Development of Greenhouse Gas Emissions Inventories and Forecasts in the Border States of Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas

Juan A. Maldonado, Stephen M. Roe, Cristina Quiroz
E.H. Pechan and Associates, 5528-B Hempstead Way, Springfield, VA 22151
juan.maldonado@pechan.com, steve.roe@pechan.com, cristina.quiroz@pechan.com

Randy Strait, Thomas Peterson, Edward Ranger
Center for Climate Strategies, c/o EESI, 130 Locust St., Suite 200, Harrisburg, PA 17101
tdp1@mac.com

ABSTRACT

This paper presents the results of a successful collaboration between Mexico state agencies and the Center for Climate Strategies (CCS) to develop state-level greenhouse gas (GHG) emission inventories and forecasts for the states of Baja California, Sonora, Chihuahua, Nuevo León, Coahuila, and Tamaulipas. Final results will be showcased for the state of Sonora which completed an inventory and forecast in July, 2008. Preliminary results will be shared for the remaining states of Baja California, Chihuahua, Nuevo León, Coahuila, and Tamaulipas whose inventory and forecasts are in the process of development through July 2009.

These inventories and forecasts cover the period from 1990 to 2020 and include emissions for each of the six gases recognized by the Intergovernmental Panel on Climate Change (IPCC). Both sources and sinks of carbon dioxide (CO_2) are included and reported in terms of their carbon dioxide equivalents (CO_2e). State-level emissions are categorized into the following eight sectors: 1) electricity supply and use; 2) residential/commercial/industrial fuel combustion; 3) transportation; 4) industrial processes and product use; 5) fossil fuel industries; 6) agriculture; 7) waste management; and 8) forestry and land use.

These inventories and forecasts may serve as the starting points in state-level planning projects. A complimentary objective is to supply training to build capacity within each state to prepare future updates to its GHG inventory and forecast.

INTRODUCTION

Under a technical support agreement with the state of Sonora Ecology and Sustainable Development Commission (CEDES for its initials in Spanish), the Center for Climate Strategies (CCS) completed a greenhouse gas (GHG) inventory and forecast in July 2008. Under similar technical support agreements with states of Baja California, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas, CCS is undergoing a project (henceforth the Project) to develop of comprehensive greenhouse gas (GHG) inventories and forecasts for each state with a completion date of September 2009.

The Project is based on similar assistance that CCS has provided to the state of Sonora and many U.S. states (including Arizona and New Mexico) and through its implementation will provide consistent data sets useful for both in-state and regional planning efforts, including the Western Climate Initiative (WCI). Moreover, significant effort was devoted to maintain consistency with Mexico's National GHG Emissions Inventory (INEGEI for its initials in Spanish) developed as part of the country's obligations with the United Nations Framework Convention on Climate Change (UNFCCC).[1]

All inventories and forecasts cover the period from 1990 to 2020 and account for emissions associated with each of the six gases recognized by the Intergovernmental Panel on Climate Change (IPCC). Both sources and sinks of carbon dioxide (CO_2) are contemplated and reported in terms of their carbon dioxide equivalents (CO_2e). State-level emissions are characterized according to the following eight sectors: 1) electricity supply and use; 2) residential/commercial/industrial fuel combustion; 3) transportation; 4) industrial processes and product use; 5) fossil fuel industries; 6) agriculture; 7) waste management; and 8) forestry and land use.

GENERAL PRINCIPLES AND GUIDELINES

CCS seeks to maintain the following principles in developing state-level inventories and projections:

- **Transparency:** All data sources, methods, and key assumptions are reported to allow open review and opportunities for additional revisions later based on input from others.
- **Consistency:** To the extent possible, the inventory and projections are designed to be externally consistent with current or likely future systems for state and national GHG emissions reporting. Preference was given to the quantification methods developed by the IPCC as found in the 2006 IPCC National Gas Inventories Guidelines.[2] An alternative source of methods included the U.S. Environmental Protection Agency (EPA) Emission Inventory Improvement Program (EIIP) guidelines.[3]
- **Priority of Existing State and Local Data Sources:** In gathering data and in cases where data sources conflicted, a higher priority was placed on local and state data and analyses, followed by regional sources, with national data or simplified assumptions such as constant linear extrapolation of trends used as defaults where necessary.
- **Priority of Significant Emissions Sources:** In general, sources with relatively small emissions levels received less attention than those with larger GHG contributions.
- **Comprehensive Coverage of Gases, Sectors, State Activities, and Time Periods:** This analysis aimed to comprehensively cover GHG sources and sinks associated with activities in each Border state. It covers all six GHGs covered by IPCC guidelines and reported in national inventories: CO_2, methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). The inventory estimates are for the year 1990, with subsequent years included up to most recently available data (typically to 2005), with projections to 2020.
- **Use of Consumption-Based Emissions Estimates:** To the extent possible, emissions that are caused by activities occurring within state boundaries were considered. This approach can differ from how inventories are compiled (e.g., on an in-state production basis), in particular for electricity. Emissions associated with electricity consumption were reported as well as emissions from mere electricity generation. The rationale for this method of reporting is that it can more accurately reflect the impact of state-based policy strategies such as energy efficiency on overall GHG emissions. It can also resolve double-counting and exclusion problems with multi-emissions issues.

SPECIFIC CONSIDERATIONS OF THE PROJECT

A major concern for the states was to maintain consistency with national and regional GHG initiatives. Most notably, the inventories and forecast needed to meet the expectations of the National Institute of Ecology (INE for its initials in Spanish), the government agency responsible for developing and publishing Mexico's National GHG Emissions Inventory. Conformance with INE's approach was achieved by relying almost exclusively on international emission quantification methods, in this case, the 2006 IPCC guidelines. In all cases, Tier 1 methods were applied in absence of state, national, or regional specific rates and/or emission factors.

Additionally, the National GHG Emissions Inventory served as the main reference for identifying significant sources of emissions. At the national level significant sources accounted for 88 percent of total emissions and encompassed twelve emissions categories. A list of significant sources is shown in Table 1. The list of national significant sources was subsequently revised to reflect the likely emissions profile of each state.

Table 1. Significant sources in the national GHG emissions inventory for 2002.

Sources	Emissions [Gg CO_2e]	Distribution %
Total	643,183	100%
Energy - Fuel Consumption - Electricity Generation	152,469	24%
Energy - Fuel Consumption – Transportation	111,959	17%
Energy - Fuel Consumption - Manufacturing	51,025	8%
Agriculture - Enteric Fermentation	37,366	6%
Energy - Fugitive Fuel Emissions - Gas and Petroleum Systems	37,020	6%
Energy - Fugitive Fuel Emissions - Petroleum Refining	36,690	6%
Waste - Solid Waste Management	34,960	5%
Industrial Processes - Mineral Products	30,618	5%
Waste - Wastewater Management	28,566	4%
Energy - Fuel Consumption - Other	25,160	4%
Industrial Processes - Metal Production	15,322	2%
Agriculture - Agricultural Soils	7,449	1%
Other	74,579	12%

Another consideration was the need to maintain consistency with WCI and existing state inventories in Baja California[4] and neighboring states in the U.S. It was agreed to maintain CCS characterization of emissions sectors because CCS had already completed inventories for all U.S. WCI members except for California and Oregon. This list of members also includes the border states of Arizona and New Mexico. In the case of Baja California, it was decided to expand their 2005 GHG Inventory to cover the period from 1990 to 2020 in accordance to CCS emissions characterization.

DESCRIPTION OF DEVELOPMENT ACTIVITIES

Pechan, under contract with CCS, provides technical support, oversight, and quality assurance for the development of each state inventory and forecast (I&F). The applicable state environmental agency assists in the development of their respective I&F through data gathering, review of GHG estimates, and review of project documentation.

The Project is further divided in two phases. During each phase, each party is responsible for completing a series of tasks. Development activities are shown in Tables 2 and 3 for Phase I and Phase II, respectively. As of March 2009, the Project is closing in all activities pertaining to Phase I.

Table 2. Development activities during phase I.

CCS	Border States
Develop project workplan and schedule	Designate a technical coordinator for the Project
Conduct a project kick-off meeting with representatives of all five states. This meeting will provide an overview of the project, detailed GHG sector-level approaches to data gathering and GHG	Attendance at the project kick-off meeting.

CCS	Border States
emission estimation using Sonora as an example, and present an initial set of recommendations on data sources and emission estimation methods.	
Provide a set of GHG sector-specific data entry workbooks (MS Excel) for each state to store the data needed for each I&F, and provide access for each state to a web-based tool (Central Desktop) for the purpose of sharing information with each state agency.	In consultation with Pechan staff, gather activity data from national, state and local sources to support emissions estimation and forecasting.
Assist each state agency to complete entry of data into each of the MS Excel workbooks described above.	Entry of the relevant data into the MS Excel workbooks.
Conduct data research on publicly available publications and databases.	Review of final MS Excel workbooks completed by CCS.

Table 3. Development activities during Phase II.

CCS	Border States
Develop a draft GHG inventory for each state covering the years 1990-2005 and a GHG forecast for the years 2006-2020. Within the draft I&F report, include comparative reviews of the estimation approaches applied in other GHG assessments at the state and national level to ensure coherence, consistency, and comparability in future information exchanges and policy planning between each state and other jurisdictions. Also within the draft I&F report, assess relevant policies that are in place that could achieve GHG reductions during the forecast years.	Technical consultation and review of the GHG estimation methods applied by CCS and the use of information gathered during Phase I of the project.
Respond to comments from each state on the draft I&F and prepare a final version of each state report. The final report should indicate, in addition to the results analysis, the applications for the potential users of this report, so as to suggest future actions for the continuity of this project and final conclusions.	Provide a review of the draft I&F report developed for each state.
Hold a workshop that includes representatives from all five states to present the results of the project.	Attend the Phase II workshop, where the final results will be presented for all five states.

SONORA INVENTORY AND FORECAST

As shown in Table 4, activities in Sonora accounted for approximately 19.9 million metric tons of gross CO_2e emissions (consumption basis) in 2005, an amount equal to about 3.1 percent of Mexico's gross GHG emissions in 2005 excluding carbon sinks, such as carbon stock in forest land. Sonora's gross consumption-based emissions increased by about 35 percent from 1990 to 2005, while national emissions rose by 52 percent from 1990 to 2005. The growth in Sonora's emissions from 1990 to 2005 is primarily associated with electricity consumption and transportation activities. National annual emissions values were estimated at 655 million metric tons of CO_2e.[1]

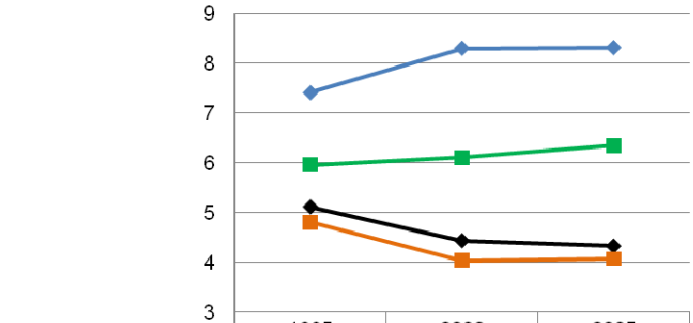
Table 4. Sonora historical and reference case GHG emissions, by sector.

Reference Case GHG Emissions for Sonora - Consumption Basis							
(Million Metric Tons CO2e)	1990	1995	2000	2005	2010	2015	2020
Energy Consumption Based	**9.4**	**11.1**	**13.1**	**13.2**	**15.5**	**19.1**	**23.4**
Electricity Consumption Based	**4.03**	**5.50**	**7.03**	**6.84**	**7.58**	**9.76**	**12.2**
Fuel Oil	4.03	5.50	6.72	4.84	3.95	6.42	8.86
Natural Gas	0.00	0.00	0.30	2.00	3.63	3.34	3.32
Net Imported Electricity	1.2E-03	1.7E-03	2.3E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Electricity Production Based	4.03	5.50	7.03	6.84	7.58	9.76	12.2
Res/Comm/Ind (RCI)	**1.58**	**2.56**	**1.27**	**1.06**	**1.43**	**1.78**	**2.30**
Liquid Petroleum Gas	0.58	0.58	0.55	0.44	0.47	0.49	0.52
Natural Gas	0.24	0.27	0.28	0.33	0.37	0.41	0.46
Diesel	0.70	1.65	0.37	0.24	0.54	0.82	1.26
Wood	0.06	0.06	0.06	0.05	0.05	0.05	0.06
Transportation	**3.61**	**2.85**	**4.65**	**5.10**	**6.26**	**7.35**	**8.70**
Road Gasoline	1.65	1.75	1.96	2.44	3.17	3.73	4.39
Road Diesel	0.93	0.05	1.54	1.54	1.83	2.16	2.55
Waterborne Navigation	0.11	0.11	0.17	0.20	0.32	0.50	0.79
Aviation	0.26	0.28	0.32	0.26	0.29	0.30	0.31
Other	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Fossil Fuel Industry	**0.16**	**0.18**	**0.19**	**0.22**	**0.23**	**0.24**	**0.25**
Natural Gas Industry	0.16	0.18	0.19	0.22	0.23	0.24	0.25
Transmission	0.04	0.05	0.05	0.05	0.05	0.06	0.06
Distribution	0.12	0.14	0.14	0.15	0.16	0.16	0.17
Pipeline Fuel Use	0.00	0.00	0.00	0.02	0.02	0.02	0.02
Industrial Processes	**0.70**	**0.95**	**1.28**	**1.76**	**2.31**	**3.11**	**4.19**
Cement Manufacture (CO2)	0.62	0.84	1.13	1.56	2.05	2.76	3.71
Lime Manufacture (CO2)	0.03	0.04	0.05	0.07	0.09	0.12	0.16
Limestone and Dolomite Use (CO2)	0.01	0.02	0.02	0.03	0.04	0.06	0.08
ODS Substitutes (HFC, PFC)	0.03	0.04	0.05	0.07	0.09	0.12	0.16
Other (CO2)	0.01	0.02	0.02	0.03	0.04	0.06	0.08
Waste Management	**1.07**	**1.26**	**1.38**	**1.58**	**1.66**	**1.74**	**1.82**
Waste Combustion	0.13	0.17	0.21	0.29	0.30	0.31	0.33
Landfills	0.46	0.54	0.62	0.70	0.74	0.78	0.82
Wastewater Management	0.48	0.55	0.56	0.60	0.62	0.65	0.68
Agriculture	**3.56**	**2.96**	**2.61**	**3.36**	**3.58**	**3.87**	**4.18**
Enteric Fermentation	1.98	1.57	1.36	1.83	1.97	2.13	2.30
Manure Management	0.18	0.16	0.16	0.18	0.18	0.19	0.20
Agricultural Soils	1.37	1.20	1.07	1.28	1.39	1.52	1.66
Rice Cultivation	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agricultural Burning	0.03	0.03	0.03	0.07	0.03	0.03	0.03
Forestry and Land Use	**-8.21**	**-9.12**	**-6.29**	**-8.42**	**-7.96**	**-7.96**	**-8.69**
Forested Landscape	-8.21	-9.12	-6.29	-8.42	-7.96	-7.96	-8.69
Forest Wildfires	1.8E-04	1.7E-04	3.4E-04	2.3E-04	2.5E-04	2.5E-04	2.1E-04
Gross Emissions Consumption Based	**14.7**	**16.3**	**18.4**	**19.9**	**23.0**	**27.8**	**33.6**
increase relative to 1990		*10%*	*25%*	*35%*	*57%*	*89%*	*129%*
Emission Sinks	**-8.21**	**-9.12**	**-6.29**	**-8.42**	**-7.96**	**-7.96**	**-8.69**
Net Emissions (incl. forestry*)	**6.50**	**7.13**	**12.1**	**11.5**	**15.1**	**19.9**	**24.9**
increase relative to 1990		*10%*	*86%*	*77%*	*132%*	*206%*	*284%*

Initial estimates of carbon sinks within Sonora's forests have also been included in this report. However additional work is needed to gain an understanding of CO_2 emissions/sinks for other land uses, most notably grassland, which is the predominant type of vegetation in the state. Additional work to improve land use carbon sink estimates could lead to substantial changes in the initial estimates provided in this report. The current estimates indicate that about 8.42 $MMtCO_2e$ were stored in Sonora forest biomass in 2005. Inclusion of this sink leads to *net* emissions of 11.5 $MMtCO_2e$ in Sonora for 2005.

Figure 1 compares the state's and Mexico's emissions per capita and per unit of economic output. On a per capita basis, Sonora emitted about 7.41 metric tons (Mt) of gross CO_2e in 1995, higher than the national average of 5.96 tCO_2e for the same year. Sonora's per capita emissions increased to 8.31 $MtCO_2e$ while national per capita emissions for Mexico grew to 6.35 $MtCO_2e$ in 2005. Although Sonora's population has grown at the national rate, emissions have increased in the state at a higher rate, causing state emissions per capita to grow at a faster rate. On the other hand, Sonora's economic growth exceeded emissions growth throughout the 1990-2005 period leading to declining estimates of GHG emissions per unit of state product. From 1995 to 2005, Sonora emissions per unit of gross product dropped by 15 percent based on domestic product at constant 2003 Mexican pesos values

Figure 1. Historical Sonora and Mexico gross GHG emissions per capita and per unit of economic output.



	1995	2000	2005
Sonora GHG/Capita (tCO2e/capita)	7.41	8.30	8.31
MX GHG/Capita (tCO2e/capita)	5.96	6.10	6.35
Sonora GHG/$ (kgCO2e/$)	5.12	4.44	4.33
MX GHG/$ (kgCO2e/$)	4.80	4.03	4.06

As illustrated in Figure 2 and shown numerically in Table 4, under the reference case projections, Sonora's gross GHG emissions continue to grow and are projected to reach 33.6 $MMtCO_2e$ by 2020. This would be an increase of 129 percent over 1990 levels.

Figure 2. Sonora gross consumption-based GHG emissions by sector, 1990-2020.

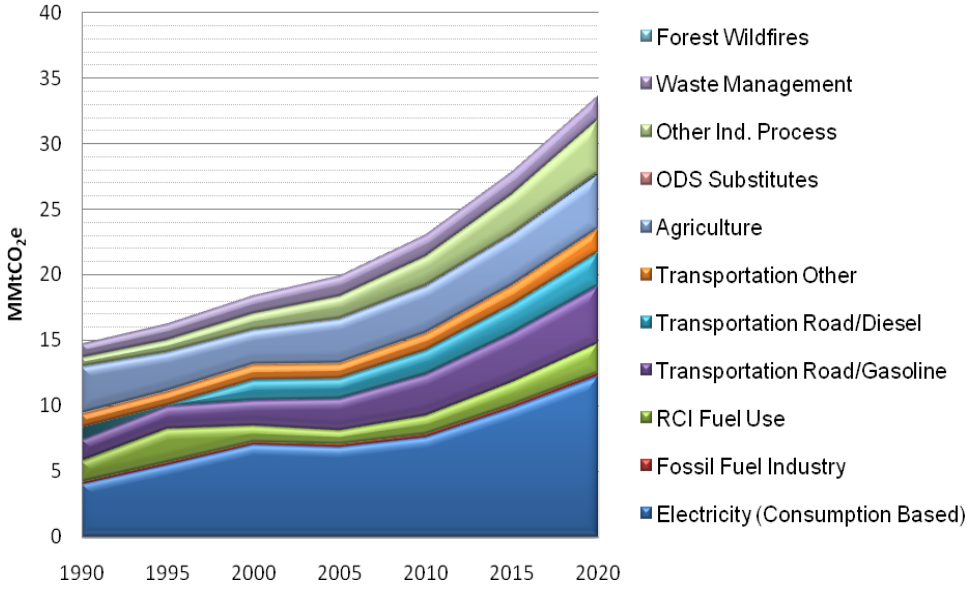
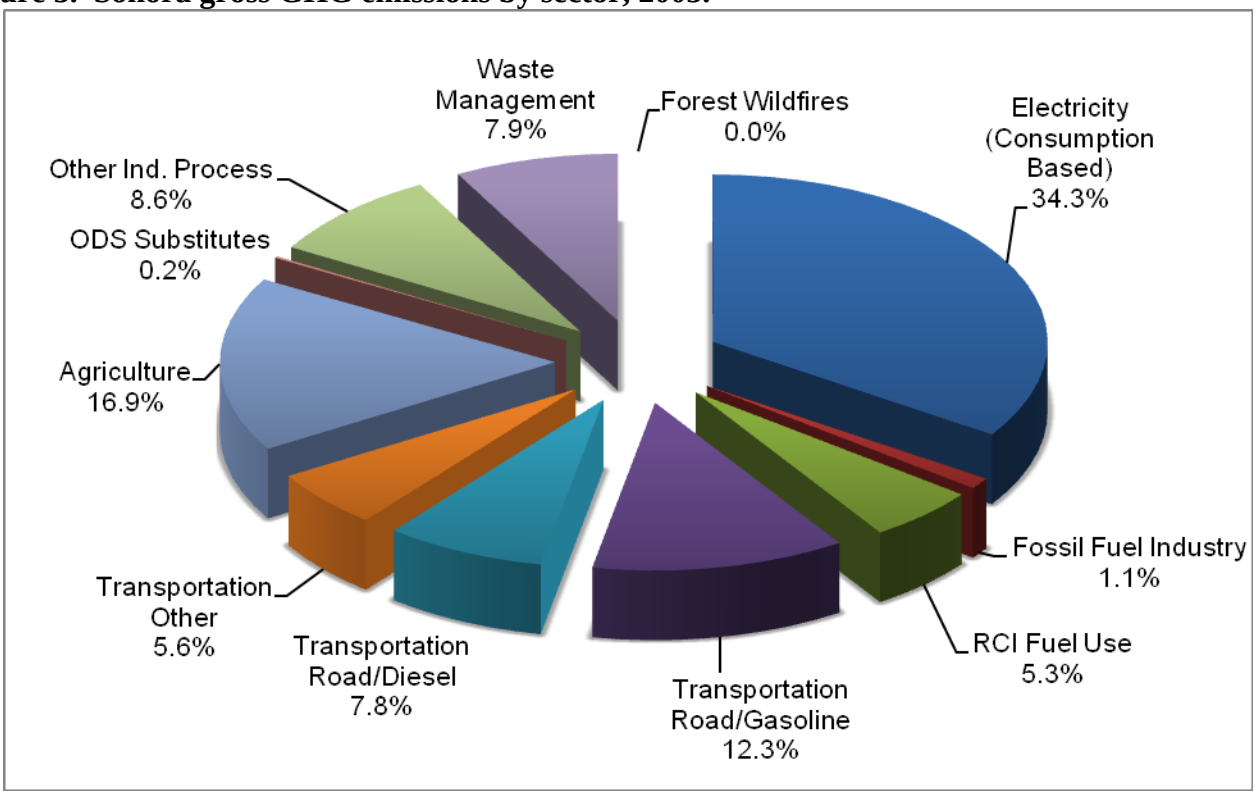


Figure 3 shows the distribution of emissions by sector. In 2005, the top contributors to emissions were the electricity supply, transportation, and agriculture sectors.

Figure 3. Sonora gross GHG emissions by sector, 2005.



Some data gaps exist in this analysis, particularly for the reference case projections. Key tasks in resolving the data gaps include review and revision of key emissions drivers that will be major determinants of Sonora's future GHG emissions (such as the growth rate assumptions for electricity generation and consumption, transportation fuel use, industrial processes, and RCI fuel use).

A Closer Look at the Three Major Sources[5]

Electricity Supply Sector

Five power plants provide electricity in the state of Sonora. The plants with the largest output are Puerto Libertad in the municipality of Pitiquito and Guaymas II in the municipality of Guaymas generating a total of gross electricity of 3,081 and 2,044 gigawatt-hour (GWh), respectively, in 2004. Both plants operate conventional thermal units that combust fuel oil. Virtually all fuel oil comes from combustóleo (residual fuel oil). Activity data collected by CEDES from the Comisión Federal de Electricidad suggests that trace amounts of diesel are burned in lieu of combustóleo, when the latter is not available to supply all energy needs at these plants. Natural gas is the energy source at the plants of Hermosillo in the city of Hermosillo and Naco Nogales in the municipality of Agua Prieta. The Hermosillo and Naco Nogales plants generated 1,253 and 1,717 GWh of gross electricity in 2004, and operate combined cycle units. A small amount of electricity is generated at El Novillo hydroelectric plant located in the municipality of Soyopa. Gross electricity generation at El Novillo in 2004 totaled 174 GWh. Imported electricity from natural gas power plants in the US accounted for another 6 GWh in 2004.[5]

Except for the hydroelectric plant of El Novillo, the power plants in Sonora combust some form of fossil fuel to generate electricity. In 2004, energy from the combustion of fuel oil accounted for 73 percent of total primary energy used with the remainder coming from combustion of natural gas. Fossil

fuel consumption for electricity production was responsible for 6.5 $MMtCO_2e$ of GHG emissions in 2004 and is estimated to increase to 12.2 $MMtCO_2e$ by 2020.

The fraction of electricity use associated with imported electricity in Sonora was estimated to be negligible (0.1 percent). Because electricity imports are very small compared to in-state production, production-based emission and consumption-based emissions are the same to three significant digits. It is important to note that the consumption-based approach can better reflect the emissions (and emission reductions) associated with activities occurring in Sonora, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for policy-making. The available literature indicated that Sonora has not been a net exporter of electricity to other states or the United States.

Transportation Sector

Transportation activities accounted for about 26 percent of Sonora's gross GHG emissions in 2005 (about 17 $MMtCO_2e$). The sector was divided into five subsectors as follows: a) road vehicles fueled by gasoline, b) road vehicles fueled by diesel, c) marine vessels fueled by diesel, d) airplanes fueled by kerosene, and e) unspecified vehicles fueled by other hydrocarbon fuels.

In 2005, transportation emissions totaled 5.1 $MMtCO_2e$, of which 48 percent resulted from gasoline combustion by onroad light-duty vehicles, 30 percent resulted from diesel combustion by on-road heavy-duty vehicles, 5 percent from jet fuel combustion by airplanes, and 4 percent from diesel combustion by marine vessels. The remaining 13 percent share of emissions was attributed to non–specified sources combusting lubricants and small amounts of liquefied petroleum gas. By 2020, transportation emissions are estimated to reach 8.7 $MMtCO_2e$, of which gasoline combustion from on-road vehicles accounts for 44 percent, diesel combustion by on-road heavy vehicles for 26 percent, diesel combustion by marine vessels for 23 percent, and jet fuel combustion by airplanes for 3 percent. The share of non-specified sources is estimated at 6 percent.

According to CEDES, Ferromex operates railroads in the state of Sonora. However, neither inventory nor forecast emissions were calculated due to the absence of fuel consumption information for this subsector.

Agricultural Sector

Non-fuel combustion emissions from agricultural activities are reported in the agricultural sector which accounted for 17 percent of the gross GHG emissions in 2005. This is significantly higher than the national average for agricultural emissions for the same year (7 percent). However, this is not at all surprising considering the importance of the agricultural sector to the economy in Sonora.

These emissions primarily come from enteric fermentation and agricultural soils. Enteric fermentation is the result of normal digestive processes of ruminant livestock resulting in methane emissions. Agricultural soils emit nitrous oxide emissions as a result of the addition of commercial nitrogen fertilizers, manure, nitrogen fixing crops, and decomposing crop residues. Emissions from the agricultural sector are projected to increase by about 24 percent between 2005 and 2020, with the majority of this increase coming through agricultural soils and enteric fermentation with mean annual growth rates of 1.7 percent and 1.5 percent, respectively.

Smaller sources of GHG emissions in the agricultural sector include methane and nitrous oxide emissions from livestock manure management and crop residue burning. A notable subsector for which data were not available to estimate net CO_2 emissions is changes in cropland management. Changes in cropland management include bringing new acres into active cultivation, use of no- or low-tillage systems, additions of manure, conservation programs that keep crop land under permanent cover, and other management methods. Each of these management methods can result in net losses/gains in

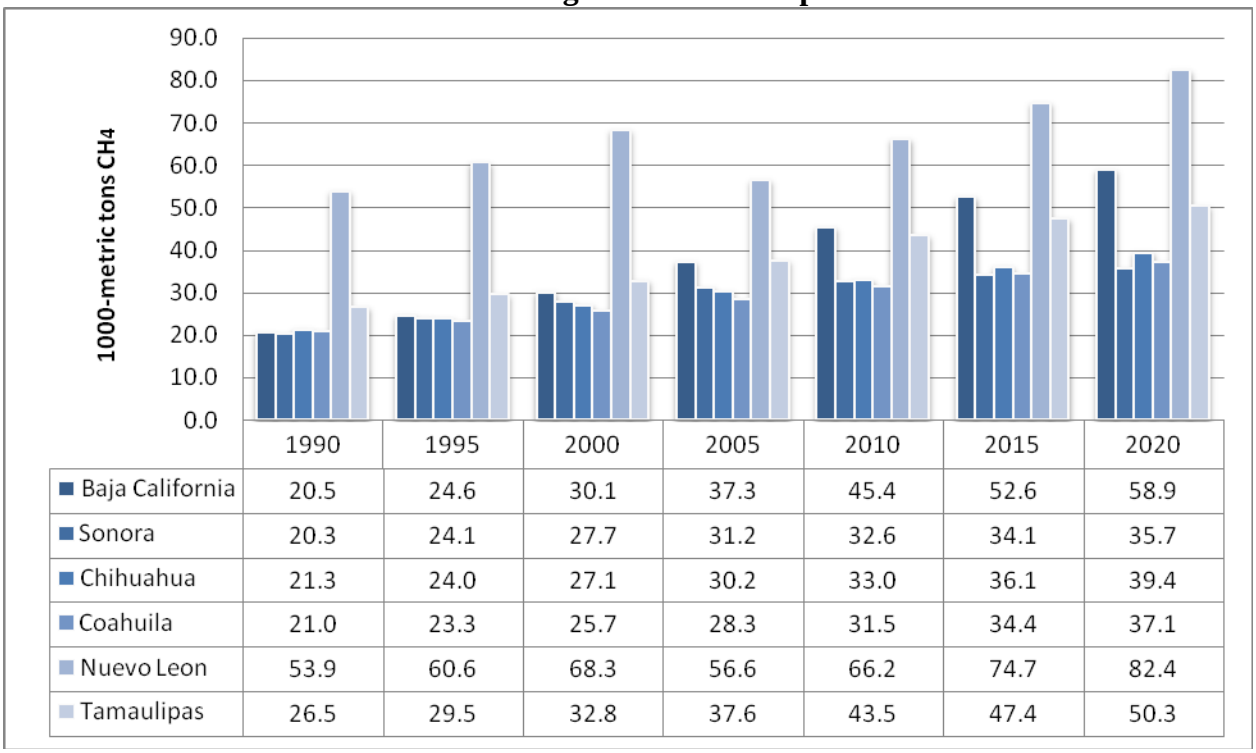
agricultural soil carbon, which means that CO_2 has been directly lost or indirectly sequestered from the atmosphere.

ILLUSTRATIVE COMPARISON OF SIX BORDER STATES

Methane emissions from the decomposition of organic substances in landfills do not represent a large portion of state-level emissions but it represents an important sector in the region. There is interest in developing landfill projects where landfill gas is either captured and flared or used as an energy source. These projects can generate carbon credits under existing voluntary programs in North America (e.g., the Voluntary Carbon Standard). In the presence of a healthy carbon market, these projects would attract foreign investment, create local jobs, and mitigate GHG emissions.

Figure 4 shows historical and forecast methane emissions from the management of municipal solid waste. Emissions are greater in states with larger industrial centers like Nuevo Leon and Tamaulipas. With the exception of the state of Nuevo Leon, no other states list active landfill gas control systems.

Figure 4. Methane emissions from the management of municipal solid waste.



	1990	1995	2000	2005	2010	2015	2020
Baja California	20.5	24.6	30.1	37.3	45.4	52.6	58.9
Sonora	20.3	24.1	27.7	31.2	32.6	34.1	35.7
Chihuahua	21.3	24.0	27.1	30.2	33.0	36.1	39.4
Coahuila	21.0	23.3	25.7	28.3	31.5	34.4	37.1
Nuevo Leon	53.9	60.6	68.3	56.6	66.2	74.7	82.4
Tamaulipas	26.5	29.5	32.8	37.6	43.5	47.4	50.3

CONCLUSIONS

As a result of these state-level GHG inventory and forecast projects, states are gaining an understanding of important contributing source sectors. For states that have begun climate change mitigation planning, the inventories and forecasts are important inputs to inform the types of policies and the stringency needed to meet reduction goals. These results will also be important sources of information regionally for climate change mitigation planning purposes both within Mexico, as well as across North America.

REFERENCES

1. Luege, J.L. *México Tercera Comunicación Nacional Ante la Convención Marco de las Naciones Unidas Sobre el Cambio Climático*. SEMARNAT-INE. México, DF. 2006; pp 33-74.

2. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. IPCC, 2007. http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

3. *Volume VIII: Estimating Greenhouse Gas Emissions of the Emission Inventory Improvement Program (EIIP) Document Series*, U.S. Environmental Protection Agency, Washington, DC, 2003.

4. Centro Mario Molina. *Inventario Estatal de Emisiones de Gases de Efecto Invernadero del Estado de Baja California 2005*. Prepared for the Secretaría de Protección al Ambiente del gobierno del estado de Baja California by Centro Mario Molina, México, DF, 2007.

5. CCS. *Greenhouse Gas Emissions in Sonora and Reference Case Projections 1990-2020*. Prepared for the Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora. CCS, Harrisburg, PA, 2008

KEY WORDS

Climate Change, Greenhouse Gases, Emissions Inventory, Emissions Forecast, Mexico, Border States, Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, Tamaulipas.

ACKNOWLEDGMENTS

CCS would like to acknowledge our team partners in these projects for all six border States:

Lic. Sócrates Bastida Hernández, Secretario
Secretaría de Protección al Ambiente del Gobierno del Estado de Baja California

Arq. Ángel López Guzmán, Director General
Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora

M.V.Z. Silvia Castro Arreola, Directora de Ecología
Secretaría de Desarrollo Urbano y Ecología del Estado de Chihuahua

Dr. Héctor Franco López, Secretario
Secretaría de Medio Ambiente y Recursos Naturales de Coahuila

Quím. José Luis Tamez Garza, Director General
Agencia de Protección al Medio Ambiente y Recursos Naturales en el Estado de Nuevo León

Ocean. Heberto Cavazos Lliteras, Director General
Dirección General de Medio Ambiente del Gobierno del Estado de Tamaulipas