Collective action for watershed management: field experiments in Colombia and Kenya*

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APPENDIX 1 – Main Ecological and Economic Characteristics of the Watersheds

A.1. Fuquene Lake Watershed[1]

The Fuquene Lake and Coello River watersheds are typical of the socio-environmental situation in the Andes[2]. Fuquene Lake watershed (Fuquene) encompasses the valleys of Ubaté and Chiquinquirá in the states of Cundinamarca and Boyaca, Colombia. Fuquene is located about two hours from the Colombian capital, Bogotá, on a good all-weather road. It covers an area of 187,200 ha including 17 municipalities[3], with a population of 229,000 inhabitants[4], about 59% of which is rural (DANE, 2005). The altitude ranges from 2300-3300 meters above the sea level (masl), with an annual rainfall between 700 and 1500 mm. For the municipalities in the watershed, the 2003 Life Condition Index, a measure of welfare, ranged between "very low" and "high"[5], reflecting the socioeconomic heterogeneity in the zone.

The largest land use in the watershed is pasture (59%), followed by agriculture (26%), forest (4%), *páramo* (2%) and lake (2%)[6]. Land degradation is a serious concern, with 13,000 hectares classified as severely eroded and 40,000 as moderately eroded. The principal economic activities in the watershed are agriculture (cropping and dairy) and mining. The medium and large scale dairy operations, located in the lower part of the watershed along the shores of the lake, are high input and highly productive. Land values in this area are among the highest in the country, and many hacienda owners are wealthy and politically well connected.

* The research for this paper emerged from the project "Sustaining Collective Action that Links Economical and Ecological Scales" (SCALES –PN20) of the CGIAR Challenge Program on Water and Food. The project was led by the Centro Internacional de Agricultura Tropical (CIAT) and the partners involved in the economic games were the Universidad de los Andes, World Wide Fund for Nature (WWF-Colombia), Semillas de Agua, Fundación Humedales, and The World Agroforestry Centre (ICRAF) in Kenya.

[1] For more information see http://www.infoandina.info/andean/index.shtml?apc=Ba1e1-&s=B&e=h

[2] Ramirez, M.C., and H. Cisneros (eds.) (2006), *Andean System of Basins: Watershed Profiles Enhancing Agricultural Water Productivity Through Strategic Research*, Technical Report No. 1, Challenge Program on Water and Food. P.O. Box 2075, Colombo Sri Lanka.

[3] The municipalities that belong to the Fuquene watershed are Carmen de Carupa, Ubate, Tusa, Sutatausa, Cucunubá, Suesca, Villapinzón, Lenguazaque, Gachetá, Fúquene, Susa y Simijaca in Cundinamarca and San Miguel de Sema, Ráquira, Caldas, Chiquinquirá y Saboya in Boyacá.

[4] Rubiano, J., M. Quintero, R. Estrada and A. Moreno (2006) 'Multi-scale analysis for promoting integrated watershed management', *Water International* 31 **3**:398-412

[5] Sarmiento, A., A. Cifuentes, C. González and J. Coronado (eds.) (2006), *Los municipios colombianos hacia los objetivos de desarrollo del milenio: salud, educación y reducción de la pobreza*. Bogotá, DNP, PDH, UNDP y GTZ.

[6] Rubiano et al., Op cit

Crops are grown mainly in the upper and middle parts of the watershed. Land ownership in upper and middle part of the watershed is generally by smallholders, however in the higher areas appropriate for potato cultivation, much of the land is rented out to large-scale producers who better able to take this risks associated with this high-risk-high-reward crop. Despite the fact that it is against environmental regulations, significant cultivation occurs in the *páramos*, which are ecologically fragile and play a key role in maintenance of ecosystem function, especially supply and regulation of water flow[7].

Lake Fuquene[8] is located at the bottom of the watershed, is at the center of environmental controversy. The health of the lake, mainly for biodiversity but increasingly as a provider of environmental services such as tourism and urban water supplies and flood control, is currently driving change in the watershed[9].

The environmental authority for the Fuquene watershed, the *Corporacion Autonoma Regional de Cundinamarca (CAR)*[10] is responsible for developing and implementing the watershed management plan, and there is widespread discontent with their inaction. Local municipal governments have some responsibility for resolving water conflicts and for undertaking conservation activities. While some are more active than others, they are limited in what they can achieve given their purely local scope. There are few NGOs or civil society organizations working in Fuquene. Local universities and international organizations have a research presence, but until very recently, little had been done in terms of mobilizing communities to address issues at the watershed level, politically[11].

A.2. Coello River Watershed

The Coello River watershed, located the state of Tolima in the central Andean Cordillera covers an area of 190,000 ha ranging from 280 to 5300 masl. Annual rainfall ranges from below 1000 mm to more than 3970 mm. The watershed includes ecosystems ranging from dry forest to *páramo* to snow-capped peaks, and is home to national parks and private reserves. The watershed contains some or all of eight municipalities[12] with a population of 622,395 in 2005, including the city of Ibagué (pop. 425,770). Counting this city, only 16% of the population is rural and even without Ibague urbanization rates are above 50%. The Life Condition Index for municipalities in the Coello watershed range from "medium low" to "medium high," a slightly narrower range than for Fuquene, with urban municipality scoring higher than rural ones[13]. The Pan-American Highway passes through the watershed, generating economic activity but at a cost of soil erosion and air pollution[14].

Main economic activities in Coello include agriculture and livestock. The upper part of the watershed is mainly forested, however land there is increasingly being converted into pastures for livestock, coffee and horticultural crops. In the middle altitude areas, sugar cane and fruit trees are common; this regional accounts for 30% of Colombia's fruit and vegetable production. The lower part of the watershed includes 30,000 ha of large-scale, irrigated rice, cotton, and sorghum as well as beef cattle. Rice demands the largest share of water channeled through the rivers and irrigation systems (500

[7] Rangel, O. (2006), Presentation CORPOCUENCAS International Seminar: Management and Conservation of Andean Ecosystems. Cali, 4-6 December, 2006.
[8] See http://www.livinglakes.org/fuquene/.
[9] Johnson N., J. Garcia, J. Rubiano, M. Quintero, R.D. Estrada, E. Mwagi, A. Morena, A. Peralta, and S. Granados (2009), 'Water and Poverty in Two Colombian Watersheds', *Water Alternatives,* 2 **1**: 34-52.
[10] See http://www.car.gov.co
[11] Candelo, C., L. Cantillo, J. Gonzalez, A.M. Roldan and N. Johnson (2008), 'Empowering Communities to Co-manage Natural Resources: Impacts of the *Conversatorio de Acción Ciudadana'*, paper presented at the Second International Forum on Water and Food, CGIAR Challenge Program on Water and Food (CPWF), Addis Abeba, Ethiopia, 10-14 November 2008.
[12] The municipalities that make up the Coello River watershed are Ibagué, San Luis, Rovira, Cajamarca – Anaime, Espinal, Flandes, Valle del San Juan y Coello.
[13] Sarmiento et al., Op cit
[14] Johnson et al, Op cit

million m^3) followed by fruit (41 million m^3) and coffee (1.5 million m^3)[15]. The environmental authority responsible for the Coello watershed is the *Corporacion Autonoma de Tolima* (*CorTolima*).

Progress on a comprehensive plan has been slow. Water has not traditionally been scarce in Coello, however there is growing awareness that inappropriate land use in the upper watershed combined with growing demand for irrigation, domestic water and hydroelectric power in the lower areas are rapidly leading to a situation that is not sustainable[16]. While in Fúquene the main environmental emphasis was on the lake at the bottom of the watershed, in Coello the process focuses on conserving the upper parts of the watershed. Some NGOs are working to preserve *páramos* and in doing so they are seeking to link with downstream stakeholders who are benefiting or could benefit from the environmental service provided by the *páramos*[17]

A.3. Nyando Basin

The Nyando river basin is located in Western Kenya where it drains into the world's second largest freshwater lake, Lake Victoria. In turn, Lake Victoria is an important component of the Nile river system. While the Nyando is small compared to some of the other basins that make up the Lake Victoria and Nile systems, it has a heavy influence on the ecology of Lake Victoria. Large amounts of sediment and other pollutants are carried along the three main tributaries of the Nyando, contributing disproportionately to the sedimentation and eutrophication of the Lake Victoria ecosystem. The Nyando basin spans from the Mau forest in the upper reaches, through a range of farming systems, to an alluvial plain and wetland where the river enters Lake Victoria. Altitudes vary from about 1100 masl in the flood plain near Lake Victoria to almost 3000 masl in some parts of the Mau forest in the upper-most areas. The basin has three main tributaries, the Awach in the south, the Kapchorean in the middle and the Ainabgetuny in the north. The basin is heavily modified, with large-scale deforestation in the upper basin and wetland conversion in the lower basin[18]

The Nyando basin covers an area of approximately 3,517 square kilometers and had a population of approximately 746,000 people[19]. At that time, the average population density was 212 persons per square kilometer across the basin, with some areas supporting up to 750 persons per square kilometer and other areas with as few as 50 persons per square kilometer. As of 1997 the incidence of poverty, as measured by food purchasing power in Kenya's poverty mapping study, was generally high in the Nyando basin, with an average poverty incidence of 58 percent in Kericho District, 63 percent in Nandi District, and 66 percent in Nyando District, compared to the national average of 53 percent[20]. HIV/AIDS prevalence is 28 percent in Nyando District, seven percent in Nandi District, and 12 percent in Kericho District. The basin is primarily inhabited by two ethnic groups: the Luo who occupy the lowlands and part of the midlands and the Kalenjin who occupy the highlands. Small numbers of a third ethnic group, the Ogiek, occupy parts of the forest margin at the uppermost parts of the basin. Almost all the basin falls in the three administrative districts of Nyando, Nandi and Kericho, with small portions of the basin in other neighboring districts[21]

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[15] Fujisaka, S. (2007), Impacts of the *CPWF/Escalas* in the Rio Coello watershed, CPWF Impact Assessment Project, BPF mimeo

[16] Johnson et al, Op cit

[17] Candelo et al, Op cit.

[18] World Agroforestry Center (2006), 'Improved Land Management in the Lake Victoria Basin: Final Report on the TransVic Project', Occasioal Paper 07, Nairobi, Kenya.

[19] Mungai, D., B. Swallow, J. Mburu, L. Onyango, and A. Njui (eds.) *Proceedings o a Workshop of Reversing Environmental and Agricultural Decline in the Nyando River Basin,* Nairobi, ICRAF, NEMA, the Water Quality Component of the Lake Victoria Environmental Management Programe (LVEMP) and the Ministry of Agricultural and Rural Development.

[20] Central Bureau of Statistics (2003), "*Poverty in Kenya",* Nairobi, Central Bureau of Statistics and International Livestock Research Institute

[21] Swallow, B., L. Onyango and R. Meinzen-Dick (2007) 'Irrigation Management and Poverty Dynamics: Case Study of the Nyando Basin in Western Kenya', in B. van Koppen. M. Giordano and J. Butterworth (eds.)

Kenya's formal water resource management institutions have been radically transformed with the passage and implementation of the Water Act of 2002. Until 2002, the focus of water management was on the provision of water for domestic and productive uses, but the increasing concerns about water scarcity, low coverage of water services and declining water quality led to a new water policy. Under that act, water resource management and water allocation is the responsibility of the Water Resources Management Authority (WRMA), while regulation of water services providers is the responsibility of the Water Services Regulatory Board (WSRB). The Water act 2002 provides for the management of water as a resource within the context of catchments defined by WRMA which formulates strategies for the management, use, development, conservation, protection and control of water resources within each catchment area. Several community groups – committees - have been established over the last 15 years with support from the Ministry of Agriculture, a national authority[22].

APPENDIX 2 – GAMES PROTOCOLS

INSTRUCTIONS FOR VOLUNTARY CONTRIBUTION MECHANISM

Basic instructions:

- The instructors should be absolutely neutral in their verbal and physical expressions. The game does not have correct or incorrect decisions, and the team members should avoid any expressions that might influence players' decisions.
- The phrases in italics should not be read. They are specific instructions for the instructors.
- The instructions must always be read in order to give the same information to all players during all sessions.

FIRST STAGE INSTRUCTIONS (Without communication)

<< When all participants have arrived, the monitor must begin to read the instructions>>

Good morning / evening, we would like to thank you for accepting this invitation. We will spend about three hours, which will include explaining the activity, playing the game and answering a short survey at the end. Let's get started.

The follow exercise is a different and entertaining way to actively participate in a project about individual decisions. Depending on the decisions that you make today, you can win some money. That's why it is important to pay attention to these instructions. The funds to cover these expenses are donated by a scientific organization.

If you have any question, any of us can answer and help you *<<here is important to introduce all the team members>>*

<<It is necessary to ask if there are people who live in the same house, and organized them randomly in groups of 5 people in such a way no people who live together be in the same group>>

Community-based Water Law and Water Resource Management Reform in Development Countries, CAB International 2007.

[22] Ibid.

<< It is important to clear that the game is independent for each group. What happens in one group doesn't affect the other groups>>

Each of you could be asking why we are going to give you money. We use money because it is necessary for this exercise to have you make economic decisions, decisions with consequences for your own pocket, like in real life. The money isn't a payment to your participation and we hope it won't be your only motivation.

It is very important that each person makes his/her decision individually, with no help from the other group members. During the game, the players cannot communicate with their group partners. If you need help, you can ask one of us. We won't reveal your decisions or your earnings to anybody.

This exercise is intended to recreate a situation in which a group or family must make decisions about how to maintain a natural resource shared by the community, for example, contributing to water spring care or trying to reduce watershed contamination. This exercise is different from other exercises in which other persons have already participated in this community. Therefore, comments that you have heard from other people don't necessarily apply to this exercise.

You will play several rounds, and in each round you have to decide how much to contribute to a community project which benefits everybody in the community. For each round you have 25 units to spend and you decide how many of these units to spend on the community project, and how many you keep for yourself. It is important to understand that these units are not real, these are imaginary units, so you won´t have them in your hand, but in your mind. You can think of this as the amount of effort or work you invest in the community project. The level of this effort is between 0 and 25.

Each unit that you obtain in this game is equivalent to ___ (pesos/shilling). For example, if you get 500 units over 20 rounds of the game, you will win ___ (pesos/shillings). This exercise is similar to the way you manage your time in real life: you can distribute your time among activities that benefit only you and your family, and activities that benefit everybody in the community, for example caring for the water springs.

At the end of the round you will have earnings equivalent to the sum of two things:

1) The quantity of units you keep for yourself
2) The quantity of units that you get back from the total of the project. This amount will be calculated in this manner:

   The total quantity of units contributed to the community project for you and the other 4 players that will be doubled and distributed in equal parts among the 5 players of the group. Each of you will receive the same number of units, no matter how many units you contribute.

For example, suppose that the total number of units contributed to the project is 60. If we double this amount we have 120, and we will distribute this amount equally among the 5 players. Each person will receive 24 units from the community project.

The contribution decision is written down on an **ORANGE DECISION CARD** like this <<*The monitor shows and gives the orange decision cards to the players*>>. These cards have a number, please check that all the cards have the same number, this will be your player number from now on.

These cards have a blank space for the round number, which the monitor will be announcing, and a blank space to write down your contribution decision, which goes from 0 to 25. The monitor will collect the ORANGE DECISION CARDS during each round. Then he/she will sum the total units that the group decided to contribute to the community project, and the total amount will be multiplied by 2, and divided among 5. Then the monitor will announce the amount that each player gets from the community project.

Remember decisions are made privately and everybody can decide on how much they invest on the community project.

<<Now, the monitor should give the player calculation sheet to the players>>

Each of you has on your desk a **PLAYER CALCULATION SHEET**, which will be used to save the information about your decisions in each round that can be helpful to make your future decisions. In the fist column (column A), you should write down your contribution decision, the same number that you have written down on the ORANGE DECISION CARD. Remember that you have 25 units of effort that you can send to the community project or keep for yourself. On the second column (B), you should write down the units that you kept. On the third column (C), you should write down the total contribution to the project (the sum of individual contributions). Column D is the number of units to distribute among the players (column C multiplies by 2). Column E is the amount of units that you received from the group project. On the last column (F), you should write down your profits, which are the sum of the units you kept (column B) plus the units you received from the project (column E). Remember that your profits will be changed to pesos/shillings: each unit that you win will be equivalent to ___ (pesos/shilling) and we will give it to you at the end of the game.

Please, write down your player number on the upper part of the paper.

Let's look at an example. Imagine that each of you decides to spend 5 units on the community project, and write this number down on the ORANGE CONTRIBUTION CARD. If each member of the group contributes 5 units, the sum of the contribution of the 5 members will be 25 (5*5=25). If we multiply this by 2, we will have 50 units, that means that each player gets 10 units from the community project. Remember that we have supposed that each player contributed the same amount of units (5), so at the end of the round each player will have 30 units: 20 that was kept and 10 that was received from the common project.

The next round starts with deciding on the contribution to the public good.

It is very important to remember always that the decisions are absolutely individual, which means that the numbers you write down on the game cards are private and you must not show them to the other members of your group.

Are there any questions about this? *<<Monitor pauses to answer questions>>*

Remember that the points you earn depend on your own decisions and will become money at the end of the exercise.
Consent form: This paper is a requirement for universities that conduct activities with participation of people. On this form, we give you information about the confidential management of the information that we collect through these activities. If you agree to participate, you should read and sign this consent form, certifying that you were informed about the study and the management of the information. The information you write down on the form is confidential and only the researches of the study will know it. This form is very important because it is not only a guarantee of confidentiality about the information management, but it is also necessary for giving you the money at the end of the game.

<<The instructor reads the consent form out loud. Then the instructor asks the players to write down their player number at the top of the form, and write their name and identification number, and sign the format >>

To start the first round of the game we will organize the seats and desks in a circle where each of you face outwards. Finally, to get ready to play the game, please let us know if you have difficulties reading or writing numbers and one of the monitors will sit next to you to assist you with these. And keep in mind that from now on, no conversation or statements should be made by during the game

unless you are instructed to. Remember that all the decisions are private and nobody will know other player's decisions.

We will have first a few rounds of practice that will NOT count for the real earnings, just for practicing of the game.

SECOND STAGE INSTRUCTIONS

COMMUNICATION

<< When the first 10 real rounds finish, the instructor lets participants communicate before each round>>

From now on, we are going to start a new game very similar to the past game. The only difference is that you can, if you want, talk for two minutes with your team partners before you make your decisions. You will have the possibility to talk to the other group members before playing, and this communication is completely voluntary. For the first two minutes of each round, you can talk about whatever you want. When the time allowed to speak has finished, you should return to your seat and make your decisions in the same way that you have been doing.

You can talk about whatever you want, about the game and the rules, but you can´t make any promise of payments or units transfer during or at the end of the game. It is just an open conversation. Your decisions will continue to be private and confidential, and can´t be known by the other players.

<< The instructor let the players talk during two minutes. The instructor and the other team members must be careful about no influence the conversation>>

INSTRUCTIONS FOR THE IRRIGATION GAME

Basic instructions:

- The instructors should be absolutely neutral on their verbal and physical expressions. The game does not have correct or incorrect decisions, and the team members should avoid any expressions that might influence players' decisions.
- The phrases in italics should not be read. They are specific instructions for the instructors.
- The instructions must always be read in order to give the same information to all players during all sessions.

FIRST STAGE INSTRUCTIONS

<< When all participants have arrived, the monitor must begin to read the instructions>>

Good morning / evening, we would like to thank you for accepting this invitation. We will spend about three hours, which will include explaining the activity, playing the game and answering a short survey at the end. Let's get started.

The follow exercise is a different and entertaining way to actively participate in a project about individual decisions. Depending on the decisions that you make today, you can win some money. That's why it is important to pay attention to these instructions. The funds to cover these expenses are donated by a scientific organization.

If you have any question, any of us can answer and help you.

<<Here is important to introduce all the team members>>

<<It is necessary to ask if there are people who live in the same house, and organize them randomly in groups of 5 people in such a way no people who live together be in the same group>>

<< It is important to be clear that the game is independent for each group. What happens in one group doesn't affect the other groups>>

Each of you could be asking why we are going to give you money. We use money because it is necessary for this exercise to have you make economic decisions, decisions with consequences for your own pocket, like in real life. The money isn't a payment to your participation and we hope it won't be your only motivation.

It is very important that each person makes his/her decision individually, with no help from the other group members. During the game, the players cannot communicate with their group partners. If you need help, you can ask one of us. We will not reveal your decisions or your earnings to anybody.

In this exercise it is intended to recreate a situation in which a group or family must make decisions about the use of water to irrigate their plots. You have been selected to participate in a five-person group with other people who have agreed to participate. This exercise is different from other exercises in which other persons have participated already in this community. Therefore, comments that you have heard from other people don't necessarily apply to this exercise.

You will play several rounds equivalent, for example, to years or months. Each round consists of two decisions. First, each of you decides how much to contribute to a public fund in order to maintain the water canal. The quantity of water units available for the five players depends on the contribution of the five players. The next decision is for each player to take some quantity of the water units available. Each unit that you obtain in this game is equivalent to ___ (pesos/shillings). For example, if you get 200 units over 20 rounds of the game, you will win ___ (pesos/shillings).

In each round, you have 10 units to spend, and you decide how many of these units to spend in the public water fund, and how many you keep for yourself. It is important to understand that these units are not real, they are imaginary units, so you won´t have they in your hand, but in your mind. You can think of this as the amount of effort you invest in the maintenance of the water canal. The level of this effort is between 0 and 10.

In order to know how much water will be available for the group of the five players, depending on the total contributions, you can see the TABLE OF AVAILABLE WATER QUANTITY *<<The monitor shows TABLE OF AVAILABLE WATER QUANTITY poster>>*

This table contains the information that you need to calculate the resulting quantity of the available water, depending on your contribution and those of the other 4 players. On this table you can see the sum of units invested in the public fund and the water available, resulting from your decision and the decision of the other 4 players. Your decision and the decisions of the other 4 members of your group will be added, and this sum will determine how much water will be available.

For example, say everybody invested 2 units in the maintenance of the water canal, and kept the other 8 units for themselves. The sum of the units contributed to the fund is 10 (2*5=10), which means 0 units of water. As a result everybody ends up with 8 units at the end of that round.

Another example is that everybody invests 5 units in the public fund, the sum of units will be 25 (5*5=25), which means 40 units of available water to allocate among the 5 players.

The contribution decision is written down on an **ORANGE DECISION CARD** like this <<*The monitor shows and gives the orange decision cards to the players*>>. These cards have a number, please check that all the cards have the same number, from now on this will be your player number.

These cards have a blank space for the round number, which the monitor will be announcing, and a blank space to write down your contribution decision, which range from 0 to 10. The monitor will collect the ORANGE DECISION CARDS during each round. Then the monitor will sum the total units that the group decides to contribute to the public fund and she or he will write on the board the current size of the public fund, according to the table of available water.

Remember decisions are made privately and everybody can decide on how much they invest in maintenance of the water canals.

After the first decision is made, the monitor collects the orange cards and announces the amount of water available. The next decision is to take a **quantity of water** from the available water. Everybody has the same amount of land for water their crops. Each of you receives, FOR ALL THE ROUNDS, randomly a card marked with the following characters: A, B, C, D, E. The player who obtains character A will be the first to decide how much water takes to irrigate his or her plot. Next, the player with the character B decides, then the player with the character C, then the player with the character D, and finally the player who has the character E.

This means that characters on the cards define the order in which the plots of each player are situated through the watershed <<*The monitor shows a draw in a poster that represents this situation*>>.

On this graph, the water flows from up to down. The player who has the letter A will be the first person who decides how much water to take and writes down his/her decision on a **YELLOW DECISION CARD** like this << *the monitor shows and gives the yellow decision cards to the players*>>. The monitor will receive the YELLOW DECISION CARD from the first participant and will subtract the collected water from the total available water and write the remaining amount of water on a BLUE piece of paper to show to player B, who has the second option to make a decision. The monitor will go to each player seat to show the available water (blue paper) and to receive the yellow paper with each player`s decision. This process continues until player E has made a decision.

The next round starts again with first deciding on the contribution to the public good, in order to maintain the watershed.

<<*Now, the monitor should give the player calculation sheet to the players*>>

Each of you has on your desk a **PLAYER CALCULATION SHEET**, which will be used to save the information about your decisions on each round that can be helpful to make your future decisions. On the fist column (column A), you should write down your contribution decision, the same number that you have written down on the ORANGE DECISION CARD. Remember that you have 10 units of effort that you can send to the public fund or keep for yourself. On the second column (B), you should write down the units that you kept. On the third column (C), you should write down your extraction decision, the same that you have written on the YELLOW DECISION CARD. This amount can't be larger than the available water, which will be shown to you on the BLUE PAPER by the monitor. Column D is the amount of water available after your decision. On the last column (E), you should write down your profits, which are the sum of the units you kept (column B) plus the units of water you extracted (column C). Remember that your profits will be changed to pesos/shillings: each unit that you win will be equivalent to ___ (pesos/shillings) and we will give it to you at the end of the game.

Please, write down your player number on the upper part of the paper.

<< In order to explain the next example, could be useful to use the poster or players location on the watershed>>

Let's look at an example. Imagine that each of you decides to contribute 7 units to the public fund, and write this number down on the ORANGE CONTRIBUTION CARD. If each member of the group contributes 7 units, the sum of the contribution of the 5 members will be 35 (7*5=35). Now the monitor announced the amount of available water according to the TABLE OF WATER AVAILABILITY QUANTITY, which corresponds to 75 units of water. Then, the player A will make his/her water extraction decision. Imagine he/she decides to extract 15 units of water, he/she must write it down on his/her YELLOW DECISION CARD, and give the paper to the monitor. The monitor will write the remaining quantity of water on the BLUE PAPER (75-15=60), and will give it to the next player, player B.

Then the player B will decide the amount of water to extract. He/she must write this decision on the ORANGE DECISION CARD and give the card to the monitor. Suppose the quantity the player B decides to extract, of the remaining 60 units of water, is 15 units. Then the monitor will write down the remaining water on the BLUE PAPER (60-15=45), and will give it to player C. Player C makes his or her extraction decision, suppose it is 15 units, and writes it down on the YELLOW CARD. Then he/she must give this paper to the monitor, who will calculate and write down the remaining amount of water on the BLUE PAPER (45-15=30) and will give it to player D. Then player D makes its extraction decision, suppose it will be 15 too, and write it down on the YELLOW PAPER. Then he/she gives this paper to the monitor, who will calculate and write down the remaining amount of water on the BLUE PAPER (30-15=15) and will give it to player E. Finally, player E makes his/her extraction decision, suppose it will be 15, so the final remaining water will be zero (0).

The next round starts again with first deciding on the contribution to the public good (water canal maintenance).

It is very important to remember always that the decisions are absolutely individual, which means that the numbers you write down on the game cards are private and you must not show them to the other members of your group.

Are there any questions about this? <<*Monitor pauses to answer questions*>>

Remember that the points you earn depend on your own decisions and will become money at the end of the exercise.

Consent form: This paper is a requirement for universities which conduct activities with participation of people. On this format, we give you information about the confidential management of the information that we collect by these activities. If you accept to participate, you should read and sign this consent form, certifying that you were informed about the study and the management of the information. The information you write down on the format is confidential and only the researchers of the study will see it. This form is very important because it is not only a guarantee of confidentiality about the information management, but it is also necessary to be able to give you the money at the end of the game.

<<The instructor reads the consent form out loud. Then the instructor asks the players to write down their player number at the top of the form, and write their name and identification number, and sign the form >>

To start the first round of the game we will organize the seats and desks in a circle where each of you face outwards. Finally, to get ready to play the game, please let us know if you have difficulties reading or writing numbers and one of the monitors will sit next to you to assist you with these. And keep in mind that from now on, no conversation or statements should be made during the game unless you are instructed to.

We will have first a few rounds of practice that will NOT count for the real earnings, just to practice of the game. For these rounds, the monitor will distribute the letters by his/her own criterion. When we begin the real rounds that are going to count toward your earnings, the letters are going to be distributed randomly.

<<Distribute the letters for the practice rounds>>

Now, we are going to distribute randomly the letters, A to E, for the next rounds. Remember that the letter you get will be your position on the watershed, and will be the same for all the rounds.

<< The instructor could put all the letters inside a dark bag and let players to take letters out>>

Note: *It could be useful remembering the players which card they have to use (orange or yellow) every time. Maybe telling them something like: "Round number 1, please write it down in an orange card. Now please make your contribution decision and write it down too"*

SECOND STAGE INSTRUCTIONS

COMMUNICATION

<< When the first 10 real rounds finish, the instructor will let participants communicate before each round>>

From now on, we are going to start a new game very similar to the last game. The only difference is that you can, if you want, talk for two minutes with your team partners before you make your decisions. You will have the possibility to talk to the other group members before playing, and this communication is completely voluntary. For the first two minutes of each round, you can talk about whatever you want. When the allowed time to speak has finished, you should return to your seat and make your decisions in the same way that you have been doing.

<< The instructor let the players talk for two minutes. The instructor and the other team members must be careful about not to influence the conversation>>

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

HIGH PENALTY

Each of you has a right to one-fifth part of the water of the watershed. This amount is calculated after the available water is announced. The order to extract the water remains the same for all rounds: ABCDE. A dice is thrown in each round. When 6 is thrown, an inspector arrives and will check the water extraction. If the subject has taken more than one-fifth of the total, the subject pays back the extra amount taken, and an extra amount of 6 units.

Are there any questions about this? *<<Monitor pauses to answer questions>>*

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

LOW PENALTY

Each of you has a right to one-fifth part of the water of the irrigation system. This amount is calculated after the available water is announced. The order to extract the water remains the same for all rounds: ABCDE. A dice is thrown in each round. When 6 is thrown, an inspector arrives and will

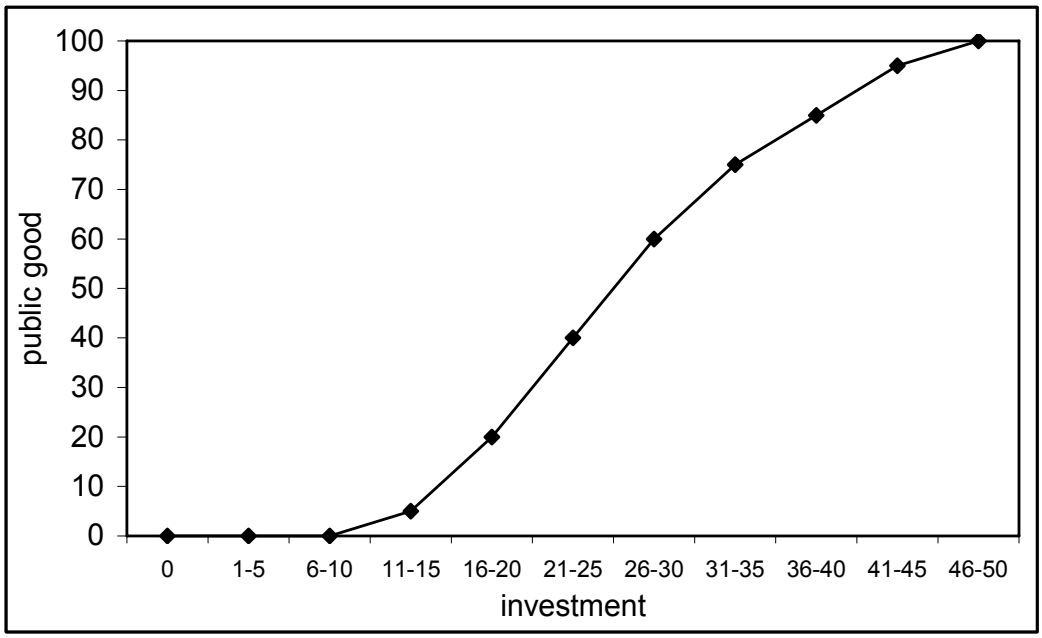
check the water extraction. If the subject has taken more than one-fifth of the total, the subject pays back the extra amount taken.

Now, we are going to distribute the cards with the letters A, B, C, D and E for the next rounds.

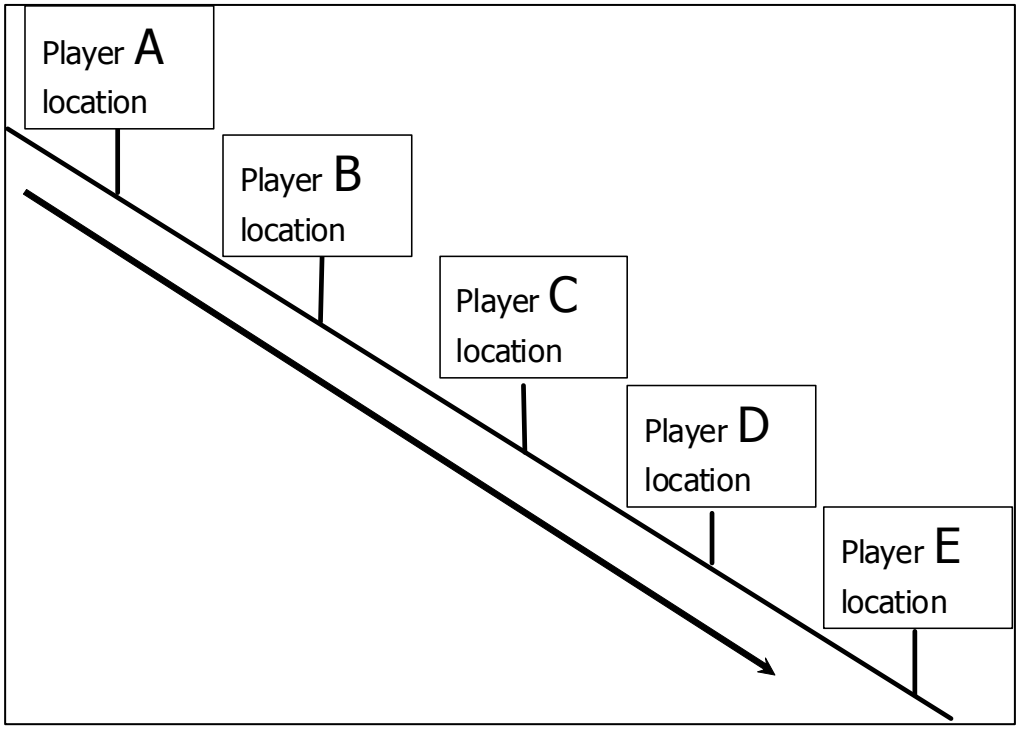
Are there any questions about this? <<*Monitor pauses to answer questions*>>

APPENDIX 3 – IRRIGATION GAME GRAPHS

A3.1. Water Production Function

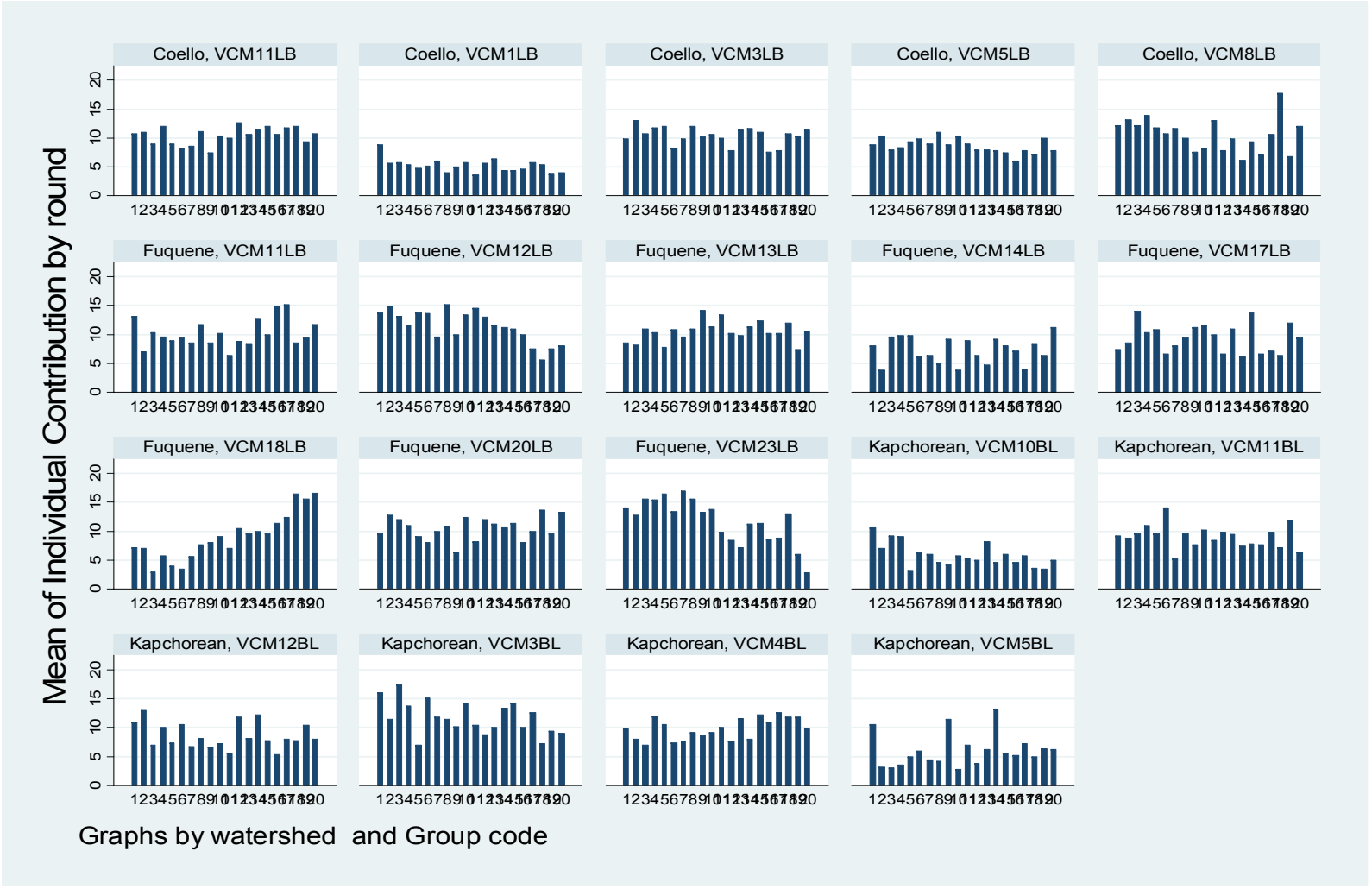


A3.2. Players location along the water canal

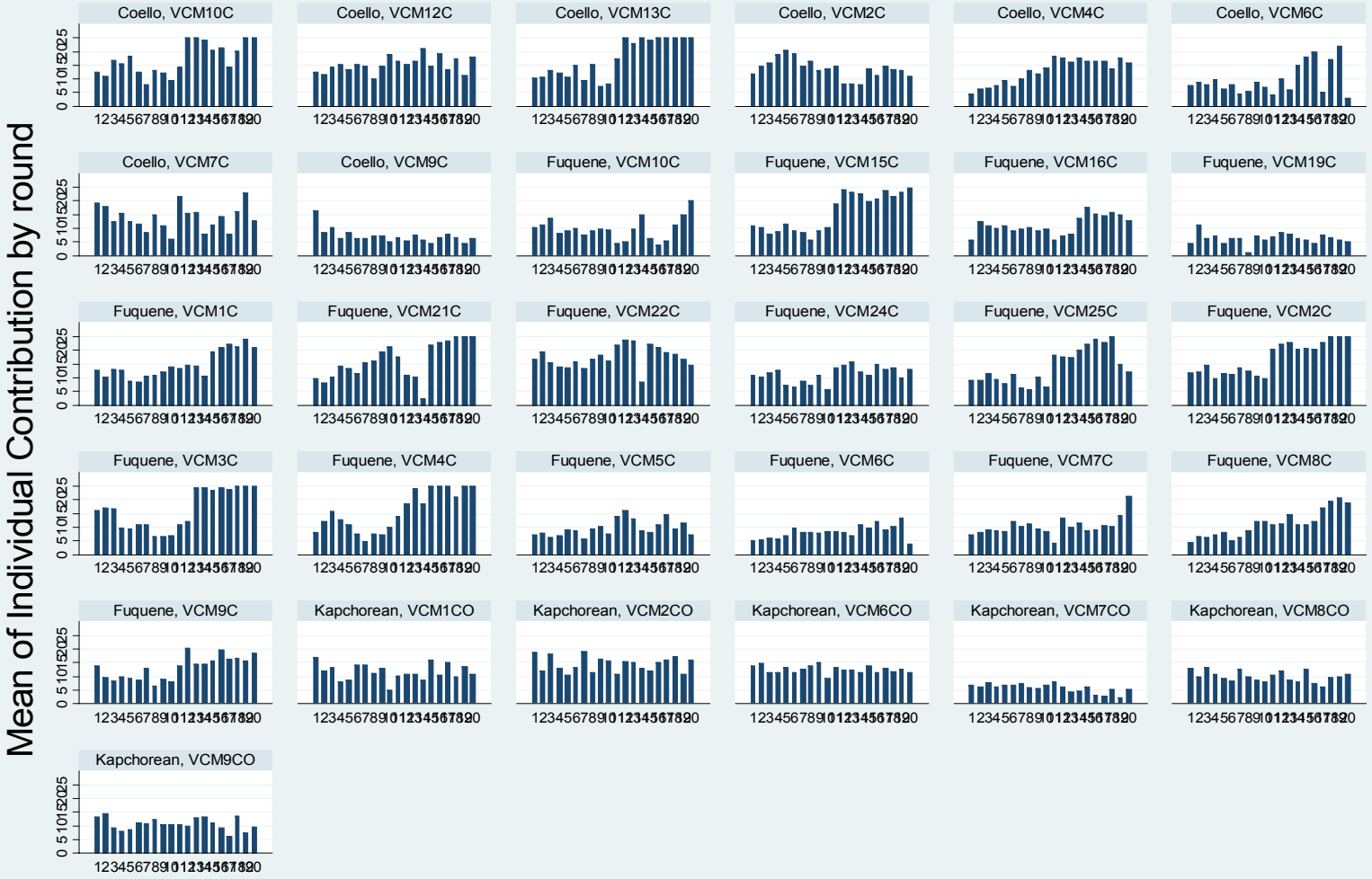


APPENDIX 4 – GRAPHS OF GROUPS CONTRIBUTION DECISIONS OVER TIME

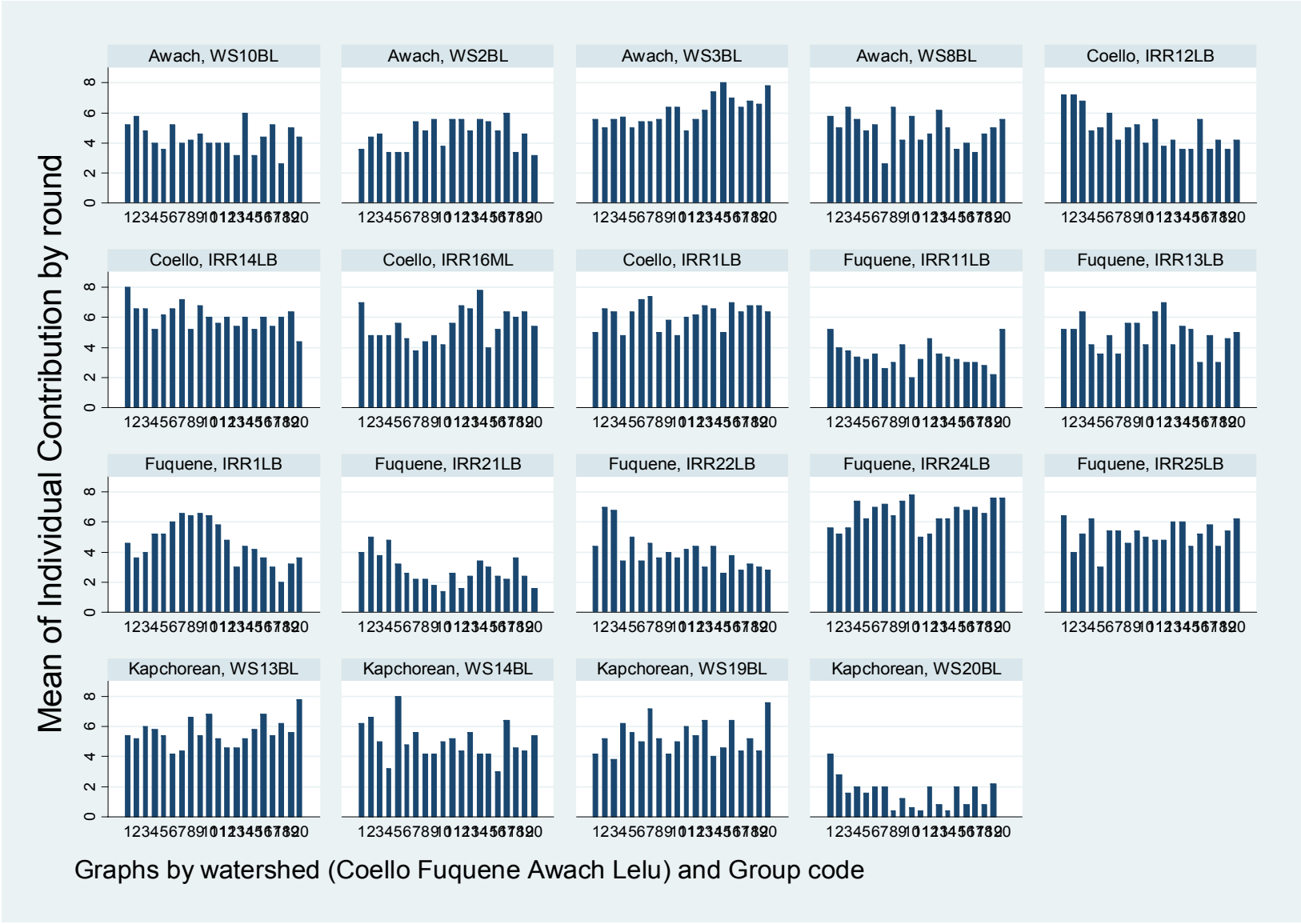
A4.1. Voluntary Contribution Mechanism - *Base Line*



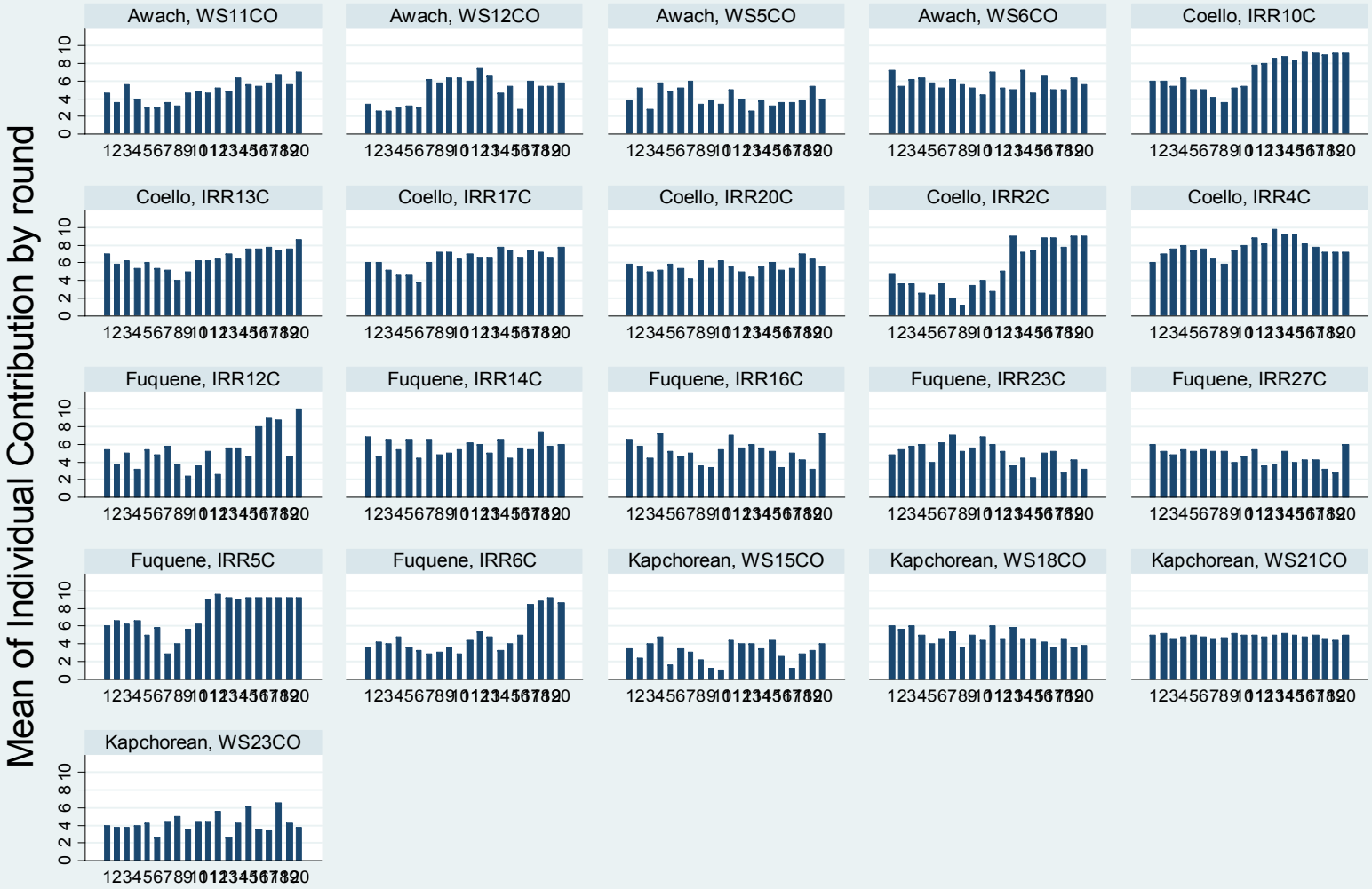
A4.2. Voluntary Contribution Mechanism – *Communication*



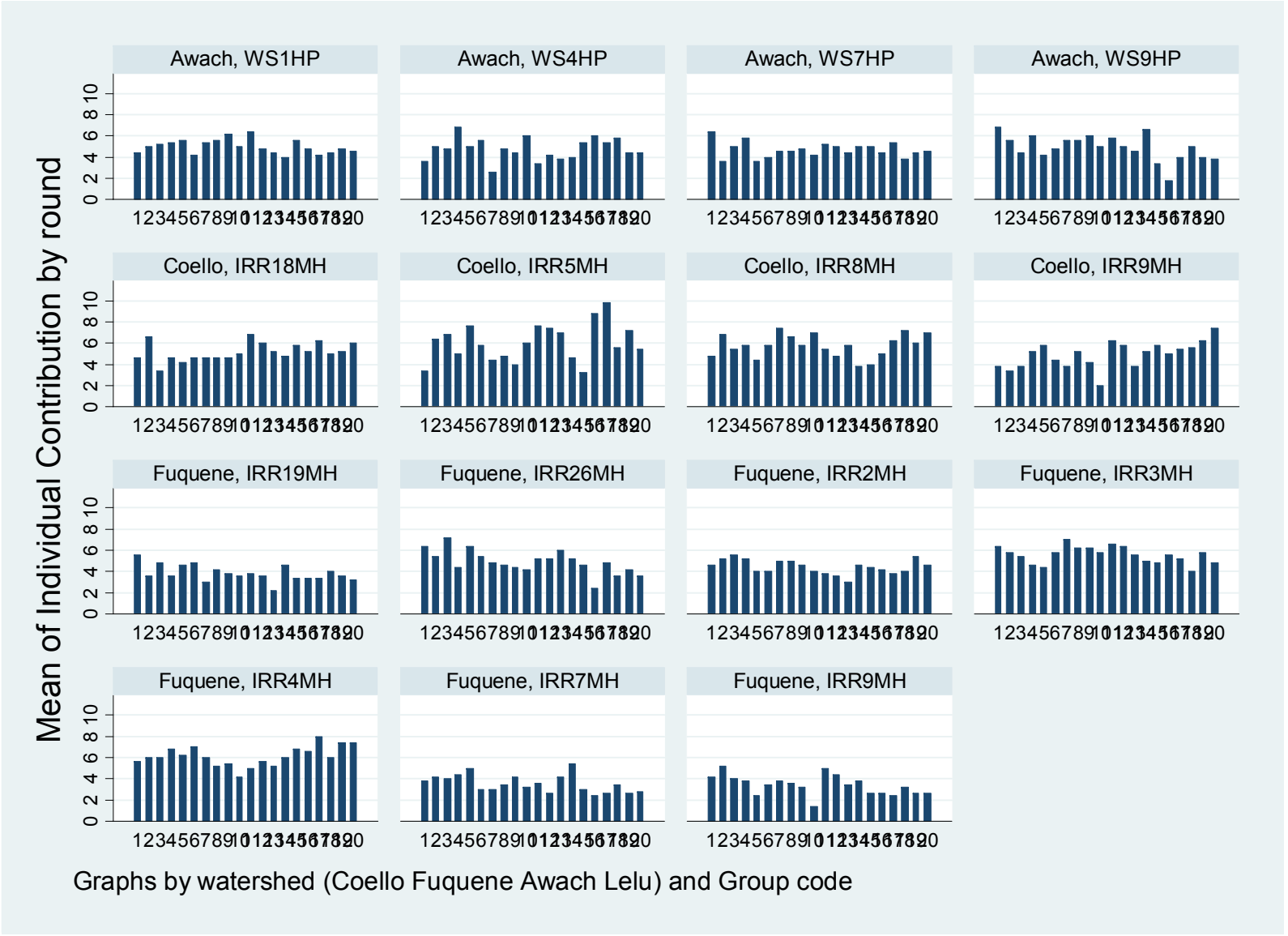
A4.3. Irrigation Game– *Base Line*



A4.4. Irrigation Game– *Communication*



A4.5. Irrigation Game– *High Penalty*



A4.6. Irrigation Game– *Low Penalty*