A Twelve Year Record of National and Global Gas Flaring Volumes Estimated Using Satellite Data

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ABSTRACT

A series of national and global estimates of gas flaring volumes have been produced spanning a twelve year time period (1995 through 2006) using low light imaging data acquired by the Defense Meteorological Satellite Program (DMSP). A calibration for estimating gas flaring volumes using DMSP data was developed based on a pooled set of reported national gas flaring volumes and data from individual flares. A regression model was developed for estimating gas flaring volumes with a prediction interval of +/- 1.61 billion cubic meters (BCM). While Nigeria has been widely reported as the country with the largest volume of gas flaring, satellite data indicate that Russia has twice the gas flaring volume of Nigeria. Global gas flaring has remained largely stable over the past fourteen years, in the range of 150 to 170 billion cubic meters (BCM). In 2004 the gas flaring volume of 160 BCM was 25% of the natural gas consumption of the USA and an added 84,000 thousand metric tons of carbon emissions into the atmosphere. A number of countries have exhibited declines in gas flaring over the past twelve years including Fifteen countries (or areas) exhibit a downward trend in gas flaring from 1995 to 2006, including Algeria, Argentina, Bolivia, Cameroon, Chile, Egypt, India, Indonesia, Libya, Nigeria, North Sea, Norway, Peru, Syria and UAE. The largest decrease (-10 BCM) was in Nigeria. Countries where gas flaring increased include Russia (excluding KM) with +10 BCM, Kazakhstan (+5 BCM) and Iraq (+3 BCM). Countries participating in the Global Gas Flaring Reduction (GGFR) initiative with gas flaring reductions detected during the GGFR period (2002-2006) include Angola and Cameroon.

1. INTRODUCTION

Gas flaring is a widely used practice for the disposal of natural gas in petroleum producing areas where there is no infrastructure to make use of the gas. The companion procedure called venting is the release of gas without combustion. Venting is not only dangerous, but releases gases known to absorb thermal radiation much better that carbon dioxide, contributing to the greenhouse affect. Gas flaring is widely recognized as a waste of energy and an added load of carbon emissions to the atmosphere. Because the flaring combustion is incomplete, substantial amounts of soot and carbon monoxide are produced, contributing to air pollution problems. Information on the spatial and temporal distribution of gas flaring have been available previously due the sparse and unverifiable nature of the reporting done by countries and petroleum companies..

The World Bank in cooperation with the Government of Norway launched a Global Gas Flaring Reduction (GGFR) initiative at the World Summit on Sustainable Development in August, 2002. The ultimate goal of the GGFR is the elimination of most gas flaring and venting. The GGFR is a public-private partnership with participation from governments of oil-producing countries, state-owned companies and major international oil companies. The GGFR identifies areas where gas flaring occurs and works with the countries and companies to promote regulatory frameworks and infrastructure investment to bring flared gas to markets. A growing array of technologies to capture and make use of the gas have emerged, ranging from transport to markets as gas using pipelines, reinjection to boost oil production, conversion to liquids that can be more readily transported, and use on site. Poverty reduction is also an integral part of the GGFR program, which provides concepts for how local communities close to the flaring sites can use natural gas and liquefied petroleum gas (LPG) that may otherwise be flared and wasted. Participating countries include Algeria (Sonatrac), Angola (Sonangol), Cameroon, Chad, Ecuador, Equatorial Guinea, Indonesia, Kazakhstan, Khanty-Mansiysk (Russian Federation), Nigeria, Norway and the United States.

GGFR gathers national level gas flaring volumes and has released 2004 estimates for twenty countries believed to have the highest levels of gas flaring (Table 1). Note that for several countries the estimates include both flaring and venting. The GGFR estimates that global flaring in 2004 stood at 150 billion cubic meters (BCM) and that Nigeria had the largest amount of gas flaring, nearly a sixth of the total. There are a large number of countries with no publicly reported gas flaring volumes and it is widely agreed that there is substantial uncertainty regarding the magnitude of gas flaring. These uncertainties can be attributed to the fact that the reporting is voluntary and because heretofore there have not been independent methods for estimating national and global flaring volumes.

Table 1
GGFR 2004 Top Twenty Gas Flaring Countries

Country	Gas Flaring (BCM)
1. Nigeria	24.1
2. Russia (total)	14.9
Khanty-Mansiysk (6.4)	
Russia excluding KM (8.3)	
3. Iran	13.3
4. Iraq	8.6
5. Angola	6.8
6. Venezuela	5.4
7. Qatar	4.5
8. Algeria	4.3
9. Indonesia	3.7
10. Equatorial Guinea	3.6
11. USA	2.8
12. Kuwait	2.7
13. Kazakhstan	2.7
14. Libya	2.5
15. Azerbaijan	2.5
16. Mexico	1.5
17. United Kingdom	1.6
18. Brazil	1.5
19. Gabon	1.4
20. Congo	1.2

Without independent data sources and methods for estimating gas flaring - how can progress towards the elimination of gas flaring be assessed? Through the GGFR a substantial amount of effort and international attention has been focused on the reduction of gas flaring since 2002. Is it possible to monitor gas flaring to identify areas where gas flaring has been reduced over time? Is it possible to independently estimate gas flaring volumes?

The objective of this project, which was commissioned and funded by the World Bank's Global Gas Flaring Reduction partnership, is to investigate the use of earth observation satellite data for the detection of gas flaring and estimation of gas flaring volumes. None of the currently available earth observation sensors have been designed and flown specifically for the observation of gas flaring. However, several systems have a capability to detect gas flares based on the radiative emissions from the flames. Given the wide spatial distribution and possibility that gas flaring activity fluctuates over time, particular attention has to be given to sensors that collect data globally on a frequent basis and have a capability to readily detect gas flaring. The other factor to consider is the length of the archived record and the prospects for continuity of the observations. Based on these considerations we have initially worked with the low light imaging data from the U.S. Air Force Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). The detection of gas flares in OLS data was first described in 1973 (Croft, 1973). A digital archive extends from 1992 to the present and the observations are expected to continue into the coming decades from DMSP and the U.S. National Polar Orbiting Environmental Satellite System (NPOESS). We present the first consistently derived global map of gas flaring and a time series of national and global estimates of gas flaring. The estimates make it possible to discern countries where gas flaring is on the decline and conversely to identify countries where flaring levels have remained stable or are on the increase.

2. METHODS

2.1. DMSP Nighttime Lights

The DMSP OLS was designed to collect global cloud imagery using a pair of broad spectral bands placed in the visible and thermal. The DMSP satellites are flown in polar orbits and each collects fourteen orbits per day. With a 3000 km swath width, the each OLS is capable of collecting a complete set of images of the earth twice a day. At night the visible band signal is intensified with a photomultiplier tube (PMT) to enable the detection of moonlit clouds. The boost in gain enables the detection of lights present at the earth's surface. Most of the lights are from human settlements (cities and towns) and fires, which are ephemeral. Gas flares are also detected and can easily be identified when they are offshore or in isolated areas not impacted by urban lighting.

NGDC serves as the long term archive for DMSP data and has data holding extending from 1992 to the present. The archive is organized as individual orbits which are labled to indicate the year, month, data and start time. For this project the individual orbits were processed with automatic algorithms that identify image features (such as lights and clouds) and the quality of the nighttime data. These algorithms have been described in Elvidge et al. (1997 and 2001). The following criteria were used to identify the best nighttime lights data for compositing:

1. Center half of orbital swath (best geolocation and sharpest features).
2. No sunlight present.
3. No moonlight present.
4. No solar glare contamination.
5. Cloud-free (based on thermal detection of clouds).
6. No contamination from auroral emissions.

Nighttime image data from individual orbits that meet the above criteria are added into a global latitude-longitude grid (Platte Carree projection) having a resoluiton of 30 arc seconds. This grid cell size is approximately a square kilometer at the equator. The total number of coverages and number of cloud-free coverages are also tallied. Figure 1 shows an example of a global cloud-free composite of nighttime lights. In the typical annual cloud-free composite most areas have twenty to a hundred cloud-free observations (Figure 2), providing a temporal sampling of activities such as gas flaring. Before being used in the gas flaring analysis each composite is converted into a Mollweide one km^2 equal area grid (see Figure 3).

The nighttime lights product used in the gas flaring analysis is the average visible band digital number (DN) of cloud-free light detections multiplied by the percent frequency of light detection. The inclusion of the percent frequency of detection term normalizes the resulting digital values for variations in the persistence of flaring. For instance the value for a gas flare only detected half the time is discounted by 50%. This style of nighttime lights is referred to as the “lights index”. The gas flaring analyses are conducted on the lights index images that have been converted to one kilometer square equal area grids (Mollweide projection – see Figure 3). The “sum of lights index” used to analyze the magnitude of gas flaring is derived by summing the lights index values of 8.0 or greater for all the one km^2 grid cells identified as gas flares. Grid cells having lights index values of less than eight are ignored to eliminate background noise present in the products.

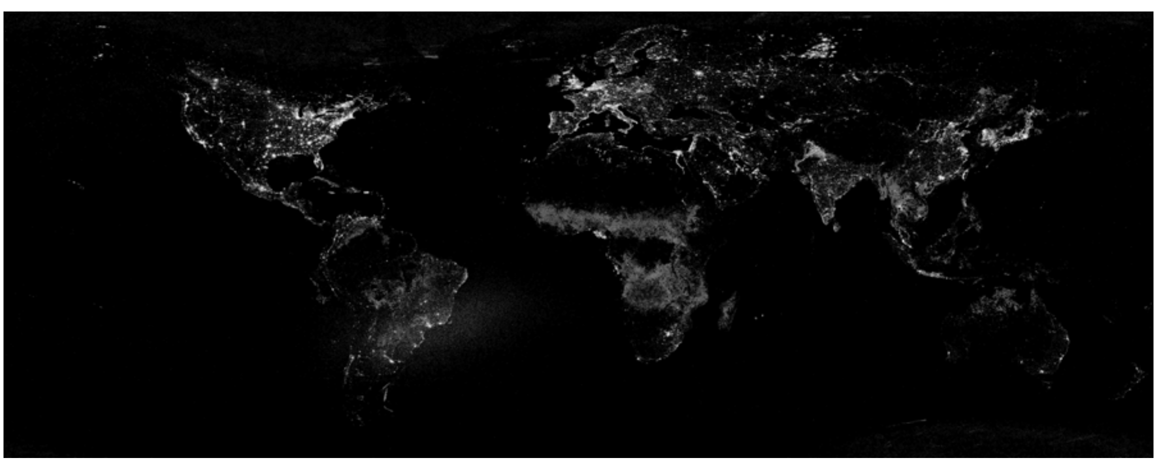

Figure 1: Nighttime lights global cloud-free composite from DMSP satellite F16 for the year 2004.

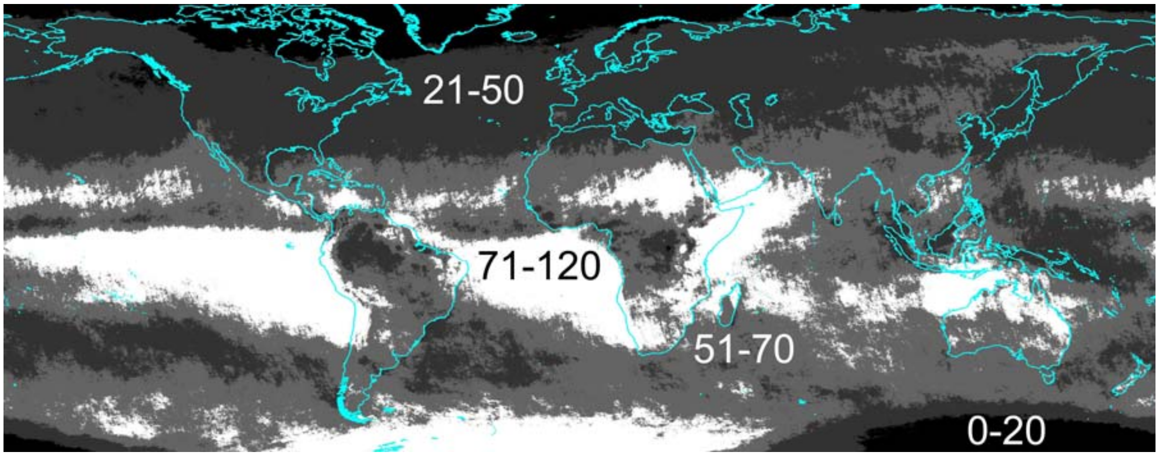

Figure 2: Tally of cloud-free coverages from DMSP satellite F16 for the year 2004.

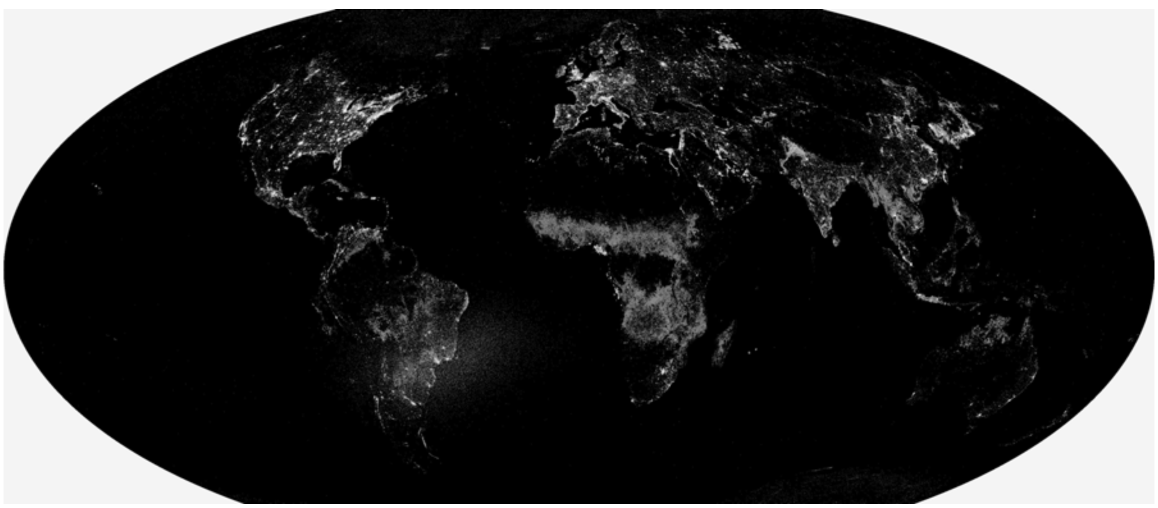

Figure 3: Mollweide equal area projection version of the DMSP nighttime lights derived from satellite F-16 for year 2004.

A set of annual composites were processed for each satellite that collected nighttime lights data from 1995 through 2006 (see Table 2). Each satellite is designated with as a flight number, such as F12 for DMSP flight number 12. Data for the archive generally begins within a few weeks after launch. Over time the satellites/ sensors age and eventually are no longer able to produce data. The degradation is typically gradual enough that a replacement satellite can be deployed to ensure continuity. Thus in some years two satellite collected data and two separate composites were produced. The annual composites were used to estimate gas flaring volumes for each year from 1995 through 2006. The earlier part of the DMSP archive (1992-1994) was not found to be consistent with the later part of the record. It may be possible to extend the record back to 1992 with additional effort.

2.2. Intercalibration of the Annual Composites

Because the OLS has no on-board calibration the individual composites were intercalibrated via an empirical procedure. Samples of lighting from human settlements (cities and towns) were extracted from numerous candidate calibration areas and examined. In reviewing the data it was found that the data from satellite year F121999 had the highest digital values. Because there is saturation (DN=63) in the bright cores of urban centers and large gas flares F121999 was used as the reference and the data from all other satellite years were adjusted to match the F121999 data range. In examining the candidate calibration areas it was found that many had a cluster of very high values (including saturated data with DN=63) and a second cluster of very low values. It was

Table 2

Annual Composites Produced

Year	Satellites			
1995	F12			
1996	F12			
1997	F12	F14		
1998	F12	F14		
1999	F12	F14		
2000		F14	F15	
2001		F14	F15	
2002		F14	F15	
2003			F15	
2004			F15	F16
2005			F15	
2006			F15	

concluded that having a wide spread of digital number values would be a valuable characteristics since it would permit a more accurate definition of the intercalibration equation. By examining the scattergrams of the digital number values for each year versus F121999 we were able to observe evidence of changes in lighting based on the width of the primary data axis and outliers away from the primary axis. Our interpretation was that areas having very little change in lighting over time would have a clearly defined diagonal axis with minimal width. Of all the areas examined Sicily had the most favorable characteristics – an even spread of data across the full dynamic range and a more sharply defined diagonal clusters of points. Figure 4 shows the scattergrams for each of the satellite years versus F121999 for the nighttime lights of Sicily. The second order regression model was developed for each satellite year is shown in Table 3.

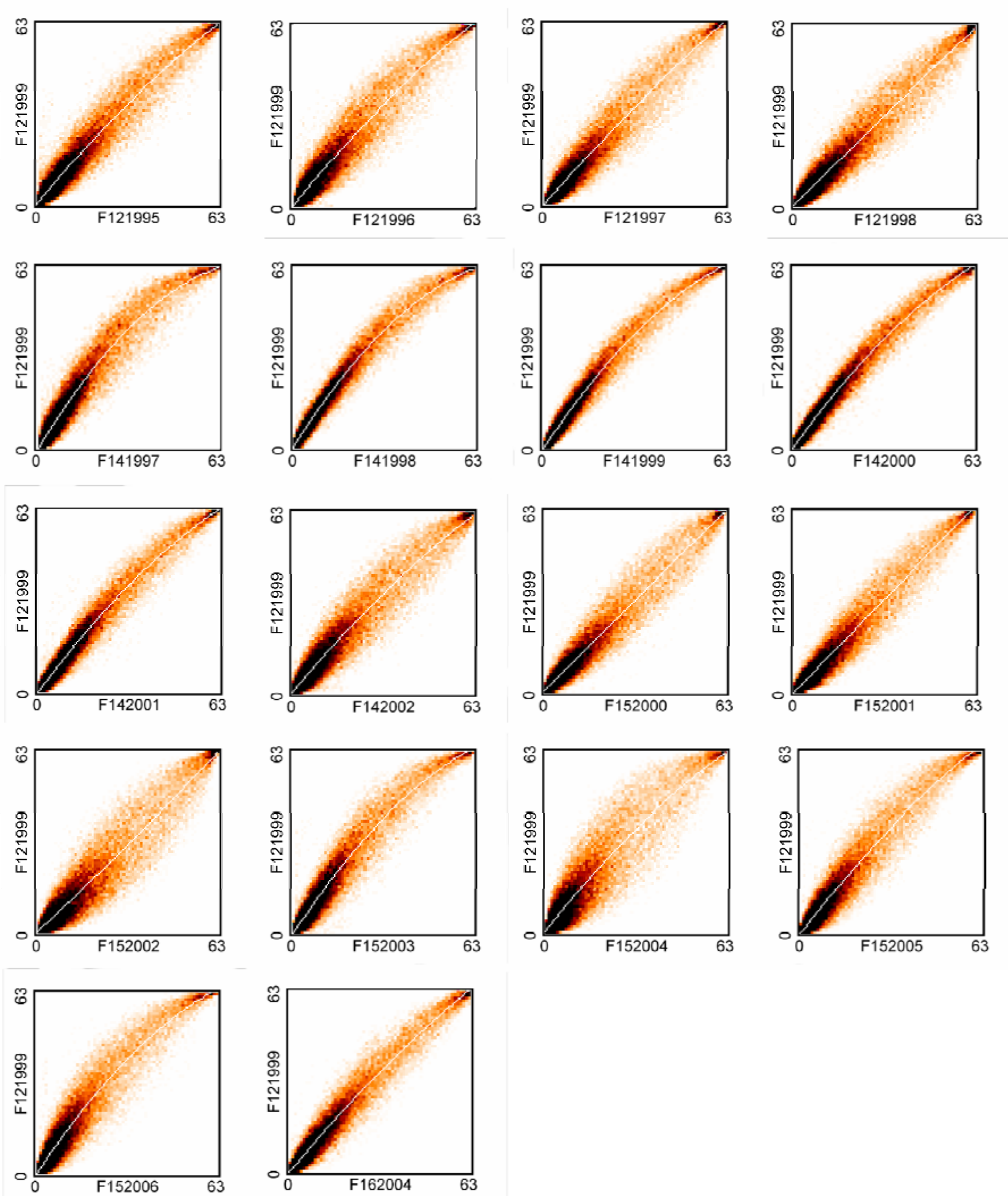

Figure 4. Intercalibration scattergrams for the nighttime lights of Sicily.

Table 3

Equations For Intercalibrating the Annual Nighttime Lights Products

F121995_adjusted = $0.482 + 1.20x – 0.0033x^2$	N= 38685	$R^2 = 0.93$
F121996_adjusted = $0.518 + 1.23x – 0.0035x^2$	N= 39083	$R^2 = 0.92$
F121997_adjusted = $0.176 + 1.14x – 0.0021x^2$	N= 39611	$R^2 = 0.93$
F121998_adjusted = $0.344 + 1.02x – 0.0007x^2$	N= 39676	$R^2 = 0.94$
F141997_adjusted = $0.030 + 1.66x – 0.0103x^2$	N= 37880	$R^2 = 0.94$
F141998_adjusted = $0.186 + 1.60x – 0.0096x^2$	N= 37581	$R^2 = 0.97$
F141999_adjusted = $-0.160 + 1.51x – 0.0078x^2$	N= 38704	$R^2 = 0.97$
F142000_adjusted = $0.116 + 1.39x – 0.0059x^2$	N= 37715	$R^2 = 0.97$
F142001_adjusted = $-0.255 + 1.34x – 0.0053x^2$	N= 39343	$R^2 = 0.96$
F142002_adjusted = $0.447 + 1.20x – 0.0035x^2$	N= 38642	$R^2 = 0.93$
F152000_adjusted = $0.367 + 1.03x – 0.0007x^2$	N= 39204	$R^2 = 0.94$
F152001_adjusted = $-0.153 + 1.05x – 0.0004x^2$	N= 40103	$R^2 = 0.94$
F152002_adjusted = $0.463 + 0.92x + 0.0011x^2$	N= 40047	$R^2 = 0.89$
F152003_adjusted = $-0.219 + 1.52x – 0.0079x^2$	N= 38727	$R^2 = 0.94$
F152004_adjusted = $0.583 + 1.27x – 0.0045x^2$	N= 39143	$R^2 = 0.86$
F152005_adjusted = $-0.385 + 1.31x – 0.0042x^2$	N= 39885	$R^2 = 0.93$
F152006_adjusted = $-0.011 + 1.52x – 0.0078x^2$	N= 39200	$R^2 = 0.91$
F162004_adjusted = $-0.430 + 1.21x – 0.0030x^2$	N= 39465	$R^2 = 0.95$

The objective of the intercalibration is to make it possible to pool the sum of lights index values from each year of the time series. One sign of a successful intercalibration is the convergence of values in years where two satellite products are available. In most cases the intercalibration yielded substantial convergence. Figure 5 and 6 show the raw versus intercalibrated sum of light index values for Algeria. Note that values from the two collecting satellites converged well in 1997, 1998, 1999, 2000, 2001 and 2004. In reviewing the results for many countries it is clear that the intercalibration brought about substantial convergence. However it was not uncommon to have one or two years where the convergence was not as full. An example of this is shown for the 2002 Algeria data where the F14 values are lower than those from F15. In reviewing the data from sixty countries or areas there is no obvious pattern in the satellite or year for the cases of incomplete convergence. One possible explanation for incomplete convergence occur where there are shifts in flaring activity between the satellite overpasses.

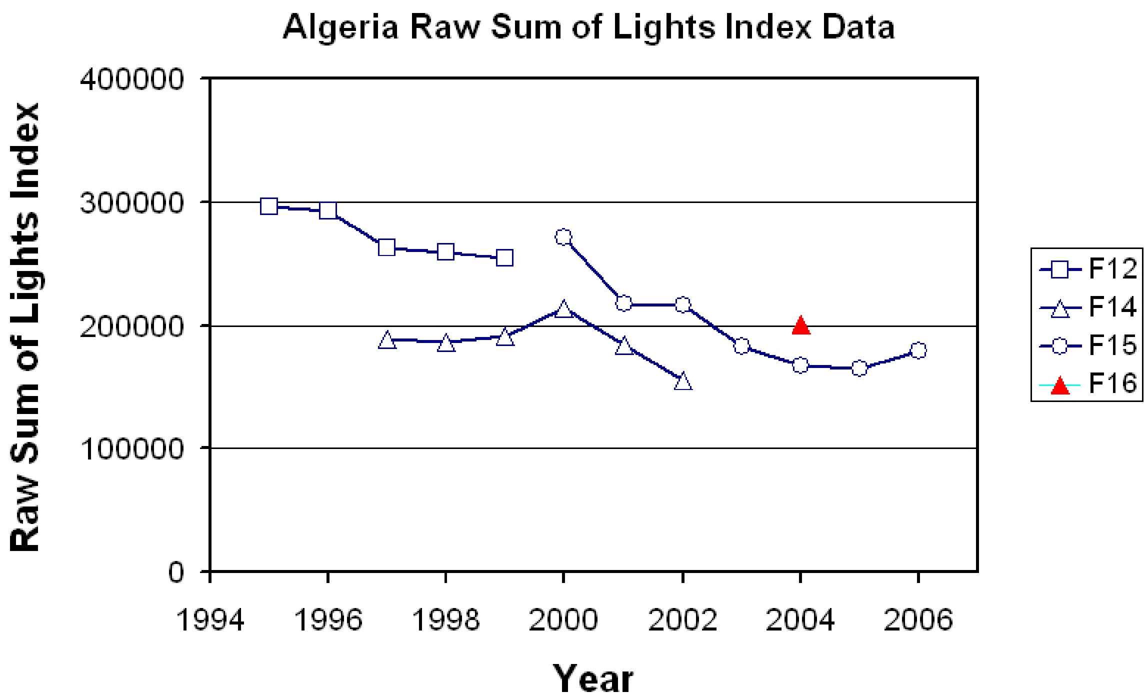

Figure 5. Raw sum of lights index values for the gas flares of Algeria.

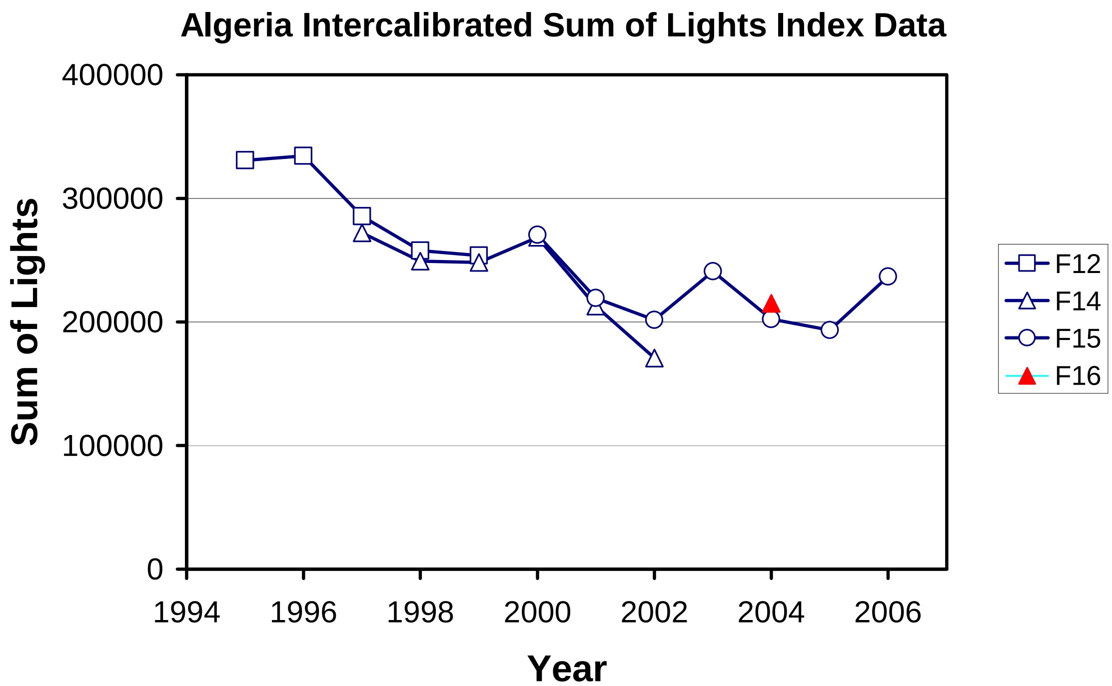

Figure 6. Intercalibrated sum of lights index values for the gas flares of Algeria.

2.3. Identifying Gas Flares in DMSP Nighttime Lights

Gas flares are identified visually in the nighttime lights composites. There are three general characteristics for gas flares that provide the visual clues for their identification:

1. Because gas flares are very bright point sources of light with no shielding to the sky, they tend to form circular lighting features with a bright center and wide rims.

2. Most gas flares are active for a period of years – but there are few gas flares that persist with little change in intensity over a full decade. Thus many gas flares exhibit color in color composite images made using data from the beginning, middle and end of the nighttime lights time series. Figure 7 shows an example of this phenomenon for gas flares in Nigeria. The image was made using the nighttime lights from 1992 as blue, 2000 as green, and 2006 as red. Flares active in 2006 – but not 2000 or 1992 are red.

Those active in 2006 and 2000 are yellow. Those active in 2000 but not 1992 or 2006 are green. Those active in 1992 but not 2000 or 2006 are blue.

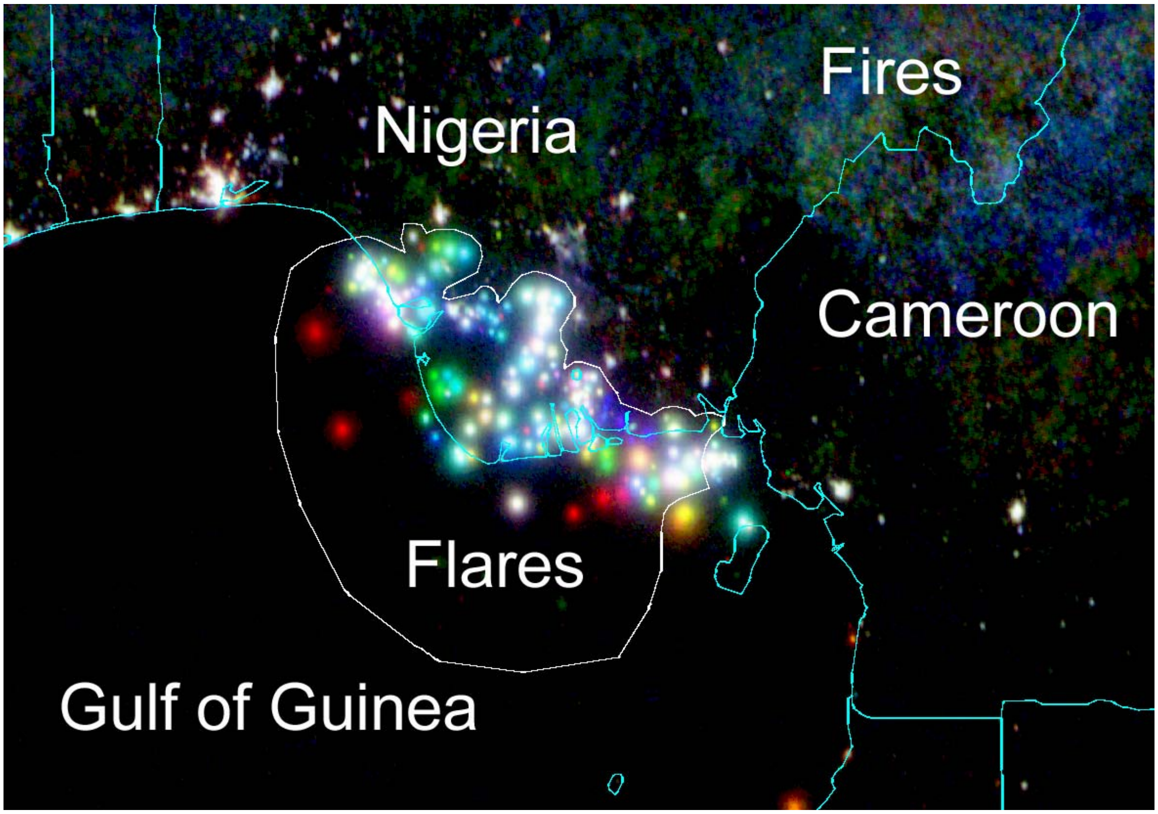

Figure 7. Color composite of the nighttime lights of the Nigeria region generated using 1992 as blue, 2000 as green, and 2006 as red. Note that the colors of the flares indicate their activity patterns during the three years used in the color composite. The vector polygon drawn around the gas flares is shown in white.

3) Gas flares tend to be in remote locations, outside of urban centers. When present offshore there are easy to identify (see Figure 7). For onshore gas flares NGDC reviews a 30 arc second Landscan 2004 global population density grid from the U.S. Department of Energy (Dobson et al. 2000) to evaluate lights identified as potential gas flares. In addition, we review NASA MODIS satellite hot spot data, which can assist in clarifying the identity of gas flares on land.

2.4. Vectors and Extractions:

Using these three visual criteria it is possible to manually draw vector polygons to identify the gas flares for individual countries. Figure 7 shows an example of the vectors drawn for a country. An extraction was then run on the sum of lights and cloud-free coverage Mollweide projection images. The extracted fields include the area of lighting detected, the number of saturated grid cells, the minimum, maximum and average number of cloud-free observations encountered under the polygon vectors, and the sum of lights index. The extraction produces a text file (csv) that can be imported into a spreadsheet for analysis and plotting.

Note that vectors were only drawn for the offshore gas flares for USA, Mexico and Canada. The onshore flares in both Mexico and Canada could not be unambiguously identified. It is known that there are gas flares in the Province of Alberta in Canada – but these are commingled with lights from cities and towns, agricultural burning, and lights present at tar sand extraction sites. Onshore gas flares in Mexico are likewise commingled with other lights in a way that made their identification problematic. Gas flares in the Prudhoe Bay region of Alaska are in the 70+ degree latitude range where there are few DMSP satellite data coverages and in some years – no coverages.

2.5. Calibration to Estimate Gas Flaring Volumes

A calibration was developed to estimate gas flaring volumes for individual countries based on the sum of lights index values and a set of reported gas flaring volumes for countries and individual flares. The steps in developing the calibration included the removal of outliers, regression modeling, and establishing the prediction interval of the model. The “R” statistical software package was used in these analyses (R Development Core Team, 2007).

2.5.1. Selection of calibration data: All of the reported BCM values available from the

GGRR were considered. This includes the GGFR estimates from 2004, all the individual flares (or flare sets) and reported values for countries for years other than 2004. The Russia data were discarded a priori based on visual examination of the scattergram of the sum of lights index versus BCM. For all other data outliers were identified based on the following tests (Figures 8-10): 1) plot of the standardized residuals versus estimated values , 4) normal qq-plot, and 3) Cook's distance (Hamilton, 1992). The points with the numbers are the outliers: 4 - Nigeria F121996, 7 - Nigeria F152005, 9 - Nigeria F152002, and 10 - Nigeria F121997. Nigeria F121996, F152005 and F152002 were identified as outliers based on the plot of the standardized residuals and the QQ plot (Figures 8 and 9). Nigeria F121996 and Nigeria F121997 were identified as outliers (Figure 10) based Cook's distances greater than 1.

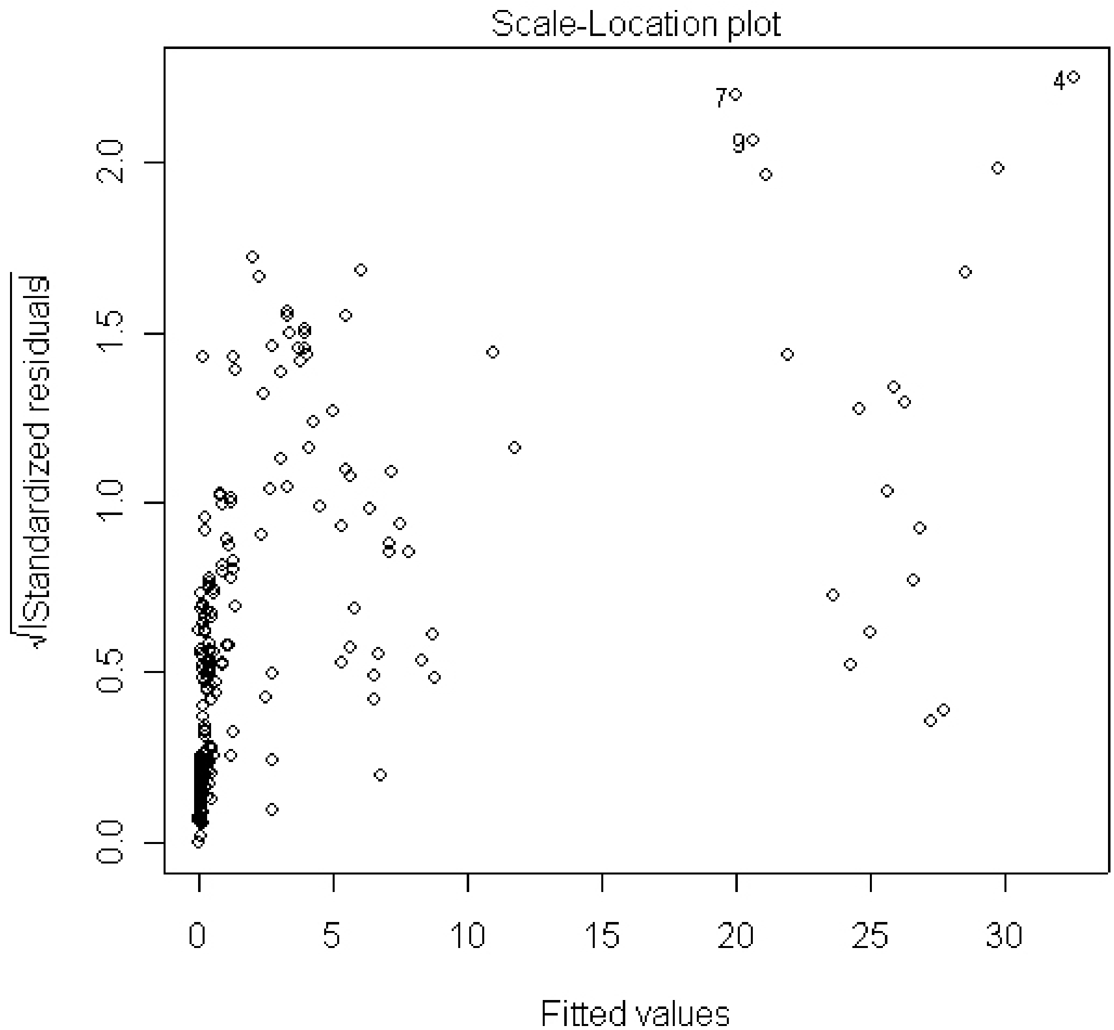

Figure 8. Plot of the standardized residuals versus estimated values used to identify outliers (4 - Nigeria F121996, 7 - Nigeria F152005, 9 - Nigeria F121997).

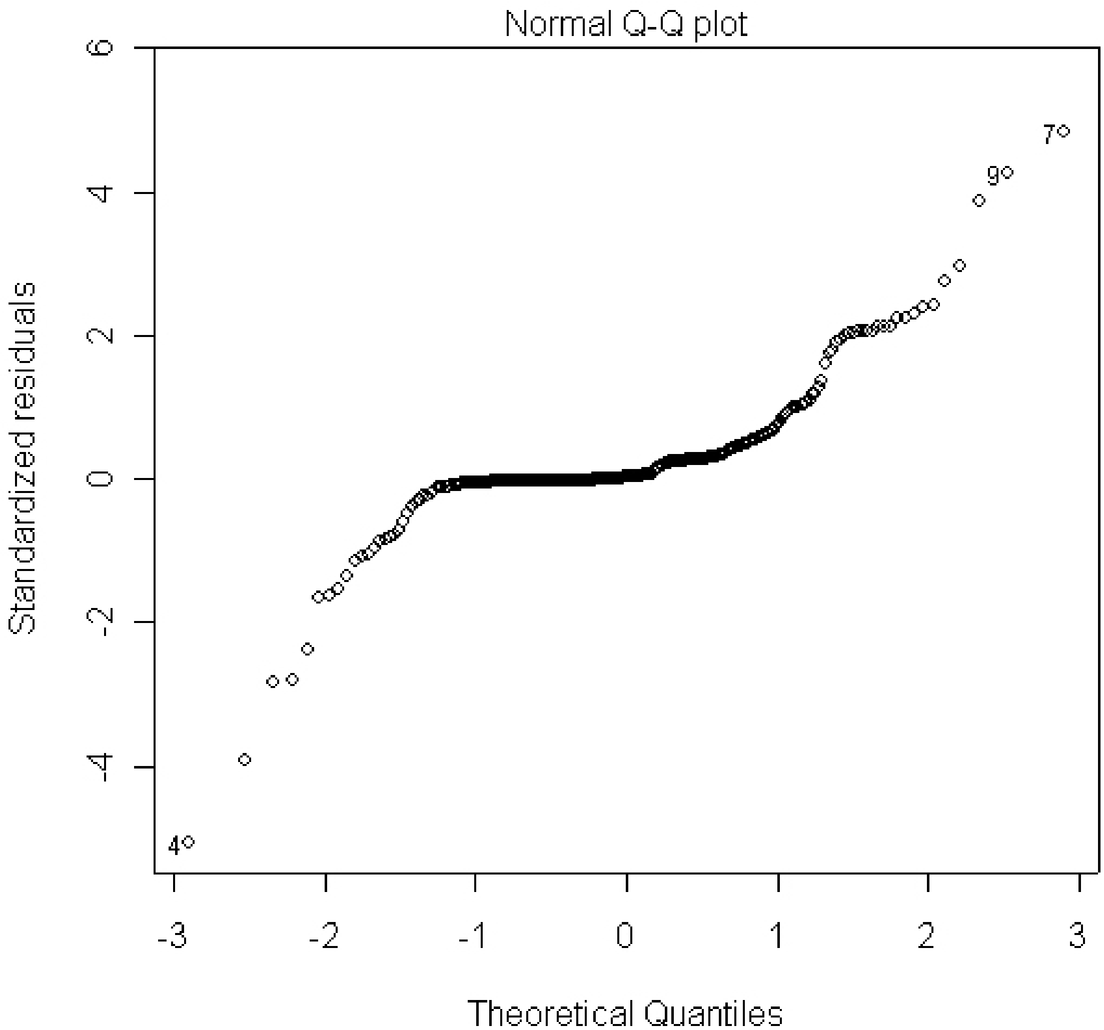

Figure 9. Normal qq-plot used to identify outliers (4 - Nigeria F121996, 7 - Nigeria F152005, 9 - Nigeria F121997).

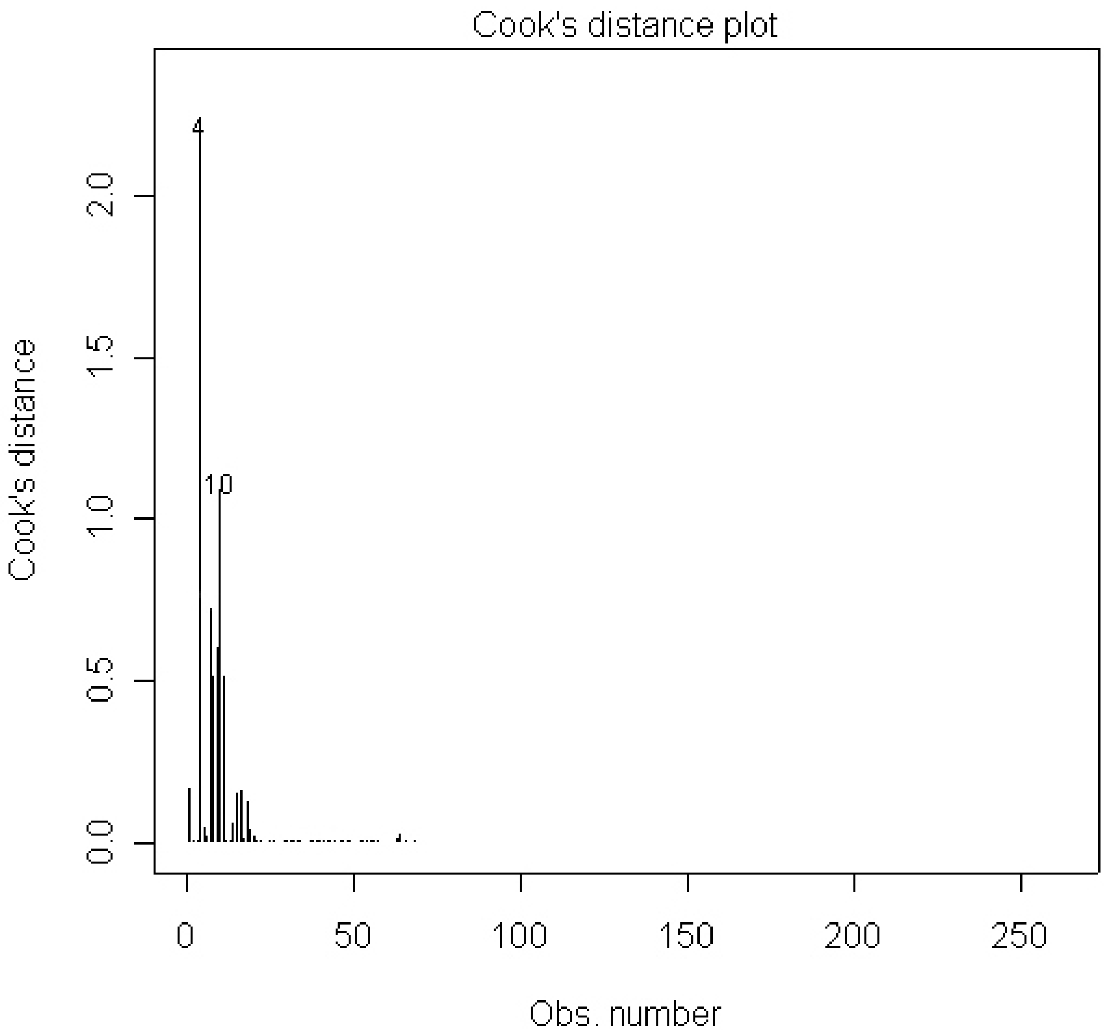

Figure 10. Cook's distance plot used to identify outliers (4 - Nigeria F121996 and 10 - Nigeria F121997).

2.5.2. Estimation model: A linear regression model was used with a zero intercept (Figure 11). The model is: BCM= 0.00002646 * Sum of lights index , R^2 = 0.978, P-value < 2.2e-16. The model was cross-validated by randomly removing segments of the calibration set (cross validation). The model results changed very little in these test indicating that the model is not highly dependent on the data from a single country or flare set. The data used in the model are available in Appendix 1.

2.5.3. BCM estimates and prediction intervals: After obtaining the least squares estimation equation, we used it to make predictions of the BCM of flared gas for the individual countries with a 90% prediction interval. The prediction interval of the regression model is approximately 1.61 BCM, which defines the upper and lower bound for the BCM estimates as a form of error bar for each estimate. The prediction interval varies slightly across the range of encountered values. The prediction intervals can be considered the error bars for the BCM estimates made for the individual countries, encompassing the errors and uncertainties present in both the reported BCM values and the nighttime lights.

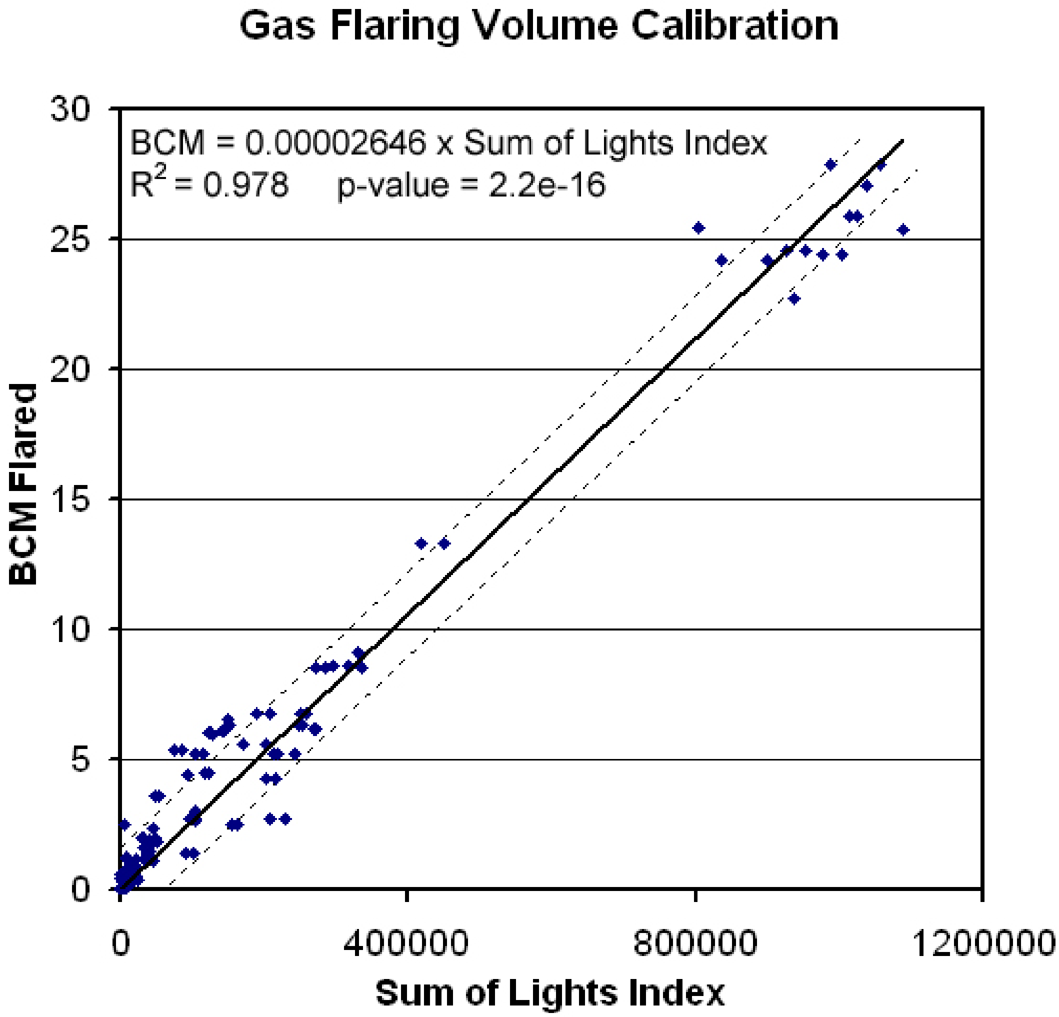

Figure 11. Plot of the reported BCM levels of flared gas versus the sum of light index, regression line (solid line) and 90% prediction intervals for individual BCM estimates (dashed lines).

3. RESULTS

3.1. A Global Map of Gas Flaring

A global map of gas flaring was prepared by combining the gas flares identified in each of the individual annual composites. A reduced resolution version of this map is shown in Figure 12. The largest area of gas flaring is in Western Siberia (Russia). Other areas with large concentrations of gas flaring includes the Persian Gulf region, North Africa, and the Gulf of Guinea.

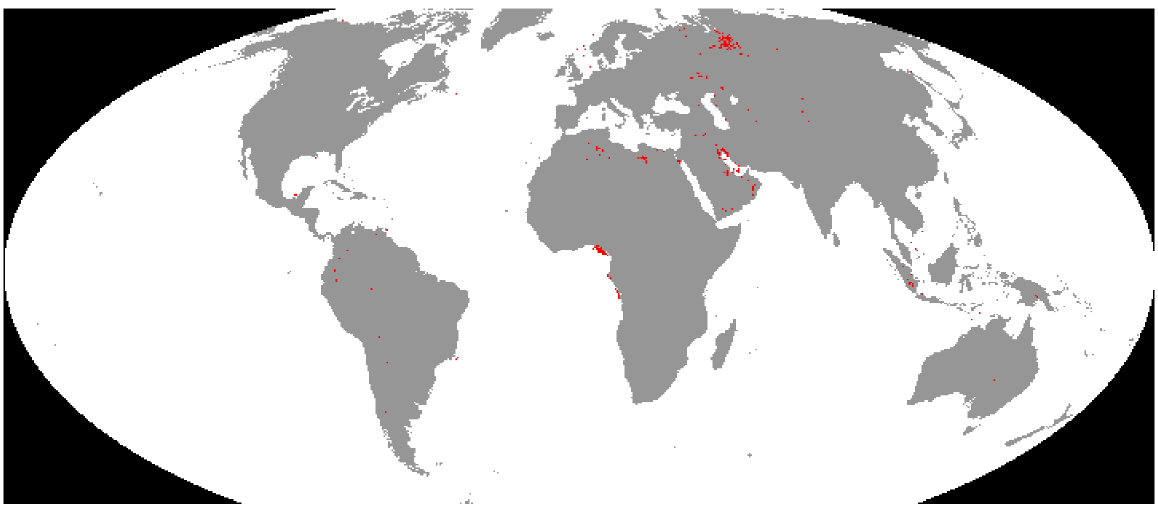

Figure 12. Gas flares of the world – 2004 – in a Mollweide one kilometer equal area projection.

3.2. National Gas Flaring Estimates

Gas flaring volumes were estimated for individual countries based on the sum of lights index values. The estimates for individual countries or areas for the year 2004 are shown as a bar chart in Figure 13. The estimates indicate that gas flaring in Russia were approximately twice the volume of Nigeria's. The full set of estimates from 1995-2006 are in Appendix 2.

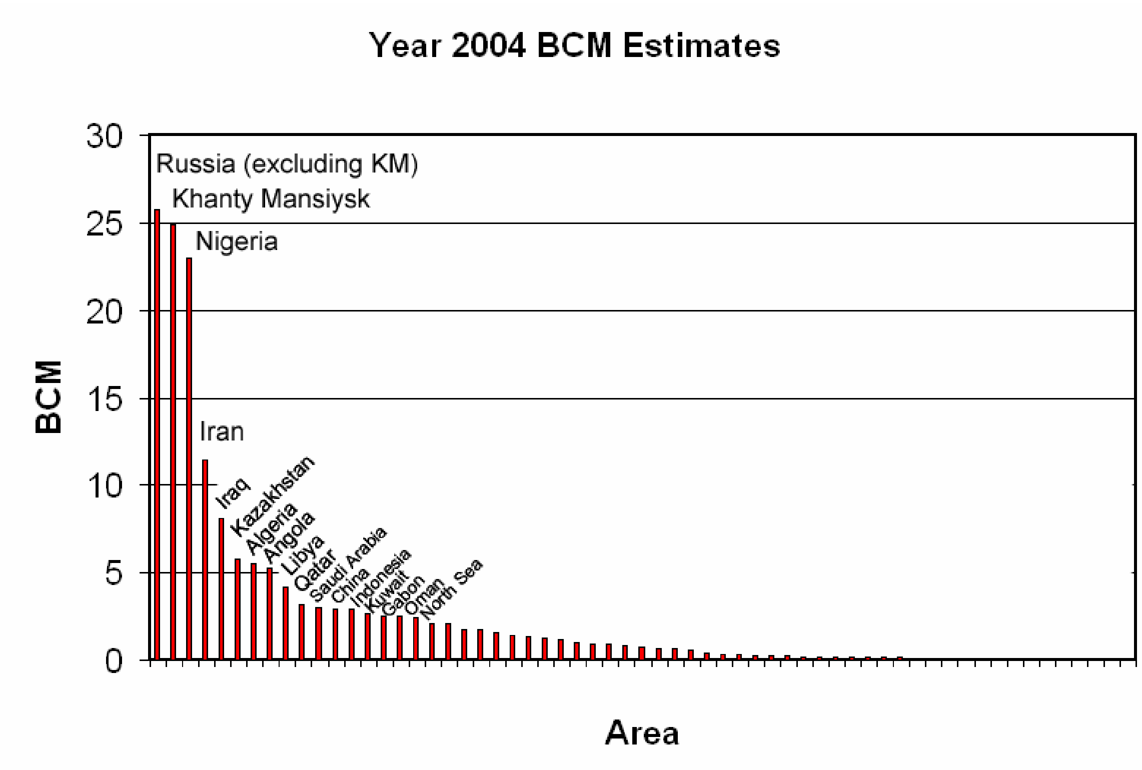

Figure 13. Year 2004 gas flaring estimates in billions of cubic meters (BCM).

3.3. Trends Over Time:

Extraction of the sum of lights index across the DMSP nighttime lights time series, from 1995 through 2006, reveals gas flaring trends for individual countries. The charts for each of the countries or areas with gas flaring are provided in Appendix 3. The charts have been examined and divided into categories based on the flaring activity across the full time series (1995-2006) and across the GGFR time frame (2002-2006).

3.3.1. Long Term Trends

3.3.1.1. Long Term Decreasers

Sixteen countries (or areas) exhibit a downward trend in gas flaring from 1995 to 2006, including Algeria, Argentina, Bolivia, Cameroon, Chile, Egypt, India, Indonesia, Libya, Nigeria, North Sea, Norway, Peru, Syria, UAE and USA (offshore). Nigerian gas flaring has had several ups and downs – but the overall reduction in gas flaring is in the range of 10 BCM. Algeria, Libya and Syria had decreases better than 2 BCM since 1995.

3.3.1.2. Peak In The Middle

Thirteen countries had peaks in gas flaring between the end points of the time series – but nearly the same quantity of gas flaring in recent years as in the mid-1990's. This includes Angola, Brazil, Brunei, Canada, Colombia, Congo, Cote d' Ivoire, Democratic Republic of Congo, Irish Sea (UK), Mexico, Tunisia, Venezuela and Vietnam.

3.3.1.3. Stable Flaring

Nine countries had largely stable gas flaring across the time series. In some cases there were ups and downs – but no obvious trend. This includes Australia, Ecuador, Gabon, Iran, Kuwait, Malaysia, Khanty-Mansiysk (Russia), Romania, and Trinidad.

3.3.1.4. Long Term Increasers

Twenty-two countries have an upward trend in gas flaring over the time series. This includes Azerbaijan,Chad, China, Equatorial Guinea, Ghana, Iraq, Kazakhstan, Kyrgyzstan, Mauritania, Myanmar, Oman, Philippines, Papua New Guinea, Qatar, Russia (excluding KM), Saudi Arabia, South Africa, Sudan, Thailand, Turkmenistan, Uzbekistan, and Yemen. The largest increases were in Russia (+10 BCM), Kazakhstan (+5 BCM) and Iraq (+4 BCM).

3.3.2. Short term trends (2002-2006):

3.3.2.1. Stable Flaring: Thirty-four countries or areas exhibited largely stable gas flaring from 2002 through 2006. This includes Algeria, Argentina, Australia, Brunei, Colombia, Democratic Republic of Congo, Ecuador, Egypt, India, Indonesia, Iraq, Irish Sea (UK), Kyrgyzstan, Libya, Myanmar, Mexico, Myanmar, Nigeria, North Sea, Norway, Oman, Philippines, Qatar, Romania, Khanty-Mansiysk (Russia), South Africa, Syria, Tunisia, Turkmenistan, UAE, USA, Uzbekistan, Venezuela, and Vietnam.

3.3.2.2. Short Term Decreasers: Seven countries exhibited a downward trend in gas flaring from 2002 to 2006. This includes Angola, Bolivia, Cameroon, Chile, Cote d"Ivoire, Gabon, and Peru. The largest declines from 2002-2006 were in Angola and Gabon, each declining by about 1 BCM.

3.3.2.3. Short Term Increasers: Twenty-one countries show an upward trend in gas flaring from 2002 through 2006: Azerbaijan, Brazil, Canada (offshore), Chad, China, Congo, Equatorial Guinea, Ghana, Iran, Kazakhstan, Kuwait, Libya, Malaysia, Mauritania, PNG, Russia (excluding KM), Saudi Arabia, Sudan, Thailand, Trinidad, and Yemen. Gas flaring in Russia increased by six BCM and the increase in Iran was 3 BCM.

3.4. Global Trend in Gas Flaring: When the BCM estimates for all the countries and areas are combined it forms an estimate of global gas flaring volume. This is shown for the fifteen year time period in Figure 14. Overall flaring has remained largely stable between 150 and 170 BCM from 1995 to 2006. There were dips in gas flaring in 1999 and 2002. Gas flaring increased by more than ten BCM from 2002 to 2003 and then declined for two years after that before rising again in 2006.

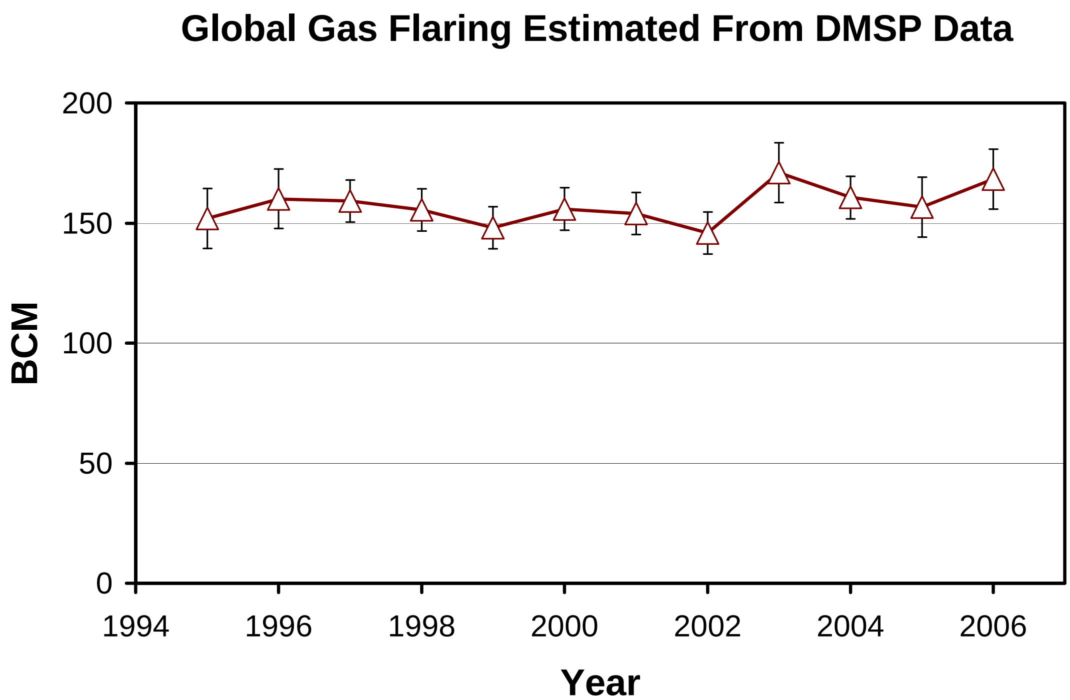

Figure 14. Global gas flaring has remained largely stable for the past fifteen years.

3.5. Sources of Error and Uncertainty

There are a number of sources of uncertainty and error in the results of this study. To the extent to which these errors are present in the calibration data (see Figure 11) these sources of uncertainty contribute to the +/- 1.61 BCM prediction interval. The sources of error or uncertainty include:

- Errors in the reported flare volume data. Not all countries or companies collect and report gas flaring data and where flaring data are available it is possible for errors to have been introduced. Flaring data reported by different sources often differ with no clear way to determine the "best" value. In addition to these general uncertainties, there are also a number of known uncertainties in the reported data.

For Brazil, Indonesia, Venezuela and the USA, the reported numbers include unknown quantitites of vented gas in addition to the flared gas. Since the DMSP only detects flared gas, if there is significant vented gas the satellite estimates will be lower than the reported values.

For Russia, the reported volumes only include flared volumes of gas associated with oil production. In addition to this flaring, there is known to be a very significant volume of gas flared from condensate stripping ventures. GGFR reported numbers include both flaring and venting. Since the DMSP only detects flared gas - the inclusion of an undefined amount of venting in any of the reported BCM values contributes to error in the calibration and BCM estimates.

- Variations in flare efficiency. The volume of gas present in the oil, the procedures used in oil/gas separation, and the type of equipment used for the flaring all affect the efficiency of the flaring and the amount of light emitted for detection by the satellite. For instance it is possible that a smoky flare will have more of the light absorbed by soot particles – which may reduce the brightness of the flare.

- Inclusion of flaring from processing facilities. In some cases the flares that have been identified in the satellite data are from processing facilities - not production facilities. The issue here is that the reported BCM values in some cases include flaring from processing facilities and other cases only include flaring from production facilities.

- Mis-identification of flares. Flares that are imbedded in well defined areas of urban lighting were not identified in this study - representing an undercount of flaring. In other cases errors of omission and errors of commission may have been made in the identification of flares.

- Non-continuous sampling. It is possible for flaring activity to vary substantially over the course of a year or even within a single day. The data used in this analysis are all from the early evening (7 to 10 pm) and have been screened for factors such as sunlight, moonlight and clouds to produce a uniform product from year to year. The screening to exclude sunlit data combined with an early evening overpass time results in an absence of samples during summer months at high latitudes. In total most flares have 40 to 80 valid samples in a year (see AVG CF CVG column in Appendix 2). Since the OLS sensors acquire six scan lines per second – the cumulative observation time for 60 valid samples is only 10 seconds! In some cases the temporal distribution of the valid observations may not have been sufficient to capture a representative sum of lights index. Due to the launch dates and sensor or orbit degradations it was not possible to include a full year of observations in each of the satellite products. The most conspicuous example is the F121994 product, which only includes data from the last four months of 1994.

- Environmental effects. There are some environmental conditions which contribute to either reductions or enhancements to the quantity of light from gas flares that escapes into space for detection by the OLS. Countries like Saudi Arabia and Algeria have very dry atmospheres with less attenuation of light into space as compared to the humid tropical atmospheres present in countries such as Nigeria and Indonesia. Another possible environmental effect that has not been addressed is the affect of variations in surface backgrounds. Because the flares are unshieled they emit light in all directions. For that portion of the light that is emitted in a downward direction (towards the ground) there is a possibility that the photons will either be absorbed by the surface or reflected. Thus flares over a dark background - such as water - may appear smaller and dimmer than flares on a bright reflective background.

- Persistent lighting at petroleum facilities. As flaring is reduced at a site the sum of lights index values will drop. But even with all flaring eliminated – there may be detection of facility lighting.

- OLS sensor differences. It is known that the optical throughput of orbiting sensors tends to decline over time due to the accumulation of dust on mirrors. Detectors, stabilizing gyroscopes and electronics can all degrade over time and effect data quality. The intercalibration procedure was designed to account for as many of these effects as possible. But the intercalibration procedure may not have fully addressed differences in the spectral bandpasses of the different OLS sensors. Since the reference data used in the intercalibration were electric lights not gas flares. The OLS nighttime “visible” band straddles the visible and near infrared portion of the spectrum. Thus variation in the near infrared portion of the OLS sensor bandpasses might impact the comparability of results from different satellites.

4. ADDITIONAL SATELLITE DATA SOURCES

A review has been conducted to identify additional satellite data sources that could be used to either confirm the locations of active gas flares or to monitor gas flaring activity over time. We have identified four readily available sources that have high potential value. These four were selected based on global coverage, a capability to detect gas flares, and no cost for accessing the data.

4.1. Landsat data from NASA’s Geocover database: NASA has assembled global databases of geolocated Landsat data covering the majority of land and nearshore areas for three epochs (mid-1970’s, early 1990’s, and early 2000’s). The data from the 1990’s and 2000’s were acquired with Landsat sensors having two short-wave infrared bands that typically saturate on gas flares. The data may be downloaded from the University of Maryland’s Global Land Cover Facility (GLCF). Since there is generally only a single coverage for each area Geocover could not be used to track gas flaring activity through a year. However, at 30 meter resolution the 1990’s and 2000’s data can be used to confirm the identity of suspected gas flares observed with coarser spatial resolution imagery, such as DMSP, MODIS and ATSR (discussed below). A Geocover Landsat scene (path 154 row 017) from July 12, 2000 covering a section in Khanty-Mansiysk has been closely examined for gas flares and other features. The image and identified features are shown in Figure 15 with spectral bands 7, 5, and 4 overlain as red, green, and blue. Bands 5 and 7 are the short wave infrared band sensitive to gas flaring. Center points of the DMSP identified gas flares in year 2000 are shown as red triangles. For the 56 DMSP identified gas flares 36 had active gas flare features in the Landsat, 15 had exploration / production features, three were small towns, one was a small airstrip and two were petroleum processing facilities.. Figures 15 provides a key to full resolution images of a production area, an active gas flare, a small town and a processing facility (Figure 16-19) which were identified in DMSP data as gas flares. Figures 16 show the Landsat data can be used to improve the accuracy of gas flare identification in coarse resolution data sources such as DMSP. Given the possibility that flares may be shut off at times during the year it is reasonable to expect that not all the active flares during a year will show up in an image acquired on a randomly selected date / time. The distribution of DMSP identified gas flares and Landsat features are shown plotted on the DMSP F152000 sum of lights image in Figure 18.

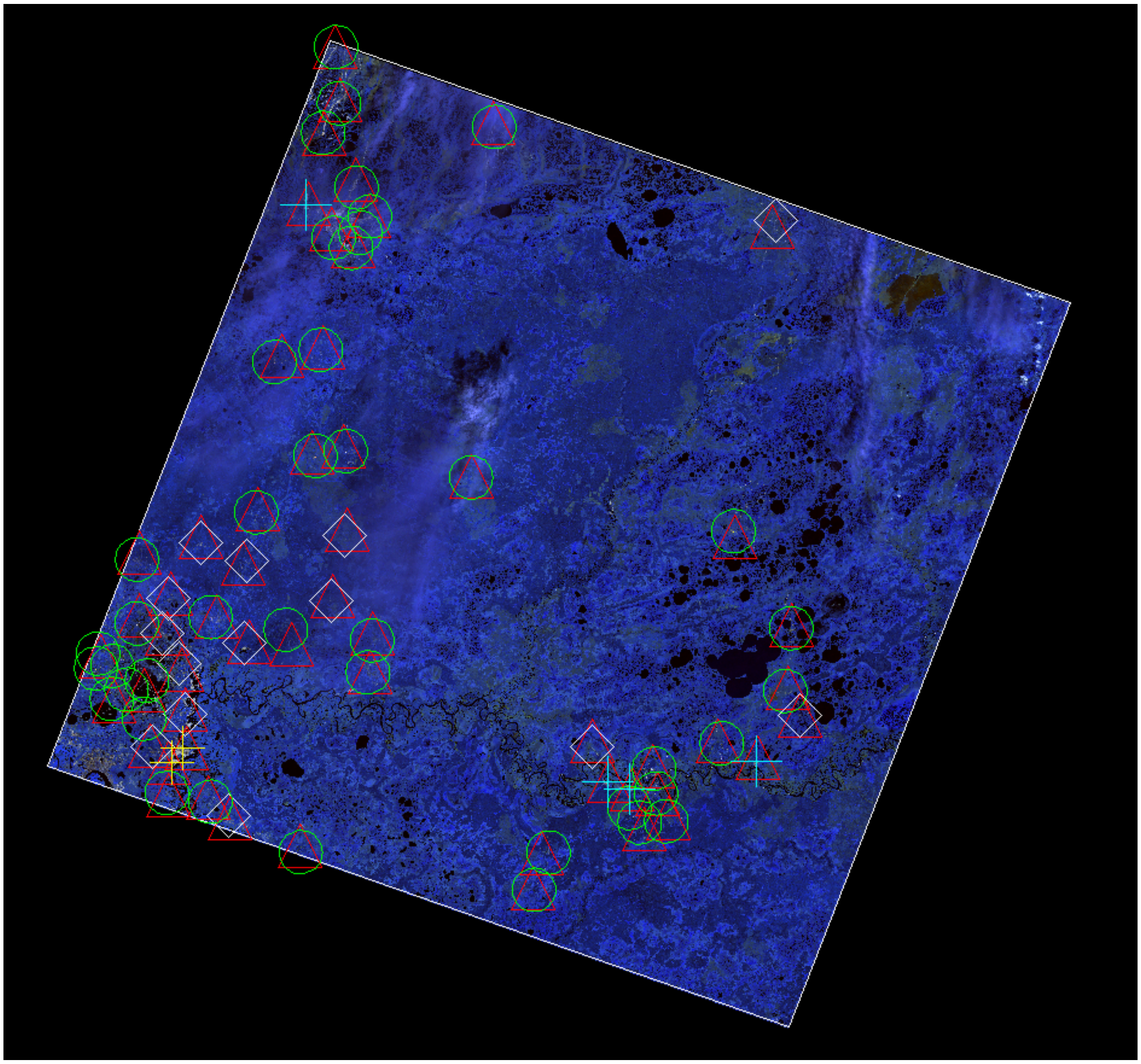

Figure 14. Landsat ETM+ path 154 row 17 acquired July 12, 2000. The red triangles mark the centers of DMSP identified gas flares in 2000. Gas flare features found in the Landsat are marked with green circles. In cases where no flare was found in the Landsat the type of feature present was either a petroleum processing facility (yellow crosses), small town (cyan crosses) or had a network of roads and drill pads (white diamonds).

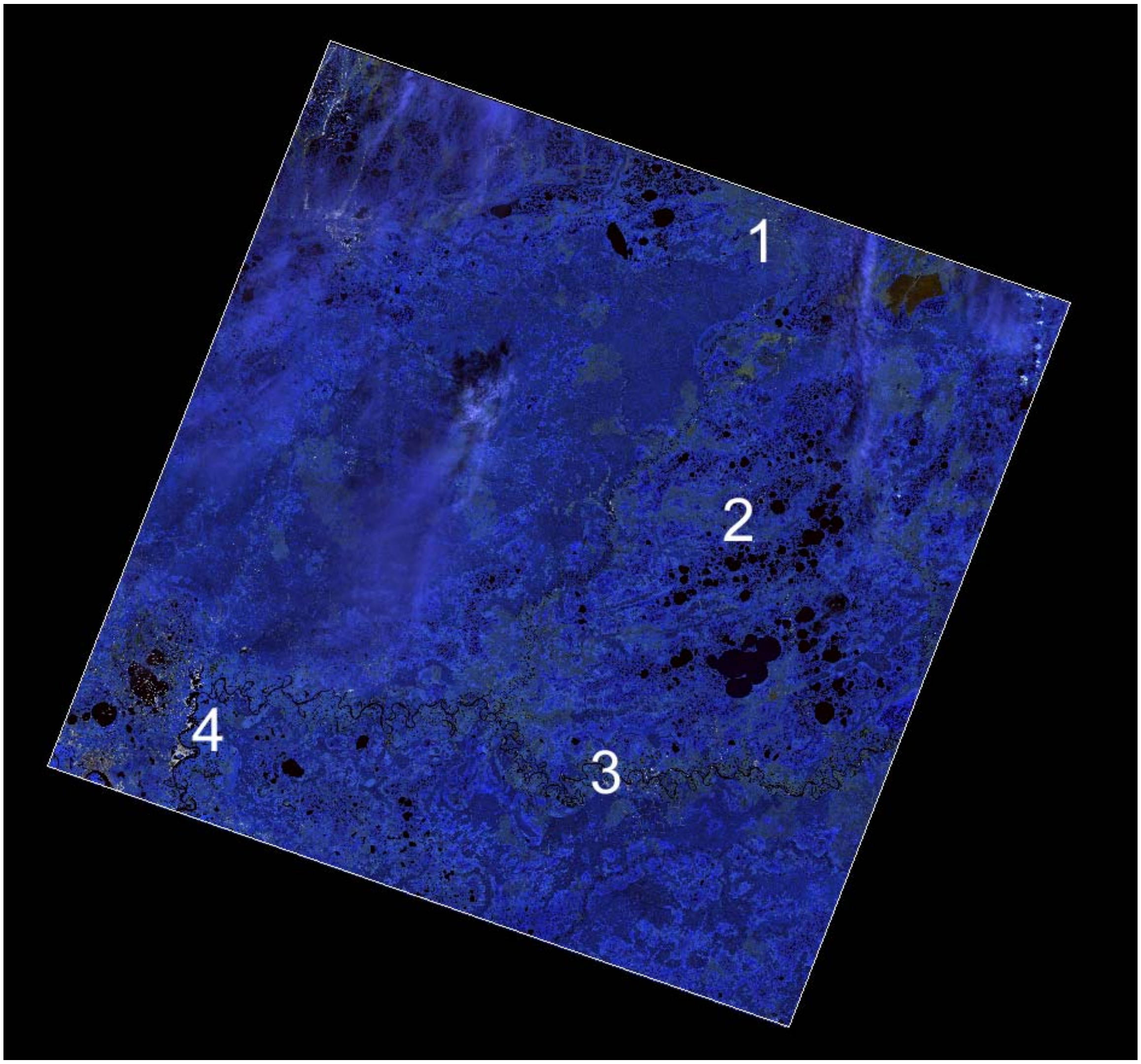

Figure 15. Numbered key to full resolution images shown in Figure 16.

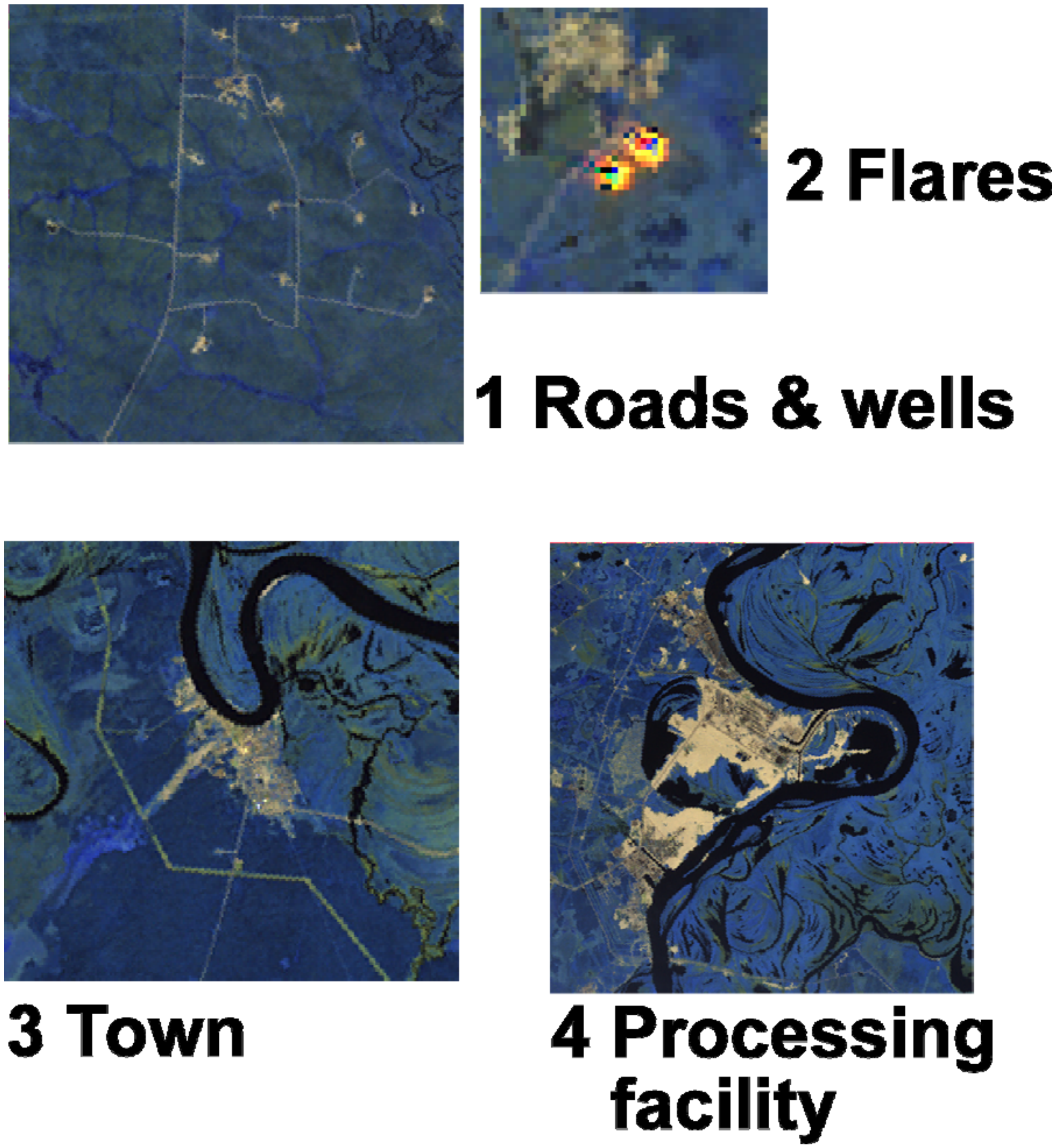

Figure 16. Features found in Landsat data at sites identified as gas flares in DMSP data. Location numbering showing in Figure 15.

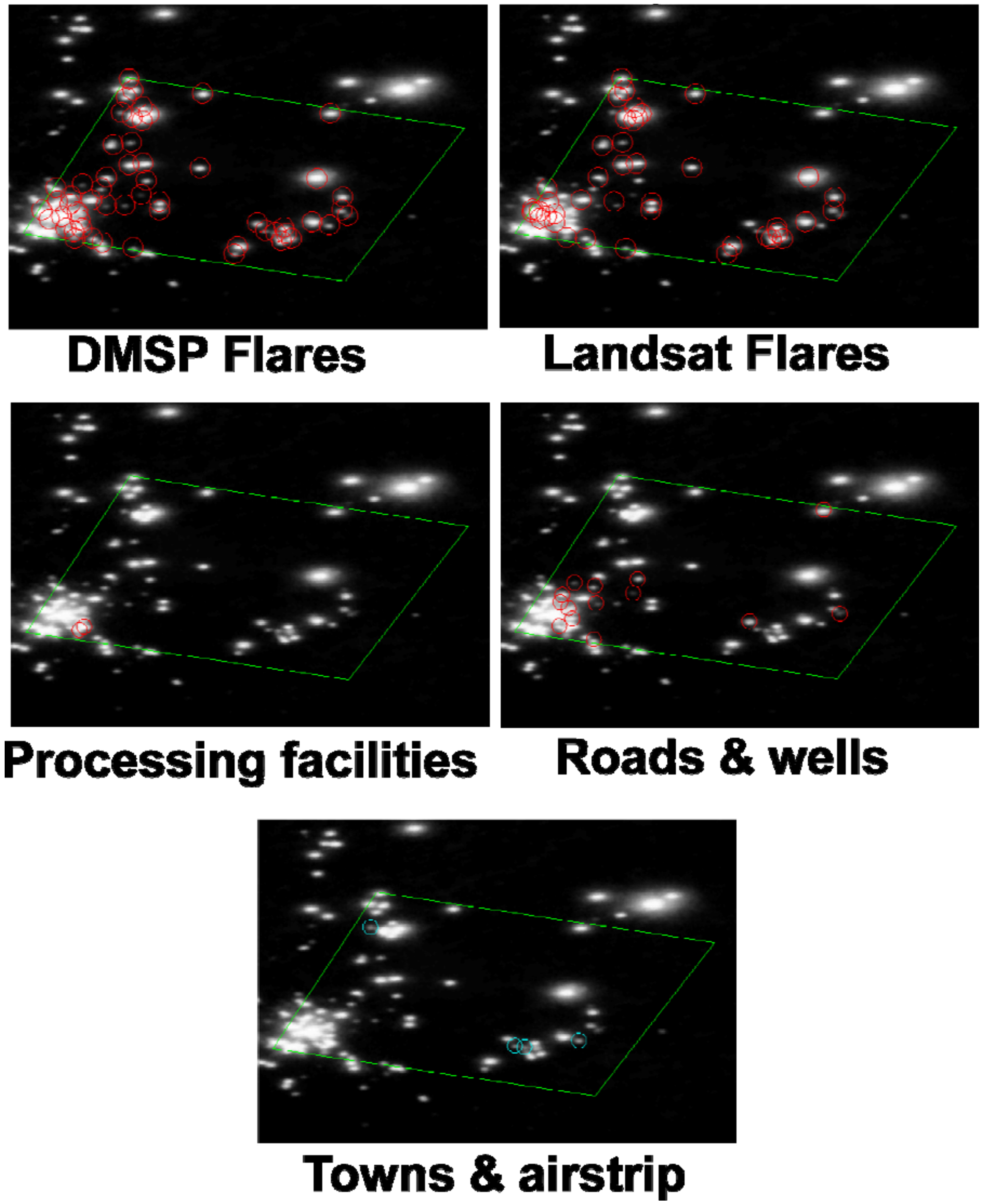

Figure 17. DMSP satellite F15 sum of lights image for the Landsat scene area from year 2000. Locations of DMSP identified gas flares, Landsat identified gas flares, petroleum processing facilities, roads and wells, and towns or airstrips are circles. The BCM estimates for the area are approximately 3 to 4 % higher (in error) based on the inclusion of the towns.

4.2. MODIS: The U.S. National Aeronautics and Space Administration (NASA) operates two polar orbiting earth observation sensors known as MODIS (Moderate Resolution Imaging Spectrometer). MODIS collects data in 36 spectral bands, most with one kilometer spatial resolution. With a 1200 kilometer image swath and both a daytime and nighttime pass – MODIS collects nearly global data every 24 hours. One of the standard products from MODIS is active fire detections. The MODIS fire detection algorithm uses a spectral band in the 3-5 um (micrometer) range and a second spectral band in the 10-12 um range. Active fires are anomalously bright in the 3-5 um band relative to the 10-12 um band. To explore the ability of MODIS to detect gas flares NGDC examined individual MODIS images and also contructed an annual MODIS fire product. Figure 18 shows the MODIS image of Khanty-Mansiysk acquired about twenty minutes after the Landsat scene collection (Figure 14). The MODIS image was made with the spectral bands used in active fire detection. Only a small number of gas flares found in the Landsat data were located as hot spots in the MODIS data despite the near simultaneity of the observations. A similar result is evident when looking at a full year of MODIS fire detections. Figure 19 shows the accumulation of all the MODIS fire detections for the year 2004. In reviewing single orbit MODIS scenes and the annual composite of MODIS fire detections our assessment is that MODIS detects the large gas flares. It should be noted that the MODIS active fire detection product is only generated for land areas (no offshore flare detections). Also, since the MODIS active fire detections are lists of latitudes and longitudes of detections – it is not possible to calculate the percent frequency of detections – as is done with DMSP. Since the number of valid observations over a year has spatial variation it is useful to normalize the detections by the number of valid observations – forming a percent frequency of detection. The MODIS archive would need to be reprocessed to calculate annual percent frequencies of fire detections.

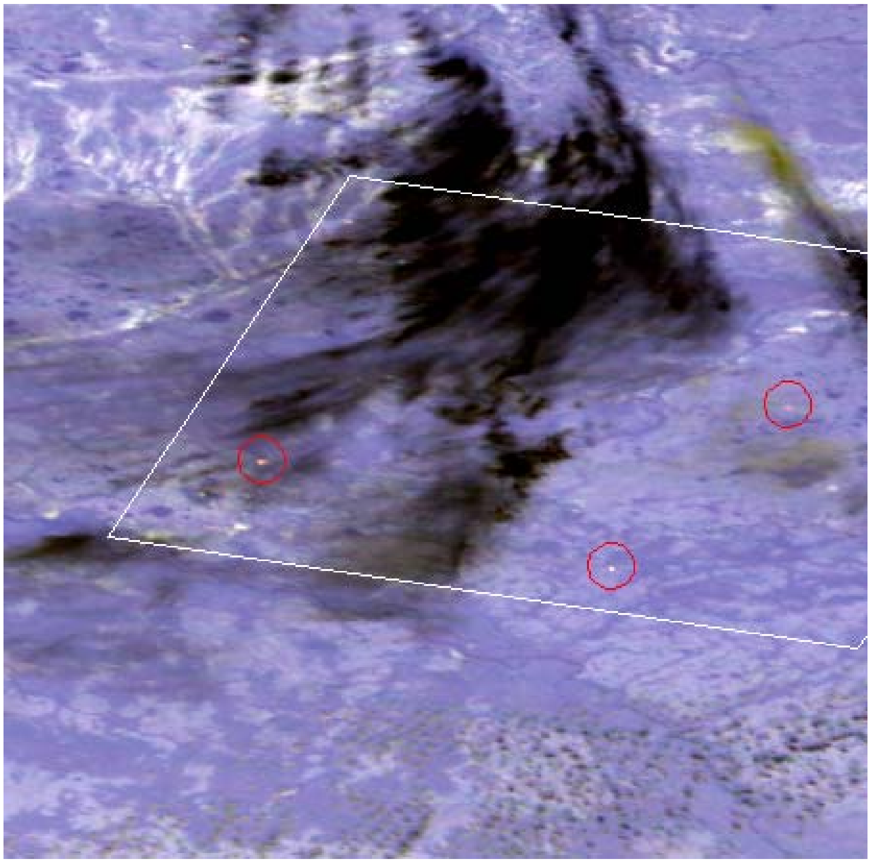

Figure 18. MODIS image acquired on July 12, 2000 over the Landsat scene area from the same date shown in Figure 14. The image is a color composite made with bands 21, 22 and 31 as red, green and blue. Bands 21 and 31 are used in the MODIS active fire detection algorithm. Three active gas flares, circled in red, were identified visually. Note that the Landsat scene area (Figure 14) is outlined in white. The MODIS scene does not fully cover the Landsat scene – resulting in truncation on the right hand side.

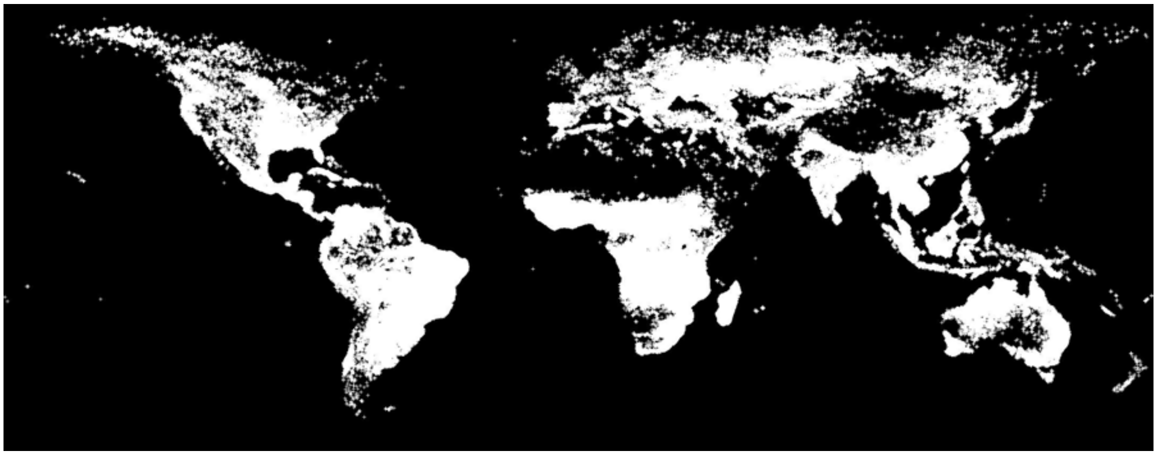

Figure 19. Plot of all the MODIS active fire detections from 2004.

4.3. ATSR and AATSR. The European Space Agency (ESA) has operated polar orbiting sensors known as Along Track Scanning Radiometer since 1995 and the Advanced Along Track Scanning Radiometer (AATSR) since 2003. These sensors have four spectral bands, one kilometer resolution and 500 km swath width. The European Space Agency ESRIN Earth Observation Center in Frascati, Italy produces an active fire detection product from ATSR and AATSR nighttime data. The fire detections are grouped into monthly sets which can be downloaded from their web site (http://dup.esrin.esa.int/ionia/wfa/index.asp).   The ATSR fire data run from November 1995 through 2002. AATSR fire data run from 2003 to the present. NGDC has aggregated the 2004 ATSR fire detections for comparison to the DMSP and MODIS gas flare detections. Figure 20, 21 and 22 compare gas flare detections from DMSP, MODIS and AATSR for KM, Nigeria and the Northern Persian Gulf region. In Nigeria and the Persian Gulf AATSR detected many of the gas flares identified with DMSP.

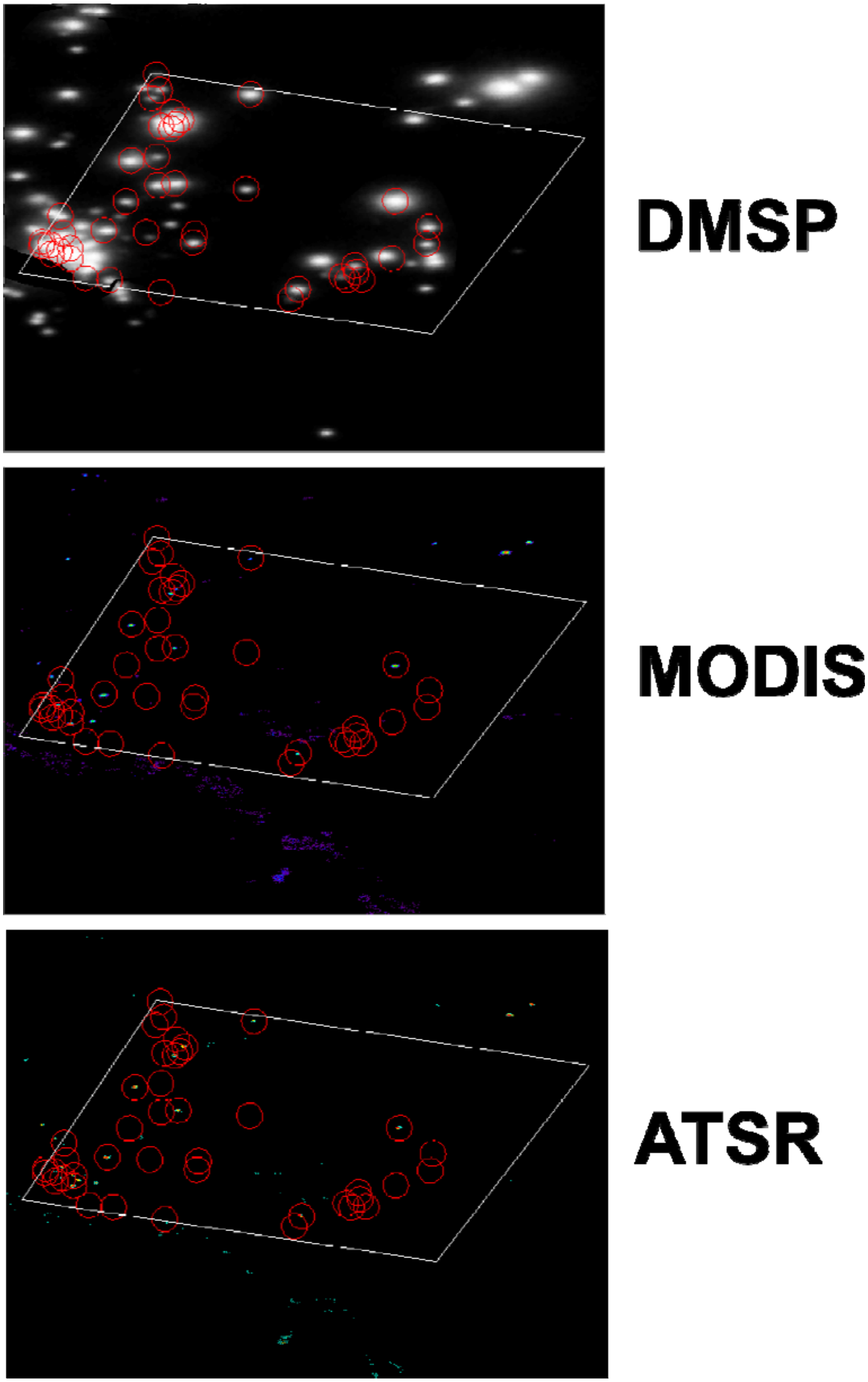

Figure 20. Year 2004 composites of DMSP gas flares plus active fire detections from MODIS and ATSR in the Khanty-Mansiysk region. Locations of active gas flares found in Landsat data (Figure 14) are circled in red.

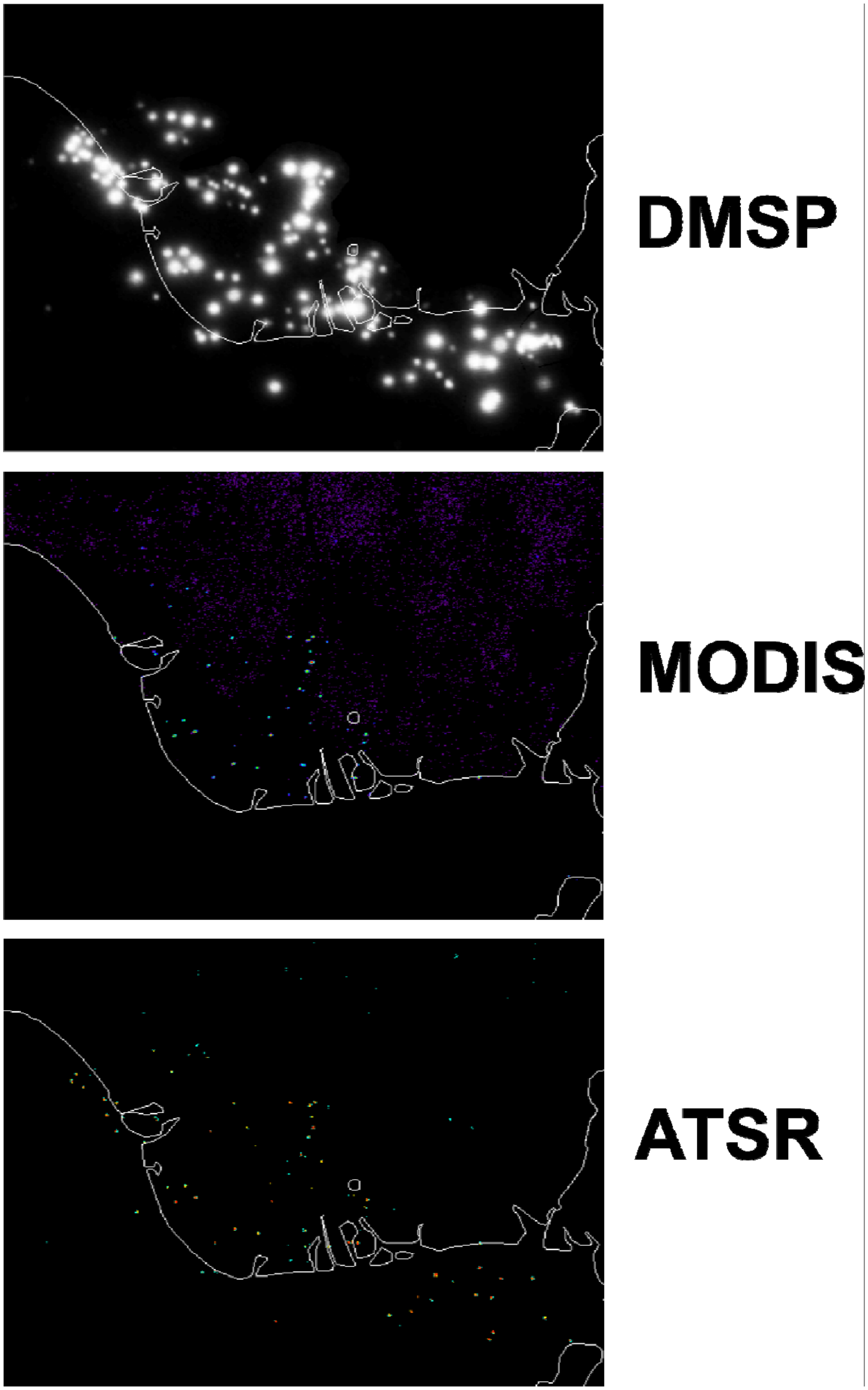

Figure 21. Year 2004 composites of DMSP gas flares plus active fire detections from MODIS and ATSR in Nigeria.

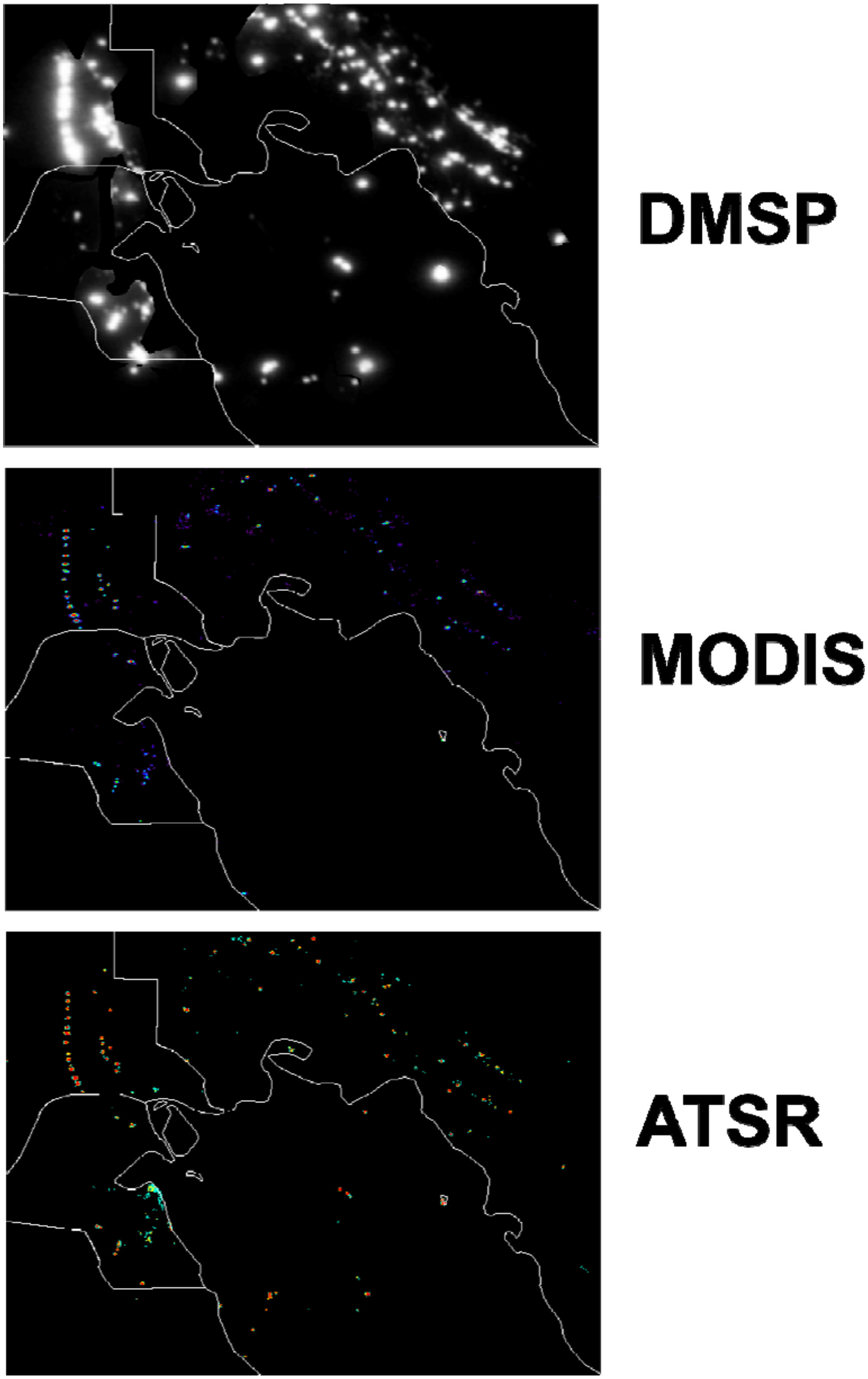

Figure 22. Year 2004 composites of DMSP gas flares plus active fire detections from MODIS and ATSR in the Northern Persian Gulf region.

4.4. Google Earth: This system makes it possible to interactively view moderate to high spatial resolution imagery around the world. The base imagery in most areas is a color composite made with Landsat Thematic Mapper data – though not the spectral bands selected for gas flare detection (Figure 14). In an increasing number of areas the base imagery is ~1 meter resolution data from the Digital Globe Corporation Quickbird satellite. NGDC built a link to Google Earth that features a DMSP color composite image of global gas flares from 2006 (red), 2000 (green) and 1992 (blue). Figure 23 shows a Google Earth overview of the DMSP gas flares for a portion of Nigeria. It is possible to use the interface to zoom in on individual DMSP identified gas flares to view the base imagery present in Google Earth. Zooming in on the point marked as "X" in Figure 23 it was possible to locate two gas flares – each appearing as an orange ball of flame in Digital Globe imagery. One of these is shown in Figure 24.

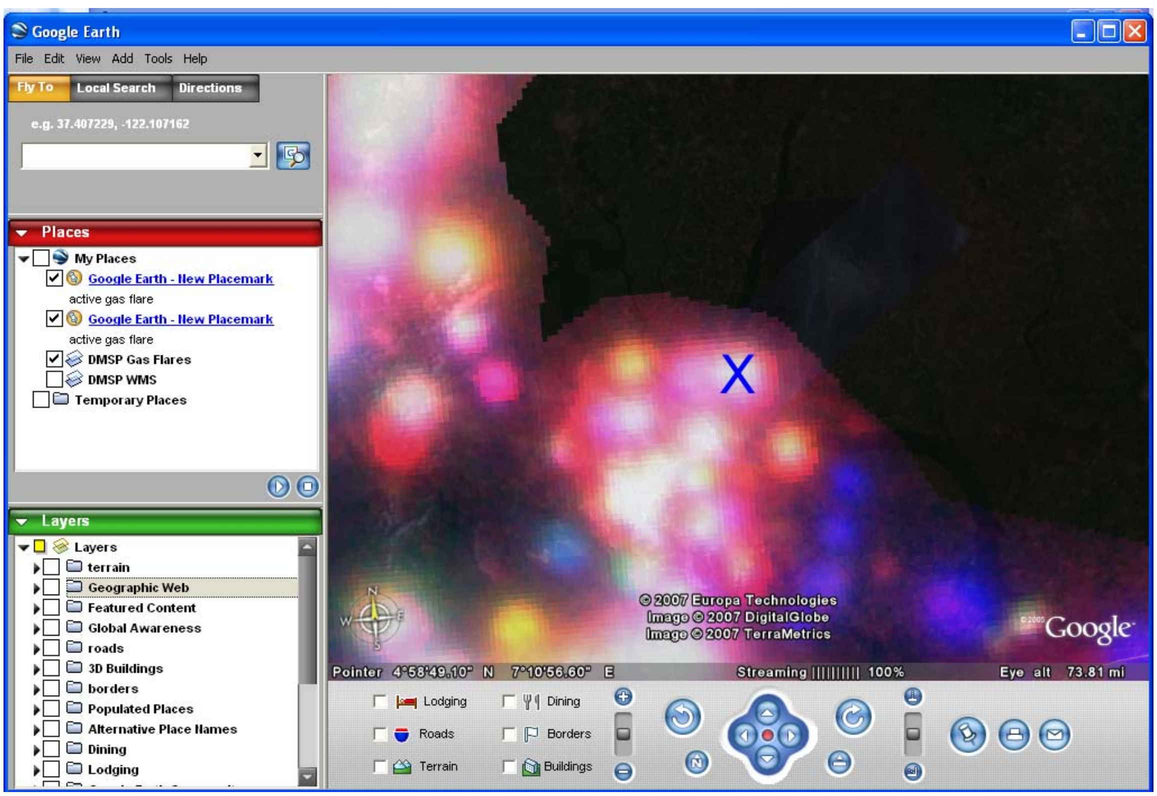

Figure 23. DMSP gas flares covering a portion of Nigeria viewed with Google Earth. The image is a color composite made with flares from 2006 as red, 2000 as green and 1992 as blue. When Google Earth was zoomed in on the point marked with an "X" gas

flares were found in the full resolution base images from the Quickbird satellite (see Figure 24).

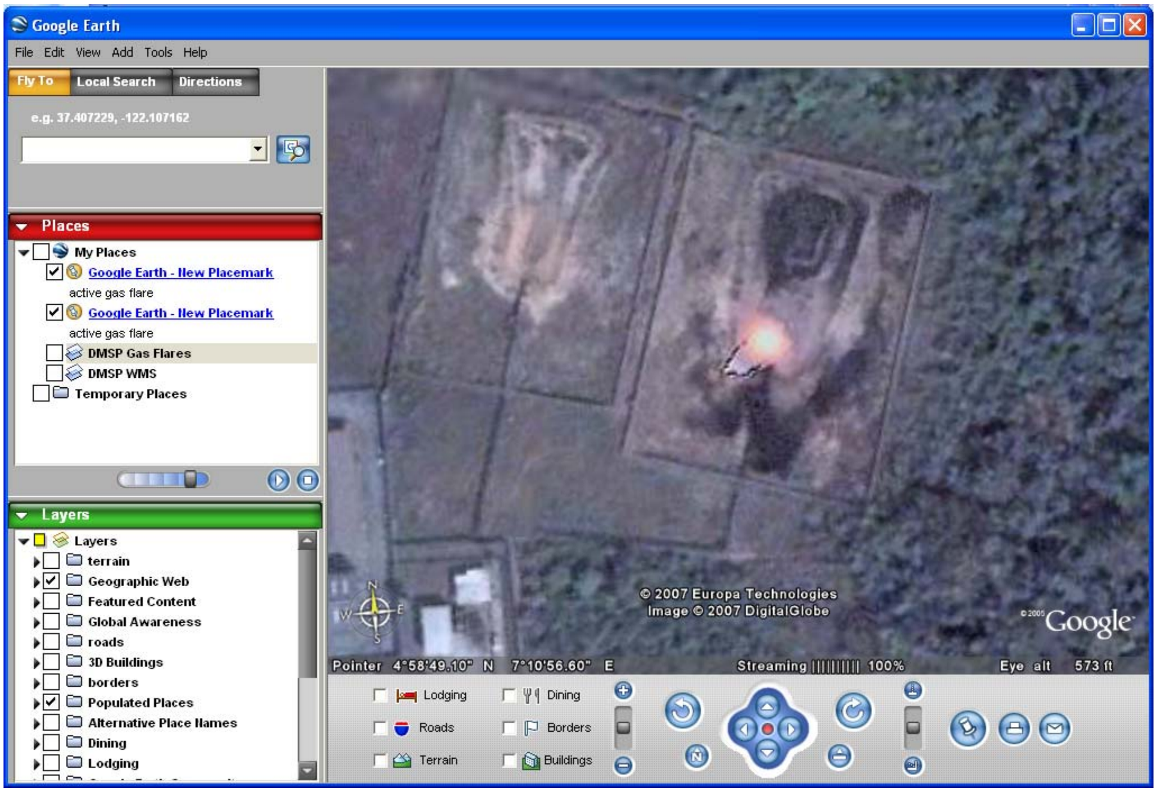

Figure 24. Google Earth zoomed in at full resolution one of two gas flares located near the “X” marked on Figure 23. The base image is one meter resolution color satellite imagery from Digital Globe Corporation. The active gas flare shows up as an orange ball of flame.

5. CONCLUSION

5.1 Summary

The first globally consistent survey of gas flaring has been conducted using satellite data. A series of national and global estimates of gas flaring volumes have been produced covering a twelve year period spanning 1995 through 2006. Gas flaring estimates were produced for sixty countries or areas, tripling the number listed by GGFR. While Nigeria has been widely reported as the country with the largest volume of gas flaring, satellite data indicate that Russia has more than twice the gas flaring volume of Nigeria. Global gas flaring has remained largely stable over the past fourteen years, remaining in the range of 150 to 170 BCM. The global gas flaring estimate for the year 2004 is 160 BCM, slightly higher than the 150 BCM estimated by the GGFR. The DMSP estimate of 160 BCM of flaring in 2004 is 25% of the USA natural gas consumption that year and represents an added carbon emission burden to the atmosphere of 84,000 thousand metric tons.

The DMSP based list of the top twenty flaring countries is shown in Table 4. Seven of the countries on the GGFR top twenty list are not in the DMSP top twenty – including the USA, Equatorial Guinea, Mexico, Azerbaijan, Brazil, Congo, and the United Kingdom. Added to the list in their place are Saudi Arabia, China, Oman, North Sea, Uzbekistan, Malaysia and Egypt. It is likely that the North Sea has taken the UK spot on the GGFR top twenty list since the DMSP flaring detected in the North Sea was not differentiated by nation. The explanation for the USA's absence from the DMSP top twenty list can be attributed to the fact that the DMSP flaring estimates only cover the offshore flaring present in the Gulf of Mexico (no onshore flaring). The GGFR's Azerbaijan estimate of 2.5 BCM is far beyond the flaring estimate coming from DMSP. Other differences in the two lists may be due to the inclusion of estimates from a broader suite of countries via DMSP than the limited set available through traditional sources drawn on by the GGFR.

Sixteen countries (or areas) exhibit a downward trend in gas flaring from 1995 to 2006, including Algeria, Argentina, Bolivia, Cameroon, Chile, Egypt, India, Indonesia, Libya, Nigeria, North Sea, Norway, Peru, Syria, UAE and USA offshore (Gulf of Mexico). The largest decrease detected was in Nigeria – where gas flaring has been reduced by more than 10 BCM.

Twenty-two countries have an upward trend in gas flaring over the time series. This includes Azerbaijan,Chad, China, Equatorial Guinea, Ghana, Iraq, Kazakhstan, Kyrgyzstan, Mauritania, Myanmar, Oman, Philippines, Papua New Guinea, Qatar, Russia (excluding KM), Saudi Arabia, South Africa, Sudan, Thailand, Turkmenistan, Uzbekistan, and Yemen. The largest increases were in Russia (+10 BCM), Kazakhstan (+5 BCM) and Iraq (+4 BCM).

Table 4
DMSP 2004 Top Twenty Gas Flaring Countries

Country / Area	**Gas Flaring (BCM)**
1. Russia (total)	50.7
Khanty-Mansiysk (24.9)	
Russia excluding KM (25.8)	
2. Nigeria	23.0
3. Iran	11.4
4. Iraq	8.1
5. Kazakhstan	5.8
6. Algeria	5.5
7. Angola	5.2
8. Libya	4.2
9. Qatar	3.2
10. Saudi Arabia	3.0
11. China	2.9
12. Indonesia	2.9
13. Kuwait	2.6
14. Gabon	2.5
15. Oman	2.5
16. North Sea	2.4
17. Venezuela	2.1
18. Uzbekistan	2.1
19. Malaysia	1.7
20. Egypt	1.7

The DMSP-OLS archive has provided a twelve record of global gas flaring and a substantial number of usable observations in each year. However, if one were to design a satellite sensor specific to the global monitoring of gas flares it would be substantially different from the DMSP-OLS. While gas flares are readily identified offshore in OLS data, it was not possible to identify gas flares imbedded in the lighting present in urban centers. Elvidge et al. (2007) identified specific shortcomings of the OLS and many of these impact the observation of gas flares, including: 1) coarse spatial resolution, 2) lack of on-board calibration, 3) lack of systematic recording of in-flight gain changes, 4) limited dynamic range, 5) six-bit quantitization, 6) signal saturation in the cores of many gas flare features, 7) lack of specific spectral bands tailored for measuring flare size, temperature gaseous composition and combustion efficiency. Improvements in some of these areas are anticipated with the launch of the Visible Infrared Imaging Radiometer Suite (VIIRS) in the 2010 time range. There are also a number of current sensors, such as NASA's Moderate Resolution Imaging Radiometer System (MODIS) and the Indian Resourcesat AWiFS sensor that have potentially high value in global monitoring of gas flares that have yet to be fully explored.

We fully expect that improvements in the estimation of gas flaring volumes will be achieved in the future through the inclusion of multiple satellite data sources. It is also clear that improvements in satellite estimates of gas flaring will require reliable sources of in situ measurements of gas flaring volumes for calibration.

It is anticipated that by providing independent estimates of gas flaring volumes, satellite observations will play a key role in guiding efforts to reduce gas flaring. In many cases national governments responsible for establishing the regulatory framework for resource extraction have not known the magnitude of the flaring. Companies engaged in building the infrastructure to use or market associated gas may be able to use the results to identify gas flaring areas where there services may be offered. International petroleum companies will be able to assess the efficacy of efforts made to reduce gas flaring in remote locations under the direction of their subsidiaries and contractors. The satellite remote sensing has moved from a curiosity to an operational and vital capability in the effort to reduce and ultimately eliminate most gas flaring.

5.2 Recommended Next Steps

The following is a list of possible next steps aimed at improving the accuracy of the gas flaring estimates and understanding the effectiveness of flaring reduction efforts.

Extending the DMSP Record. Several satellite years could be added to the gas flaring record including F162005, F162006 and 2007 from both F15 and F16. In addition, the data could be processed into monthly increments back to 1992 to provide a basis estimating the variability within single years. This could lead to improvements in the prediction intervals of the BCM estimates.

Production of a Landsat based database of active flares. The NASA Geocover Landsat (2000-2001) scenes in gas flaring regions of the world could be processed to identify locations and magnitudes of active gas flares. This list would be incomplete since there are generally not multiple coverages available. A preliminary review of the scenes indicates that gas flares can identified based on saturation (DN=255) in both bands 5 and 7. The database would have latitude, longitude, date, and aggregated DN as a magnitude indicator. These data would be useful in confirming the identity of gas flares in coarser resolution satellite data.

Integration of Monthly MODIS and ATSR / AATSR data. Monthly grids of MODIS and ATSR / AATSR active fire detections could be produced and integrated into the identification of gas flares and the estimation of gas flaring volumes. The ATSR record extend back to late 1995 and AATSR fire detection data are being produced currently. This record spans nearly the same time period as the OLS (1992 to present). The MODIS record extends from 2000 to the present. Maximizing the value of the ATSR, AATSR and MODIS fire detections would require that the detection frequency be normalized to account for the number of valid observations. Some discussions with NASA and ESA would be required to determine the feasibility of such a normalization.

Improving the Identification of Gas Flares. Using the data from 1-3 above plus Google Earth – it would be possible to improve the identification of gas flares in the coarse resolution DMSP record. In the example shown in Figure 14-16 it was found that four small gas flare features from DMSP (out of 56) were actually probably not gas flares. Three of these were small towns and one was an airstrip.

Analyzing Gas Flaring Volumes Versus Oil Production. It is known that there is substantial variability in natural gas content of petroleum and also in the efficiency with which the gas is recovered. It is also known that global oil production has been rising over time. It would be possible to analyze gas flaring volumes versus oil production to determine the efficiency with which countries are handling their associated gas. This would be a better indicator of the effectiveness of gas flaring reduction efforts than gas flaring volumes alone.

ACKNOWLEDGMENT

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Appendix 1. Calibration Data

Area	Satellite Year	Sum of Lights Index	BCM Reported
Nigeria	F142001	986375	27.860
Nigeria	F152001	1056653	27.860
Nigeria	F121995	1038408	27.074
Nigeria	F142000	1023892	25.880
Nigeria	F152000	1012886	25.880
Nigeria	F142002	803577	25.445
Nigeria	F141997	1088087	25.368
Nigeria	F121999	953204	24.555
Nigeria	F141999	925278	24.555
Nigeria	F121998	977152	24.415
Nigeria	F141998	1003263	24.415
Nigeria	F152004	834418	24.195
Nigeria	F162004	900626	24.195
Nigeria	F152003	936579	22.716
Iran	F152004	416732	13.300
Iran	F162004	448356	13.300
Algeria	F121995	330967	9.100
Iraq	F152004	295921	8.600
Iraq	F162004	315542	8.600
Algeria	F121996	334488	8.500
Algeria	F121997	285557	8.500
Algeria	F141997	272198	8.500
Algeria	F121998	257731	6.800
Algeria	F141998	249027	6.800
Angola	F152004	188676	6.800
Angola	F162004	206864	6.800
Indonesia	F142001	148262	6.525
Indonesia	F152001	150103	6.525
Indonesia	F121999	152101	6.360
Indonesia	F141999	149868	6.360
Algeria	F121999	253772	6.300
Algeria	F141999	248135	6.300
Algeria	F142000	268600	6.200
Algeria	F152000	270425	6.200
Indonesia	F142000	144678	6.101
Indonesia	F152000	140079	6.101
Indonesia	F142002	123707	6.050
Indonesia	F152002	124957	6.050
Indonesia	F152003	128504	5.967
Algeria	F142002	170959	5.600

Algeria	F152002	201476	5.600
Venezuela	F152004	75805	5.400
Venezuela	F162004	84248	5.400
Indonesia	F152004	104536	5.202
Indonesia	F162004	114350	5.202
Algeria	F142001	212915	5.200
Algeria	F152001	219347	5.200
Algeria	F152003	240970	5.200
Qatar	F152004	115829	4.500
Qatar	F162004	123636	4.500
Indonesia	F152005	92373	4.437
Algeria	F152004	202207	4.300
Algeria	F162004	215043	4.300
Eq. Guinea	F152004	47836	3.600
Eq. Guinea	F162004	52497	3.600
Kuwait	F152005	103724	3.000
Kuwait	F152004	95393	2.710
Kuwait	F162004	103759	2.710
Kazakhstan	F152004	208428	2.700
Kazakhstan	F162004	228034	2.700
Kuwait	F152006	104741	2.680
Libya	F152004	154477	2.500
Azerbaijan	F152004	5655	2.500
Libya	F162004	162878	2.500
Azerbaijan	F162004	5390	2.500
Brazil_offshore	F142001	45050	2.360
Brazil_offshore	F152001	45987	2.360
Brazil_offshore	F142000	46636	2.010
Brazil_offshore	F152000	48293	2.010
Qatar North Offshore	F152004	29993	2.000
Zafiro	F152004	30443	2.000
Qatar North Offshore	F162004	32791	2.000
Zafiro	F162004	32858	2.000
Brazil_offshore	F142002	38766	1.930
Brazil_offshore	F152002	40255	1.930
Brazil_offshore	F121999	44336	1.860
Brazil_offshore	F141999	49746	1.860
Mexico	F152004	31707	1.600
Mexico	F162004	32958	1.600
Brazil_offshore	F152005	40432	1.450
Gabon	F152004	89327	1.400
Gabon	F162004	100714	1.400
Brazil_offshore	F152003	38269	1.390
Flare	F152003	7871	1.266
Flare	F152002	8507	1.189
Flare	F142001	20621	1.185
Flare	F152001	21563	1.185
Brazil_offshore	F152004	31380	1.140
Brazil_offshore	F162004	31551	1.140

Cameroon	F152004	44799	1.100
Cameroon	F162004	46513	1.100
Flare	F152005	12694	1.035
Flare	F152004	12714	1.005
Flare	F162004	13417	1.005
Flare	F142002	16900	0.972
Flare	F152002	17892	0.972
Flare	F152003	19591	0.871
Flare	F152003	11215	0.828
Flare	F152002	13822	0.754
Flare	F152002	13471	0.722
Flare	F152005	7962	0.719
Flare	F152005	13413	0.715
Norway	F142000	5060	0.700
Norway	F152000	5354	0.700
Norway	F121999	14553	0.690
Norway	F141999	2555	0.690
Flare	F152004	8203	0.663
Flare	F162004	8568	0.663
Flare	F152004	12707	0.661
Flare	F162004	12969	0.661
Flare	F152004	12948	0.661
Flare	F162004	13920	0.661
Flare	F152004	15910	0.661
Flare	F162004	17490	0.661
Flare	F152004	13838	0.659
Flare	F162004	14401	0.659
Flare	F152005	13235	0.640
Flare	F152005	12970	0.632
Flare	F152003	12452	0.601
Flare	F152002	11393	0.593
Flare	F152003	9845	0.581
Norway	F142001	1112	0.570
Norway	F152001	3593	0.570
Flare	F152003	11307	0.531
Flare	F152005	21468	0.487
Flare	F152004	8580	0.481
Flare	F162004	9740	0.481
Norway	F121996	5173	0.450
Norway	F121998	5072	0.450
Norway	F141998	5072	0.450
Norway	F142002	0	0.450
Norway	F152002	3183	0.450
Norway	F152003	3639	0.440
Norway	F152004	2756	0.425
Norway	F162004	2875	0.425
Norway	F121995	16339	0.410
Norway	F121997	4855	0.400
Norway	F141997	3829	0.400
Flare	F152004	23266	0.386

Flare	F162004	24571	0.386
Flare	F142000	16454	0.384
Flare	F152000	17906	0.384
Flare	F121997	11862	0.369
Flare	F141997	12766	0.369
Flare	F121998	16395	0.342
Flare	F141998	14973	0.342
Flare	F152002	5923	0.314
Flare	F121999	14757	0.297
Flare	F141999	13898	0.297
Flare	F152005	9363	0.289
Flare	F152003	10085	0.285
Flare	F152004	3529	0.275
Flare	F162004	3347	0.275
Flare	F152004	12871	0.273
Flare	F162004	12474	0.273
Flare	F152004	7838	0.271
Flare	F162004	8694	0.271
Flare	F152005	4299	0.270
Flare	F152005	7137	0.270
Flare	F152002	8722	0.259
Flare	F152005	6932	0.242
Flare	F152002	4294	0.162
Flare	F152005	3149	0.157
Flare	F152005	2917	0.146
Flare	F152005	4629	0.113
Flare	F152004	1907	0.099
Flare	F162004	2165	0.099
Flare	F152003	1228	0.094
Flare	F152005	3353	0.091
Flare	F152004	4775	0.090
Flare	F162004	4766	0.090
Flare	F152004	7696	0.089
Flare	F162004	8555	0.089
Flare	F152002	2113	0.087
Flare	F152002	2331	0.086
Flare	F152004	1681	0.081
Flare	F162004	2371	0.081
Flare	F152002	910	0.075
Flare	F152003	1873	0.071
Flare	F152004	3069	0.070
Flare	F152005	4709	0.070
Flare	F162004	3578	0.070
Flare	F152002	1003	0.069
Flare	F152005	3539	0.066
Flare	F152005	2174	0.061
Flare	F152004	3755	0.059
Flare	F162004	3997	0.059
Flare	F152005	3532	0.058
Flare	F152003	1486	0.054

Flare	F152004	6623	0.054
Flare	F162004	6888	0.054
Flare	F152004	2608	0.051
Flare	F162004	3214	0.051
Flare	F152005	2788	0.051
Flare	F152005	3589	0.051
Flare	F152004	2274	0.049
Flare	F152005	2036	0.049
Flare	F162004	2376	0.049
Flare	F152005	3079	0.045
Flare	F152004	1295	0.042
Flare	F162004	1486	0.042
Flare	F152004	3012	0.040
Flare	F162004	3256	0.040
Flare	F152005	1569	0.036
Flare	F152005	569	0.034
Flare	F152004	2682	0.032
Flare	F162004	2686	0.032
Flare	F152004	3740	0.029
Flare	F162004	3455	0.029
Flare	F152005	1420	0.027
Flare	F152003	967	0.026
Flare	F152005	1569	0.024
Flare	F152005	1570	0.021
Flare	F152004	1526	0.021
Flare	F162004	1874	0.021
Flare	F152005	1498	0.020
Flare	F142000	1785	0.020
Flare	F152000	1614	0.020
Flare	F152004	1595	0.019
Flare	F162004	1901	0.019
Flare	F121999	1646	0.019
Flare	F141999	1696	0.019
Flare	F121998	1771	0.018
Flare	F141998	1866	0.018
Flare	F142001	1315	0.017
Flare	F152001	1382	0.017
Flare	F142002	1301	0.017
Flare	F152002	1417	0.017
Flare	F152004	2274	0.017
Flare	F152004	1401	0.017
Flare	F162004	2376	0.017
Flare	F162004	1749	0.017
Flare	F152004	1307	0.016
Flare	F162004	1658	0.016
Flare	F121997	1869	0.015
Flare	F141997	2264	0.015
Flare	F152003	1334	0.014
Flare	F152002	1826	0.014
Flare	F152004	2680	0.012

Flare	F162004	2988	0.012
Flare	F152003	179	0.012
Flare	F152005	2324	0.009
Flare	F152005	1674	0.008
Flare	F152002	1812	0.008
Flare	F152003	1611	0.007
Flare	F152004	1744	0.007
Flare	F162004	1892	0.007
Flare	F152003	989	0.006
Flare	F152003	0	0.000
Flare	F152004	196	0.000
Flare	F152004	876	0.000
Flare	F152004	751	0.000
Flare	F152004	653	0.000
Flare	F152005	715	0.000
Flare	F152005	663	0.000
Flare	F162004	175	0.000
Flare	F162004	1030	0.000
Flare	F162004	908	0.000
Flare	F162004	750	0.000

Appendix 2. BCM Estimates By Country

Satellite Year	Country / Area	N Saturated	Sum Lights	Avg CF Cvg	BCM estimates	90% prediction interval
F121995	Algeria	238	330967	48.46	8.758	1.61
F121996	Algeria	287	334488	44.58	8.852	1.61
F121997	Algeria	130	285557	50.88	7.557	1.61
F121998	Algeria	173	257731	50.68	6.820	1.61
F121999	Algeria	156	253772	35.14	6.716	1.61
F141997	Algeria	90	272198	33.19	7.203	1.61
F141998	Algeria	86	249027	44.96	6.590	1.61
F141999	Algeria	54	248135	54.06	6.566	1.61
F142000	Algeria	129	268600	58.42	7.108	1.61
F142001	Algeria	99	212915	48.63	5.634	1.60
F142002	Algeria	66	170959	41.54	4.524	1.60
F152000	Algeria	0	270425	61.13	7.156	1.61
F152001	Algeria	170	219347	66.12	5.805	1.60
F152002	Algeria	61	201476	66.44	5.332	1.60
F152003	Algeria	151	240970	65.42	6.377	1.61
F152004	Algeria	12	202207	62.56	5.351	1.60
F152005	Algeria	125	193603	72.73	5.123	1.60
F152006	Algeria	157	236674	26.69	6.263	1.61
F162004	Algeria	63	215043	50.59	5.691	1.60
F121995	Angola	153	181924	66.1	4.814	1.60
F121996	Angola	431	246409	57.45	6.521	1.61
F121997	Angola	250	263485	62.68	6.973	1.61
F121998	Angola	380	283812	61.44	7.511	1.61
F121999	Angola	319	270704	41.59	7.164	1.61
F141997	Angola	124	265759	61.28	7.033	1.61
F141998	Angola	192	269690	68.44	7.137	1.61
F141999	Angola	294	279885	64.47	7.407	1.61
F142000	Angola	322	239922	78.44	6.349	1.61
F142001	Angola	180	223422	77.73	5.912	1.61
F142002	Angola	88	202571	61.85	5.361	1.60
F152000	Angola	305	246157	70.27	6.514	1.61
F152001	Angola	410	253738	67.06	6.715	1.61
F152002	Angola	81	210925	76.18	5.582	1.60
F152003	Angola	302	206468	69.9	5.464	1.60
F152004	Angola	54	188676	81.95	4.993	1.60
F152005	Angola	160	182816	80.47	4.838	1.60
F152006	Angola	70	170777	48.4	4.519	1.60
F162004	Angola	101	206864	76.94	5.474	1.60
F121995	Argentina	8	45485	53.49	1.204	1.60
F121996	Argentina	3	31217	57.55	0.826	1.60
F121997	Argentina	0	26461	43.94	0.700	1.60
F121998	Argentina	1	19613	48.46	0.519	1.60
F121999	Argentina	0	21069	24.97	0.558	1.60
F141997	Argentina	0	31310	43.85	0.829	1.60
F141998	Argentina	0	23167	54.74	0.613	1.60
F141999	Argentina	0	22732	39.49	0.602	1.60

F142000	Argentina	0	16908	48.78	0.447	1.60
F142001	Argentina	0	19017	50.86	0.503	1.60
F142002	Argentina	2	21304	43.56	0.564	1.60
F152000	Argentina	0	13613	51.69	0.360	1.60
F152001	Argentina	0	17301	55.82	0.458	1.60
F152002	Argentina	0	18329	60.4	0.485	1.60
F152003	Argentina	0	20525	64.53	0.543	1.60
F152004	Argentina	0	16044	59.87	0.425	1.60
F152005	Argentina	0	13621	51.93	0.360	1.60
F152006	Argentina	0	15662	41.28	0.414	1.60
F162004	Argentina	0	16105	58.8	0.426	1.60
F121995	Australia	0	30670	70.94	0.812	1.60
F121996	Australia	0	36009	64.63	0.953	1.60
F121997	Australia	0	29118	67.08	0.771	1.60
F121998	Australia	0	26806	65.08	0.709	1.60
F121999	Australia	0	28136	33.92	0.745	1.60
F141997	Australia	0	33438	62.59	0.885	1.60
F141998	Australia	0	31231	62.3	0.826	1.60
F141999	Australia	0	32601	62.87	0.863	1.60
F142000	Australia	0	28750	74.18	0.761	1.60
F142001	Australia	0	27108	69.48	0.717	1.60
F142002	Australia	0	22848	70.21	0.605	1.60
F152000	Australia	0	26429	72.49	0.699	1.60
F152001	Australia	0	24556	66.12	0.650	1.60
F152002	Australia	0	20264	86.7	0.536	1.60
F152003	Australia	0	26248	78.09	0.695	1.60
F152004	Australia	0	27385	88.4	0.725	1.60
F152005	Australia	0	21719	82.06	0.575	1.60
F152006	Australia	0	24180	44.19	0.640	1.60
F162004	Australia	0	28719	74.98	0.760	1.60
F121995	Azerbaijan	0	82	40.54	0.002	1.60
F121996	Azerbaijan	0	98	30.14	0.003	1.60
F121997	Azerbaijan	0	805	29.74	0.021	1.60
F121998	Azerbaijan	0	2378	37.67	0.063	1.60
F121999	Azerbaijan	0	5748	22.26	0.152	1.60
F141997	Azerbaijan	0	1703	23.3	0.045	1.60
F141998	Azerbaijan	0	3130	32.31	0.083	1.60
F141999	Azerbaijan	0	6164	39.9	0.163	1.60
F142000	Azerbaijan	0	5843	36.27	0.155	1.60
F142001	Azerbaijan	0	5561	30.47	0.147	1.60
F142002	Azerbaijan	0	4740	27.95	0.125	1.60
F152000	Azerbaijan	0	5440	38.83	0.144	1.60
F152001	Azerbaijan	0	5762	43.62	0.152	1.60
F152002	Azerbaijan	0	4259	49.48	0.113	1.60
F152003	Azerbaijan	0	5667	45.32	0.150	1.60
F152004	Azerbaijan	0	5655	41.92	0.150	1.60
F152005	Azerbaijan	0	7711	49.1	0.204	1.60
F152006	Azerbaijan	2	9903	20.61	0.262	1.60
F162004	Azerbaijan	0	5390	36.05	0.143	1.60
F121995	Bolivia	0	19606	76.83	0.519	1.60

F121996	Bolivia	0	18323	69.32	0.485	1.60
F121997	Bolivia	0	31175	51.44	0.825	1.60
F121998	Bolivia	0	16082	70.17	0.426	1.60
F121999	Bolivia	0	17141	46.06	0.454	1.60
F141997	Bolivia	0	31178	52.88	0.825	1.60
F141998	Bolivia	0	17761	68.64	0.470	1.60
F141999	Bolivia	0	15401	69.92	0.408	1.60
F142000	Bolivia	0	13268	73.25	0.351	1.60
F142001	Bolivia	0	9460	66.54	0.250	1.60
F142002	Bolivia	0	10015	51.76	0.265	1.60
F152000	Bolivia	0	12338	72.07	0.327	1.60
F152001	Bolivia	0	9119	73.63	0.241	1.60
F152002	Bolivia	0	9576	75	0.253	1.60
F152003	Bolivia	0	10687	78.34	0.283	1.60
F152004	Bolivia	0	7676	77.64	0.203	1.60
F152005	Bolivia	0	5878	76.47	0.156	1.60
F152006	Bolivia	0	4509	50.26	0.119	1.60
F162004	Bolivia	0	7849	65.96	0.208	1.60
F121995	Brazil	0	25939	65.58	0.686	1.60
F121996	Brazil	0	34494	62.52	0.913	1.60
F121997	Brazil	0	40673	52.9	1.076	1.60
F121998	Brazil	1	49278	55.07	1.304	1.60
F121999	Brazil	3	50336	35.3	1.332	1.60
F141997	Brazil	0	41063	47.09	1.087	1.60
F141998	Brazil	0	49841	58.1	1.319	1.60
F141999	Brazil	0	55468	57.05	1.468	1.60
F142000	Brazil	0	51696	63.15	1.368	1.60
F142001	Brazil	0	46649	62.7	1.234	1.60
F142002	Brazil	0	40178	54.78	1.063	1.60
F152000	Brazil	0	52613	63.26	1.392	1.60
F152001	Brazil	0	47595	66.93	1.260	1.60
F152002	Brazil	0	41290	75.63	1.093	1.60
F152003	Brazil	0	40005	71.82	1.059	1.60
F152004	Brazil	0	35640	61.2	0.943	1.60
F152005	Brazil	9	54523	65.96	1.443	1.60
F152006	Brazil	0	47509	41.53	1.257	1.60
F162004	Brazil	0	36832	56.55	0.975	1.60
F121995	Brunei	0	1864	25.41	0.049	1.60
F121996	Brunei	0	2154	16.03	0.057	1.60
F121997	Brunei	0	1999	29.02	0.053	1.60
F121998	Brunei	0	3991	27.56	0.106	1.60
F121999	Brunei	0	4833	12.56	0.128	1.60
F141997	Brunei	0	3225	22.45	0.085	1.60
F141998	Brunei	0	3716	40.3	0.098	1.60
F141999	Brunei	0	4769	18.03	0.126	1.60
F142000	Brunei	0	5679	20.22	0.150	1.60
F142001	Brunei	1	7136	25.56	0.189	1.60
F142002	Brunei	0	4579	43.38	0.121	1.60
F152000	Brunei	0	5260	17.89	0.139	1.60
F152001	Brunei	1	7952	23.27	0.210	1.60

F152002	Brunei	0	5159	34.84	0.137	1.60
F152003	Brunei	0	5449	29.27	0.144	1.60
F152004	Brunei	0	3637	34.85	0.096	1.60
F152005	Brunei	0	3165	32.7	0.084	1.60
F152006	Brunei	0	5418	16.91	0.143	1.60
F162004	Brunei	0	3522	34.54	0.093	1.60
F121995	Cameroon	93	52467	50.08	1.388	1.60
F121996	Cameroon	177	57438	41.09	1.520	1.60
F121997	Cameroon	80	54764	41.47	1.449	1.60
F121998	Cameroon	12	51976	35.2	1.375	1.60
F121999	Cameroon	92	53341	29.22	1.412	1.60
F141997	Cameroon	31	52670	36.73	1.394	1.60
F141998	Cameroon	58	52712	40.97	1.395	1.60
F141999	Cameroon	61	53249	40.07	1.409	1.60
F142000	Cameroon	91	51814	53.13	1.371	1.60
F142001	Cameroon	25	52568	54.85	1.391	1.60
F142002	Cameroon	133	49039	39.86	1.298	1.60
F152000	Cameroon	92	53599	44.48	1.418	1.60
F152001	Cameroon	85	55259	47.2	1.462	1.60
F152002	Cameroon	114	49533	47.22	1.311	1.60
F152003	Cameroon	158	49850	41.46	1.319	1.60
F152004	Cameroon	75	44799	57.38	1.186	1.60
F152005	Cameroon	175	42978	55.61	1.137	1.60
F152006	Cameroon	116	44646	29.42	1.181	1.60
F162004	Cameroon	82	46513	55.07	1.231	1.60
F121995	Canada_offhsore	0	1073	34.07	0.028	1.60
F121996	Canada_offhsore	0	675	34.31	0.018	1.60
F121997	Canada_offhsore	0	2783	30.94	0.074	1.60
F121998	Canada_offhsore	10	23432	24.51	0.620	1.60
F121999	Canada_offhsore	0	7544	15.87	0.200	1.60
F141997	Canada_offhsore	0	6262	20.8	0.166	1.60
F141998	Canada_offhsore	0	23416	29.19	0.620	1.60
F141999	Canada_offhsore	0	9413	27.86	0.249	1.60
F142000	Canada_offhsore	0	2912	35.17	0.077	1.60
F142001	Canada_offhsore	0	2404	26.28	0.064	1.60
F142002	Canada_offhsore	0	4364	25.92	0.115	1.60
F152000	Canada_offhsore	0	2337	38	0.062	1.60
F152001	Canada_offhsore	0	2498	35.74	0.066	1.60
F152002	Canada_offhsore	0	8582	42.59	0.227	1.60
F152003	Canada_offhsore	0	6445	41.26	0.171	1.60
F152004	Canada_offhsore	0	7529	46.05	0.199	1.60
F152005	Canada_offhsore	0	5199	42.71	0.138	1.60
F152006	Canada_offhsore	10	19018	13.25	0.503	1.60
F162004	Canada_offhsore	0	5953	32.66	0.158	1.60
F121995	Chad	0	118	48.87	0.003	1.60
F121996	Chad	0	136	42.06	0.004	1.60
F121997	Chad	0	41	42.27	0.001	1.60
F121998	Chad	0	46	46.1	0.001	1.60
F121999	Chad	0	35	39.02	0.001	1.60
F141997	Chad	0	54	35.57	0.001	1.60

F141998	Chad	0	37	60.03	0.001	1.60
F141999	Chad	0	18	54.27	0.000	1.60
F142000	Chad	0	8	78.72	0.000	1.60
F142001	Chad	0	69	65.48	0.002	1.60
F142002	Chad	0	370	54.91	0.010	1.60
F152000	Chad	0	0	67.17	0.000	1.60
F152001	Chad	0	71	61.18	0.002	1.60
F152002	Chad	0	290	67.14	0.008	1.60
F152003	Chad	0	2257	64.26	0.060	1.60
F152004	Chad	0	2452	68.64	0.065	1.60
F152005	Chad	0	2856	73.04	0.076	1.60
F152006	Chad	0	2890	39.88	0.076	1.60
F162004	Chad	0	2980	58.15	0.079	1.60
F121995	Chile	0	16057	60.1	0.425	1.60
F121996	Chile	0	18494	56.83	0.489	1.60
F121997	Chile	0	14402	48.76	0.381	1.60
F121998	Chile	0	12370	44.89	0.327	1.60
F121999	Chile	0	15792	26.14	0.418	1.60
F141997	Chile	0	17731	49.2	0.469	1.60
F141998	Chile	0	15656	50.75	0.414	1.60
F141999	Chile	0	15135	38.71	0.401	1.60
F142000	Chile	0	14420	45.67	0.382	1.60
F142001	Chile	0	13665	50.14	0.362	1.60
F142002	Chile	0	11624	55.38	0.308	1.60
F152000	Chile	0	13114	49.54	0.347	1.60
F152001	Chile	0	12545	54.8	0.332	1.60
F152002	Chile	0	10182	63.71	0.269	1.60
F152003	Chile	0	8910	61.41	0.236	1.60
F152004	Chile	0	7964	62.08	0.211	1.60
F152005	Chile	0	6222	51.42	0.165	1.60
F152006	Chile	0	5248	52.66	0.139	1.60
F162004	Chile	0	7736	61.91	0.205	1.60
F121995	China	30	70327	44.32	1.861	1.60
F121996	China	59	103719	40.53	2.745	1.60
F121997	China	50	101006	38.46	2.673	1.60
F121998	China	25	78116	45.04	2.067	1.60
F121999	China	17	92238	29.02	2.441	1.60
F141997	China	32	107185	28.81	2.836	1.60
F141998	China	3	84097	39.39	2.225	1.60
F141999	China	2	92396	42.82	2.445	1.60
F142000	China	0	97296	44.65	2.575	1.60
F142001	China	0	88652	41.24	2.346	1.60
F142002	China	2	91145	36.55	2.412	1.60
F152000	China	0	87403	49.33	2.313	1.60
F152001	China	2	94528	54.26	2.502	1.60
F152002	China	1	87335	60.17	2.311	1.60
F152003	China	4	109276	51.14	2.892	1.60
F152004	China	0	110211	56.44	2.917	1.60
F152005	China	11	107293	66.81	2.839	1.60
F152006	China	15	128918	24.01	3.412	1.60

F162004	China	3	109350	46.47	2.894	1.60
F121995	Colombia	0	18741	46.38	0.496	1.60
F121996	Colombia	1	12002	41.82	0.318	1.60
F121997	Colombia	0	18464	36.32	0.489	1.60
F121998	Colombia	0	23582	50.68	0.624	1.60
F121999	Colombia	0	12276	29.51	0.325	1.60
F141997	Colombia	0	32064	40.43	0.849	1.60
F141998	Colombia	0	25606	56.38	0.678	1.60
F141999	Colombia	0	12753	47.44	0.337	1.60
F142000	Colombia	0	13636	60.05	0.361	1.60
F142001	Colombia	0	17251	65.81	0.457	1.60
F142002	Colombia	0	13682	56.24	0.362	1.60
F152000	Colombia	0	11273	49.25	0.298	1.60
F152001	Colombia	0	16865	56.55	0.446	1.60
F152002	Colombia	0	12165	65.9	0.322	1.60
F152003	Colombia	0	13093	61.01	0.346	1.60
F152004	Colombia	0	13467	62.57	0.356	1.60
F152005	Colombia	0	9405	69.01	0.249	1.60
F152006	Colombia	0	11168	37.97	0.296	1.60
F162004	Colombia	0	14415	65.73	0.381	1.60
F121995	Congo	12	34674	60.6	0.918	1.60
F121996	Congo	20	30395	54.31	0.804	1.60
F121997	Congo	0	29598	57.16	0.783	1.60
F121998	Congo	51	58018	50.79	1.535	1.60
F121999	Congo	54	57581	37.09	1.524	1.60
F141997	Congo	0	29683	54.76	0.786	1.60
F141998	Congo	22	54212	54.42	1.435	1.60
F141999	Congo	52	61991	59.94	1.640	1.60
F142000	Congo	31	57379	66.7	1.518	1.60
F142001	Congo	6	44682	72.58	1.182	1.60
F142002	Congo	0	36210	59.5	0.958	1.60
F152000	Congo	6	64699	63.61	1.712	1.60
F152001	Congo	18	54895	62.21	1.453	1.60
F152002	Congo	0	37342	67.28	0.988	1.60
F152003	Congo	32	45478	60.67	1.203	1.60
F152004	Congo	11	45375	76.76	1.201	1.60
F152005	Congo	79	49619	73.71	1.313	1.60
F152006	Congo	70	58338	44.7	1.544	1.60
F162004	Congo	8	52338	69.18	1.385	1.60
F121995	Cote d'Ivoire	0	2138	63.01	0.057	1.60
F121996	Cote d'Ivoire	0	3711	52.79	0.098	1.60
F121997	Cote d'Ivoire	0	3901	51.25	0.103	1.60
F121998	Cote d'Ivoire	0	2939	64.94	0.078	1.60
F121999	Cote d'Ivoire	0	3283	38.77	0.087	1.60
F141997	Cote d'Ivoire	0	3881	52.92	0.103	1.60
F141998	Cote d'Ivoire	0	3759	76.81	0.099	1.60
F141999	Cote d'Ivoire	0	2871	58.18	0.076	1.60
F142000	Cote d'Ivoire	0	3178	65.32	0.084	1.60
F142001	Cote d'Ivoire	0	4949	77.2	0.131	1.60
F142002	Cote d'Ivoire	1	8996	55.21	0.238	1.60

F152000	Cote d'Ivoire	0	3359	62.83	0.089	1.60
F152001	Cote d'Ivoire	0	4888	60.88	0.129	1.60
F152002	Cote d'Ivoire	0	10068	67.09	0.266	1.60
F152003	Cote d'Ivoire	0	3286	63.84	0.087	1.60
F152004	Cote d'Ivoire	0	859	65.24	0.023	1.60
F152005	Cote d'Ivoire	0	1093	77.37	0.029	1.60
F152006	Cote d'Ivoire	0	1458	42	0.039	1.60
F162004	Cote d'Ivoire	0	1191	76.74	0.032	1.60
F121995	Dem_Rep_Congo	0	11979	59.42	0.317	1.60
F121996	Dem_Rep_Congo	16	16180	53.53	0.428	1.60
F121997	Dem_Rep_Congo	1	18134	59.71	0.480	1.60
F121998	Dem_Rep_Congo	0	16056	56.73	0.425	1.60
F121999	Dem_Rep_Congo	0	10755	36.95	0.285	1.60
F141997	Dem_Rep_Congo	0	18092	56.47	0.479	1.60
F141998	Dem_Rep_Congo	0	15709	59.17	0.416	1.60
F141999	Dem_Rep_Congo	0	13527	62.99	0.358	1.60
F142000	Dem_Rep_Congo	2	10270	74.63	0.272	1.60
F142001	Dem_Rep_Congo	0	10470	70.96	0.277	1.60
F142002	Dem_Rep_Congo	6	10813	64.01	0.286	1.60
F152000	Dem_Rep_Congo	0	9819	67.03	0.260	1.60
F152001	Dem_Rep_Congo	6	11084	61.37	0.293	1.60
F152002	Dem_Rep_Congo	0	11394	70.01	0.302	1.60
F152003	Dem_Rep_Congo	19	14992	64.62	0.397	1.60
F152004	Dem_Rep_Congo	3	10453	76.85	0.277	1.60
F152005	Dem_Rep_Congo	11	8439	75	0.223	1.60
F152006	Dem_Rep_Congo	5	10770	45.49	0.285	1.60
F162004	Dem_Rep_Congo	6	11200	72.61	0.296	1.60
F121995	Ecuador	0	42096	46.9	1.114	1.60
F121996	Ecuador	0	47107	48.09	1.247	1.60
F121997	Ecuador	0	45547	36	1.205	1.60
F121998	Ecuador	0	39006	47.6	1.032	1.60
F121999	Ecuador	0	37253	26.86	0.986	1.60
F141997	Ecuador	0	43270	40.91	1.145	1.60
F141998	Ecuador	0	39073	53.26	1.034	1.60
F141999	Ecuador	0	38395	44.49	1.016	1.60
F142000	Ecuador	0	33334	55.27	0.882	1.60
F142001	Ecuador	0	35382	69.36	0.936	1.60
F142002	Ecuador	0	32166	58.12	0.851	1.60
F152000	Ecuador	0	32379	49.87	0.857	1.60
F152001	Ecuador	0	35812	55.24	0.948	1.60
F152002	Ecuador	0	31050	66.18	0.822	1.60
F152003	Ecuador	0	34522	53.14	0.914	1.60
F152004	Ecuador	0	35879	54.96	0.949	1.60
F152005	Ecuador	0	34520	61.89	0.914	1.60
F152006	Ecuador	0	41969	41.39	1.111	1.60
F162004	Ecuador	0	37388	64.62	0.989	1.60
F121995	Egypt	17	82801	48.35	2.191	1.60
F121996	Egypt	53	87097	43.11	2.305	1.60
F121997	Egypt	20	82917	46.75	2.194	1.60
F121998	Egypt	11	66298	52.1	1.754	1.60

F121999	Egypt	20	71750	30.42	1.899	1.60
F141997	Egypt	10	80295	33.09	2.125	1.60
F141998	Egypt	5	70415	45.21	1.863	1.60
F141999	Egypt	8	74602	56.17	1.974	1.60
F142000	Egypt	2	67703	55.57	1.792	1.60
F142001	Egypt	0	64671	43.63	1.711	1.60
F142002	Egypt	4	63508	34.04	1.681	1.60
F152000	Egypt	0	61515	55.48	1.628	1.60
F152001	Egypt	5	61263	63.77	1.621	1.60
F152002	Egypt	1	60929	66.69	1.612	1.60
F152003	Egypt	3	66646	64.64	1.764	1.60
F152004	Egypt	0	61973	62.91	1.640	1.60
F152005	Egypt	3	54635	67.71	1.446	1.60
F152006	Egypt	2	64409	26.04	1.704	1.60
F162004	Egypt	2	67558	49.88	1.788	1.60
F121995	Eq_Guinea	0	22441	55.54	0.594	1.60
F121996	Eq_Guinea	19	23944	49.4	0.634	1.60
F121997	Eq_Guinea	0	32548	47.33	0.861	1.60
F121998	Eq_Guinea	36	40230	43.74	1.065	1.60
F121999	Eq_Guinea	15	42911	32.22	1.136	1.60
F141997	Eq_Guinea	0	32964	46.68	0.872	1.60
F141998	Eq_Guinea	33	39606	49.93	1.048	1.60
F141999	Eq_Guinea	9	44591	46.1	1.180	1.60
F142000	Eq_Guinea	24	43728	60.71	1.157	1.60
F142001	Eq_Guinea	44	50099	65.43	1.326	1.60
F142002	Eq_Guinea	25	38323	44.9	1.014	1.60
F152000	Eq_Guinea	30	43723	51.33	1.157	1.60
F152001	Eq_Guinea	44	51716	55.77	1.369	1.60
F152002	Eq_Guinea	29	37883	53.33	1.003	1.60
F152003	Eq_Guinea	15	43629	48.16	1.155	1.60
F152004	Eq_Guinea	26	47836	64.46	1.266	1.60
F152005	Eq_Guinea	114	46566	66.22	1.232	1.60
F152006	Eq_Guinea	87	53794	37.13	1.424	1.60
F162004	Eq_Guinea	71	52497	63.6	1.389	1.60
F121995	Gabon	27	79196	56.27	2.096	1.60
F121996	Gabon	73	88806	48.08	2.350	1.60
F121997	Gabon	3	76287	50.96	2.019	1.60
F121998	Gabon	88	96178	48.77	2.545	1.60
F121999	Gabon	64	94534	31.27	2.502	1.60
F141997	Gabon	4	87402	52.41	2.313	1.60
F141998	Gabon	23	96553	53.62	2.555	1.60
F141999	Gabon	54	91953	48.68	2.433	1.60
F142000	Gabon	97	90519	57.03	2.395	1.60
F142001	Gabon	88	92927	66.15	2.459	1.60
F142002	Gabon	20	89116	51.15	2.358	1.60
F152000	Gabon	79	93762	56.26	2.481	1.60
F152001	Gabon	150	98610	59.62	2.610	1.60
F152002	Gabon	29	94080	58.72	2.490	1.60
F152003	Gabon	152	108717	53.85	2.877	1.60
F152004	Gabon	29	89327	69.81	2.364	1.60

F152005	Gabon	70	81795	68.89	2.165	1.60
F152006	Gabon	11	73091	43.38	1.934	1.60
F162004	Gabon	55	100714	62.1	2.665	1.60
F121995	Ghana	0	0	62.95	0.000	1.60
F121996	Ghana	0	0	58.35	0.000	1.60
F121997	Ghana	0	0	52.6	0.000	1.60
F121998	Ghana	0	0	59.61	0.000	1.60
F121999	Ghana	0	0	46.86	0.000	1.60
F141997	Ghana	0	0	47.29	0.000	1.60
F141998	Ghana	0	0	75.5	0.000	1.60
F141999	Ghana	0	0	65.45	0.000	1.60
F142000	Ghana	0	0	70.36	0.000	1.60
F142001	Ghana	0	0	75.94	0.000	1.60
F142002	Ghana	0	329	58.5	0.009	1.60
F152000	Ghana	0	0	64.17	0.000	1.60
F152001	Ghana	0	0	58.58	0.000	1.60
F152002	Ghana	0	156	71.63	0.004	1.60
F152003	Ghana	0	196	64.78	0.005	1.60
F152004	Ghana	0	967	68.23	0.026	1.60
F152005	Ghana	0	349	76.96	0.009	1.60
F152006	Ghana	0	774	39.92	0.020	1.60
F162004	Ghana	0	1116	73.12	0.030	1.60
F121995	India	0	50737	53.94	1.343	1.60
F121996	India	12	50629	49.84	1.340	1.60
F121997	India	14	56214	40.77	1.488	1.60
F121998	India	13	48834	50.31	1.292	1.60
F121999	India	23	48694	42.13	1.289	1.60
F141997	India	7	59773	33.32	1.582	1.60
F141998	India	7	50098	63.53	1.326	1.60
F141999	India	18	49924	63.58	1.321	1.60
F142000	India	5	40882	73.95	1.082	1.60
F142001	India	5	36324	62.93	0.961	1.60
F142002	India	0	33783	52.66	0.894	1.60
F152000	India	5	40687	68.71	1.077	1.60
F152001	India	19	41956	76.8	1.110	1.60
F152002	India	2	37549	89.03	0.994	1.60
F152003	India	0	30645	83.55	0.811	1.60
F152004	India	0	24360	73.99	0.645	1.60
F152005	India	0	22640	72.44	0.599	1.60
F152006	India	0	31675	47.92	0.838	1.60
F162004	India	0	26057	69.22	0.690	1.60
F121995	Indonesia	2	149038	36.09	3.944	1.60
F121996	Indonesia	49	167607	35.79	4.435	1.60
F121997	Indonesia	1	179595	39.18	4.753	1.60
F121998	Indonesia	26	169116	33.24	4.475	1.60
F121999	Indonesia	22	152101	21.4	4.025	1.60
F141997	Indonesia	2	189226	45.07	5.008	1.60
F141998	Indonesia	4	159023	36.37	4.208	1.60
F141999	Indonesia	14	149868	35.25	3.966	1.60
F142000	Indonesia	12	144678	37.21	3.829	1.60

F142001	Indonesia	29	148262	43.12	3.923	1.60
F142002	Indonesia	28	123707	53.12	3.274	1.60
F152000	Indonesia	28	140079	39.35	3.707	1.60
F152001	Indonesia	62	150103	41.78	3.972	1.60
F152002	Indonesia	19	124957	52.74	3.307	1.60
F152003	Indonesia	29	128504	47.52	3.401	1.60
F152004	Indonesia	0	104536	54.61	2.766	1.60
F152005	Indonesia	3	92373	51.82	2.444	1.60
F152006	Indonesia	5	115016	31.51	3.044	1.60
F162004	Indonesia	2	114350	54.81	3.026	1.60
F121995	Iran	320	425860	52.97	11.270	1.61
F121996	Iran	537	457372	45.59	12.103	1.61
F121997	Iran	359	471745	42.25	12.484	1.61
F121998	Iran	317	371841	53.82	9.840	1.61
F121999	Iran	217	326978	29.17	8.653	1.61
F141997	Iran	149	447047	30.45	11.830	1.61
F141998	Iran	126	354673	51.82	9.386	1.61
F141999	Iran	151	374163	55.16	9.902	1.61
F142000	Iran	203	379582	56.94	10.045	1.61
F142001	Iran	99	332376	43.44	8.796	1.61
F142002	Iran	110	321892	37.4	8.518	1.61
F152000	Iran	29	404836	62.28	10.713	1.61
F152001	Iran	286	371355	70.93	9.827	1.61
F152002	Iran	89	354982	73.53	9.394	1.61
F152003	Iran	472	452560	67.42	11.976	1.61
F152004	Iran	108	416732	62.72	11.028	1.61
F152005	Iran	461	421316	71.66	11.149	1.61
F152006	Iran	460	481117	27.24	12.732	1.61
F162004	Iran	195	448356	51.72	11.865	1.61
F121995	Iraq	66	133380	48.22	3.530	1.60
F121996	Iraq	116	126668	48.43	3.352	1.60
F121997	Iraq	100	204544	42.19	5.413	1.60
F121998	Iraq	150	234880	53.25	6.216	1.61
F121999	Iraq	148	259026	30.43	6.855	1.61
F141997	Iraq	81	195032	27.64	5.161	1.60
F141998	Iraq	88	214203	44.47	5.668	1.60
F141999	Iraq	170	269940	52.28	7.143	1.61
F142000	Iraq	172	269575	57.24	7.134	1.61
F142001	Iraq	134	278150	40.55	7.361	1.61
F142002	Iraq	173	267171	37.72	7.070	1.61
F152000	Iraq	12	286021	60.28	7.569	1.61
F152001	Iraq	374	299408	65.58	7.923	1.61
F152002	Iraq	165	245092	68.31	6.486	1.61
F152003	Iraq	77	254670	64.32	6.739	1.61
F152004	Iraq	226	295921	57.59	7.831	1.61
F152005	Iraq	361	256941	71.68	6.799	1.61
F152006	Iraq	529	289124	26.44	7.651	1.61
F162004	Iraq	354	315542	51.87	8.350	1.61
F121995	Irish Sea (UK)	0	1408	15.22	0.037	1.60
F121996	Irish Sea (UK)	0	2092	22.32	0.055	1.60

F121997	Irish Sea (UK)	0	2595	18.98	0.069	1.60
F121998	Irish Sea (UK)	0	2424	15.81	0.064	1.60
F121999	Irish Sea (UK)	0	1971	14.65	0.052	1.60
F141997	Irish Sea (UK)	0	2353	12.33	0.062	1.60
F141998	Irish Sea (UK)	0	3233	11.19	0.086	1.60
F141999	Irish Sea (UK)	0	2146	21.05	0.057	1.60
F142000	Irish Sea (UK)	0	1576	19.74	0.042	1.60
F142001	Irish Sea (UK)	0	2047	27.51	0.054	1.60
F142002	Irish Sea (UK)	0	1402	21.32	0.037	1.60
F152000	Irish Sea (UK)	0	1341	24.31	0.035	1.60
F152001	Irish Sea (UK)	0	1782	32.25	0.047	1.60
F152002	Irish Sea (UK)	0	892	33.22	0.024	1.60
F152003	Irish Sea (UK)	0	1219	22.11	0.032	1.60
F152004	Irish Sea (UK)	0	1430	38.53	0.038	1.60
F152005	Irish Sea (UK)	0	1181	43.84	0.031	1.60
F152006	Irish Sea (UK)	0	1586	20.91	0.042	1.60
F162004	Irish Sea (UK)	0	1695	26.75	0.045	1.60
F121995	Kazakhstan	75	91214	33.85	2.414	1.60
F121996	Kazakhstan	111	100598	39.26	2.662	1.60
F121997	Kazakhstan	110	130225	28.03	3.446	1.60
F121998	Kazakhstan	132	147626	45.24	3.907	1.60
F121999	Kazakhstan	201	136507	23.79	3.612	1.60
F141997	Kazakhstan	84	130303	28.4	3.448	1.60
F141998	Kazakhstan	95	151419	38.34	4.007	1.60
F141999	Kazakhstan	124	128128	39.21	3.391	1.60
F142000	Kazakhstan	193	155424	44.68	4.113	1.60
F142001	Kazakhstan	57	149976	31.83	3.969	1.60
F142002	Kazakhstan	210	228542	29.21	6.048	1.61
F152000	Kazakhstan	13	150636	47.79	3.986	1.60
F152001	Kazakhstan	94	156573	44.54	4.143	1.60
F152002	Kazakhstan	237	206747	47.91	5.471	1.60
F152003	Kazakhstan	298	220909	48.28	5.846	1.60
F152004	Kazakhstan	187	208428	55.14	5.516	1.60
F152005	Kazakhstan	234	215427	61.62	5.701	1.60
F152006	Kazakhstan	438	305844	20.29	8.094	1.61
F162004	Kazakhstan	254	228034	40.75	6.034	1.61
F121995	Kuwait	36	80120	49.66	2.120	1.60
F121996	Kuwait	60	85535	51.36	2.264	1.60
F121997	Kuwait	72	100309	45.17	2.654	1.60
F121998	Kuwait	81	76648	57.82	2.028	1.60
F121999	Kuwait	79	71109	28.11	1.882	1.60
F141997	Kuwait	60	97938	28.66	2.592	1.60
F141998	Kuwait	46	71748	51.11	1.899	1.60
F141999	Kuwait	36	71745	54.68	1.899	1.60
F142000	Kuwait	67	79754	56.13	2.111	1.60
F142001	Kuwait	47	68710	42.37	1.818	1.60
F142002	Kuwait	42	77808	40.31	2.059	1.60
F152000	Kuwait	53	85444	60.69	2.261	1.60
F152001	Kuwait	114	79253	72.64	2.097	1.60
F152002	Kuwait	56	84081	71.19	2.225	1.60

F152003	Kuwait	158	108131	70.82	2.861	1.60
F152004	Kuwait	56	95393	63.21	2.524	1.60
F152005	Kuwait	139	103724	72.86	2.745	1.60
F152006	Kuwait	152	104741	29.51	2.772	1.60
F162004	Kuwait	83	103759	57.42	2.746	1.60
F121995	Kyrgyzstan	0	348	22.57	0.009	1.60
F121996	Kyrgyzstan	0	673	15.16	0.018	1.60
F121997	Kyrgyzstan	0	680	21.58	0.018	1.60
F121998	Kyrgyzstan	0	805	28.14	0.021	1.60
F121999	Kyrgyzstan	0	951	31.33	0.025	1.60
F141997	Kyrgyzstan	0	731	20.81	0.019	1.60
F141998	Kyrgyzstan	0	843	29.56	0.022	1.60
F141999	Kyrgyzstan	0	1001	39.43	0.026	1.60
F142000	Kyrgyzstan	0	1145	46.47	0.030	1.60
F142001	Kyrgyzstan	0	769	39.38	0.020	1.60
F142002	Kyrgyzstan	0	788	33.39	0.021	1.60
F152000	Kyrgyzstan	0	895	51.2	0.024	1.60
F152001	Kyrgyzstan	0	619	50.04	0.016	1.60
F152002	Kyrgyzstan	0	664	52.52	0.018	1.60
F152003	Kyrgyzstan	0	767	39.46	0.020	1.60
F152004	Kyrgyzstan	0	789	42.46	0.021	1.60
F152005	Kyrgyzstan	0	719	58.52	0.019	1.60
F152006	Kyrgyzstan	0	755	21.9	0.020	1.60
F162004	Kyrgyzstan	0	699	31.79	0.018	1.60
F121995	Libya	56	241507	49.06	6.391	1.61
F121996	Libya	120	251807	49.96	6.664	1.61
F121997	Libya	76	194965	45.98	5.159	1.60
F121998	Libya	66	164073	50.42	4.342	1.60
F121999	Libya	44	155613	32.8	4.118	1.60
F141997	Libya	33	190774	33.23	5.048	1.60
F141998	Libya	20	169353	46.57	4.482	1.60
F141999	Libya	14	157562	56.63	4.170	1.60
F142000	Libya	15	164922	59.99	4.364	1.60
F142001	Libya	9	139236	48.87	3.685	1.60
F142002	Libya	12	133727	40.33	3.539	1.60
F152000	Libya	17	160834	60.79	4.256	1.60
F152001	Libya	41	145767	69.29	3.857	1.60
F152002	Libya	14	137945	67.56	3.650	1.60
F152003	Libya	46	171387	72.89	4.535	1.60
F152004	Libya	5	154477	62.85	4.088	1.60
F152005	Libya	41	152333	70.21	4.031	1.60
F152006	Libya	65	182967	25.55	4.842	1.60
F162004	Libya	12	162878	51.3	4.310	1.60
F121995	Malaysia	0	75277	37.03	1.992	1.60
F121996	Malaysia	36	86098	35.19	2.278	1.60
F121997	Malaysia	14	95054	36.01	2.515	1.60
F121998	Malaysia	13	70328	38.56	1.861	1.60
F121999	Malaysia	11	68377	24.14	1.809	1.60
F141997	Malaysia	0	102431	32.86	2.711	1.60
F141998	Malaysia	0	74415	51.58	1.969	1.60

F141999	Malaysia	6	67893	43.11	1.797	1.60
F142000	Malaysia	1	63528	49.01	1.681	1.60
F142001	Malaysia	2	59857	52.82	1.584	1.60
F142002	Malaysia	0	53835	54.66	1.425	1.60
F152000	Malaysia	3	58496	41.79	1.548	1.60
F152001	Malaysia	5	62582	52.02	1.656	1.60
F152002	Malaysia	0	54321	62.02	1.438	1.60
F152003	Malaysia	9	71967	47.94	1.904	1.60
F152004	Malaysia	0	63092	59.53	1.670	1.60
F152005	Malaysia	7	63163	55.57	1.671	1.60
F152006	Malaysia	4	71650	32.74	1.896	1.60
F162004	Malaysia	3	67420	53.68	1.784	1.60
F121995	Mauritania	0	0	56.1	0.000	1.60
F121996	Mauritania	0	0	49.87	0.000	1.60
F121997	Mauritania	0	0	48.98	0.000	1.60
F121998	Mauritania	0	0	47.48	0.000	1.60
F121999	Mauritania	0	0	43.72	0.000	1.60
F141997	Mauritania	0	0	29.55	0.000	1.60
F141998	Mauritania	0	0	56.31	0.000	1.60
F141999	Mauritania	0	0	57.55	0.000	1.60
F142000	Mauritania	0	0	61.75	0.000	1.60
F142001	Mauritania	0	0	57.33	0.000	1.60
F142002	Mauritania	0	0	39.14	0.000	1.60
F152000	Mauritania	0	0	69.33	0.000	1.60
F152001	Mauritania	0	0	82.48	0.000	1.60
F152002	Mauritania	0	0	86.94	0.000	1.60
F152003	Mauritania	0	0	89.63	0.000	1.60
F152004	Mauritania	0	0	83.08	0.000	1.60
F152005	Mauritania	0	32	75.31	0.001	1.60
F152006	Mauritania	0	2422	59.75	0.064	1.60
F162004	Mauritania	0	0	63.53	0.000	1.60
F121995	Mexico	0	42044	44.4	1.113	1.60
F121996	Mexico	75	61232	53.92	1.620	1.60
F121997	Mexico	168	88878	33.78	2.352	1.60
F121998	Mexico	159	86826	49.04	2.298	1.60
F121999	Mexico	126	75565	37.53	2.000	1.60
F141997	Mexico	121	89799	25.23	2.376	1.60
F141998	Mexico	118	91236	49.59	2.414	1.60
F141999	Mexico	110	65341	36.48	1.729	1.60
F142000	Mexico	91	71975	58.62	1.905	1.60
F142001	Mexico	51	53989	49.62	1.429	1.60
F142002	Mexico	31	42221	35.54	1.117	1.60
F152000	Mexico	75	69098	63.39	1.829	1.60
F152001	Mexico	112	61809	70.2	1.636	1.60
F152002	Mexico	38	45798	76.83	1.212	1.60
F152003	Mexico	77	49294	72.1	1.304	1.60
F152004	Mexico	19	31707	67.14	0.839	1.60
F152005	Mexico	51	32665	66.61	0.864	1.60
F152006	Mexico	38	37344	42.71	0.988	1.60
F162004	Mexico	31	32958	57.83	0.872	1.60

F121995	Myanmar	0	0	41.2	0.000	1.60
F121996	Myanmar	0	0	38.15	0.000	1.60
F121997	Myanmar	0	0	46.8	0.000	1.60
F121998	Myanmar	0	381	42.1	0.010	1.60
F121999	Myanmar	0	549	27.1	0.015	1.60
F141997	Myanmar	0	16	28.37	0.000	1.60
F141998	Myanmar	0	434	57.24	0.011	1.60
F141999	Myanmar	0	626	45.12	0.017	1.60
F142000	Myanmar	0	960	55.25	0.025	1.60
F142001	Myanmar	0	905	51.68	0.024	1.60
F142002	Myanmar	0	1306	52.1	0.035	1.60
F152000	Myanmar	0	983	44.05	0.026	1.60
F152001	Myanmar	0	887	49.75	0.023	1.60
F152002	Myanmar	0	1045	62.36	0.028	1.60
F152003	Myanmar	0	1060	52.69	0.028	1.60
F152004	Myanmar	0	1117	63.84	0.030	1.60
F152005	Myanmar	0	809	54.18	0.021	1.60
F152006	Myanmar	0	1027	33.45	0.027	1.60
F162004	Myanmar	0	1378	62.65	0.036	1.60
F121995	Nigeria	946	1038408	51.76	27.480	1.66
F121996	Nigeria	2727	1240517	47.37	32.828	1.68
F121997	Nigeria	404	1134886	48.53	30.033	1.67
F121998	Nigeria	390	977152	44.35	25.858	1.65
F121999	Nigeria	359	953204	35.61	25.225	1.65
F141997	Nigeria	174	1088087	43.77	28.794	1.66
F141998	Nigeria	135	1003263	53.8	26.549	1.65
F141999	Nigeria	252	925278	51.75	24.486	1.65
F142000	Nigeria	902	1023892	59.71	27.095	1.66
F142001	Nigeria	777	986375	59.9	26.103	1.65
F142002	Nigeria	496	803577	47.8	21.265	1.64
F152000	Nigeria	712	1012886	49.75	26.804	1.66
F152001	Nigeria	1633	1056653	53.34	27.962	1.66
F152002	Nigeria	233	785429	57.32	20.785	1.63
F152003	Nigeria	944	936579	47.77	24.785	1.65
F152004	Nigeria	337	834418	60.9	22.081	1.64
F152005	Nigeria	1152	763098	62.38	20.194	1.63
F152006	Nigeria	915	805261	33.59	21.310	1.64
F162004	Nigeria	559	900626	52.19	23.833	1.64
F121995	North Sea	1	154484	19.06	4.088	1.60
F121996	North Sea	0	123588	22.83	3.271	1.60
F121997	North Sea	2	133719	25.67	3.539	1.60
F121998	North Sea	2	105735	18.4	2.798	1.60
F121999	North Sea	1	113245	13.72	2.997	1.60
F141997	North Sea	0	132786	16.48	3.514	1.60
F141998	North Sea	4	108010	14.33	2.858	1.60
F141999	North Sea	2	109538	18.62	2.899	1.60
F142000	North Sea	0	114658	21.72	3.034	1.60
F142001	North Sea	0	105156	24.48	2.783	1.60
F142002	North Sea	0	96939	17.6	2.565	1.60
F152000	North Sea	0	87497	24.9	2.315	1.60

F152001	North Sea	0	90049	29.59	2.383	1.60
F152002	North Sea	0	77115	32.27	2.041	1.60
F152003	North Sea	0	93760	22.61	2.481	1.60
F152004	North Sea	0	90608	42.31	2.398	1.60
F152005	North Sea	0	72471	36.36	1.918	1.60
F152006	North Sea	0	90868	18.46	2.405	1.60
F162004	North Sea	0	91291	28.55	2.416	1.60
F121995	Norway	0	16339	12.72	0.432	1.60
F121996	Norway	0	5173	21.02	0.137	1.60
F121997	Norway	0	4855	20	0.128	1.60
F121998	Norway	0	5072	7.6	0.134	1.60
F121999	Norway	10	14553	2.36	0.385	1.60
F141997	Norway	0	3829	2.37	0.101	1.60
F141998	Norway	2	5072	3.67	0.134	1.60
F141999	Norway	0	2555	1.67	0.068	1.60
F142000	Norway	0	5060	0.69	0.134	1.60
F142001	Norway	0	1112	0.23	0.029	1.60
F142002	Norway	0	0	0	0.000	1.60
F152000	Norway	0	5354	17.16	0.142	1.60
F152001	Norway	0	3593	18.41	0.095	1.60
F152002	Norway	0	3183	20.97	0.084	1.60
F152003	Norway	0	3639	9.44	0.096	1.60
F152004	Norway	0	2756	28.04	0.073	1.60
F152005	Norway	0	4543	29.21	0.120	1.60
F152006	Norway	0	2111	15.94	0.056	1.60
F162004	Norway	0	2875	21.91	0.076	1.60
F121995	Oman	18	61821	60.27	1.636	1.60
F121996	Oman	28	66051	50.37	1.748	1.60
F121997	Oman	12	75358	55.17	1.994	1.60
F121998	Oman	25	61244	59.69	1.621	1.60
F121999	Oman	12	66625	53.83	1.763	1.60
F141997	Oman	13	79588	38.48	2.106	1.60
F141998	Oman	7	60443	56.87	1.600	1.60
F141999	Oman	0	69266	71.14	1.833	1.60
F142000	Oman	7	70050	77.19	1.854	1.60
F142001	Oman	7	74434	65.35	1.970	1.60
F142002	Oman	16	75636	55.14	2.002	1.60
F152000	Oman	12	68623	79.2	1.816	1.60
F152001	Oman	41	79971	92.53	2.116	1.60
F152002	Oman	22	87080	100.53	2.304	1.60
F152003	Oman	92	99654	91.31	2.637	1.60
F152004	Oman	5	89640	88.59	2.372	1.60
F152005	Oman	61	79691	87.64	2.109	1.60
F152006	Oman	37	83666	45.17	2.214	1.60
F162004	Oman	16	99220	71.9	2.626	1.60
F121995	Peru	0	9264	40.12	0.245	1.60
F121996	Peru	0	9558	41.01	0.253	1.60
F121997	Peru	0	8820	31.09	0.233	1.60
F121998	Peru	0	8570	40.77	0.227	1.60
F121999	Peru	0	7637	29.3	0.202	1.60

F141997	Peru	0	9206	30.1	0.244	1.60
F141998	Peru	0	9104	41.52	0.241	1.60
F141999	Peru	0	7894	41.7	0.209	1.60
F142000	Peru	0	7150	46.08	0.189	1.60
F142001	Peru	0	6381	47.56	0.169	1.60
F142002	Peru	0	6263	48.62	0.166	1.60
F152000	Peru	0	6861	41.55	0.182	1.60
F152001	Peru	0	5989	41.41	0.158	1.60
F152002	Peru	0	5568	54.3	0.147	1.60
F152003	Peru	0	6615	43.5	0.175	1.60
F152004	Peru	0	5245	42.38	0.139	1.60
F152005	Peru	0	4229	42.63	0.112	1.60
F152006	Peru	0	3619	29.19	0.096	1.60
F162004	Peru	0	5597	48.94	0.148	1.60
F121995	Philippines	0	1310	42.37	0.035	1.60
F121996	Philippines	0	1073	34.84	0.028	1.60
F121997	Philippines	0	1510	52.02	0.040	1.60
F121998	Philippines	0	1278	44.36	0.034	1.60
F121999	Philippines	0	1184	23.91	0.031	1.60
F141997	Philippines	0	1570	36.07	0.042	1.60
F141998	Philippines	0	1411	59.86	0.037	1.60
F141999	Philippines	0	1218	49.36	0.032	1.60
F142000	Philippines	0	1278	58.39	0.034	1.60
F142001	Philippines	0	1430	41.35	0.038	1.60
F142002	Philippines	0	3868	54.4	0.102	1.60
F152000	Philippines	0	991	46.58	0.026	1.60
F152001	Philippines	0	1341	43.59	0.035	1.60
F152002	Philippines	0	3197	66.62	0.085	1.60
F152003	Philippines	0	3040	56.67	0.080	1.60
F152004	Philippines	0	2203	62.53	0.058	1.60
F152005	Philippines	0	1956	57.81	0.052	1.60
F152006	Philippines	0	2563	36.34	0.068	1.60
F162004	Philippines	0	2424	61.24	0.064	1.60
F121995	PNG	0	3994	32.27	0.106	1.60
F121996	PNG	0	5247	21.74	0.139	1.60
F121997	PNG	0	6079	32.84	0.161	1.60
F121998	PNG	4	21443	22.48	0.567	1.60
F121999	PNG	0	9990	13.87	0.264	1.60
F141997	PNG	0	5928	43.52	0.157	1.60
F141998	PNG	0	21489	24	0.569	1.60
F141999	PNG	2	9738	19.42	0.258	1.60
F142000	PNG	0	13013	40.28	0.344	1.60
F142001	PNG	0	10374	34.15	0.275	1.60
F142002	PNG	0	10159	39.03	0.269	1.60
F152000	PNG	0	13042	39.27	0.345	1.60
F152001	PNG	4	12116	28.72	0.321	1.60
F152002	PNG	0	10041	46	0.266	1.60
F152003	PNG	0	9189	40.89	0.243	1.60
F152004	PNG	0	11272	46.4	0.298	1.60
F152005	PNG	2	21658	44.95	0.573	1.60

F152006	PNG	0	21662	26.39	0.573	1.60
F162004	PNG	0	11950	48.83	0.316	1.60
F121995	Qatar	34	45289	57.13	1.198	1.60
F121996	Qatar	35	67995	41.73	1.799	1.60
F121997	Qatar	85	121650	43.84	3.219	1.60
F121998	Qatar	79	113311	58.26	2.999	1.60
F121999	Qatar	145	126601	37.17	3.350	1.60
F141997	Qatar	42	123984	28.42	3.281	1.60
F141998	Qatar	54	116142	54.65	3.073	1.60
F141999	Qatar	146	125640	64.39	3.325	1.60
F142000	Qatar	207	138727	60.81	3.671	1.60
F142001	Qatar	104	107610	50.51	2.848	1.60
F142002	Qatar	111	103502	41.12	2.739	1.60
F152000	Qatar	92	139575	63.68	3.694	1.60
F152001	Qatar	242	125392	81.47	3.318	1.60
F152002	Qatar	152	119428	82.22	3.160	1.60
F152003	Qatar	236	131375	70.08	3.477	1.60
F152004	Qatar	76	115829	67.14	3.065	1.60
F152005	Qatar	164	98990	83.47	2.620	1.60
F152006	Qatar	180	111256	28.44	2.944	1.60
F162004	Qatar	101	123636	59.69	3.272	1.60
F121995	Romania	0	3012	26.8	0.080	1.60
F121996	Romania	0	2996	24.32	0.079	1.60
F121997	Romania	0	3868	24.7	0.102	1.60
F121998	Romania	0	2578	33.03	0.068	1.60
F121999	Romania	0	2931	13.35	0.078	1.60
F141997	Romania	0	4009	17.75	0.106	1.60
F141998	Romania	0	3609	26.88	0.096	1.60
F141999	Romania	0	3862	32.6	0.102	1.60
F142000	Romania	0	3207	30.08	0.085	1.60
F142001	Romania	0	3655	25.8	0.097	1.60
F142002	Romania	0	3035	20.62	0.080	1.60
F152000	Romania	0	2794	34.15	0.074	1.60
F152001	Romania	0	3240	39.25	0.086	1.60
F152002	Romania	0	3285	37.7	0.087	1.60
F152003	Romania	0	3568	31.29	0.094	1.60
F152004	Romania	0	2804	34.93	0.074	1.60
F152005	Romania	0	3648	46.93	0.097	1.60
F152006	Romania	0	3980	14.3	0.105	1.60
F162004	Romania	0	3311	25.29	0.088	1.60
F121995	Russia_KM	574	922924	24.63	24.423	1.65
F121996	Russia_KM	498	854010	25.84	22.600	1.64
F121997	Russia_KM	277	776040	25.6	20.536	1.63
F121998	Russia_KM	428	803405	32.63	21.261	1.64
F121999	Russia_KM	305	685227	20.8	18.133	1.63
F141997	Russia_KM	210	846966	21.26	22.413	1.64
F141998	Russia_KM	374	881041	17.63	23.315	1.64
F141999	Russia_KM	205	689134	25.44	18.237	1.63
F142000	Russia_KM	447	886828	35.4	23.468	1.64
F142001	Russia_KM	447	870841	11.85	23.045	1.64

F142002	Russia_KM	1501	878974	4.68	23.260	1.64
F152000	Russia_KM	29	732216	40.9	19.377	1.63
F152001	Russia_KM	469	858639	33.08	22.722	1.64
F152002	Russia_KM	298	835416	49.52	22.108	1.64
F152003	Russia_KM	443	1092925	34.17	28.922	1.66
F152004	Russia_KM	157	926944	53.12	24.530	1.65
F152005	Russia_KM	658	996062	52.79	26.359	1.65
F152006	Russia_KM	434	907456	27.97	24.014	1.64
F162004	Russia_KM	458	954934	33.88	25.271	1.65
F121995	Russia_not_KM	393	611528	22.35	16.183	1.62
F121996	Russia_not_KM	281	545211	25.49	14.428	1.62
F121997	Russia_not_KM	331	519517	26.25	13.748	1.62
F121998	Russia_not_KM	514	629247	27.74	16.652	1.62
F121999	Russia_not_KM	793	585458	13.92	15.493	1.62
F141997	Russia_not_KM	385	479027	12.55	12.677	1.61
F141998	Russia_not_KM	362	685298	16.69	18.135	1.63
F141999	Russia_not_KM	523	620606	19.08	16.423	1.62
F142000	Russia_not_KM	775	716061	22.76	18.949	1.63
F142001	Russia_not_KM	563	502005	10.54	13.285	1.62
F142002	Russia_not_KM	373	223817	7.56	5.923	1.61
F152000	Russia_not_KM	0	583484	36.97	15.441	1.62
F152001	Russia_not_KM	321	708043	32.77	18.737	1.63
F152002	Russia_not_KM	482	823600	43.03	21.795	1.64
F152003	Russia_not_KM	379	982109	30.14	25.990	1.65
F152004	Russia_not_KM	130	938475	50.19	24.835	1.65
F152005	Russia_not_KM	827	1072699	55.08	28.387	1.66
F152006	Russia_not_KM	522	1055828	28.66	27.940	1.66
F162004	Russia_not_KM	448	1006709	34.08	26.641	1.65
F121995	Saudi Arabia	48	103546	54.19	2.740	1.60
F121996	Saudi Arabia	107	116292	47.29	3.077	1.60
F121997	Saudi Arabia	113	129091	46.24	3.416	1.60
F121998	Saudi Arabia	86	112997	58.21	2.990	1.60
F121999	Saudi Arabia	106	103608	39.19	2.742	1.60
F141997	Saudi Arabia	53	129319	28.79	3.422	1.60
F141998	Saudi Arabia	47	115324	52.3	3.052	1.60
F141999	Saudi Arabia	29	107074	64.19	2.834	1.60
F142000	Saudi Arabia	86	117585	61.88	3.112	1.60
F142001	Saudi Arabia	61	109261	50.81	2.891	1.60
F142002	Saudi Arabia	52	108775	44.61	2.879	1.60
F152000	Saudi Arabia	51	117308	66.14	3.104	1.60
F152001	Saudi Arabia	118	115019	82.37	3.044	1.60
F152002	Saudi Arabia	27	110673	83.77	2.929	1.60
F152003	Saudi Arabia	120	133602	79.81	3.536	1.60
F152004	Saudi Arabia	36	113913	70.47	3.014	1.60
F152005	Saudi Arabia	99	118906	83.53	3.147	1.60
F152006	Saudi Arabia	115	152669	31.53	4.040	1.60
F162004	Saudi Arabia	64	116079	61.35	3.072	1.60
F121995	South Africa	0	2313	65.56	0.061	1.60
F121996	South Africa	0	2452	63.03	0.065	1.60
F121997	South Africa	0	3560	46.25	0.094	1.60

F121998	South Africa	0	4514	61.08	0.119	1.60
F121999	South Africa	0	3765	24.86	0.100	1.60
F141997	South Africa	0	4587	41.48	0.121	1.60
F141998	South Africa	0	5255	49.6	0.139	1.60
F141999	South Africa	0	4611	50.03	0.122	1.60
F142000	South Africa	0	5249	65.56	0.139	1.60
F142001	South Africa	0	5062	59.43	0.134	1.60
F142002	South Africa	0	4215	42.45	0.112	1.60
F152000	South Africa	0	4584	71.05	0.121	1.60
F152001	South Africa	0	5040	67.76	0.133	1.60
F152002	South Africa	0	4552	75.46	0.120	1.60
F152003	South Africa	0	6054	68.52	0.160	1.60
F152004	South Africa	0	6007	69.19	0.159	1.60
F152005	South Africa	0	5144	64.42	0.136	1.60
F152006	South Africa	0	4857	44.96	0.129	1.60
F162004	South Africa	0	5642	58.39	0.149	1.60
F121995	Sudan	0	0	50.52	0.000	1.60
F121996	Sudan	0	0	44.48	0.000	1.60
F121997	Sudan	0	0	46.44	0.000	1.60
F121998	Sudan	0	424	55.75	0.011	1.60
F121999	Sudan	0	1258	40.57	0.033	1.60
F141997	Sudan	0	485	33.01	0.013	1.60
F141998	Sudan	0	441	63.73	0.012	1.60
F141999	Sudan	0	1086	65.11	0.029	1.60
F142000	Sudan	0	3393	76.55	0.090	1.60
F142001	Sudan	0	2967	66.39	0.079	1.60
F142002	Sudan	1	3182	53.9	0.084	1.60
F152000	Sudan	0	4152	66.36	0.110	1.60
F152001	Sudan	0	3162	70.14	0.084	1.60
F152002	Sudan	0	3008	80.66	0.080	1.60
F152003	Sudan	0	3426	74.75	0.091	1.60
F152004	Sudan	0	6531	80.09	0.173	1.60
F152005	Sudan	5	8110	78.71	0.215	1.60
F152006	Sudan	0	9896	51.38	0.262	1.60
F162004	Sudan	0	7036	74.12	0.186	1.60
F121995	Syria	57	121476	42.24	3.215	1.60
F121996	Syria	127	120392	44.34	3.186	1.60
F121997	Syria	42	109113	40.43	2.887	1.60
F121998	Syria	64	110162	53.72	2.915	1.60
F121999	Syria	89	106530	32.7	2.819	1.60
F141997	Syria	48	111833	26.19	2.959	1.60
F141998	Syria	25	100833	40.16	2.668	1.60
F141999	Syria	65	105726	54.64	2.798	1.60
F142000	Syria	58	108646	55.43	2.875	1.60
F142001	Syria	1	73795	43.47	1.953	1.60
F142002	Syria	0	48456	34.52	1.282	1.60
F152000	Syria	62	111615	57.87	2.954	1.60
F152001	Syria	4	75876	55.79	2.008	1.60
F152002	Syria	0	46954	69.38	1.243	1.60
F152003	Syria	5	44581	54.36	1.180	1.60

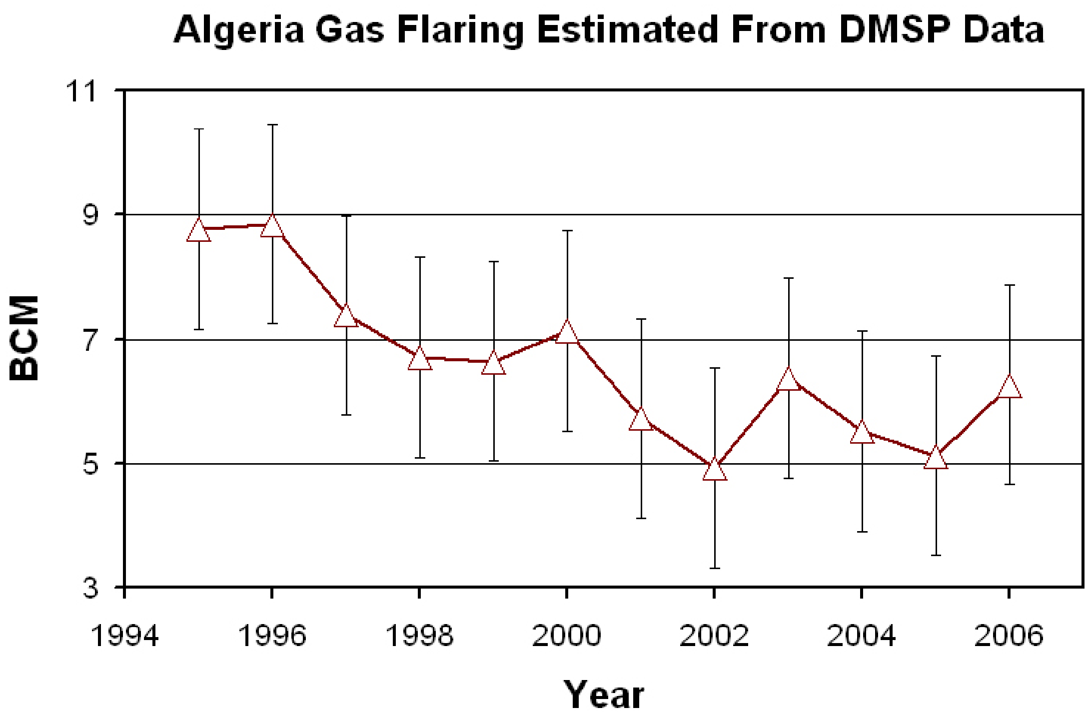
F152004	Syria	0	35679	55.96	0.944	1.60
F152005	Syria	0	32328	70.95	0.855	1.60
F152006	Syria	0	35200	24.71	0.932	1.60
F162004	Syria	0	36933	48.16	0.977	1.60
F121995	Thailand	0	4708	35.49	0.125	1.60
F121996	Thailand	0	4819	41.1	0.128	1.60
F121997	Thailand	0	4776	31.06	0.126	1.60
F121998	Thailand	0	4088	40.49	0.108	1.60
F121999	Thailand	0	5602	26.79	0.148	1.60
F141997	Thailand	0	5012	29.49	0.133	1.60
F141998	Thailand	0	4760	56.07	0.126	1.60
F141999	Thailand	0	5431	47.2	0.144	1.60
F142000	Thailand	0	5852	54.23	0.155	1.60
F142001	Thailand	0	5508	50.37	0.146	1.60
F142002	Thailand	0	5557	53.05	0.147	1.60
F152000	Thailand	0	5145	36.12	0.136	1.60
F152001	Thailand	0	5695	51.41	0.151	1.60
F152002	Thailand	0	5158	57.96	0.136	1.60
F152003	Thailand	0	7663	53.79	0.203	1.60
F152004	Thailand	0	7969	63.58	0.211	1.60
F152005	Thailand	0	7284	61.63	0.193	1.60
F152006	Thailand	0	8694	34.69	0.230	1.60
F162004	Thailand	0	9397	53.86	0.249	1.60
F121995	Trinidad	0	4336	61.67	0.115	1.60
F121996	Trinidad	0	8643	50.49	0.229	1.60
F121997	Trinidad	0	4945	42.91	0.131	1.60
F121998	Trinidad	0	2802	58.95	0.074	1.60
F121999	Trinidad	0	2275	35.9	0.060	1.60
F141997	Trinidad	0	7113	43.31	0.188	1.60
F141998	Trinidad	0	3226	66.9	0.085	1.60
F141999	Trinidad	0	3009	62.34	0.080	1.60
F142000	Trinidad	0	3530	69.79	0.093	1.60
F142001	Trinidad	0	3767	65.88	0.100	1.60
F142002	Trinidad	0	2293	53.8	0.061	1.60
F152000	Trinidad	0	3178	62.87	0.084	1.60
F152001	Trinidad	0	3529	64.03	0.093	1.60
F152002	Trinidad	0	2004	78.04	0.053	1.60
F152003	Trinidad	0	3071	76.35	0.081	1.60
F152004	Trinidad	0	2745	69.45	0.073	1.60
F152005	Trinidad	0	5542	78.37	0.147	1.60
F152006	Trinidad	0	7496	52.44	0.198	1.60
F162004	Trinidad	0	2734	65.16	0.072	1.60
F121995	Tunisia	0	7942	39.47	0.210	1.60
F121996	Tunisia	0	7564	39.36	0.200	1.60
F121997	Tunisia	0	7067	40.94	0.187	1.60
F121998	Tunisia	0	7433	49.64	0.197	1.60
F121999	Tunisia	2	10462	28.38	0.277	1.60
F141997	Tunisia	0	7174	28.89	0.190	1.60
F141998	Tunisia	0	8881	41.28	0.235	1.60
F141999	Tunisia	0	11061	40.77	0.293	1.60

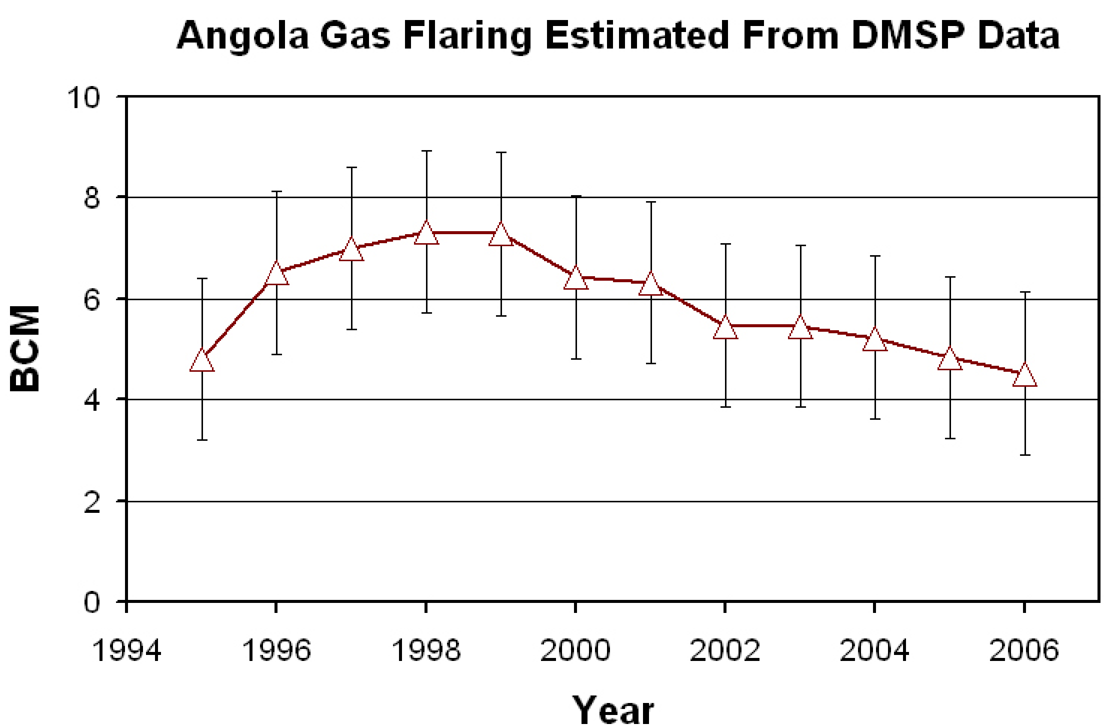
F142000	Tunisia	0	9792	49.64	0.259	1.60
F142001	Tunisia	0	9398	41.03	0.249	1.60
F142002	Tunisia	0	8173	34.35	0.216	1.60
F152000	Tunisia	0	8301	53.59	0.220	1.60
F152001	Tunisia	0	8979	52.29	0.238	1.60
F152002	Tunisia	0	8399	59.82	0.222	1.60
F152003	Tunisia	0	8709	52.2	0.230	1.60
F152004	Tunisia	0	8178	53.26	0.216	1.60
F152005	Tunisia	0	8328	66.66	0.220	1.60
F152006	Tunisia	1	10030	20.89	0.265	1.60
F162004	Tunisia	0	8520	45.15	0.225	1.60
F121995	Turkmenistan	2	17895	44.33	0.474	1.60
F121996	Turkmenistan	2	26047	36.14	0.689	1.60
F121997	Turkmenistan	2	16964	33.32	0.449	1.60
F121998	Turkmenistan	3	31466	43.89	0.833	1.60
F121999	Turkmenistan	15	47664	24.58	1.261	1.60
F141997	Turkmenistan	1	14853	23.4	0.393	1.60
F141998	Turkmenistan	0	31620	35.36	0.837	1.60
F141999	Turkmenistan	12	48698	39.91	1.289	1.60
F142000	Turkmenistan	0	40555	45.74	1.073	1.60
F142001	Turkmenistan	4	39067	34.69	1.034	1.60
F142002	Turkmenistan	2	47330	33.08	1.252	1.60
F152000	Turkmenistan	0	40568	48.42	1.074	1.60
F152001	Turkmenistan	12	43394	47.79	1.148	1.60
F152002	Turkmenistan	4	50455	52.36	1.335	1.60
F152003	Turkmenistan	26	58446	44.89	1.547	1.60
F152004	Turkmenistan	2	63020	46.92	1.668	1.60
F152005	Turkmenistan	14	46670	62.86	1.235	1.60
F152006	Turkmenistan	13	52037	21.46	1.377	1.60
F162004	Turkmenistan	10	59397	38.79	1.572	1.60
F121995	UAE	35	72214	58.49	1.911	1.60
F121996	UAE	49	75771	45.56	2.005	1.60
F121997	UAE	37	68603	45.21	1.815	1.60
F121998	UAE	56	58151	59.31	1.539	1.60
F121999	UAE	61	62788	47.95	1.662	1.60
F141997	UAE	34	71007	31.9	1.879	1.60
F141998	UAE	23	59482	54.18	1.574	1.60
F141999	UAE	26	61153	69.12	1.618	1.60
F142000	UAE	46	68018	68.92	1.800	1.60
F142001	UAE	23	57157	58.85	1.513	1.60
F142002	UAE	22	54135	48.24	1.433	1.60
F152000	UAE	14	66450	71.8	1.758	1.60
F152001	UAE	60	60491	89.24	1.601	1.60
F152002	UAE	20	54371	90.82	1.439	1.60
F152003	UAE	56	61999	78.85	1.641	1.60
F152004	UAE	19	52996	78.59	1.402	1.60
F152005	UAE	44	49792	86.86	1.318	1.60
F152006	UAE	34	57733	33.39	1.528	1.60
F162004	UAE	29	55699	64.84	1.474	1.60
F121995	USA_offshore	0	12792	46.97	0.339	1.60

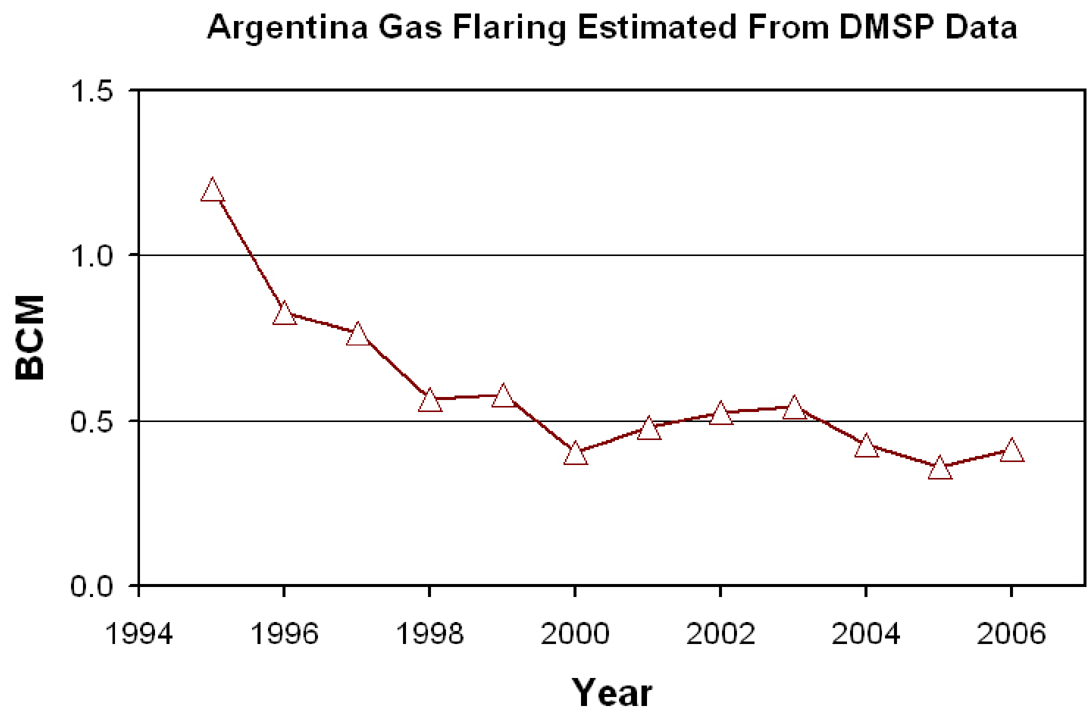
F121996	USA_offshore	0	15156	51.68	0.401	1.60
F121997	USA_offshore	0	17546	28.83	0.464	1.60
F121998	USA_offshore	0	13841	45.44	0.366	1.60
F121999	USA_offshore	0	13145	23.12	0.348	1.60
F141997	USA_offshore	0	20908	24.77	0.553	1.60
F141998	USA_offshore	0	14456	44.2	0.383	1.60
F141999	USA_offshore	0	13457	17.1	0.356	1.60
F142000	USA_offshore	0	7709	30.69	0.204	1.60
F142001	USA_offshore	0	8164	22.78	0.216	1.60
F142002	USA_offshore	0	9197	11.12	0.243	1.60
F152000	USA_offshore	0	7347	52.22	0.194	1.60
F152001	USA_offshore	0	7854	54.6	0.208	1.60
F152002	USA_offshore	0	6196	57.67	0.164	1.60
F152003	USA_offshore	0	6656	52.18	0.176	1.60
F152004	USA_offshore	0	5194	55.92	0.137	1.60
F152005	USA_offshore	0	3370	61.88	0.089	1.60
F152006	USA_offshore	0	5521	27.83	0.146	1.60
F162004	USA_offshore	0	3897	45.35	0.103	1.60
F121995	Uzbekistan	8	41731	44.44	1.104	1.60
F121996	Uzbekistan	29	50981	42.69	1.349	1.60
F121997	Uzbekistan	7	40981	26.26	1.084	1.60
F121998	Uzbekistan	12	47887	46.93	1.267	1.60
F121999	Uzbekistan	4	36903	28.78	0.977	1.60
F141997	Uzbekistan	12	56008	30.37	1.482	1.60
F141998	Uzbekistan	4	50654	41.08	1.340	1.60
F141999	Uzbekistan	1	38234	41.11	1.012	1.60
F142000	Uzbekistan	12	49542	50.08	1.311	1.60
F142001	Uzbekistan	18	73119	38.84	1.935	1.60
F142002	Uzbekistan	67	104423	37.86	2.763	1.60
F152000	Uzbekistan	17	46734	51.14	1.237	1.60
F152001	Uzbekistan	50	69183	54.9	1.831	1.60
F152002	Uzbekistan	55	92317	58.59	2.443	1.60
F152003	Uzbekistan	84	89159	57.24	2.359	1.60
F152004	Uzbekistan	47	76925	50.08	2.036	1.60
F152005	Uzbekistan	189	93765	66.68	2.481	1.60
F152006	Uzbekistan	193	111291	21.83	2.945	1.60
F162004	Uzbekistan	69	78257	42.86	2.071	1.60
F121995	Venezuela	1	83047	50.27	2.198	1.60
F121996	Venezuela	12	77858	45.83	2.060	1.60
F121997	Venezuela	18	88621	41.02	2.345	1.60
F121998	Venezuela	40	99545	49.29	2.634	1.60
F121999	Venezuela	41	99070	34.15	2.622	1.60
F141997	Venezuela	12	95166	40.86	2.518	1.60
F141998	Venezuela	10	114432	67.01	3.028	1.60
F141999	Venezuela	27	101819	53.03	2.694	1.60
F142000	Venezuela	51	107827	63.1	2.853	1.60
F142001	Venezuela	30	90898	65.61	2.405	1.60
F142002	Venezuela	10	71986	58.52	1.905	1.60
F152000	Venezuela	47	105210	53.56	2.784	1.60
F152001	Venezuela	42	88732	57.32	2.348	1.60

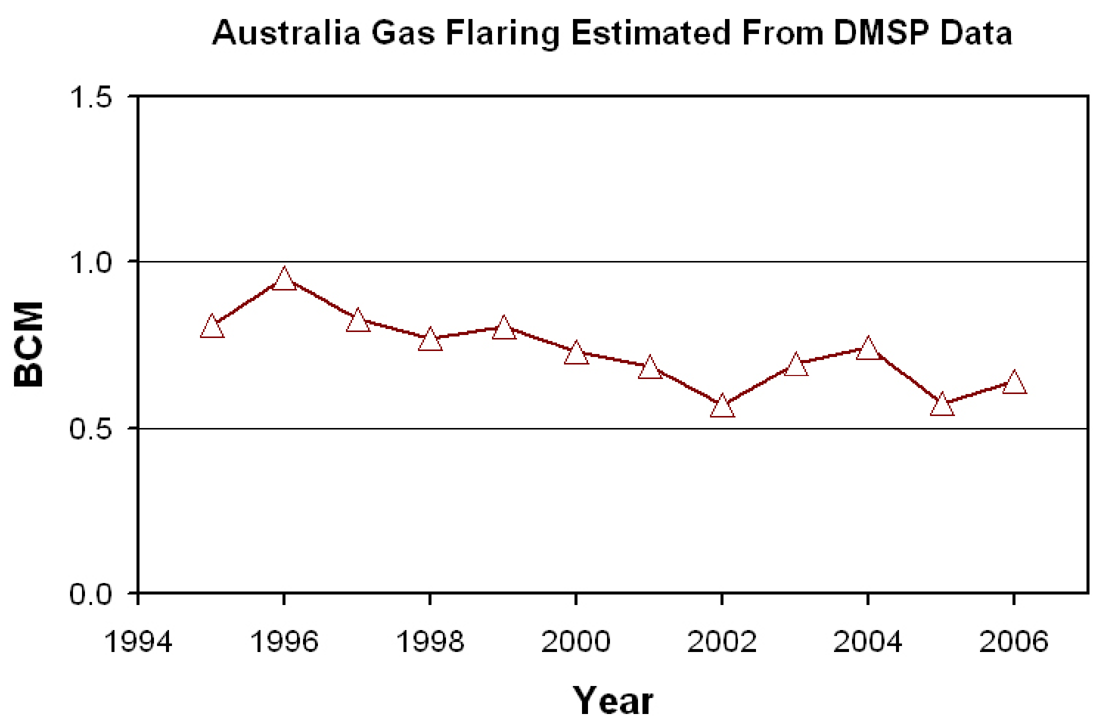
F152002	Venezuela	1	64975	68.38	1.719	1.60
F152003	Venezuela	24	71203	66.7	1.884	1.60
F152004	Venezuela	4	75805	54.3	2.006	1.60
F152005	Venezuela	21	70408	65.56	1.863	1.60
F152006	Venezuela	6	80274	42.95	2.124	1.60
F162004	Venezuela	23	84248	53.65	2.229	1.60
F121995	Vietnam	40	27319	45.01	0.723	1.60
F121996	Vietnam	43	24891	42.8	0.659	1.60
F121997	Vietnam	2	20521	43.19	0.543	1.60
F121998	Vietnam	20	19651	45.42	0.520	1.60
F121999	Vietnam	32	34638	23.05	0.917	1.60
F141997	Vietnam	0	17766	31.85	0.470	1.60
F141998	Vietnam	0	21639	60.79	0.573	1.60
F141999	Vietnam	25	30843	47.68	0.816	1.60
F142000	Vietnam	19	27168	59.61	0.719	1.60
F142001	Vietnam	0	24179	51.64	0.640	1.60
F142002	Vietnam	18	18975	62.23	0.502	1.60
F152000	Vietnam	20	24300	50.63	0.643	1.60
F152001	Vietnam	36	26511	53.6	0.702	1.60
F152002	Vietnam	14	19603	74.18	0.519	1.60
F152003	Vietnam	23	22550	50.22	0.597	1.60
F152004	Vietnam	9	21371	72.56	0.566	1.60
F152005	Vietnam	20	20287	63.75	0.537	1.60
F152006	Vietnam	2	21303	45.96	0.564	1.60
F162004	Vietnam	11	22233	63.81	0.588	1.60
F121995	Yemen	1	13876	53.97	0.367	1.60
F121996	Yemen	1	15069	58.83	0.399	1.60
F121997	Yemen	0	18162	49.59	0.481	1.60
F121998	Yemen	0	14439	58.09	0.382	1.60
F121999	Yemen	1	18462	47.51	0.489	1.60
F141997	Yemen	0	15419	36.55	0.408	1.60
F141998	Yemen	0	16100	62.39	0.426	1.60
F141999	Yemen	2	20350	75.61	0.539	1.60
F142000	Yemen	0	23388	79.84	0.619	1.60
F142001	Yemen	0	19393	63.75	0.513	1.60
F142002	Yemen	0	19503	59.42	0.516	1.60
F152000	Yemen	0	24104	79.05	0.638	1.60
F152001	Yemen	0	22314	83.99	0.590	1.60
F152002	Yemen	0	20396	93.14	0.540	1.60
F152003	Yemen	3	28262	90.28	0.748	1.60
F152004	Yemen	0	27083	90.34	0.717	1.60
F152005	Yemen	16	33578	77.08	0.889	1.60
F152006	Yemen	28	59278	54.47	1.569	1.60
F162004	Yemen	1	26265	79.94	0.695	1.60

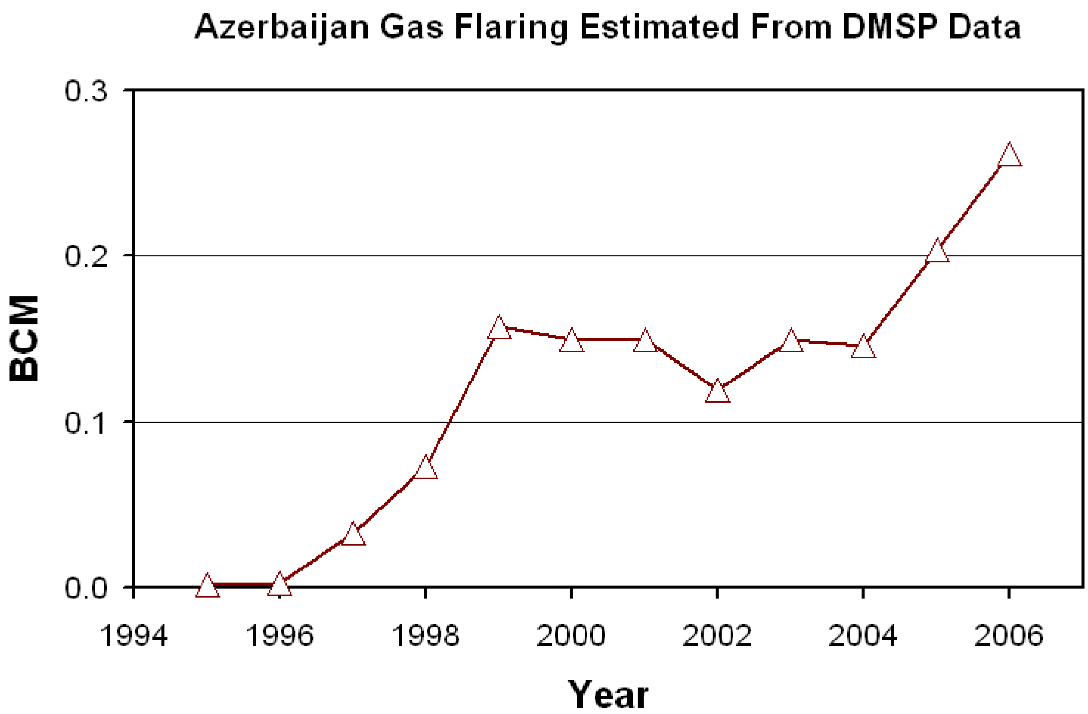
Appendix 3. Trends in Gas Flaring For Individual Countries and Areas

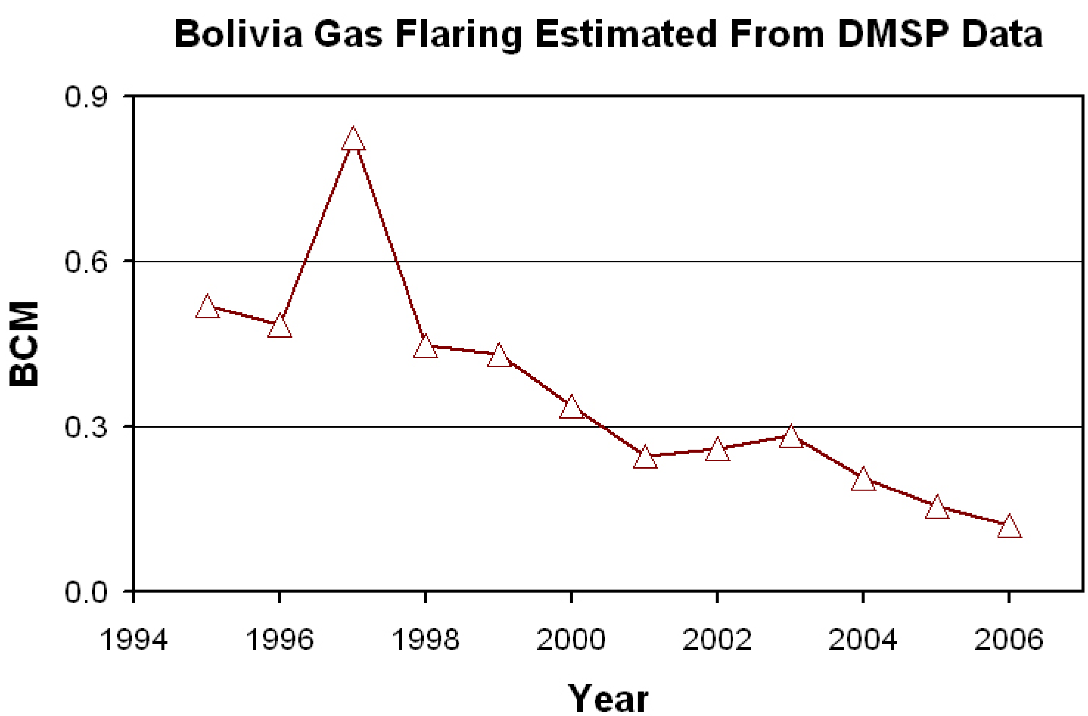

Algeria Gas Flaring Estimated From DMSP Data
BCM
11
9
7
5
3
1994
1996
1998
2000
2002
2004
2006
Year

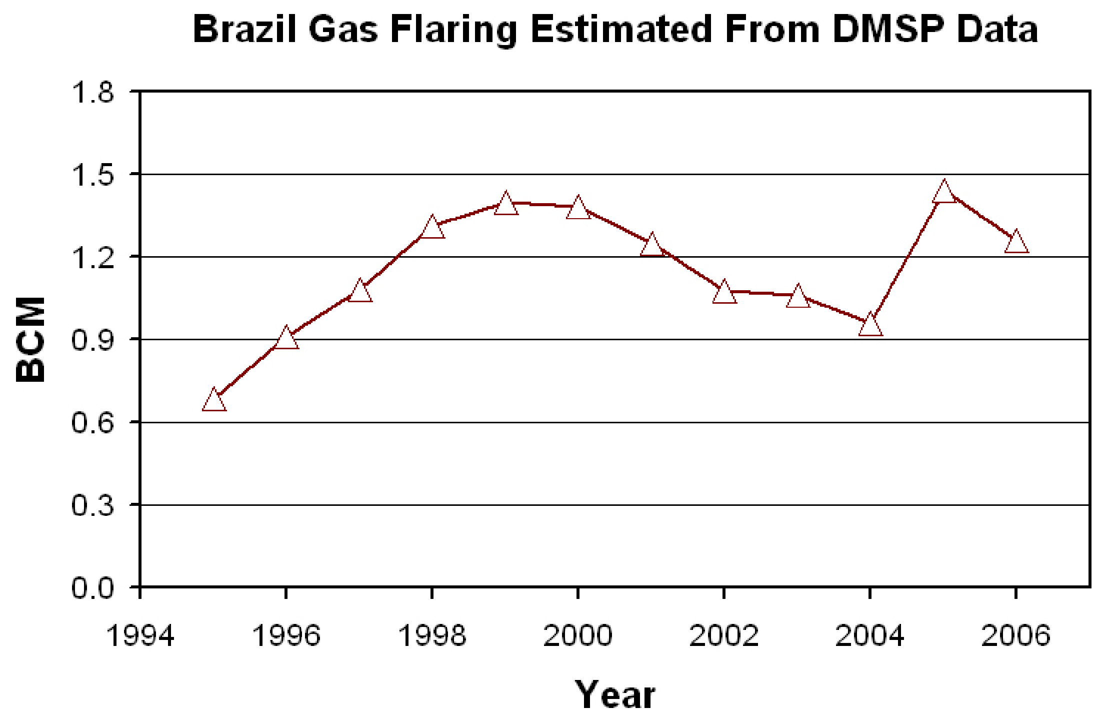

Angola Gas Flaring Estimated From DMSP Data
BCM
10
8
6
4
2
0
1994
1996
1998
2000
2002
2004
2006
Year

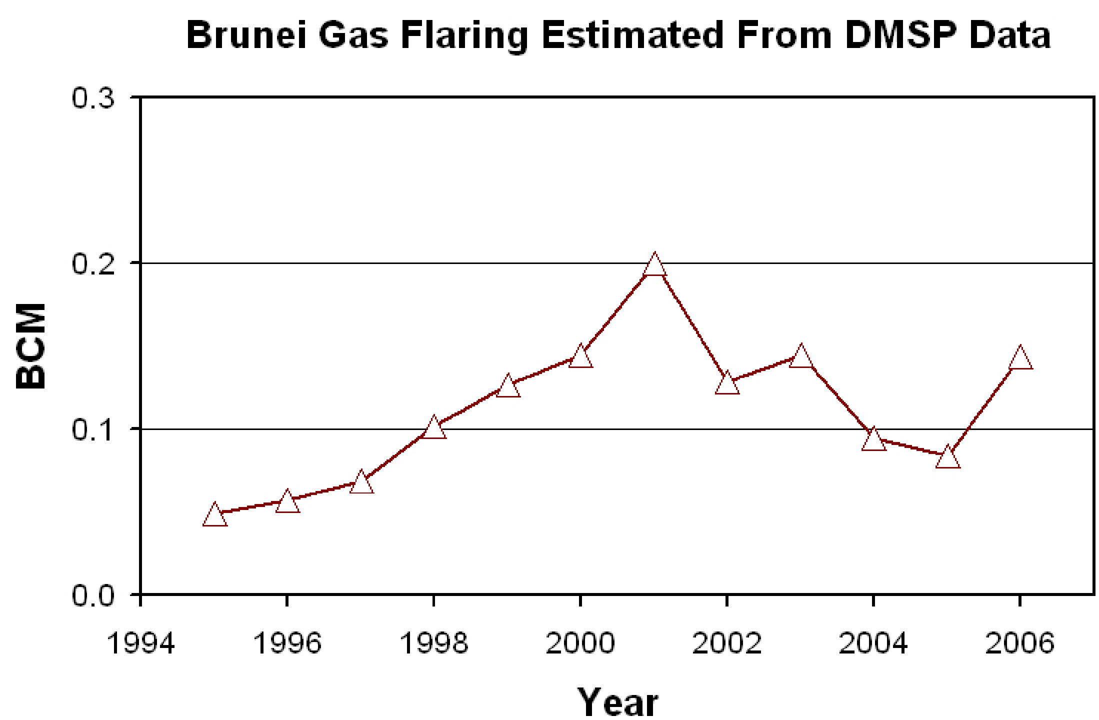

Argentina Gas Flaring Estimated From DMSP Data
BCM
1.5
1.0
0.5
0.0
1994
1996
1998
2000
2002
2004
2006
Year


Australia Gas Flaring Estimated From DMSP Data
BCM
1.5
1.0
0.5
0.0
1994
1996
1998
2000
2002
2004
2006
Year

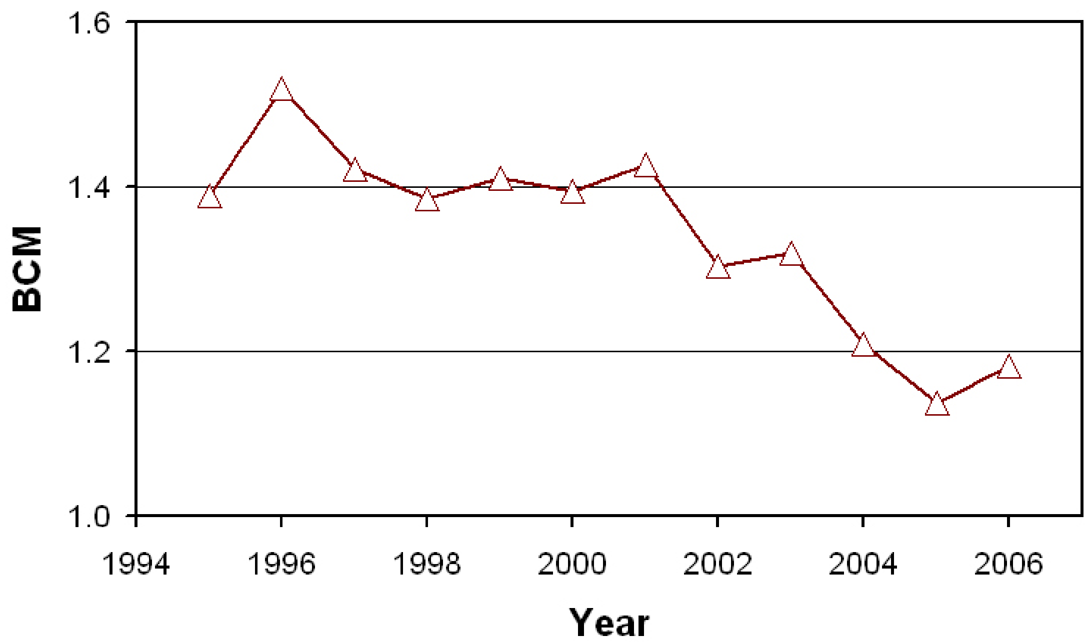

Azerbaijan Gas Flaring Estimated From DMSP Data
BCM
0.3
0.2
0.1
0.0
1994
1996
1998
2000
2002
2004
2006
Year


Bolivia Gas Flaring Estimated From DMSP Data
BCM
0.9
0.6
0.3
0.0
1994
1996
1998
2000
2002
2004
2006
Year

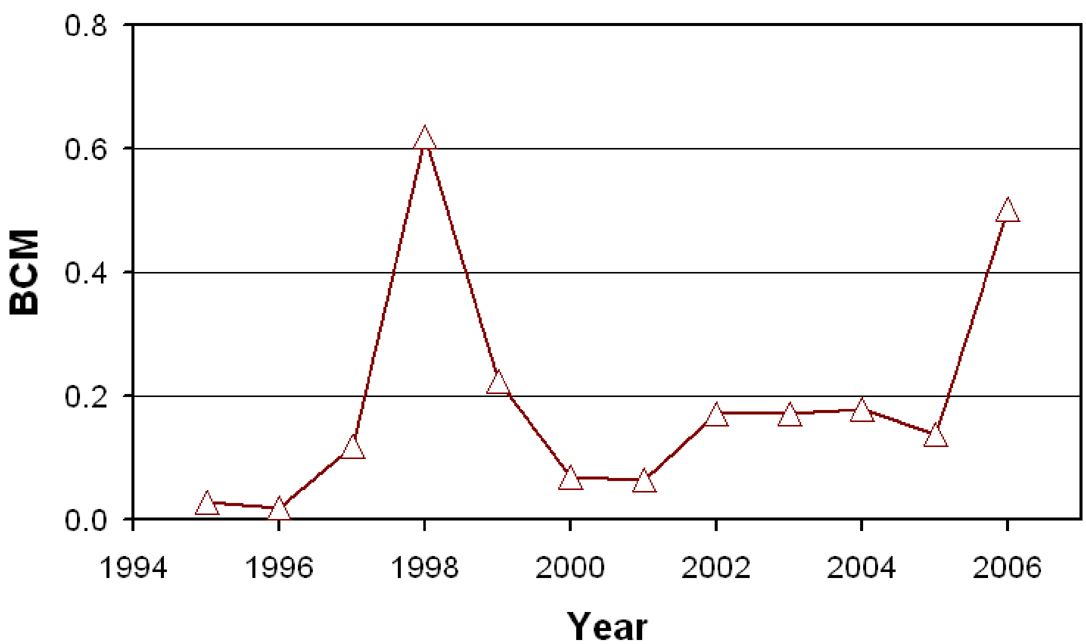

Brazil Gas Flaring Estimated From DMSP Data
BCM
1.8
1.5
1.2
0.9
0.6
0.3
0.0
1994
1996
1998
2000
2002
2004
2006
Year


Brunei Gas Flaring Estimated From DMSP Data
BCM
0.3
0.2
0.1
0.0
1994
1996
1998
2000
2002
2004
2006
Year

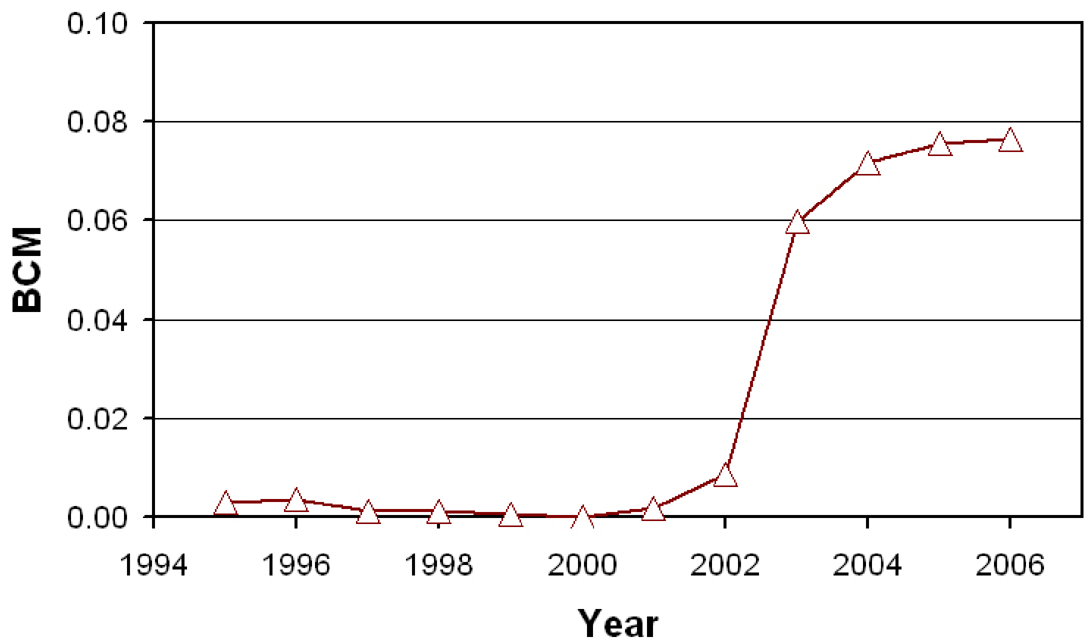
Cameroon Gas Flaring Estimated From DMSP Data



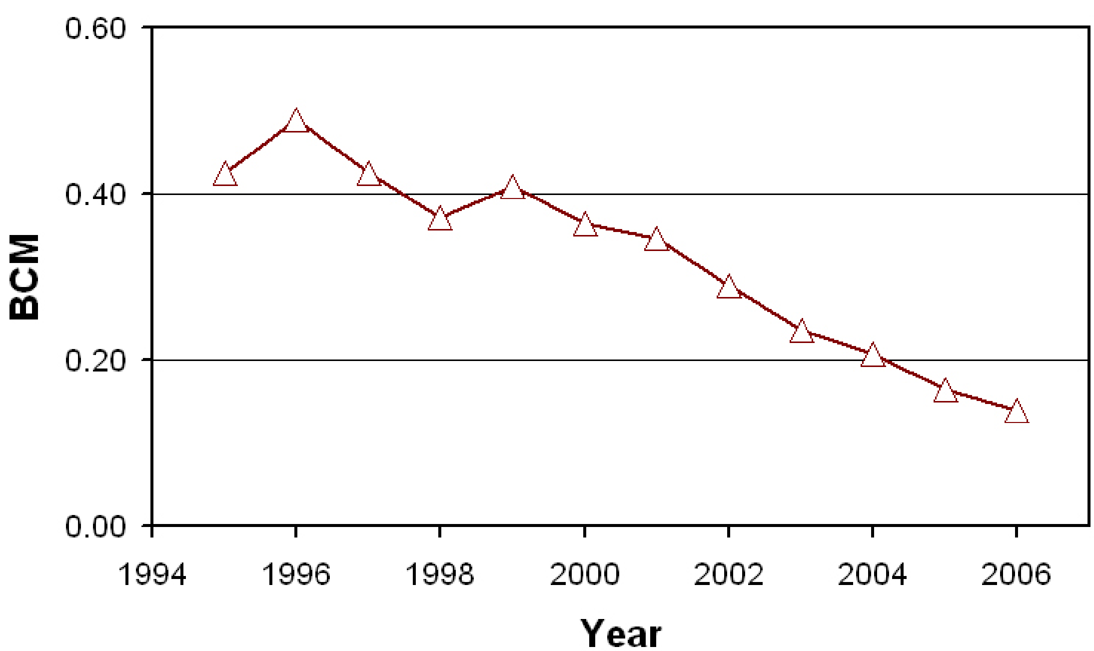
Canada Offshore Gas Flaring Estimated From DMSP Data

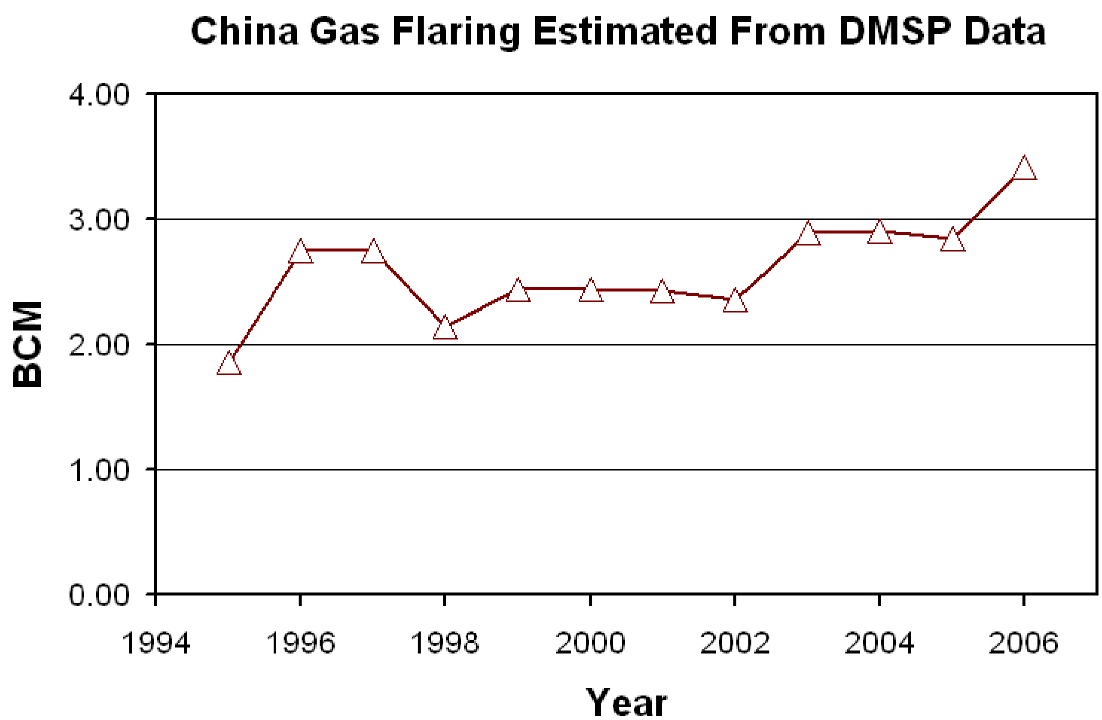


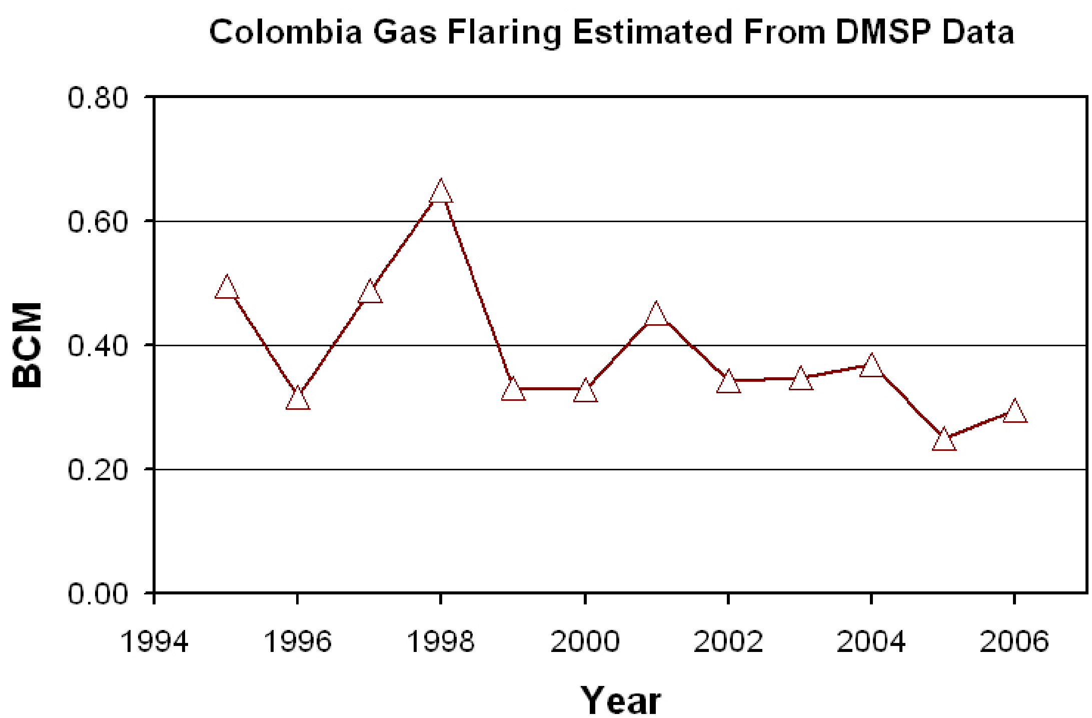
Chad Gas Flaring Estimated From DMSP Data

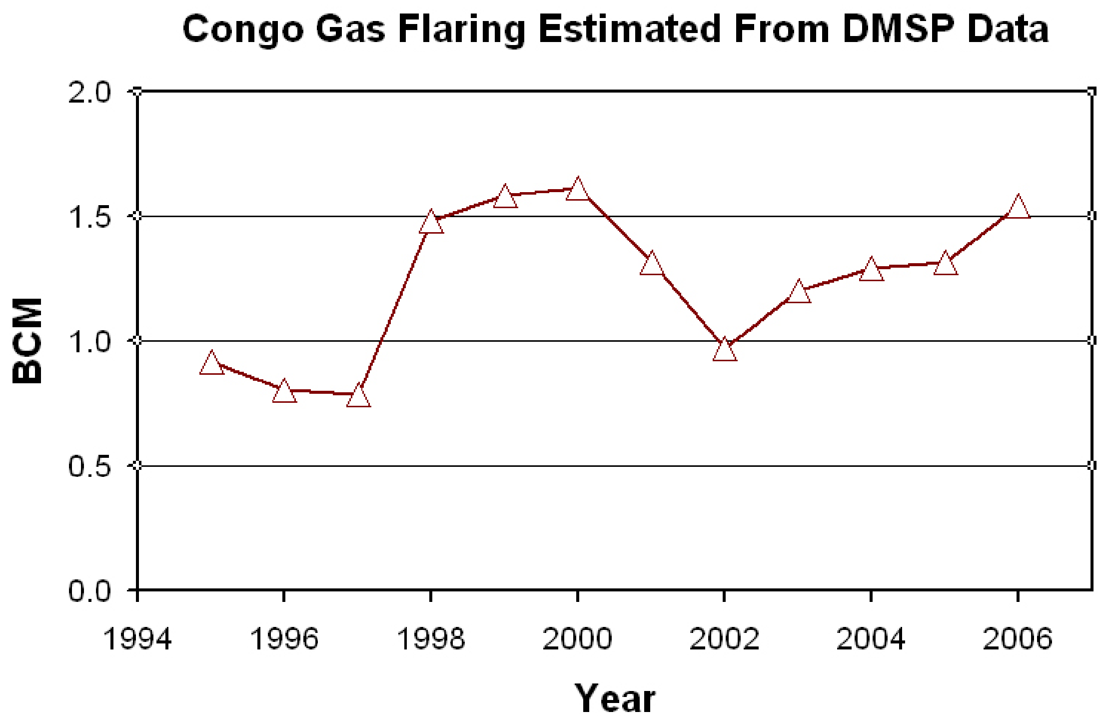


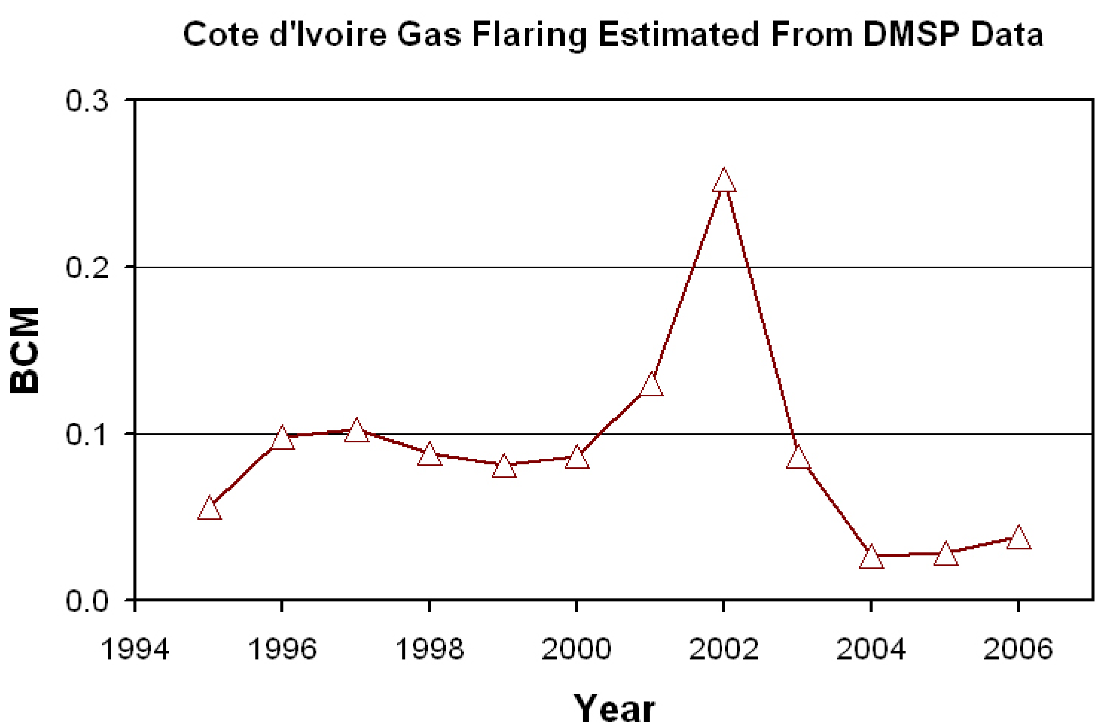
Chile Gas Flaring Estimated From DMSP Data

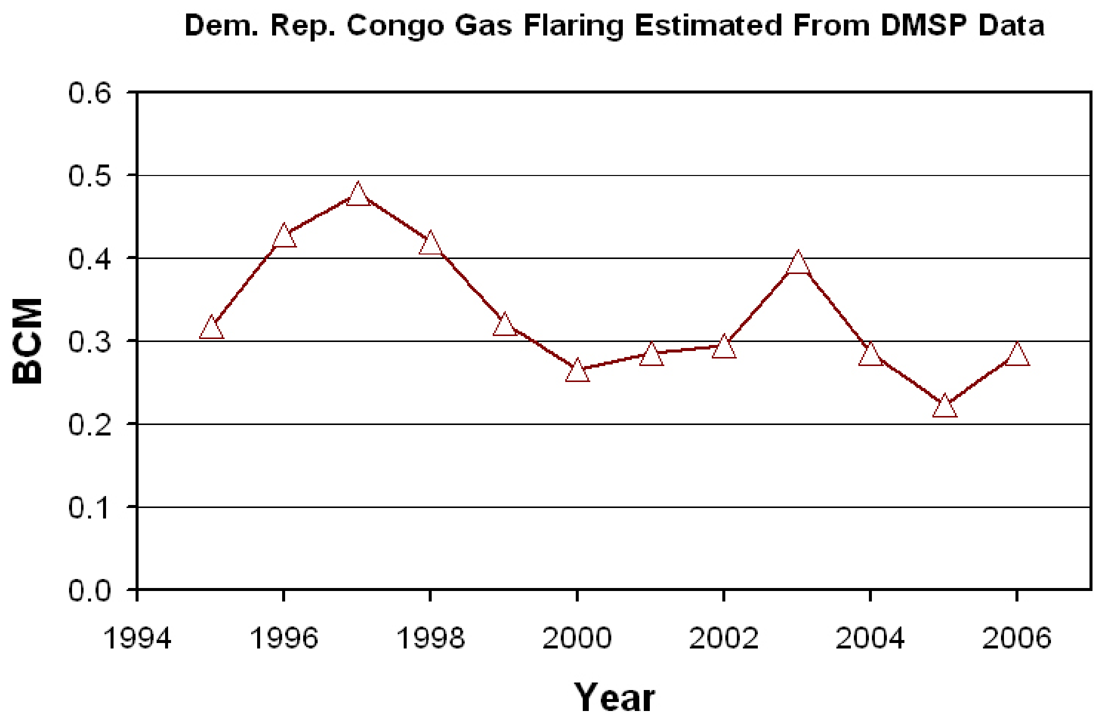



China Gas Flaring Estimated From DMSP Data
4.00
3.00
2.00
1.00
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

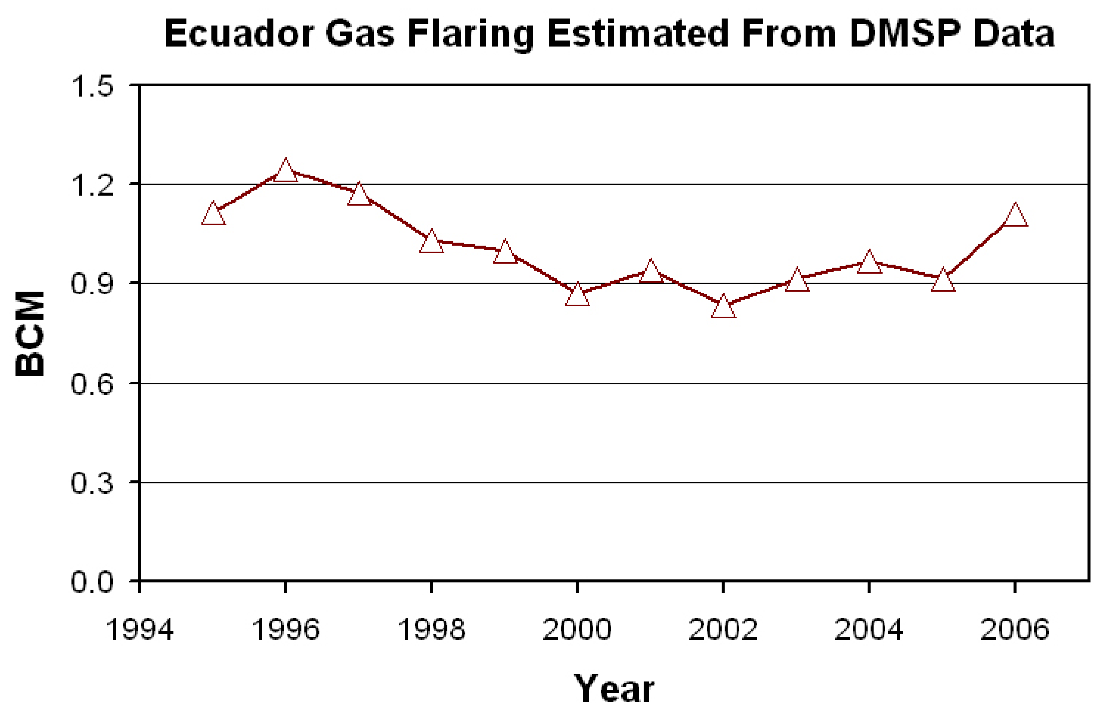

Colombia Gas Flaring Estimated From DMSP Data
0.80
0.60
0.40
0.20
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Congo Gas Flaring Estimated From DMSP Data
BCM
2.0
1.5
1.0
0.5
0.0
1994
1996
1998
2000
2002
2004
2006
Year

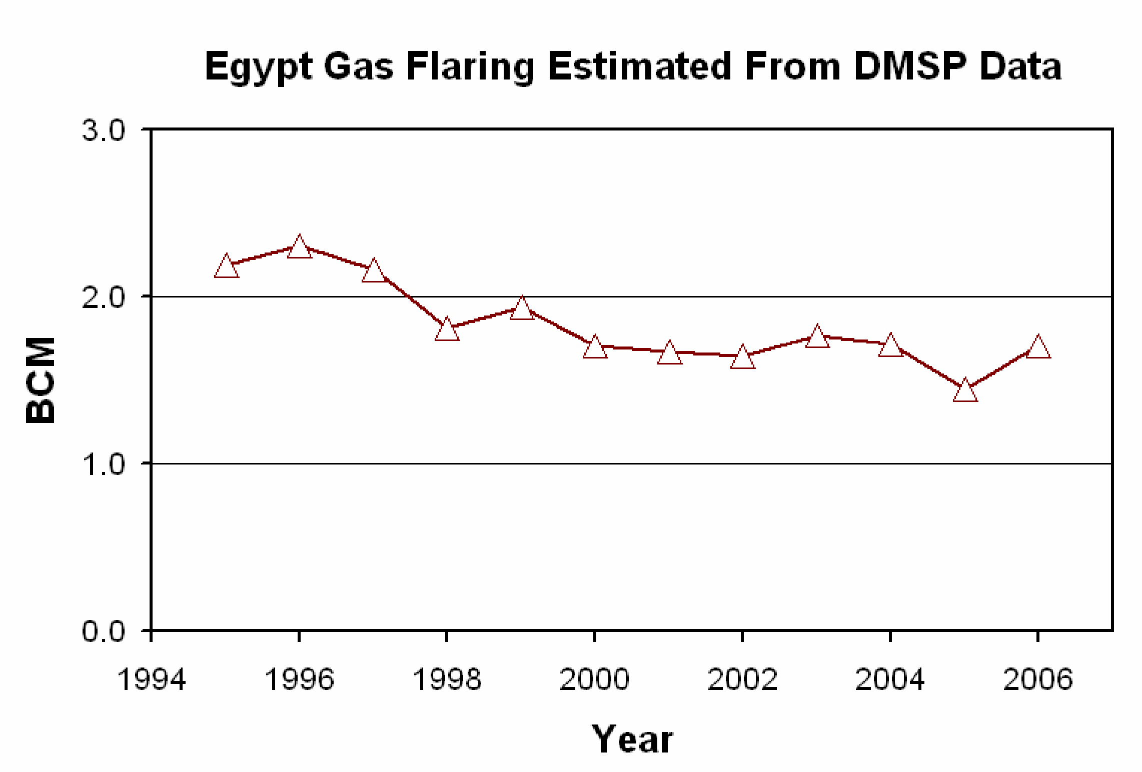

Cote d'Ivoire Gas Flaring Estimated From DMSP Data
BCM
0.3
0.2
0.1
0.0
1994
1996
1998
2000
2002
2004
2006
Year

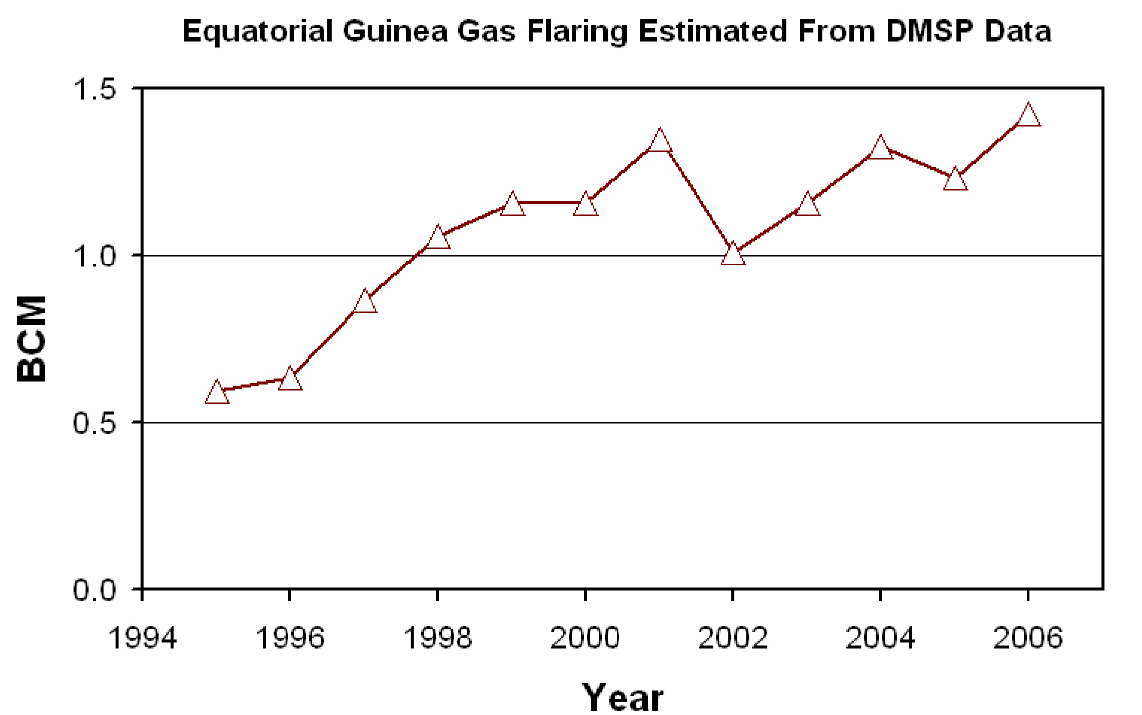


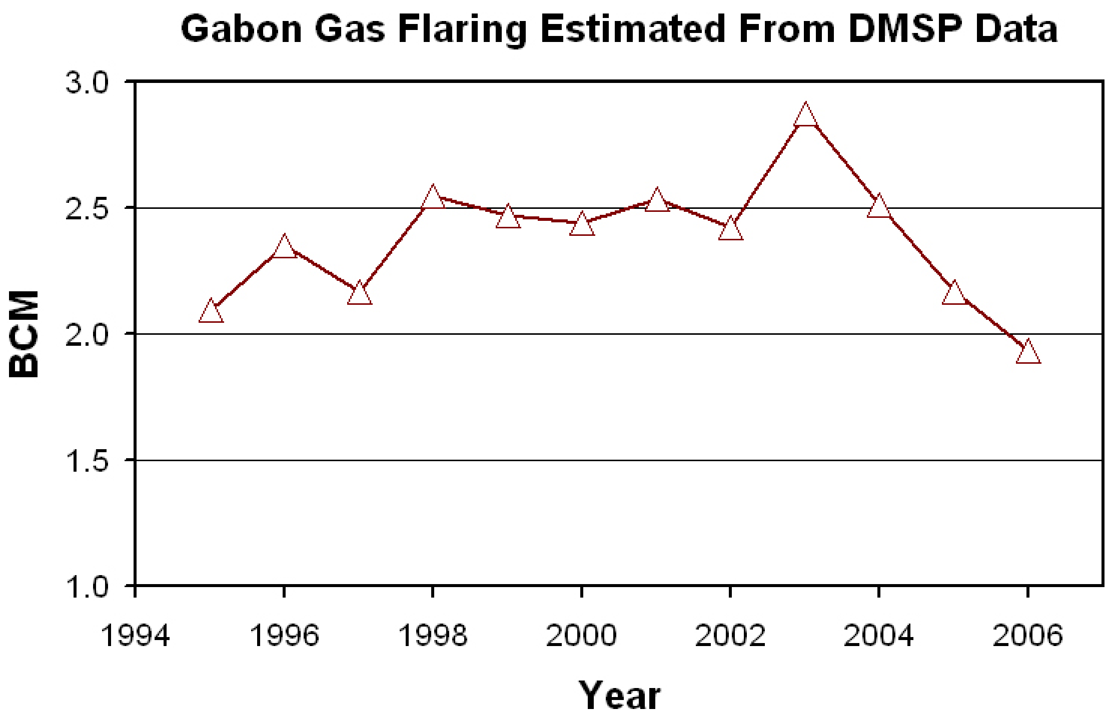
Dem. Rep. Congo Gas Flaring Estimated From DMSP Data
BCM
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1994
1996
1998
2000
2002
2004
2006
Year

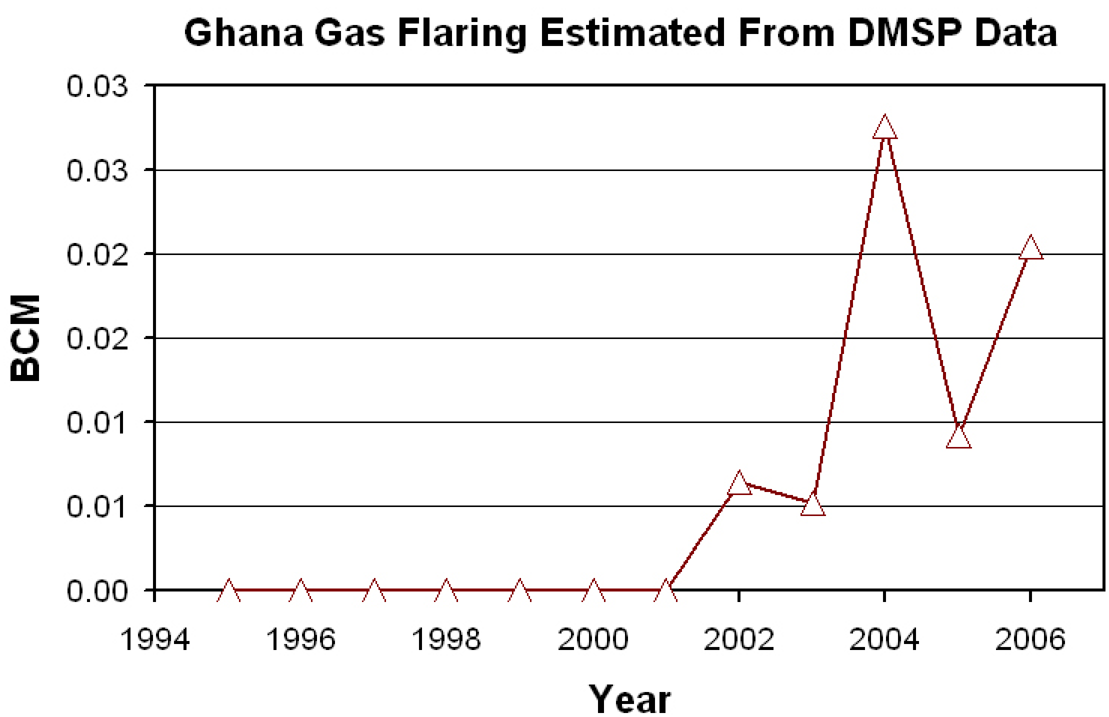


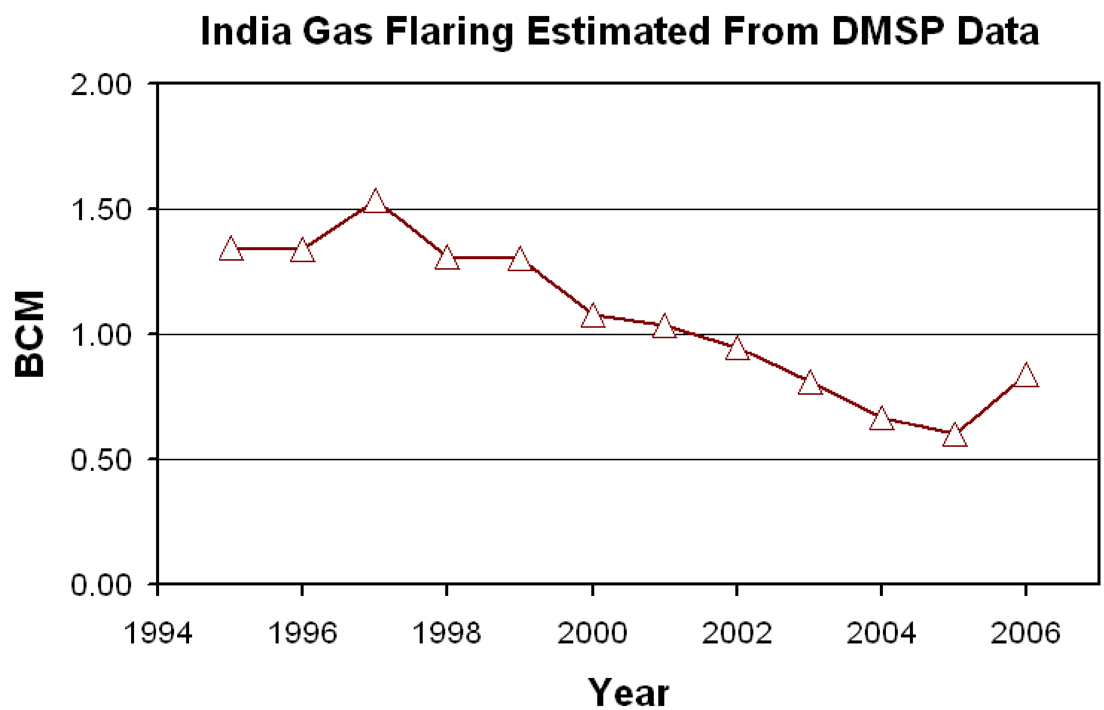
Ecuador Gas Flaring Estimated From DMSP Data
BCM
1.5
1.2
0.9
0.6
0.3
0.0
1994
1996
1998
2000
2002
2004
2006
Year

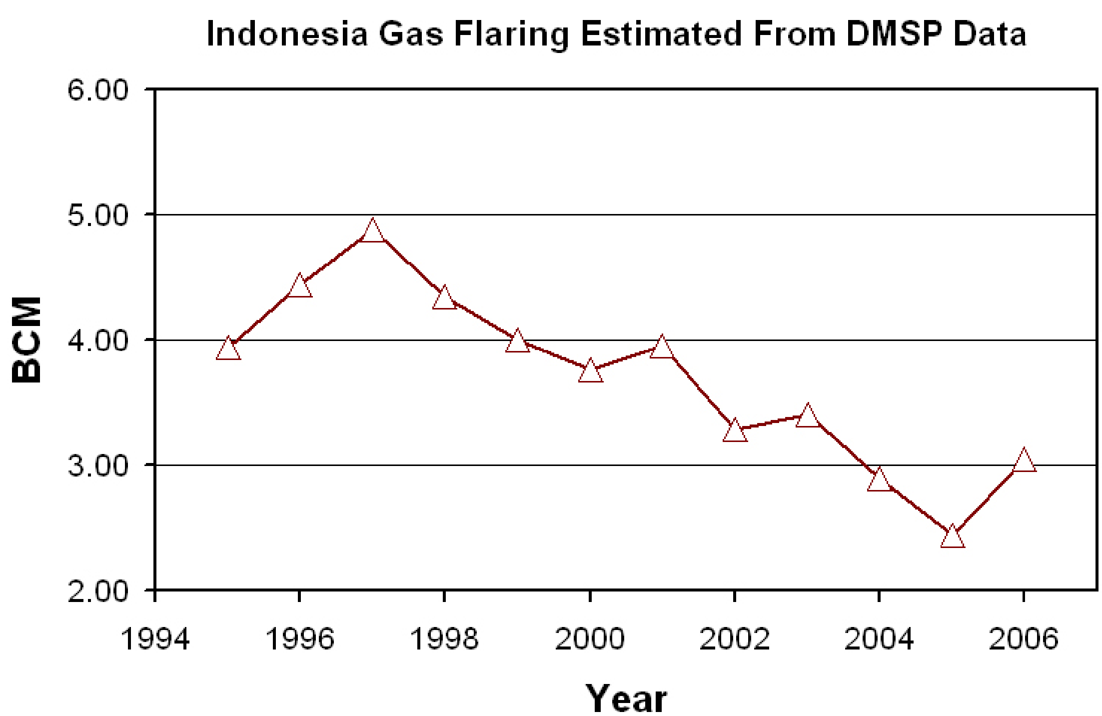

Egypt Gas Flaring Estimated From DMSP Data
BCM
3.0
2.0
1.0
0.0
1994
1996
1998
2000
2002
2004
2006
Year

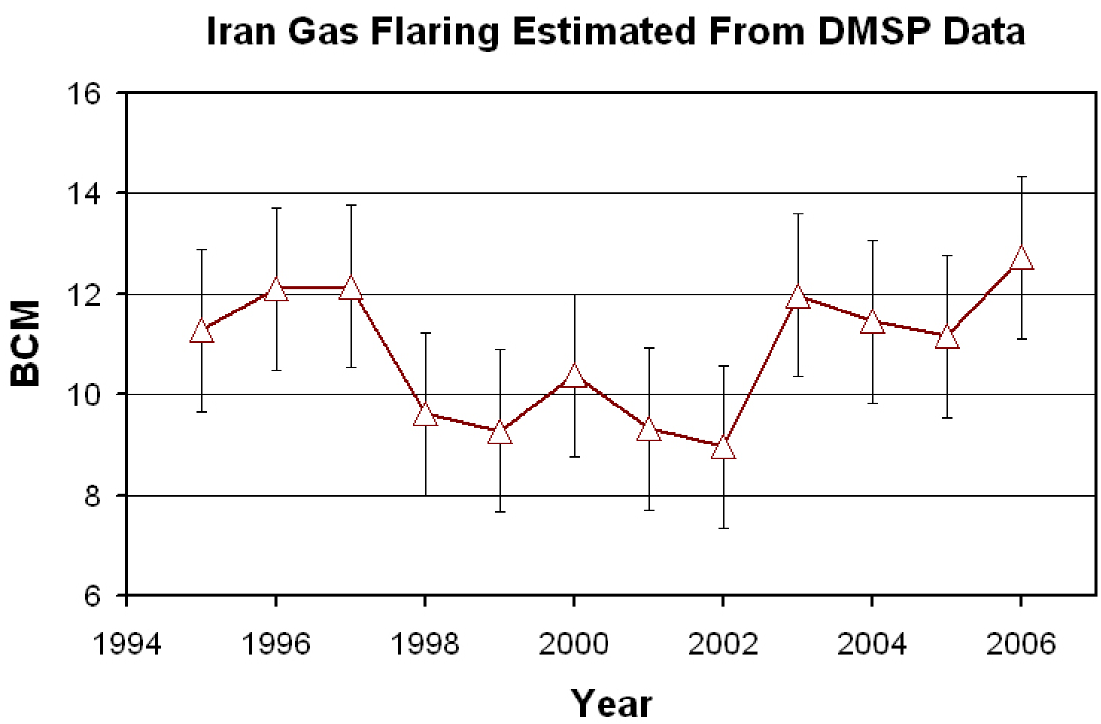

Equatorial Guinea Gas Flaring Estimated From DMSP Data
BCM
1.5
1.0
0.5
0.0
1994
1996
1998
2000
2002
2004
2006
Year

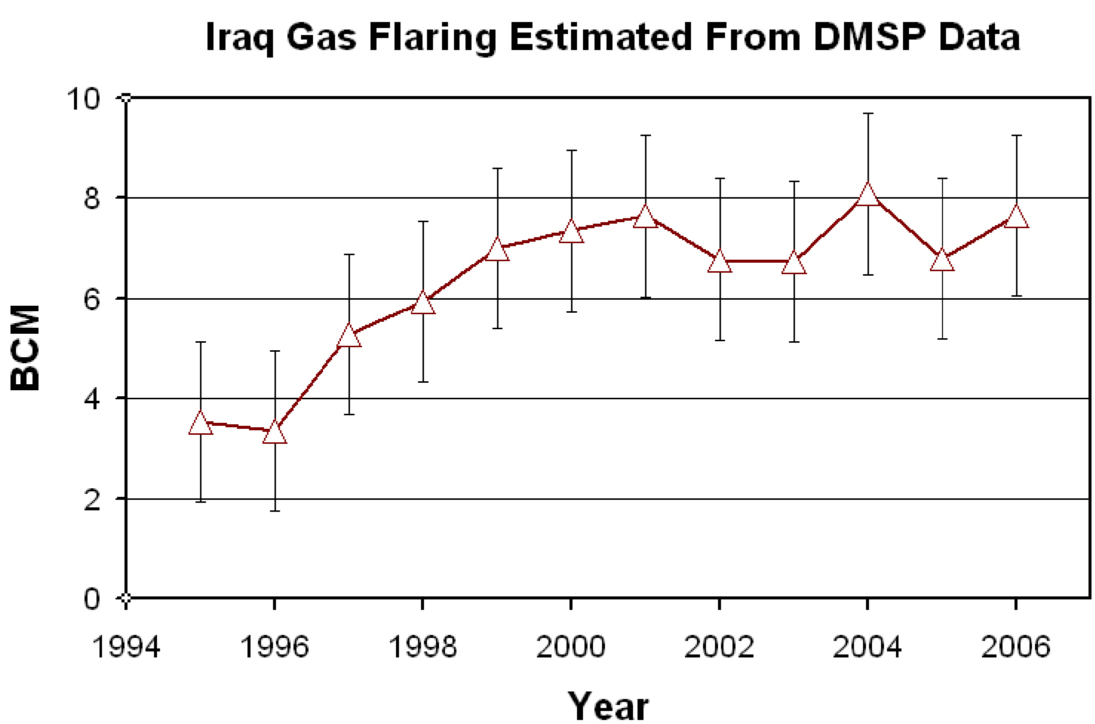

Gabon Gas Flaring Estimated From DMSP Data
BCM
3.0
2.5
2.0
1.5
1.0
1994
1996
1998
2000
2002
2004
2006
Year

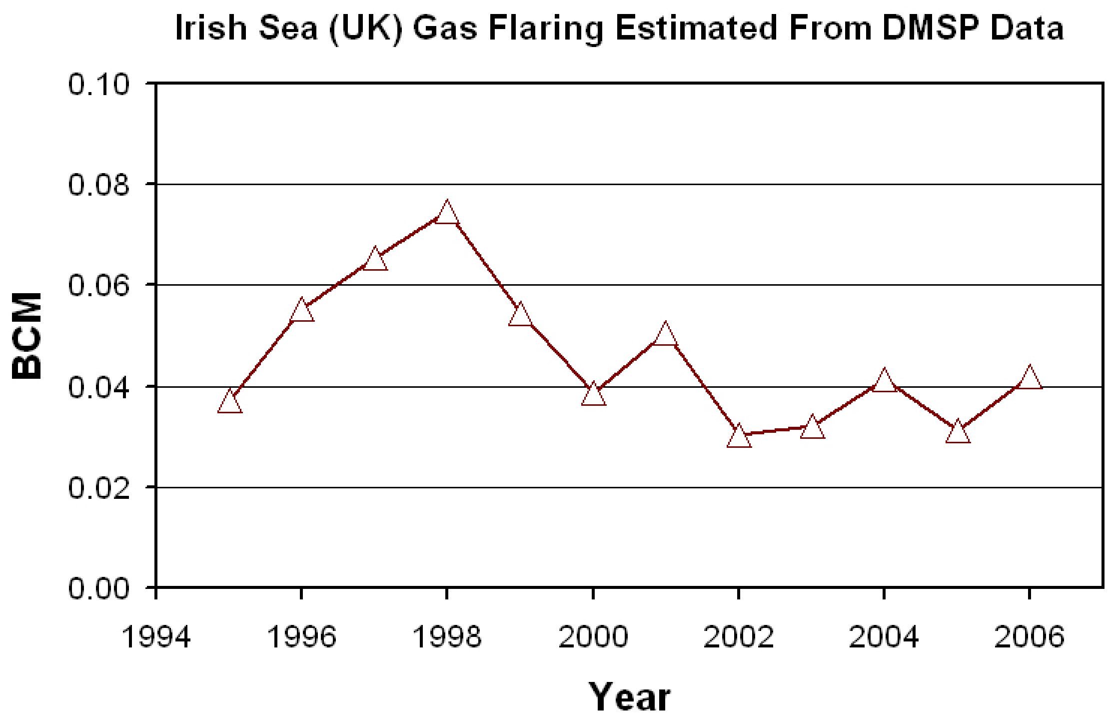

Ghana Gas Flaring Estimated From DMSP Data
BCM
0.03
0.03
0.02
0.02
0.01
0.01
0.00
1994
1996
1998
2000
2002
2004
2006
Year

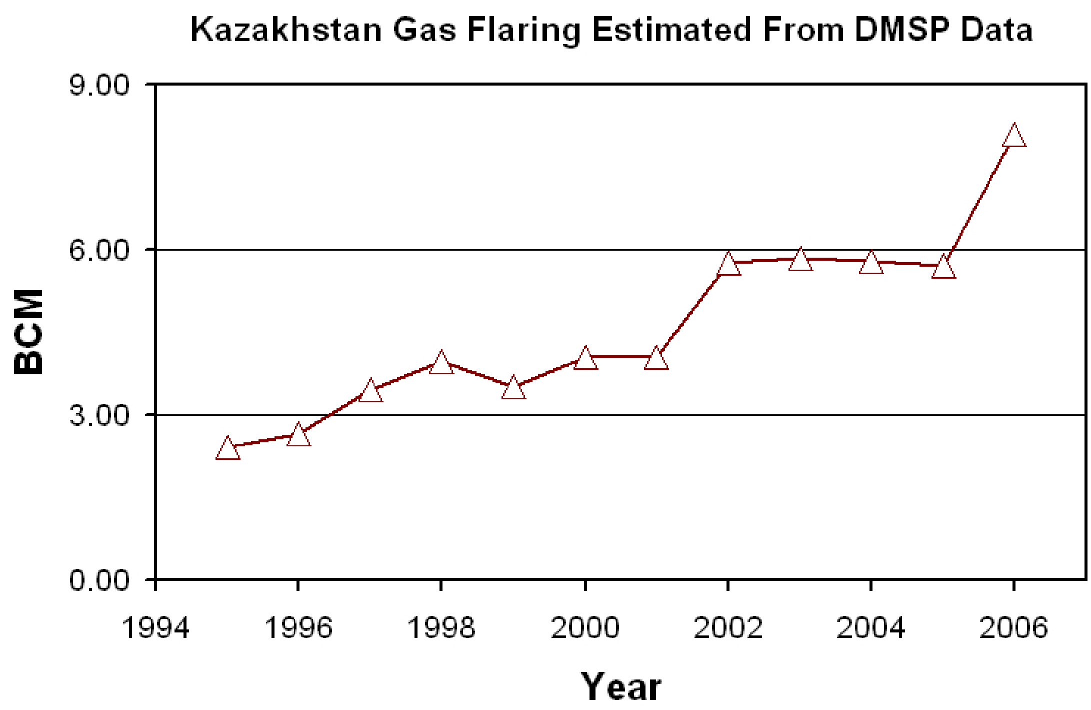

India Gas Flaring Estimated From DMSP Data
2.00
1.50
1.00
0.50
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

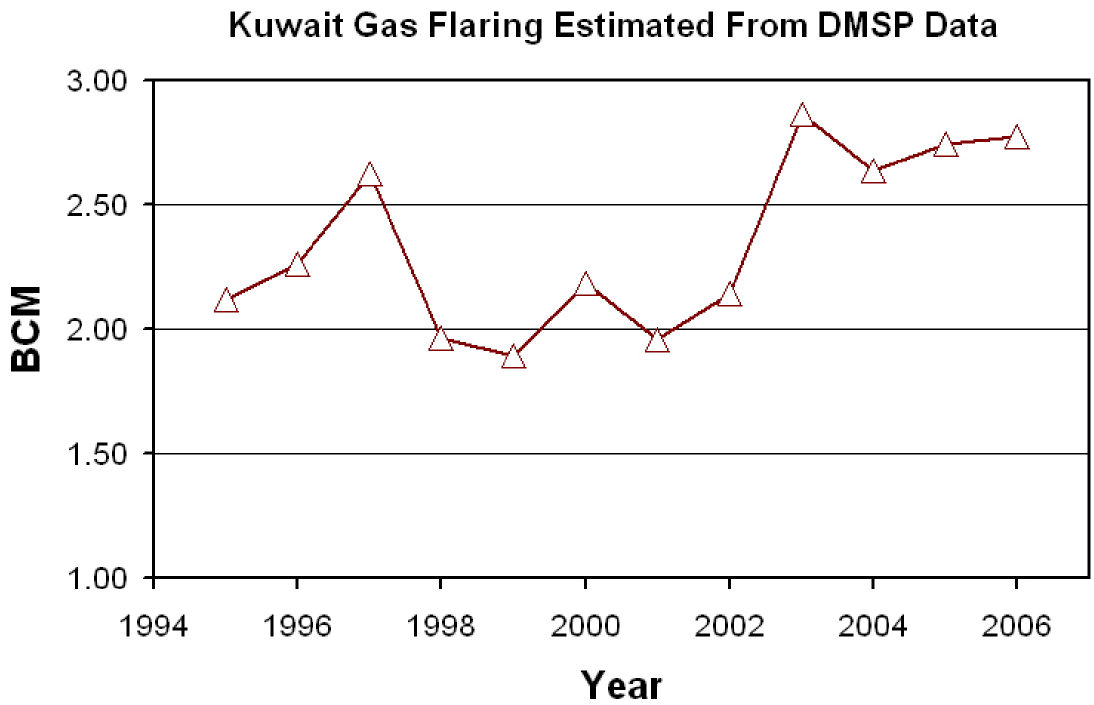

Indonesia Gas Flaring Estimated From DMSP Data
6.00
5.00
4.00
3.00
2.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

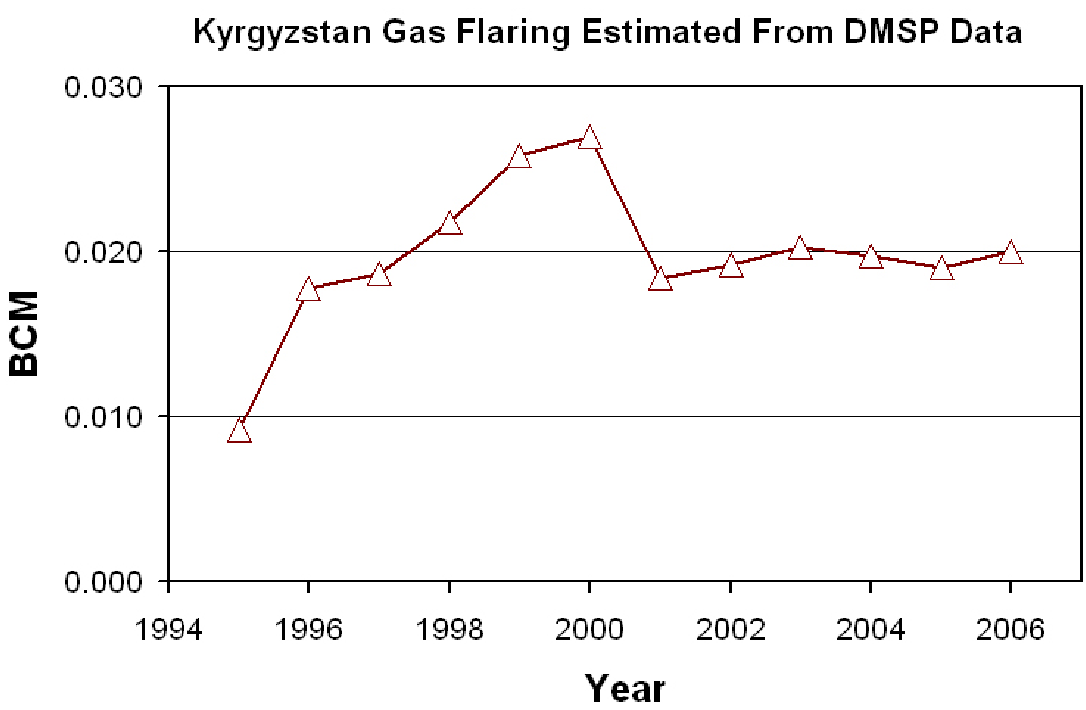

Iran Gas Flaring Estimated From DMSP Data
BCM
16
14
12
10
8
6
1994
1996
1998
2000
2002
2004
2006
Year

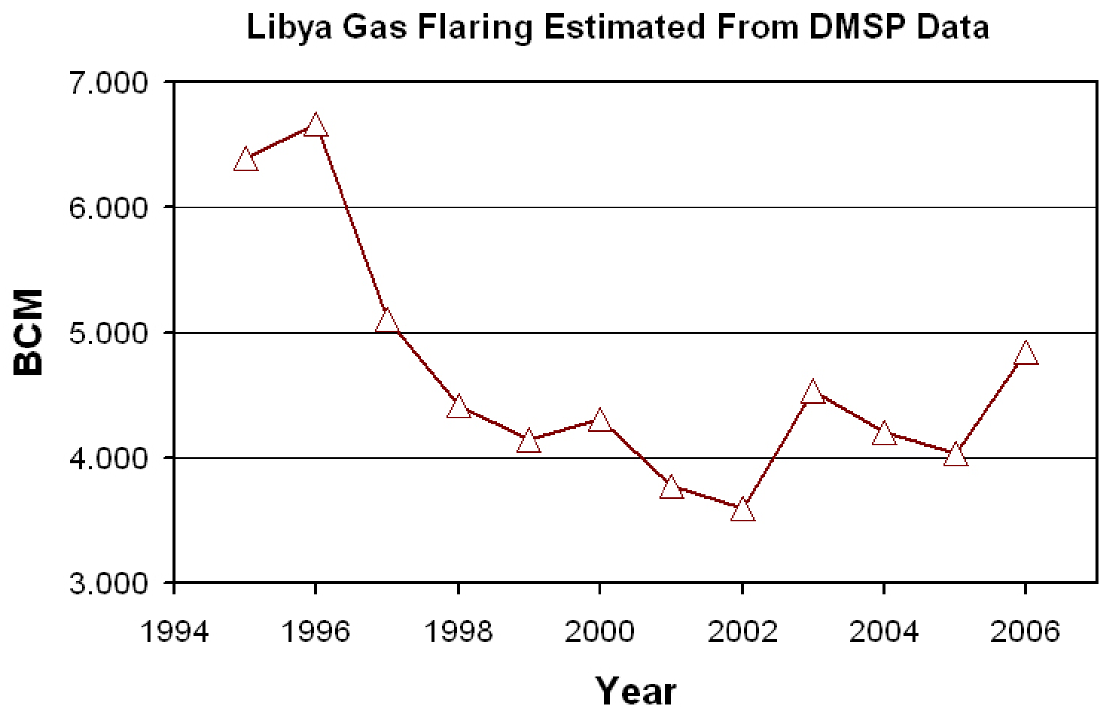

Iraq Gas Flaring Estimated From DMSP Data
BCM
10
8
6
4
2
0
1994
1996
1998
2000
2002
2004
2006
Year

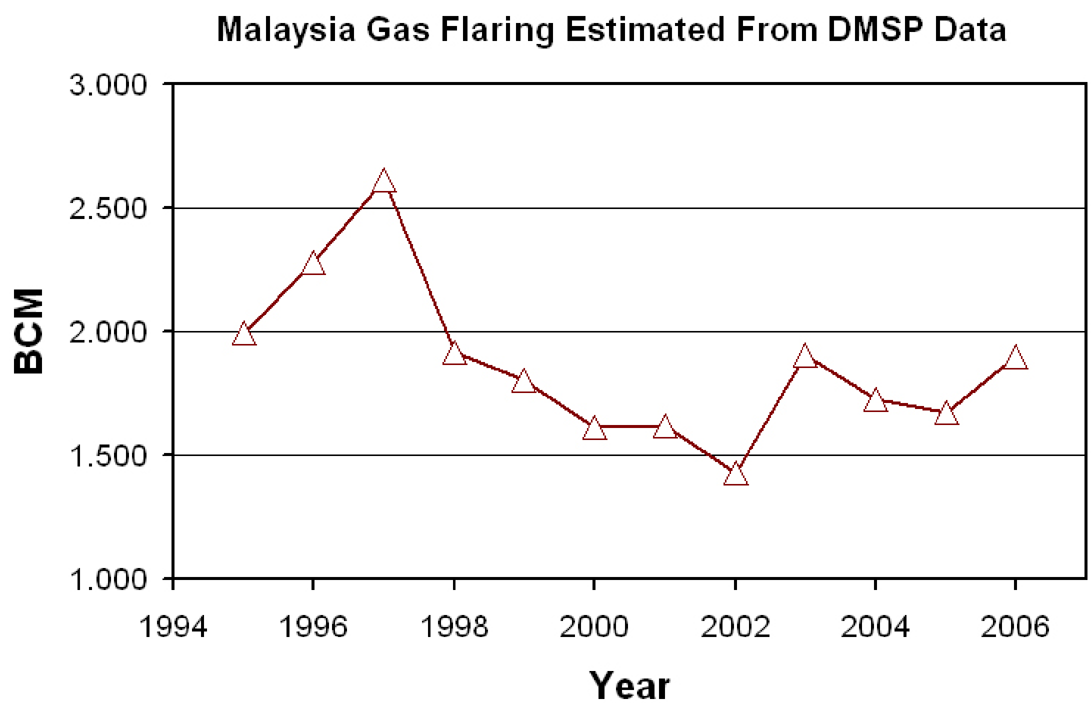

Irish Sea (UK) Gas Flaring Estimated From DMSP Data
0.10
0.08
0.06
0.04
0.02
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

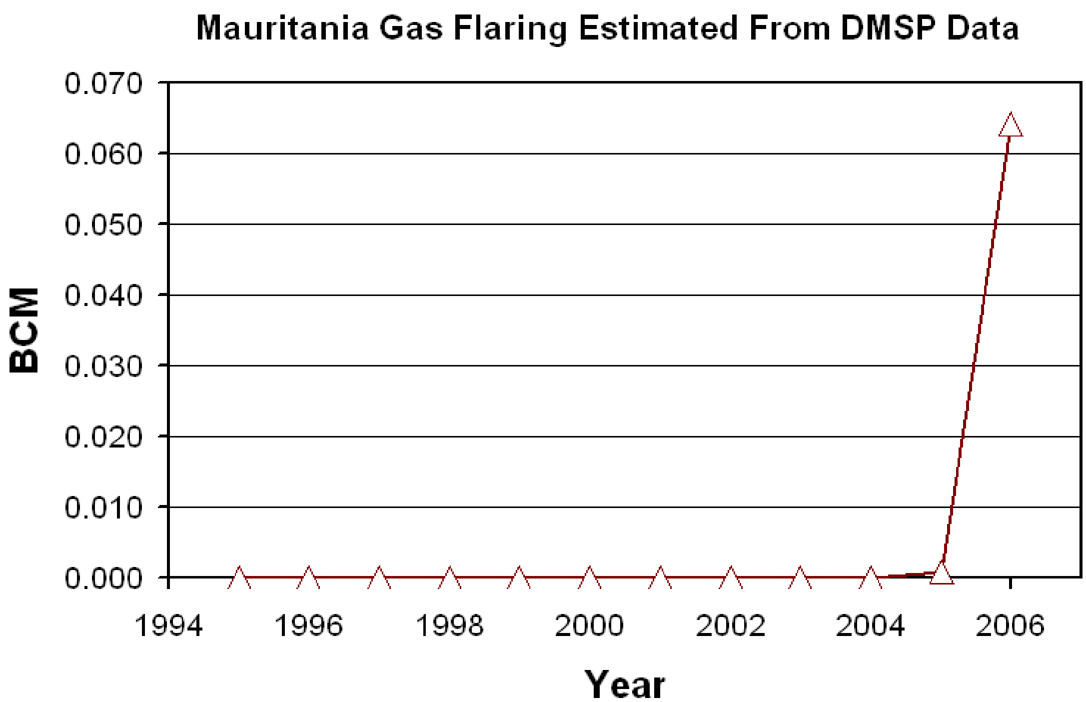

Kazakhstan Gas Flaring Estimated From DMSP Data
9.00
6.00
3.00
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Kuwait Gas Flaring Estimated From DMSP Data
3.00
2.50
2.00
1.50
1.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

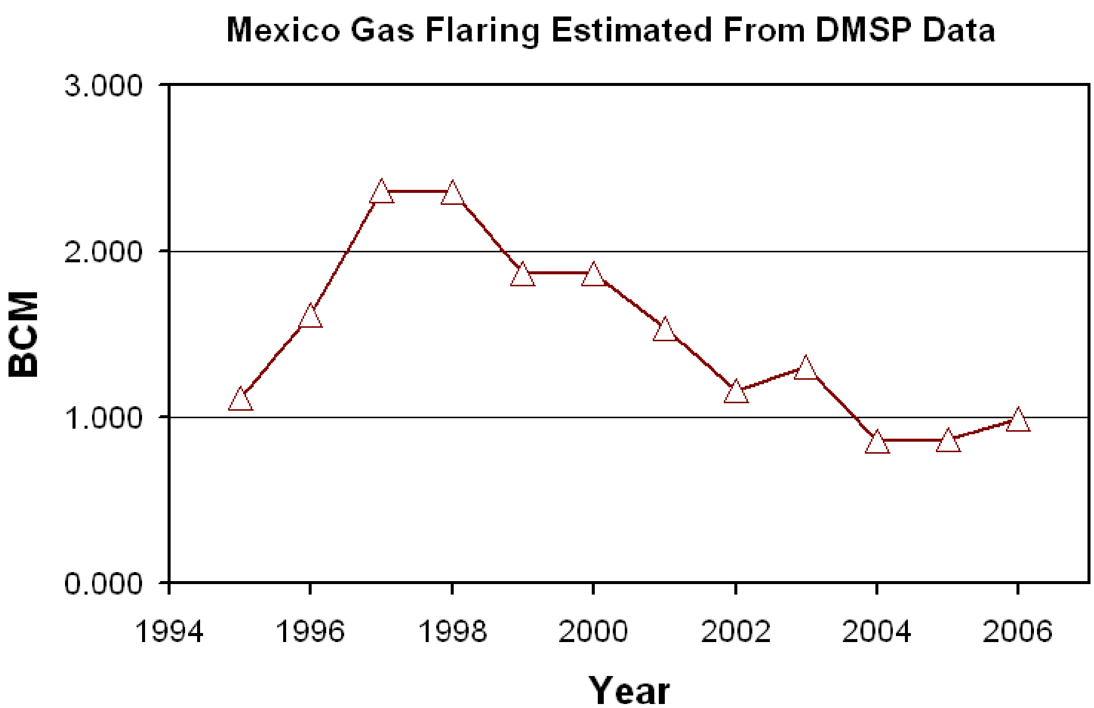

Kyrgyzstan Gas Flaring Estimated From DMSP Data
0.030
0.020
0.010
0.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Libya Gas Flaring Estimated From DMSP Data
7.000
6.000
5.000
4.000
3.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year

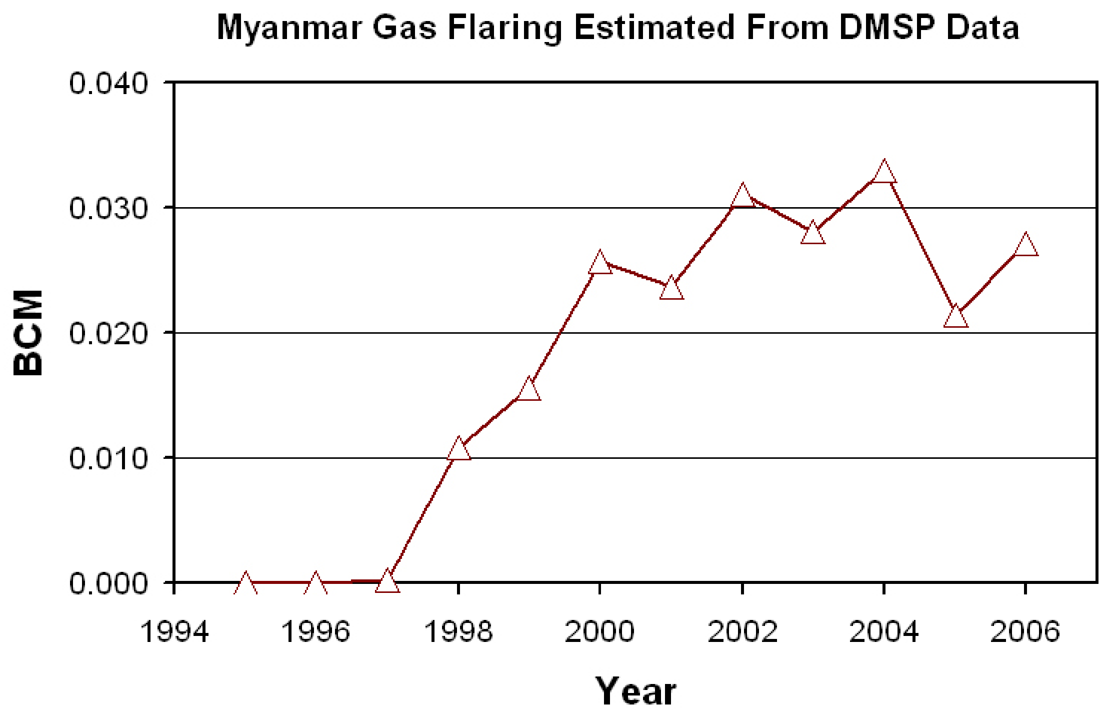

Malaysia Gas Flaring Estimated From DMSP Data
3.000
2.500
2.000
1.500
1.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year



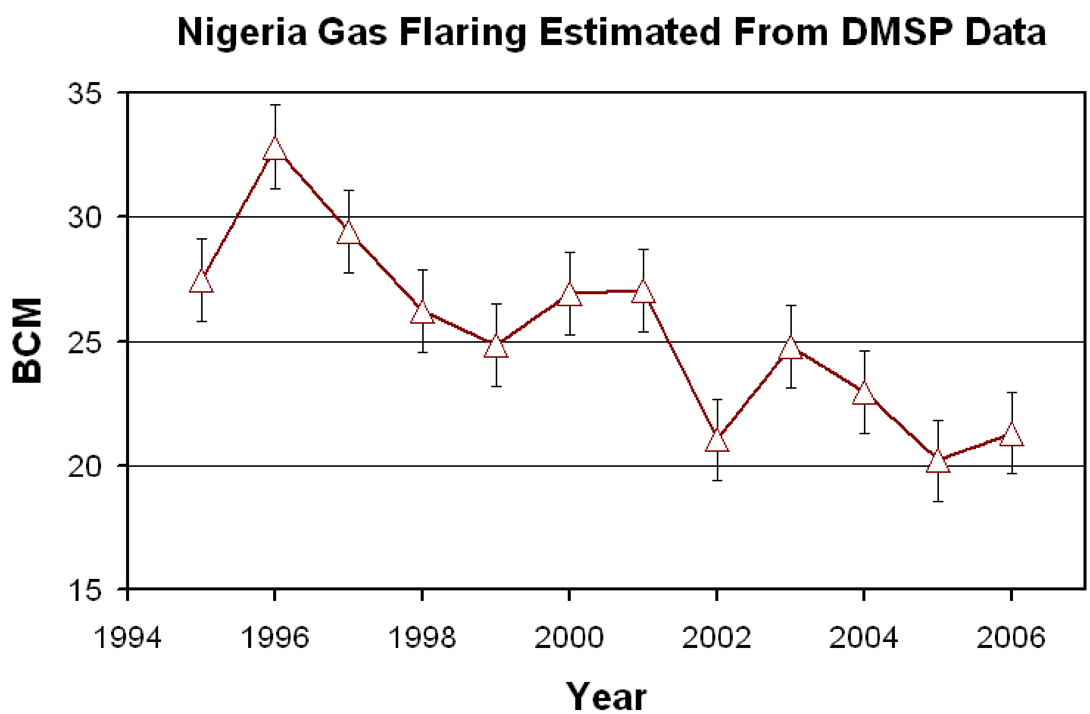
Mauritania Gas Flaring Estimated From DMSP Data
BCM
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
1994
1996
1998
2000
2002
2004
2006
Year



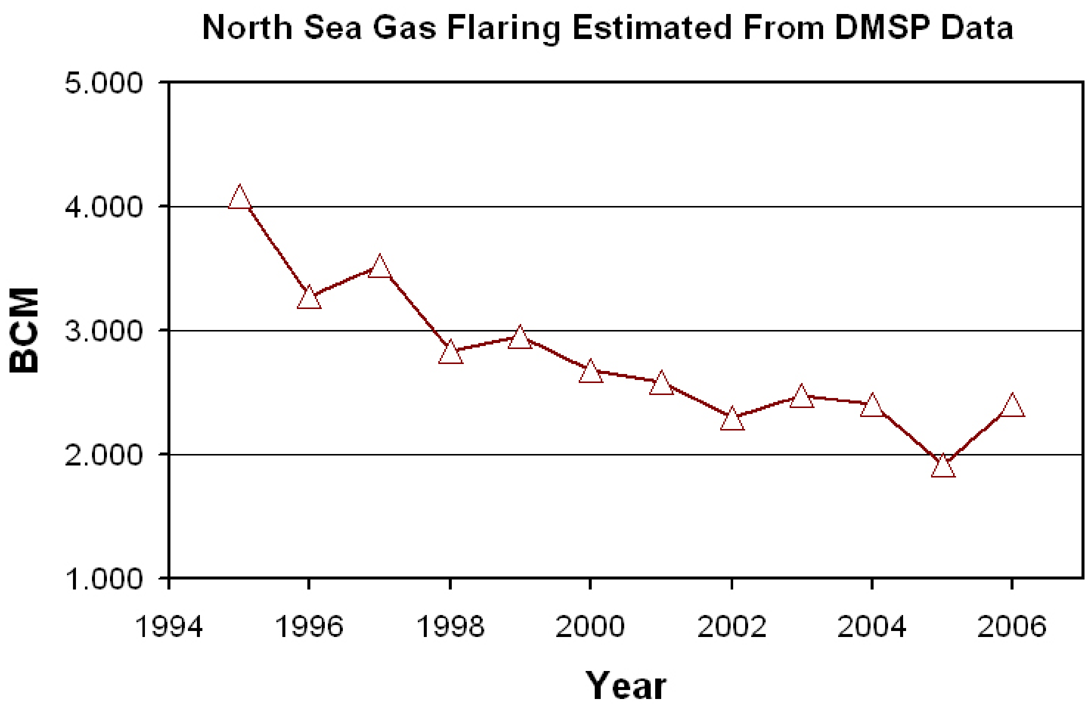
Mexico Gas Flaring Estimated From DMSP Data
BCM
3.000
2.000
1.000
0.000
1994
1996
1998
2000
2002
2004
2006
Year

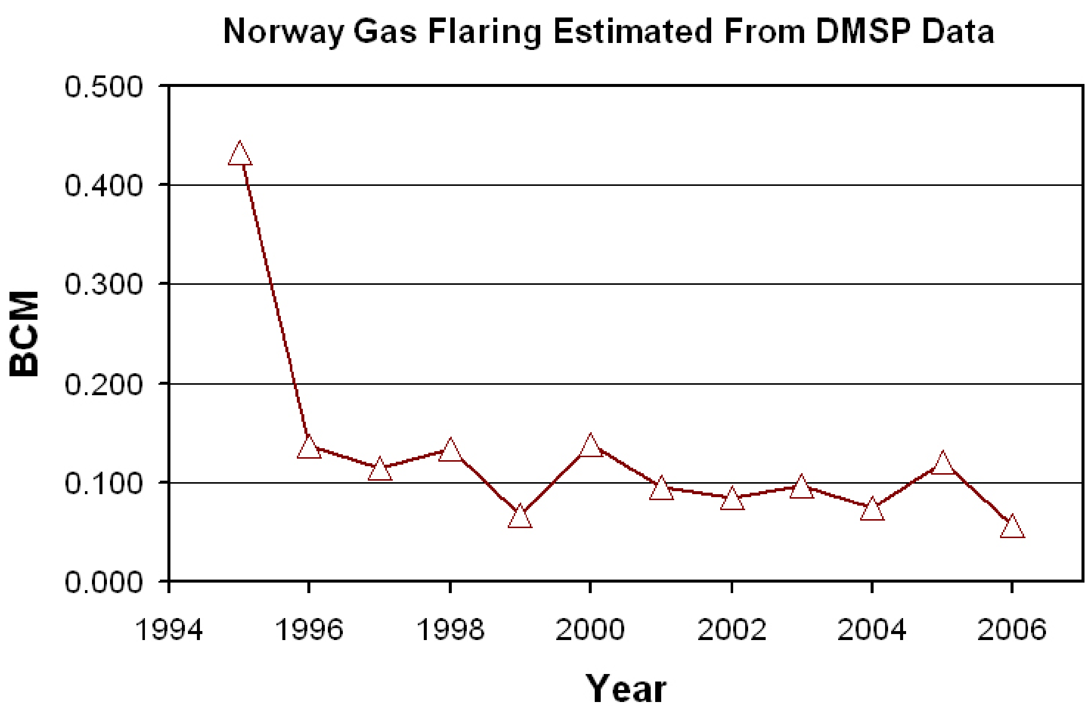


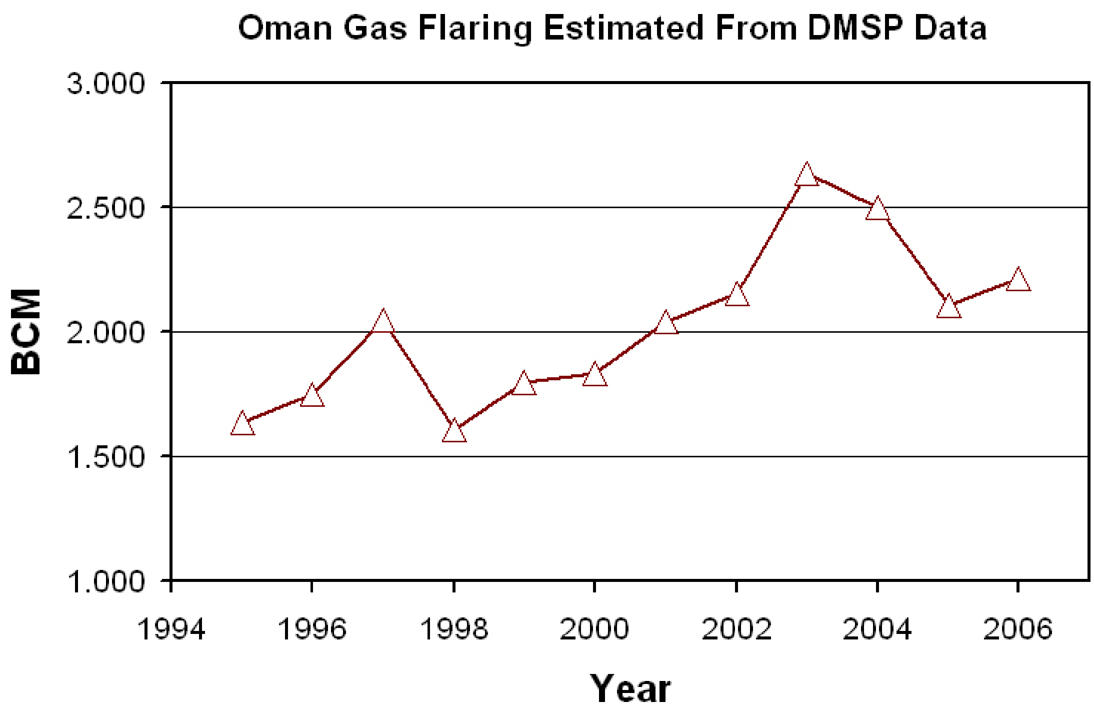
Myanmar Gas Flaring Estimated From DMSP Data
0.040
0.030
0.020
0.010
0.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year



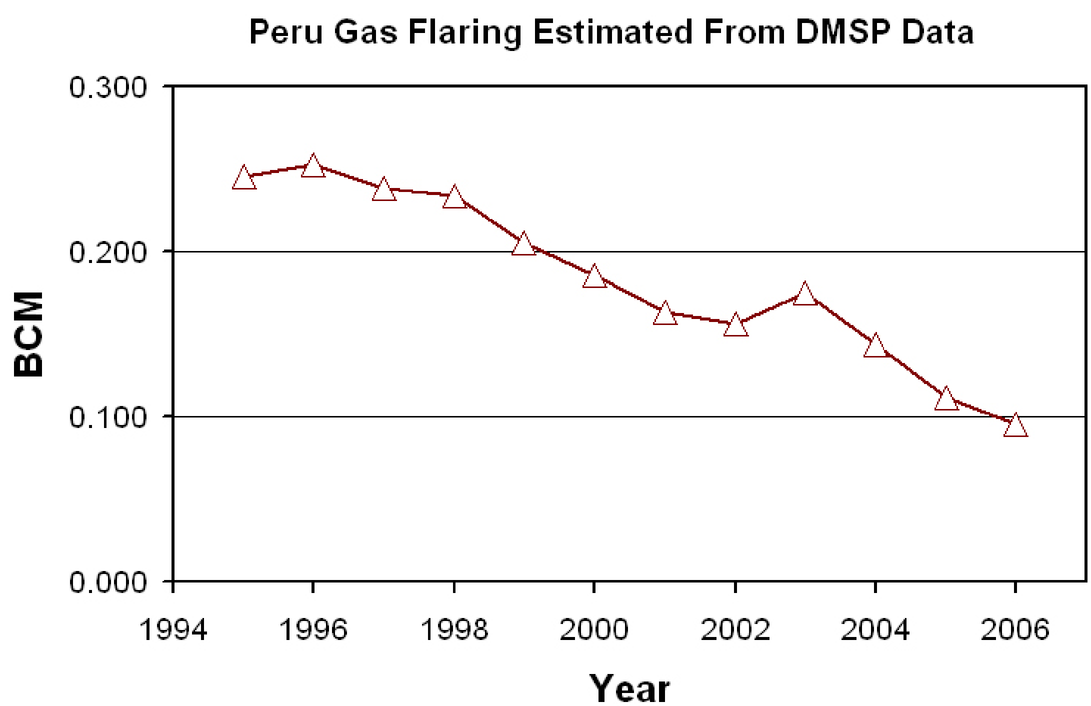
Nigeria Gas Flaring Estimated From DMSP Data
35
30
25
20
15
BCM
1994
1996
1998
2000
2002
2004
2006
Year


North Sea Gas Flaring Estimated From DMSP Data
BCM
5.000
4.000
3.000
2.000
1.000
1994
1996
1998
2000
2002
2004
2006
Year

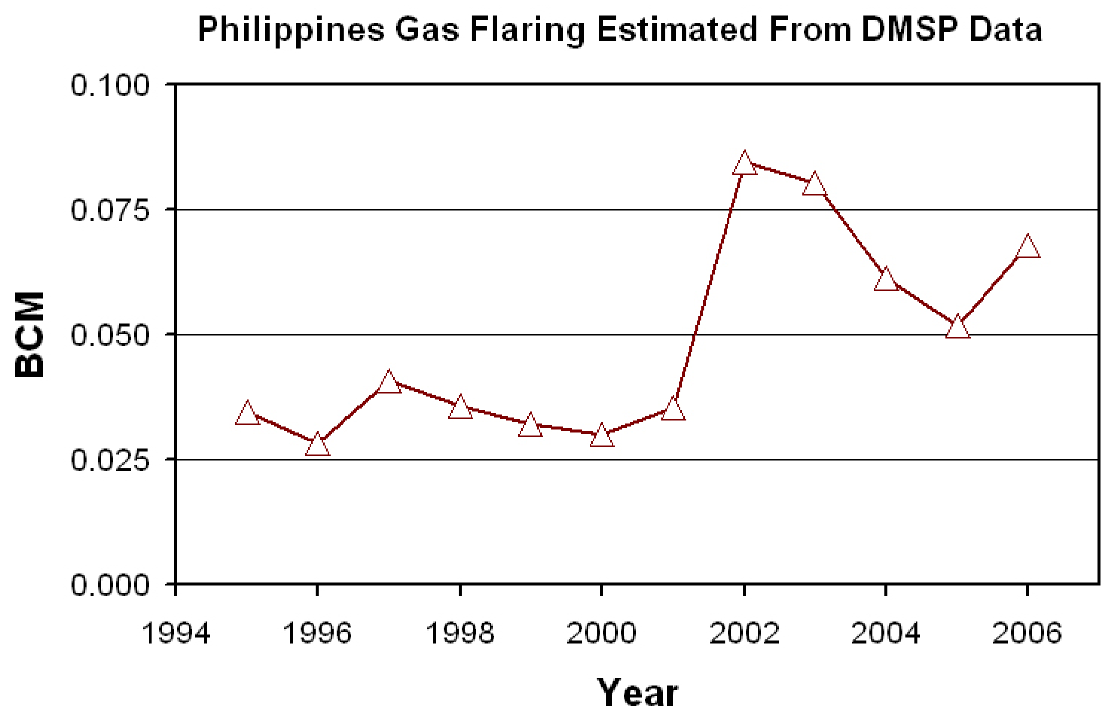

Norway Gas Flaring Estimated From DMSP Data
BCM
0.500
0.400
0.300
0.200
0.100
0.000
1994
1996
1998
2000
2002
2004
2006
Year

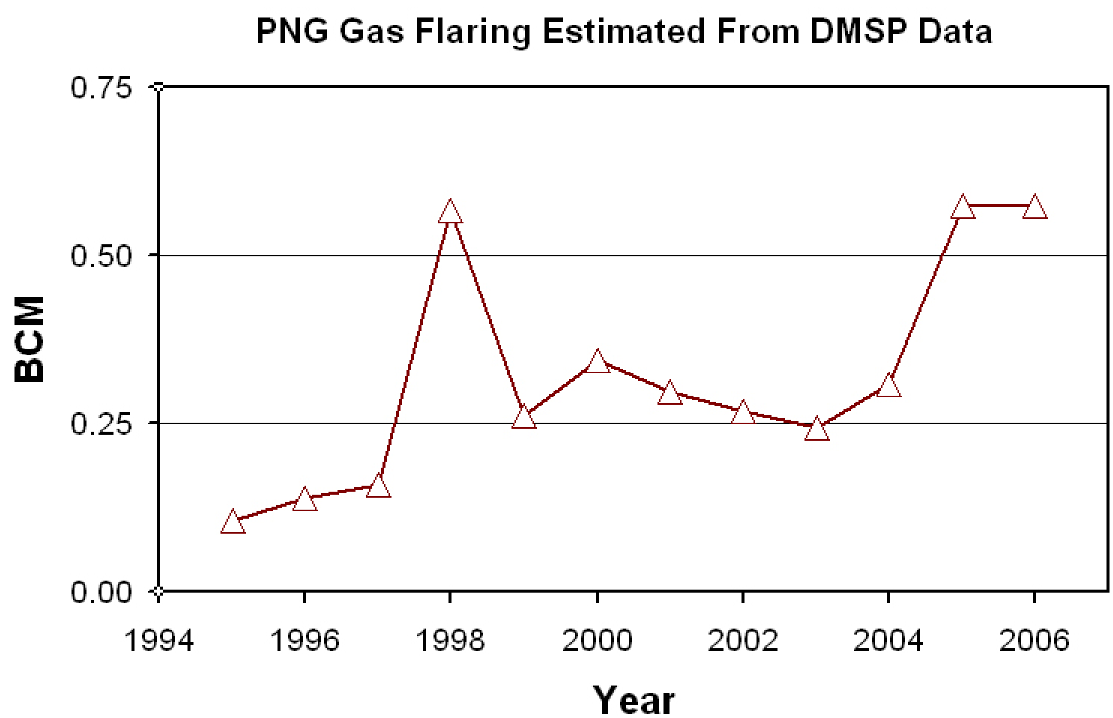


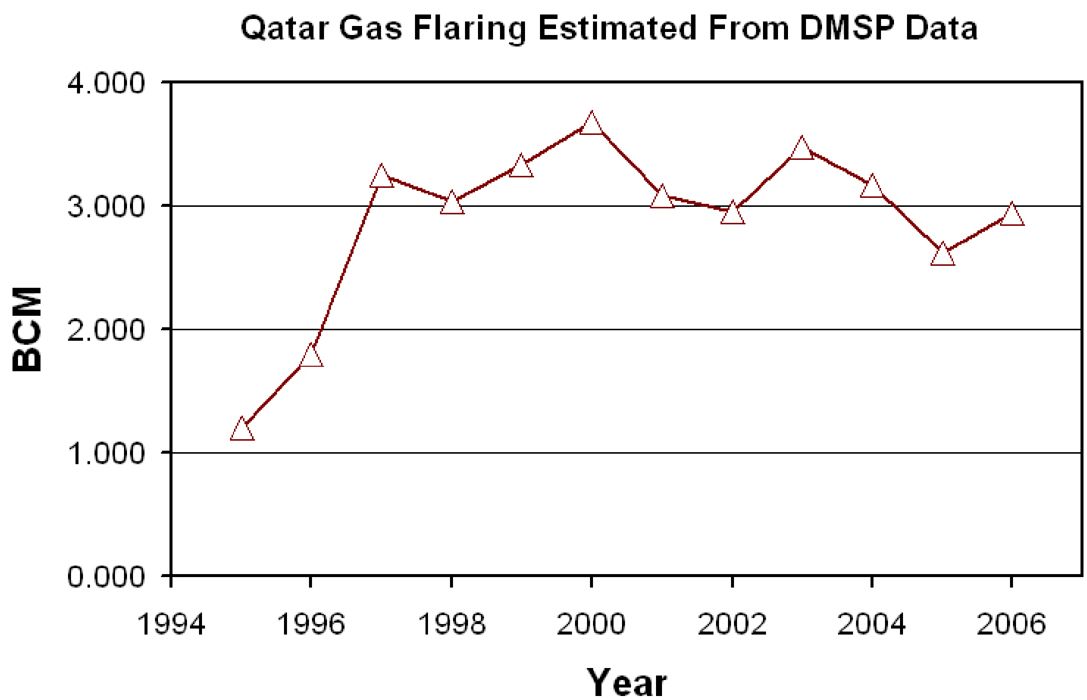
Oman Gas Flaring Estimated From DMSP Data
3.000
2.500
2.000
1.500
1.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year

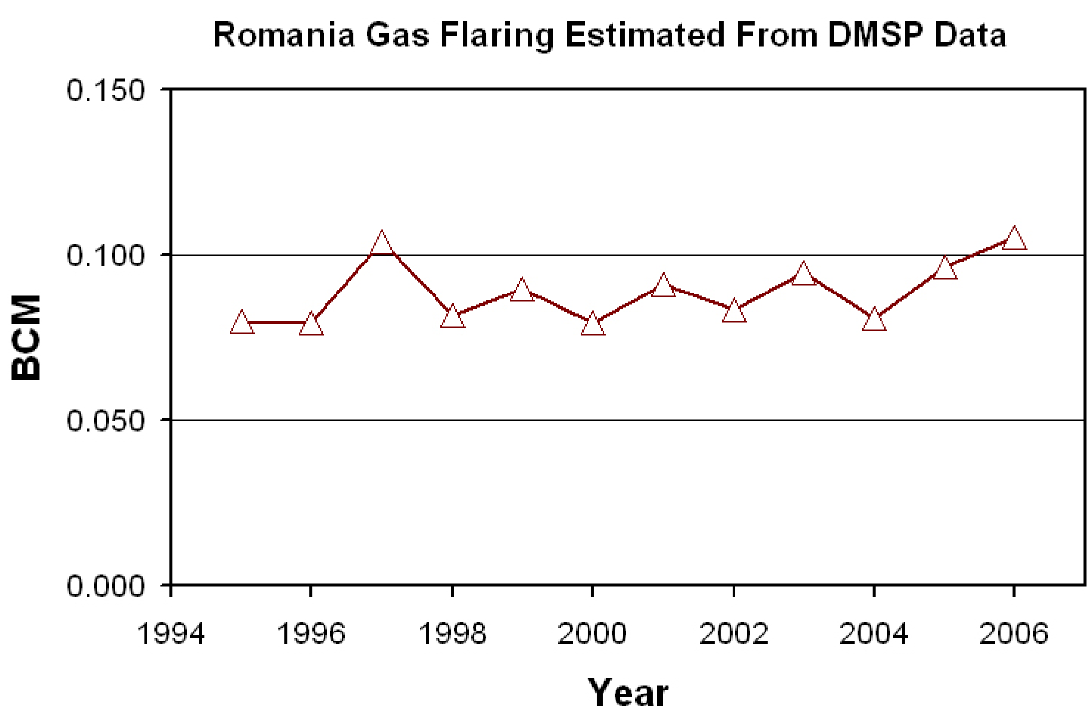


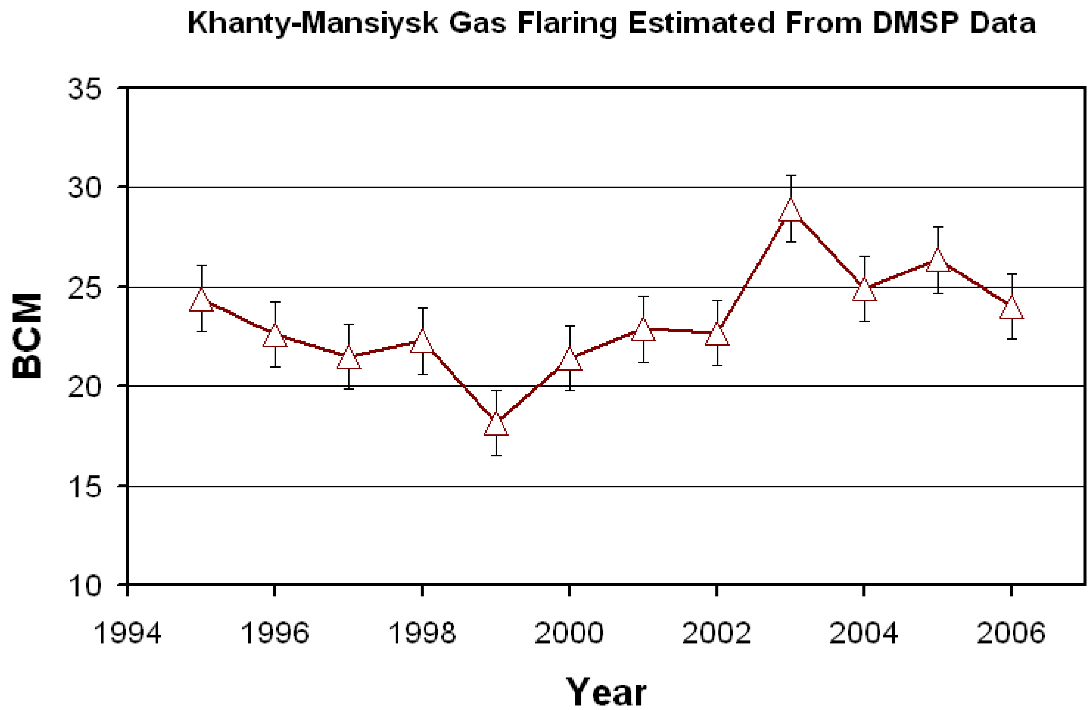
Peru Gas Flaring Estimated From DMSP Data
0.300
0.200
0.100
0.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year

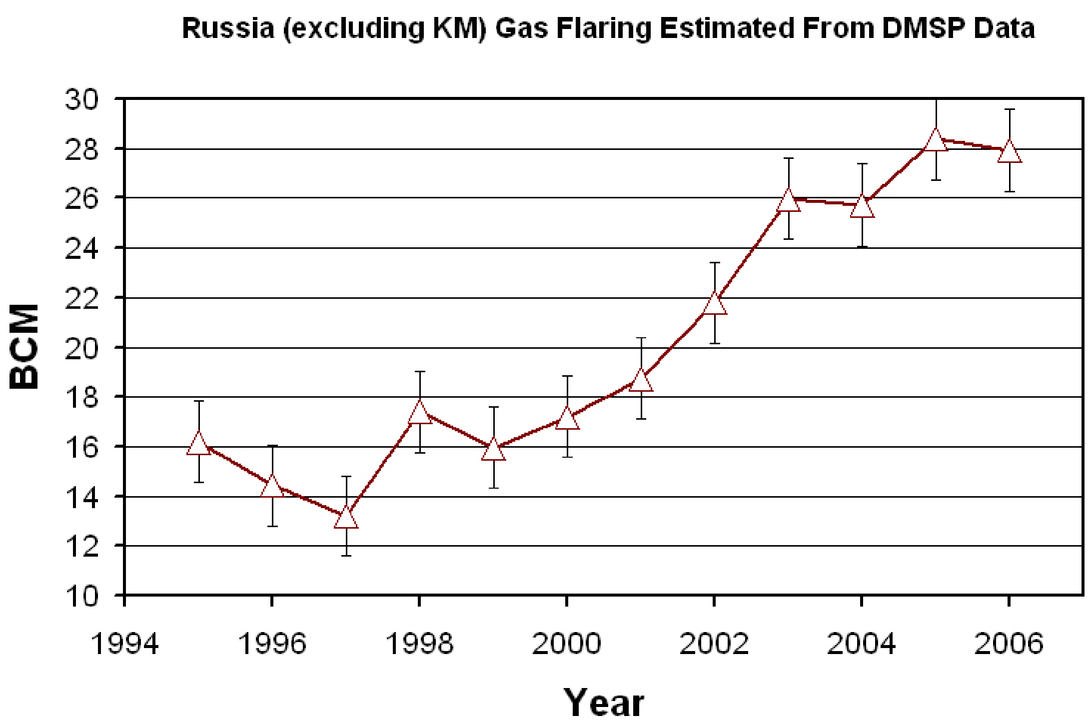

Philippines Gas Flaring Estimated From DMSP Data
0.100
0.075
0.050
0.025
0.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year

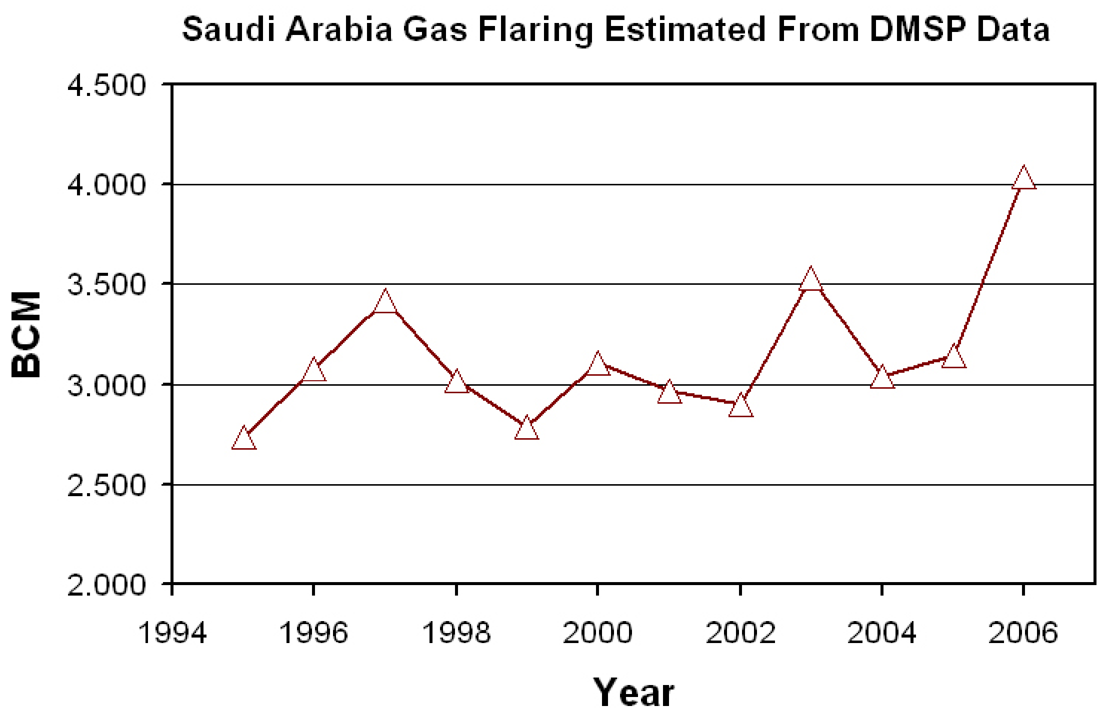

PNG Gas Flaring Estimated From DMSP Data
0.75
0.50
0.25
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year

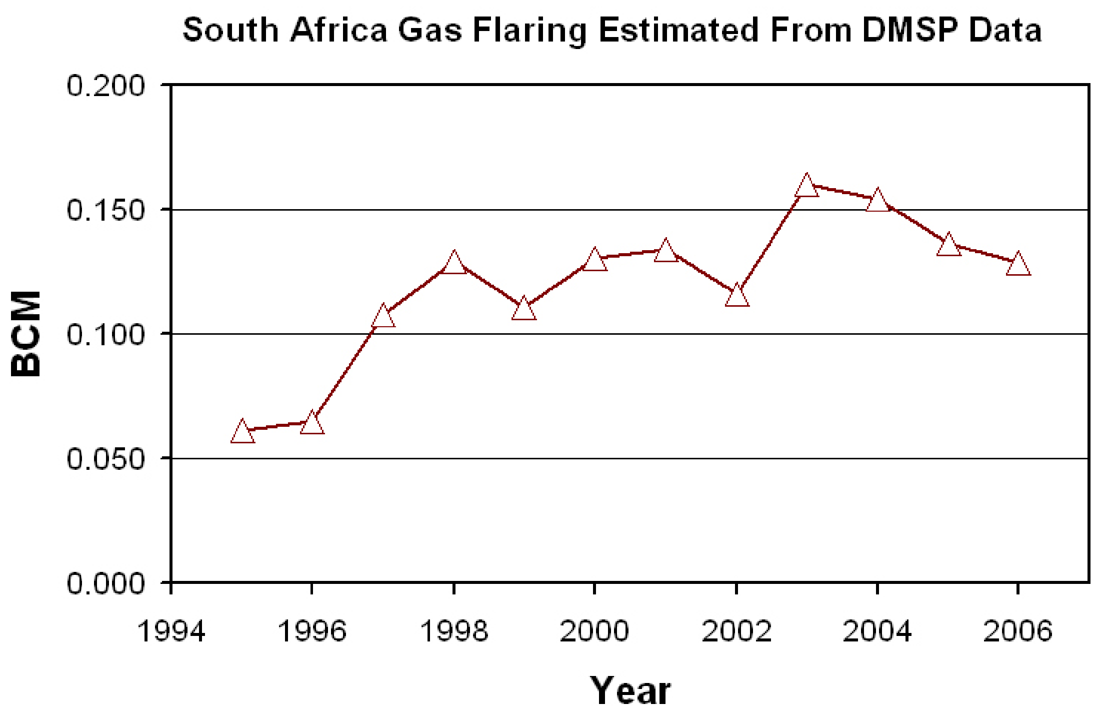

Qatar Gas Flaring Estimated From DMSP Data
BCM
4.000
3.000
2.000
1.000
0.000
1994
1996
1998
2000
2002
2004
2006
Year

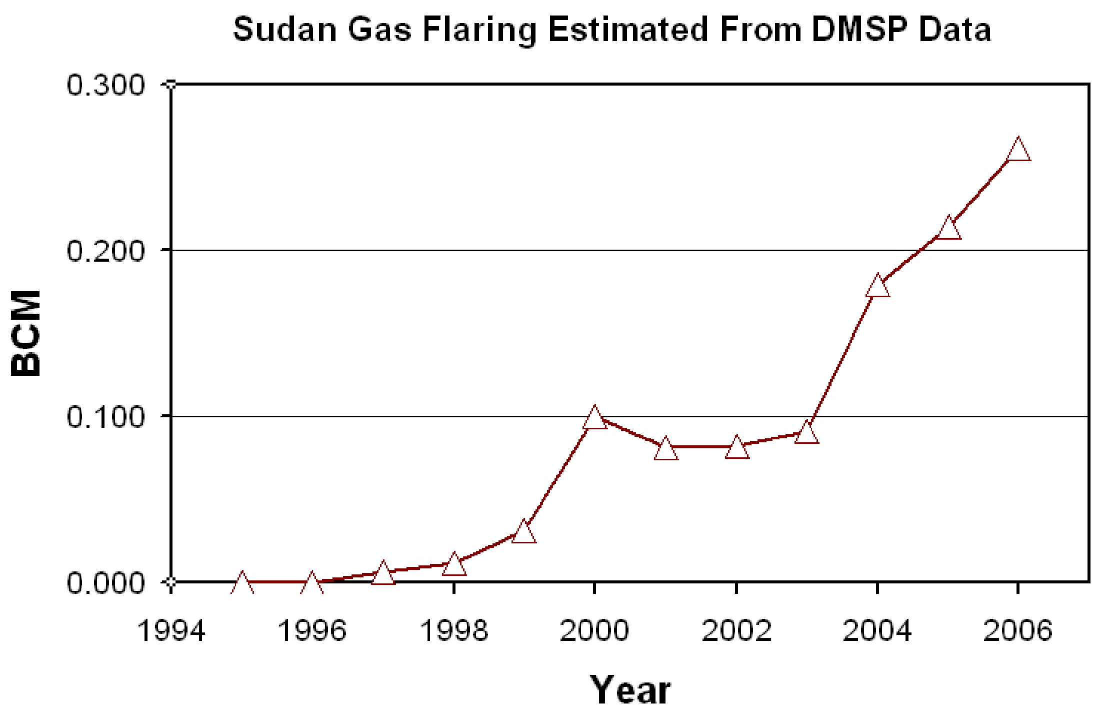

Romania Gas Flaring Estimated From DMSP Data
BCM
0.150
0.100
0.050
0.000
1994
1996
1998
2000
2002
2004
2006
Year


Khanty-Mansiysk Gas Flaring Estimated From DMSP Data
35
30
25
20
15
10
BCM
1994
1996
1998
2000
2002
2004
2006
Year

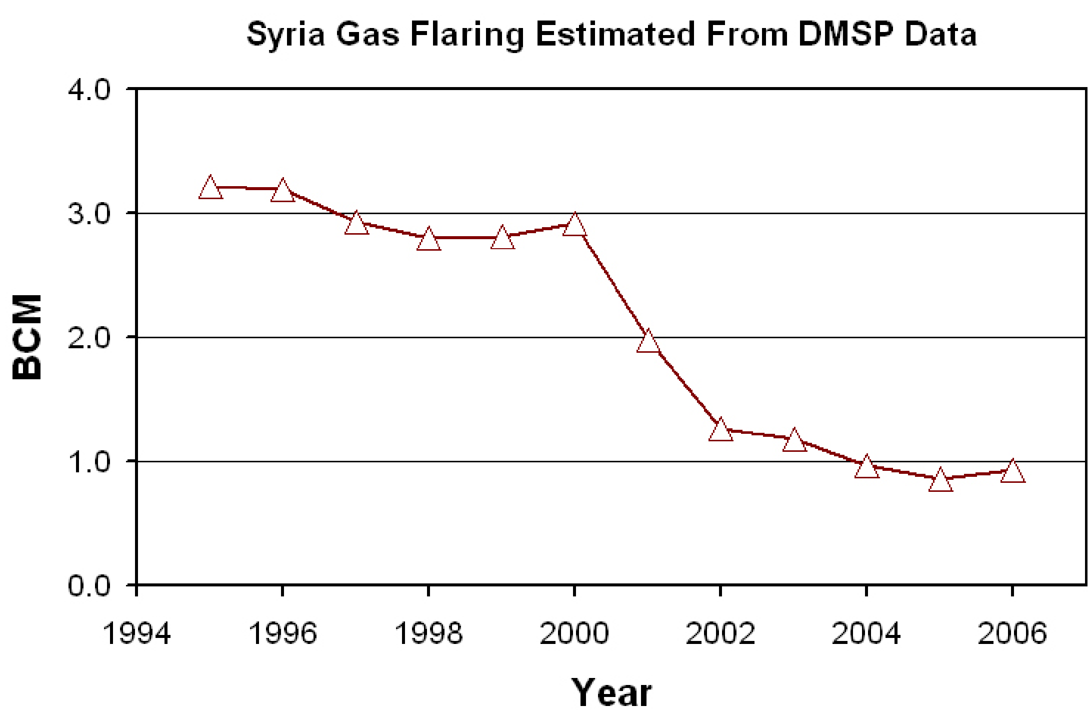

Russia (excluding KM) Gas Flaring Estimated From DMSP Data
30
28
26
24
22
20
18
16
14
12
10
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Saudi Arabia Gas Flaring Estimated From DMSP Data
BCM
4.500
4.000
3.500
3.000
2.500
2.000
1994
1996
1998
2000
2002
2004
2006
Year

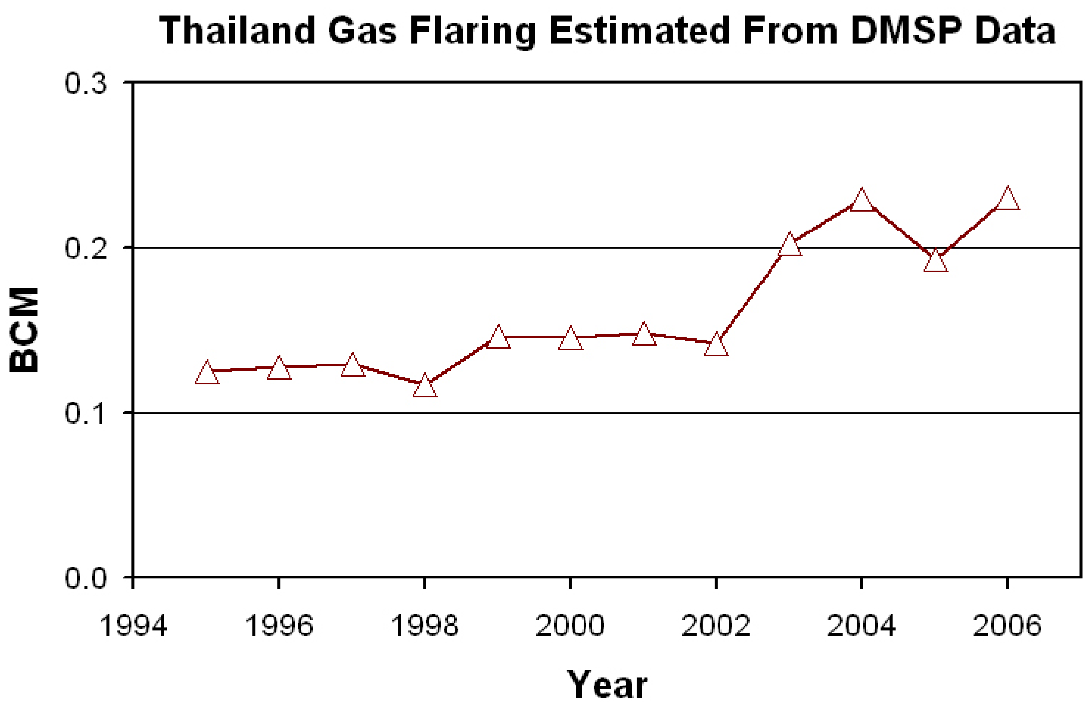

South Africa Gas Flaring Estimated From DMSP Data
BCM
0.200
0.150
0.100
0.050
0.000
1994
1996
1998
2000
2002
2004
2006
Year



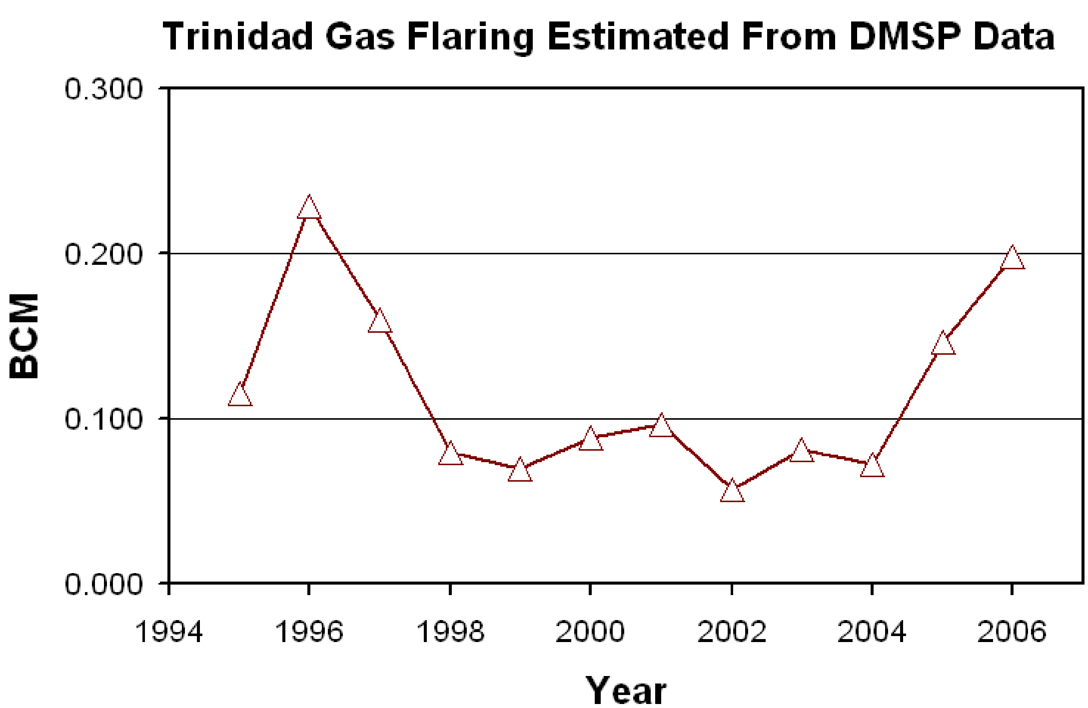
Sudan Gas Flaring Estimated From DMSP Data
BCM
0.300
0.200
0.100
0.000
1994
1996
1998
2000
2002
2004
2006
Year



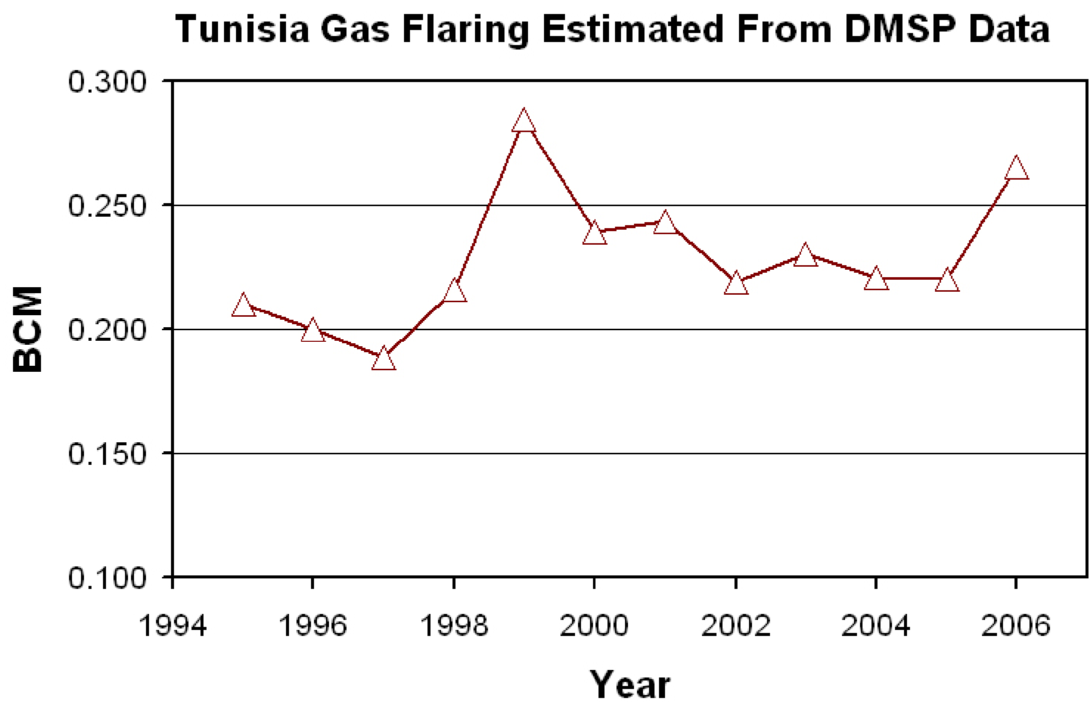
Syria Gas Flaring Estimated From DMSP Data
BCM
4.0
3.0
2.0
1.0
0.0
1994
1996
1998
2000
2002
2004
2006
Year



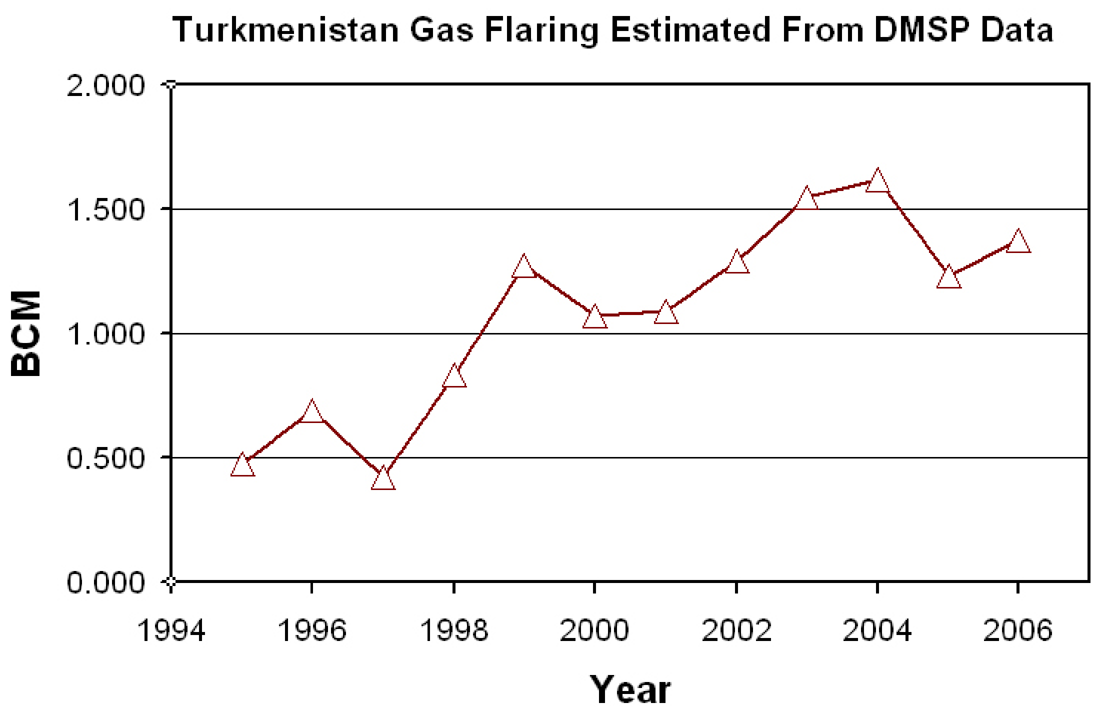
Thailand Gas Flaring Estimated From DMSP Data
0.3
0.2
0.1
0.0
BCM
1994
1996
1998
2000
2002
2004
2006
Year



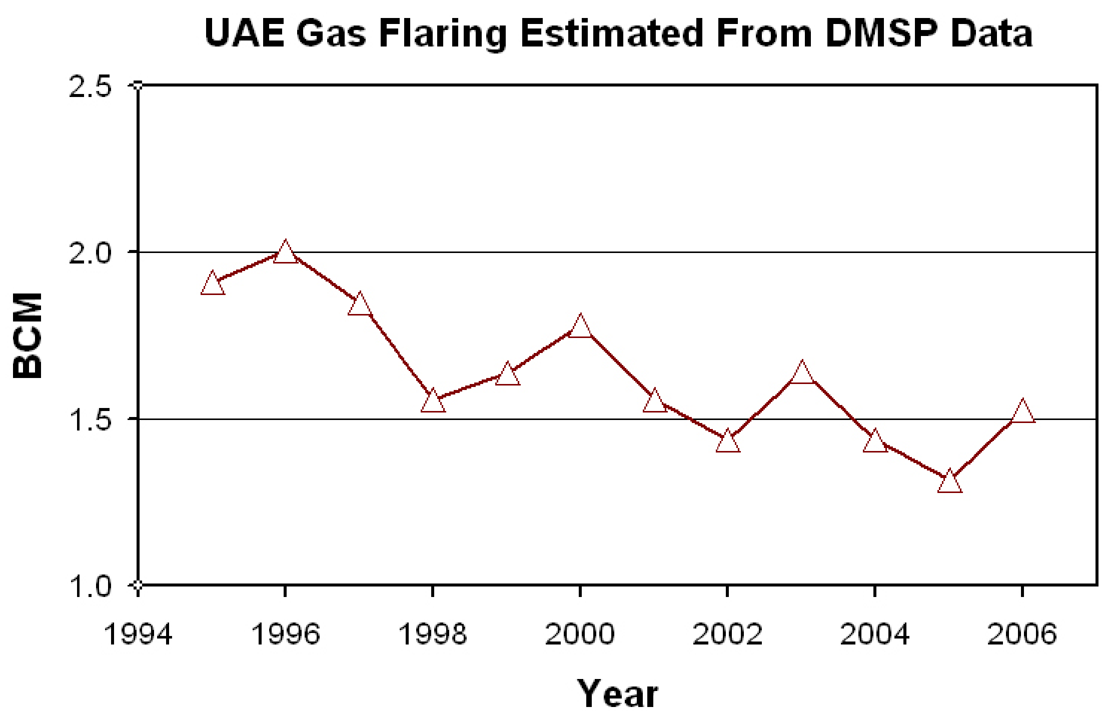
Trinidad Gas Flaring Estimated From DMSP Data
0.300
0.200
0.100
0.000
BCM
1994
1996
1998
2000
2002
2004
2006
Year

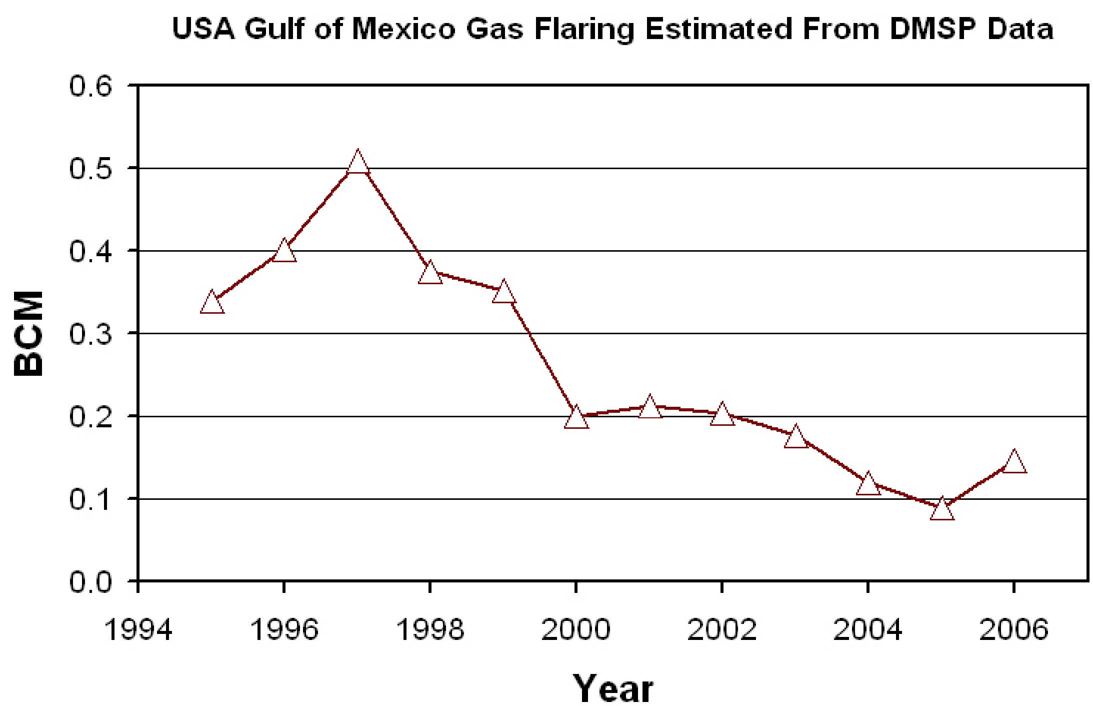


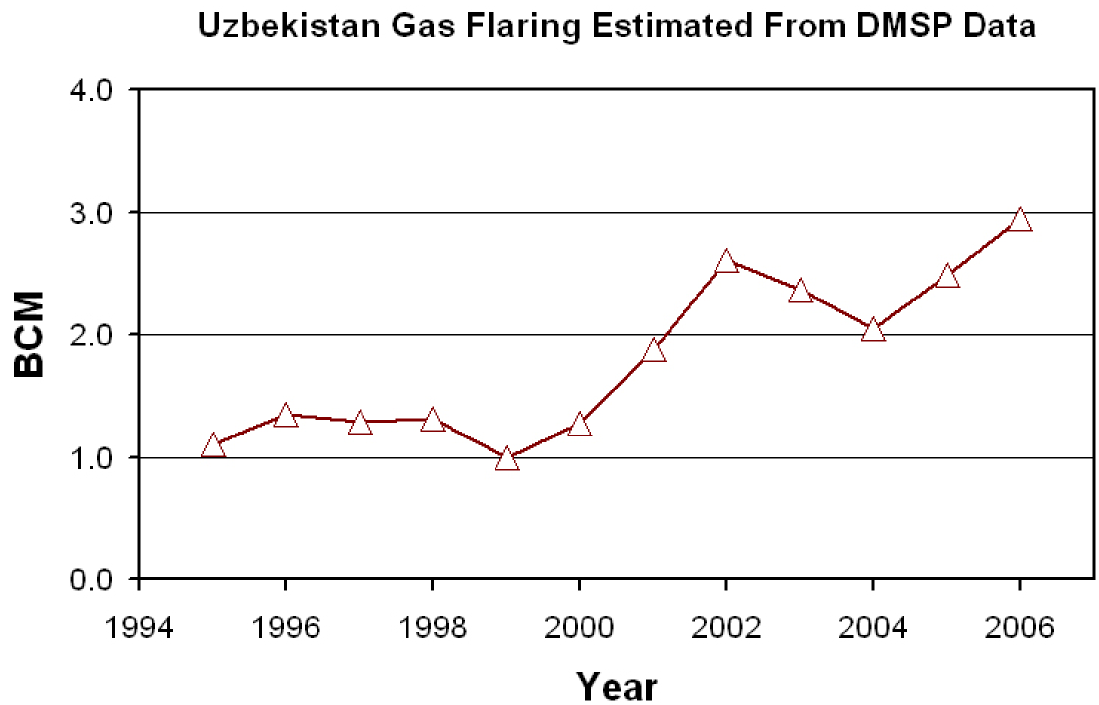
Tunisia Gas Flaring Estimated From DMSP Data
BCM
0.300
0.250
0.200
0.150
0.100
1994
1996
1998
2000
2002
2004
2006
Year

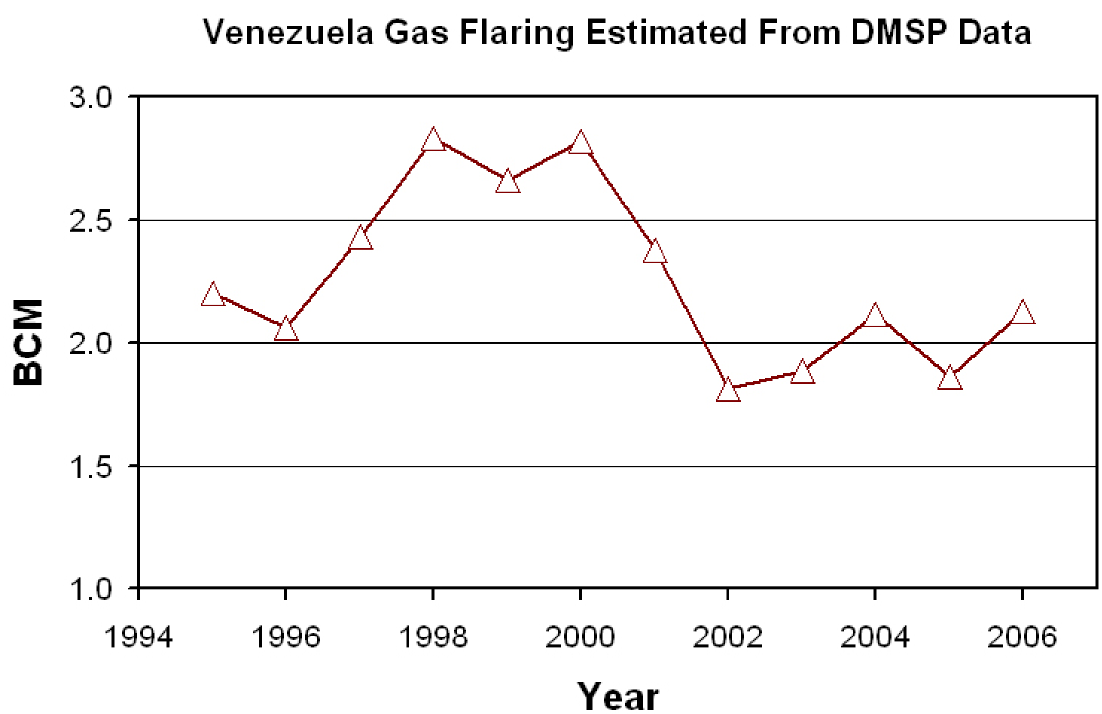


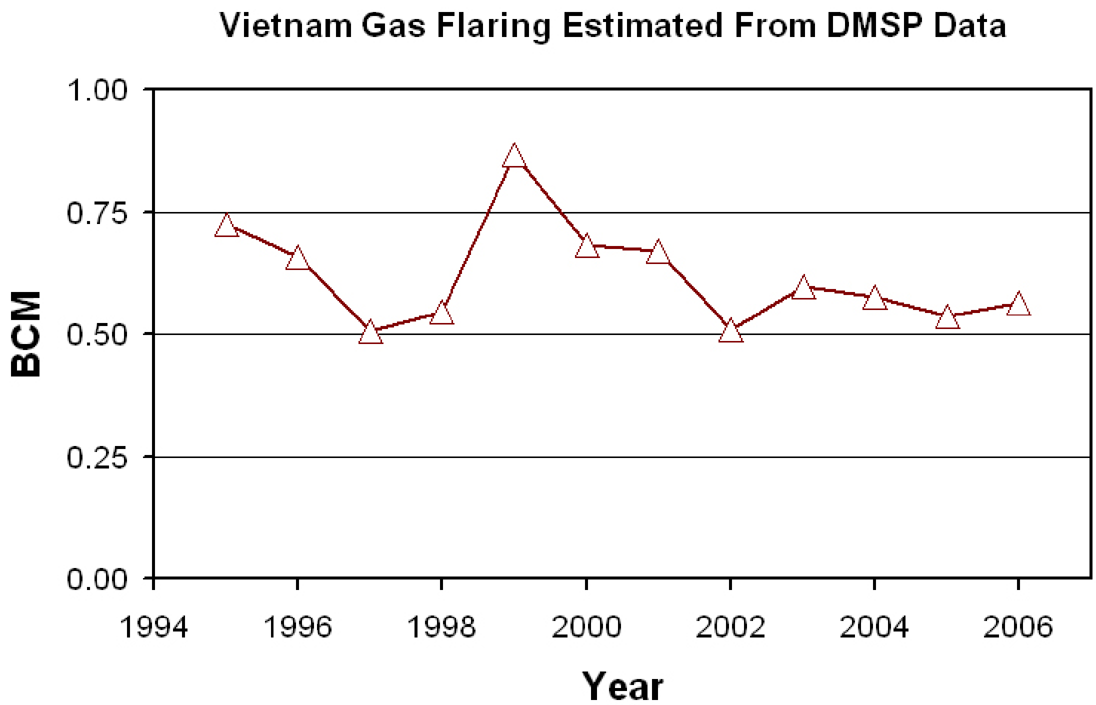
Turkmenistan Gas Flaring Estimated From DMSP Data
BCM
2.000
1.500
1.000
0.500
0.000
1994
1996
1998
2000
2002
2004
2006
Year

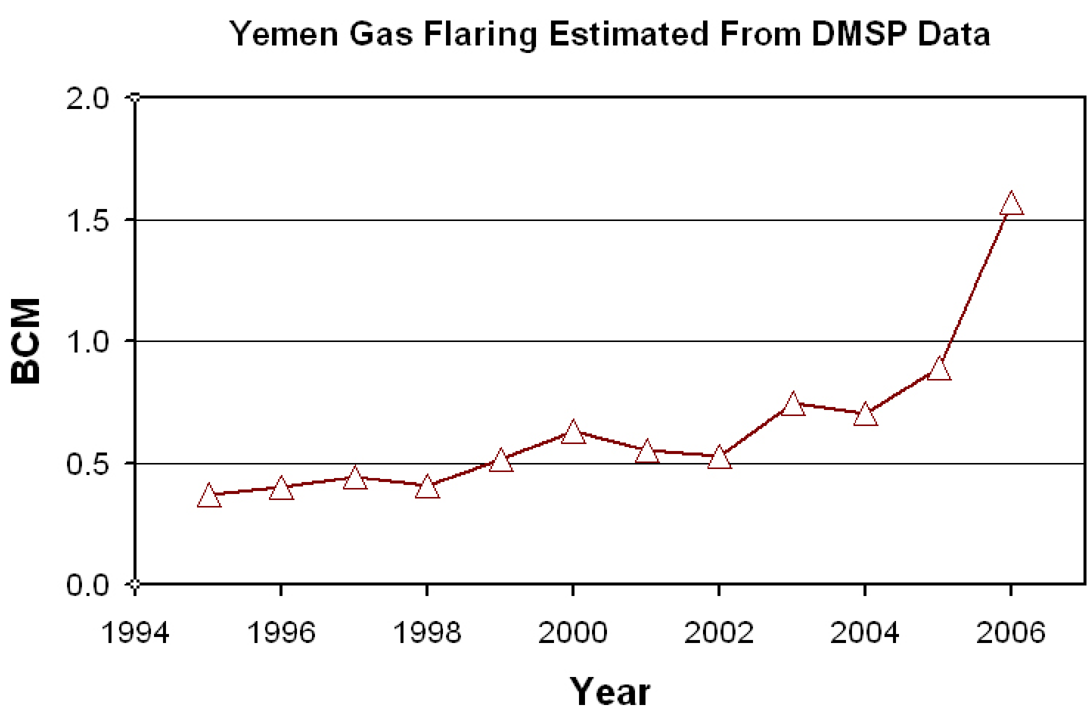

UAE Gas Flaring Estimated From DMSP Data
BCM
2.5
2.0
1.5
1.0
1994
1996
1998
2000
2002
2004
2006
Year


USA Gulf of Mexico Gas Flaring Estimated From DMSP Data
BCM
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1994
1996
1998
2000
2002
2004
2006
Year


Uzbekistan Gas Flaring Estimated From DMSP Data
4.0
3.0
2.0
1.0
0.0
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Venezuela Gas Flaring Estimated From DMSP Data
3.0
2.5
2.0
1.5
1.0
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Vietnam Gas Flaring Estimated From DMSP Data
1.00
0.75
0.50
0.25
0.00
BCM
1994
1996
1998
2000
2002
2004
2006
Year


Yemen Gas Flaring Estimated From DMSP Data
2.0
1.5
1.0
0.5
0.0
BCM
1994
1996
1998
2000
2002
2004
2006
Year