The Potential for Carbon Management in Reducing CO_2 Emissions in the Middle East

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1. Introduction

In its Fourth Assessment Report [1], the Intergovernmental Panel on Climate Change (IPCC) concluded that "*warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level*". The IPCC has also stated that most of the observed increase in temperature in the second half of the 20th century can be directly attributed to the increase in anthropogenic greenhouse gas concentrations; notably those of carbon dioxide, methane and nitrous oxide.

Translating these conclusions into predictions of how climate change is likely to affect the Middle East is difficult. However, there is increasing concern in many countries in the region that climate change will pose serious threats to their environments and their economies. In the U.A.E., for example, increasing global sea level could have a serious impact on the country, with a large fraction of the population, infrastructure and industry being located in coastal areas [2]. Also, in what has been referred to as "*one of the world's most water-stressed regions*" [3], any changes in temperature and rainfall patterns that lead to a decrease in the availability of freshwater will result in an even greater need for desalination, requiring additional energy and leading to higher CO_2 emissions and costs.

This study looks at current environmental stress in the Middle East using several sustainability and environmental indicators, before focusing on the contribution by countries of the Middle East to global carbon dioxide (CO_2) emissions. A breakdown of the origins of these emissions points to ways to address CO_2 emissions reduction in the region through Carbon Management. We then consider some of the steps that the U.A.E. is currently taking to mitigate climate change by controlling its CO_2 emissions.

2. Key Features

An analysis of the current environmental situation in the Middle East using the *ecological footprint* sustainability indicator and several environmental indicators reveals [4] that, for all countries, their total *biocapacity* is insufficient to meet the demand they are placing on their natural resources, resulting in an *ecological deficit*. With countries such as Kuwait, Saudi Arabia and the U.A.E., very large contributions (75 – 85%) to their ecological footprints result from their CO_2 emissions – their *carbon footprint*. Finally, looking at the use of water resources, water withdrawals are above the global average for many countries in the region and exceed the natural rate of replenishment for more than half of the countries.

Total CO_2 emissions in the Middle East reached approximately 1.45 Gt of CO_2 in 2005 [5]. The 6 countries of the GCC contributed approximately half of these emissions despite their combined populations being only 20% of the population of the region. Moreover, it is the smaller countries of the GCC – Bahrain, Kuwait, Qatar, and the U.A.E. – that had the highest per capita emissions in the region in 2005. Per capita emissions throughout the GCC are considerably higher than in the rest of the Middle East, or in many other parts of the industrialized world.

The most important anthropogenic source of CO_2 in the GCC countries is the production of electricity and heat (42%) [6]. The industrial sector also makes a significant contribution (36%) through the activities of the oil and gas industries. Industrial emissions arise from exploration and production activities, from oil refineries and gas processing plants, but also from the downstream petrochemical and fertilizer industries. As a result, approximately 75% of emissions in the GCC countries can be attributed to such *point sources*, and this situation has led the U.A.E. to focus its efforts on these two sectors of the economy as the basis of its carbon management strategy. Two approaches have been investigated so far – (a) a gradual elimination of flaring of associated gas (mainly methane) during hydrocarbon production and processing, and (b) the development of CO_2 capture and storage (CCS) projects for power plants and in oil and gas production.

The total amount of gas being flared in the Middle East is estimated to be approximately 35 billion m^3 per year, contributing about 5% of total CO_2 emissions. The recent historical trend in flaring in the region, however, has varied widely during the past 10 years. Some countries have experienced an increase in the amount of gas flared at production sites, while others have been able to stabilize or decrease their flaring.

The U.A.E. has been rather successful in reducing its flaring of gas during this period. ADNOC has reported a more than 70% reduction in the volume of gas flared, with as much as 95% of its Zero-Flaring Objective being achieved in some fields. The method for reducing flaring in the U.A.E. is through enhanced oil recovery (EOR) in which the associated natural gas is re-injected into the oil reservoir to increase production, rather than being flared or vented. Other possible approaches for reducing flaring are to liquefy the gas for shipping to international markets, or to transport it via pipelines to local markets.

The potential for CO_2 storage or sequestration (CCS) in the Middle East is considered to be very high [7]. Estimates of the amount of CO_2 that could be sequestered in the region include: 100 – 1000 Gt in *onshore* oil and gas fields; 75 – 200 Gt in *offshore* oil and gas fields; and up to 500 Gt in *aquifers*. An important initiative aimed at creating a national CCS network in the U.A.E. has been introduced through the MASDAR program in 2007. The goal of this initiative is to capture CO_2 from point sources – such as power generating plants and oil and gas production facilities – and supply it to oil fields for injection underground as part of an EOR program, followed by eventual sequestration. The chances of success for this project are high as the sources of CO_2 are relatively close to the oil fields. In addition, 5 fields produce more than 80% of the U.A.E.'s oil output and so there are several very large hydrocarbon reservoirs that are suitable for eventual storage of the CO_2. Based on estimates of the amount of natural gas that is currently being re-injected for EOR, a CCS network in the U.A.E. could reduce the country's CO_2 emissions by up to 40%.

3. Conclusions

Carbon Management, based on flaring-reduction and CCS for EOR and eventual sequestration, appears to be a cost-effective way for a country such as the U.A.E. to achieve significant reductions in CO_2 emissions as part of a climate change mitigation strategy. With other major oil and natural gas producing countries in the Middle East, there is a high potential to achieve a substantial decrease in the region's CO_2 emissions using such an approach. Indeed, it provides a unique opportunity for oil and gas producers in the region to be a part of the solution rather than the cause of the problem.

4. References

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