ABSTRACT

Livestock farming is one of the significant anthropogenic sources of greenhouse gases (GHGs). Among the GHGs emitted from the livestock, CH$_4$ and N$_2$O are the two main components with CH$_4$ being emitted in significant quantity. Major regional contribution to the livestock CH$_4$ emission flux comes from India, China, Brazil and US. In fact, India, with largest livestock population in the world (nearly 500 million), contribute 10-15 Tg yr$^{-1}$ of CH$_4$ through enteric fermentation. Therefore, the projection of CH$_4$ emission from livestock and its implication on the environment is critically important. The assessment of climate damage and monetization of damage of CH$_4$ emission estimation should help for effective design of climate change mitigation policies.

The objective of the present thesis is to study CH$_4$ emission from livestock in India and assess its impact. Baseline CH$_4$ emission estimation, future projection, and its mitigation scenarios are developed. The study comprised of the development of system dynamic models for CH$_4$ estimation. Its projection for 25 year period (2007-2032) and economic damage estimation for policy tools, i.e. social cost of carbon (SCC) presented in the thesis. Detailed emission estimation with a spatial map for CH$_4$ emission in India is represented by a geographical map with the help of GIS tool. Different climate metrics such as Global Warming Potential (GWP), Global Temperature Change Potential (GTP), and Absolute Global Surface Temperature Change Potential (AGTP) are also used here. The SCC development is based on Integrated Assessment Model (IAM). An IAM used for monetization of damage caused by GHG emissions.

For the baseline scenario the livestock CH$_4$ emission worked out to 15.3 Tg yr$^{-1}$ for the year 2012. GTP of CH$_4$ emission attributed by livestock was 1030 Tg CO$_2$e (GTP$_{20}$) and 62 Tg CO$_2$e (GTP$_{100}$) at 20 and 100 year time horizon, respectively. Its contribution to the surface
temperature rise would be 0.70 m Kelvin and 0.036 m Kelvin over 20 and 100 year time period, respectively. Annual CH₄ emission cause surface temperature peaks 0.9 m Kelvin in the year 2021. Thus AGTP gives important information in terms of actual temperature change due to annual CH₄ emission. Projection of CH₄ emission under different growth scenario suggest that in modified scenario less CH₄ emitted which is only 16-33% increase in CH₄ emission will occur against 98% for baseline scenarios, from 2007 to 2032. Temperature impact on business as usual (BAU) is greater than those for modified scenario due to high CH₄ emission in BAU. In the modified scenarios, mitigation potential could be up to 38.77% to 32.65 %. Monetization of damage estimation in term of SCC of CH₄ from livestock worked out to: SCC of CH₄ $62 - $1151 CO₂e in 2032. Highest SCC is in BAU and lowest in MS I. High SCC suggests that even a small increase in CH₄ emission can lead to high negative impact on the environment.

This study gives a significant contribution to science by understanding CH₄ emission from livestock trend in future and impact analysis in climate as well as on damage estimation on the environment. The main contribution of the work can be summarized in the following points: (1) development of a system dynamic model for GHGs emission estimation and projection, which can be applicable to other sector for GHGs emission estimation and projections (2) it provides a detailed CH₄ emission inventory/database for India up to district level, (3) projection of future emission and impact on climate change, (4) impact of CH₄ emission in surface temperature response using GTP, AGTP and (5) a IAM developed to estimate SCC of non-CO₂ GHGs, and (6) range of climate change induced-economic damage reduction scenarios in terms of SCC to guide robust mitigation policy making. However, we recommend that other GHGs emission estimation, its projection and impact assessment should further be extended to understand the trend of other GHGs emission from livestock.