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A METHOD FOR STRATEGIC DECISION MAKING IN A WATERSHED: GAME THEORY

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Abstract

Rapid growth of urban areas and their development problems in industrializing countries have had major impacts on the environment. Water, the main source of life on earth is under the threat of various types of pollution. These threats have been forceful in demonstrating the necessity of the management and planning of drainage basins. The importance of the evaluation of the total economic value of the water resources and aquatic ecosystems of drainage basins has not yet been accepted in the current planning system of Turkey. However, there are many actors and regulations about environmental issues and planning. Furthermore, these actors can make decision, independently. This situation causes conflicts among actors, so the situation calls for the organization of special drainage management institutions for drainage basins.

The aim of this paper is to explore the use of game theoretic approach to analyze the strategic decisions of different interest groups (players) and develop a better understanding of the decision making process and its consequences on a drainage basin. We use the case of the Nilüfer Watershed from the north-western region of Turkey. The Nilüfer Watershed contains fertile agricultural lands and the third biggest industrial city (Bursa). In addition, a strategic plan prepared for Bursa Province, so we can evaluate some strategies with helping game theory, and application of the strategic decisions will also discuss.

Key words: strategic decision making, game theory, sustainable development, water basin planning.

1. Introduction

Ever since the II. World War our planet has been experiencing continuous growth of population and consumption of natural sources. Environmental problems and sustainable development policies have been on the agenda of a number of the United Nations Conferences, especially after 1980s. (Bartone, C., and others, 1995; Serageldin and others, 1995). Indeed, the significance of the ecological approach for economic growth was being discussed as early as 1970s (Isard, 1972; Kozlowski and Hughes, 1972). These efforts pointed to the need for a renewed way of addressing such problems. Spatial planning today is faced with the challenge to promote sustainable urban development and management policies to overcome the economic and ecological costs. The management and protection of the water resource and the hydrological system is closely related to the sustainable management of river basins. Therefore the ecological approach to planning has emphasized the importance of the river basin concept in spatial planning (Teclaff, 1996; Aydemir and Aydemir, 1998; Heathcote, 1998; Reimold, 1998).

The concept of "river basin" as an integrated spatial planning unit is not recognized in the current planning and management system in Turkey even though specific river basins are defined by the General Directorate of State Hydraulic Works (DSI). Although, water basin development plans (only drinking water resources) also take place within special purposed physical plans and special location plans, water basin management can not be solved (Ünal, 2003; Law no: 4856, 2003; Law No: 5216, 2004; http://www.dsi.gov.tr). Therefore, there are many actors who make decision on environmental and planning issues in a watershed.

Strategic planning approach is also a suggested tool for sustainable development (Hens and Nath, 2003; Williams, 2002; Leitmann, 1994). Strategic choice approach, which is used in industrial management, depends on decision theory. Strategic planning has been used, especially in England, since the 1960s, and systematic methods have been developed in British strategic planning such as interrelated decision areas technique. Today, strategic planning occurs in the EU directives for a balanced regional development with environmental consciousness (Williams, 2002). The concept of "strategic planning" has been appropriated especially in metropolitan cities in Turkey, recently. The Municipality Law (Law no: 5272, article 17, 38, 41, 2004) and the Metropolitan Municipality Law (Law No: 5216, article 7, 18, 2004) consist of strategic plan approach.

This paper aims to explore the applicability of the game theory to the problem of strategic decision and sustainable development within a river basin. According to Selten (1988), most of the strategic decision problems occur in human life and they are quite complicated. Usually, rational solutions are not easily available. Selten (1988) emphasizes "strategic decision problems of business and war are subject to the additional difficulty that the unstructured nature of such situations makes it very hard to analyze them in a rigorous way". We believe that decision making under uncertainty or non-cooperative situation in planning seems like the decision problems of business and military. Nijkamp (1980) proposes negotiations between agents for solving externalities in environmental problems and he added that game-theoretic strategies could be used for negotiations. Therefore, game theory, which explains the uncertain situation that many decision makers are in, will affect planning discipline in a positive way.

2. Method: Game Theory

Game theory explains the interactive decision making process in the situation with more than one decision maker (Von Neumann and Morgenstern, 1944; Luce and Raiffa, 1967; Myerson, 1991; Aumann and Hart, 1992). Möbius (2004) explains "game theory is a formal way to analyze interaction among a group of rational agents who behave strategically". Luce and Raiffa (1967) define the term of interactive such as "each player attempts to maximize his utility in a situation where his outcome depends not only upon his choice, but upon the choices of each of the other players; in turn, their choices are influenced by the choice they think he is going to make, for they too are attempting to maximize a function over which they do not have full control". Rationality and common knowledge are basically assumed in the theory (Luce and Raiffa, 1967; Rasmusen, 1994). In other words, every decision maker chooses what is best for his/her and expects the best response.

Modern applications of game theory, in particular to social sciences, use mainly non-cooperative games; because non-cooperative games are better at defining real world situations (Gardner, 1995; Ritzberger, 2002). Players, information, strategies, payoffs, and equilibrium are essential elements in a game (Rasmusen, 1994). Information of players about the decision situation affects choices of players. Indeed, expectations or preferences are determined to be a players' decision (Von Neumann and Morgenstern, 1944; Luce and Raiffa, 1967). Games, in which each player knows exactly what has happened in previous moves, are called games with “perfect information” such as chess (Mycielski, 1992). Additionally, if every player knows the rules of game and payoff function, a game has complete information (Vego-Redondo, 2003; Fudenberg and Tirole, 1991). Some special two-person, non-cooperative games are shown in Table 1.

Table 1 Two-Person, Non-Cooperative Games (www.gametheory.net)

Prisoner’s Dilemma

		Prisoner 2	
		Deny	Confess
Prisoner 1	Deny	1, 1	0, 8
	Confess	8, 0	**2, 2**

Battle of the Sexes

		Husband	
		Boxing	Opera
Wife	Boxing	**1, 2**	0, 0
	Opera	0, 0	**2, 1**

Matching Pennies

		Player 2	
		Heads	Tails
Player 1	Heads	1, -1	-1, 1
	Tails	-1, 1	1, -1

Rock Paper Scissors

		Child 2		
		rock	paper	scissors
Child 1	rock	0, 0	-1, 1	1, -1
	paper	1, -1	0, 0	-1, 1
	scissors	-1, 1	1, -1	0, 0

For games with only two players, the strategic form can be very conveniently represented by two matrices of the same dimension. Player 1’s pure strategies are identified with the rows of the matrices (player 1 is the “row player”) and player 2’s pure strategies are identified with the columns of the matrices (player 2 is the “column player”). The left entry is Player 1’s pay off and the right, player 2’s. Bold characters represent the best response each player.

Equilibrium is a set of the best strategies. In other words, in equilibrium, each player is playing the strategy that is a "best response" to the strategies of the other players (Gardner, 1995). No one has an incentive to change his strategy given the strategy choices of the others. Dominance approach is used to solve two-person games. A dominant strategy solution exists when every player has a dominant strategy (Von Neumann and Morgenstern, 1944; Vego-Redondo, 2003). For instance, players have a dominant strategy in the Prisoner’s Dilemma Game, so the pair of the dominant strategies is equilibrium point (see in Table 1). However, some games have no dominant strategy. These kinds’ games are solved by process of elimination which is called iterated dominance or iterated strict dominance (Fudenberg and Triole, 1991; Ritzberger, 2002). The Battle of the Sexes and

The Matching Pennies (see in Table 1) can not be solved by a dominance approach. On the other hand, a mixed strategy equilibrium also exists. Nash (1951) defines equilibrium points as “a finite non-cooperative game always has at least one equilibrium point”, and in a Nash equilibrium each agent plays the best response to the equilibrium strategies of the other agents. Vego-Redondo (2003) defines more detailed the theorem; “in every game where there is any finite number of players and these players have only a finite number of pure strategies available, some Nash equilibrium (possibly in mixed strategies) always exists”. Selten (1988) introduced the idea of refinements of the Nash equilibrium with the concept of (subgame) perfect equilibria in 1965. Aumann (1974) proposed the concept of a correlated equilibrium and Myerson (1994) has developed this equilibrium concept. Harsanyi (1967) developed the Bayesian Nash equilibrium in games with incomplete information. At the same time, cooperative game theory reached important result in papers by Nash (1950) and Shapley (1953) on bargaining games. Aumann and Hart (1992) define the bargaining theory as a “bridge” between the non-cooperative and the cooperative game theory.

After the publication of Von Neumann and Morgenstern’s (1944) book, game theory has become an increasingly important approach for theoretical analysis in the social sciences such as international relationship, sociology, psychology, evolutionary biology, computer science and management sciences. However, the theory has been widely used in economy and war scenarios. Although game theory applications in planning are limited in number, they are very important studies on location problem in spatial planning. Stevens (1961) researches the strategic problem of two competitive sellers’ location along a line. Hotelling formulation was used to solve this problem as a simple two-person, zero-sum game. Isard and Reiner (1962) explore behaviours of industrialists who choose location for investment. Isard (1967) investigates the location of a large-scale steel plant in alternatives of three regions which desire to promote an industrial agglomeration. The choosing procedure is an alternating leader-follower procedure. Gabszewich and Thisse (1992) designed the model to describe spatial competition among firms. In this model, a population of consumers is spread out over a geographical area, while firms selling a homogeneous product are located in the same space. Furthermore, firms named as players, and prices and/or location determined strategies.

We see that game theory is commonly used in location problems in planning. On the other hand, game theory is vastly used in environmental problems such as sharing of natural resources problems and reduction of emission. Hardin (2000) published a paper called “the Tragedy of the Commons” in 1968. This famous paper deals with “freedom in a commons brings ruin to all”, and he applied the prisoners’ dilemma to the problem of population growth and natural resources. In addition, water-sharing and reduction of emission problems requires cooperation amoung countries, and the outcomes depend on cooperation of agents in these studies (Ray, 2000; Maler and Zeeuw, 1998; Barret, 1998; Kuismin**,** 1998). Similarly, sharing problem of a river as a natural resource is the main study area in environmental planning and regional science (Dinar and Wolf, 1994; Kucukmehmetoglu and Guldman, 2002; Rogers, 1993). Freeman (2000) used the game theoretic approach, also for a water-sharing problem according to international law in Tigris-Euphrates Basin. Other research is about the Tigris-Euphrates River using game theory by Kucukmehmetoglu (2004). In the paper, coalition among agents is discussed and satisfying the level of each country is demonstrated by using Shapley Value.

In this paper, strategic decision making processes are analyzed in two-player and non-cooperative games, and Nash equilibrium is explored in these games. Players generally make independent decisions without any form of cooperation situation in the Nilüfer watershed. Decision makers, behaviours, and conflicts are examined next chapter. We evaluate the strategies of industrial development, environmental protection and industrial location in the watershed which are determined by Bursa 2020 Strategic Plan.

3. Determination of Decision Makers, Strategies and Conflicts in the Nilüfer Watershed

3.1. Economic Development and Environmental Infrastructure

The Nilüfer Watershed, which is the most polluted part in the Susurluk River Basin from the north-western region of Turkey, is chosen as the case study area. The Nilüfer Stream is deeply polluted by industrial, agricultural and domestic wastewater (Bursa Environmental Report, 2000; Report of Bursa Wastewater Master Plan, 2002). The provincial border of Bursa does not correspond with the Nilüfer Watershed’s natural borders. Basin boundaries and administrative borders do not match and this creates many actors as decision makers. The geographical location of the Nilüfer Watershed is seen below Figure 1.

There has been an increase in the population growth rate within the area due to the industrial development in the 1960s and since then. In 2000, population of the Bursa Province was over 2 million and 3.3 million people are expected to live in metropolitan region in 2020 (SIS, 2002a; Bursa 2020 Strategic Plan, 1998). Therefore, the environmental infrastructure of the city of Bursa has been planned according to expected population (Report of Wastewater Master Plan, 2002). However, its infrastructure is not even sufficient to fulfill the needs of its present population. There are sewerage systems in all the settlements that have municipality, but cesspools are used in villages. However, none of the settlements have wastewater treatment plants except the Bursa metropolitan area. Unfortunately, the other settlements' domestic wastewaters are discharged directly into the Nilüfer Stream or its branches. Additionally, leakages of domestic solid wastes cause ground water pollution because of inefficient sanitary landfill (Report of Wastewater Master Plan, 2002, Bursa Environmental Report, 2000; Bursa 2020 Strategic Plan, 1998, Action Plan of Blue Nilüfer, 1997).

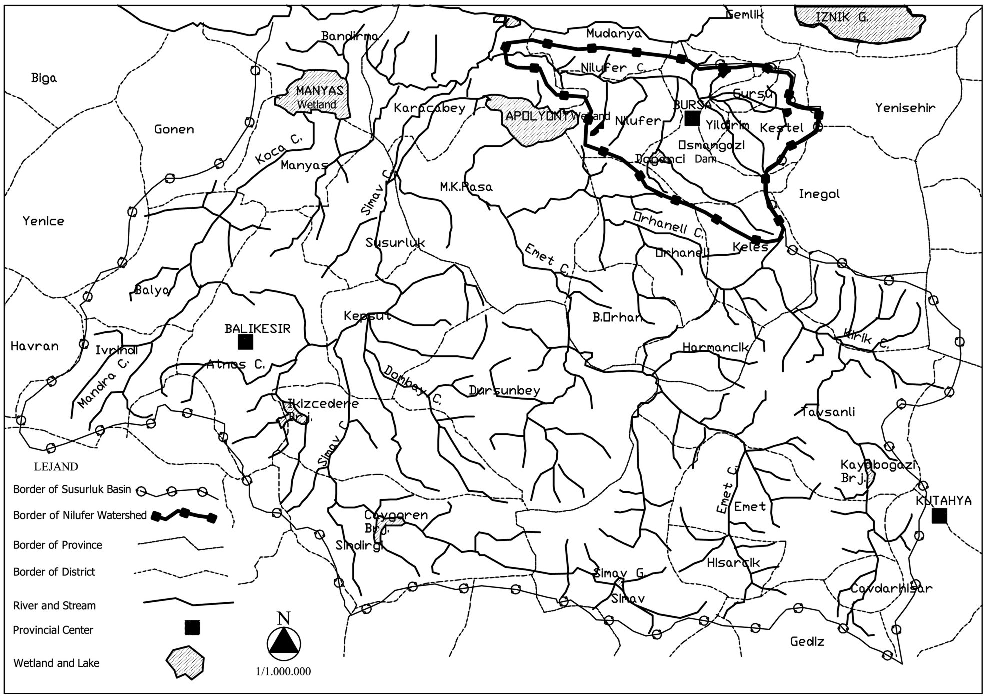

Figure 1. The Nilüfer Watershed in the Susurluk River Basin (adapted from DSI, 2000; Geographical Map of Turkey, p 20,21, 40, 41, 2004; Basaran and Bölen, 2004)

Bursa is the third biggest industrial city in Turkey (SIS, 1993; SIS, 2002a). Nowadays, there are 6 organized industrial districts and 2 small scale industrial areas in the watershed. Additionally, 2 more organized industrial districts and 9 small scale industrial areas are under construction. The organized industrial districts in the watershed do not have a common wastewater treatment plant except the Bursa Organized Industrial District. The Bursa Organized Industrial District was constructed in 1961, and the common wastewater treatment plant was built in 1998 (Report of Wastewater Master Plan, 2002, Bursa Environmental Report, 2000; Action Plan of Blue Nilüfer, 1997). Land use in the watershed is shown in the Figure 2.

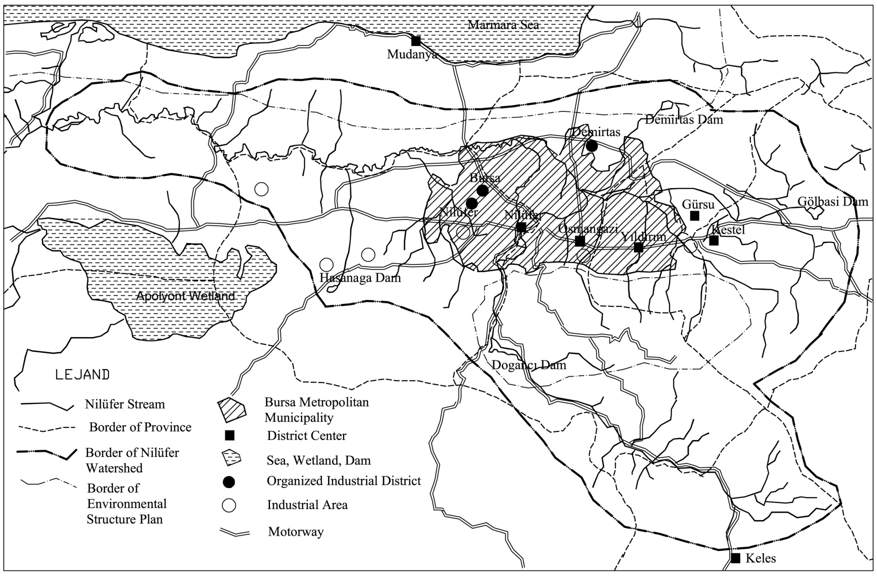

Figure 2 Land Use in the Nilüfer Watershed (Basaran, 2003; Basaran and Bölen, 2004)

Furthermore, there are many factories which are separately located in Bursa. Approximately 588 plants are established (as of 2000) in Bursa Province, and 58,5 % of establishments –neither private sector nor public sector- do not have a wastewater treatment plant (see below in Table 2). Due to the increasing product costs, existing ones are not working effectively. Hence, all industrial wastewater is discharged without treatment to surface water in the watershed (Bursa Environmental Report, 2000; DSI, 2000). Therefore, we can declare that authorities who are in charge of inspecting water pollution do not fulfill their duties.

Table 2 Wastewater Treatment Plants of Factories in Bursa, 1998 (Bursa Environmental Report, p.71, 2000)

Sectors	**Number of companies**			**Number of companies which have insufficient wastewater treatment**		
	Sum	Public	Private	Sum	Public	Private
Food	205	8	197	187	8	179
Textile	128	2	126	59	-	59
Leather	162	-	162	58	-	58
Other sectors	93	4	89	40	1	39
SUM	588	14	574	344	9	335

In addition to industrial development, agricultural products have always been considered very important for the economy of Bursa city (SIS, 1982; SIS, 1998). The Watershed has fertile agricultural lands, but they are destroyed by unplanned industrial and housing areas (Bursa Environmental Report, 2000; Bursa 2020 Strategic Plan, 1998). Furthermore, the Nilüfer Stream cannot be used for irrigation because of pollution. The pollution of the Nilüfer Stream causes an increasing demand on ground water, so a shortage of fresh water causes increasing competition among settlement, industry and agriculture.

The pollution of the Nilüfer Stream has been periodically measured by the General Directorate of State Hydraulic Works (DSI). As measurements of the DSI, water pollution and fresh water consumption have increased because of the industrial development, agriculture and growth of population in the watershed. The results of the water analysis of 1979-1982 showed that the stream was polluted, and according to the analysis of 2000, pollution is still increasing. It is possible to say that the biological balance in the stream is completely destroyed (DSI, 1984; DSI, 2000).

3.2. Decision Makers, their Behaviours and Conflicts

There are 31 official authorities who make decisions on the environmental issues and planning in the watershed; 6 local units (provincial directorate of ministries) and the Regional Directorate of State Hydraulic Works, the Bursa Provincial Governor, the Bursa Special Provincial Administration, the Bursa Metropolitan Municipality, 3 District Municipalities within of the Metropolitan Municipality (Nilüfer, Yildirim, Osmangazi), 7 District Municipalities (Keles, Gürsu, Mudanya, Karacabey, M.K.Pasa, Orhaneli, Kestel) and 11 Sub-District Municipalities (Basaran, 2003; Basaran and Bölen, 2004). In addition, private enterprises and residents affect the decision making process.

All decision makers (players) have their own tasks and each one develop its strategy according to its own task. Some strategies conflict the other players' strategies. Most obvious conflicts are about authority in preparing plans, and they are competing to be the approval authority. Municipalities do not want to accord with decisions on industrial land use in the upper scale plan (Ünal 2003, Basaran, 2003; Dasöz, 1995). Moreover procedures on discharge permissions, emission permit and operation licenses have a complex decision making process. It is not clear that institution is granting which permit and who holds the authority; these all create chaos (Basaran and Bölen, 2004). For example, the Ministry of Environment and Forestry is responsible for "discharge license" outside the Bursa Metropolitan Municipality borders, and the Ministry has higher wastewater standards than the standards of the Bursa Metropolitan Municipality do (Regulation, 2004; Regulation, 1998). However, the Ministry of Environment and Forestry does not have enough personnel and sufficient budget for monitoring and inspection. Furthermore, district municipalities are easier on handing out licenses for industrial investments.

In recent years, unplanned industrial areas are increasing around Bursa. As planned industrial areas are fully occupied and prices of industrial lands are high, entrepreneurs choose settlements where land is cheaper. Industrial companies are willing to be close to these settlements, thus they choose to be close to Bursa (Bursa 2020 Strategic Plan, 1998). Districts of the city consider industry as a step towards development and progress; therefore they want industrial terrains in their areas.

In conclusion, we observe a non-cooperative situation in the watershed, because a watershed planning and management system does not exist. This situation has threatened the sustainability of water as a natural resource. Indeed, the co-organization of the decision makers and cooperation among stakeholders may provide the sustainability of the watershed.

4. Evaluation of the Strategic Decision Process

The Bursa 2020 Strategic Plan is examined for determination of strategic decisions. The Bursa 2020 Strategic Plan, which was approved in 1998, is one of the first strategic plan experiences in Turkey. The Strategic Plan was prepared together by the Bursa Provincial Governor, the Ministry of Public Works and Settlement, and the Bursa Metropolitan Municipality. Provincial boundaries are accepted as boundaries for the plan (The Bursa

2020 Strategic Plan, 1998). However, a solid management system is not mentioned. Therefore, the plan involves many authoritative parties, and this situation cause to increase conflict among decision makers (Bademli, 2001).

Bursa 2020 Strategic Plan (1998) is based on two basic strategies; economic development and environmental protection, because industrial development and environmental protection are the major conflict in the watershed at the moment. This conflict can be represented by the game of the Battle of the Sexes (Matrix 1). When the environmentalist chooses the strategy of industrial development, industrialist prefers the strategy of industrial development. The environmentalist wins “1” unit, because environmental costs rise for the environmentalist, and the industrialist wins “2” unit, because the industrialist increases economic benefit. On the contrary, when the environmentalist chooses the strategy of environmental protection, the industrialist prefers the strategy of the environmental protection, so the environmentalist wins “2” unit, the industrialist wins “1” unit.

Matrix 1 Conflict between Environmentalist and Industrialist

		Industrialist	
		Industrial development	Environmental Protection
Environmentalist	Industrial development	**1, 2**	0, 0
	Environmental Protection	0,0	**2,1**

In short, if the strategy of environmental protection is chosen, the industrial development should be restricted, or players have to pay environmental costs. However, we realize that municipalities, public authorities and industrial investors do not consider environmental costs in the watershed. The municipalities have not yet solved their environmental infrastructure problems, and the most of the factories have no wastewater treatment plant, and they have no discharge license, but they work (Bursa Environmental Report, 2000; Bursa Metropolitan Municipality, 2004). That is to say, decision makers in the watershed prefer the strategy of industrial development. On the other hand, a balance should be found between these two strategies for sustainable development.

The Bursa 2020 Strategic Plan (1998) targets environmental protection. The Bursa Metropolitan Municipality has also appropriated same strategy. However, this strategy causes the conflict between municipalities and industrial enterprises. The conflict is illustrated in Matrix 2.

Matrix 2 Conflict between a Municipality and an Industrial Enterprise

		Industrial enterprise	
		Environmental protection	Industrial development
Municipality	Environmental protection	1, 1	0, 3
	Industrial development	3, 0	**2, 2**

As seen in Matrix 2, when the municipality chooses the strategy of environmental protection, if the industrial enterprise prefers the strategy of environmental protection, both players win “1” unit. However, if the industrial enterprise prefers the strategy of industrial development, the industrial enterprise wins “3” unit whereas the municipality does not gain a utility, because environmental costs of the municipality increase. On the other hand, the municipality chooses the strategy of industrial development, if the industrial enterprise prefers the environmental protection, the municipality wins maximum payoff “3”. If the industrial enterprise prefers the strategy of industrial development, both player wins “2” unit. This situation seems like the Prisoner’s Dilemma game. The strategy of industrial development is dominant strategy for the municipality and the industrial enterprise, so the game has a Nash equilibrium (2, 2).

The Bursa Strategic Plan (1998) proposes to direct industrial investments to organized industrial districts, because it has provision to control industrial pollution. On the other hand, no more industrial plants will be allowed in districts of Kestel and Gürsu (upstream area) which were once at the outskirts of the city and now they are integrated in the city. This way the Bursa plain will be protected and the pollution on the up-stream basin will not be carried down-stream. It is a very important problem that pollution is carried by water and local authorities are not willing to take responsibility for the cost of the pollution. The Metropolitan Municipality does not want to be held responsible for water pollution caused by up-stream industrial plants. The same situation is the case for the down-stream areas of the watershed. Pollution caused within the Metropolitan Municipality creates negative effects for the agriculture in the down-stream of the watershed. This shows that the basin should be considered and treated as a whole to overcome these problems. All agents are linked and the decision of one would influence the other and vice versa.

The Bursa Strategic Plan (1998) targets environmental protection and the reduction of industrial water pollution. In addition, the Bursa Metropolitan Municipality appropriates the strategies of improvement the quality of life and environment, and the sustainability of ecologic system. Improving environmental infrastructure and municipal wastewater treatment is also the main strategy. Furthermore, the Metropolitan Municipality aims to develop a sewerage system outside the metropolitan area (Report of Wastewater Master Plan, 2002; Bursa 2003).

In the Matrix 3, the strategic decision process is analyzed between the Metropolitan Municipality and an industrial enterprise. Each player has two strategies. The first strategy of the Metropolitan Municipality is to develop industry and to direct industrial investments to organized industrial districts in the downstream area (S_{A1}), and the second strategy is to develop environmental infrastructure in the watershed (S_{A2}). The industrial enterprise has two location strategies; to locate in the organized industrial districts in the upstream (S_{B1}), to locate in the organized industrial districts in downstream (S_{B2}).

In the watershed, industry trends to develop at up-stream areas, because of proximity to Bursa city, transportation and housing facilities. The second biggest organized industrial district (Demirtas) locates in upstream. In addition, Kestel Organized Industrial District established in upstream, in 2004. In short, industrial enterprises trend to locate in upstream, so the first location strategy of player B has maximum payoff (3). The decision making process between the Metropolitan Municipality and an industrial enterprise illustrates in Matrix 3.

Matrix 3 The Decision Making Process of the Metropolitan Municipality and an Industrial Enterprise

		Industrial Enterprise	
		S_{B1}	S_{B2}
Metropolitan Municipality	S_{A1}	0, 3	3, 2
	S_{A2}	**1, 3**	0, 2

When the Metropolitan Municipality chooses the first strategy (to develop industry and to direct industrial investments to organized industrial districts in the downstream area- S_{A1}), the industrial enterprise prefers the first strategy (to locate upstream area-S_{B1}). Hence, the Metropolitan Municipality wins "0" unit, and the industrial enterprise wins "3" unit. On the other hand, if the Metropolitan Municipality chooses the second strategy (to develop environmental infrastructure in the watershed), industrial enterprise prefers the first strategy (to locate upstream area), again. Thus, the Metropolitan Municipality wins "1" unit, industrial enterprise wins "3" unit. The pair of the strategy ($S_{A2,}$ S_{B1}) shows the Nash equilibrium, so it is the best response for both players.

Matrix 3 indicates that the first strategy of the Metropolitan Municipality always fails in non-cooperative situation. If the industrial enterprise chose the second strategy, the Metropolitan Municipality would gain "3" unit instead of "1" unit. However, payoff of the industrial enterprise would decrease. In short, when district municipalities in upstream have the strategy of industrial development, industrial enterprises prefer to locate in upstream. Therefore, if the Metropolitan Municipality would like to realize the first strategy, conflict between her and district municipalities should be solved. The conflict matrix is seen in Matrix 4.

Matrix 4 Conflict between the Metropolitan Municipality and a District Municipality in Upstream

		The district municipality in upstream	
		Industrial development in upstream	Environmental protection
Metropolitan Municipality	Industrial development in upstream	0, 3	0, 1
	Preventing the upstream from industry	**3, 3**	3, 1

Despite of the Strategic Plan, coordination among actors can not be established. There is competition among municipalities in the watershed, so district municipalities plan new industrial areas. When player consider the Strategic Plan, the decision making process will change (see in Matrix 5).

Matrix 5 The Decision Making Process of the Metropolitan Municipality and a District Municipality in Upstream

		A district municipality in Upstream	
		Industrial development in upstream	Environmental Protection
Metropolitan Municipality	Industrial development in upstream	0, 3	0, 1
	preventing the upstream from industry	0, 0	**3, 1**

When players harmonize with the Strategic Plan, payoff of the Metropolitan Municipality increases whereas payoff of district municipalities decreases. In other words, if district municipalities prefer the strategy of environmental protection, their payoffs will decrease. Indeed, district municipalities do not want to give up the strategy of industrial development. Therefore, the Metropolitan Municipality should develop new strategy for industrial enterprises and the district municipalities. This situation is illustrated in Matrix 6.

Matrix 6 The Decision Making Process of the Metropolitan Municipality and an Industrial Enterprise

		Industrial Enterprise	
		S_{B1}	S_{B2}
Metropolitan Municipality	S_{A1}	0, 2	**3, 3**
	S_{A2}	1, 2	0, 3

When the industrial enterprise chooses to locate in downstream, the first strategy of the Metropolitan Municipality (to develop industry and to direct industrial investments to organized industrial districts in the downstream area-S_{A1}) realizes. However, this situation will create new conflicts among district municipalities of downstream. Competition for industrial income will rise among district municipalities, so environmental degradation will increase in downstream area. Indeed, improvement of the industrial location strategies may not solve environmental problem in the watershed.

5. Conclusion

In this study, interactive decision making processes are analyzed according to game theoretic approach in the Nilüfer Watershed. A watershed is chosen for analyzing of behaviours of decision makers (players), because environmental externalities could be easily understood in river systems. The Nilüfer Watershed, is a rich agricultural area, located in the heavily industrialized and urbanized Bursa metropolitan area. Furthermore, according to the General Directorate of State Hydraulic Works (DSI) data, water pollution increases in the Nilüfer Stream. The Nilüfer watershed’s natural border does not correspond with administrative border, and a watershed management does not exist. We determined 31 public authorities who decide on the environmental issues and planning in the watershed. All of the authorities develop own strategies, and they act independently from each other, so we explain this situation as a non-cooperative situation. Moreover, players do not consider environmental and planning legislation. However, the cooperation among decision makers will provide the sustainability of the watershed.

In this paper, the strategic decision making process is evaluated with two-person, non-cooperative games. The Bursa 2020 Strategic Plan involves the development of industry and the protection of environment. It also points out that these subjects are themes of the major conflicts in the city. This conflict of an environmentalist and industrialist represents the Battle of the Sexes game, and the game has no dominant strategy. In addition, the conflict of a municipality and an industrial enterprise is modeled like the Prisoner’s Dilemma game. The game demonstrates that the strategy of industrial development is dominant strategy for the municipalities and the industrial enterprises. In conclusion, players always choose the strategy of industrial development because of economic benefits.

The various environmental protection strategies were developed in the Bursa Strategic Plan. One of the main strategies is to lead industry in organized industrial districts in order to control their environmental impacts and to protect agricultural land. Moreover, Bursa is growing towards the west (downstream area) and new industrial areas will be organized here. Therefore, the strategies of the Metropolitan Municipality and the location strategies of the industrial enterprise are evaluated. The decision matrix shows that whatever strategy the Metropolitan Municipality chooses, industrial enterprise prefers to locate in upstream area. Furthermore, the strategy of to direct industry to downstream causes conflict between the Metropolitan Municipality and district municipalities of upstream. On the other hand, when the industrial investors choose location in downstream area instead of upstream area, it creates a new argument. Environmental degradation and industrial pollution can not be solved in a long term. This problem shows the importance and necessity of basin scaled planning. Water basins are ecological systems and decisions for one spot can affect the whole basin.

We believe that determination of payoffs in planning and environmental decision making process is an important problem. Generally, in many of the experiments with matrix games the payoffs have tended to be money, but some other measurement units are also used such as distance unit, time unit. However, payoffs of strategies cannot determinate in planning problems, easily. Therefore, payoffs should be determined by pre-analysis.

The main outcome of the paper will be to point to new directions in the planning process and to open to discussion the use of game theory in planning. Game theoretic approach will make it easier for the agents to cooperate if the conflicts in the planned area are clearly defined, and game theory provides evaluation strategic decision. It is possible to achieve cooperative bargaining solutions where all agents are winners. Actually, this is the target of planning because sustainable development of the river basin depends on bargaining where all agents are winners.

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