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Applying evolutionary games to Sanitation Boards

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1 Introduction

Sanitation Boards (SBs) provide drinking water and sanitation in rural and urban communities with populations up to 10.000 inhabitants in Paraguay.

SBs have very different levels of success; some are efficient and sustainable over the time, but others have problems to persist and financial problems. Some of the problems are related to inadequate tariffs, electricity cost and high rate of morosity due to difficulties in applying the existing rules to users that avoid paying their bills for several months but still use the service [2, 3].

We are interested in the last two of them, the high rate of non-payment reached and the inability of SBs to apply existing norms with users that fail to pay their bills.

In this work we formulate the sustainability problem of SBs as a cooperation problem [6]. In the literature, there are evolutionary games models studying the evolution and maintenance of cooperation in a group of people [4, 5]. We propose that these models can reproduce the behavior of SBs and give a better understanding of the problem because as in the literature, depending on the circumstances a rock-scissors-paper cycle behavior is observed in the SBs.

2 Numerical Results

This is a part of an ongoing work. At this moment we have general data [7] and we are in the process of collecting more specific data from SBs. With data from [7] we implement [4]. We compare three SBs (ITA1, ITA2 and ITA3) with different level of cooperation (Figure 1).

According to the Figure 1 in groups with small (ITA3) or large cooperation (ITA1) cycles are more pronounced than in medium cooperation (ITA2). Depending on the amplitude of the cycles, the quality of service and operation of the SB would be more or less

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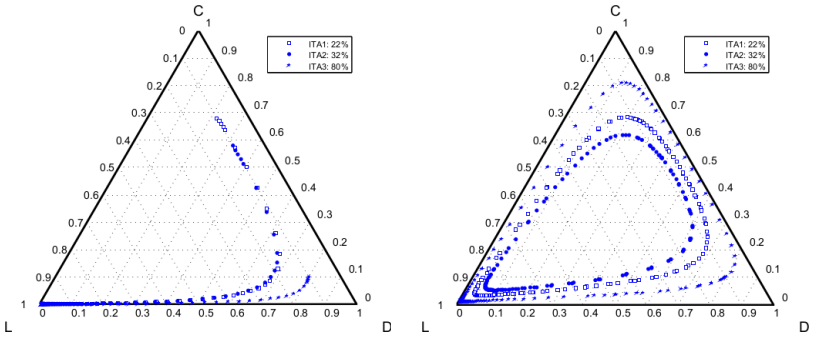

(a) (b)

Figure 1: Comparation of SBs with different level of cooperation. Parameters: N=5, (a)r=1.8, σ=0.5 y (b) r=3, σ=1. Initial values: ITA1 $x_c = 0.68$, $x_d = 0.22$ y $x_l = 0.10$; ITA2 $x_c = 0.58$, $x_d = 0.32$ y $x_l = 0.10$; ITA3 $x_c = 0.10$, $x_d = 0.80$ y $x_l = 0.10$

affected. As a result, ITA2 will have a less variation in the service than the others two groups but it will have to deal with a higher rate of non-payment.

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References

[1] UNICEF and World Heald Organization. Progress on Sanitation and Drinking Water: Update and MDG Assessment. UNICEF/WHO, 2015.

[2] J. Abbate Diálogos por el agua: Sistemtización de los 4 foros de Escucha con las Juntas de Saneamiento del Paraguay. GEAM/AVINA. 2011.

[3] PNUD. Experiencias ciudadanas innovadores: juntas de saneamiento y farmacias sociales en el Paraguay. 2008.

[4] C. Hauert, S. De Monte, J. Hofbauer, and K. Sigmund Volunteering as Red Queen mechanism for cooperation in public goods games. *Science* 296(5570):1129–32. 2002.

[5] T. Sasaki, A. Brannstrom, U. Dieckmann, and K. Sigmund. The take-it-or-leave-it option allows small penalties to overcome social dilemmas. *Proc. Natl. Acad. Sci. U. S. A.*, vol. 109, no. 4. 2012.

[6] R. Botta,G. Blanco and C. Schaerer. Evolution of cooperation in evolutionary games for Sanitation Boards, 17, 2, 6:1-17 *CLEI Electronic Journal. 2014.*

[7] SENASA. Base de Datos de SENASA . 2016.