deviation.
[2] Age is a continuous variable given in years.
[3] A dummy variable that takes 1 when the subject is male, otherwise 0.
[4] Education represents years of schooling.
[5] Agricultural involvement is a dummy variable that takes 1 when a subject is stably employed or engage in agriculture sector otherwise 0.
[6] Monthly income is given in Nepalese rupees (NPR).
[7] Single family is a dummy variable that takes value of 1 if it is in a single family structure, otherwise 0.
[8] Family size is the number of family members.
[9] Critical thinking disposition is the summation of rates from 1 to 5 over 13 items, and the theoretical range is 13-65. In each item, a question is posed and a subject is asked to choose among 1 "strongly disagree," 2 "disagree," 3 "neutral," 4 "agree" and 5 "strongly agree."
[10] The "SVO" represents a dummy variable of 1 when a subject is prosocial, otherwise, 0.

Table 2: The frequency and percentage of generation choices of A and B (percentage in parenthesis)

Generation choices between A and B	Area		Total
	Urban	Rural	
A	21 (35.59 %)	10 (16.13 %)	31 (25.62 %)
B	38 (64.41 %)	52 (83.87 %)	90 (74.38 %)
Total	59 (100.00 %)	62 (100.00 %)	121 (100.00 %)

Table 3: The frequency and percentage of generation choices between A and B with respect to a number of prosocial memebrs in each generation

# of prosocial members per generation	Urban		Rural	
	A	B	A	B
0	5 (8.48 %)	3 (5.10 %)	7 (11.29 %)	0 (0.00 %)
1	10 (16.95 %)	10 (16.95 %)	3 (4.84 %)	10 (16.13 %)
2	6 (10.17 %)	23 (40.00 %)	0 (0.00 %)	25 (40.32 %)
3	0 (0.00 %)	2 (3.39 %)	0 (0.00 %)	17 (27.42 %)
Subtotal	21 (35.59 %)	38 (64.41 %)	10 (16.13 %)	52 (83.87 %)
Total	59 (100 %)		62 (100 %)	

Table 4: Definitions of variables included in regressions

Variables	Definition of variables included in regressions
Variables at generation level	
Generation choices between A and B	A dummy variable that takes 1 if the generation choose option B, otherwise 0.
# of prosocial members in a generation	A number of prosocial members in each generation.
Area dummy	A dummy variable that takes 1 if the generation is from the rural area, otherwise 0.
Gender	A variable that represents the number of males in each generation.
Education	A variable that represents average years of schooling over three subjects in each generation.
Monthly income	A variable that represents an average household income of three subjects in each generation.
Single family	A dummy variable that represents a number of members in a generation whose with a single family.
Agricultural involvement	A variable that represents a number of members in a generation who engage in agriculture.
Variables at individual level	
Individual opinion change	A dummy variable that takes 1 when a subject changes her individual attitude or opinion to support A, B or N before and after deliberation or over a course of deliberation.
Critical thinking disposition	A variable that represents the summation of rates from 1 to 5 over 13 items of questions. each subject answers in her questionnaire and the theoretical range is 13-65
Preunanimity	A dummy variable that takes 1 when all members in a generation have same opinion between A or B before deliberation, otherwise 0.
Minority	A dummy variable that takes 1 when the subject have a different opinion from other two members in a generation, otherwise 0.
Gender	A dummy variable that takes 1 when the subject is male, otherwise 0.
Agricultural involvement	A dummy variable that takes 1 when the subject engages. in agriculture sector otherwise 0
Education	A variable that represents the subject's years of schooling.
Single family	A dummy variable that takes 1 if the subject has a single family, otherwise 0.
Monthly income	A variable that represents monthly household income.

Table 5: Marginal effects of logit regression for generation choices between A and B where the dependent variable of generation choices takes 1 when the generation chooses B, otherwise 0 ($N = 121$)

Variables	Model 1	Model 2
Area dummy (Urban areas $= 0$)	0.142^{**}	0.122
	(0.065)	$(.114)$
# of prosocial members in a generation	0.215^{***}	0.225^{***}
	(0.025)	(0.028)
Gender		-0.026
		(0.042)
Education		-0.004
		(0.015)
Monthly income		-0.000
		(0.000)
Single family		-0.003
		(0.039)
Critical thinking disposition		(-0.001)
		(0.008)
Agricultural involvement		-0.028
		(0.036)

***significant at the 1% level, **significant at the 5% level and *significant at the 10% level.
The Wald χ^2 statistic is 41.47 and 43.27 for logit model 1 and model 2, respectively.

Table 6: The frequency and percentage of change in individual opinions for supporting option "A", "B", or "N" ambivalent/no ideas before and after the deliberation (percentage in parenthesis)

Individual opinion change	Areas	
	Urban	Rural
AA	30 (16.95 %)	17 (9.14 %)
AB	12 (6.78 %)	2 (1.08 %)
AN	9 (5.08 %)	2 (1.08 %)
BB	99 (55.93 %)	146 (78.49 %)
BA	11 (6.21 %)	4 (2.15 %)
BN	9 (5.08 %)	10 (5.38 %)
NN	2 (1.13 %)	0 (0.00 %)
NA	3 (1.69 %)	1 (0.54 %)
NB	2 (1.13 %)	4 (2.15 %)
Total	177 (100.00 %)	186 (100.00 %)

Table 7: The number of generations that reach postunanimity after the deliberation

Unanimity	Generation decision		Subtotal
	A	B	
Non-preunanimity - Postunanimity	1	6	7
Preunanimity - Postunanimity	10	58	68
Preunanimity - Non-postunanimity	13	10	23
Non-preunanimity - Non-postunanimity	6	17	23
Subtotal	30	91	121

Table 8: Models 1 and 2: marginal effects of a logit regressions for individual opinion change ($N = 363$)

	Model 1	Model 2
Area dummy (Urban areas = 0)	-0.106^{***}	-0.132^{**}
	(0.039)	(0.055)
Critical thinking disposition	-0.010^{***}	-0.010^{***}
	(0.003)	(0.003)
Preunanimity	-0.103^{**}	-0.096^{**}
	(0.045)	(0.048)
Minority	0.160^{***}	0.140^{**}
	(0.059)	(0.065)
Including other socio-demographic variables in model 2		
Gender (base group = female)		0.038
		(0.043)
Education (years of schooling)		-0.007
		(0.006)
Monthly income		0.000
		(0.000)
Family size		-0.001
		(0.042)
Agricultural involvement		0.003
		(0.049)

***significant at the 1% level, **significant at the 5% level and *significant at the 10% level. The Wald χ^2 statistic is 45.21 and 41.50 for logit model 1 and model 2, respectively, and significant at the 1 percent level.