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MANAGEMENT AND POTANTIAL BIOGASE QUANTITIES OF WASTE FROM ANIMAL BREEDING ENTERPRISES: ANTALYA CASE

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Abstract

In the livestock enterprises, the wastes which are produced after the production can be shown as a pollutant source when not properly managed. Wastes from livestock enterprises must be stored and managed properly. The use of renewable energy sources is increasing due to the reduction of fossil energy resources and the environmental pollution of these resources. Biogas energy production among renewable energy sources in the direction of developing technology and increasing population needs can be applied in areas where animal breeding facilities are carried out. In case of animal wastes reaching underground and surface water resources for biogas production, water pollution will occur. Therefore, the properly storage of wastes on animal barns and transfer to biogas plants may remove the potential negative effects on water resources. In cases where waste from livestock enterprises is not stored properly, these enterprises will be the source of pollutants for water resources. In study area, primarily livestock potential enterprises that will cause pollution problems to water resources have been determined. Potential biogas quantities to be generated from these facilities have been calculated and the potential contributions of livestock enterprises to energy costs have been investigated.

Key words: *Antalya, Animal waste, Biogas, Water pollution.*

INTRODUCTION

Wastes that develop as a result of industrial and agricultural activities are among the primary reasons of water pollution (Kaplan et.al., 1999). In this regard, nitrogen and phosphorous are especially important with regard to both underground water pollution and eutrophication in surface waters. Eutrophication along with related ecological impacts prohibit the use of all water resources as drinking and service water in addition to endangering them (Sharpley, 1995; Anonymous, 2000).

Animal wastes may pollute surface and underground water resources as a result of uncontrolled waste management. This is caused due to impacts related with the animals directly reaching a water source, manure piles, surface flow waters seeping from shelters and open feeding areas, seepage from manure storage structures, submergence of storage areas in addition to surface flow from manure application areas and pastures (Anonymous, 2005).

Pollution of waters with nitrate (NO_3) is among the primary fields of interest among manure related pollution. Because nitrate (NO_3) is increasingly accumulated in the soil with manure that is defined as output in animal production and as input in plant growth. Certain amounts of this accumulated nitrate depending on various conditions such as soil, topography, climate etc. are washed and reach various depths of the soil and mostly the surface and underground water sources (Kaplan et. al. 1999).Nitrate pollution in underground waters attracts worldwide attention as a significant problem for areas that are near agricultural fields (McLay et.al., 2001).

A significant amount of manure is obtained in livestock businesses depending on capacity. Manure processing is a primary concern for many businesses and issues such as the cleaning, removal, storage and use of manure are either not noticed or emphasized. Solid and liquid manure that is obtained at various plants is either removed in an uncontrolled manner or is thrown away. The failure to make use of organic manure results in wasting of national wealth in addition to significant environmental issues (Şimşek et.al., 2001).

Biogas that is produced by transforming organic wastes into methane gas in an oxygen free environment can be used as a source of heat and electricity in businesses and the materials that remains at the end of the process can also be used as an enriched source of manure (Gül, 2006). The sulfur emission of biogas fuels is almost zero, they reduce acid rain, contribute to the atmospheric carbon cycle while preventing the increase of global warming (Saraçoğlu, 2004).

The study was carried out at the Antalya district of the Mediterranean Region in Turkey where people are mostly engaged in agriculture. Greenhouse cultivation is popular at the coastal parts of the city due to suitable climate conditions, however the number of livestock businesses increases with increasing distance from the sea. The objective of the study was to evaluate the total numbers of cattle per district in addition to the potential pollution and potential biogas production values for the total number of cattle. It has been considered that the study results shall contribute to the betterment of manure utilization applications in the study region as well as raising awareness regarding the pollution potential for water sources.

MATERIAL AND METHODS

Data regarding the capacities of cattle breeding businesses active in the region were acquired from 2016 VETBIS system data by way of Antalya Directorate of Provincial Food, Agriculture and Livestock. Livestock businesses were determined based on a consideration of their potential to pollute the water resources. In this regard, livestock businesses at the districts of Alanya, Manavgat, Korkuteli and Elmalı comprise the study material. Whereas the potential biogas energy amounts that can be obtained from businesses were calculated according to Hill (1982) and Ekinci et.al. (2010). Average amount of manure obtained from adult cattle can be taken as 43 kg/day for the calculation of manure amount. Accordingly, an adult cattle produces 1-1.5 tons manure/month. The energy value of the biogas volume due to cattle manure can be considered 20 MJ m^{-3} (Ekinci et.al., 2010). The MJ value that is taken as basis corresponds to the thermal energy value for the annual amount of manure that can be acquired from one cattle. In addition, the distance to water sources of the villages where the cattle breeding businesses in the study area are located in along with the elevation differences between the business and water source have been determined via Google Maps (Anonymous, 2018).

RESULTS AND DISCUSSION

Greenhouse cultivation in the city of Antalya is carried out in areas close to the coast with plant production as the primary agricultural output. The fact that the Taurus Mountains are located to the north of the city decreases the microclimate effect and thereby ovine and cattle breeding or fruit gardens resistant to cold climate are observed more in these areas. It is observed that the wastes and manure from cattle businesses in the region are directly discharged to the rivers. It was determined as a result of a comparison between the districts in the study region that livestock breeding is carried out in villages near water sources especially in the Korkuteli and Elmalı districts. When the total cattle numbers of the district in the study area were examined, it was determined that the cattle capacity of Korkuteli, Alanya, Elmalı and Manavgat are 20214, 4952, 10615 and 5734 respectively and that the distance of the businesses to the water sources was less than 5 km. Potential wet manure and biogas energy amount was calculated based on the number of animals in the study region according to Hill (1982) and Ekinci et.al. (2010). The distances to the water sources and potential pollution levels were tried to be determined for the wet manure amount from the businesses in the study region.

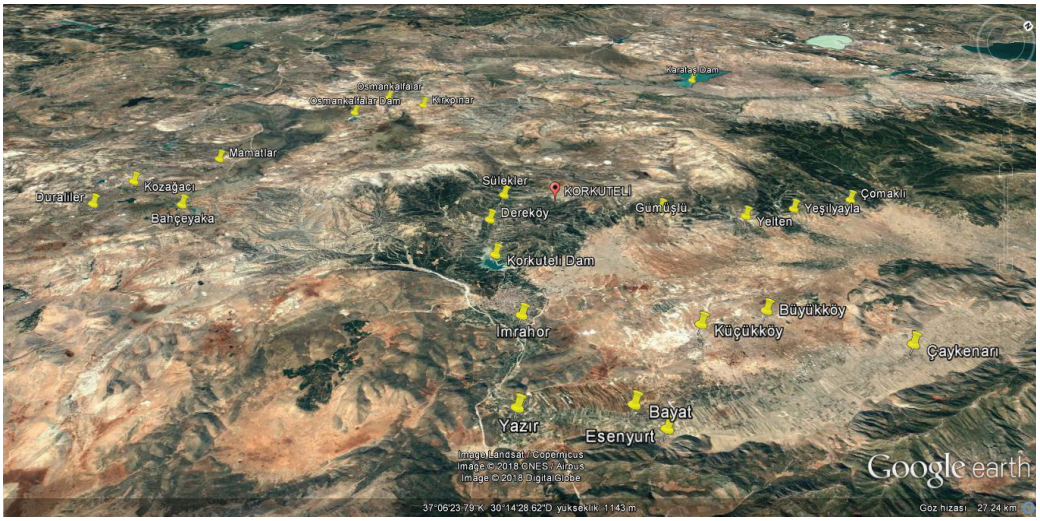

Figure 1. Satellite views of cattle breeding enterprises that may create potential pollution in the Korkuteli District.

It was observed that the businesses in the region do not aim to store their manure and wastes, that they do not give importance to storage structures and that they are not very sensitive towards the environment.

It is specified in studies carried out in our country that the livestock breeding businesses do not give necessary importance to storing the manure formed (Saltuk, 2017).

Therefore, similar findings were observed in the study area. Especially businesses in rural regions away from the district centers spread out the manure on the field and let it wait there. Wet manure amount and potential biogas energy amount that can be obtained from the Korkuteli district with the highest number of cattle in the study region have been given in Table 1.

Table 1. The amount of potential wet manure and obtainable biogas energy in the Korkuteli District

Village	Animal numbers	Water source	Distance of water source (km)	Altitude difference (m)	Annual average amount of wet manure (kg)	Annual amount of obtainable biogas energy (MJ)
Bahçeyaka	385	Kızıldere	0.6	49	6042575	2528716,485
Bayat	2972	Korkuteli River	0.5	2	46645540	19520377,64
Büyükköy	2262	Korkuteli River	5	26	35502090	14857030,36
Çaykenarı	601	Irrigation Canal	1.2	3	9432695	3947424,954
Çomaklı	1890	Dam	5	6	29663550	12413699,11
Dereköy	319	Korkuteli River	0.5	27	5006705	2095222,23
Duraliler	131	Kozağacı Pond	1.8	105	2056045	860420,4143
Esenyurt	150	Korkuteli River	0.4	10	2354250	985214,2149
Gümüşlü	830	Yelten Pond	5	192	13026850	5451518,656
İmrahor	152	Korkuteli River	0.5	12	2385640	998350,4044
Kırkpınar	636	Osmankalfalar Pond	3	184	9982020	4177308,271
Kozağacı	450	Kozağacı Pond	1	20	7062750	2955642,645
Küçükköy	2505	River	1.7	83	39315975	16453077,39
Mamatlar	533	Irrigation Canal	1.5	38	8365435	3500764,51
Osmankalfalar	300	Osmankalfalar Pond	2	57	4708500	1970428,43
Sülekler	368	Korkuteli River	0.8	2	5775760	2417058,874
Yazır	763	Korkuteli River	1	6	11975285	5011456,306
Yelten	3383	Yeşilyayla Pond	3.8	20	53096185	22219864,59
Yeşilyayla	1584	Yeşilyayla Pond	1.2	14	24860880	10403862,11
Toplam	20214	-	-	-	317258730	132767437,6

As can be seen Table 1, Yelten village has the highest wet manure and biogas energy amount that can be potentially obtained in the Korkuteli district.

Bayat village with the second highest cattle number in the district has the highest probability of polluting the water sources with animal wastes.

It was determined that the distance to the water sources in 6 out of the 19 villages with cattle in the district is less than 1 km. The businesses in these villages close to the water sources made up 21.5% of the total district potential. It was determined upon an evaluation of proximity to water sources and the number of animals that 6 villages of the Korkuteli district were about 0 - 0,8 km away from water sources, whereas the distances of 9 villages from water sources was 1-2 km and that the remaining 4 villages were 2,1 - 5 km away from water sources.

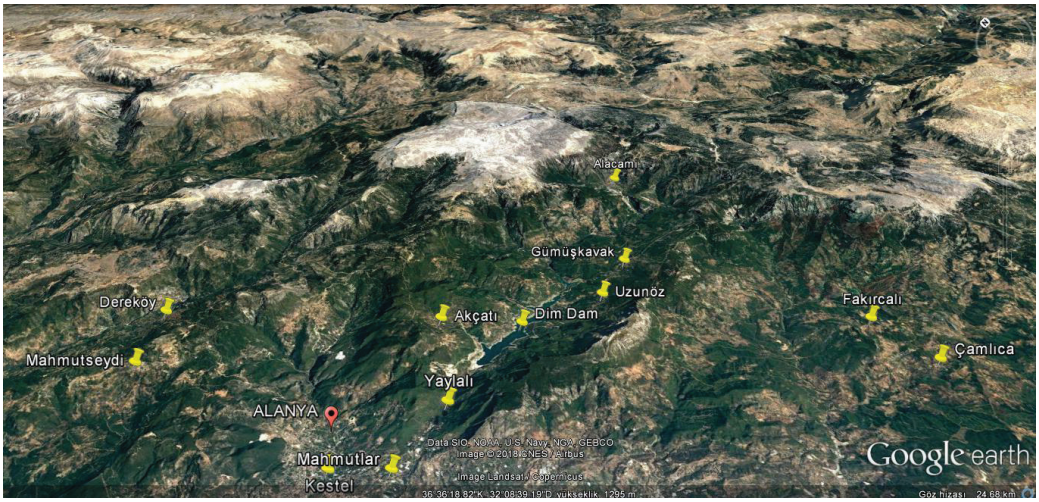

Figure 2. Satellite views of cattle breeding enterprises that may create potential pollution in the Alanya District

Wet manure amount and potential biogas energy amount that can be obtained from the Alanya district in the study region have been given in Table 2.

Table 2. The amount of potential wet manure and obtainable biogas energy in the Alanya District

Village	Animal numbers	Water source	Distance of water source (km)	Altitude difference (m)	Annual average amount of wet manure (kg)	Annual amount of obtainable biogas energy (MJ)
Akçatı	88	Dim Dam	2	602	1381160	577992,340
Alacami	321	Dim River	4	262	5038095	2108358,420
Çamlıca	692	Oba River	5	270	10860940	4545121,578
Dereköy	906	Dim River	1	359	14219670	5950693,858
Fakırcalı	118	Oba River	1.8	471	1852010	775035,182
Gümüşkavak	260	Dim Dam	2	343	4080700	1707704,639
Kestel	538	Dim River	2	20	8443910	3533634,984
Mahmutlar	998	Dim River	5	15	15663610	6554958,576
Mahmutseydi	606	Dim River	3.2	264	9511170	3980265,428
Uzunöz	172	Dim Dam	2	493	2699540	1129712,300
Yaylalı	253	Dim Dam	1	42	3970835	1661727,975
Toplam	4952	-	-	-	77721640	32525205,280

It was observed that the number of cattle in the Alanya district was low in comparison with the province in general, but that the number of animals increased especially in businesses that are close to the water sources. It was concluded that solid and liquid wastes of

businesses that are close to the water sources may mix in with the surface waters thus resulting in environmental pollution as well as economic losses. As can be seen in Table 2, Mahmutlar village has the highest wet manure and biogas energy amount that can be obtained from the district of Alanya. It is observed that Yaylalı village has the highest probability of polluting the water sources with wastes from cattle.

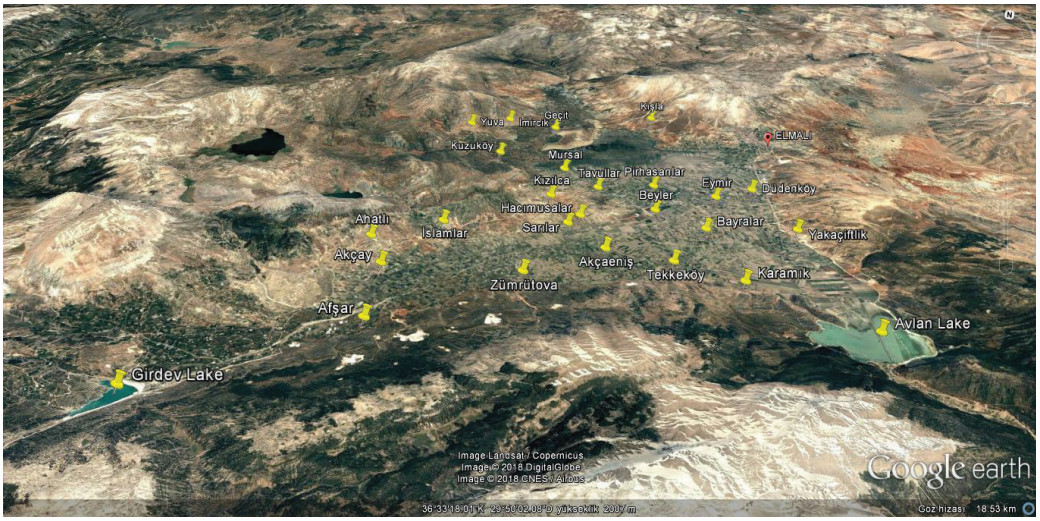

Figure 3. Satellite views of cattle breeding enterprises that may create potential pollution in the Elmalı District

The amount of wet manure and potential biogas energy amount that can be obtained from the district of Elmalı have been given in Table 3.

Table 3. The amount of potential wet manure and obtainable biogas energy in the Elmalı District

Village	Animal numbers	Water source	Distance of water source (km)	Altitude difference (m)	Annual average amount of wet manure (kg)	Annual amount of obtainable biogas energy (MJ)
Afşar	122	Akçay	0.5	4	1914790	801307,561
Ahatlı	72	Gavurçay River	2.8	59	1130040	472902,823
Akçaeniş	181	Akçay	0.9	2	2887880	1188825,153
Akçay	155	Akçay	2.1	18	2432725	1018054,689
Bayralar	1172	Akçay	0.5	2	18394540	7697807,065
Beyler	54	Akçay	2	1	847530	354677,117
Çaybaşı	197	Akçay	0.5	2	3091915	1293914,67
Düdenköy	377	Kurutma Canal	0.5	3	5917015	2476171,727
Eymir	388	Kurutma Canal	2.5	3	6089660	2548420,769
Geçit	381	Kurutma Canal	0.7	2	5979795	2502444,105
Hacımusalar	155	Akçay	1.4	7	2432725	1018054,689
İmircik	94	Kurutma Canal	2	13	1475330	617400,907
İslamlar	55	Gavurçay River	0.4	7	863225	361245,212
Karamık	92	Avlan Lake	3.4	17	1443940	604264,718
Kışla	908	Kurutma Canal	3.5	15	14251060	5963830,047
Kızılca	108	Akçay	3.4	72	1695060	709354,235
Kuzuköy	124	Kurutma Canal	4.3	11	1946180	814443,750
Mursal	354	Kurutma Canal	3.8	13	5556030	2325105,547
Pirhasanlar	112	Kurutma Canal	5	2	1757840	735626,613
Sarılar	164	Akçay	1	6	2573980	1077167,541
Tavullar	624	Akçay	4	1	9793680	4098491,134
Tekkeköy	289	Akçay	2.2	4	4535855	1898179,387

Yakaçiftlik	601	Kurutma Canal	0.2	13	9432695	3947424,954
Yuva	3706	Kurutma Canal	3	18	58165670	24341359,201
Zümrütova	130	Akçay	1.7	10	2040350	853852,320
Toplam	10615	-	-	-	166602425	69720325,938

The fact that businesses in the Elmalı district are small and family owned may decrease potential pollution and the fruit gardens in the region such as apple, peach and plum allows for the use of the generated manure. However, it should be kept in mind that the generated manure should be stored in a suitable environment for this purpose. The nutrients in the manure can be preserved in this manner while also eliminating the pollution problem. Table 3 indicates the highest amount of wet manure and biogas energy in the Elmalı district can be obtained from the Yuva village. While Bayralar village with the second highest number of cattle in the district was determined to have the highest probability of polluting the water sources.

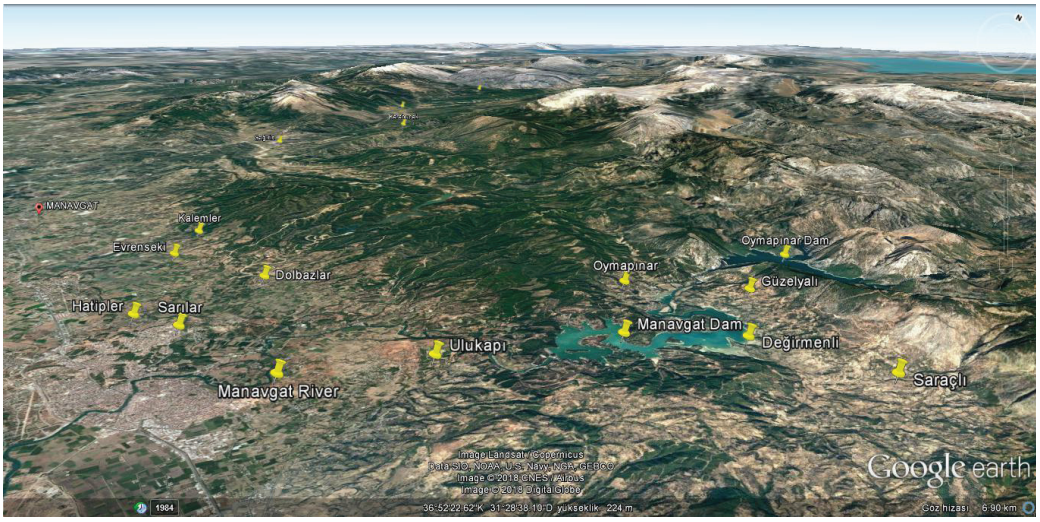

Figure 4. Satellite views of cattle breeding enterprises that may create potential pollution in the Manavgat District

Amounts of wet manure and potential biogas that can be obtained from the Manavgat district have been given in Table 4.

Table 4. The amount of potential wet manure and obtainable biogas energy in the Manavgat District

Village	Animal numbers	Water source	Distance of water source (km)	Altitude difference (m)	Annual average amount of wet manure (kg)	Annual amount of obtainable biogas energy (MJ)
Değirmenli	114	Manavgat Dam	0.2	12	1789230	748762,803
Dolbazlar	132	Manavgat River	4.2	22	2071740	866988,509
Evrenseki	1008	Kargıçayırı River	4.6	17	15820560	6620639,523
Gaziler	72	Köprüçay	1.5	55	1130040	472902,823
Güzelyalı	141	Manavgat Dam	1	94	2212995	926101,362
Hatipler	77	Manavgat River	3.4	39	1208515	505743,297
Oymapınar	51	Manavgat Dam	0.5	23	800445	334972,833
Kalemler	447	Kargıçayırı River	3.5	50	7015665	2935938,360
Karabucak	482	Köprüçay	4	276	7564990	3165821,677
Karabük	199	Köprüçay	0.4	38	3123305	1307050,858
Ulukapı	1449	Manavgat River	2.8	71	22742055	9517169,315

Sağırin	1092	Köprüçay	2	20	17138940	7172359,484
Saraçlı	318	Manavgat Dam	4	84	4991010	2088654,135
Sarılar	152	Manavgat River	2	46	2385640	998350,404
Total	5734	-	-	-	89995130	37661455,38

As can be seen in Table 4, the highest wet manure and biogas energy amounts in the Manavgat district can be obtained from the Ulukapı village. Whereas Değirmenli village has the highest probability of polluting water sources with cattle waste. Nitrate level in the well waters near the manure storage areas of businesses may reach dangerous levels for humans and animals. Excessive nitrate intake may result in pain, vomiting as well as comas and deaths in animals (Kaya and Akar, 2002). It may lead to the onset of various hereditary diseases in humans as a result of the impairment of the immune system (Weyer et al., 2001). Manure and wastes that are generated as a result of any livestock breeding activity should be stored in suitable environments. In addition, the animal manure generated can be transformed into biogas and electrical energy thus decreasing the energy costs of businesses while also paving the way for a greener environment (Bilgin, 2003).

CONCLUSION

A total of 651577925 tons of wet manure may potentially be obtained from the cattle in the study region. In addition, it has also been determined that a total of 272674424,2 MJ biogas energy amount can be obtained from this wet manure. Energy costs of businesses may be decreased if this potential biogas energy can be used in the businesses. It can be stated that the potential pollution due to cattle breeding businesses in the region may be high in the Elmalı and Korkuteli districts depending on the number of cattle and that the districts of Alanya and Manavgat may have lower levels of potential pollution. Amount of manure generated at the businesses vary depending on the number of cattle. It should be kept in mind that the generated manure has different ratios of organisms that are harmful for health and thus their contact with water sources should be prevented. It has been observed that no precautions have been taken in majority of the cattle breeding businesses in the study area for the storage of the liquid or solid wastes without harming the environment. Animal wastes that are randomly stored on lands that are close to the water sources may mix in with the surface waters, accumulate around the living areas thus resulting in the formation of odors and flies. The demands of the region for potential new and renewable energy sources may be met from these areas and the proper storage of manure may contribute to plant production while also reducing the energy costs of the businesses by way of the potential biogas and electrical energy it may supply.

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