SIERRA SPRINGS: A generic table-top game addressing conflict and cooperation between stakeholders involved in managing land, forest and water in a subhumid tropical mountain watershed.

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Abstract

Participatory role-playing games and modeling can be useful tools for helping stakeholders understand how their choices, behavior and management of natural resources affect the long-term availability of those resources and their overall wellbeing. Participatory scoping and consensus building is most important in buffer zones surrounding Biosphere Reserves, as a number of social actors converge with different and sometimes very conflicting views and interests regarding rural livelihoods and natural resource management. As a first step in building a role playing game and companion model for the Sepultura Reserve in Chiapas, Mexico, we have developed – with active stakeholder collaboration- a generic land-use board-game. The purpose of the game is to incresas stakeholder awareness on issues related to social conflict and cooperation regarding watershed management, but also to act as a DEMO that will motivate stakeholders to tailor it or modify it substantially to meet their more specific views and interests. The game can be easily adapted to other situations involving territorial issues. In short, each of four players colonizes a quadrant of a watershed with different types of land-use-tokens having different values. The Game has various social modes (Robinson Crusoe; competition, collective planning among equals; deliberation among the unequal). In the competitive modes of the game, whoever makes N points first, wins. In the collective planning modes, the game is solved like a board puzzle and unless everybody makes N points, nobody wins. In the "deliberation among unequals" the powerless try to revert land and resource accumulation. Government Agencies subsidizing different land uses can either cooperate or defect while promoting their interest, with effects on players¨ decisions and on the dynamics of the game. Colonization (land development) has: (1)management restrictions (e.g. intensive sites cannot be contiguous); (2) social restrictions (each player shares half of his potential colonization sites with his two neighbors; whoever colonizes first these border sites owns them); (3) local deforestation consequences on water supply that affect neighbor´s performance; (4)

global/local deforestation consequences on water supply that threaten all players; (5) opportunities for being a good sport or for retaliating against a neighbor or against the whole community in the competitive mode of the game; (6) cooperation dilemmas between players, and coordination dilemmas between government agencies; (7) Formal deliberation for discussing and modifying social rules. Cooperative modes following competitive modes enhance players´ awareness of the virtues of collective action, and allows players to perceive at least four ways of being equitable and cooperative, and the synergies and tradeoffs between these options.

Introduction

Reconciling rural well-being with sustainable land use and natural resource conservation in impoverished countries is a complex and challenging social task that requires developing an adaptive co-management process with the active participation of all stakeholders involved. In these countries, buffer zones surrounding tropical mountain biosphere reserves are sometimes highly degraded and heavily populated by small-holders who have been using the land for decades or centuries. In these zones, participatory scoping, collective learning and consensus building are most important, as a number of local, national and international social actors converge with different and sometimes very conflicting views, interests, policies and actions regarding rural livelihoods and natural resource management.

A whole new field of interests in developing socio-environmental simulations and games for conflict management in rural settings is now evolving (Bousquets et al., 2002; Garcia Barrios et al, 2008 a). Agent-based modeling has been proposed to be well suited for capturing the complex biophysical and socioeconomic settings and long-term behaviors found in peasant natural resource management systems in many underdeveloped countries (Speelman and Garcia Barrios 2006; Berger et al., 2006). The joint use of agent-based simulation and role-playing games – increasingly referred to as Companion Modelling (COMMOD) - is relatively new (Barreteau et al., 2003; Le Page and Bommel, 2005) but flourishing. This strategy causes stakeholders to become more involved, interact and thereby reframe their views, strategies, interests and conflicts. Role-playing games constitute a non-confrontational social space in which human actions and their consequences can be explored and discussed by all stakeholders, including scientists (Barreteau, 2003). The combination of simulation and role-playing also generates a potentially powerful tool for interactive learning. Participants simultaneously acquire not only new eco-technical knowledge but also new social skills such as the ability to understand each other´s views and interests, collectively explore scenarios, negotiate and define and commit to practical solutions. Companion Modelling has proven its capacity to help stakeholders

understand, mediate and solve social conflicts involving common pool resources in rural settings (Bousquets and Trebuil, 2005; Gurung et al., 2006).

In a COMMOD process, the different stakeholders, including scientists, should develop a common vision on resource management in an interactive fashion. The participatory process may take months or even years and requires (a) a general diagnostic that allows for the identification of relevant issues, stakeholders and processes (always open to validation or rejection), (b) building role playing games (RPG), (c) developing computer simulations that reproduce the game´s dynamics or assist the RPG process (d) playing the RPGs with stakeholders (e) running scenarios in the simulators and (f) collective discussion of overall results to facilitate mediation. The process is cyclical in a general sense but it doesn't advance in a predetermined fashion; the sequence and iteration of steps is flexible, as it should be adapted to the specific conditions and nature of the collective learning process.

Figure 1. The small town of Los Angeles, in the heart of the Upper Tablón River, the most important watershed of the REBISE buffer zone.

In 2006 our group started a number of projects in the buffer zone of the La Sepultura Biosphere Reserve (REBISE) in the subhumid tropical mountains of Chiapas, at Mexico´s southern border (figure 1). The project´s ultimate purpose is to contribute to an ongoing social effort aimed at increasing stakeholder capacity to engage in

relevant actions for the sustainable co-management of the buffer zone. On the one hand we are working with small and medium land-owners on the participatory design and establishment of silvopastoral systems for reorientating deforestation and overgrazing towards environmental friendly cattle production in the Tablón River watershed (García-Barrios, 2007 a). On the other hand, we are developing a COMMOD process to facilitate watershed co-management among producers, government and non-government agencies who are engaged in promoting conservation, agriculture and ranching in the buffer zone on a daily basis (García-Barrios, 2007b).

Describing the COMMOD process at the REBISE is beyond the scope of this paper, but we should say that, to date, we have: (a) finished a general participatory diagnostic based on field work, literature review, workshops and interviews; (b) developed in-depth-research on cattle and tree management in local rangelands; (c) established, with the farmers, 68 experimental agroforestry plots with local forage trees; (d) actively participated in a network that includes most NGOs, some government agencies and all research groups working in REBISE; (e) organized an international ARIDNET research workshop that included farmers and other local actors, and addressed land degradation in the REBISE. (García Barrios et al. 2008 b) with the participation of farmers and other local actors. This included a short course on CPR experiments and role playing games by Marco Janssen, Daniel Castillo-Brieva and Luis García Barrios, followed by two days devoted to explore ideas for RPGs for the REBISE buffer zone; (f) developed and road-tested "Sierra Springs" (SP) as a generic RPG to increase awareness about the dilemmas and benefits of collective action in NRM. We are currently developing an online- interactive version; and (g) held a two day workshop with the local people to play SP, identify issues and actors, and assist them in developing preliminary versions of RPGs that capture their interests. From these activities, the following picture emerges about the issues to be addressed in a COMMOD process:

Biosphere Reserves in most of the Neo-Tropics are of a fragmented nature and are surrounded by a matrix of conventional agricultural and cattle production systems. The Sepultura Biosphere Reserve is no exception. It is notorious in Mexico (a mega-diverse country) for its biodiversity. It harbors in its buffer zone the upper Tablón river basin (circa 300 km2). This watershed is a degraded mountainous area with a mosaic of forest relics, maize fields, and grasslands that have been intensively used by farmers for 50 years. For all practical purposes, land is privately owned and

exploited, and few areas are considered commons. Slash and burn maize agriculture was practiced in the sixties and seventies. Land use was intensified in the eighties during a maize commodity boom, and steep erodable slopes were cultivated continuously with a high use of agrochemicals. In 1993-1994 three contrasting international/national policies and forces impacted the watershed:

(1) USA maize dumping after the North America Free Trade Agreement (NAFTA) rendered local maize production for the market unprofitable. Farmers started migrating temporarily to the USA, and accelerated a land use shift to extensive cattle grazing supported by the ministry of agriculture and their own migra-dollars (what a great word!!!). Rangelands currently occupy 70% of cleared mountainous land and continue to expand. Cattle graze deep into the remaining woodlands and into the margins of the forested core zone, preventing recruitment and long term forest persistence.

(2) Following international agreements on biodiversity conservation, the REBISE was created. Land owned by farmers in the buffer zone was not expropriated but became formally subject to management restrictions (no hunting and fishing, no deforesting and no burning); in compensation, farmers receive from the government very modest payments for environmental services. The government conservation agency in charge of the reserve supports the need for a strategy that includes sustainable agriculture and rural livelihoods. It has an extremely small staff and budget and can hardly enforce and promote its policies.

(3) International and National NGOs and corporations, as well as universities and research centres are promoting environmentally friendly land uses such as organic coffee and palm understory plantations as well as low-level sustainable lumber extraction and environmentally friendly cattle production; These projects are still very modest and in their early phases.

Local people are pursuing living standards that are constantly rising due to the adoption of urban consumption and cultural patterns. As in most rural settings, there is a marked inequity in land, assets and income distribution. Farmers acknowledge significant resource degradation resulting from their activity (and suffer the consequences) but they righteously defend their need to make a living, given insufficient government support and other social opportunities. Since 1993, they have restrained from clearing significant patches of forest and from using fire indiscriminately, but now and then they bend the law. They are interested in agroforestry projects as a means to reduce overgrazing and water shortage, but are

used to paternalistic individual subsidies and are slow to organize and fully cooperate amongst themselves. Local people perceive contradictory signals from the government: they get higher individual subsidies for market-based consumption than for socially organized production. They simultaneously receive a modest conservation bonus and financial support for maize and cattle with high environmental impact. They perceive lack of transparency in some government offices and little or no coordination between them.

In short, sustainable co-management of the buffer zone implies a great number of issues and actors. Furthermore, unlike irrigation water, fisheries, etc. resources are not owned or perceived as common pool resources (CPR) and because of land tenure patterns and the cultural background of the local dwellers and government officers,- there might be little awareness of the dilemmas and benefits of collective action to control and revert the higher scale effects of individual externalities. We consider that proper participatory identification of relevant issues is a difficult but critical step in the COMMOD building process. We also consider that – although an RPG should be a non-confrontational experience- it should explicitly address the processes and consequences of competition and the dilemmas and benefits of cooperation and coordination.

Between august 2008 and March 2009, we developed, repeatedly road-tested with different stakeholders and played with local people a generic RPG aimed at facilitating participatory selection of the relevant issues to be addressed in the next steps of the COMMOD process (figure 2). In this paper we describe the main features of this RPG, briefly discuss how this and similar generic RPGs could be useful to some COMMOD experiences and present some theoretical principles for facilitating and interpreting the dynamics of the game.

Figure 2. Road-testing the game levels of Sierra Springs with ECOSUR researchers

Explicitly addressing social conflict and cooperation through Sierra Springs

Commod processes (Bousquets and Trebuil, 2005) and Common Pool Resource (CPR) games and experiments (e.g. Castillo-Brieva and Sayseb, 2005; Janssen and Ostrom, 2006) have mainly focused on situations where natural and social barriers limit a fully private appropriation of natural resources that are critical for local livelihood (i.e. irrigation water, fisheries, common forests and common rangelands). In such cases, there is a potential for the tragedy of the commons and/or for very unequal NR sharing which may drive society to resource depletion, inefficiency, injustice and conflict. Thus, as long as such resources are relevant for livelihoods, local people (and government agencies) tend to recognize the virtue and need for collective action and more readily become interested in a COMMOD process that can help socially desirable CPR norms and institutions to evolve. In many RPG involving CPR, conflict and cooperation are not explicitly built into the game and may or may not emerge in a playing session.

In Mexico's tropical mountains, deforestation rates due to agriculture and animal husbandry are among the highest in the world. Land is owned mostly as “ejidos” and

“indigenous communities”, two regimes that imply social property but private tenure and use of land by whomever meets the requirements to develop it first. Until three decades ago, these land property regimes were fairly well supported and regulated by traditional institutions. As a consequence of market growth and neo-liberal policies, however, such institutions have become weak, and after recent constitutional reforms these lands can be fully privatized. Thus, few if any watershed resources are perceived as CPR.
In mountainous watersheds under private ownership, cooperation dilemmas and the benefits of collective action are less obvious. Land owners tend to tolerate and imitate private land mismanagement, such as excessive forest clearing or overgrazing, well after the higher scale effects of individual externalities (risk of fire, river and spring dry-out, water contamination, cancellation of ES payments, etc.) impact most or all of the members of the community.

In the early stages of a COMMOD process involving private land owners, when the objectives and social actors are being identified and selected by local stakeholders, it seems useful to develop first, a simple RPG. Such an RPG should increase awareness and catalyse and focus initial discussions on (1) how undesired higher scale consequences can emerge from individual behaviours righteously defended as private, and (b) how such behaviours influence, and are influenced by, competition, cooperation, defection, coordination, dialogue and leadership styles among stakeholders (both local and external). At a more profound level, such RPGs and discussions could increase stakeholder awareness of the tradeoffs, risks, dilemmas, challenges and benefits of collective action. This could help stakeholders decide what the relevant issues, social actors and rules are for a fully developed RPG—one that explicitly addresses the development of acceptable institutions and norms that can help solve specific socio-environmental issues.

Previous research has demonstrated that simple models with a low degree of realism can be efficient for increasing awareness. We have developed a highly stylised RPG with several playing levels that explicitly challenge private landholders to explore the consequences of trying to make a sustainable rural livelihood (and to additionally pursue some common interests) in a restrictive and unforgiving natural environment. This RPG includes several playing levels and imposes contrasting institutional settings to achieve this goal, including: (a) competition and strategic cooperation, potentially conducive to unequal income distribution and social exclusion; (b) land use planning

aimed at equitable income distribution; and (c) game "a" with formal collective deliberation in advanced stages of the game; aimed at trying to agree upon rules that revert inequity. In all three cases, interaction among government agencies with contrasting policies in the area can influence the local dynamics.

SIERRA SPRINGS: a detailed description

Game components (see figure 3)

A board divided into 4 territories bordered by 4 creeks. Each of four player has the task of colonizing one territory. The entire locale consists of 48 sites. Each site represents 1 Hectare (or any other unit of measurement, for example, acres, square miles, etc).
One large blue token that represents the main spring. It is located in the center of the board.
48 olive tokens that represent virgin forest or secondary re-growth during play.
A simple table that counts olive tokens removed from the board during development.

Each player colonize a quadrant has:

30 tokens, divided into lots of 6, representing 5 types of land use. Each type token has a distinct value.(F = Forest Management = 1; M = Moderate Grazing = 2; I = Intensive grazing = 3; E= Grassland Exclusion for Silvopastoral System Establishment = 0; S= productive silvopastoral system = 4.
An abacus for keeping the current score derived from tokens placed or removed on the board.
8 cards that represent benefits that may be acquired from points awarded.
1 die to throw on each turn. If it lands on "6", the player has experienced a "bad year" and loses his/her turn.

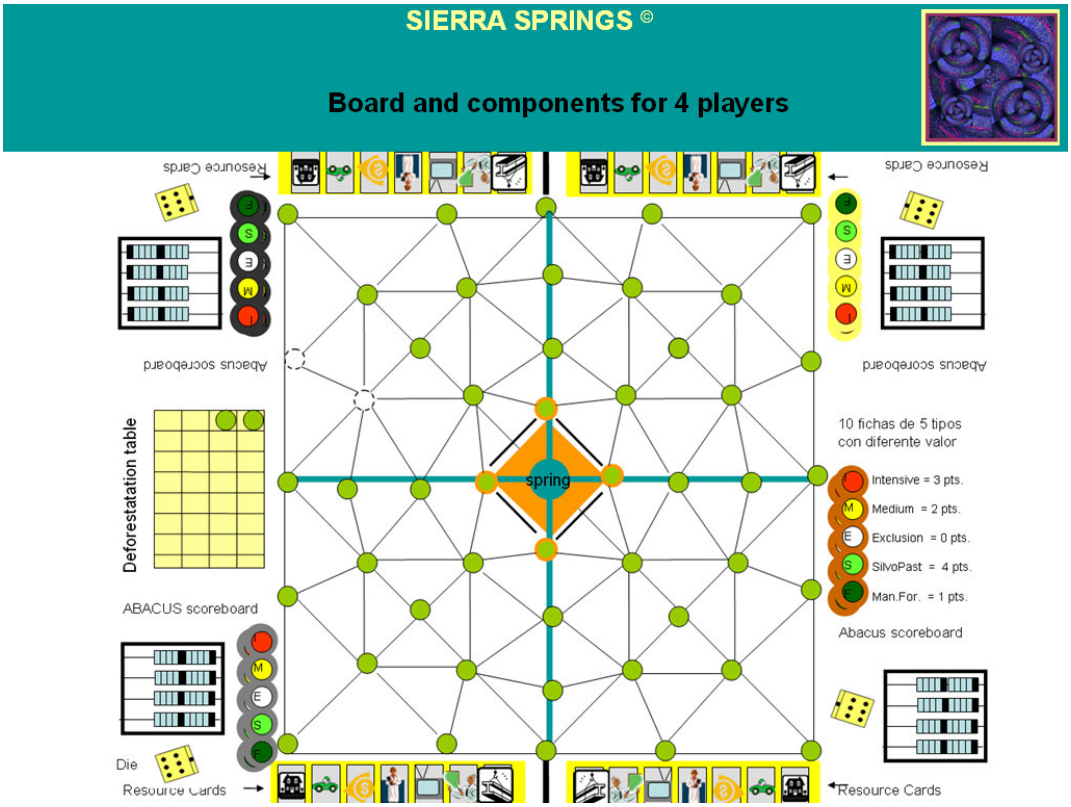

Figure 3 . Sierra Springs board and components

Players

Four players who set out to colonize and develop a quadrant of the watershed. Player five is locally in charge of the Ministry of Conservation office and can influence the colonizer player´s decisions.
Player Six is locally in charge of the Ministry of Cattle Ranching office and can influence the colonizer player´s decisions.

The general rationale of the Sierra Springs games

Four players decide to colonize a wooded locale, divided into 4 territories bordered by 4 creeks. Each player colonizes one territory. The entire locale has 48 sites. Sites located on the creeks are owned by whoever colonizes them first. Each player gets to colonize between 8 and 16 sites.

A player colonizes a chosen site with a token that represents one possible type of development. Some tokens may be placed freely in any location, while others may not. Each different type of development is valued distinctly. Points awarded per type of colonization, allow residents to acquire "material benefits" These benefits are available to the player when he/she attains a certain number of points, and are represented by a specific resource card. In the "competitive mode" of the game, whoever meets a specified number of points first, wins the game. In the "collective planning for equity mode", all players must meet the winning score, otherwise, all lose the game.

Most types of development involve site deforestation. If the total deforestation exceeds a certain threshold, the spring that supplies water to the players dries up, all residents must migrate and all players lose the game.

The same occurs if more than two sites surrounding the main spring are deforested. In the case that more than two sites on a creek are deforested, that creek temporarily runs out of water and the neighboring players lose all development in that locale, except for sites that are "managed forest." These lost sites may be recolonized on the subsequent turn by whoever chooses to do so first.

When a player creates any of the three "check" situations, the next player is able to avoid "check-mate" by reforesting the proper site; this involves the subtraction of points from a player's current score.

Players may be influenced by the representatives of the minister of agriculture or the minister of conservation, or both. If the territory of a player embodies the interests of one ministry, that player and the ministry both receive a premium as well as a "garbage management bonus". Ministries can promote their interests separately, but to promote sustainable land use innovation, they must coordinate.

The dilemma for the player in the competitive version of the game is whether to keep the game going or to place the game in check and check mate when someone is ahead. For his partners, the dilemma is whether to altruistically (or strategically) reforest a site and lose points to keep the game going. For the player in the collective planning version of the game the dilemma is whether to let his individual

preferences, goals and achievements to get in the way of a “everybody wins” solution with maximum collective premiums and bonuses.

In the most advanced and complex level of the game (“Sierra Springs- Reloaded”), the potential for “strategic cooperation”, “moral hazard” and “ free-riding” are introduced. The social-assymetry effects of these actions can be reverted through formal deliberation and “substantive cooperation”, but deliberation can be denied by any player and a happy ending is not warranted.

How many ways can this game be played?

The game has two land development versions:
(A) Land development with conventional land uses : managed forest, moderate ranching with moderate grazing, ranching with intense (over)grazing.
(B) Land development with conventional land uses and a silvo-pastoral innovation.
These two versions can be played in two social modalities:
(1) Competition: the first player that reaches a certain number of points wins;
(2) collective planning for equity: everyone works to solve the game as a puzzle which can only be resolved when all players have the number of points required to win. Premiums do not have to be equitably distributed. Maximizing the total number of premiums favors solving the community´s garbage management problem.

The same ecological restrictions operate over all game levels.

The five levels of the SP game

1. Preliminary Base-Line Game, without Management and Space Restrictions but with a High Possibility of a “Bad Year” (Game 1)

Each player receives one territory of 16 wooded sites (the 8 sites over the creeks are not currently under dispute with other players).
Each player has 16 turns and 16 opportunities to colonize his sites (using F, M, or I tokens). Every three points accumulated, each player picks a resource card. Cards should be arranged in the order of preference, and spread out on the table. There are no restrictions with regards to deforestation nor for the positioning of the tokens.

The only restriction is that commonly called “a bad year” and does not allow for the investment of time and resources in colonization. Therefore, on each one of the 16 turns, a coin is thrown: if it lands HEADS, colonize, if TAILS, “bad year”. If colonizing, tokens should be placed as desired, F (1 point), M (2 points) or I (3 points).

When the 4 players have stopped play after 16 turns, the preferred land use of each player is noted, as well as number of points, and order and choice of their resource cards. This preliminary game allows players to become familiar with the board and tokens, and allows the organizers to understand how “Robinson Crusoe” players would choose to develop the land and to prioritize needs, given that full colonization and satisfaction are not guaranteed.

Figure 4. Farmers playing game 2 at Los Angeles Community Workshop , Tablón River Basin.

2. Competition with Conventional Development (Game 2)

BASIC RULES:

1. On each player´s turn in a round, the die is thrown. If it lands on a "6", the player has a "bad year" and loses his/her turn. If not, the player places a token on his/her territory. Sites on creeks bordering territories are owned by whomever colonizes them first (see figure 4).

2. Token "F" does not deforest territory and is worth 1 point. (The small olive-token indicating pristine forest is placed on top of the F token). Token "M" does deforest, and is worth 2 points. Token "I" may only be played to substitute for an "M" token, and is worth one point more (3 points). In the two latter cases, olive tokens are removed from the board and placed on the deforestation table.

3. The winnner is the first to accumulate 24 points, at which point the game will end with the completion of the round. If more than two players have 24 points, the winning goal is increased one point.

4. If a player has 6 "I" tokens, he/she and the minister of ranching both win a "premium." For each premium that received, the community receives a collective premium that helps them resolve a common-interest problem (i.e. garbage sanitation; road improvement, etc. A total of 6 collective premiums are required for this purpose.

ECOLOGICAL RESTRICTIONS FOR COLONIZING SITES:

1. The "I" sites should be considered over-grazed, suffering from heavy erosion and bare of trees. Two contiguous "I" sites (i.e. connected by a line on the same or a different territory) generate nonlinear effects (excessive local erosion, heat and dryness) that collapse production on these sites and nullify the points these tokens provide. It should be avoided by players. "M" tokens can be rotated with (or substituted by) an "F"; an "I" token can't (i.e. no secondary succession can take place in a reasonable time).

2. If there are more than 2 sites deforested with “M” or “I” over a creek, the latter is temporarily dried out, and those involved lose their token(s), points and rights over these sites. In order to use these sites again with any token, they must first wait a turn. If a player has both creeks dried, and neither he or his neighbors reforest at least one on the following turn, that player loses ALL of his/her “I” and “M” tokens in the territory (and corresponding points).

3. If there are more than 32 deforested sites, or more than two deforested sites surrounding the main spring, the game is considered to be in “CHECK”. Another player in the round needs to “sacrifice” (lose points) in order to reforest an M or I site in his territory to fix this situation. If the check is not resolved on the same round, there is “CHECK-MATE” and EVERYONE LOSES THE GAME, including resource cards and premiums.This includes any community and ministry premiums.

PARTICIPATION OF THE MUNICIPALITY AND THE MINISTRIES OF RANCHING AND CONSERVATION

The ministries influence the decisions of the players by subsidizing actions that support their interest. In the competitive game, this subsidy is implicit in the capacity of the player to colonize a site during his turn. In the game of cooperation, the secretaries subsidize a “simple turn” (as in the competition game) or a “double turn” following conditions explained later.

The ministries may influence the decisions of players by giving them premiums for development in their sector. They consider it important that players specialize in the development each minister promotes in order to create economies of scale and to show visible results before the federal budget minister.

Therefore, if a player has six “I” tokens or six or more “F” tokens, the federal government grants a three part premium:

- A premium for the player that owns the territory.
- A premium for the local official of the secretariat (Conservation for “F” tokens, Ranching for “I” tokens).

- A premium that complements a municipal fund created to solve a communal issue that everybody is interested in (i.e. Garbage sanitation, road pavement, other public facilities).
- A player can obtain a premium from both secretaries. The “M” tokens do not generate premiums.

3. If the municipal fund reaches 6 premiums, the community can attend to the common-interest problem.

HOW MANY GENERAL DEVELOPMENT CONFIGURATIONS OCCUR IN GAME 2 ?

The constraints and attractors for the dynamics of this game are:
1. All players seek to win the game; commonly, one wins "by a nose." Therefore the game tends to converge to token combinations (attractors) that satisfy: "everyone reaches 24 points in the final round."
2. Only 32 sites may be deforested.
3. There can only be 16 intensive sites throughout all the locale. These can be distributed symmetrically (4-4-4-4) or asymmetrically (5-3-5-3 or 2-6-2-6). This analysis assumes that no one would want to have contiguous intensive sites with no value.
4. It is improbable that the number of placed tokens per player will be highly asymmetric (i.e. 8-16-8-16). We consider for analysis only equitable (12-12-12-12) and moderately asymmetric solutions (13-11-13-11 and 14-10-14-10).
5. No player may have more than 6 intensive sites. The sum of intensives in 2 contiguous quadrants cannot exceed more than 10 tokens.

We have developed a simple algorithm and implementation in Pascal that searches all possible combinations of tokens that satisfy the game's constraints and goal (program, PUZZLE, L. García Barrios 2008). Each "general solution" is a 4x3 matrix with players in rows and number of F, M, and I tokens in columns; for each row, F +2M + 3I = 24. This matrix is defined without an interest in the identity of any player, so matrices that only differ in the order of the rows are considered redundant and discarded. Spatial variants on the board of these "player X token vector" matrixes are also considered redundant and not counted. Selected matrices are later screened to discard those cases that do not meet spatial restrictions that cannot be studied analytically. Overall, this competitive game has a couple dozens of "general solutions" that "attract" the game, but only ONE that generate premiums . It only produces a total of two collective premiums so the expectation of solving a common-interest problem cannot be met. This situation changes in other levels of the game.

3. Collective Planning for Equity with Conventional Development (Game 3)

BASIC RULES

1. The idea is for all players to cooperate by choosing and arranging tokens on the board in such a way that every player receives at least 24 points per module, WITHOUT BREAKING ANY OF THE ECOLOGICAL RESTRICTIONS OF THE PREVIOUS GAME.

2. This version should not be played by turns as the four players must work cooperatively to solve the puzzle of development throughout the entire locale. It's up to the four players how much they want to coordinate in order to solve the puzzle. If convenient, players can be given a time limit for finding a solution.

3. The representative of a ministry can whisper to any player and make suggestions in order to promote its interest in acquiring a premium. He/she should not make these suggestions out loud.

4. The three-part premiums from the government are offered in the same manner as the previous game and awarded to each player. A premium will be given out to a player when he reaches 6 "F" or 6 "I" on his territory, HOWEVER, THEY ARE ONLY awarded after the puzzle has been completely solved, i.e. when all players have 24 points. If a player rearranges his own territory so that he no longer qualifies for the premium, it will be revoked -- for the player, the officials and the municipality.

HOW MANY GENERAL DEVELOPMENT CONFIGURATIONS SOLVE GAME 3 ?

In this case, the attractors of game 2 become exact solutions for game 3. Again this competitive game has a couple dozens of "general solutions" that "attract" the game, but only ONE that generate premiums . It only produces a total of two collective premiums so the expectation of solving a common-interest problem cannot be met. This situation changes in other levels of the game.

4. Competition with SILVOPASTORAL innovation (Game 4)

BASIC RULES:

1. Inflation has increased the price of living. Now, in order to acquire a resource card, players need to have 4 points (not 3 as in the previous game). The winning score has changed from 24 points to 32. As before, the first to reach 32 points wins the game.

2. Conventional development options will not allow players to reach 32 points. However, an innovation has been introduced that requires more time and effort but results in more points. This innovation is SHADE TREES FOR FORAGING that can be developed on moderately grazed pasture sites (M). We call the innovation silvopastoral (S).

3. The cost of this type of development is higher, since stabilizing young trees on the terrain requires the exclusion of cattle from the land for two years. Because of this, the player must substitute his M token (value 2 points) for an EXCLUSION token (E) with a value of ZERO POINTS. Only on the following turn may the V be substituted for a SILVOPASTORAL (S) token worth 4 points. This higher value is derived from the site's ability to produce pasture and tree forage of a very high nutritional value.

4. Of course, the ZERO value of stage E is a simplification, because it does not consider relay cropping during the exclusion period (i.e. intercropping the young trees with small annual staple crops during these first two years) nor the value previously accumulated in stage M. But this value adequately captures in relative terms the investment of resources and time for the innovation. The risk of falling behind in points which might allow for the victory of another player makes innovation challenging and keeps the game competitive.

5. The remaining rules of game 2 apply in 4 as before.

PARTICIPATION OF THE MUNICIPALITY AND THE MINISTRIES OF RANCHING AND CONSERVATION

The government offers a three-part premium to players that have 6 “F” tokens, 6 “I” tokens or 6 “S” tokens. The ministries of ranching and of conservation promote the “S” innovation by investing in a “hybrid” of their sectoral interests. If before starting a turn they both coordinate to offer aid for this option, they add up their subsidies. Consequently, each player that has also chosen to place a “S” token on that turn gets a DOUBLE TURN. In this case, he can move directly from an M token to an “S”, or can place two “E” tokens on two “M”.

Before the start of a round, the four producers and the two ministries publicly announce their decision SIMULTANEOUSLY. If each minister opts for their own sector, the turns remain SINGLE TURN as they did in the earlier games.

If the minister of conservation aids the hybrid silvopastoral and the minister of ranching does not, all players who chose “I” during the turn are offered a double turn to play “I”. If the secretary of agriculture aids the hybrid and the secretary of conservation does not, then all players who chose “F” are offered a double turn to play “F”.

The rules are summarized on the payoff table (fig. 5) that describes the effects of coordinating or not coordinating.

The representative of a ministry can whisper to any player and make suggestions in order to promote its interest in acquiring a premium. He/she should not make these suggestions out loud nor decide for the player.

Each ministry can invest in their own sector or in the hybrid silvopastoral project.

If only one cooperates with the silvopastoral project and the other does not, the common fund will be slanted towards the sector that did not cooperate

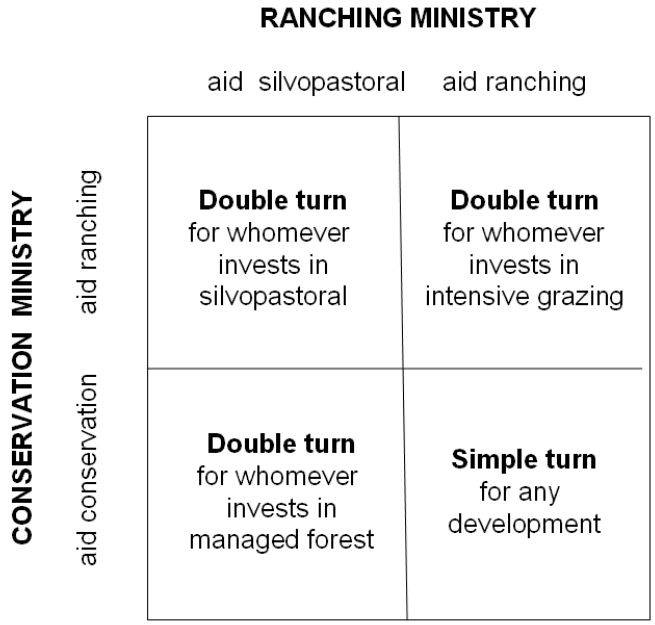

Figure 5. Payoff function for coordination between ministries

5. Collective Planning for Equity, with Silvopastoral Innovation (Game 5)

BASIC RULES:

The proposition is to cooperate by arranging all of the tokens on the board in such a way that every player receives at least 32 points per territory, WITHOUT BREAKING ANY OF THE ECOLOGICAL RESTRICTIONS DESCRIBED IN THE PREVIOUS GAME.

This version should not be played by turns as the four players work together to solve the puzzle. If convenient, players can have a time limit to solve the puzzle.

The ministries follow the same rules as those in the competitive game (4).

HOW MANY GENERAL DEVELOPMENT CONFIGURATIONS OCCUR IN GAMES 4 and 5 ?

1. In the competitive game, all players attempt to win the game; commonly, one wins "by a nose." In this way the competitive attractors satisfy: "all must reach 32 points in the final turn".

2. In the cooperative game, the same attractors become exact solutions.

3. Through the PUZZLE algorithm and further spatial screening, we find that there are fourteen attractors/solutions for games 4 and 5. Three of these solutions do not generate premiums and eleven generate between 1 and 6 premiums. Some solutions generate premiums for the three types of development (FSI) but others only for two or one.

Premium distribution in the collective planning games: a potential source of conflict.

When a player wins a premium for specializing in a certain land use, he might later resist the collective need to reorganize the landscape during the planning process (if this implies loosing his premium) in order to achieve equal number of points for all. Furthermore, achieving equity in points does not warrant that premiums will also be equally distributed (see figure 6). Therefore equity in this game can be viewed and pursued by players in at least four ways (and their combinations): all player have equal number of development sites; all have the same number of final points; all have the same number of premiums; total number of premiums allows solving a common interest problem.

Figure 6.1 refers to the cases in which there is only conventional development. For each solution with premiums, it shows the relation between the number of three-part premiums obtained and the inequality of how these premiums are shared among the 4 players (the greater the Gini coefficient, the greater the inequality). It is worth noticing that the solutions with the highest number of premiums are also those that are the most equitable.

Figure 6.2 refers to the case where players have introduced the silvopastoral innovation. It is worth noticing that the only solution with 6 premiums is also the most equitable. Solutions with 3 premiums vary strongly in premium equitability.

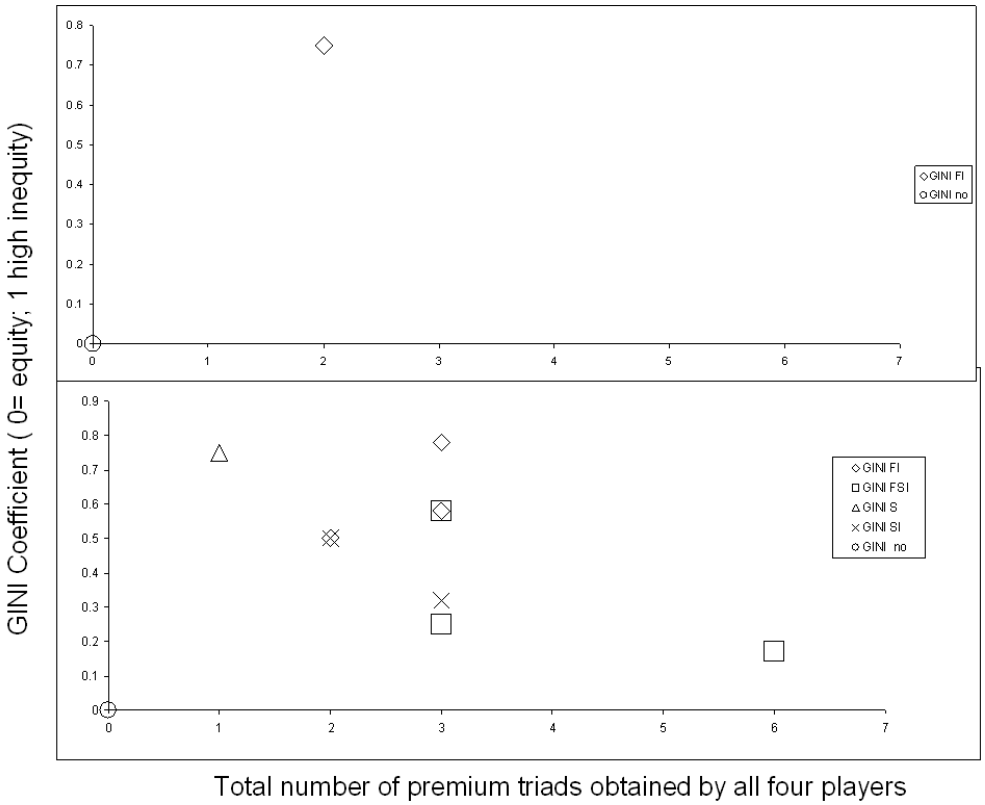

Figure 6.1 and 6.2. Solutions have different number of premiums. The latter can be equally (gini = 0) or very unequally (gini > 0.5) distributed among players. Letters F, S and I in the figure labels indicate respectively if the premiums are obtained by specializing in forest management, silvopastoral, intensive grazing or their combination.

Local People Workshop Results

In August 2008, four community leaders from the Tablón river basin participated in the International ARIDNET meeting and contributed ideas for RPGs. In January and February 2009, eight local farmers from the town of Los Angeles tested preliminary versions of SP and made useful suggestions. In March 2009 we held a two-day workshop with 30 people from Los Angeles, most of them members of the organized group that is already experimenting with silvopastoral practices. Some external social actors were invited as observers.

The first day, 16 people played in groups of four on four table boards while another fourteen watched. They played game 1 (Robinson Crusoe); three rounds of game 2

(competitive); a contest between the four winners of game 2; game 3 (collective planning puzzle) and game 5 (collective planning puzzle with silvopastoral innovation).

The second day the workshop focused on the first five steps of a COMMOD process:

(a) Researchers briefed the group on the results of an in-depth participatory community diagnostic, and listed a number of local development issues pointed out by workshop participants and other town members.

(b) Researchers explained COMMOD steps and gave examples of COMMOD and similar participatory processes in other parts of the world.

(c) Local people split into three groups to identify one or two main local issues for a RPG, related with livelihoods and land management. They later presented their choice in a plenary session. Two main topics emerged: (1) The causes and effects of deforestation, and the challenges and tradeoffs of a collective effort to introduce silvopastoral practices (see figure 7); (2) The benefits and risks of burning crop fields and grasslands: the collective consequences of restraining from using fire, vs the collective consequences of improper fire management.

(d) The three groups listed the main social actors involved in those issues and their roles. They later presented their lists in a plenary session.

(e) The three groups were provided with a variety of playing materials and started exploring in a preliminary fashion what a “Tree Cutting vs Tree Planting ” and a “Fire Management” game could look like.

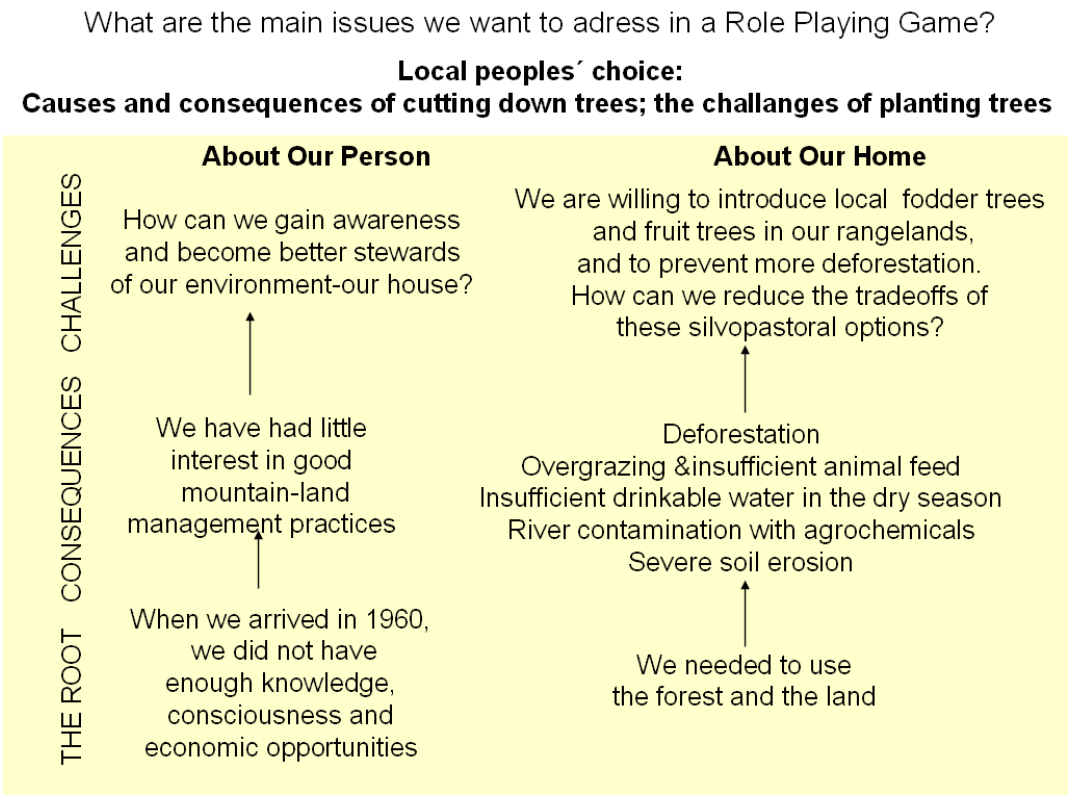

Figure 7. Mental map of the discussion over the deforestation / reforestation issue for a RPG.

Describing and explaining the results of this workshop is beyond the scope of this paper. We will only list a few interesting facts directly related with the effect of Sierra Springs on the COMMOD process:

1) In Robinson Crusoe and the competitive game, players could have colonized 40% of the whole board with I´s; but on average only colonized 25% of them. M and F tokens were equally used. At first, all players colonized border sites along creeks with forest management, to comply with our conservation preferences and/or with there self-image and preferences. They relaxed this criteria as they noticed that this would limit their efforts to accumulate points.
2) Even after playing the competitive game twice and gaining familiarity with its rules, they did not engage in drying a creek to reduce the advantage of a neighbor nor deforesting the spring to put the whole community at risk; two valid competitive strategies. Whenever they reached the 32 site deforestation threshold, someone happily reforested a site to keep the game

going. This is in contrast with the very competitive way the game was commonly played during road-tests by academics. It is possible that a meta-game was being played by the local people who seemed to keep in mind the idea that aggressive behaviors would be strongly disapproved of in real life. Yet, when the four winners of the competitive played against each other in a Grande Finale with their teams supporting them; their competitive strategies were suicidal and ended the game in the first few rounds by drying a creek and the spring simultaneously (figure 8). After everyone laughed, they played again in a more judicious way. This episode of spontaneous stronger competition between teams could be mirroring the higher intensity of resource management conflicts between local communities than within them.

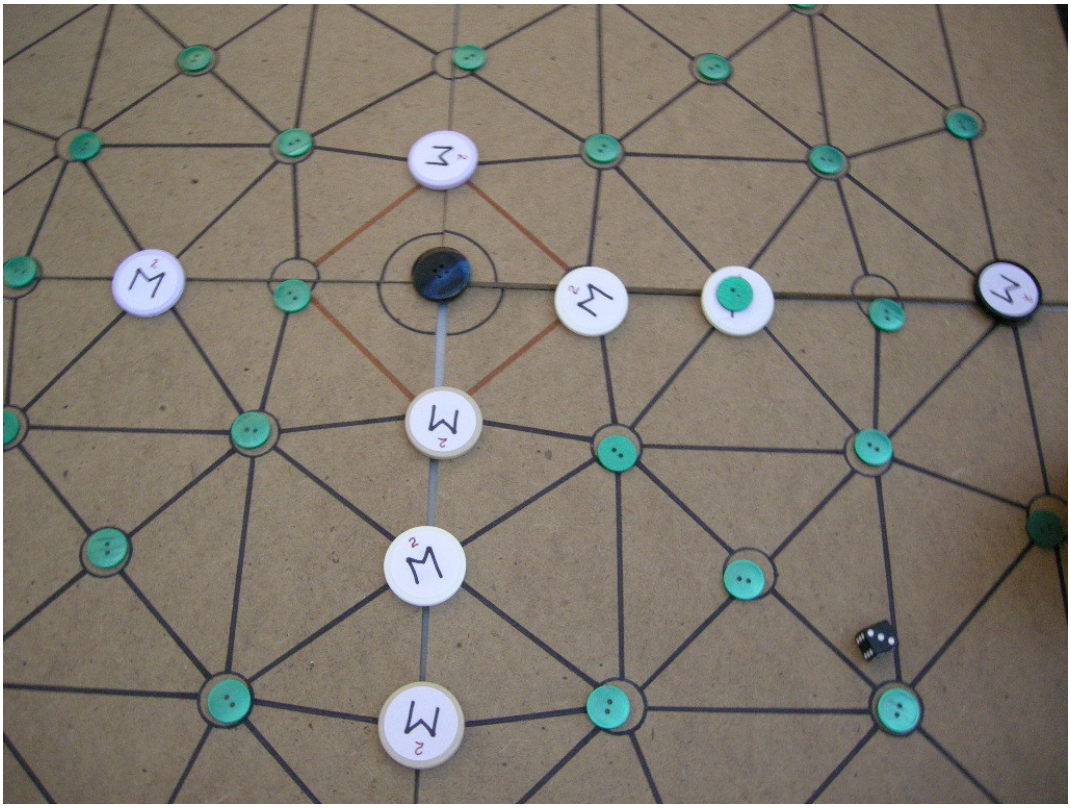

Figure 8. Shortly after starting the game, no player became aware of, nor was willing to solve, this simultaneous "check" on a creek and the spring. Everybody lost in this "Grande Finale" between team winners.

3) Solving the puzzle in the collective planning games (3 and 5) is a non-trivial optimization task that cannot be solved at the quadrant level and requires coordination among all players. While most players explore possibilities

through trial and error until they develop a coherent strategy, some highly intuitive players "see" a solution almost immediately. The former tend to focus on their own quadrant while the latter tend to drive all players into their strategy. These leaders can be inclusive, patient and polite, or they can command and control every player´s move. Interestingly, we have seen in workshop and in previous road tests that when a very determined local leader emerges, all other players follow him without hesitation; even before they fully understand what he is up to. In such cases we have repeatedly seen the puzzle solved without conflicts in 5 to 10 minutes. When academics, high government officers and watershed management experts have played Sierra Springs, such intuitive strong leaders have a tough time trying to coordinate the group and sometimes give up in anger and frustration. Solving the puzzle in these cases has taken between 30 minutes and four hours.

4) In the collective planning games, there is a tradeoff in getting premiums for specializing in a given land use: On the one hand it adds to the community fund for solving a common interest problem. On the other, once a player achieves a premium in his quadrant, he might be reluctant to give it back if required to solve the puzzle globally. Local players were hardly hesitant to give back premiums for achieving the common goal. Again, resistance has been seen more frequently among academics.
5) Local players had fun with the competitive game but were more interested in the collective planning game; more so with the silvopastoral version (game 5) that allowed them to accumulate enough premiums to "solve" the garbage sanitation problem, a very sensitive topic in their everyday life. After the participatory diagnostic and the workshop, the whole town has taken collective action to solve the worst part of this problem.
6) Sierra Springs catalyzed the process of identifying a specific local issue that can be addressed by a fully developed RPG and the listing of relevant social actors. After playing SP, 20 people -- between the ages of 14 and 76 -- very creatively developed in record time (one hour), 2 simple but playable games representing, in a metaphoric way the challenges of reverting the consequences of deforestation in the REBISE buffer zone (see figure 9). These ideas will be fully explored in a second workshop that will include external stakeholders.

Figure 9. Local players designing the game "GREEN MAN vs COWBOY", a metaphor of the drivers of deforestation and reforestation.

A new level for the game: SIERRA SPRINGS RELOADED (SPR)

After a number of road tests and the workshop, we have recently added a level of complexity to the game. In previous levels, players are taken step by step through contrasting conditions: base-line isolation from their neighbors, competition and collective planning. In SPR we create conditions in the competitive games (A1 or B1) for a full expression of some strategic cooperation dilemmas: moral hazard and punishment. We also include the possibility for players to stop the game and formally discuss and try to change the social rules, in order to revert strong inequity.

Under the usual ecological constraints, a player who reaches 24 points in game 2 (or 32 points in game 4) does not win and end the game. Instead, he receives a COIN that he/she can "invest" in his next turn by placing it on top another player´s F or M token, if the latter agrees to host him. Investor and host share the profit of this

investment equitably (each receives a COIN from the BANK). The player can invest his profit again in the same site -- with or without permission from the owner- and now secure most of the additional benefits for himself (moral hazard). In his turn, the owner of the land can retaliate by retrieving his F or M token (at the cost of loosing all his capital at that site) so that all of the investor´s capital at the site is also lost (see payoff functions in fig 10). If the owner of the land for any reason decides not to retaliate, the investor can invest a third time and now take over the land with all its points. These new rules can create a simple tit-for-tat situation but also more interesting cooperative dynamics. On each turn, the investor can invest all the COINS he can with other players (one per site per turn). Coins count as points until they are hosted by another player´s token. Any player who reaches 24 (32) points receives an initial coin from the bank and can now invest this and previously accumulated coins.

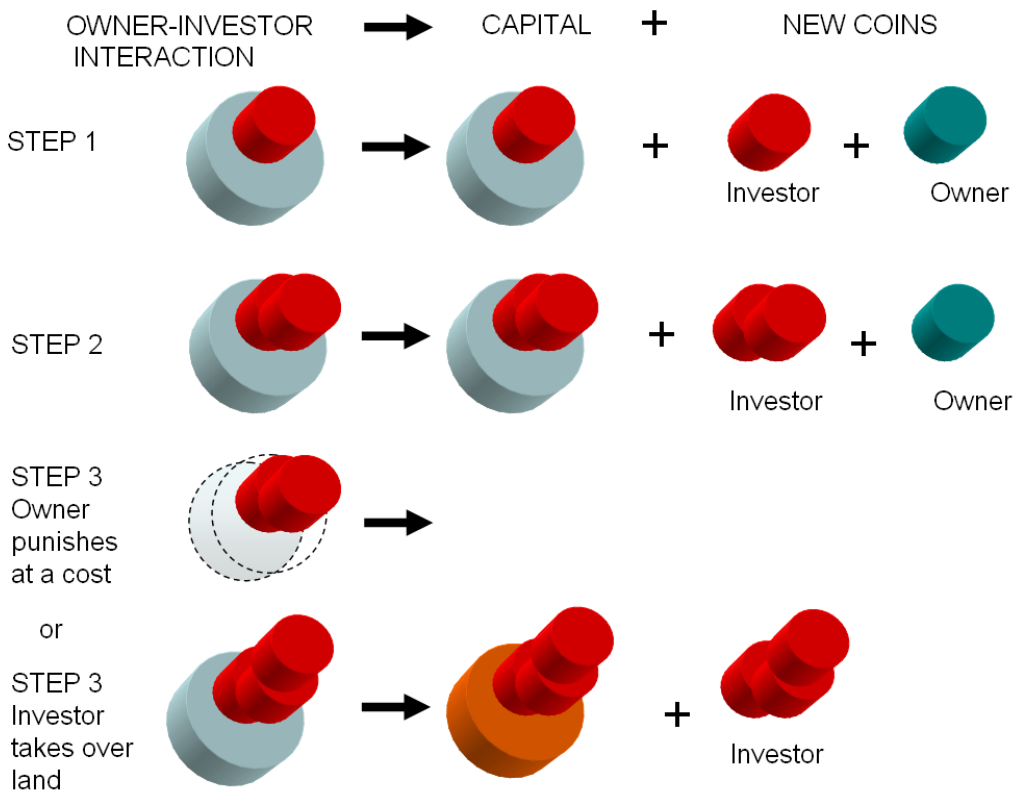

Figure 10. Payoff functions for investor (red) and site owner (blue) after an interaction between them. Larger pieces are land-use tokens and smaller pieces are colored coins

After extra-territorial expansion has started, land and coin accumulation can be contested by one or more players who request formal deliberation of the social rules of the game in order to revert inequity. If all agree, deliberation starts an open-ended verbal game. The board game then continues until formal deliberation is again requested. Through deliberation, all player can reach 24 (32) points and become investors, but deliberation and a happy ending are not guaranteed.

Theoretical considerations on interpreting the dynamics and outcomes of the six levels of Sierra Springs.

Like other role playing games, SP is a heuristic tool whose goal is to facilitate the understanding of complex realities, both for people who experience them directly and for those who observe them from the outside. The purpose of the game is to stimulate -- during its course and under certain controlled conditions -- the empirical expression of the multiple trajectories that can evolve for a society engaged in the colonisation of an undeveloped forested watershed, under restrictive and unforgiving environmental conditions. In principle, both the players and observers can gain a new practical and theoretical awareness by observing the evolution of these trajectories over the course of the game. Such an awareness, however, is not independent of previous experience, theory and values. SP is a generic game that allows for the expression of distinct behavioural modes that arise from personal theories and interpretations of reality.

<u>The Game-Theory Perspective</u>

From the game-theory perspective, the observed trajectories could be interpreted as the result of the combined rational strategies chosen by the players in terms of (1) their objectives (i.e. obtain a certain number of points), (2) the rational strategies of the other players, (3) the basic rules/restrictions established previously by an external authority (the designers of the game), (4) the amount and distribution of information and (5) the element of chance.

Under this game theory paradigm, we can expect four different situations defined by the dominant incentive structure.

a) Autonomous occupation of the territory. In the initial stages of the game, players have strong incentives to engage in a zero sum strategic game, the goal of which is to accumulate property rights over the territory, maximize the odds of accumulating points in the future, minimize other players´ scores, or to cooperate with them.

b) Use of aggressive tactics.
When the territory becomes overcrowded and/or the victory of a neighbour is imminent, players can create situations that will ruin the resources of the potential victor(s) , reduce their points and eventually take over their property along creeks.
c) Strategic cooperation.
The game can produce positive sum situation with incentives for all players to cooperate strategically.
d) Moral Hazard.
Players may have the opportunity to take advantage of cooperative situations to increase their own score to the detriment of those who cooperate with them.

A game theoretical approach assumes that agents act rationally and are determined by the evolution of current and expected incentive structures. Players´ actions that do not conform to such structures can be interpreted as mistakes caused by poor understanding of the game´s purpose and rules. We would then expect self-correction as players become more familiar with the game. A more interesting possibility is that players might be engaged in a "meta-game" (of which SP is only a part), driven by real life social relations among players. "Mistakes" could then results from persistent strategic behaviours derived from an incentive structure that is more complex, profound and difficult to perceive. Thus, players that share a social, economic or political arena in real life might refrain from adopting aggressive and opportunistic behaviours when considering their consequences "outside of the game".

Beyond a strategic game

Orthodox rationalism –implicit in game theory – has been strongly criticized by social psychology, neuro-behavioural science and analytical philosophy (for an excellent review see Huang, 2008). This critique refers not only to its theoretical grounds but also to its lack of explanatory power. The four situations previously described

(strategic behaviour, aggression, strategic cooperation and moral risk) can also be explained by models of limited, context-based rationality which conform better to current scientific knowledge of human behaviour.

As well as real-life land colonizers, SP players are not "rational fools" (sensu Amartya Sen, 2000); i.e super-oportunistic wise guys that interact in a historical and normative void. As well as external observers, they engage and behave according to their temper, life stories, practical knowledge, beliefs, feelings, habits, attitudes, self-assumed social roles, etc. These determine how they will behave and how they will interpret other player´s behaviours. This creates a context that strongly determines the unwritten rules and restrictions of the meta-game and the practical knowledge about socially acceptable procedures and protocols for cooperating, coordinating and punishing rule violators. One of the most important methodological consequences is the behavioural sesgo known as compliance bias (Green and Tunstall, 2001), which we have seen among SP players and which most probably occurs in other RPGs. In other words, players perform according to what they think other players and external observers consider a socially acceptable behaviour.

There is a second, more important consequence of players involving in the game their real-life experiences as social actors. These are the processes of deliberative rationality they might promote and/ or engage in to achieve common goals during the game :

SP can be played by farmers in two contrasting social modes and a third one that combines both:

(a) In the competitive mode, farmers try to achieve individual goals. They can display strategic, aggressive, cooperative and opportunistic behaviours, combined with real life conventional behaviour depending on the specific context in which the game is being played (i.e. amongst economic graduate students, smart opportunism is a highly conventional conduct; among rural small-holders it is not).

(b) In the collective planning mode, farmers form a deliberative community in search of a common and more or less coherent goal. Players are invited from the beginning to try to meet a goal that is acceptable to all and to develop a strategy to attain it. The goal here is established by the designer of the game (i.e. everybody makes N

points and everyone together tries to obtain M premiums) but it could also be defined by players, according to their own normative criteria and ethical models. (Ecological rules/restrictions are a given and not subject to discussion). While trying to define goals and to lead, follow or ponder different strategies, the players discover that they belong to one or more distinct ethical traditions and will try to establish shared standards of behaviour and of benefit distribution. Players belong to distinct deliberative traditions, defined by their social practices and modes of life, and therefore by shared standards of behaviour and criteria of distributive justice, that distinguish them as "farmers-of-such-locality", "officers-of-such-government-agency", "researchers-of-such-status-of-such-university", etc. Yet, they can explicitly engage in a language-game that does not require that they share a body of common logic and ethical premises in order to produce a result that is acceptable to all. The most experienced players might even define and share excellence criteria for the game and apropiarse individually or collectively the internal benefits of cooperation (i.e. the psychological, moral aesthetic, or spiritual goods derived from it). Thus, players can obtain not only goods and services but they can expand their domain over the powers and virtues appreciated by their own intellectual and deliberative traditions.

Of course, language-games might fail when groups belonging to rival traditions are not able to engage into rational deliberation to construct a shared notion of common good. This could happen either because one or several rival traditions lack the resources to engage in fruitful deliberation, or because the political setting and the relation of power is not appropriate for this purpose. Usually both reasons go together. For example, orthodox economics and other forms of manipulative professional activity, when engaged in rational deliberation, lack the resources to understand and share values related to the concept of "common good", as well as to explain notions such as efficiency, strategy, opportunity and cooperation in terms that can be rationally defined and understood by other non-individualistic/non-manipulative perspectives. Thus, when playing the game, we could expect people representing these traditions of thought to fail to engage in a multi-traditional rational deliberation and, if having the prestige or power to do so, to guide the game into a game-theoretic solution.

(c) In "SP Reloaded", deliberation about the social rules of the game begins when players have become economically differentiated after a certain number of rounds and an asymmetry of power has been established. Deliberation occurs if one or more players request it and all others are willing to accept the choice. This represents in a

stylized form the way in which participatory planning actually takes place in our current society. There are different reasons why farmers might request and accept (or not) to formally deliberate about the rules. For example, (1) a player – either "rich or poor" might want to explore new ways of cooperation and mediation that can increase everyone's income. The rest might be willing to accept these changes (or not) depending on how they expect such additional income will be distributed. (2) A poor player, in the name of distributive justice, might want to explore a more equitable way of occupying the territory and a rich player might be willing to accept it if he/she considers the change morally fair. (3) A player might wish to muster collective wisdom to explore all the strategic, ethical and aesthetic possibilities of the game.

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