Appendix 2.
Description of procedure for identifying the Outcome Set for Sierra Springs for ME

Under ME, the SS game can be analyzed as a puzzle that combines arithmetic and geometric elements. Because of the interacting, multi-scale effects of its rules, SS lends itself to solution through use of a combination of constraint-propagation and searches (much like Sudoku).

Many of the constraints that we used in identifying SS's outcome set result from the riparian zones' restrictive environmental and spatial conditions. Players cannot avoid competing in those zones if they are to earn at least the subsistence living. From the constraints upon players' riparian-zone options, other constraints can be inferred to reduce the search space to a manageable size.

Configurations of tokens that satisfy ME can be classified according to different frameworks. The framework that we used is that an outcome is a legal riparian colonization to which four additional sets of tokens—one set for each quadrant interior—have been "fitted" to produce a configuration that satisfies ME. The outcome-identification procedure that we based upon this framework was, broadly, as follows:

1. Identify and list all of the legal riparian colonizations.
2. For each legal riparian colonization, identify the sets of four quadrant-interior colonizations that, when used in combination with the riparian colonization under consideration, satisfy ME.
3. From the list of combinations of riparian and quadrant-interior colonizations generated in Steps 1 and 2, eliminate any that (when deployed on the SS board) are rotations, reflections, or inconsequential rearrangements of each other.

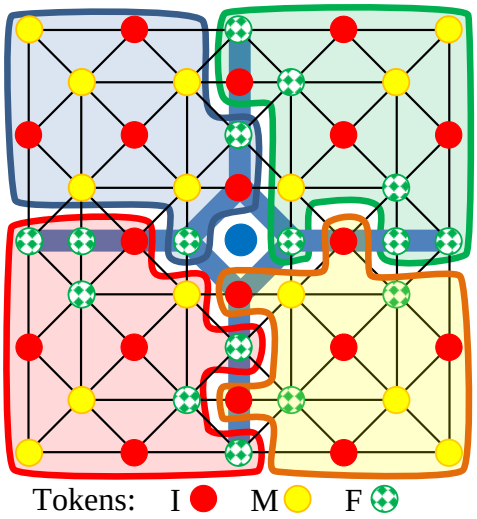
The list of combinations that results from Steps 1 through 3 is the outcome set for ME. The same riparian constraints that make SS amenable to solution via that procedure make the framework that we employed useful for understanding the players' forms of coordination and competition. Some terms (and corresponding acronyms) chosen for describing outcomes according to that framework are used in Figure 2a (reproduced here for the reader's convenience).

- Riparian Triad (RT): The set of tokens placed on riparian sites by a single player.
- Complete Triad (CT): The complete set of tokens placed by a single player. (Includes those placed on both riparian and quadrant-interior sites).
- Outcome (Sometimes referred to in this paper as a "Board"): An arrangement of tokens that satisfies ME. All arrangements that are reflections, rotations, or trivial rearrangements of each other are classified as the same outcome.

Note that Figure 2b of the main text is not an outcome since it does not give 24 points to each player.

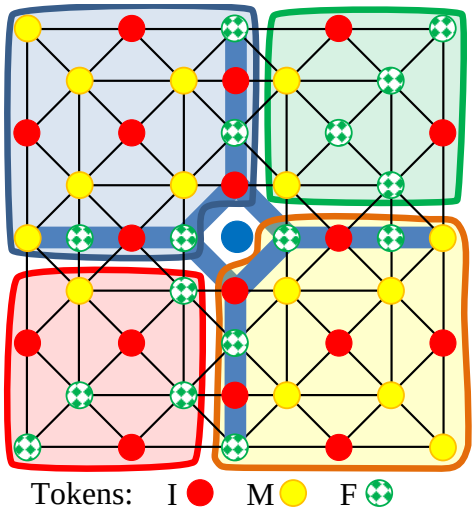
Fig. 2. Schematic diagrams of the SS game board, showing results that give the maximum possible number of bonuses for the group of four players under two different conditions: (a) Obligatory ME, and (b) no obligation to achieve ME. Lines drawn around each quadrant enclose the tokens placed by each player. In (b), players 1 and 3 have been ceded control of all of the riparian sites that are available to them. RT = The set of tokens that the player has placed on riparian sites. (Format is [<number of F tokens>, <number of Ms>, <number of Is>].) CT = The complete set of tokens that the player has used. (Format is the same as for RTs.) Total Bonuses = sum of PES and PB. PB =Provision Bonus (equal to the number of points earned in excess of the 24 needed for survival). (Note that (b) is not an outcome because it does not give 24 points to each player.)

(a) ME plus 4 bonuses



	Player			
	1	2	3	4
RT [F,M,I]	[2,0,1]	[4,0,1]	[0,0,3]	[4,0,1]
TC [F,M,I]	[2,5,4]	[6,3,4]	[2,3,6]	[6,3,4]
Points	24	24	26	24
Total bonuses	0	1	2	1
PES	0	1	0	1
PB	0	0	2	0

(b) Maximum possible bonuses if ME not met



	Player			
	1	2	3	4
RT [F,M,I]	[4,1,3]	[0,0,0]	[4,1,3]	[0,0,0]
TC [F,M,I]	[4,6,6]	[4,2,2]	[4,6,6]	[4,1,3]
Points	34	14	34	15
Total bonuses	10	0	10	0
PES	0	0	0	0
PB	10	0	10	0