



Game Theory in water resources management

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Rural water management is a basic requirement for the development of the primary sector and involves the exploitation of surface/ground-water resources. Rational management requires the study of parameters that determine their exploitation mainly environmental, economic and social. These parameters reflect the influence of irrigation on the aquifer behaviour and on the level-streamflow of nearby rivers as well as on the profit from the farming activity for the farmers' welfare.

The question of rural water management belongs to the socio-political problems, since the factors involved are closely related to user behaviour and state position. By applying Game Theory one seeks to simulate the behaviour of the system 'surface/ground-water resources to water-users' with a model based on a well-known game, "The Prisoner's Dilemma" for economic development of the farmers without overexploitation of the water resources. This is a game of two players that have been extensively studied in Game Theory, economy and politics because it can describe real-world cases.

The present proposal aims to investigate the rural water management issue that is referred to two competitive small partnerships organised to manage their agricultural production and to achieve a better profit. For the farmers' activities water is required and ground-water is generally preferable because consists a more stable recourse than river-water which in most of the cases in Greece are of intermittent flow.

If the two farmer groups cooperate and exploit the agreed water quantities they will gain equal profits and benefit from the sustainable availability of the water recourses (p). If both groups overexploit the resource to maximize profit, then in the medium-term they will incur a loss (g), due to the water resources reduction and the increase of the pumping costs. If one overexploit the resource while the other use the necessary required, then the first will gain great benefit (P), and the second will suffer a significant loss (G). According to Game Theory both parties, due to lack of confidence, will not cooperate and will eventually overexploit the resource, although their long-term interests would be the rational management. The lack of cooperation between the two players leads in the 3rd preference of each player, while cooperation secures their 2nd preference. In addition, the administrative authorities may intervene in the game by setting penalties (fines, irrigation block) on players who have "unorthodox" behaviour to ensure collaborative strategy.

Game Theory techniques obtain the equilibrium point of the system as the outcome of interaction among stakeholders through a process of supply-demand under cooperation and conflict. For every strategy, functions will be formed such that to be used for any agricultural product and in different regions based on rural water costs. Thus, the game applies under variable annual strategies and time intervals providing the accumulated profit of the stakeholders with respect to the environmental cost. The outcome will provide a useful decision-making tool for both stakeholders and administrative authorities for optimal water resources management in relation to the agricultural development.