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Biogas Plants' Distribution and Balance Development in Nepal: A World System Perspective

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Abstract:
Background: Nepal has over a half century history of promoting domestic biogas. Over 290,902 biogas plants were installed throughout the country till the end of fiscal year 2012/13. The trend of biogas development in Nepal is encouraging over the year.
Objective: This paper aims at examining biogas plants' distribution and balance development in Nepal through world system perspective.
Methodology: The results have been estimated by using secondary data of FY 1992/93 to 2012/13. The data have tabulated and analyzed through applying the simple statistical techniques of analysis and world system perspective.
Results: Biogas plants' penetration is high in periphery area than others at greater extent. The plants' distribution in periphery area of Nepal has been increasing over the years in case of biogas. Moreover, there is positive correlation between total biogas plants constructed throughout the nation and plants constructed in periphery and semi-periphery area of Nepal while negative correlation of total biogas plants constructed throughout the nation with plants constructed in core area.
Conclusion: Biogas contributes for balance development by mobilizing more resources including subsidy to semi-periphery and periphery areas of Nepal. In general assumptions of the world system perspective, resources are less mobilized for periphery area as well as core area exploits semi-periphery and periphery area; however, it is different in case of biogas plants' distribution in Nepal. It means that the world system perspective is not applicable all sector and part of the world.

Keywords: *Balance Development, Biogas Plants, World System Perspective*

1. Introduction

Energy is necessary for daily survival (World Commission on Environment and Development, 1987). Energy is an essential ingredient of socio economic development and economic growth (Goldemberg, 1996). Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat (Wikipedia). Whereas non renewable energy is energy that comes from resources which are not continually replenished such as coal, petroleum fuels and fuel wood etc. Those non-renewable sources of energy are also taken as traditional sources of energy. About 16 percent of global energy consumption comes from renewable resources, with 10 percent of all energy from traditional biomass, mainly used for heating, and 3.4 percent from hydroelectricity. New renewable energy (small hydro, modern biomass, wind, solar, geothermal, and bio-fuels) accounted for another 3 percent and are growing very rapidly. The share of renewable energy in electricity is around 19 percent, with 16 percent of electricity coming from hydroelectricity and 3 percent from new renewable (Wikipedia). Reliable and sustainable supply of energy is the basic needs of the people for meaningful life including cooking, lighting and economic activities.

Moreover, fuel crisis exists also in the supply of traditional sources of energy (firewood). Beside, increasing population pressures means that fuel wood from forest, in most part of the country is now being used faster than it can be replenished by natural growth or re-plantation. This demand for wood, coupled with commercial exploitation of trees for construction, pulping and other uses, mean that the forests are being destroyed at an alarming high rate. As a result, it is as usual that people lose out in two ways: not only cannot they develop, because of high cost of petroleum fuel, but also their traditional life-style is threatened as fuel wood is becoming less available day by day.

To cope up with the increasing pace of population growth in Nepal, production of food grains need to be increased. For that, more land needed to be used for agriculture. More fertilizers must be used to maintain fertility of soil and enhance the agricultural productivity. These demands make the fuel problem even worse, as new agricultural land must come from the forests. As wood becomes less available, people turn to other fuels, such as dried cattle dung and agricultural residues, which could be used for organic fertilizer.

View in this perspective, renewable energy is important alternative for sustainable development. In such circumstances, Nepal has very high potential to exploit the renewable energy particularly biogas at greater extent. The energy sector of Nepal is characterized by a very heavy reliance on traditional resources that contribute to more than 85 percent of the total energy

consumption (AEPC, 2012, p. 1). Renewable energy technologies such as biogas, solar and micro-hydro are widely promoted in Nepal and biogas only considered for this study. The use of renewable energy can reduce the dependency on traditional sources of energy.

Among others, biogas is the mixture of different gases produced by methanogenic bacteria feeding on bio-degradable materials in anaerobic (without oxygen) conditions. Biogas is 50-70 percent methane and 30-40 percent carbon dioxide (BSP-Nepal). It also contains small amount of other gases. Biogas is about 20 percent lighter than air. It is odorless and colorless and burns with a clear blue flame similar to that of LPG. Its calorific value is about 20 MJ per m^3 and it burns with 60 percent efficiency in a conventional biogas stove. Over 290,902 biogas plants were installed throughout the country till the end of fiscal year 2012/13 (BSP-Nepal, 2012). The trend of biogas development in Nepal is encouraging over the year.

Nepal has over a half century history of promoting domestic biogas. The history of biogas in Nepal goes back to 1955 AD in which the biogas technology was first introduced at St. Xavier School, Godawari, Lalitpur by late father B.R. Saubolle. Thereafter, Government of Nepal (GoN) started biogas program mainly as the technology for high quality organic manure production and with potential to reduce fire wood consumption in Fiscal Year (FY) 1974/75. More and more development oriented agencies started getting involved in this technology. In 1977 a private company called Gobar Gas and Agricultural Development Company (GGC) started its program in close cooperation with Agricultural Development Bank Ltd. (ADBL) mobilized resources from various donor agencies for building awareness and technical capability in the country. To meet the ever growing demand for biogas plants and services, GGC also worked with Non Government Organizations (NGOs), and Community Based Organization (CBOs). In order to expedite the progress rate towards achieving the biogas potential of Nepal, Biogas Support Program (BSP) was launched in 1992, in collaboration with ADB/N and GGC with the grant support from Netherlands Development Organization (SNV/Nepal). Biogas Program came under the umbrella of Alternative Energy Promotion Center (AEPC) in 1996. As the result, biogas plant installation was rapidly increased after the end of nineties. Biogas program developed and resisted as a first CDM project in Nepal as well.

There are several studies on biogas conducted in Nepal and beyond. A study by White (2005) concluded that biogas as an alternative energy to help develop China's agriculture oriented rural economy. Ghimire T. (2006) found that the overall energy, environmental and economic condition had been improved with biogas. Subedi (2006) showed higher standard of living, higher productivity and reduces pressure on traditional natural fuel resources are the main benefit of biogas and reduction on the work load of women.

In addition to Arthur, Baidoo, & Antwi (2011) found that the associated harmful environmental, health and social effects with the use of traditional biomass and fossil fuel has enhanced the growing interest in the search for alternate cleaner source of energy globally. Likewise, Yadav (2012) reveal**ed the significant role of biogas for sustainable development in Nepal.** The study also concluded that **the vital role of biogas to mitigate climate change and for quality of life. Another study by** Adhikary (2012) dealt with green economy in pursuance of sustainable development and nature for an improved and sustained quality of life.

The studies have been conducted in Nepal and abroad reveal the fact that role of biogas is vital for development including environmental protection and other benefits. The studies conducted in Nepal either focus on technical aspects or environment aspects of biogas and less focusing on balance development. The applicability of these facts is yet to be seen in the context of Nepal. In this context, a sociological study of biogas is considerable to investigate. The study then concentrates its attention to assess role of biogas plants' distribution for balance development. To sum up, the study deals with the following issues: Does biogas plants' distribution play significant role for balance development? Are biogas plants distributed in all core, semi periphery and periphery of Nepal as per world system perspective? Does core area have larger number of biogas than semi-periphery and periphery area of Nepal?

2. Objectives of the Study

The main objective of this study is to examine the role of biogas plants' distribution for balance development in Nepal through world system perspective. Its specific objectives are as follows:

- To assess biogas plants' distribution in core, semi-periphery and periphery area of Nepal.
- To analyze trend of biogas plants' distribution in core, semi-periphery and periphery area of Nepal.
- To evaluate correlation of total plants constructed throughout Nepal with plants constructed in core, semi-periphery and periphery areas of Nepal.

3. World System Perspective

World-systems theory (also known as world-systems analysis or the world-systems perspective) is a multidisciplinary, macro-scale approach to world history and social change that stresses that the world-system (and not nation states) should be the primary (but not exclusive) unit of social analysis (Barfield, 1997). The best known version of the world-systems approach has been developed by Immanuel Wallerstein (Halsall, 1997). Wallerstein notes that world-systems analysis calls for an unidisciplinary historical social science, and contends that the modern disciplines, products of the 19th century, are deeply flawed because they are not separate logics, as is manifest for example in the de facto overlap of analysis among scholars of the disciplines (Barfield, 1997).

World-system refers to the inter-regional and transnational division of labor, which divides the world into core countries, semi-periphery countries, and the periphery countries (Barfield, 1997). Core countries focus on higher skill, capital-intensive production, and the rest of the world focuses on low-skill, labor-intensive production and extraction of raw materials (Lechner, 2001). This constantly reinforces the dominance of the core countries. Nonetheless, the system is dynamic, in part as a result of

revolutions in transport technology, and individual states can gain or lose the core (semi-periphery, periphery) status over time (Lechner, 2001).

Wallerstein characterizes the world system as a set of mechanisms which redistributes surplus value from the periphery to the core. In his terminology, the core is the developed, industrialized part of the world, and the periphery is the "underdeveloped", typically raw materials-exporting, poor part of the world; the market being the means by which the core exploits the periphery. It means core area is developed part of the world while semi-periphery and periphery area are the underdeveloped part of the world.

4. Data and Methods

In order to conduct this study, descriptive cum analytical research design has been adopted. Descriptive research design has been utilized mainly for conceptualization of the problem. Analytical research design has been followed mainly to analyze the results. This study is based on secondary data only. In order to achieve the objectives of the study, the data have been collected from the database of Biogas Sector partnership-Nepal (BSP-Nepal). This study has used cross-sectional data of Nepalese biogas sector for the period of 1992/93 to 2012/13 as mentioned in Annex-1. The annual data obtained **from the database of BSP-Nepal has tabulated and analyzed** through applying the simple statistical techniques of analysis such as table, percentage, graphs, and correlation coefficient (r). Besides that world system perspective has been employed in the study in order to examine biogas plants' distribution in Nepal to assess its contribution for balance development.

5. Empirical Results

This session is based on world system perspective. Wallerstein characterizes the world system as a set of mechanisms which redistributes surplus value from the semi-periphery and periphery to the core area of the world. In his terminology, the core is the developed, industrialized part of the world, and the periphery is the "underdeveloped", typically raw materials-exporting, poor part of the world; the market being the means by which the core exploits the semi-periphery and periphery.

Biogas plants' distribution has been determined through applying world system perspective to assess the contribution of biogas for balance development. In order to employ this theory, Nepal has divided into core, semi-periphery and periphery area. View in this perspective, core consisted of all metropolitan city and sub-metropolis, semi-periphery comprised of all municipalities and periphery area has included all VDCs of Nepal. The summary of plants distribution in Nepal as per world system perspective is given Table-1.

Categories	Core	Semi-periphery	Periphery	Total
Basis of area division	All metropolitan city and sub-metropolis	All municipalities	All VDCs of Nepal	Nepal
Plants	2,371	33,101	255,430	290,902
Percent	0.82	11.38	87.81	100

Table 1: Summary of Plants Distribution in Nepal as per World System Perspective
Source: Annex-1

Table-1 shows biogas plants' distribution in core, semi-periphery and periphery area of Nepal. This consists of plant distribution in both number and percentage. This distribution has also shown in Figure-1.

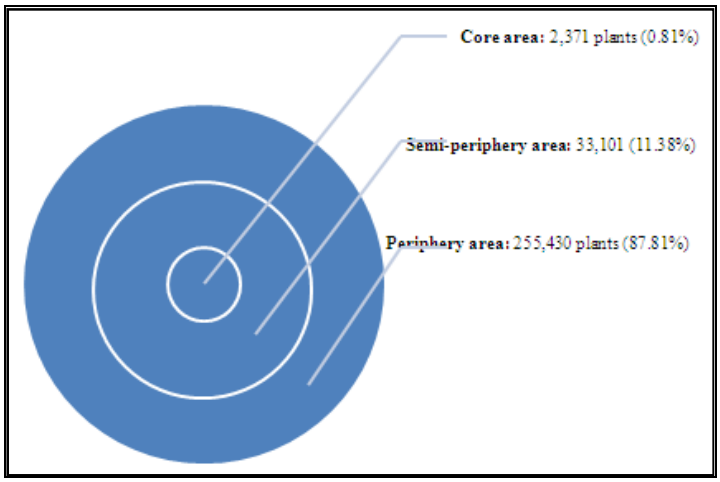

Figure 1: Biogas plants' distribution in core, semi-periphery and periphery areas of Nepal
Source: Annex-1

Table 1 and Figure 1 represent the penetration of biogas plans in Nepal. Plants' distribution in core area of Nepal is only 0.81 percent while semi-periphery area has 11.38 percent of biogas plants. However, periphery area has 87.81 percent of biogas plants

which is highest distribution of biogas plants. It means that biogas penetration is high in periphery area. Periphery area is undeveloped part of nation in compare to core and semi-periphery area of Nepal. In general, resources are less mobilized for periphery area; however, it is reverse in case of biogas plants' distribution in Nepal.
Moreover, the trend of biogas plants' distribution in core, semi-periphery and periphery area of Nepal is given in Figure 2 based on Annex-1.

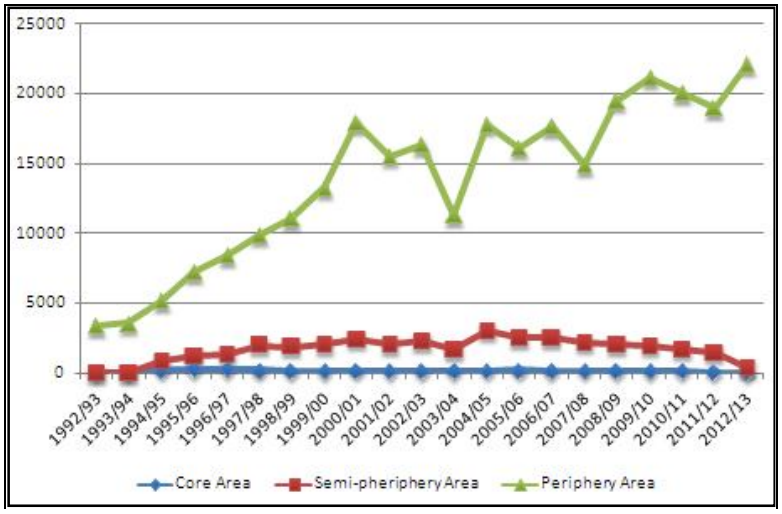

Figure 2: Trend of biogas plants' distribution in core, semi-periphery and periphery area of Nepal
Source: Annex-1

The trend of biogas plants' distribution in core and semi-periphery areas is decreasing while the trend in periphery area is increasing. It means resources distribution including subsidy from government of Nepal to periphery area has been increasing over the years in case of biogas in Nepal. This result contradicts with general assumptions of the world system perspective. In general assumptions of the world system perspective, resources are less mobilized for periphery area as well as core area exploits semi-periphery and periphery area; however, it is reverse in case of biogas plants' distribution in Nepal. It means that the world system perspective is not applicable all sector and part of the world. The results show that biogas contributes for balance development by mobilizing more resources to periphery area.
Table-2 shows the correction among the variables. The correlation coefficient (r) between total biogas plants and plants in core area is -0.04. It means that there is very low degree of negative correlation between them. It means total plants and plants in core area move in the opposite direction. However, the correlation coefficient (r) between total biogas plants and plants in semi-periphery area is 0.58. It means that there is high degree of positive correlation between them. It means that total plants and plants in semi-periphery area move in the same direction.

SN	Region	Correlation with Total Plants
1	Core Area	(0.04)
2	Semi-periphery Area	0.58
3	Periphery Area	0.99

Table 2: Correlation of Total Plants Constructed throughout Nepal with Plants Constructed in Core, Semi-periphery and Periphery Areas of Nepal
Source: Annex-1

Likewise, the correlation coefficient (r) between total biogas plants and plants in periphery area is 0.99. It means that there is very high degree of positive correlation between them. It means total plants and plants in periphery area move in the same direction. It has about perfect correction between them. If total plants increase then the plants in periphery and semi-periphery area also increases and vice versa. It means that there is positive relation between total biogas plants constructed throughout the nation and plants constructed in periphery and semi-periphery area of Nepal that contribute in the balance development. This result supports the result of preceding analysis of the study.

6. Conclusion
The results of the empirical analysis lead to the important conclusions. ***First***, biogas plants' penetration is high in periphery area than others at greater extent. Plants' distribution in core area of Nepal is only 0.81 percent while semi-periphery area has 11.38 percent of biogas plants. However, periphery area has 87.81 percent of biogas plants. ***Second***, the resources distribution to periphery area than core and semi-periphery areas of Nepal has been increasing over the years in case of biogas. The trends of biogas plants' distribution in core and semi-periphery areas are decreasing while the trend in periphery area is increasing.

Moreover, there is positive correlation between total biogas plants constructed throughout the nation and plants constructed in periphery and semi-periphery area of Nepal that contribute in the balance development. On the other hand, there is negative correlation of total biogas plants constructed throughout the nation with plants constructed in core area. ***Finally***, the results show that biogas contributes for regional balance by mobilizing more resources to periphery area that leads to balance development of the nation. In general, resources are less mobilized for periphery area as well as core area exploits semi-periphery and periphery area; however, it is reverse in case of biogas plants' distribution in Nepal. It means that the world system perspective is not applicable all sector and part of the world.

There are *several avenues* for future research in the area of the role of biogas for regional balance in Nepal. *One* extension of the present study is to use a comparison of biogas with other renewable energy technologies in case of balance development. A *second* research avenue is to make study by adding qualitative variables that are correlated with balance development to get greater insight into the results. A *final* avenue of research is to survey the opinions of experts and stakeholders on the role of biogas for balance development in Nepal.

7. Acknowledgements

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Fiscal Year	Number of Plants			
	Core Area	Semi-periphery Area	Periphery Area	Total
1992/93	0	0	3,318	3318
1993/94	0	0	3,506	3506
1994/95	182	679	4,254	5115
1995/96	217	987	5,953	7157
1996/97	191	1153	7,043	8387
1997/98	163	1848	7,858	9869
1998/99	120	1756	9,176	11052
1999/00	101	1938	11,226	13265
2000/01	146	2290	15,421	17857
2001/02	89	1943	13,495	15527
2002/03	112	2151	14,077	16340
2003/04	70	1587	9,602	11259
2004/05	156	2891	14,756	17803
2005/06	173	2342	13,603	16118
2006/07	123	2389	15,151	17663
2007/08	144	2046	12,694	14884
2008/09	121	1898	17,460	19479
2009/10	111	1832	19,215	21158
2010/11	94	1647	18,315	20056
2011/12	46	1428	17,505	18979
2012/13	12	296	21,802	22110
Total	**2,371**	**33,101**	**255,430**	**290,902**

Annex 1: Biogas Plants' Distribution in Core, Semi-periphery and Periphery Area of Nepal
Source: The Database of BSP-Nepal

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