Supplementary Information

**Sectoral assessment of greenhouse gas emissions in Pakistan**

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**Table S1: Net calorific values and CO2 emission factors by fuel types used for estimation**

|  |  |  |
| --- | --- | --- |
| Fuel | Net Calorific Value  (TJ/kt) | CO2 Emission Factor  (t CO2/TJ) |
| Crude oil | 41.99 | 72.60 |
| Motor gasoline | 44.84 | 68.61 |
| Jet Kerosene | 43.32 | 70.79 |
| Gas/Diesel oil | 44.18 | 73.33 |
| Residual fuel oil | 40.85 | 76.59 |
| LPG | 45.41 | 62.44 |
| Naphta | 44.84 | 72.60 |
| Coking coal | 27.65 | 92.71 |
| Sub bit. Coal | 18.81 | 94.15 |
| Natural gas | 39.77 | 55.82 |

Source: (HDIP, 2013; IPCC, 1997)

**Table S2: GHG inventory comparison between 1994 and 2012**

|  |  |  |  |
| --- | --- | --- | --- |
| GHG emissions | 1994 | 2012 | CAGR (%) |
| Carbon dioxide (Tg CO2eq) | 94.97 | 178.80 | 3.6 |
| Methane (Tg CO2eq) | 72.27 | 107.27 | 2.2 |
| Nitrous Oxide (Tg CO2eq) | 11.00 | 80.60 | 11.7 |
| TOTAL (Tg CO2eq) | 178.24 | 366.67 | 4.1 |

**Table S3: A comparison of emissions by sector between 1994 and 2012**

|  |  |  |  |
| --- | --- | --- | --- |
| Sectors | 1994 | 2012 | CAGR (%) |
| Energy (Tg CO2eq) | 84.31 | 165.13 | 3.8 |
| Industrial Processes (Tg CO2eq) | 11.30 | 19.41 | 3.1 |
| Agriculture (Tg CO2eq) | 71.61 | 161.91 | 4.6 |
| Land Use Change and Forestry (LUCF) (Tg CO2eq) | 6.57 | 9.67 | 2.2 |
| Wastes (Tg CO2eq) | 4.45 | 10.55 | 4.9 |
| Total (Tg CO2eq) | 178.24 | 366.67 | 4.1 |

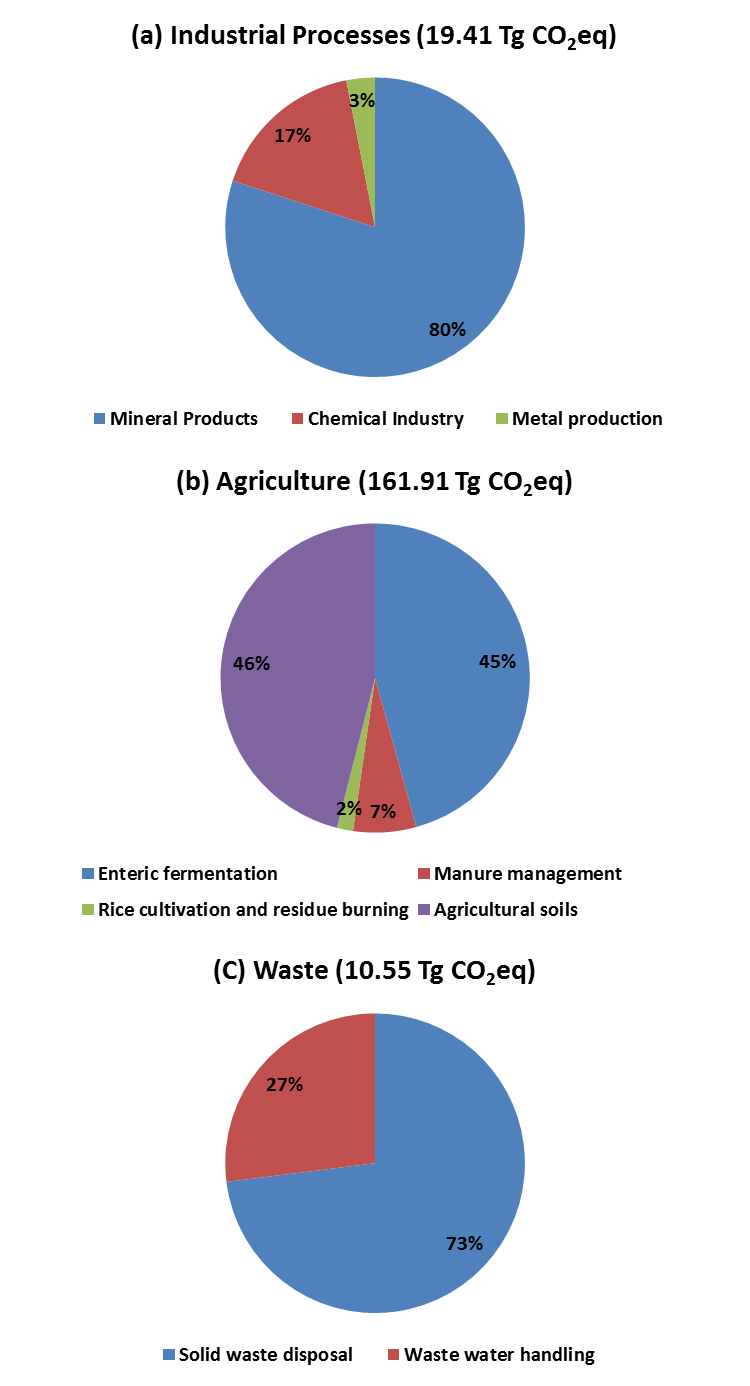
**Table S4: Comparison of per capita emissions and emission intensity**

|  |  |  |  |
| --- | --- | --- | --- |
|  | 1994 | 2012 | CAGR (%) |
| Total GHG emissions (Tg CO2eq) | 178.24 | 366.67 | 4.1 |
| Population (million) | 117.93 | 179.20 | 2.4 |
| Total GHG emissions (tonnes of CO2 equivalent per capita) | 1.51 | 2.05 | 1.7 |
| GDP at constant factor cost in billion US$ of 2000 | 60.02 | 122.34 | 4.0 |
| Total GHG emissions (kilogram of CO2 equivalent) per $ GDP in US$ of 2000 | 2.97 | 3.00 | 0.1 |

Source: (UNFCCC, 2003; MoF, 2011, 2012a-b, 2013, 2014; World Bank, 2012)

**Table S5. Main contributors to Pakistan's CO2 equivalent GHG emissions, 2012**

|  |  |  |
| --- | --- | --- |
| Source categories | Percentage share | Main emission sources |
| Power generation | 13 | Power (oil); Power (gas) |
| Manufacturing industries | 10 | Fertilizer; Cement; Brick Kiln; Iron and Steel; General industry |
| Transport | 10 | Highly dispersed and mobile |
| Mineral products | 4 | Cement production |
| Livestock | 23 | Highly dispersed |
| Synthetic fertilizer use | 20 | Highly dispersed |
| Solid waste disposal | 2 | Highly dispersed |
| Other sources | 18 | Varied and dispersed |
| Total | 100 | As above |



**Figure S1: GHG emissions from (a) industrial processes, (b) agriculture, and (c) waste sector**

**References**

HDIP, (2013): Pakistan Energy Yearbook 2012, Hydrocarbon Development Institute of Pakistan, Ministry of Petroleum and Natural Resources, Government of Pakistan, Islamabad.

IPCC, (1997): Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [J.T. Houghton, L.G. Meira Filho, B. Lim, K. Treanton, I. Mamaty, Y. Bonduki, D.J. Griggs, and B.A. Callander (eds.)]. Intergovernmental Panel on Climate Change, Meteorological Office, Bracknell, United Kingdom.

MoF, (2011). Annual Report 2010-11 (State of the Economy).Government of Pakistan, Islamabad (Available at: [www.sbp.org.pk/reports/annual/](http://www.sbp.org.pk/reports/annual/)).

MoF, (2012a). Annual Report 2011-12 (State of the Economy).Government of Pakistan, Islamabad (Available at: [www.sbp.org.pk/reports/annual/](http://www.sbp.org.pk/reports/annual/)).

MoF, (2012b). Pakistan Statistical Year Book 2012, Pakistan Bureau of Statistics, Government of Pakistan, Islamabad (Available at: [www.pbs.gov.pk/content/pakistan-statistical-year-book-2012](http://www.pbs.gov.pk/content/pakistan-statistical-year-book-2012))

MoF, (2013). Annual Report 2012-13 (State of the Economy).Government of Pakistan, Islamabad (Available at: [www.sbp.org.pk/reports/annual/](http://www.sbp.org.pk/reports/annual/)).

MoF, (2014). Pakistan Economic Survey (2013-14), Ministry of Finance (MoF), Government of Pakistan, Islamabad (Available at: [www.finance.gov.pk/survey\_1415.html](http://www.finance.gov.pk/survey_1415.html)).

UNFCCC. 2003. Pakistan’s Initial National Communication on Climate Change. United Nations Framework Convention on Climate Change (UNFCCC), Bonn (Available at: unfccc.int/resource/docs/natc/paknc1.pdf).

World Bank, (2012). World Bank National Accounts Data 2012. The World Bank Group, Washington, D.C. (Available at: <http://databank.worldbank.org/data/databases.aspx>).