orage Po ial in Turkey, Modeling and Prefeasibility Stud

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PURPOSE OF THE WORK

The climate change and emission inventory for Turkey was prepared and published in 2007 as the First National Communication on Climate Change (Jan. 2007). Analysis showed that the total CO_2 emission was 231 Tg according to 2004 data, which is about 0.9 % of world total. The emissions had increased to 297.12 million tons of CO2 in 2008.

This paper gives assessment of possible geologic sites for CO_2 storage and calculation of CO_2 emissions from thermal power plants with capacities > 500 MWe, cement factories, steel industry, sugar factories and refineries in Turkey. Coupling of sources and sinks resulted in a decision to use the emissions from a cement factory which is about 130 km from the selected oil field, Caylarbasi. The cement factory does not have capture facilities yet, but during modelling it was assumed that CO_2 is available at the factory site (Okandan, et.al,2009).

INTRODUCTION

When the CO_2 emissions inventory is examined, thermal power plants, cement factories, iron and steel industry and refineries are the main sources where CO_2 is emitted in large amounts in centeralized locations. Emissions in transport and domestic uses are scattered sources and considered to be decreased by efficiency measures.

The CO_2 inventory in Turkey (Fig. 1) show that annual increase is high. The policy measures are to promote energy efficiency and use of renewable energy sources. However it is foreseen that as in all countries dependency on fossil fuels will be continuing. So the second measure will be to promote technologies that will produce less CO_2 as in coal fired thermal power plants. However CO_2 cannot be eliminated totally since all combustion processes result in CO_2 as the product. Then measures must be taken to mitigate the CO_2 emissions which will be possible by underground storage of CO_2 in geological formations. If the CO_2 emissions from 7887 industrial sites worldwide was estimated to be 13.5 Gt/year (IEA 2008) is considered, geologic sites must be considered other than known oil and gas reservoirs.

ASSESSMENT OF CO_2 EMISSIONS

During this study data were collected from thermal power plants, cement factories, steel industry and for the year 2006 which were available at the time of the study. As expected fossil fuel fired power plants, steel industry, cement factories, oil refineries showed large amounts of CO_2 emissions respectively as calculated using the IPCC methodology (Figure 2).

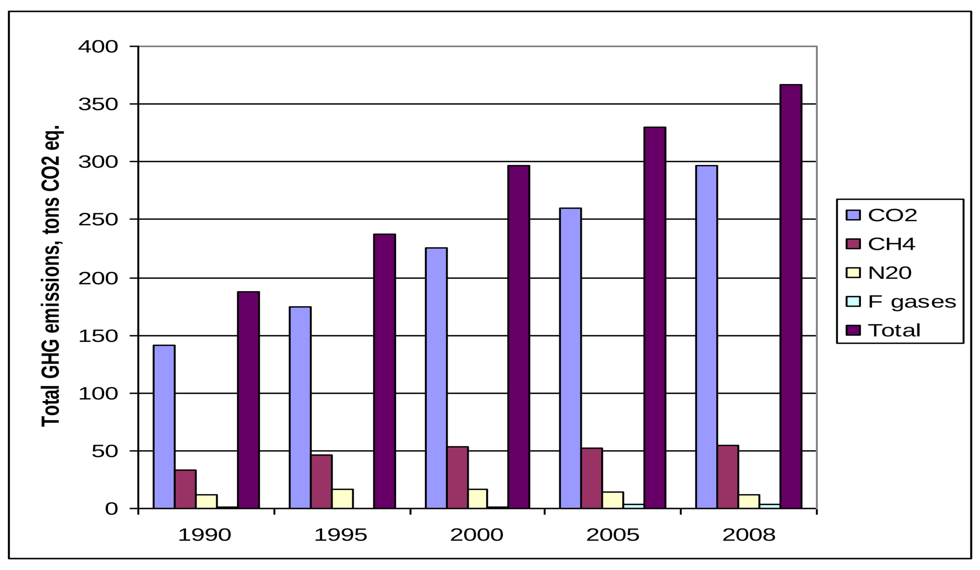

Figure 1. Emmissions inventory for Turkey (TUİK; 2009)

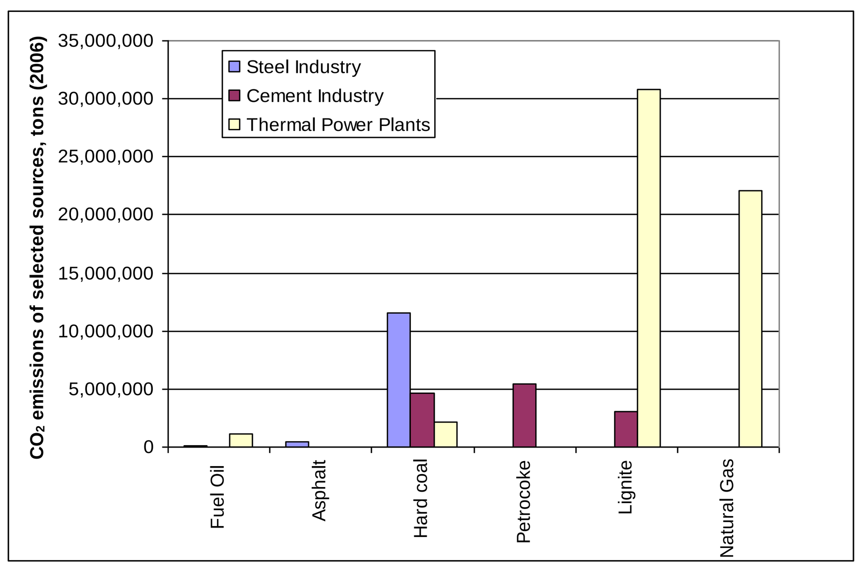

Figure 2. CO_2 emissions from sites selected for the project

ASSESSMENT OF POSSIBLE GEOLOGIC STORAGE SITES

The possible geologic sites are abandoned or mature oil and gas fields, deep aquifers, soda mine salt caverns and possibly coal bed methane sites and natural CO_2 fields. Figure 2 shows the location of oil and gas fields and other possible storage sites in Turkey. The natural CO_2 reservoir, Dodan with 10 billion Sm3 capacity can be used for storage.

The characteristics of geologic formations are very critical for CO2 storage projects, and almost all of the characterization data exist in producing oil and gas fields. The exploration activities since 1954 in Turkey have resulted in locating more than 120 oil and gas fields. However the size of these fields are not very large, biggest one being Batı Raman heavy oil field. The fields are located mostly in Thrace Region and in Southeastern Turkey. For this project the target was to look into oil fields in Southeastern part of the country close to a power plant or cement factory.

Caylarbasi heavy oil field (Figure 5) was chosen because of its high porosity and little or no fracture in the reservoir. The injected CO_2 will be benefited as an EOR agent enhancing the production of some extra oil before storage cycle starts. The field was discovered during 1993 and was put on production during the same year. The limestone reservoir has 11.8 API gravity oil. 7 wells were drilled in the area on being a dry well and presently 3 of them are still producing.

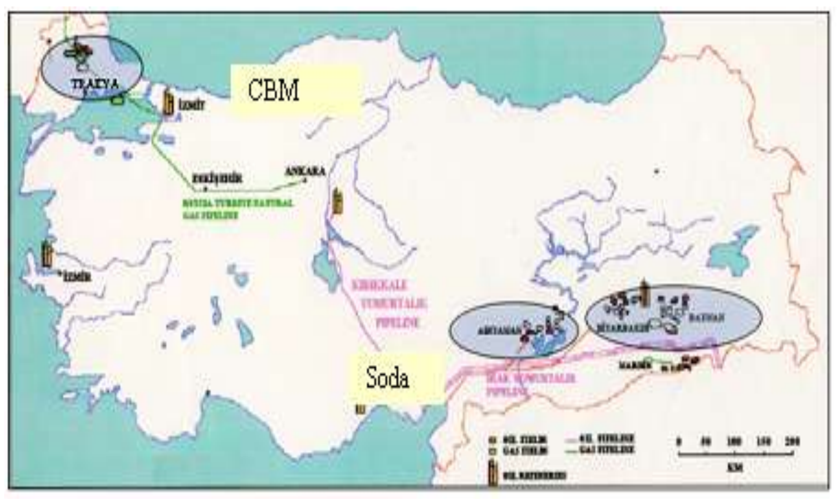

Figure 3. Possible geologic storage sites in Turkey

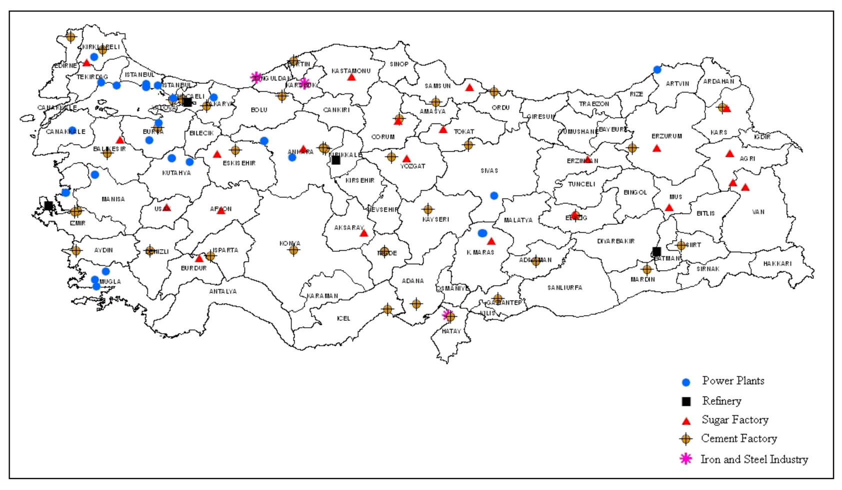

Figure 4. Location of thermal power plants and industrial sites studied during the project

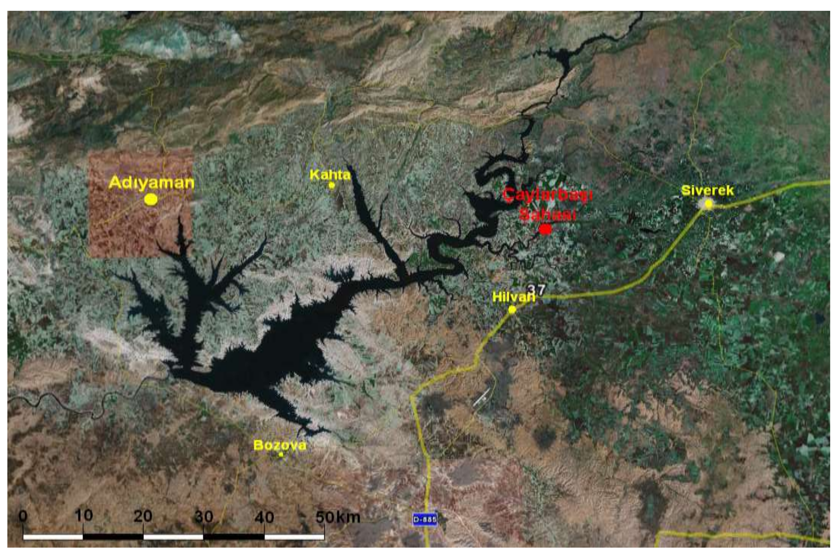

Figure 5. Location of Caylarbasi Field

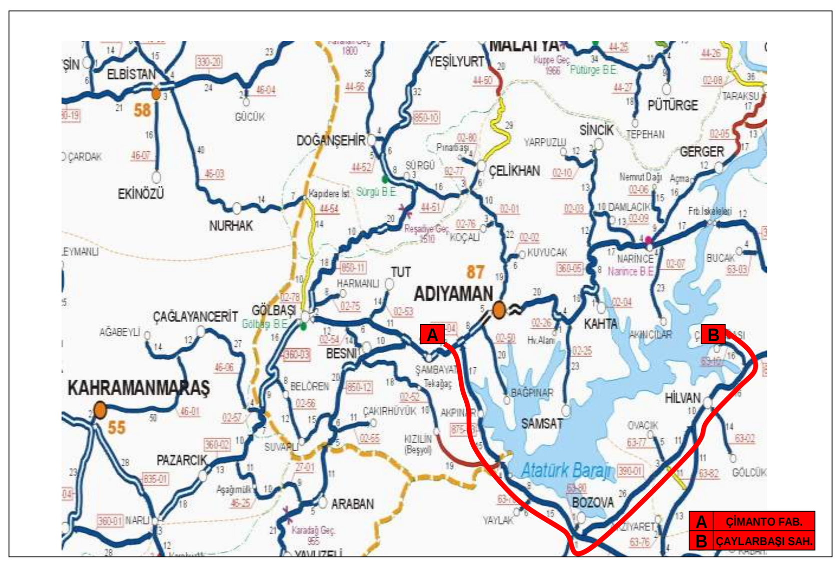

Figure 6. Location of cement factory with respect to Caylarbasi oil field

MODELING RESULTS

The geological and numerical model of the field were created using Petrel- Eclipse software. After obtaining an acceptable history match, CO_2 injection cycle continued for 20 years. Then the CO_2 storage cycle started. 8 different scenarios were studied. The best scenario resulted in 2 million barrels of oil production during 8 years and 280 million Sm3 of CO_2 to be stored during the next 12 years. It was assumed that the CO_2 produced during the project will be re-injected using the recycling unit as taken into account during technical feasibility analysis.

The amount of CO_2 that can be stored in the selected field can only handle the emissions from a cement factory which is about 130 km. from the field. The technical and economic feasibility was based on this conclusion.

TECHNICAL AND ECONOMIC FEASIBILITY

The selected cement factory is about 130 km from the field (Figure 6) It was assumed that the CO2 will be available at the factory site so the feasibility includes the liquefaction process and transport using a pipeline or tankers. In Caylarbasi field investment for the drilling of new producing and CO_2 injection wells were considered as well as compressors and the CO_2 recycling unit.

Investment and operating costs for tanker transport was calculated as 34 million USD and 408 000 USD/ month operating cost for tanker transport compared to 53.5 million USD investment cost and 414 000 USD/ month operating cost for pipeline transport. So tanker transport will be feasible because of the small amount of CO_2 to be handled and the duration of the project. The economic analysis at 10 % discount rate showed that if oil is 100$/barrel it will be possible to inject CO_2 and produce oil for 6 years. For CO_2 storage period it is obvious that new incentives and mechanisms will be necessary to support the operating cost of storage operation.

CONCLUSIONS

- Assessments indicate Turkey is responsible only for the 1% of worlds CO_2 emissions. Establishment of Carbon Market is underway which will also specify the sectors and activities that will be included in the evaluations.
- The present study indicated that the known oil and gas reservoirs due to their small volumes can only accommodate CO_2 emissions from small industrial sites.
- In such a case the transport of CO_2 will be feasible by tankers as seen during this project.
- The natural CO2 reservoir, Dodan is the available large volume reservoir, presently 7 billion Sm^3 volume is available, where storage may be considered.
- However possibilities of storage in deep saline aquifers must be considered and a possible pilot project will enable the parties to investigate its applicability.
- One critical aspect of CCS application is to set incentives for CO_2 storage.
- The present know how on CO2 injection as gained from CO_2 - EOR application in Batı Raman will make the future CO_2 storage projects easy to handle.

ACKNOWLEDGEMENT

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